

# Sustainability in Computer Science Education

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# GO GOALS



<https://go-goals.org/>





## RESPONSIBLE CONSUMPTION AND PRODUCTION

How much food is wasted every day worldwide?

- a) None, as all the food is eaten or frozen
- b) One third of all food produced**
- c) Very little, as people have dramatically reduced the waste





## RESPONSIBLE CONSUMPTION AND PRODUCTION

Oil is the most polluting industry in the world. Which industry comes second?

- a) Coal extraction
- b) Textile industry
- c) Cellphone industry





## AFFORDABLE AND CLEAN ENERGY



Energy is the main contributor to climate change, producing:

- a) 30% of greenhouse gases
- b) 50% of greenhouse gases
- c) 60% of greenhouse gases





## CLEAN WATER AND SANITATION



The percentage of freshwater resources devoted to crops and livestock production in 2020 was?

- a) 25%
- b) 55%
- c) 75%





## GENDER EQUALITY



Why are rural women more affected by climate change than men?

- a) Because they are weaker
- b) Because they don't have insurance policies
- c) Because they produce 60% to 80% of the crops





## DECENT WORK AND ECONOMIC GROWTH



The transition to a low greenhouse gas economy is expected to lead to:

- a) A loss of 15% of jobs
- b) A net creation of jobs
- c) A loss of 30 % of jobs





## SDG PROBLEMS (ISSUES)

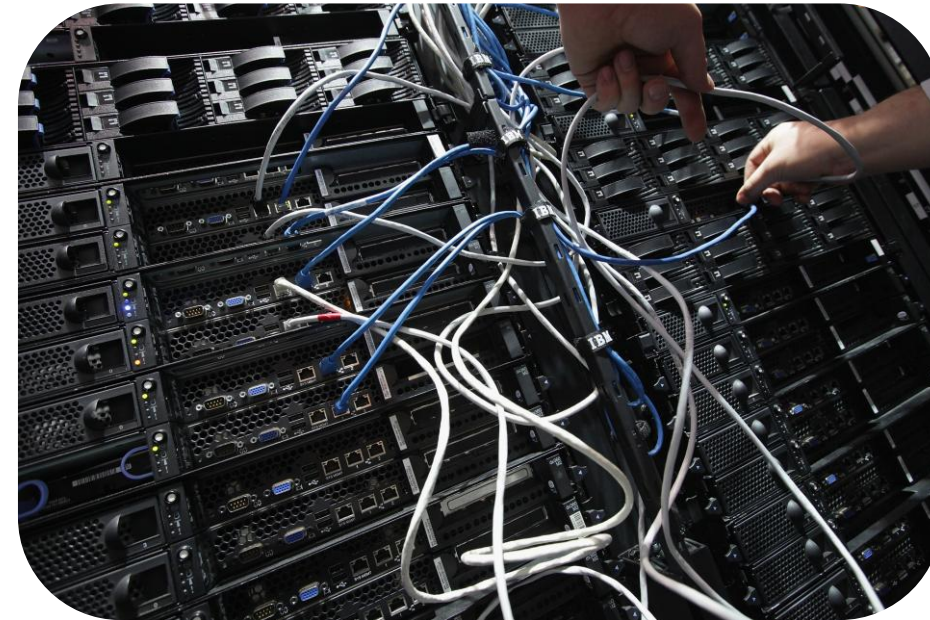
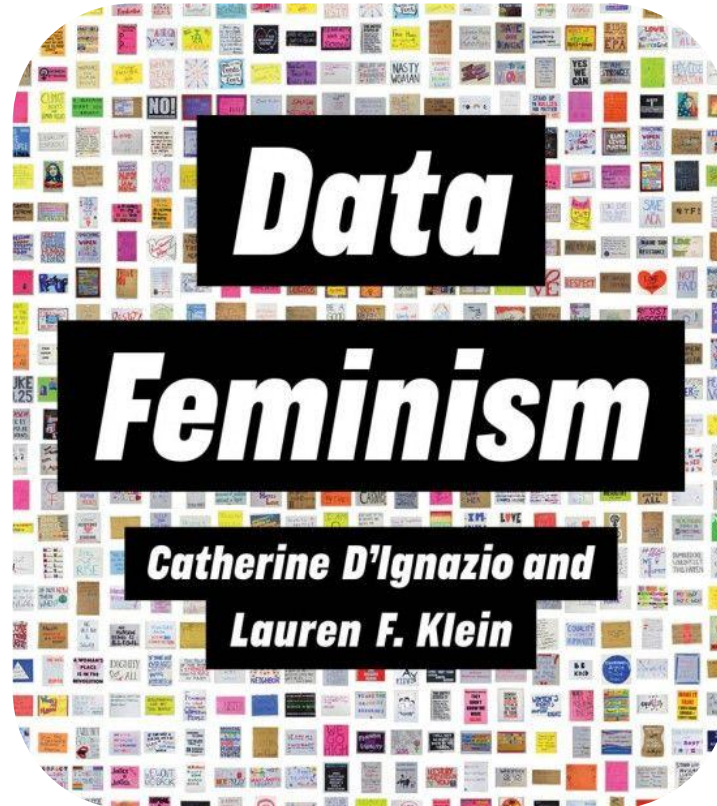


