ENVIRONMENTAL IMPACT OF EDTECH: THE HIDDEN COSTS OF DIGITAL LEARNING

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FOREWORD

Facing up to the environmental impact of EdTech

The ever-growing presence of digital technologies in education is intimately connected to many “big picture” issues. Everyone involved in EdTech now has to reflect on their work in ways that might seem extraneous at first glance, yet are utterly integral to the long-term significance and impact of what we do. There are a lot of connections that need to be made. For example, how is EdTech implicated in the continued corporate takeover of public education? How does EdTech articulate with the worldwide resurgence of populism, nationalism, and far-right politics? How do we explain the apparent failure of EdTech to impact on sustained patterns of poverty, social inequality, and injustice that blight all societies?

Yet perhaps the most difficult – but arguably most critical - connection is rethinking EdTech in light of ongoing environmental breakdown and climate collapse. As this report admirably demonstrates, everyone involved in EdTech needs urgently to engage with the environmental implications of their work. In short, how can we progress toward future forms of digital technology use in education that are fit for purpose in an eco-compromised and resource-constrained world?

Thinking about EdTech along environmental lines opens up a host of different directions, debates, reactions, and responses. On one hand, many people in the EdTech sector might well be drawn to the possible reinvention of “green” forms of educational technology use. Indeed, it is well worth considering how digital technologies might play a part in supporting less environmentally impactful forms of education provision, or perhaps offering ways of coping with climate-related disruptions to conventional forms of schooling. For example, how might digital technologies be part of “emergency” efforts to ensure educational continuity in a world of increasingly frequent climate-related disruptions? Similarly, how might digital technologies be used to support education provision for growing numbers of people forced into climate-forced migration?

On the other hand, it is also important to contemplate the need for less EdTech in light of the clear environmental harms associated with the use of digital technologies. For instance, the energy and resource demands of AI and other data-driven computing seem to be fast becoming unsustainable – not least because of a data centre industry that depends on excessive amounts of electricity and water consumption. At the same time, the manufacturing of computing hardware carries on depleting planetary supplies of rare metals and minerals, while the disposal of digital devices continues to result in toxic e-waste being dumped onto some of the poorest parts of the world. When seen in these terms, it is increasingly difficult to justify the ways that many education systems in Europe, North America and parts of East Asia have come to depend on a state of "always-on" and "in-the-cloud" digital excess that hardly seems sustainable, let alone ethically sound.

So, it is high time to start talking about EdTech at a planetary-scale and engage in some serious discussions around what the continued use of digital technology might look like in the forthcoming decades. Is it possible to develop genuinely "green" forms of EdTech … or do we need to radically scale-back and slow-down levels of digital technology consumption in education? Of course, these environmental challenges are not unique to education – and there are certainly other areas of society that also need to quickly face up to these issues. Nevertheless, schools, colleges, and universities are ideally-placed to begin addressing the environmental implications of digital technology – leading by example and inspiring their students, teachers, local families and communities to reassess the environmental impact of their own digital technology consumption.

It is becoming increasingly apparent that education needs to radically rethink its relationship with digital technology. That said, there are no easy answers or clear solutions to any of the problems, concerns, and tensions raised in this report. The future is essentially unknowable – these are not trends that can be neatly predicted, forecast and addressed. Instead, deciding on what future forms of environmentally appropriate EdTech might look like needs to be the focus of serious discussion and debate. It is important that these conversations begin to take place as soon as possible. This report is a great place to start!

Neil Selwyn, Professor in the Faculty of Education, Monash University
Melbourne, September 2024

1. Introduction

As we embrace the digital age, the growing Educational Technology (EdTech) industry has fundamentally transformed the global educational landscape, with a focus on developing innovative tools aimed at enhancing learning experiences and improving accessibility.offering innovative tools that enhance learning and accessibility. From interactive learning platforms and digital textbooks to virtual classrooms and AI-driven personalised learning experiences, EdTech solutions have become increasingly integral to educational systems across all levels. This digital revolution has not only enhanced accessibility and flexibility in education but has also been accelerated by recent global events, such as the COVID-19 pandemic, which necessitated swift transitions to remote and hybrid learning models.

EdTech is less often associated with environmental considerations; typically, discussions focus on the potential environmental benefits such as reducing paper consumption and lowering the carbon footprint associated with commuting to schools and colleges. However, this rapid expansion of technology brings along significant environmental risks that cannot be ignored. Selwyn (2021, p. 502) notes, “there is nothing ‘virtual’ or ‘artificial’ about digital technology,” meaning that producing, consuming, and disposing of educational technology has material impacts including resource utilisation, energy consumption, and electronic waste generation.

As global awareness of climate change and sustainability grows, industries across the board are being held accountable for their environmental practices, and EdTech is no exception. Environmental responsibility should be integrated into EdTech’s practices, processes, and learning content design. Policy-makers and decision-makers need to drive this integration, rather than placing the burden on users, such as teachers or children, to verify the environmental impact of EdTech tools. However, ultimately, it is the responsibility of EdTech companies to ensure their product and services are environmentally sustainable. Additionally, institutional leaders within the education sector bear significant responsibility in the selection and implementation of EdTech tools.

Recently, after winning her second term as the European Commission president in July 2024, Ursula von der Leyen declared in her plenary at the European Parliament that within her first 100 days, she will put forward a new lean Industrial Deal to channel investment into green tech. Simultaneously, she plans to launch an investigation into the effect of digital media on student wellbeing (von der Leyen, 2024). This aligns closely with the Global Digital Compact, introduced by the UN Secretary-General's Common Agenda in 2021 (UN, 2021), now in its second revision (UN, 2024). One of its key principles emphasises the need for environmentally sustainable technologies:

> "Digital technologies unlock new capabilities and opportunities for measuring, monitoring and solving environmental challenges and implementing multilateral environmental agreements. The infrastructure required to deliver digital goods and services already consumes substantial resources and produces significant carbon emissions as well as e-waste. Our cooperation will leverage digital technologies for sustainability while minimising their negative environmental impacts" (UN, 2024, p. 2).

This principle speaks to the fact that climate change has accelerated over the past forty years more than three times, with global temperature rising more than 1°C. Global, large-scale weather-related disasters may seem unrelated to EdTech but they are causing massive disruption in learning for all age groups all over the world, while disproportionately affecting systematically excluded communities and students in particular geographical locations. Some statistics, for example, suggest that "1.2 billion children – half of all children globally – live in places that have high risk of flooding, severe drought, or other climate shocks" (Green & Voutilainen, 2024, p. 9).

