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Beyond content: Teaching mathematics for a sustainable future

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Beyond content: teaching mathematics for a sustainable future

When teaching mathematics (or any subject, really), the content we are teaching is just the tip of the iceberg. Underneath the surface, the content is carried by the examples we choose, the way we frame problems, our interactions with students, and how we talk about our discipline in relation to the world. We always implicitly, and rarely explicitly, communicate what the discipline is for and what it means to act as a future professional in the discipline.

In this seminar, I will start from a question that concerns all university teachers: what kind of learning environment do we want to create, and what kinds of roles do we invite our students to imagine for themselves? While some courses have obvious connections to societal challenges and others do not, we make pedagogical choices that shape students' sense of agency, responsibility, and belonging. We can model professional behaviour that sets the content in a broader context, discuss the roles the subject plays—directly or indirectly—in addressing complex real-world questions, and use teaching methods that help all students being heard and taken seriously.

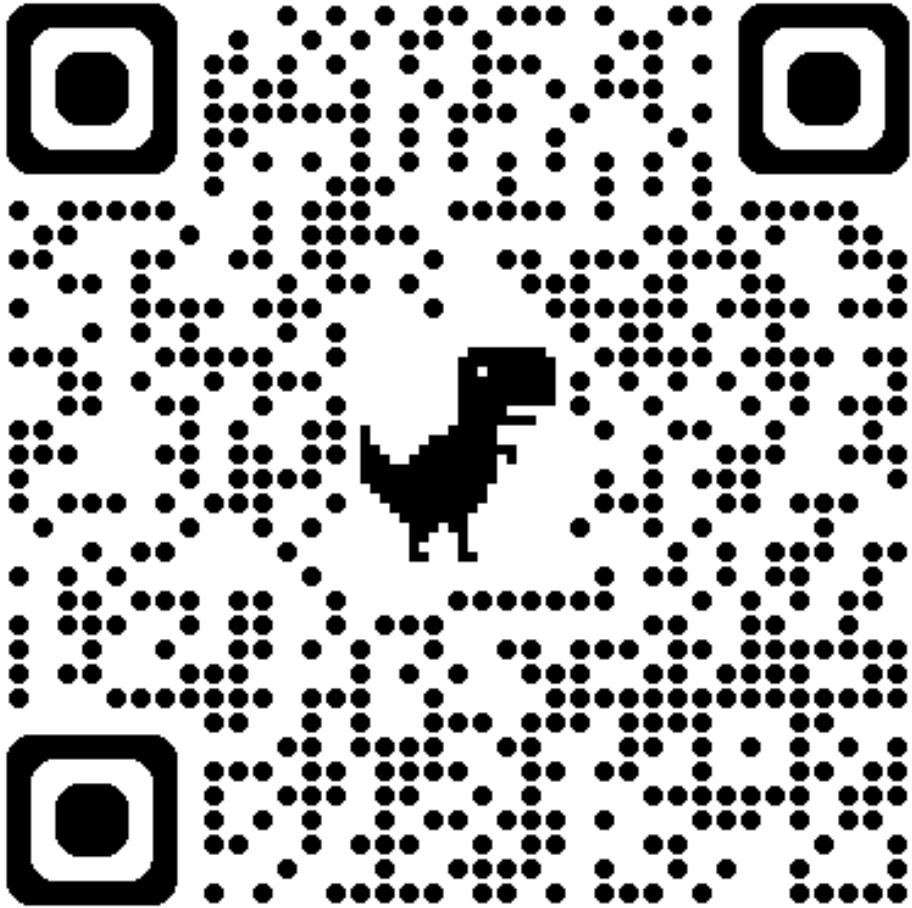
Then, engaging with questions of sustainability does not require adding extra content into a course. It emerges from our efforts to empower students, the value we place on diverse contributions, and our belief that what we all do—inside and beyond the university—can make a difference.

I look forward to exploring these ideas together and discussing concrete ways of teaching mathematics that are both academically rigorous and deeply meaningful for us and our students.



Download slides for today?

