



UMEÅ UNIVERSITY

# A Daunting but Essential Task

How can we better integrate sustainability perspectives into engineering education?

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# Outline

- What is (not) education for sustainable development (ESD)?
- ESD as an obstacle course: six hurdles and tools for tackling them in engineering education



# SD in the CDIO Standards

- SD in introductory course
- Focus on design for sustainable development (SD)
- SD competencies:
  - understand the implications of technology on SD
  - collaborate with external actors to develop appropriate technical solutions
  - adequately assessed
- Faculty competence on SD (*what* to teach, but not *how*?)

# Optional Standard 1: Sustainable development

“A program that identifies the ability to contribute to a sustainable development [SD] as a key competence of its graduates. The program is rich with sustainability learning experiences, **developing the knowledge, skills and attitudes required to address sustainability challenges.**”

# Education for sustainable development (ESD)

aims to equip learners with the knowledge, competencies, and agency they need to address interconnected global sustainability challenges (SDG 4.7).

## CDIO Optional standard 1:

the program “develop[s] the knowledge, skills and attitudes required to address sustainability challenges.”



Discuss with the person(s) next to you (~2 min):

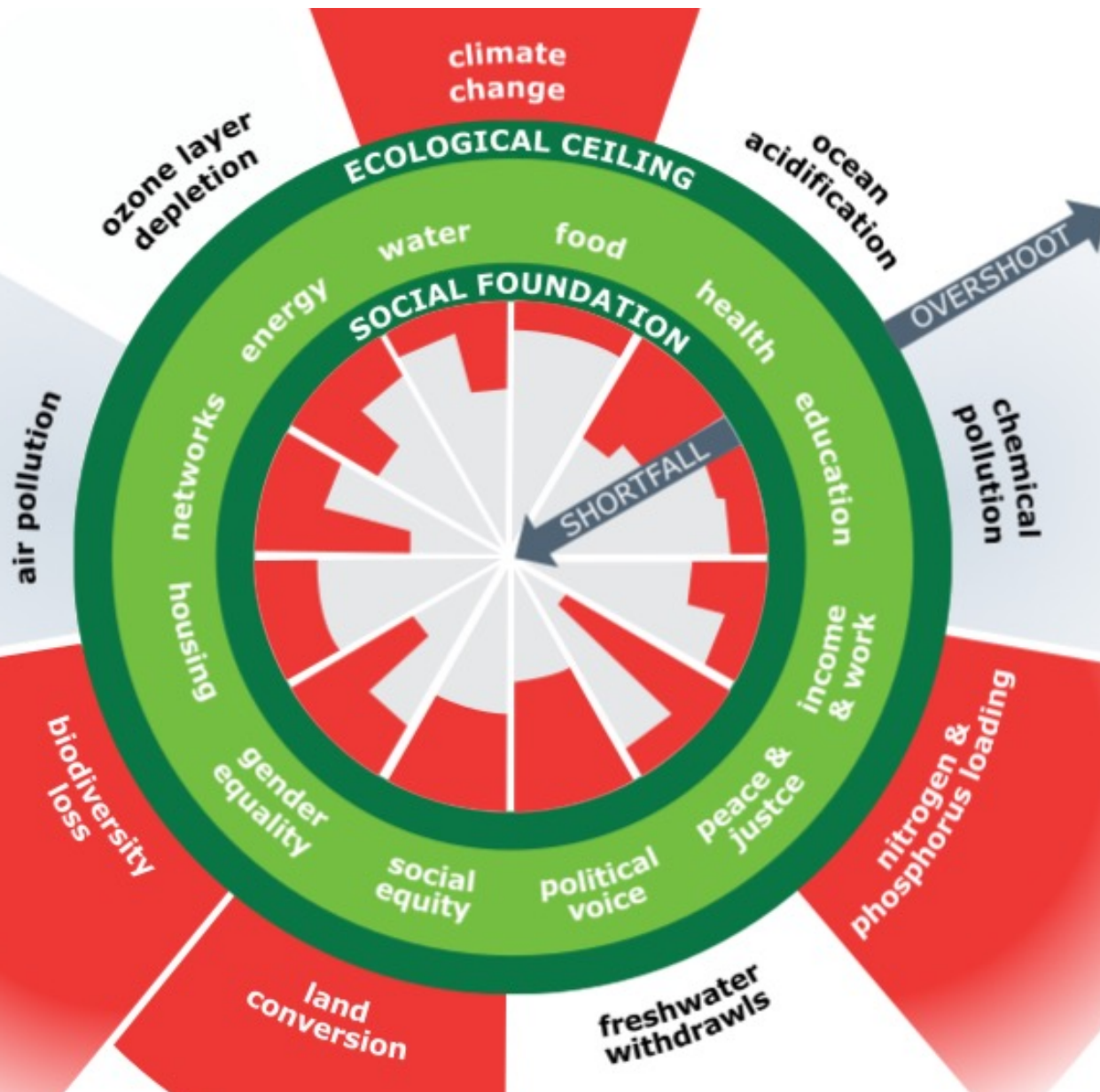
What does “developing the knowledge, skills and attitudes required to address sustainability challenges” mean for you?



