Högskolan Kristianstad

Education for Sustainable Development through Practical Work: Insights from a Laboratory-based Learning Environment

Britt-Marie Svensson, Patrik Sällström, Pille Kängsepp, Christel Persson and Celia Cabaleiro-Lago*

Department of Bioanalysis

Kristianstad University, Sweden

NATURAL SCIENCES AND SUSTAINABLE DEVELOPMENT

Experimental sciences are central to solving SD challenges

Laboratory practices have a high environmental footprint

Future scientists must be trained in sustainable experimental practices

Högskolan Kristianstad

Freese, T., et al. (2024). *The relevance of sustainable laboratory practices*. **RSC Sustainability, 2**(5), 1300–1336

EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)

- Emphasizes the **integration** of sustainability content in education and sustainable teaching methodologies.
- is interdisciplinary and **embedded** in the whole curriculum
- **aims to empower learners to make informed, responsible decisions for sustainable development**

Högskolan Kristianstad

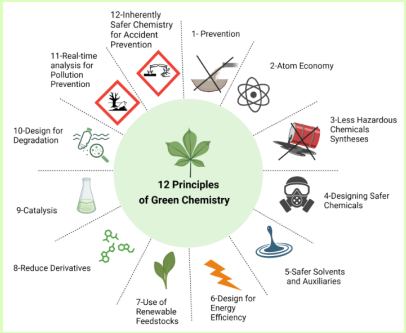
Alexander Leicht, B. C., et al. (2018). From Agenda 21 to Target 4.7: the development of Education for Sustainable Development. UNESCO,

THE CHALLENGE: INTEGRATING SD IN LABORATORY TEACHING

- Sustainability is often treated as theory rather than practice.
- Laboratory manuals focus on procedures, not implications.
- Teachers lack integration strategies and competence.

- Approaches
  - Green labs: Isolated moments, large curriculum redesign, linked to individuals.
  - Accreditation schemes: Big structural and economic load, high workload, reluctance to adoption.

Addition of Green Labs



Accreditation schemes

Burmeister, M., et al. . (2012). Education for Sustainable Development (ESD) and chemistry education [Article]. *Chemistry Education Research and Practice*, *13*(2), 59-68

Aim

To investigate whether sustainability perspectives can be integrated into existing laboratory instructions through small, targeted modifications, and to explore how such integration influences student's awareness of the SDGs and their behaviours.

- Only small alterations in the curriculum.
- Low workload (normal course development work).
- Easy to implement (Support avaliable)

Högskolan Kristianstad

STRATEGY

Increased visibility + structured reflection → enhanced sustainability awareness and behavioural change.

Identify connections between laboratory tasks and SDGs

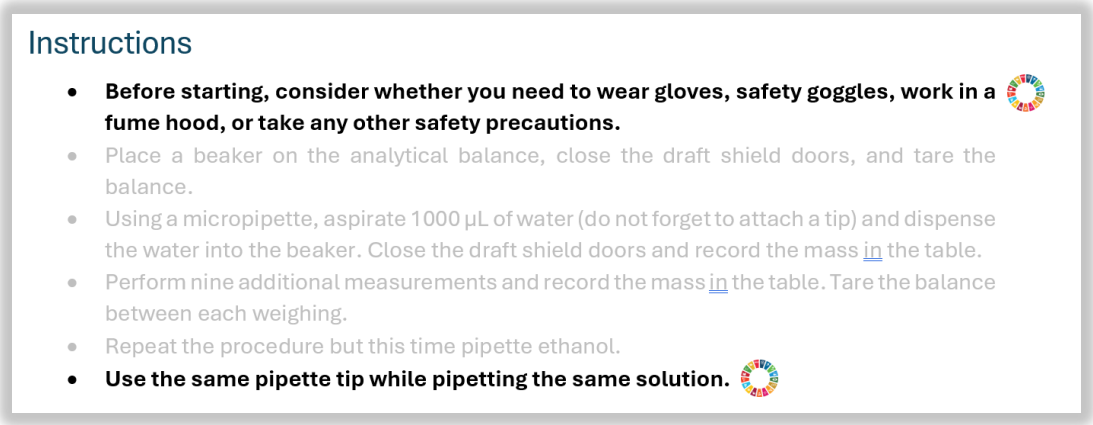
Add SDGs **symbols** to the laboratory instructions

Add reflection **prompts** to support critical discussion

Illustrations generated using ChatGPT (OpenAI)

Mapping laboratory tasks to SDGs

- Laboratory instructions were analysed from an SD perspective by the course teaching team.
- Tasks, based on their environmental impact, resource use, and societal relevance, were identified and marked with the SDGs wheel symbol.
- The analysis work was supported by a worksheet, ”sustainability worksheet”, that lists typical activities and their connection to SDGs.