<https://teachingsustainability.blogg.lu.se/downloads/>



Outline:

- Who we are
- How we think about Teaching Sustainability
- Role of teachers?
- Student-staff partnership
- Building trusting relationships
- (Sustainable pedagogies)

About us & the Initiative “*Teaching for Sustainability*”



Terese Thoni

- Educational Coordinator at the Sustainability Forum

Focus on

- *Teaching for sustainability!*
- *The role of the university in a sustainable society*



Mirjam Glessmer

Academic Developer at the
Centre for Engineering
Education, LTH

Focus on

- *Teaching for sustainability!*
- *Relationships between students and teachers*
- *GenAI*

With Rhiannon Pugh & Rachel Forsyth



Teaching

Sustainability

“about”

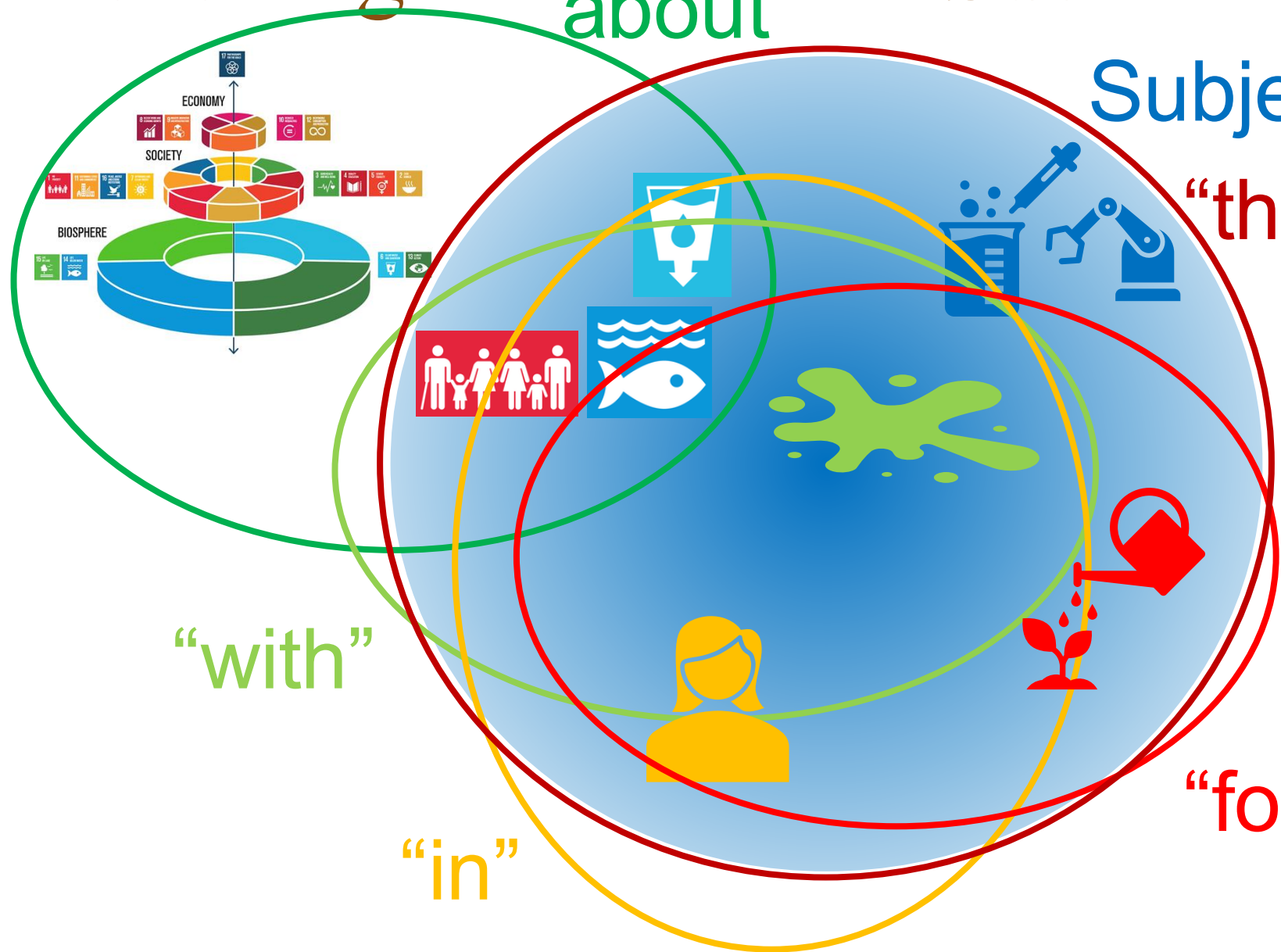
Subject

“through”