# Addressing interconnected global sustainability challenges

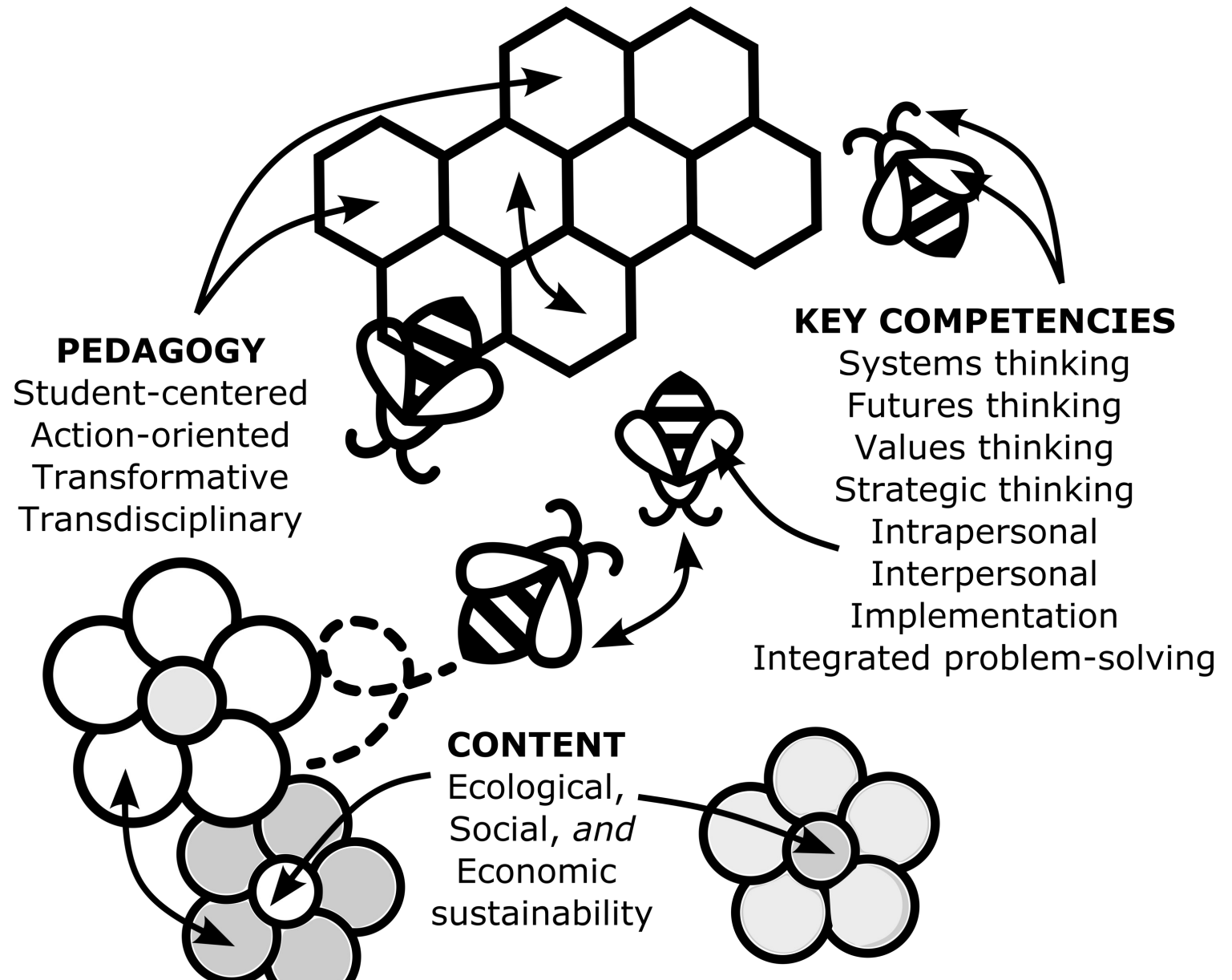
As a global community, we need to learn to live well between a social foundation (basic *human* needs) & an ecological ceiling (basic *planetary* needs)!