The dual focus on the benefits of digital technologies and environmental sustainability is rare in contemporary policies and practice. This report aims to address this gap and spotlight the often-overlooked environmental impact of tech industries, and specifically EdTech, and the need for digital transformation to align with sustainability goals. This report is fifth in the report series led by the WiKIT Research group, in which researchers discuss five impact issues relevant to holistic evaluation of EdTech, under the umbrella of the 5Es framework (Kucirkova, 2023, 2024): Effectiveness and Efficacy (Kucirkova, Lindroos Cermakova & Vackova, 2024), Ethics (Atabey et al. 2024), Equity (Lindroos Cermakova, Prado & Kucirkova, 2024), and Environment (this report).

2. Why green EdTech matters: The report's objectives

This report aims to provide a comprehensive perspective on EdTech and environment by summarising existing literature on the environmental impact of EdTech, with particular attention to issues raised in academic literature and grey literature, which includes reports, policy literature, working papers, newsletters, government documents, speeches, and white papers, and by mapping the position of EdTech industry representatives. The goal of the report is to propose some aspirational principles for the EdTech industry to guide and potentially improve the scope of their environmental impact, as well as to guide educational leaders in their evaluation of EdTech systems and tools.

By EdTech, we refer to educational technology, that is technology designed with the specific intention to educate and support learning and teaching. Examples include apps, e-books, learning platforms and management systems used in schools and homes.

We conceptualise 'environment' by highlighting sustainability, which entails the ability to endure over time. Environmental sustainability refers to the responsible management of resources to ensure that current and future generations can continue living without compromising the health of the natural environment and maintaining ecological balance (see, e.g., European Environment Agency, 2024). This is broader than 'climate resilience', which focuses on adaptation and mitigation strategies (see also Section 4). Sustainable practices go beyond mitigation strategies by focusing on changes in our behaviour that aim to reduce environmentally damaging practices by offering more sustainable alternatives. For both approaches, climate change awareness and understanding is crucial.

Environmental concerns are increasingly being acknowledged institutionally, and noteworthy initiatives are also arising on a voluntary basis. For example, the Wellcome charity in the UK has co-developed a voluntary environmental sustainability 'Concordat' in the UK research and innovation sector that "represents a shared ambition for the UK to continue delivering cutting-edge research,

but in a more environmentally responsible and sustainable way". Currently, signatories include the British Academy, Cancer Research UK, and many UK universities.

Nam and Lee (2021) advocate for a model where students act as partners in implementing climate change education. They emphasise that education plays a crucial role in addressing climate change by empowering students to understand and respond to climate challenges. They advocate for educational initiatives that can foster a grassroots movement among students, empowering individuals to engage in community-based actions that contribute to broader systemic changes in environmental sustainability and mindsets. They propose a paradigm where students are not just recipients of climate education but active partners in shaping climate action initiatives. Based at the Harvard Graduate School of Education, the authors advocate for integrating climate change education directly into operations of the educational institutions, emphasising the potential of students to drive local and societal changes through informed action and advocacy.

Environmental sustainability denotes the capability to minimise or avoid harm to the environment, ensuring long-term viability. This definition connects to the Triple S framework (Moro et al., 2023), which promotes scalable, sustainable, and serviceable practices and to our knowledge, it is the first framework to explicitly mention the environmental dimension of EdTech. It represents a strategic approach for educational institutions to effectively evaluate, adopt, and implement digital technologies. Central to the Triple S framework is sustainability, which emphasises the long-term viability and environmental impact of educational technologies. The Triple-S framework encourages institutions to select technologies that not only withstand the test of time but also minimise environmental harm by reducing e-waste and conserving resources. This sustainable approach ensures that technological investments remain beneficial and relevant, aligning with broader environmental goals. By incorporating sustainability into the evaluation process, this framework helps institutions make informed decisions that support both educational excellence and environmental stewardship.

EdTech, with its strong link to education, plays a crucial role in addressing environmental issues. It not only educates on environmental topics but also leads by example, as EdTech organisations can actively reduce and address environmental concerns through sustainable practices.

3. International context for digital and green education

UNESCO has been vocal about its desire to set the agenda for synthesising green and digital approaches to education. In their review of 100 countries, they note that around half had no mention of climate change in their national curriculum. While 95% of surveyed primary and secondary teachers felt that teaching about climate change is important, fewer than 30% expressed a readiness to teach it, and 70% of young people cannot explain climate change.

UNESCO's Greening Education Partnership is a global initiative that supports countries to address the climate crisis through education. It brings together governments, inter-governmental organisations, civil society, youth, academia, and the private sector to prepare learners with the knowledge, skills, values, and attitudes needed to tackle climate change and promote sustainable development. The UNESCO Greening Education Partnership tackles four key areas of transformative education: Greening Schools, Greening Learning, Greening Capacity & Readiness, and Greening Communities .

Greening Schools focuses on issuing green school accreditations, including teacher training and HE institutions. According to UNESCO, a green school is a learning institution that adopts a comprehensive approach to Education for Sustainable Development (ESD), addressing climate change through its teaching, facilities, operations, governance, and community partnerships. This whole-institution approach aims to empower all learners with the knowledge and skills needed for sustainable development by fostering collaboration, solidarity, and inclusive practices.

Greening Learning focuses on including climate education directly in the curriculum. It integrates climate mitigation and adaptation into all education levels, from pre-primary to tertiary, including teacher training. It highlights the links between the environment, economy, and society, engaging students' cognitive, socio-emotional, and behavioural skills to inspire sustainable actions.

Greening Capacity & Readiness focuses on specific teacher training in climate education, and **Greening Communities** focuses on life-long learning and community engagement.

While UNESCO's 'Greening education' message is framed as a set of objectives that have a potential of achieving more sustainable education, including educational technology, West (2023) cautions that the global effort during the COVID19 pandemic to find alternatives for classroom-based education triggered and scaled up harmful environmental impact. Educational sales of digital hardware to enable distant learning reached all-time highs in 2020 (West 2023, p. 250) and, for example, sale of Chromebooks that are often marketed as suitable alternatives for school use had an "unprecedented 90 per cent increase in the sale" in the third quarter of 2020 (West 2023, p. 251). Devices like laptops are resource-intensive to manufacture and mostly have very short life cycles; and their continually increasing demand for data processing and storage is energy intensive. As West (2023, 248-249) notes:

> "The beginning and end points of this process – resource extraction and device disposal – are very likely to carry serious environmental scars and take a heavy toll on a wide range of life forms. Before and during the pandemic, people, especially children and youth living in fragile and mineral-rich developing countries, were recruited to either mine raw materials for digital devices or scavenge technology dumps for materials that could be sold and reused, often to make more of the digital devices that education suddenly required. Huge upticks in technology production and use for education required power, and much of this power was sourced from fossil fuels."