“with”

“in”

“for”



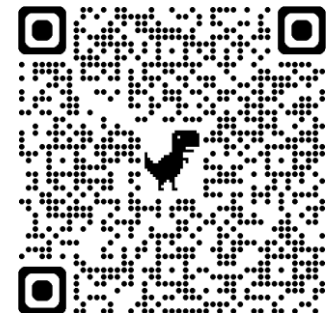
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Goal: students as capable and responsible citizens

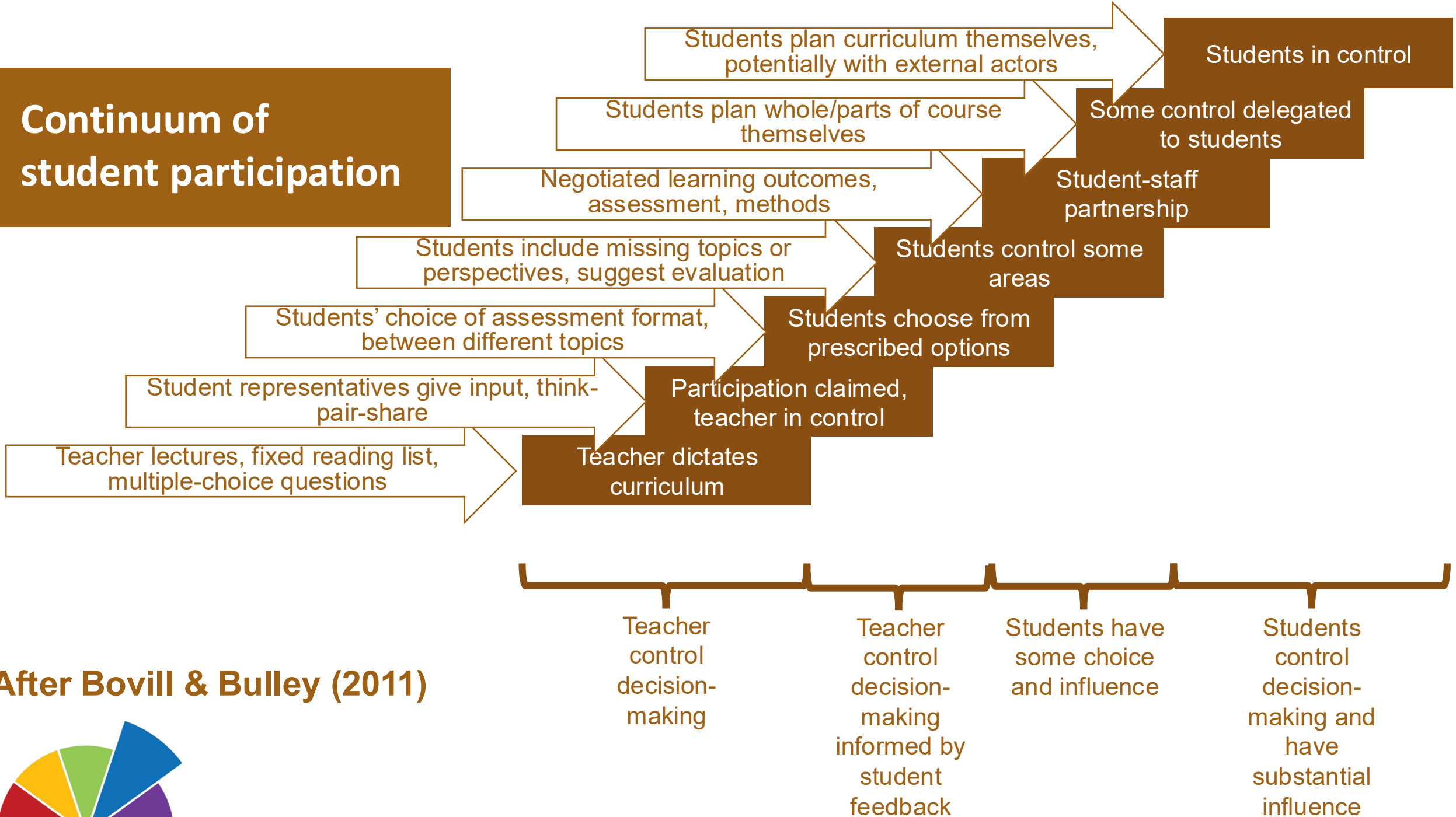
“Teaching is about being given what you were not looking for, something you did not even know you could ask for.”