CDIO Optional Standards 3.0  
[www.kateraworth.com/doughnut/](http://www.kateraworth.com/doughnut/)



# What is ESD?

All three core aspects must be addressed simultaneously!



Lönngren (forthcoming).  
Utdanning av fremtidige  
ingeniører for bærekraft:  
Komplekse utfordringer  
krever nye løsninger



# Welcome to the Obstacle Course of ESD!

Hurdle 1: Sustainability problems are wicked!

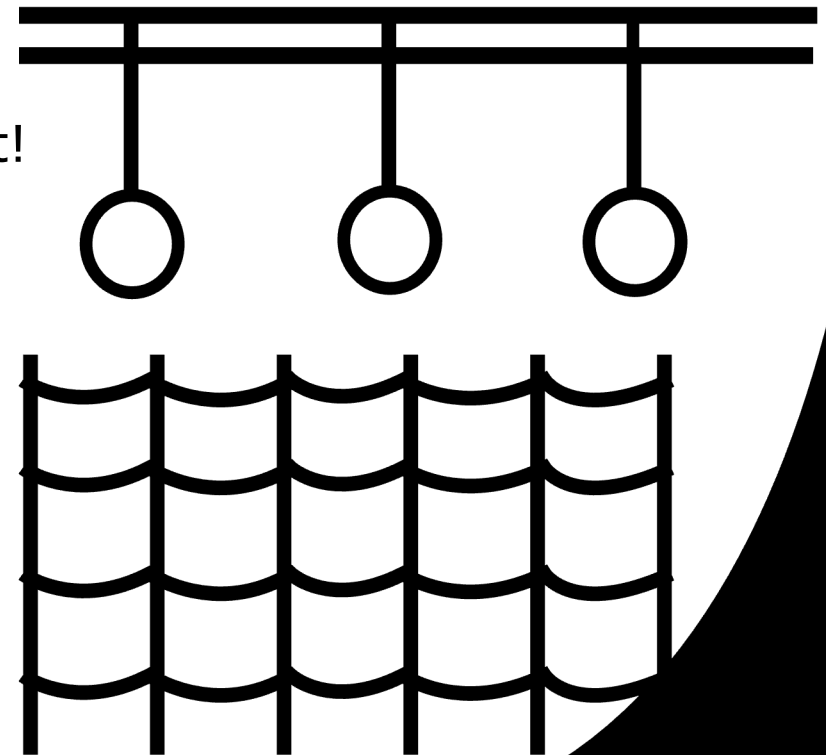
Hurdle 2: Sustainability is a normative concept!

Hurdle 3: I'm not an expert in sustainability!

Hurdle 4: My course is already crammed!

Hurdle 5: The students don't like it!

Hurdle 6: I don't know where to start!



# 1. Sustainability problems are wicked!

- High degree of complexity & uncertainty
- Value conflicts
- Conflicting problem definitions
- No right/wrong solutions
- No universally accepted criteria for evaluating potential solutions
- Unique, context-dependent, connected to other problems
- Every attempt at solving has consequences

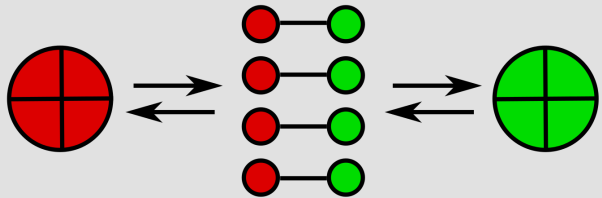


## 4 Approaches towards wicked problems



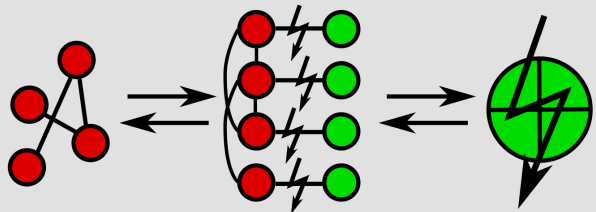
A: Simplify & Avoid

Wicked problems require concretizing problems & solutions



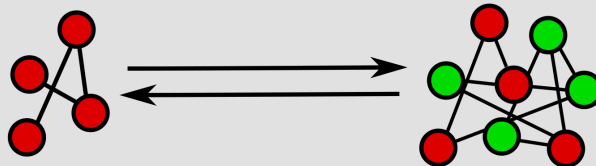
B: Divide & Control

Mechanistic approaches can be efficient, but are not always effective



C: Isolate & Succumb

Students need tools for dealing with wickedness



D: Integrate & Balance

Students can learn to work with wickedness

Lönngren et al. (2017). Avoid, Control, Succumb, or Balance, *Res in Sc Ed*, 47, 805-831.