This means that "while many children and youth experience digital technology as a dynamic portal to learning, others experience it as labour and a health hazard" as toxic, improperly discarded electronic waste gets dumped in the poorest parts of the world and "children as young as 5 years old are recruited or forced to scavenge these dumps for valuable parts and metals, many of them dangerous to handle without protective equipment" (West 2023, p. 256).

The United Nations Environment Programme (UNEP) is another global agency committed to sustainable digital transformation, which harnesses digital technologies to achieve environmental targets while mitigating the environmental risks associated with increasing digitalization. The Coalition for Digital Environmental Sustainability (CODES) is one of UNEP projects. CODES acts as a global alliance advocating for sustainability-centred digital transformation, proposes three core principles: "Enable Alignment to Sustainable Development," which calls for reorienting digitalization to support common sustainability goals; "Mitigate Harm with Sustainable Digitalization," which aims to reduce the negative environmental and social impacts of digital technologies; and "Innovate with Purpose," which encourages audiences to invest in digital innovations that advance sustainable development objectives. These principles are sufficiently broad and thus apply equally to the Educational Technology (EdTech) industry too.

OECD has published several policy and working papers directly focusing on education and environment. *Think Green* Policy paper (OECD, 2021) highlights the role of schools in raising environmental awareness and proposes three Ps "to green up education": focusing on pedagogy, procurement and partnerships. The procurement highlights the importance of considering "Energy-using products: procuring energy-efficient equipment, such as lighting and ICT, and limiting e-waste". The recently published OECD working paper *Rethinking education in the context of climate change* (Nusche, Fuster Rabella & Lauterbach, 2024) that has been prepared within OECD's Education Policies for a Sustainable Future project suggests approaches for increasing resilience of education systems through restructuring foundational science education and cross-curricular learning and by emphasising locality of learning.

There are numerous other noteworthy initiatives that suggest various approaches to tackling the daunting reality; for example, recently, 'Save the Children' and 'Sesame Workshop' have announced a partnership aimed at equipping children and their caregivers to navigate and thrive amidst the challenges posed by the climate crisis. This initiative, unveiled at the 27th Annual Milken Institute Global Conference in May 2024, underscores a commitment to enhancing children's climate resilience through digital tools and ensuring continued learning despite climate-related disruptions. By

leveraging Sesame Workshop's educational media reach and Save the Children's global footprint, the two organisations plan to develop new educational tools, implement community-based programs, and advocate for climate resilience integration in education systems worldwide.

Save the Children has further partnered with hundrED to publish *A Call for Action: Climate Resilient Education* (Green & Voutilainen, 2024). Climate resilience is defined as "the ability of individuals, communities, and societies to prepare for, recover from, and adapt to climate change impacts in ways that reduce vulnerabilities and promote children's rights" (Green & Voutilainen, 2024, p. 6). For education this is operationalised as focusing on risk reduction, environmental sustainability in education, (which aims to reduce negative environmental impacts created by schools), and climate change adaptation through which schools can "anticipate and prepare for climate change" (Green & Voutilainen, 2024, p. 7). While this call to action focuses on the process management of behaviours and emphasises resilience strategies, UNESCO's Greening Education Partnership approach in addition highlights the urgent need to integrate environmental concerns directly into curriculum and teacher training, focusing thus not only on resilience but also sustainability - with an ambitious target of 90% of countries having a 'green curriculum' by 2030 (UNESCO 2024).

4. Research on Environment and EdTech

Technologies have become integrated into educational systems worldwide, and EdTech solutions are widely used by learners to make learning more engaging, entertaining, and productive. At the same time, technological advancement always comes at a price, and the most prominent appears to be the environmental one. Understanding the influence of educational technology on the environment has never been more crucial, and the examination of this relationship can help all audiences evaluate their practices, values, and impact on our environmental situation.

EdTech can address environmental concerns in two major ways: 1) by "greening" the learning content they produce by developing, for example, resources about climate change, loss of biodiversity, and unsustainable use of resources, and/or 2) by "greening" the practices the company and education institutions adopt in their daily operations. While no. 1 contributes to raising climate awareness and aligns with the above discussed UNESCO and OECD identified needs, it is primarily no. 2 that brings about the most direct benefits to the environment. An EdTech organisation is just like any other organisation responsible for its carbon footprint and environmental attitudes. Despite their significant impact, however, the connection between EdTech and environmental impact has been discussed to a limited extent in the literature.

Two primary environmental considerations emerge for developers of educational technology: hardware and software. The mass production and consumption inherent in hardware necessitate that manufacturers meticulously assess the energy use and emissions associated with each device, both in the short and long term. Transparent reporting of these metrics empowers educational institutions to make informed choices aligned with sustainability goals. The software development process also demands eco-conscious decision-making. By selecting tools and platforms with demonstrated green commitments and favouring cloud providers and AI technologies with transparent environmental impact statements, developers actively contribute to reducing the carbon footprint of their products. Given the increasing integration of AI, particularly large language models, into educational tools, it's imperative to prioritise providers who support sustainability and offer clear emissions data. In essence, every stage of EdTech development presents an opportunity to prioritise green hardware, infrastructure, and software applications, ensuring that the tools reaching learners support a sustainable future.

In the next section, we aim to give an overview of existing research, initiatives and recommendations for advancing the field with research-based approaches towards stimulating more sustainable approaches within the EdTech ecosystem. It is widely recognized that businesses play a crucial role in combating climate change. Industry-related environmental certifications, arising from regulated or self-regulated practices, set standards and frameworks for organisations to comply with legal requirements and improve their environmental impact by minimising waste production, resource consumption, and pollutant emissions.

However, the current legal frameworks are insufficient to combat environmental changes. The Paris Agreement adopted in 2015 set an ambitious goal of reducing global greenhouse gas emissions and keeping planetary warming to no more than 1.5°C increase. Each of the several subsequent Conference of the Parties (COP) meetings since has sought to address outstanding issues and push forward with practical actions; however, at the governmental level, a full consensus is hard to reach and responsibility is thus becoming more global and collective. As Mike Hulme notes in his book *Why We Disagree About Climate Change*, 'climate change' transcends being just a physical, observable phenomenon; it encompasses a complex concept that touches on all aspects of human life—economic, political, cultural, ethical, and spiritual, and it is within these realms that "our collective and personal identities and projects can form and take shape" (Hulme, 2009, p. 236).

