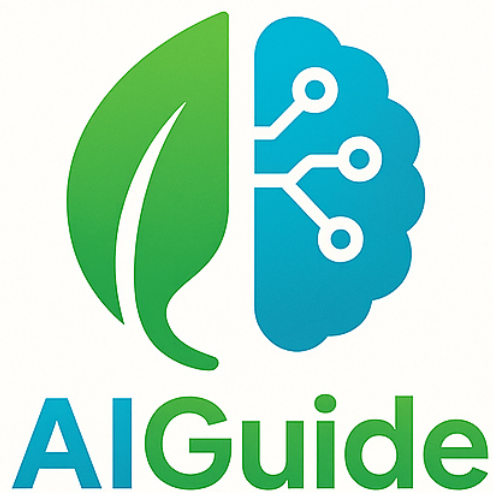




ONLINE COURSE CONTENT

MODULE 4: ADAPTING REAL-LIFE CASE SCENERIOS INTO COURSE CONTENTS

2025-1-LT01-KA220-HED-000354784

Artificial Intelligence for Green Understanding, Insights & Decision Empowerment



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A. General Information

Module No	Module 4
Subtopic	4.2. Adapting real-life case scenarios into course contents
AI Literacy Component	Instructional adaptation of AI-supported green cases; alignment between case, outcome and assessment
Decision Making Skills	Transfer to teaching; course contextualisation; scenario adaptation
Learning Objectives for STEM HE Teachers	Adapt real-life case scenarios and good examples into STEM course content and learning activities.
Learning Objectives for STEM Students	Engage with scenarios connected to their discipline.
Suggested AI Tools	ChatGPT, Claude, Microsoft Copilot, Perplexity AI, Llama, Poe
Estimated Duration	60 minutes

B. Content for STEM HE Teachers

Adapting real-life case scenarios into course contents

Highlights

- Integrating AI-supported sustainability cases into STEM higher education has educational value.
- There are active learning strategies that promote discussion, collaboration, and critical analysis of AI-supported environmental decisions.
- Students need guidance to evaluate decision alternatives, interpret AI recommendations, and recognise contextual differences.
- Techniques for facilitating reflective learning can strengthen evidence-based reasoning and sustainability competencies.

Introduction

Artificial Intelligence is increasingly used in environmental and industrial decision-making, from optimising energy consumption and forecasting climate risks to improving resource management and facilitating sustainable production systems. (Uriarte et al., 2024) However, understanding AI's role in green decision-making requires more than knowledge of AI technologies. STEM students need to understand how AI-supported solutions are developed, interpreted, evaluated, and adapted to different real-world situations.

Case-based learning has a long tradition in higher education, particularly in professional disciplines where students must apply knowledge to complex situations. Effective cases encourage learners to analyse realistic problems, consider multiple perspectives, and develop evidence-based solutions.

(Herreid, 2007) Moreover, real-world cases can enable deeper understanding of complex phenomena by examining them within their actual context. (Yin, 2018)

When AI-supported green decision cases are introduced into courses, teachers can use them in several ways such as:

- **As an introduction to a topic:** A real industrial example can motivate students before introducing theoretical concepts.
- **As an application activity:** Students can use existing knowledge to analyse how AI supports environmental decisions.
- **As a comparison framework:** Students can examine why the same AI approach may produce different outcomes in different contexts.
- **As a reflection tool:** Students can evaluate the relationship between AI recommendations and human judgement.

The objective is not to teach students to accept AI-generated decisions, but to develop their ability to critically evaluate AI as a decision-support technology. AI applications related to sustainability require consideration of broader social and environmental systems rather than focusing only on technological performance. (Vinuesa et al., 2020)

Check this video on AI and critical thinking: [Sarkar, 2025](#)

Application of Case Studies in Learning Environment

Case studies as an introduction to a topic

Case-based learning is particularly appropriate as an introduction to different topics because it shows a full picture of a theoretical concept before engaging in abstract theory. Research on case-based and problem-based learning highlights the value of authentic problems, multiple perspectives, collaboration and the application of knowledge rather than simple knowledge recall. (Allchin, 2013) A 2024 meta-analysis of 22 investigations also found that case-based teaching produced stronger cognitive learning outcomes than lecture-based teaching, including knowledge acquisition and skills development. (Bayona-Durán, 2024)