# Wicked problems as a pedagogical tool for developing ESD key competencies

## 1. Systems thinking & anticipatory competence

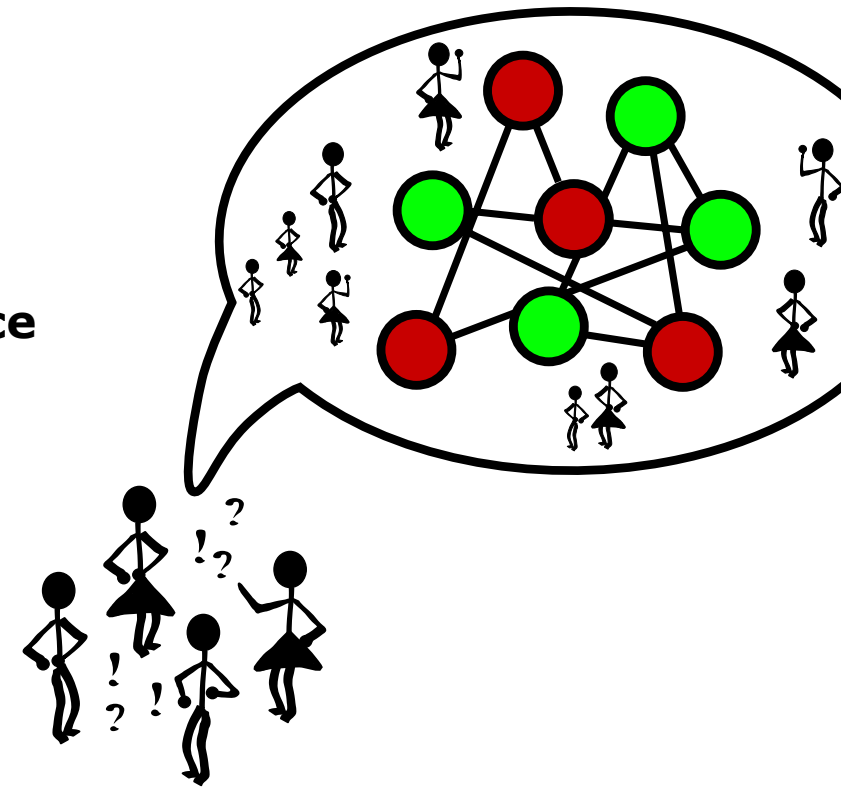
- System parts & connections
- System dynamics

## 2. Normative, inter- & intrapersonal competence

- Stakeholders & relationships
- Conflicting values & interests, ambiguity

## 3. Strategic & implementation competence

- Societal structures & power dynamics
- Envisioning & co-creating



## 2. Sustainability is a normative concept!



**But: even engineering is entangled with social norms and values**

- Engineers are human beings who develop technology for human beings
- Engineering work requires social interaction
- Technology shapes societal structures
- Technology favors some social groups (often engineers!) over others



### 3. I'm not an expert in sustainability!

**But: sustainability requires transdisciplinary approaches**

- No individual educator can be an “expert in sustainability” – collaborate!
- All perspectives are important – everyone can contribute to ESD, including students
- Sustainability problems are “wicked,” there is no “correct answer” “experts” could know – enjoy the freedom!