Gerd Biesta (2026)

<https://www.maastrichtuniversity.nl/news/world-asks-something-us-gert-biesta-democracy-education-and-learning-live-limits>



Continuum of student participation

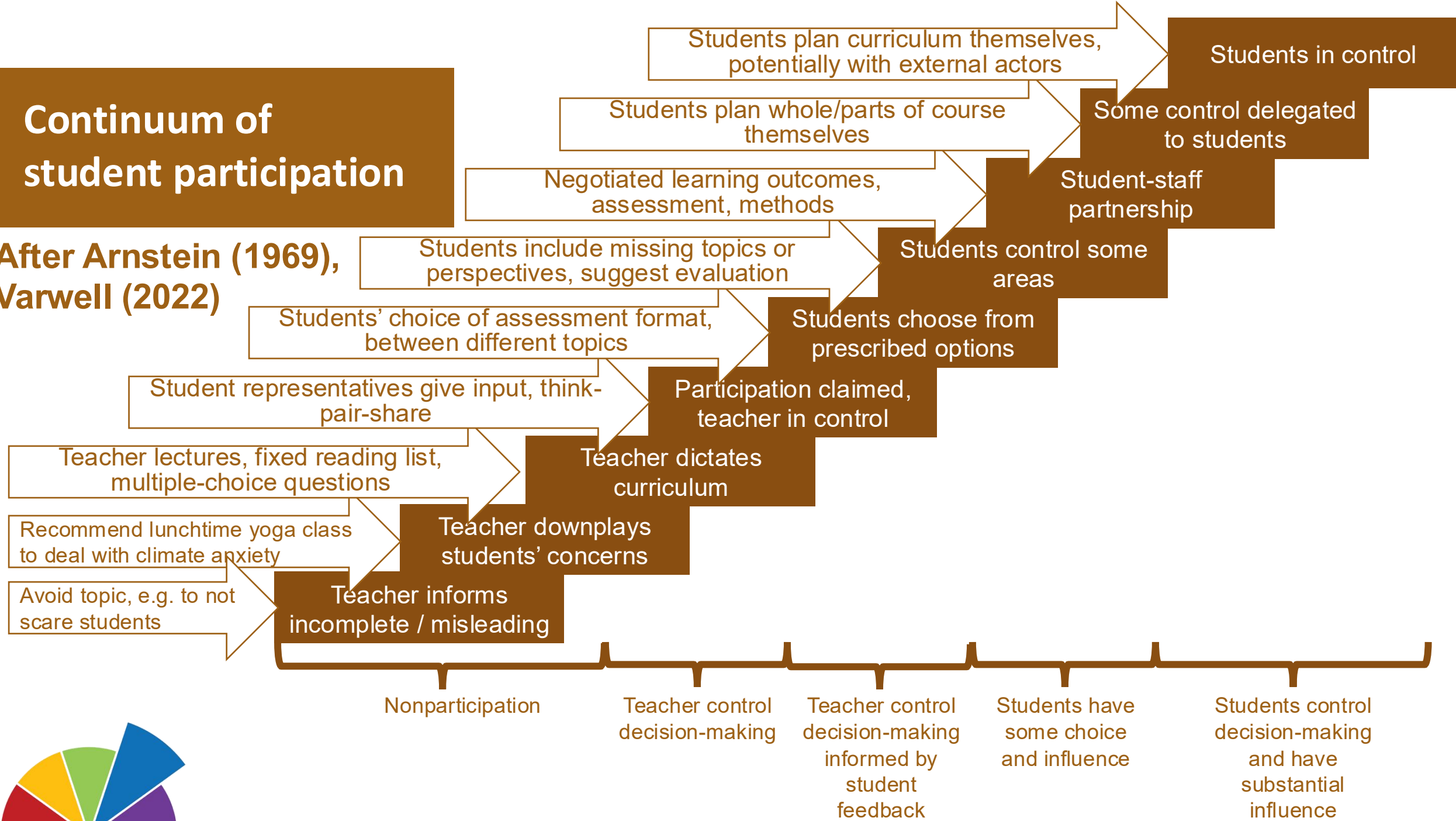


After Bovill & Bulley (2011)

