

# Teaching Sustainably in the Age of AI

Moving from the magic of AI to it's material reality

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## Learning Outcomes

- Explain the environmental impacts of generative AI
- Challenge narratives of 'weightless' digital technology
- Evaluate AI use through a sustainability lens
- Model responsible digital practice in education

# UNESCO's ESD framework for 2030

Relevant ESD competencies for this lecture

**Systems thinking:** understanding AI as a socio-technical system with environmental, social, and economic dimensions

**Critical thinking:** questioning dominant narratives of efficiency, inevitability, and neutrality

**Normative competence:** evaluating AI use against sustainability values and ethical principles

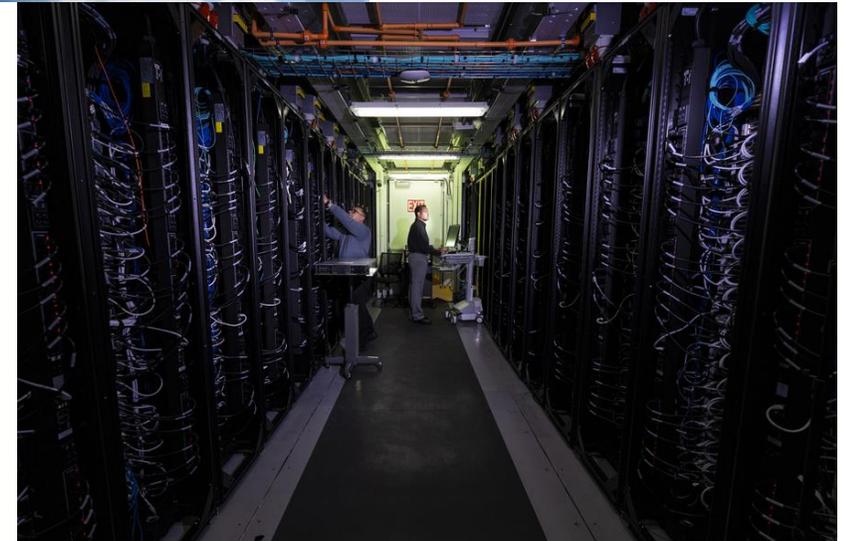
**Anticipatory competence:** considering long-term and scaled impacts of today's educational choices

**Responsibility and agency:** recognising educators' capacity to influence practice and policy



# The Myth of Weightless Technology

- Digital tools are often framed as clean and efficient
- The Cloud is a marketing term which obscures physical infrastructure
- In reality, it is a series of massive windowless warehouses filled with vibrating, heat-spewing hardware.
- Environmental impacts are spatially and socially displaced – the weight of the cloud is moved elsewhere.





## What is AI?

Large-scale machine learning models  
Trained on vast datasets using high-  
performance computing

Data centres house the computing  
infrastructure such as servers, data  
storage drives, and network equipment.

Involves two phases:

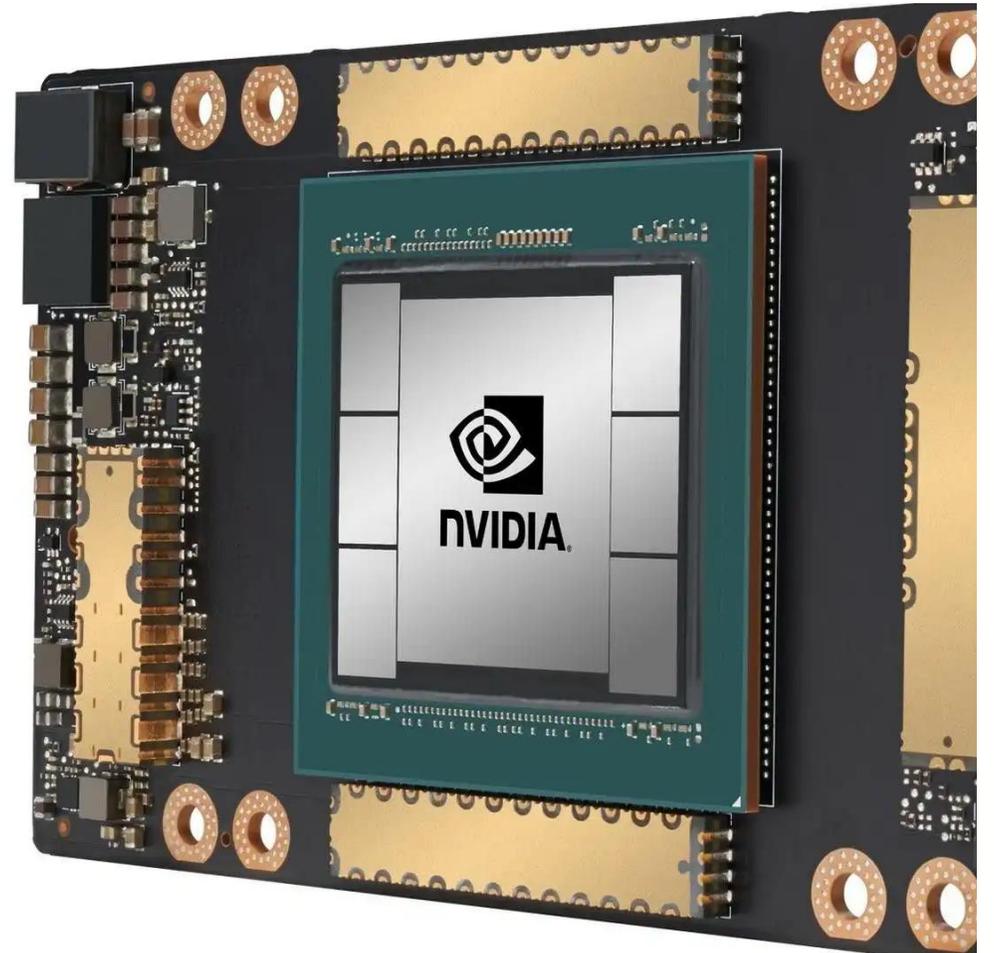
- Training (extremely resource-intensive)
- Inference (ongoing, scaled use)