4.1 Literature Review on Environment and EdTech

To substantiate the insights shared in this report, the authors conducted a rapid literature review of literature. A systematic search was conducted in Scopus, supplemented by additional search in Google Scholar. The search terms in Scopus included "EdTech AND environment", "EdTech AND climate", and "sustainable AND education AND EdTech". The results were refined by filtering for recent publications (from 2020 to 2024). Upon reviewing the results, two key research themes emerged: research focusing on positive and negative impacts. These were then manually filtered for their relevance, while identifying several more detailed search foci (see Table 1 below).

In Google scholar, the search terms included: "EdTech environment", "EdTech sustainability", and "EdTech climate change". One of the key articles identified through Google scholar (Selwyn, 2018) pointed to more refined search topics: energy consumption trends and solutions, the carbon footprint of EdTech, electronic waste generation, and device life cycle. Additionally, a general Google search for phrases "environmental impact of EdTech", "EdTech and sustainability", and "energy consumption in digital education" was performed to determine the broader discourse relevance (e.g. in the mainstream media and industry reports) of the search results.

Positive impact	Negative impact
“paperless AND education” “sustainability AND teaching” “sustainable practices AND teaching” “VR AND environment” “VR AND climate” “resource management AND education AND technology”	“carbon footprint AND internet”, “carbon footprint AND data centers” “fossil fuels AND education technology” “energy consumption AND education technology” “energy consumption AND artificial intelligence” “electronic waste generation AND education” “device lifecycle AND environment”

Table 1. Detailed search terms used in the literature review.

The following academic literature review is divided into two parts: Section 4.1.1 covers research on positive environmental effects of EdTech, followed by overview of negative environmental effects of technology in Section 4.1.2, which highlights several specific issues and, wherever possible, recommendations and solutions are included.

4.1.1 Positive Impact of Edtech on the Environment

Apart from implementing solutions that aim to neutralise negative effects of technology use (see 5.1.2), our literature review shows that EdTech solutions also offer some benefits in relation to environmental issues. The first, and perhaps the most obvious one is the reduction in paper use. By providing digital learning materials, online communication, and transferring paperwork to digital form, EdTech reduces the environmental footprint associated with traditional educational practices (Khafid et al., 2023; Hernandez, 2020). The authors argue that EdTech reduces the negative effects of deforestation, but also the emissions of the paper production process, and reduces waste from these activities (Jian et al., 2021; Kim et al., 2021; Luiz, 2017).

Another positive impact noted in the research is the reduction of the carbon footprint related to travel (to school, university, conferences, etc) and educational facilities maintenance (Versteijlen & Groesbeek, 2024), as the Internet allows more efficient facilitation of many processes - like online conferences, classes and working or studying from home (Zulfiqar et al., 2023). However, this argument is subject to critique, as it fails to account for the

carbon footprint associated with the manufacturing, utilisation, and disposal of devices used in online learning, in addition to the broader carbon footprint of the Internet as a whole (Versteijlen et al., 2017; Pasek et al., 2023).

Research further shows that students demonstrate a lack of awareness of environmental issues. However, when informed, they tend to focus more on positive contributions of digital technologies, for example on carbon emission reduction by not driving a car and taking a Zoom class online (Ørbæk, 2023). Some EdTech companies and manufacturers communicate environmental awareness to their audiences, including employees, students, and general public by explaining their practices, existing issues, and hidden environmental costs of technology usage (Fernández et al., 2019).

There are positive examples of educating students about the use of low-carbon technologies. Five years after taking a climate change course, former students of San Jose State University reported that they were making more environmentally conscious choices in their personal and professional lives, crediting the course as the initial influence for making those choices (Cordero et al., 2020). The authors made estimations of those reported choices and showed that an average course graduate contributed 2.86 tons of CO_2 emission reduction per year. Reducing this amount is similar to eliminating about a half of average American home electricity use impact in one year (5.067 tons CO2/home) (Greenhouse gases equivalencies calculator - Calculations and references | US EPA, 2024). Education about the environmental impact of business and commerce helps students to relate to the urgency of sustainable business practices, creating an incentive to engage in ecopreneurship in the future (Alfarizi & Herdiansyah, 2024). EdTech has the potential to raise environmentally cautious generations of learners, prepared for green employment (Pradhan et al., 2021).

Using specific instruments, like VR technology, also helps effectively raise environmental awareness among students, as it is more engaging to present the visualised effects of environmental issues (Hsu et al., 2018). While implementation of AR games dedicated to environmental issues in the classroom did not show much difference in successful knowledge acquisition, it pointed to students' increased motivation to learn (Czok et al., 2023). Application of E-learning technologies in entrepreneurial education context improved sustainability awareness among students. The research revealed a connection of e-learning technologies usage to sustainability efficacy, which in turn, indicates connection to sustainability awareness. (Liu et al., 2023).

4.1.2 Negative Impact of Edtech on the Environment and possible solutions

While the literature notes some positive EdTech effects, it certainly notes many more negative effects. EdTech solutions might offer solutions for positively impacting the environment, but it is crucial to address the considerable environmental costs and downsides associated with the industry. EdTech is dependent on digital devices and batteries that are made from substantial amounts of raw materials, including mica, the extraction of which is connected to child labour (Schipper et al., 2018). As a result, EdTech contributes to resource depletion and raises numerous ethical concerns.

To begin with, the proliferation of digital services and platforms in education inevitably leads to an increase in energy consumption. A case study of smart classrooms in France showed that systematic use of technology can result in an additional 1% of power usage, energy consumption, and e-waste generation (Berquin, 2021). As a possible solution, Berquin (2021) suggests considering environmental impacts in the design process. AI, rapidly increasing its presence in education technology, consumes a significant amount of energy, especially as it is becoming widely used. For example, training a large language model like OpenAI's GPT-3 requires nearly 1,300 megawatt-hours (MWh) of electricity (Luccioni et al., 2022). However, improvements in algorithms and hardware are somewhat helping to reduce the rate of increase in energy consumption (Desislavov et al., 2023).

Data processing and storage require a notable amount of data centres which consume vast amounts of energy, raising valid concerns about their negative influence on climate. Ewim and colleagues (2023) note that without intervention, data centres present a serious danger to the environment. Fortunately, innovations in renewable energy sourcing, modern cooling systems, and progress in hardware efficiency might reduce data centres' overall energy consumption (Ewim et al., 2023). The issue of energy consumption must be addressed at all levels. Companies need to optimise their software to reduce resource demands, while educational institutions and businesses are encouraged to adopt clean, renewable energy sources whenever feasible. Additionally, promoting more sustainable practices among consumers, such as prioritising the use of Wi-Fi over cellular data, is essential (Vakhitova et al., 2022; Zulfiqar et al., 2023).