# SUSTAINABLE DEVELOPMENT GOALS



AGENDA  
2015 -  
2030

# COMPUTER SCIENCE AS PART OF THE PROBLEM



# AI Environmental Impact:

Energy and Water Footprints of AI Models



## AI Energy Usage in Numbers

### Thirstiness

GPT-3 "drinks" up a 500ml bottle of water per 30 prompts in the Netherlands



### Energy Appetite

Running a ChatGPT prompt requires 10 to 100 times more energy than sending an email

### Carbon Footprint



Training GPT-3 produces 588.9 metric tons of CO<sub>2</sub>e, roughly equal to the yearly emissions of 128 cars



### Water Footprint

Training GPT-3 in Microsoft's U.S. data centers can lead to the evaporation of 700,000 liters of freshwater



### Global Energy Impact

Data centres currently use nearly 1% of the world's energy

<https://tilburg.ai/2024/09/ai-environmental-impact/>

## ALGORITHMIC THINKING TO SOLVE OUR SDG ISSUES

### Oh Dodo

I looked at your soul up in the sky  
We have taken you away  
And now you're gone  
Away and never to be found.

You're extinct because you were food to us  
You sadly became popular  
So popular that you're gone.

Humans have eaten you all  
Damn humans!  
I hope we go extinct as well.

Lizzy (Aged 10)



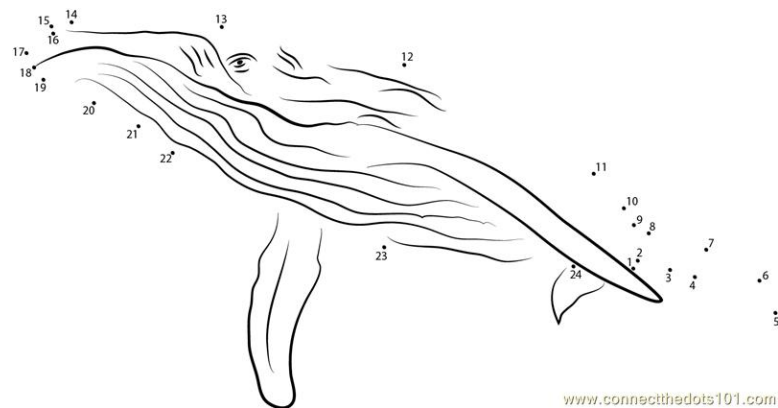
COMPUTER SCIENCE IS ALSO PART OF THE SOLUTION



Smart weeding



# UNPLUGGED CS TO SOLVE COMPLEX PROBLEMS



**This is a lion**



# Learning Goals

## Make a giant whale street art:

Write an unplugged program that automates the making of giant street art for artistically challenged users.