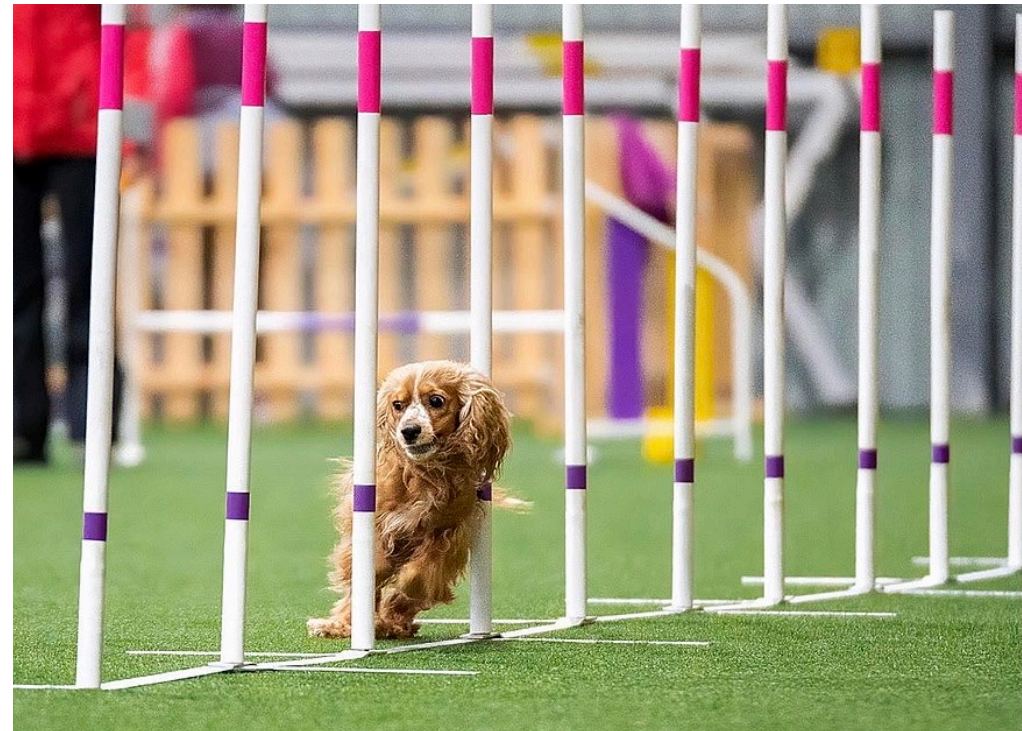




## 4. My course is already crammed!

**But: we cannot teach our students everything they will need anyways**

- The future is unknown – societies and ecosystems are changing rapidly
- We cannot fix problems with the same approaches that have caused them – students need to learn to co-create radically new approaches
- Most students will remember very little content from their studies



# Sustainability as content or framing

Construction of the Grand Ethiopian Renaissance Dam in its current political, cultural, geographical, economic, ... context



Developing a construction plan for a hydropower plant with a lot of technical detail, but no consideration of the context in which it will be built

## 5. The students don't like it!

### Or is it us???

Institutional cultures & discourses often (unintentionally) devalue SD courses/modules

- described as “something other” than the core subject area
- described in vague terms
- described as easy/not adequately assessed
- relying on guest lecturers only

Lönngren (2021). Exploring the discursive construction of ethics in an introductory engineering course. *Journal of Engineering Education*, 110(1), 44–69.  
Photo: Chad Miller



## 5. The students don't like it!



Photo: Elf

**They experience *challenges* in teaching with wicked problems:**

- Lack of knowledge
- Uncertainty/unknowability
- Ambiguity/value conflicts
- Context-dependence
- Limits of rationality
- Fear of failing/looking dumb
- Lack of time/resources

# Emotional scaffolding can help!

## Scaffolding

- Temporary support from teachers/peers that allows learners to perform tasks they would not be able to do on their own (zone of proximal development)
- Gradual transition to more independent learning
- 3 types: cognitive, metacognitive, affective/emotional

## Emotional scaffolding (working definition)

*refers to temporarily constructed emotional conditions that can allow learners to work through educational challenges.*



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EMOTE: The (Un)Emotional Engineer — Emotional Positioning and Scaffolding in Teaching and Learning about Wicked Sustainability Problems (2021-2024)