A real industrial case can function as a cognitive “hook”. Raising interest of the students on a topic in learning activities can result in many benefits, such as improving learners’ attention, memory and motivation. The process of developing interests in a learning environment can be described by the four-phase model of S. Hidi and K. A. Renninger. (Guo-Fryer, 2024)

1. Triggered situational interest: Students discover interest by themselves or supported by others through environmental features such as personal relevance or surprise.
2. Maintained situational interest: Students keep engaging with the topic, with affective, cognitive and value components.
3. Emerging individual interest: Situational interest develops with knowledge and value into intrinsically driven individual interest.
4. Well-developed individual interest: Students voluntarily seek opportunities to extend their knowledge. Suitable challenges and learning activities can facilitate the development of well-developed individual interests.

If students first encounter a concrete, real-world sustainability problem, the teacher can introduce specific concepts such as machine learning, optimisation, prediction, digital twins, constrained decision-making or AI-supported control. This is particularly useful because environmental applications of AI span many domains, including energy, manufacturing, agriculture, water and environmental monitoring.

PRACTICAL EXAMPLE

Before teaching optimisation algorithms, give students the SOCAR Carbamide scenario: “A fertilizer plant wants to increase production while reducing natural-gas consumption. Engineers have hundreds of process variables available. How would you approach the problem?” Give students 10 minutes to suggest solutions without mentioning AI. Then reveal that SOCAR used AI-supported optimisation. Students can subsequently map their proposed solutions onto concepts such as prediction, simulation and optimisation. This creates a clear problem → curiosity → theory → application sequence.

As an application activity

Case-based learning is strongly associated with moving students beyond recall towards application, analysis and evaluation, which makes it particularly appropriate after students have learned the underlying concepts. The environmental-AI literature shows that AI is already applied to environmental problems through mathematical modelling, prediction, optimisation and decision-support approaches. A systematic review by Kumar Kar et al. examined 287 papers and identified applications across areas including manufacturing, transportation, construction, agriculture and water, with regression, reinforcement learning and decision-support approaches among the commonly reported methods. (Kumar Kar et al., 2022) Thus, a real-world case study can be considered as a transfer channel from previously acquired knowledge to practical applications.

PRACTICAL EXAMPLE

After teaching multi-objective optimisation, provide students with the SOCAR case.

OPTION 1: Analyse the case together or in groups (see steps in Module 4.1)

OPTION 2: Introduce the challenge of the case and provide a simplified dataset containing production volume, natural-gas consumption, temperature, pressure and operating setpoints. Ask groups to determine which variables should be optimised and to formulate an objective. E.g. reduce natural gas consumption per tonne of product, while the level of production meets or exceeds the target value and safety and quality considerations are applied.

As a comparison framework

AI does not produce sustainability outcomes independently of its context. Reviews of AI and environmental applications show considerable variation in the problems, datasets, algorithms and organisational settings in which AI is deployed. (Konya-Nematzadeh, 2024) Consequently, students can use cases to investigate context-dependent effectiveness: the same type of AI—such as predictive optimisation—may produce very different environmental outcomes depending on the objective function, data quality, physical infrastructure, energy mix, operational constraints and human decision processes. Recent research on human–AI collaboration similarly emphasises that decision outcomes depend on the interaction between the AI system, humans and the type of decision being made. A 2026 systematic review, for example, identifies different forms of human–



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AI decision-making and highlights differences in how responsibility, interaction, trust and authority are distributed. (Li-Tian, 2026)

PRACTICAL EXAMPLE

Ask students to compare SOCAR Carbamide's industrial case (see Module 4.1) with other energy optimisation examples such as Google/DeepMind's data-centre cooling optimisation. Make the comparison by different dimensions including type and sector of the supported system, main green challenge, (energy) resources involved, AI role, AI tools, risks, main indicators and human role. Students can visualise the results, e.g. in a matrix, present the difficulties they faced during the analysis (e.g. data availability, system boundaries, scale etc.), and explain the different outcomes. They should come to a conclusion that the AI's environmental impact depends on what it is optimising, how it is deployed and what wider system it changes.