Apart from energy consumption problems, user devices and data centres are proven to be two main contributors to the digital carbon footprint (Ørbæk, 2023). There is a vast demand for new resources in manufacturing user devices and high emissions from industrial processes (Zulfiqar et al., 2023). A life cycle assessment for training large AI and deep learning technologies revealed that they can emit more than 626,000 pounds of carbon dioxide equivalent which accounts for nearly five times the lifetime emissions of the average car (Strubell et al., 2019).

Some researchers suggest that the climate impact of the ICT sector in general is hard to measure due to various factors such as challenging access to industry data or system boundaries. As possible solutions, they offer accounting for different aspects of the issue by finding connections (geographic, spatial, technical, and social) between them, and exploring ways to reduce their impact separately from the whole (Pasek et al., 2023). As an example, the authors present the case of the use of subsea internet cables, which set low environmental costs of moving data and thus, are ignored in carbon emissions conversation. However, it allows us to look at this as a spatial issue - if there is no difference (considering carbon emissions) in the distance that data travels, it might be beneficial to set up data centres in the areas where solar energy production might lower the carbon emissions even more. Additionally, policies requiring transparency about emissions might contribute to a more wholesome picture of the existing issues (McKenzie & Gulson, 2023).

Carbon emissions and energy consumption during the manufacturing process - between 70 and 80% of the energy consumed during the lifetime of a laptop occurs during its manufacturing process rather than its eventual use (Greenpeace, 2017) - is not the only problem related to user device usage. Devices are constructed from dozens of scarce metals and rare metals (Parikka, 2015). Global average digital consumption levels, keeping the current infrastructure, “would require >40% of the per capita Earth’s carrying capacity for climate change and mineral and metal resources use”, which means on average we are already consuming more resources than we have (Istrate et al., 2024, pp 5-6).

As the environmental impact of EdTech becomes apparent, there is a growing need for a paradigm shift within the industry. Selwyn (2021, 2024) suggests a complete re-evaluation of many of the core assumptions surrounding the unlimited, infinite, and replicable use of technology that the EdTech industry

and other tech industries) is founded upon. This shift involves moving away from viewing educational technology through the lens of individual benefits to focusing on collective engagement and shared responsibilities. Examples of 'Ed-Tech Within Limits' (Selwyn, 2021) include utilising recycled materials in manufacturing, encouraging the use of energy-efficient devices, extending the life cycle of technological devices by emphasising maintenance, repair, and reconstruction, while also designing for efficient longevity (Istrate et al., 2024; Satyro et al., 2018; Zulfiqar et al., 2023).

This has been supported by legal regulation in some countries. In the United Kingdom, for example, the Right to Repair Regulations were passed in 2021 () and in the US, the Digital Fair Repair Act was signed into law in December 2022. However, while legal regulation is an important step, it does not solve the problem of currently existing devices. For example, the US Digital Fair Repair Act is applicable only to products manufactured after July 1, 2023, and excludes any product sold under specific business-to-government or business-to-business contracts that are not otherwise available for direct sale by a retail seller (Ganapini, 2023).

Additionally, instead of adhering to the 'one-to-one' computing model, where each student is provided with an electronic device to access the internet and digital course materials, educational institutions could create environments where it is the norm for many students to collaborate and share devices (Selwyn, 2021). Researchers further suggest that instructional designers consider hidden environmental costs while designing learning experiences. For example, planning for the number of devices being used to achieve desired learning outcomes, taking into account the life cycle of the used device, its affordances, and the effect of the device as the resource taken from the planet (Warren et al., 2023).

As a general recommendation, most researchers point to the need to implement environmental policies applicable at different levels, from governments to schools and companies. Fostering collaboration among all participants in the ecosystem (Williams, 2020), including collaboration between schools and environmental NGOs (Vakhitova et al., 2022), is suggested as a way forward in tackling the environmental challenge. As more sophisticated technological advancements and new computational systems

help reduce the negative impact, research and innovation become a path to resolving ecological issues too.

4.2 Industry-related EdTech certifications and evaluations

In this section, we explore two interconnected phenomena: carbon offsetting and voluntary Carbon Markets (VCMs), and greenwashing. Understanding these concepts is crucial in relation to environment and EdTech as the three concepts are often cited in discussions on corporate environmental responsibility. Carbon offsetting and VCMs have been proposed as backbone for evaluating and certifying approaches in the industry, but there have also been several controversies that have accompanied the effective implementation of these approaches. In this section, we therefore provide an overview of the three concepts, followed by an overview of general certifications related to sustainability, noting the absence of specific certifications for the EdTech sector.

4.2.1. Carbon Offsetting and Voluntary Carbon Markets

Carbon offsetting is a method used by organisations and/or individuals to lower their total carbon emissions, typically through the purchase of carbon credits. Each carbon credit corresponds to one ton of carbon dioxide, or its equivalent, that has either not been emitted as originally intended or has been removed from the atmosphere (Courtnell, 2023). Organisations that cut down or remove emissions can sell their accumulated carbon credits to buyers who aim to reach net-zero or carbon-neutral status but cannot fully eliminate their excess emissions due to financial or technological constraints.

These credits are often traded in Voluntary Carbon Markets (VCMs), which are decentralised platforms where individuals or organisations purchase credits to offset their carbon emissions voluntarily (Lovell, 2010). These carbon credits are termed “voluntary” because using them to reduce emissions is not mandated by law or regulation. VCMs are complex and often controversial. The US Congregational Research Service stated the veracity of the offsets as accurate representations of GHG reduction in the VCM varies because there is no recognized central authority and no universally accepted standards for generating offsets (Miller et al., 2024), and further research has revealed that the majority of offset credits traded in today’s market deliver significantly fewer benefits than claimed (Guizar-Coutiño et al., 2022; Stapp et al., 2023).

For example, a recent study found that only six percent of tropical forest carbon credits represent actual emission reductions (West et al., 2023).

The Berkeley Carbon Trading Project suggests shifting from the notion that forests offset fossil fuel emissions to making "contributions" to global climate mitigation. This would involve investing in high-quality forest conservation projects that focus on specific locations and interventions most likely to achieve genuine climate mitigation impacts and prevent harm. This approach prioritises direct emission reductions and clarifies the impact of corporate actions (see Haya et al., 2023).

4.2.2. Greenwashing

Greenwashing, a transparency problem, occurs when companies make misleading or exaggerated claims about their environmental friendliness to appear more sustainable than they actually are (de Freitas Netto et al., 2020). Carbon offsets can be part of greenwashing when companies purchase these offsets to claim they are reducing their carbon footprint, without making significant changes to their actual emissions practices. This can give the false impression that the company is more environmentally responsible than it truly is, as the offsets may not represent real or effective emission reductions as explained above. Thus, relying on carbon offsets without substantial internal sustainability efforts can contribute to greenwashing.