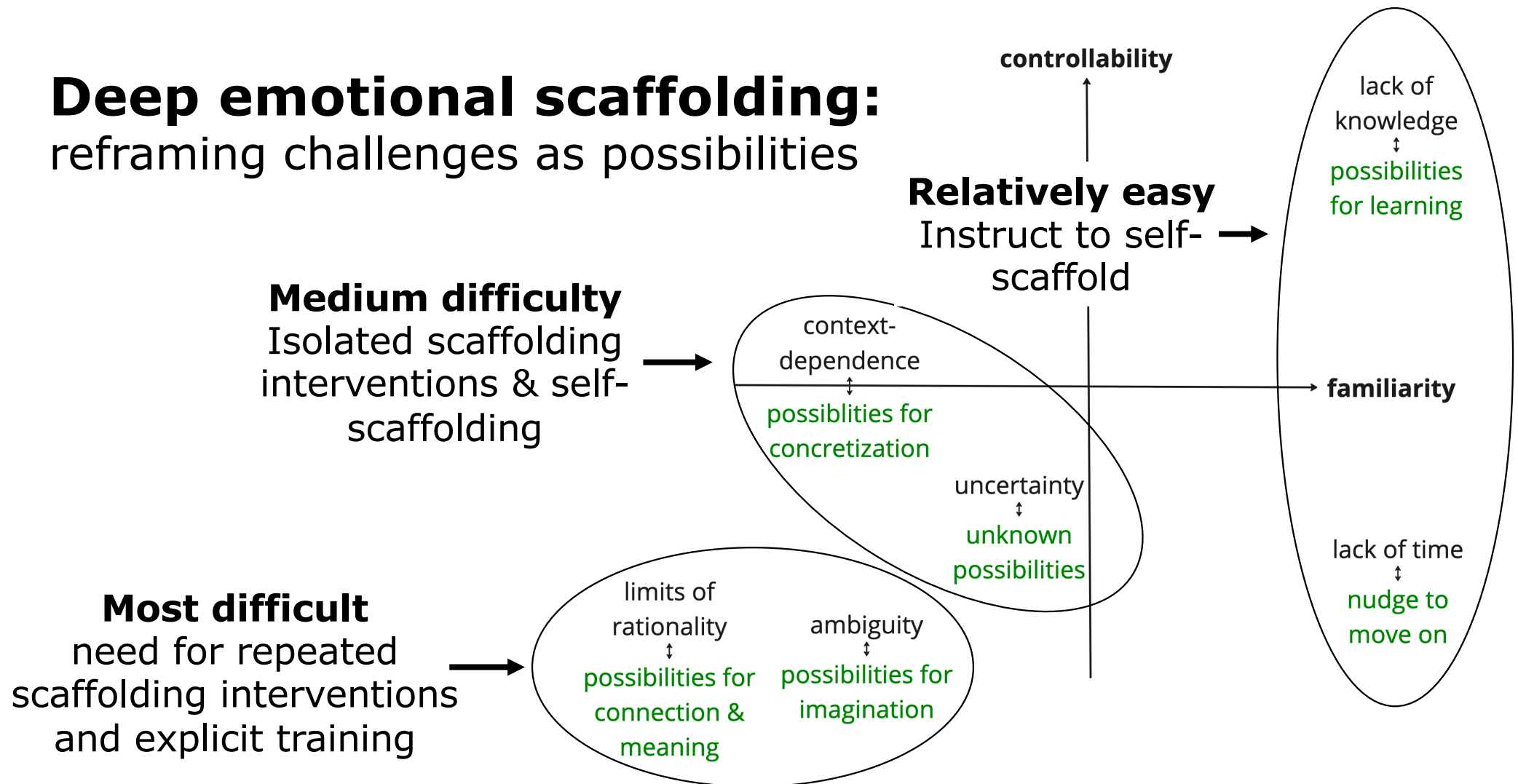
# Emotional scaffolding intentions

Level of scaffolding	Examples
<b>Shallow:</b> increases overall engagement	<ul style="list-style-type: none"><li>• Leverage enjoyment</li><li>• Leverage engagement with topic/task/group</li></ul>
<b>Shallow:</b> reduces negative emotions	<ul style="list-style-type: none"><li>• Reassure</li><li>• Lower perceived risk</li></ul>
<b>Moderate:</b> helps students deal with negative experiences of challenges	<ul style="list-style-type: none"><li>• Help work through/reframe negative emotions</li><li>• Help leverage positive emotions</li><li>• Clarify/normalize experience of challenges</li></ul>
<b>Deep:</b> helps students deal with underlying challenges	<ul style="list-style-type: none"><li>• Reframe risk/challenges to possibilities</li><li>• Leverage positive imaginaries for the future</li></ul>





# Deep emotional scaffolding: reframing challenges as possibilities



## 6. I don't know where to start!



1. Map existing elements (content, key competencies, pedagogical approaches)
2. Adjust/expand existing elements
  - Concretize (avoid simplify & avoid)
  - Frame as more wicked (avoid divide & control)
  - Add emotional scaffolding (avoid isolate & succumb)
3. Develop new ESD activities/modules/courses
4. Design adequate assessment for ESD learning
5. Design progression across the curriculum

# Final advice

- Engage in competence development for ESD content, competencies, *and* pedagogy
- Take one step (jump) at a time – something is better than nothing
- Collaborate with colleagues & students, leverage diverse perspectives & strengths
- Share your experiences, take care of yourself and each other
- Be creative, try something new, and allow yourself to have fun!



Photo: Ron Armstrong