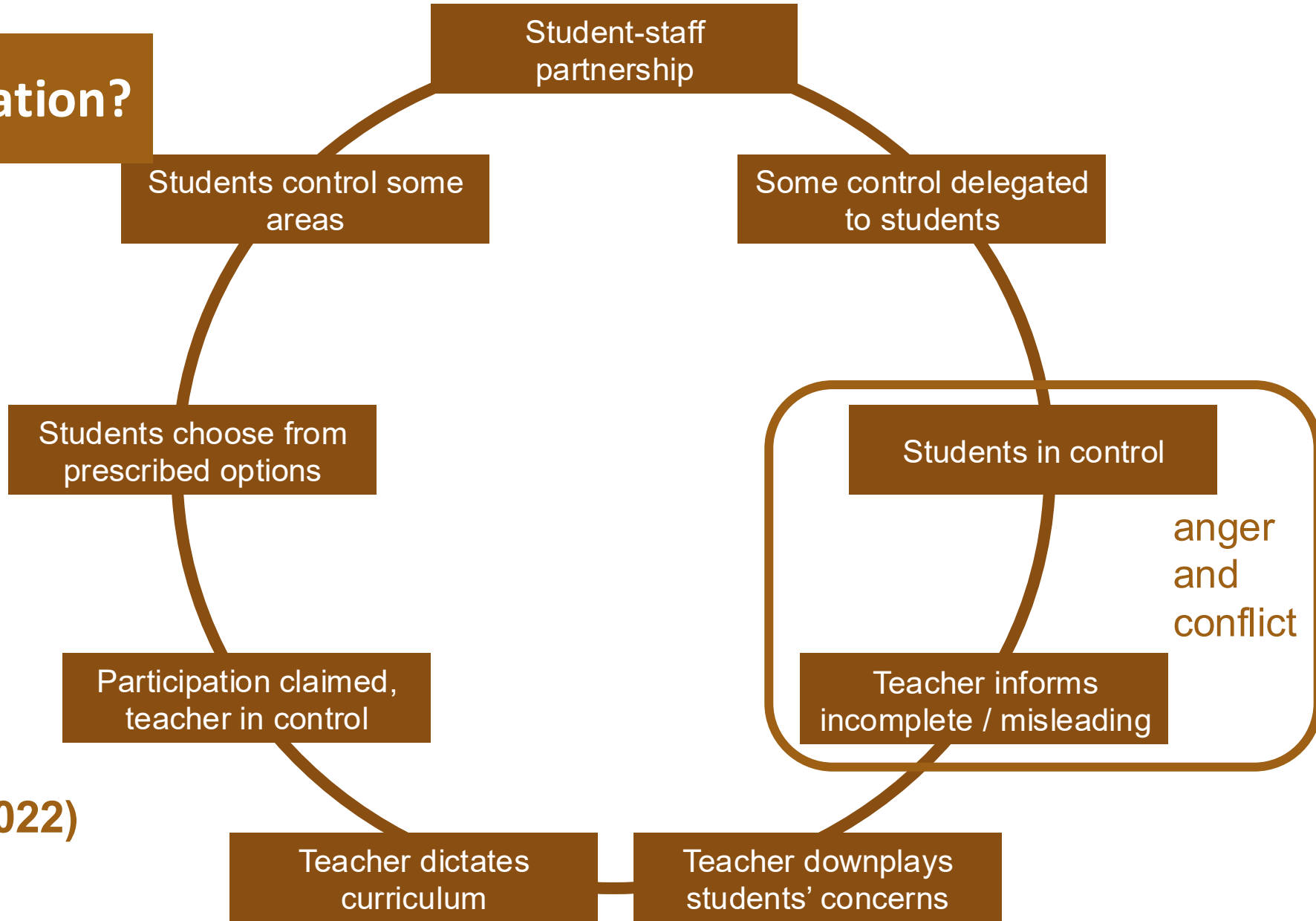


Continuum of student participation

After Arnstein (1969),
Varwell (2022)



Nonparticipation?