Instructions

- **Before starting, consider whether you need to wear gloves, safety goggles, work in a fume hood, or take any other safety precautions.**
- Place a beaker on the analytical balance, close the draft shield doors, and tare the balance.
- Using a micropipette, aspirate 1000 µL of water (do not forget to attach a tip) and dispense the water into the beaker. Close the draft shield doors and record the mass in the table.
- Perform nine additional measurements and record the mass in the table. Tare the balance between each weighing.
- Repeat the procedure but this time pipette ethanol.
- **Use the same pipette tip while pipetting the same solution.**

Högskolan Kristianstad

MAPPING LABORATORY TASKS TO SDGS

- ”Sustainability tables” were created for each laboratory and included at the end of each laboratory instruction.

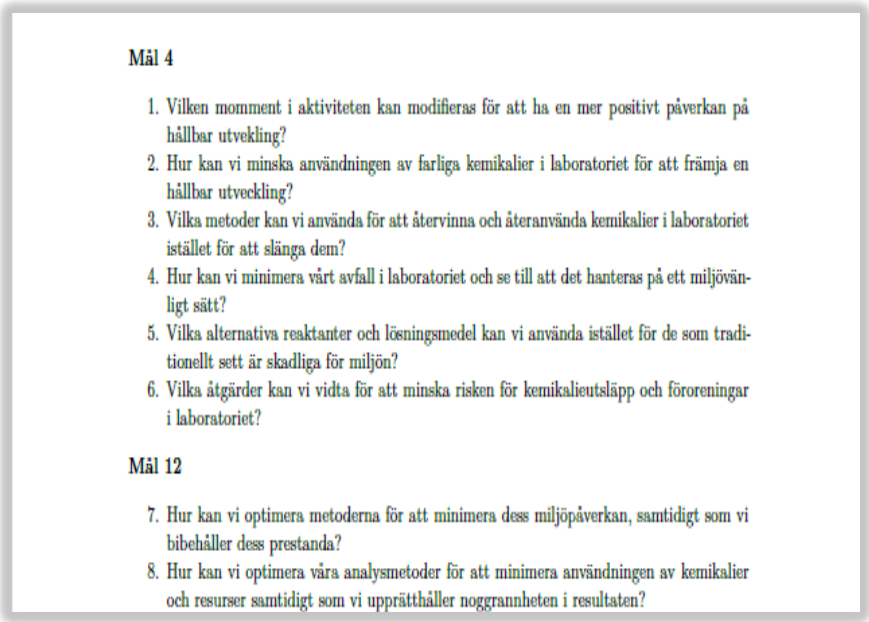
- The table describes the relationship between laboratory procedures and the SDGs.

SDG	Target	Impact	Link to laboratory task
 	12.5 Substantially reduce waste generation	Direct	The amount of plastic waste is minimized, for example, by rinsing and reusing plastic pipettes and tips for automatic pipettes when appropriate.
 	8.8 Protect workers’ rights and promote a safe and secure working environment for all	Indirect	Protective equipment is adapted to the specific task

Högskolan Kristianstad

ADDING DISCUSSION PROMPTS

- Discussion prompts about SD were embebbed in the instructions
- The ”sustainability worksheet” includes a question bank with questions classified by SDGs.
- This is a living document that grows as more laboratories are incorporated into the project.



Mål 4

1. Vilken momment i aktiviteten kan modifieras för att ha en mer positivt påverkan på hållbar utvekling?
2. Hur kan vi minska användningen av farliga kemikalier i laboratoriet för att främja en hållbar utveckling?
3. Vilka metoder kan vi använda för att återvinna och återanvända kemikalier i laboratoriet istället för att slänga dem?
4. Hur kan vi minimera vårt avfall i laboratoriet och se till att det hanteras på ett miljövänligt sätt?
5. Vilka alternativa reaktanter och lösningsmedel kan vi använda istället för de som traditionellt sett är skadliga för miljön?
6. Vilka åtgärder kan vi vidta för att minska risken för kemikalieutsläpp och föroreningar i laboratoriet?