# The AI Lifecycle

1. Extraction: Mining for rare earth elements and minerals
2. Training: Massive supercomputers running for months to 'learn.'
3. Inference: Every time a user clicks 'generate.'
4. End-of-Life: The short 3-to-5-year lifespan of high-performance Graphic Processing Units (GPUs).





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# The Physical Footprint





# Dismantling the 'weightless' myth

The lifecycle lens: AI impacts are not limited to the chat interface; they span from Extraction → Production → Use → Disposal.

The use fallacy: Most public discussions focus only on the use phase (prompting), which hides the ecological debt accumulated during hardware manufacturing and model training.

Revealing hidden costs: A true Lifecycle Analysis (LCA) accounts for the total carbon, water, and mineral spend required to keep the system operational.

## Four phases of environmental impacts of AI data centers

1. Mining and manufacturing



2. Data center construction



3. Data center operation:  
electricity and water use



4. Electric waste





# Energy: The Training Phase

- The power of training: Training a large language model (LLM) like GPT-3 consumes approximately 1,287 MWh of electricity.
- Scale comparison: This is equivalent to the annual energy consumption of 120 average U.S. homes.
- The constant burst: AI requires continuous retraining and fine-tuning cycles, making this burst a permanent feature of energy consumption.





# Energy: The Inference Phase

A single AI prompt consumes roughly 2.9 Wh, compared to 0.3 Wh for a standard Google search—a 10x increase in energy demand.

Generating just one AI image consumes as much electricity as charging your smartphone to 50%.

Data centres operate 24/7, requiring constant high-voltage electricity for both computation and complex water-cooling systems.

Corporate claims of renewable energy are often partial or based on carbon offsets rather than 24/7 carbon-free energy usage.





# Water Consumption

Chilled water is used to cool a data centre by absorbing heat from computing equipment. On average, for each kilowatt hour of energy a data centre consumes, it would need two litres of water for cooling.

Environmental costs are intentionally exported away from users. While we enjoy clean digital tools, the resulting water stress is felt by local ecosystems and communities in the regions hosting these facilities.

Microsoft reported a 34% spike in global water consumption in a single year (2022–2023), directly attributed to the massive cooling requirements of AI infrastructure.

Google's three data centres based in Dalles, Oregon use more than a quarter of the city's water supply.

Beyond direct cooling, AI uses water indirectly through the vast amounts required by the power plants generating the electricity these servers need.





# Mineral Extraction

A single NVIDIA H100 GPU—the gold standard for AI—weighs nearly 5 lbs and contains a complex cocktail of gold, copper, and rare earth elements.

Critical Minerals for AI:

Lithium (Li): Essential for the massive energy storage systems required to back up data centres.

Cobalt (Co): Vital for high-density battery technology and circuitry.

Cobalt mining in the Democratic Republic of Congo (DRC) is frequently linked to hazardous working conditions and systemic human rights violations.

Lithium extraction in the 'Lithium Triangle' of Chile/Argentina consumes vast quantities of water in arid regions, directly competing with local indigenous agriculture.