After Varwell (2022)



How teachers build trust with students (in the presence of GenAI)

Cognition

...to know the subject and what it is important for you to learn right now
 ...to know how to teach / learn the specific subject
 ...to explain and model what I think is important about my subject and your learning

...to build knowledge, skills, competences yourself
 ...to engage with the course materials and activities

Cognition

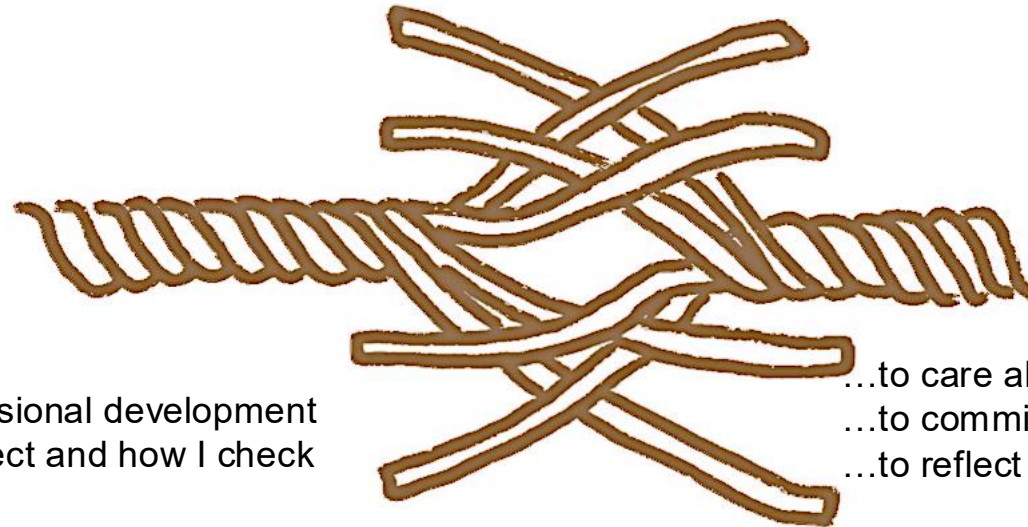
Affect

...to care about you and your learning
 ...to do my best to create the best conditions for your learning
 ...to react kindly to mistakes
 ...to make rules transparent

...to come and talk to me if things aren't going well
 ...to contribute constructively to the class

Affect

Trust me...



I trust you...

Values

...to care about my own professional development
 ...to be open about what I expect and how I check your work
 ...to be transparent about my practice

...to care about your learning
 ...to commit to what we do together in the course
 ...to reflect on your learning process and outcomes

Values

Identity

...to be interested in knowing what you are thinking

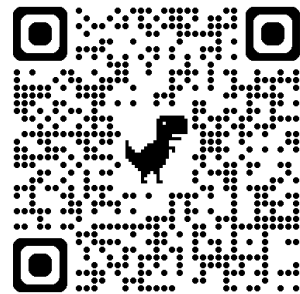
...to share your own thoughts with me

Identity

Carving space for sustainability

- Holmqvist, D., & Millenberg, F. (2024). Carving space to learn for sustainable futures: A theory-informed adult education approach to teaching. *European journal for Research on the Education and Learning of Adults*, 15(3), 299-315.

<https://rela.ep.liu.se/article/view/5237/4405>



Recommended reading! ->

Figure 1. Overview of the seed package we designed.

Learning for sustainable futures

A seed package of teaching and learning activities

The aim of this package is to provide the seeds for a pedagogical practice informed by theoretical knowledge from the fields of *adult education research* and *sustainability education research*. The included teaching and learning activities are meant to help learners realise or gauge the responsibility and freedom that we have as persons in the world. In other words, they are meant to emancipate learners to a desire to 'actively' be in the world. On the left-hand side, we describe the teaching and learning activities. A *pathway* of sorts or *use instruction* for the seeds we have designed. You are welcome to use it yourself or draw inspiration from it. On the right-hand side, we have listed the main theoretical assumptions, concepts and key references which have informed our design choices.

Part 1 – individually, at home

Learners are presented with material that highlights some aspect of sustainability issues that is relevant to them. This could be in the form of a text, video, podcast etc. Choose carefully. If possible, offer choices, as this can increase the chance of each participant finding something meaningful for them to latch onto. E.g. a book with thematic chapters where learners are free to choose the theme that most resonates with them.

Using this material as a lens, the learner then goes on a **reflexive wandering walk in their surroundings** (in or around their home, workplace, school, grocery store, or any other place that is central to their life space). Ask the learner to **document their reactions and experiences** through photography (video and audio can be offered as alternatives but may be more difficult to process in the next part of the module).