Mål 12

7. Hur kan vi optimera metoderna för att minimera dess miljöpåverkan, samtidigt som vi bibehåller dess prestanda?
8. Hur kan vi optimera våra analysmetoder för att minimera användningen av kemikalier och resurser samtidigt som vi upprätthåller noggrannheten i resultaten?

Högskolan Kristianstad

INTERVENTION

Laboratory sciences 1

- Biomedical Laboratory Science programme
- First semester
- 8 ”traditional” laboratory sessions + 1 PBL

- Intervention:
  - Student groups: One before the intervention (2023) and 3 after the intervention (2023-2024)
  - SDGs symbols in all lab manuals
  - Discussion questions in selected lab manuals
  - Written and oral reflection during PBL

Fundamental Ideas of Chemistry and Chemical Thinking

- Teacher Education Programme (grades 7–9)
- First semester
- 5 laboratory sessions

- Intervention:
  - One student group (2023)
  - SDGs symbols in lab 1 manual with side prompts
  - Discussions propmts in the lab manual
  - Written reflection on SD

Data sources and analysis

Laboratory sciences 1

- Student laboratory planning
- Observations during laboratory sessions
- Students discussion during the oral reflection
- Observations in a subsequent course

Fundamental Ideas of Chemistry and Chemical Thinking

- Student laboratory reports
- Observations during laboratory sessions

Focus of analysis:

- Students' awareness of the SDGs
- Reflections on sustainability in laboratory practice
- Observed behaviours during laboratory work

Högskolan Kristianstad

RESULTS: LABORATORY SCIENCES 1

- Increase in awareness
  - Student's laboratory planning
  - Oral discussion

The student:	Before intervention (n=20)	After intervention (n=77)
has acknowledge the symbols and understands its purpose	**n/a**	**85 %**
considers and reflects on sustainable development in the written laboratory planning for the practical Qualitative analysis	**10%**	**49 %**
links different moments to SDGs in the written laboratory planning for the practical Qualitative analysis	**0%**	**34 %**
can reflect on sustainable development issues in the discussion session after the practical.	**0%**	**82%**

Results: Fundamental Ideas of Chemistry and Chemical Thinking

- Prompts led to spontaneous discussion during the session
- Students independently evaluate resource use and choose to reduce it during the lab.
- Students reflected on the importance of promoting SD awareness in their future professional roles.

SDG	Students' reflections
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	With this, the chemicals to be analyzed were utilized more efficiently, and waste was minimized.
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	We also used small test tubes and tried to avoid unnecessary tests, all in order to reduce chemical usage
4 QUALITY EDUCATION	It should also be emphasized that it is important for students to feel a sense of responsibility for the chemicals they use, understanding that these are real and can be dangerous if mishandled.

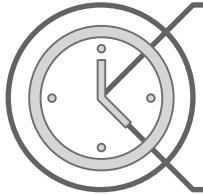
OUTCOMES

- Increased ability for discussion about how SDGs are linked to laboratory work
- Increase of proactive (and uppropmted) questions on resource use and waste
- 33% reduction in single-use plastic waste

- Declared awareness did not always translate into concrete actions
- Low awareness of other SDGs
- Global understanding requires more extended and focus discussion sessions

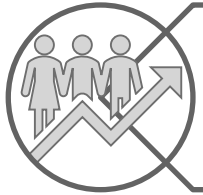
Högskolan Kristianstad

TEACHERS' PERSPECTIVE



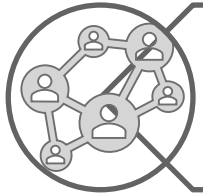
Preparatory work was not time-comsuming

The changes did not compromise the learning goals



Analysis of the laboratories led to improvements regarding the laboratories sustainability

Waste, resource management and safety was improved



The low barrier and the supporting tools make the project easy to adopt and apply.

Högskolan Kristianstad

Conclusion and way forward

Integrating sustainability into ordinary laboratory teaching is feasible without changing the core learning outcomes.

It leads to more sustainable laboratory practices and may contribute to student's behavioural change.

Awareness of the SDGs is a start. Continuous reinforment and other active pedagogical tools are needed for behavioural changes.

Högskolan Kristianstad

THANK YOU

Britt-Marie Svensson

Pille Kängsepp

Patrik Sällström

Christel Persson

Högskolan Kristianstad