To combat the phenomenon of greenwashing, new regulations and transparency requirements have been developed, including the EU's Green Taxonomy Regulation and the Sustainable Finance Disclosure Regulation (EU 2019, 2020). The taxonomy serves as a categorization framework that outlines the criteria for economic activities to be in line with achieving net zero emissions by 2050 and broader environmental objectives beyond just climate change. The EU's Sustainable Finance Disclosure Regulation is a framework designed to regulate how fund management companies and financial advisors disclose sustainability factors.

4.2.3 Certifications relevant to EdTech environmental impact

To systematically review and gather relevant certifications of EdTech and the environmental aspects, we conducted a web search with the following keywords and phrases: “environmental certifications”, “green certifications”, “sustainable certifications”, “eco-friendly certifications”, and “how to get green certifications for businesses”. Google was the primary search engine as we were looking for existing environmental certifications that companies can obtain to demonstrate their commitment to sustainability and environmental responsibility. Sources from reputable organisations and recognized industry experts were prioritised. To ensure accuracy, information was cross-referenced from multiple sources, and sources that lacked credibility were excluded. We acknowledge the web search has limitations, including potential bias in search engine algorithms and the availability of up-to-date information.

The overview of the certifications below represents some of the most common certifications and initiatives, all these are provided as part of paid services and may thus not be easily accessible to smaller businesses.

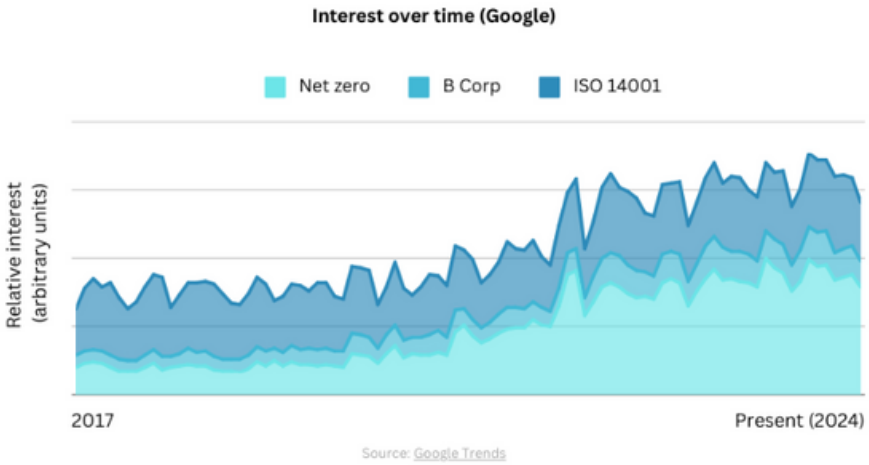

Figure 1. Google Trends comparison of “popularity” of corporate environmental certifications Net zero, B Corp and ISO 14001.

Science Based Targets initiative (https://sciencebasedtargets.org/)

‘Net-zero targets’ refer to the ambitious goals set by companies to reduce their greenhouse gas (GHG) emissions to a level where any remaining emissions are balanced out by equivalent removals from the atmosphere. According to the Science Based Targets initiative (SBTi), these targets are crucial for aligning corporate actions with global climate goals, specifically those outlined in the Paris Agreement.

Key elements of net-zero targets include:

1. Near-term science-based targets: These are intermediate goals set for 5-10 years to ensure immediate and substantial reductions in emissions, crucial for meeting longer-term climate objectives.

2. Long-term science-based targets: These outline the deep reductions needed across the value chain to align with global or sector-specific pathways to achieve net-zero by 2050 or sooner.

3. Neutralisation of residual emissions: This involves removing and permanently storing CO2 to balance out any remaining emissions that cannot be eliminated.

4. Beyond value chain mitigation: Encouraged additional actions or investments outside a company's direct value chain to further mitigate climate impacts, though these actions are supplementary and not a substitute for reducing a company's own emissions,

Note on SBTi's funding - SBTi's strives for transparency regarding its funding, as per information on their website (in August 2024), they state that 48% of their income is from validation services and 41% from core funding. Their current core funders include, for example, Bezos Earth Fund and IKEA Foundation.

Certified B Corporation (https://www.bcorporation.net/en-us/)
The esteemed 'B Corp' certification is awarded to businesses that satisfy the rigorous criteria set by the B Lab certifying body. This certification emphasises sustainability and aims to make businesses a driving force for environmental and social justice. The goal is to "balance profit and purpose" to create a fairer and less exploitative economy. To achieve B Corp status, a company is evaluated based on its interactions with suppliers, the community, employees, and the environment. If the business demonstrates an acceptable level of environmental and social impact throughout its entire business model, it can qualify as a B Corp.

B Corp Certification signifies that a business adheres to rigorous standards of verified performance, accountability, and transparency, covering aspects such as employee benefits, charitable activities, supply chain practices, and the use of input materials. To obtain this certification, a company must:

1. Demonstrate high social and environmental performance: Achieve a B Impact Assessment score of 80 or above and pass a risk review. Multinational corporations must also meet specific baseline requirement standards.

2. Make a legal commitment: This involves altering their corporate governance structure to be accountable to all audiences, not just shareholders, and achieving benefit corporation status if it is available in their jurisdiction.

3. Demonstrate transparency: Make information about their performance, as measured against B Lab's standards, publicly available on their B Corp profile on B Lab's website.

As leaders in the movement for economic systems change, B Corps enjoy significant benefits. They build trust with consumers, communities, and suppliers; attract and retain employees; and draw mission-aligned investors. Since they must undergo the verification process every three years to recertify, B Corps are inherently focused on continuous improvement, ensuring their long-term resiliency.

B Corp Certification is comprehensive, addressing multiple social and environmental issues. Achieving and maintaining certification is rigorous, requiring the involvement of various teams and departments within the company. The verification process considers the company's size and profile and involves documenting the business model, operations, structure, and work processes, along with reviewing potential public complaints and possible site visits. Recertification ensures these standards continue to be met consistently.

Note on B Lab's funding - B Lab is a philanthropically funded non-profit organisation, their 2023 Annual Report states that among their biggest funders is Reid Hoffman, Bill & Melinda Gates Foundation, Robert Wood Johnson Foundation, Jaren & Kristi Meyers, Porticus and Raise.