Part 2 – together, on site

Learners share their discoveries and narrate their experiences aided by the documentation (what did you see?). This should be done in small groups, and it is essential that everyone is given space and time to speak without being interrupted or rushed.

Each learner then chooses one image from their portfolio and ponders: what do I dream of for this place? What could it become? What do I wish could be accommodated here? (important to anchor the imagination exercise in the world). Ask learners to **intervene in the chosen image**, i.e. edit the image by pasting stickers, drawing over it, cutting out parts, etc. This can be done digitally (e.g. on the mobile phone that the picture was taken with) or physically (i.e. on printouts of the image).

Next, **learners share their place-grounded future-oriented imaginings** by showing and narrating their creations. This is done in the same small groups as before and it is again important that the exercise is allowed to take time, so everyone may speak and be heard.

Depending on the outcome, you could now capitalise on the collective excitement to maintain momentum. How might we enact, to bring about such imaginings?

Key assumptions, concepts & sources

Sustainability should be approached **holistically** and with recognition of **complexity**, and **dialectical relationships** (Hamilton, 2017; Lange, 2023). Tracing a theme, phenomenon or example can be a fruitful approach to highlight these aspects.

Meaningful learning is **anchored in the participant's lifeworld** (Millenberg, 2022); it becomes powerful when **connected to broader issues and patterns of society** (Rasmussen, 2021; von Kotze & Walters, 2023).

Places are pedagogical social constructs which invite certain modes of being-in-the-world and with each other. **Learning to 'read' places for unsustainable patters** of social and ecological domination is part of a **critical pedagogy of place** (Gruenewald, 2001)

Reflexive wandering (Maximović, Joksimović & Utić, 2020) to change the mode and pace of moving through space; to be in and outside at the same time.

When engaging with sustainability, **community and collaboration** are important (Lange, 2023). E.g. for emotional support (Gruenewald, 2003) nuance understanding (Hamilton, 2017), recognise embodied ways of knowing (von Kotze & Walters, 2023) & make democratic transitions (Arias-Maldonado, 2022).

Embrace pauses, silence, and gaps – **waiting as, disruptive and generative experience** (Bailey & Suddaby, 2023)

Sharing gives us a chance to experience and practice **conviviality** (Martinsson & Mullinari, 2023), **compassion** (Neff, 2011), **empathy** (Nichols, 2011) and **dialogue**.

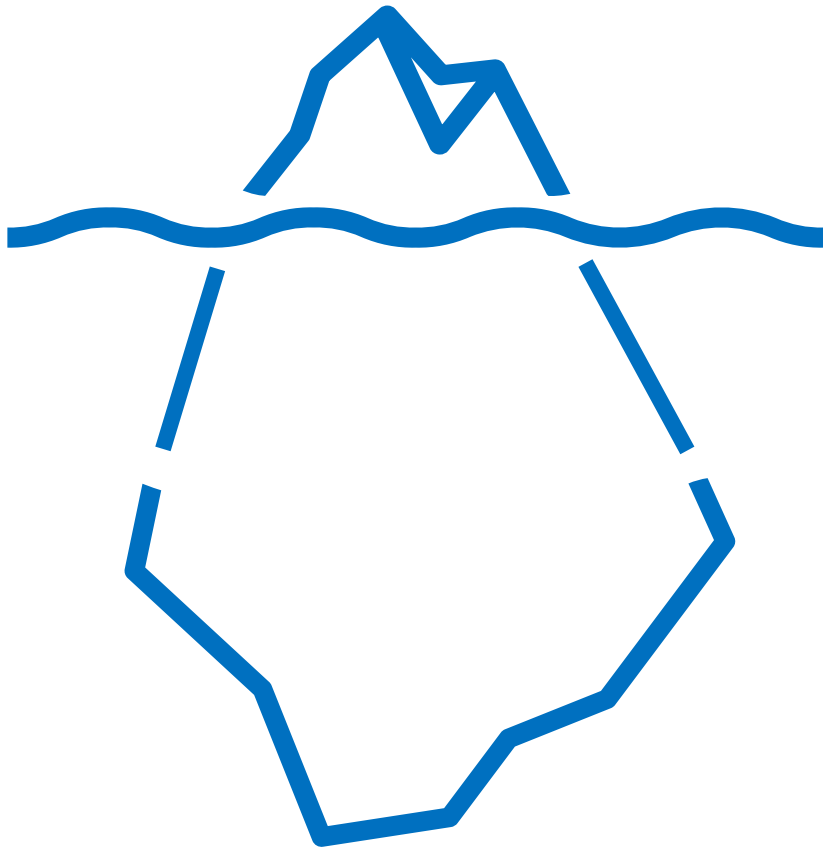
The capacity and capability of **imagining futures** is crucial both for sustainability (Gyberg, Anshelm & Hallström, 2020) and democracy (Rasmussen, 2021) and must be practiced (Jickling & Blenkinsop, 2021).