As a reflection tool

Contemporary research increasingly conceptualises AI not simply as an autonomous decision-maker but as part of a human–AI collaborative decision system. AI and humans can distribute and reshape decision-making responsibilities (Li-Tian, 2026), while specific mechanisms are required, including role configuration, interaction, deliberation, trust, explanation, authority and responsibility (Luo et al., 2026). Research specifically addressing human-in-the-loop AI for climate action argues that human involvement is important for contextualised decision-making, mitigating bias and incorporating social and cultural values. (Debnath et al., 2025) This is highly relevant to green decision-making because environmental decisions involve values and trade-offs—such as cost versus emissions, efficiency versus resilience, or production versus ecosystem protection—that cannot necessarily be resolved by technical optimisation alone.

PRACTICAL EXAMPLE

Give students an AI-generated recommendation for the presented case study, e.g., “Increase the operating setpoint because the AI model predicts a 4.5% reduction in energy consumption while maintaining production.”

Students must decide whether to accept it. Give different groups different information, e.g.:

- **Group A:** AI confidence is 95%.
- **Group B:** the prediction is based on historical data from normal operating conditions.
- **Group C:** the energy saving is substantial, but electricity is currently supplied from a low-carbon source.
- **Group D:** the recommended action could increase equipment wear.

Discuss whether human decision-makers should accept the AI recommendation or not. There is deliberately no single correct answer. Students must explain and discuss what the AI knows, does not know, which assumptions underpin the recommendation, which stakeholders are affected,



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whether the recommendation meets the sustainability objective; and when human override is justified.

Green Decision Context

Green decisions are rarely straightforward. The AI system may recommend several solutions, but decision-makers must also consider other factors like regional needs; infrastructure limitations; economic consequences or social impacts. Using real-life cases helps students understand three important principles:

- AI decisions depend on data quality and context. (Kusak, 2022)
- AI supports decisions but does not replace humans entirely. In specific contexts, such as safety-critical environments, professional investigative thinking and human elements are irreplaceable, and AI should augment rather than automate expert judgment. (COMET, 2025)
- Sustainable solutions must be adapted to local conditions. (Moallemi et al., 2020)

For adapting the case studies in STEM higher education, the following steps are recommended:

1. Selection of an authentic case with adequate data and information. The case study can be connected to the given course to be in line with the thematic structure of the course. In case of using examples from other sectors, comparison and adaptability considerations can be also explored.
2. Presentation of the case for the class. It can be a presentation or a written introduction with the amount of information we would like to share with the students preliminarily. With less information, students can have extended discussions.
3. With guided questions, let students analyse the case studies, identifying methods, benefits, challenges and other lessons learned.

Case studies can have the greatest impact on students when examined through reflection activities. Questions can be discussed at the level of the whole class or in smaller groups after the teacher's presentation. Group activities can offer further and deeper discussion opportunities in the class or even as project work.

For each case, students should identify:

- What environmental problem is being addressed? What are the effects of this challenge if it is not treated?
- What data does the AI analyse? What information may be missing?
- What decision does the AI support?
- Which human decisions remain necessary?
- Which sustainability indicators improve?
- Could another solution produce better environmental outcomes? Would the same recommendation work in another context?
- What trade-offs exist between environmental, economic, and social objectives?

Higher education teachers should coordinate the discussions to ensure continuous, equal and inclusive communication. There are different methods to conduct such discussions. (Yale University, 2026)

- Socratic Method: open-ended questions that encourage students to think critically. [Check this video on the Socratic method: The Right Questions, 2021](#)
- Fishbowl: students take turns actively participating in the discussion (inner circle) and serving as listeners (outer circle). [Check this video on the fishbowl method: Edutopia, 2018](#)
- Jigsaw: Each group discusses on a particular topic, then these students are re-shuffled to create new groups with representatives from each previous group who will share key aspects of their original discussion. The second group must synthesise and use all of the ideas in order to complete a new or more advanced task. [Check this video on the Jigsaw method: Harvard Graduate School of Education, n.d.](#)
- Think-Pair-Share: Students work individually on an active learning assignment (Think), then compare their responses with a partner and synthesise a joint solution (Pair) which can be shared with the entire class (Share). [Check this visualisation of the Think-Pair-Share method King's College London, 2019](#)