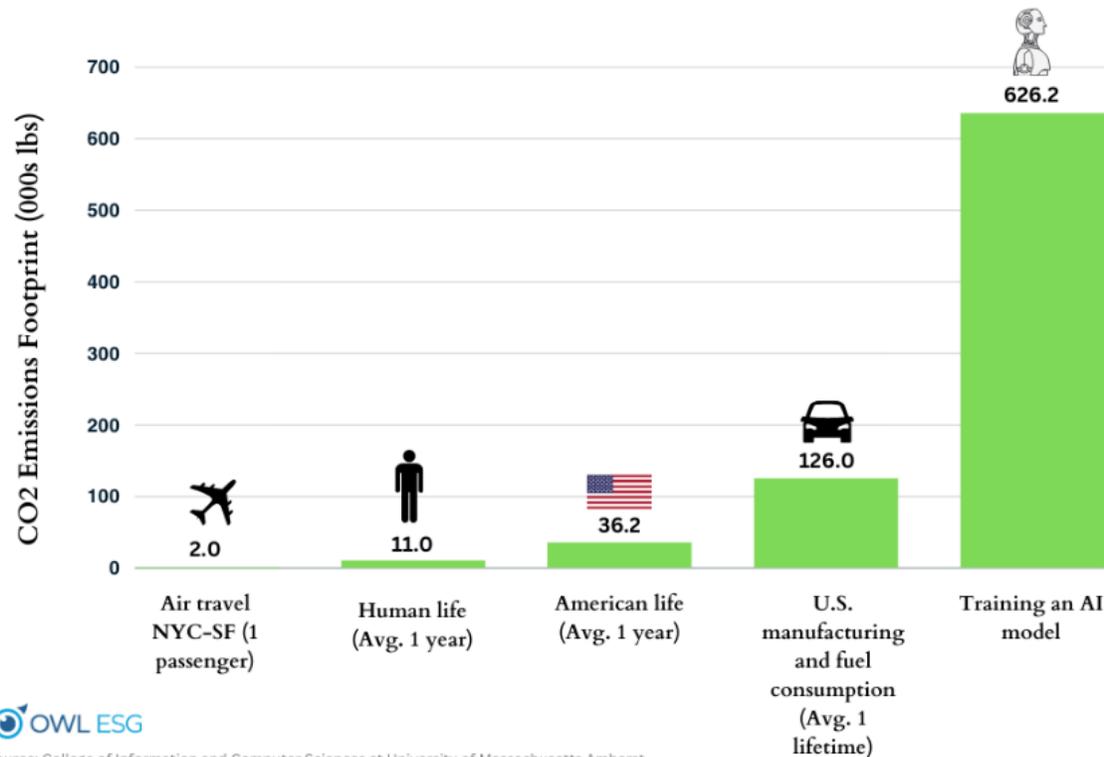
# Carbon Accounting

Many corporate net zero claims are misleading because they often ignore Scope 3 emissions—the carbon debt created while building chips and mining materials.

While inference emissions grow with everyday use, they remain largely invisible to the end user.

*If a company uses "Green Energy" to run a server (Scope 2), but that server was manufactured using coal power in another country (Scope 3), is the operation truly green?*

## CO2 Emissions Benchmarks



Source: College of Information and Computer Sciences at University of Massachusetts Amherst



# The Hardware Graveyard

AI hardware (like the NVIDIA H100) becomes obsolete significantly faster than traditional servers due to the hyper-speed of AI advancement.

We are currently creating a disposable culture for some of the most complex and resource-intensive machinery ever built.

These complex components are composed of rare alloys and multi-material layers that make high-quality recycling extremely difficult and energy-intensive.

Because disposal is costly and toxic, it often occurs in the Global South, where informal recycling leads to long-term environmental degradation and severe health impacts for local communities.





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# The Human Footprint





# The Global Supply Chain

Innovation, high-end infrastructure, and the primary economic benefits of AI are concentrated in the Global North.

The 'Material Debt' - environmental degradation from extraction and the health risks of toxic waste disposal - is shifted to marginalised regions in the Global South.

There is a significant risk that passive educational adoption of AI may unintentionally reproduce and normalise these extractive global practices.

Incorporating these global realities into the curriculum is essential for teaching responsible digital citizenship and ethical stewardship.