ISO 14001 Environmental management systems

(https://www.iso.org/standard/60857.html)

ISO 14001 is the globally acknowledged standard for environmental management systems (EMS). It offers a structured approach for organisations to develop and implement an EMS, aiming for continuous enhancement of their environmental performance. By following this standard, organisations can proactively reduce their environmental impact, comply with applicable legal requirements, and meet their environmental goals. The framework covers a range of elements, including resource utilisation, waste management, monitoring environmental performance, and engaging audiences in environmental initiatives.

The goal of this International Standard is to provide organisations with a framework that balances environmental protection with socio-economic needs while addressing changing environmental conditions. It outlines requirements that help organisations achieve the desired outcomes for their environmental management systems. A structured approach to environmental management offers top management the information needed to ensure long-term success and opportunities to contribute to sustainable development by:

- Protecting the environment by preventing or mitigating negative environmental impacts.
- Reducing the potential adverse effects of environmental conditions on the organisation.
- Helping the organisation meet its compliance obligations.
- Improving environmental performance.
- Managing or influencing the design, manufacturing, distribution, consumption, and disposal of products and services through a life cycle perspective to prevent the unintentional shifting of environmental impacts.
- Gaining financial and operational benefits from implementing environmentally sound alternatives that enhance the organisation's market position.
- Communicating environmental information to relevant interested parties.

This International Standard, like other International Standards, is not intended to increase or change an organisation's legal requirements

The Green Business Bureau (https://www.greenbusinessbenchmark.com/)
The Green Business Bureau (GBB) is popular with smaller companies due to its innovative process (SaaS - software-as-a-service). Aimed at businesses of all sizes that wish to showcase their sustainability efforts, the GBB offers customizable and company-specific assessment criteria. The Green Business Benchmark initiatives are designed to align with global frameworks such as GRI, UN SDGs, ISO14001, GHG Protocol, and SASB. This alignment aids in meeting specific ESG goals, ensuring compliance, and progressing towards additional certifications. The Green Business Benchmark certification encompasses all aspects of a business operations, including supply chain management, waste handling, energy consumption, and corporate social responsibility initiatives. This comprehensive approach showcases a deeper dedication to sustainability. Businesses can enrol in the GBB certification process, earning points for the sustainability initiatives they undertake. This allows each business to concentrate on particular areas of sustainability, with continuous advice and guidance provided to help them implement and manage new initiatives, ensuring constant improvement.

Green Business Benchmark© is an operating product company of Clearyst©, a sustainability technology platform of software solutions. Funding mechanism is unclear.

The Global Reporting Initiative (https://www.globalreporting.org/)
The Global Reporting Initiative (GRI) Standards are recognized as the global best practice for public reporting on various economic, environmental, and social impacts. Using these Standards for sustainability reporting allows organisations to disclose information about their positive or negative effects on sustainable development. The GRI Standards form a modular system of interconnected guidelines. The reporting process is supported by three series of Standards: the GRI Universal Standards, which are applicable to all organisations and include reporting on human rights and environmental due diligence in accordance with intergovernmental expectations; the GRI Sector Standards, which pertain to specific sectors; and the GRI Topic Standards, which provide disclosures for particular topics. Utilising these Standards to identify material (relevant) topics aids organisations in achieving sustainable development.

GRI acknowledges their funders on their website that include Deloitte, KMMG, PWC, Swiss State Secretariat of Economic Affairs, The Swedish International Development Cooperation Agency, Porticus and Walton Family Foundation (as of August 2024).

Change Climate (https://www.changeclimate.org/)

The aim of certification is to assess the company's adherence to the Climate Neutral Certified Standard. The certification process includes the following:

- Emission measurement and analysis of the carbon impact of all the company's products and services from cradle to customer delivery.
- Reduction of the value chain carbon emissions, and annually document plans and progress toward emissions reductions.
- Contribution to achieving global net-zero greenhouse gas (GHG) emissions by purchasing verified carbon and clean energy credits that support climate projects external to the company's value chain. For the Climate Neutral Certified label, the company will procure one carbon credit for each tonne of carbon emissions. Projects such as direct carbon removal or reforestation withdraw carbon from the atmosphere, while clean energy helps avoid emissions from fossil fuels.
- Publicly disclosing the following information on the Brand Profile Directory on the Change Climate website:

    1. Total annual GHG footprints categorised by Scope 1, 2, and 3 emissions.
    2. For recertifying entities, the annual emissions intensity for previous certification years, beginning with 2023 certifications, including any emissions adjustments. Additionally, reporting historical absolute emissions by Scope is strongly recommended.
    3. Total annual investment (in USD) in carbon removal and avoidance credits, along with the supported project types.
    4. Categories of certified products and/or services.
    5. A summary of reduction action plans and any science-aligned targets set, if applicable.
    6. Progress made toward previous reduction action plans.

Requirements for Climate Advocacy Reporting: Certified entities are highly encouraged to participate in lobbying, education, and stakeholder engagement efforts to advocate for climate solutions. Certification applications will include a mandate to report on these activities undertaken in the previous calendar year.

Change Climate is nonprofit organisation and donations and grants cover one-third of their annual operating budget; the rest comes from certification fees from companies.

Climate Partner (https://www.climatepartner.com/se)
Climate Partner certification confirms that a company has completed all five stages of a climate action plan:

- Measure carbon footprints of the company.
- Set reduction targets for consistently lowering emissions.
- Execute reduction strategies
- Fund climate initiatives (certified climate projects to support worldwide climate action).
- Promote transparency, communicate openly about the company's climate action endeavours to amplify its impact.

Climate Partner explained the process of their certification on their webpage transparently and in detail, however, we were not able to find any statement regarding their funding.

In addition to the certifications listed above, we have identified over 200 eco-friendly or environmental certifications, though none are specifically tailored for EdTech. These include specific national certificates, for example:

- EU Ecolabel (https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel_en)
- Nordic Swan Ecolabel used in Scandinavian countries (https://www.nordic-swan-ecolabel.org/)
- Norway's Miljøfyrtårn (https://www.miljofyrtarn.no/)
- Germany's Blauer Engel (https://www.blauer-engel.de/de)
- Carbon Trust Standard (https://www.carbontrust.com/) in the UK.
- Milieukeur in the Netherlands (https://www.milieukeur.nl/en/)

5. Adopting existing metrics for EdTech environment evaluations

Over the past few years, three global initiatives have emerged to establish and evaluate alternative indicators for climate change education, each offering distinct perspectives on what should be tracked. Individually and collectively, these initiatives aim to pinpoint and advocate for an indicator that addresses the shortcomings of SDG global indicator 4.7.1. These indicators have been proposed by three initiatives: the Greening Education Partnership, the MECCE project, and the GEM Report.