### Cognitive Learning Objectives

- The students can create a flowchart and a stappenplan (algorithm) to automate "creating art on wall".
- The students can execute the stappenplan.



# Learning Goals for Sustainability



## Cognitive Learning Objectives

- The students can create a flowchart and a stappenplan (algorithm) to automate "creating art on wall".
- The students can execute the stappenplan.
- The students will analyze the impact of human activities on whale populations and discuss potential solutions for conservation or raising awareness.

## Socio-emotional Learning Objectives

# Learning Goals for Sustainability



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## Socio-emotional Learning Objectives

- The students understand that whales are endangered and need to be protected
- The students will work in groups to brainstorm and develop their street art projects (teamwork and communication skills).
- Students will reflect on their own relationship with nature and discuss how they can contribute to conservation efforts in their communities.

# Learning Goals for Sustainability



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## Behavioural Learning Objectives

# Learning Goals for Sustainability



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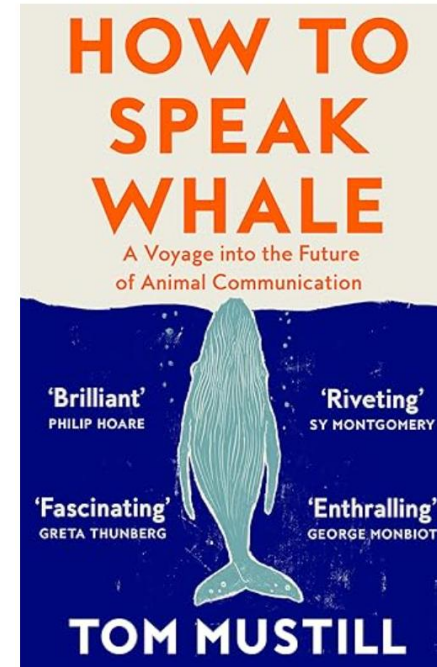
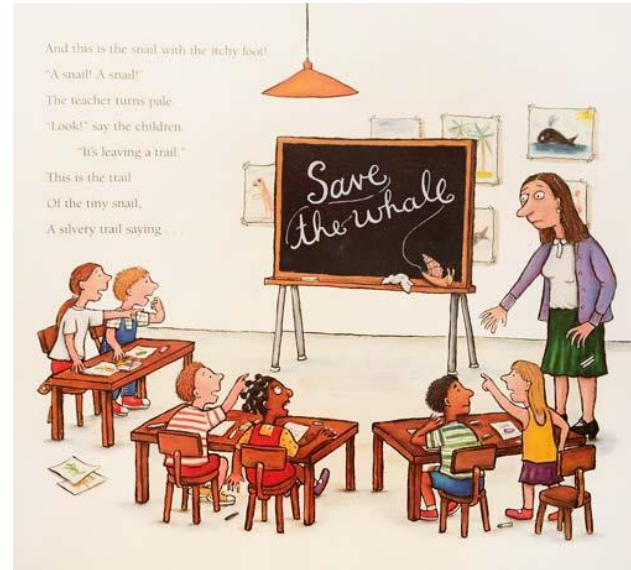
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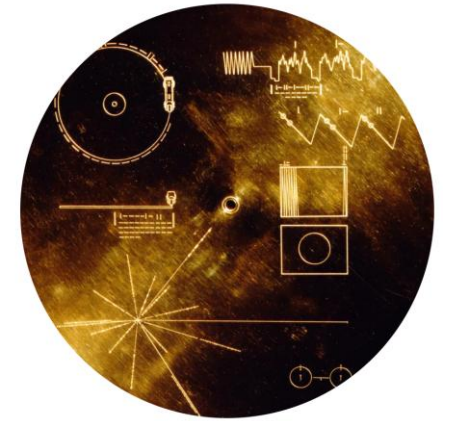
## Behavioural Learning Objectives

- The students will participate in a (school) community awareness campaign that includes their street art, demonstrating their commitment to whale conservation. This can be done in collaboration with the Dutch/Language teacher.
- The students will create and display their street art in a public space, encouraging community dialogue (e.g. writing a piece in the local newspaper/magazine) about whale conservation and environmental sustainability.