AI tools

AI tools can help you adapt and integrate case studies in your courses, for example:

- ChatGPT (OpenAI): Adapt industrial cases to different STEM disciplines
- Claude: Analyse long case studies and identify key discussion points
- Microsoft Copilot: Generate sample recommendations
- Perplexity AI: Develop real-world case studies and fictional scenarios.
- Poe: Compare different alternatives.
- NotebookLM: Organise course materials and generate guiding questions
- Gamma AI: Create visual case presentations
- Canva Magic Design: Develop infographics and teaching materials

Check the Best Practices Report for more information about the tools.

Real World Examples (Choose from best practices report)

n.a.

Example Projects (Choose from best practices report)

n.a.

Recommended Readings

Allchin, D. (2013): Problem- and Case-Based Learning in Science: An Introduction to Distinctions, Values, and Outcomes. CBE Life Sci Educ. 2013 Fall;12(3):364–372. doi: 10.1187/cbe.12-11-0190

Bayona, J. A. – Durán, W. F. (2024): A meta-analysis of the influence of case method and lecture teaching on cognitive and affective learning outcomes. The International Journal of Management

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Konya, A. – Nematzadeh, P. (2024): Recent applications of AI to environmental disciplines: A review. *Science of The Total Environment*, Volume 906, 2024, 167705. ISSN 0048-9697. <https://doi.org/10.1016/j.scitotenv.2023.167705>

Kumar Kar, A. - Kumari Choudhary, S. - Kumar Singh, V. (2022): How can artificial intelligence impact sustainability: A systematic literature review. *Journal of Cleaner Production*, Volume 376, 2022, 134120, ISSN 0959-6526. <https://doi.org/10.1016/j.jclepro.2022.134120>

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Li, H. - Tian, F. (2026): Advancing Decision-Making through AI-Human Collaboration: A Systematic Review and Conceptual Framework. *Group Decision and Negotiation* 35, 26 (2026). <https://doi.org/10.1007/s10726-026-09980-1>

Luo, Y. – Hao Y. – Gong H. – Li B. (2026): Applications of human-machine collaborative decision-making: A review of research with recent developments. *iScience*, Volume 29, Issue 6, 2026, 116056. ISSN 2589-0042. <https://doi.org/10.1016/j.isci.2026.116056>.

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Uriarte-Gallastegi, N., Arana-Landín, G., Landeta-Manzano, B., & Laskurain-Iturbe, I. (2024): The Role of AI in Improving Environmental Sustainability: A Focus on Energy Management. *Energies*, 17(3), 649. <https://doi.org/10.3390/en17030649>

Vinuesa, R., Azizpour, H., Leite, I., et al. (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. *Nature Communications*, 11, 233. <https://doi.org/10.1038/s41467-019-14108-y>



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Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods* (6th ed.). Sage Publications.

Videos/Interactive Resources

- Edutopia (2018): 60-Second Strategy: Fishbowl Discussion. Available: <https://www.youtube.com/watch?v=JVCFGLVZA3w>
- Harvard Graduate School of Education (n.d.): Using jigsaws to facilitate small-group discussions. Available: <https://instructionalmoves.gse.harvard.edu/using-jigsaws-facilitate-small-group-discussions>
- King's College London (2019): Think-Pair-Share. Available: <https://blogs.kcl.ac.uk/activelearning/2019/05/01/think-pair-share/>
- Sarkar, Advait (2025): How to stop AI from killing your critical thinking. TEDAI Vienna, September 2025. Available: https://www.ted.com/talks/advait_sarkar_how_to_stop_ai_from_killing_your_critical_thinking
- The Right Questions (2021): How to Use the Socratic Method (for Dialogue, Debate and Critical Thinking) Available: <https://www.youtube.com/watch?v=USo7V6kwfEk>



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