To structure our thinking around the types of certifications and considerations relevant for different types of evaluations, we adopted the People, Product, Process distinction. Furthermore, we adopted UNESCO's four pillars of greening education that provide useful pointers for how to approach a certification scheme for EdTech's environment according to these "Ps".

People: Organisation level certifications

In UNESCO's terms, People and organisational levels correspond to schools, so equivalent in our case would be EdTech organisations. Notably, the whole institution approach suggests the need to focus on the organisational level of EdTech. It is frequently the case the regulatory and legal frameworks compel people to comply and act in a manner that respects planetary health concerns. The people behind the EdTech and their daily practices, however, matter in terms of what gets produced and how the organisation approaches planetary health concerns, whether regulated or non-regulated by policy.

Product: Content-relevant and tech specific certifications

The green curriculum under the UNESCO scheme focuses on the content and type of support provided to learners around climate education. Similarly, EdTech targeting this aspect of environmental impact would focus on specific content areas and stimulate environmental thinking and action in learners. Furthermore, specific software requirements should be considered here. EdTech creators can apply the Triple-S Framework (Moro et al., 2022) as a first-step or foundation to subsequent environmental impact considerations in decision making and tool choice.

Processes: Skills-relevant certifications

The Greening teacher training and community are UNESCO's approaches towards enacting change in local contexts through capacity-building and awareness-raising around environmental issues. This is where criteria around EdTech's contribution to upskilling for environmental and planetary issues are important. Here, the interdependence between the various points in the supply chain, EdTech provider and end-user, e.g. school, are most visible. Procurement in schools can, for example, prioritise environmentally friendly and sustainable options in EdTech tools selection and make assessments of the environmental impact of new technologies before they are adopted in the classroom, EdTech providers can prioritise cloud providers or AI technology partners that have transparent environmental impact statements, at the same time EdTech providers would be expected to transparently measure and report on their sustainability efforts.

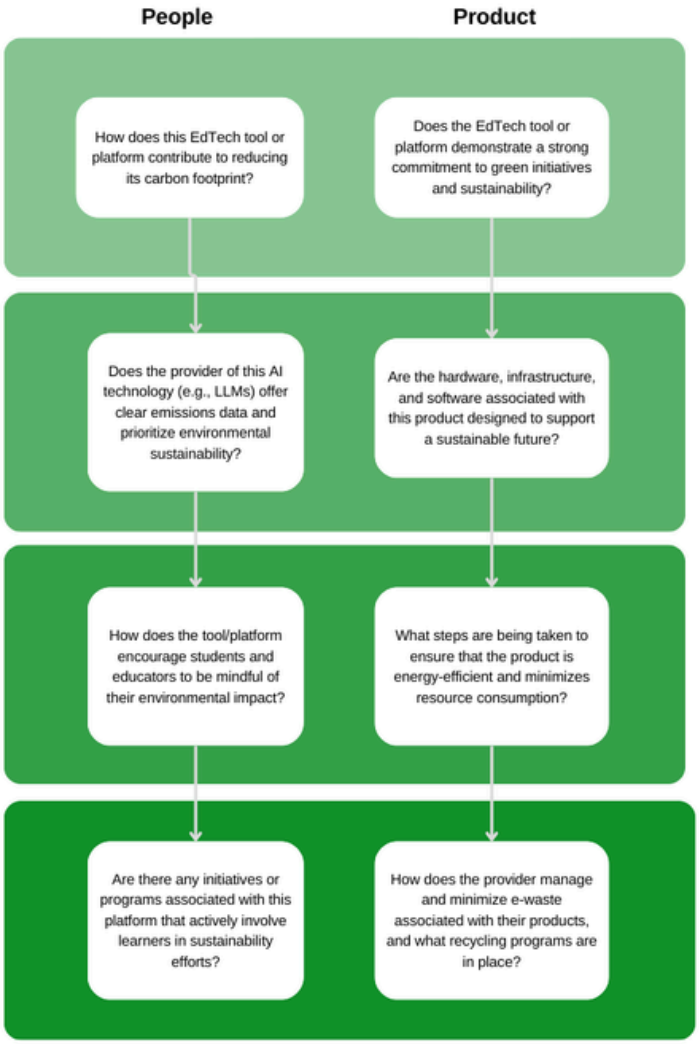

Figure 2. Suggested questions and parameters for 'People' and 'Product' dimensions.

6. Conclusion

The time of finalising this report coincided with the UNESCO Digital Learning Week (DLW) in Paris in September 2024. It is fitting to reflect on the timely message underscored during this conference that highlighted the pressing need to integrate sustainability into the digital transformation agenda, as captured in the slogan “Mettre la technologie au service de compétences vertes” (“Harnessing technology for green skills”). This dual focus of the DLW on environmental sustainability and digital transformation was epitomised in Stefania Giannini’s (Assistant Director-General of Education at UNESCO) opening keynote, where she juxtaposed two symbolic figures: Sam Altman and Greta Thunberg, representing innovation in technology and the fight against climate change. Her rhetorical question, imagining the potential collaboration between these two prominent voices, resonates with the broader theme of uniting technological progress and environmental stewardship.

Educational technology has emerged as a transformative force in how we learn, opening new possibilities while also highlighting the environmental implications of digital infrastructure. While EdTech reduces the environmental footprint of traditional educational methods—such as lowering paper usage and reducing travel-related carbon emissions—it simultaneously introduces new challenges. The production of digital devices, energy consumption associated with AI and data processing, and the growing issue of e-waste are critical concerns that require urgent attention.

Addressing these challenges calls for a rethinking of how educational technologies are designed, implemented, and consumed. Solutions such as creating eco-friendly content, adopting energy-efficient hardware, and promoting responsible consumption practices must become industry standards. Moreover, collaboration across sectors, shared responsibility, and a commitment to sustainability are essential for reducing the negative impact of EdTech. The future of education must not only prepare students for green employment and eco-entrepreneurship but also actively contribute to global environmental goals through the way educational technology is deployed.

As Selwyn (2021) and in the Foreword to this report advocates, the role of EdTech must shift from focusing on individual gains to fostering collective action. The burden is to be shared, all stakeholders are responsible: EdTech developers in how they design their products and how they operate as companies, schools in their procurement decisions and other green solutions and considerations, and policy makers in advising and regulating the landscape. This perspective encourages the development of technologies that promote communal learning, shared resources, and collaboration—aligning educational advancements with broader societal and environmental objectives. By adhering to principles similar to UNESCO's greening education pillars, the EdTech industry can grow sustainably, ensuring that technological innovation supports, rather than compromises, the health of our planet. The path forward is one of cooperation, re-evaluation, and commitment to long-term environmental stewardship, ensuring that education and technology work hand in hand to build a more sustainable future for all.

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