# CONTEXTS ARE THE KEY - WHALES



## The voyager golden record



 Roger Payne



# SOME “Loop” EXAMPLES

**Energy/Water Consumption Tracker:** Students write a program that loops through a list of household appliances and calculates the total energy consumption based on usage hours. Or track their energy and water usage of their ChatBot use. This can lead to discussions about energy and water waste.

Work in groups to develop other examples

**Sensory-Friendly Environment Simulation:** Write a program that simulates a classroom environment with various sensory inputs (like noise levels, lighting, and seating arrangements). Students can use loops to evaluate how different settings affect neurodivergent students' comfort and focus, leading to discussions about creating inclusive spaces and empathy.

**Gender Representation:** Students write a program that analyzes a dataset of characters in movies or books, using loops to count the number of male versus female characters. This can lead to discussions on gender representation and its impact on society (e.g. gender in Computer Science).

# Learning Goals

## Simulating a Sensory-Friendly Environment:

Write a program/game that simulates a classroom environment with various sensory inputs (like noise levels, lighting, and seating arrangements). Students can use loops to evaluate how different settings affect neurodivergent students' comfort and focus, leading to discussions about creating inclusive spaces and empathy.

### Cognitive Learning Objectives

**Programming Concept:** The students will apply programming concepts, such as loops and conditionals, to create a simulation that models different sensory environments.

**Data Analysis:** The students will analyze the results generated by their simulations to draw conclusions about which sensory configurations are most supportive to learning for neurodivergent students.

**Empathy:** The students will identify and describe various sensory inputs (noise levels, lighting, seating arrangements) and their potential impacts on neurodivergent students' learning experiences.

### Socio-emotional Learning Objectives

The students can interact with neurodivergent peers and feel empathy for the situation and feelings.

The students can communicate about inclusion and argue in favor of arrangements to foster an inclusive environment.

The students can encourage others to decide and act in favor of promoting an inclusive learning environment for all.

### Behavioural Learning Objectives

The students have the capacity to perceive when others need help for inclusion.

The students are able to demand and support the development of policies promoting inclusion.

The students will discuss the importance of creating sensory-friendly spaces in schools and other public areas.

The students will engage in discussions about the challenges faced by neurodivergent in traditional classroom settings, fostering empathy and understanding towards diverse learning needs.



# OTHER KEY COMPETENCIES

## Box 1.1. Key competencies for sustainability

**Systems thinking competency:** the abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.

**Anticipatory competency:** the abilities to understand and evaluate multiple futures – possible, probable and desirable; to create one’s own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.

**Normative competency:** the abilities to understand and reflect on the norms and values that underlie one’s actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.

**Strategic competency:** the abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.

**Collaboration competency:** the abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.

**Critical thinking competency:** the ability to question norms, practices and opinions; to reflect on own one’s values, perceptions and actions; and to take a position in the sustainability discourse.

**Self-awareness competency:** the ability to reflect on one’s own role in the local community and (global) society; to continually evaluate and further motivate one’s actions; and to deal with one’s feelings and desires.

**Integrated problem-solving competency:** the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating the above-mentioned competences.

Education for

Sustainable Development Goals

Learning Objectives



OTHER COMPETENCIES (ALSO NEEDED FOR COMPUTER SCIENTISTS)

Think also about interdisciplinary collaboration

Critical Thinking

Collaboration

Self-Awareness

System Thinking

LINK TO SLIDES