# The Hidden Labour of AI

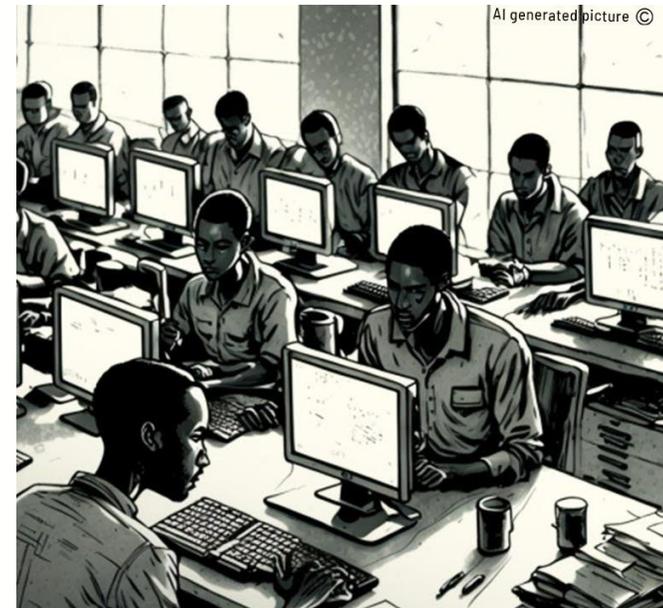
Artificial Intelligence is not just autonomous code; it is built on the foundation of vast human labour.

Thousands of workers are required to label data and filter toxic content to ensure the AI behaves and appears safe for end-users.

This work is often outsourced to regions like Kenya, India, and the Philippines, where workers perform high-stress tasks for very low wages.

Constant exposure to violent, hateful, or disturbing content during the moderation process causes significant long-term emotional trauma.

This labour is intentionally obscured in corporate AI narratives to maintain the illusion of seamless machine intelligence.





# Jevons Paradox

Efficiency improvements can sometimes lead to increased consumption rather than the intended conservation.

Can be linked to the techno-solutionism critique that producing more efficient AI will help save energy.

According to the paradox, it just makes AI cheaper to use more often, thereby increasing total demand.





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# The Educator's Dilemma





## Innovation vs Stewardship

The tension between preparing students for an AI-driven world and protecting the planet.

The Conflict: We want students to be AI-literate for their careers, but we must also teach them to be planetary stewards.

- Pedagogical gains versus environmental harm
- Convenience versus responsibility
- Innovation versus restraint
- Short-term benefits, long-term costs

# Passive Adoption Narratives

“Students are already using it”

- This narrative suggests that because technology is already present in students' lives, schools must automatically integrate it into the formal curriculum.

“Schools expect graduates to know this”

- This framing prioritises employability and market readiness as the primary drivers of educational policy.

“Technology is inevitable”

- This perspective views technological advancement as an unstoppable force of nature rather than a series of human-led choices.

These are choices, not objective truths; they are active pedagogical and ethical choices that carry significant material and social consequences.



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## Action & Ethics





## Why Scale Matters

- On an individual level, a single AI prompt feels environmentally negligible—comparable to charging a phone or boiling a kettle.
- Educational integration is not a solo act; it occurs at a population level across thousands of institutions, turning billions of "trivial" prompts into a massive, aggregate energy and water demand.
- Teacher education carries a unique responsibility. When an educator adopts a tool, they normalize that practice for hundreds of students, amplifying the ecological footprint through professional modelling.
- Small, daily pedagogical decisions accumulate over time into large-scale systemic impacts, shifting local power grids and contributing to global environmental stress.



## Auditing AI Use in Education

Educators must start by asking if the proposed use of AI is truly necessary or if a traditional, lower-impact method would be equally effective.

Critical evaluation of the specific value AI adds to the learning experience—does it deepen understanding, or is it merely a shortcut for a task of marginal value?

Bringing the "hidden debt" into view by estimating the electricity, water, and material costs associated with the specific digital tools being integrated.

Asking the difficult question: Who bears these costs?. This requires acknowledging that while we gain convenience, the ecological and social toll is often spatially and socially displaced to marginalised global communities.



## Digital sobriety

Use AI only where it adds clear pedagogical value

Prefer low-carbon alternatives where possible

Avoid automating tasks that matter for human learning

Remember: the norms modelled now persist across careers.



## Institutional Change

Schools and universities must move beyond individual choice by embedding strict sustainability criteria into their procurement contracts for all software and AI vendors.

Establish clear, campus-wide AI usage guidelines that prioritise limited, purposeful application over broad, unchecked adoption.

Procurement policies should actively favour vendors that demonstrate high transparency and lower environmental footprints, such as those utilising carbon-free energy or smaller, specialised models.

Shifting the burden of ethical stewardship from the individual educator to the institution through collective standards and shared responsibility.



## Summary & key takeaway

- AI has weight: carbon, water, minerals, labour
- Scale turns small choices into systemic impacts
- Sustainability is about intentional, limited use

### **Final message**

Do not be a passive consumer of AI—be an active educational steward.



## Post-lecture activity

### Steps to digital sobriety:

1. I will group my AI queries together to minimize idle energy waste in server clusters.
2. I will cite the AI tool used *and* reflect on its estimated environmental cost.
3. I will prioritise tools that run on local device hardware rather than the Cloud whenever possible.
4. I will experiment with Small Language Models (e.g., Mistral, Phi-3) for specialised classroom tasks.

# Recommended reading

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