Prefiguration, i.e. thinking, behaving and being as if that which we'd like to bring about already exists – as if we were already free (Graeber, 2004, 2013). This can be seen as a **chosen margin** or liminal space (hooks, 2014/1990).

Collecting and sharing examples of place-anchored future imaginings can foster community and invite **radical openness** (Gruenewald, 2003; hooks, 2010, Arias-Maldonado, 2022).



What do we mean by ‘pedagogy’ in sustainability education? (Sandri, 2022)



Teaching methods, e.g. activities (think-pair-share, role play), assessments (authentic, portfolio), ...

Educational approach, e.g. content framing, assessment style, learning objectives and delivery structure

Pedagogy: “*educator’s worldview or ‘lens’, in the context of learning and teaching, which shapes the way they see their practice, the role of education, and the processes and purposes of learning*”

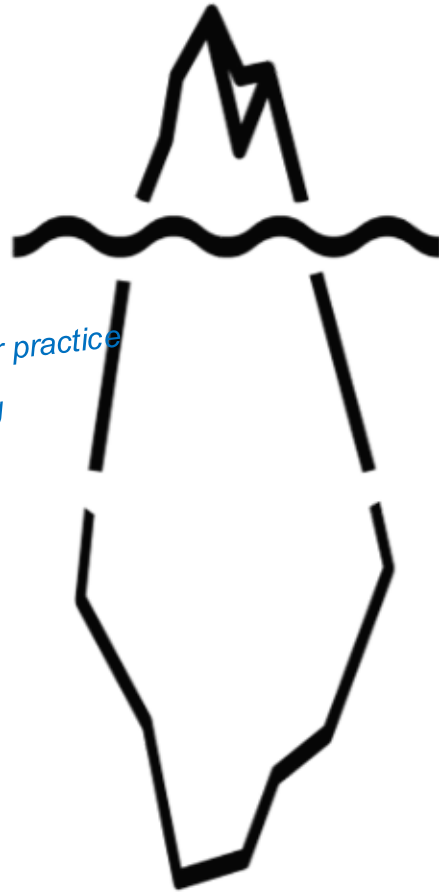
Sandri, O. (2022). What do we mean by ‘pedagogy’ in sustainability education? *Teaching in Higher Education*, 27(1), 114-129. <https://doi.org/10.1080/13562517.2019.1699528>



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HANDOUT

Teaching for Sustainability: Pedagogy, educational approach, teaching methods



MCQs
Minute papers

Opportunities for practice
Frequent testing

Drill & practice!
Behaviorism

Teaching methods: What does your educational approach mean for your activities, assessments, ... ?

- Impromptu interviews
- Think-pair-share

- *Advance organizers*
- *Minute papers*
- *Think-pair-share*

Educational approach: What does your pedagogy mean for your content framing, assessment style, learning objectives and delivery structure, ... ?

- Diversity of voices
- Empower & unleash
- ➔ Liberating structures

- *Peer discussions*
- *Opportunities to apply learning*
- ➔ *Active learning*

Pedagogy: What matters to you in learning, teaching, sustainability?

- Good relationships
- Trust
- Listening to each other
- ➔ Relational pedagogy

- *Optimizing for how we know the brain works*
- *Practice!*
- ➔ *Constructivism*



HANDOUT

Teaching for **Sustainability**: Pedagogy, educational approach, teaching methods



Teaching methods: What does your educational approach mean for your activities, assessments, ... ?

- *“Carving space” / Active lunch break*
- *Role play*
- *Include feeling & doing*
- *Student participation*
- *Work on community challenges*
- *Tanner (2013)*

Educational approach: What does your pedagogy mean for your content framing, assessment style, learning objectives and delivery structure, ... ?

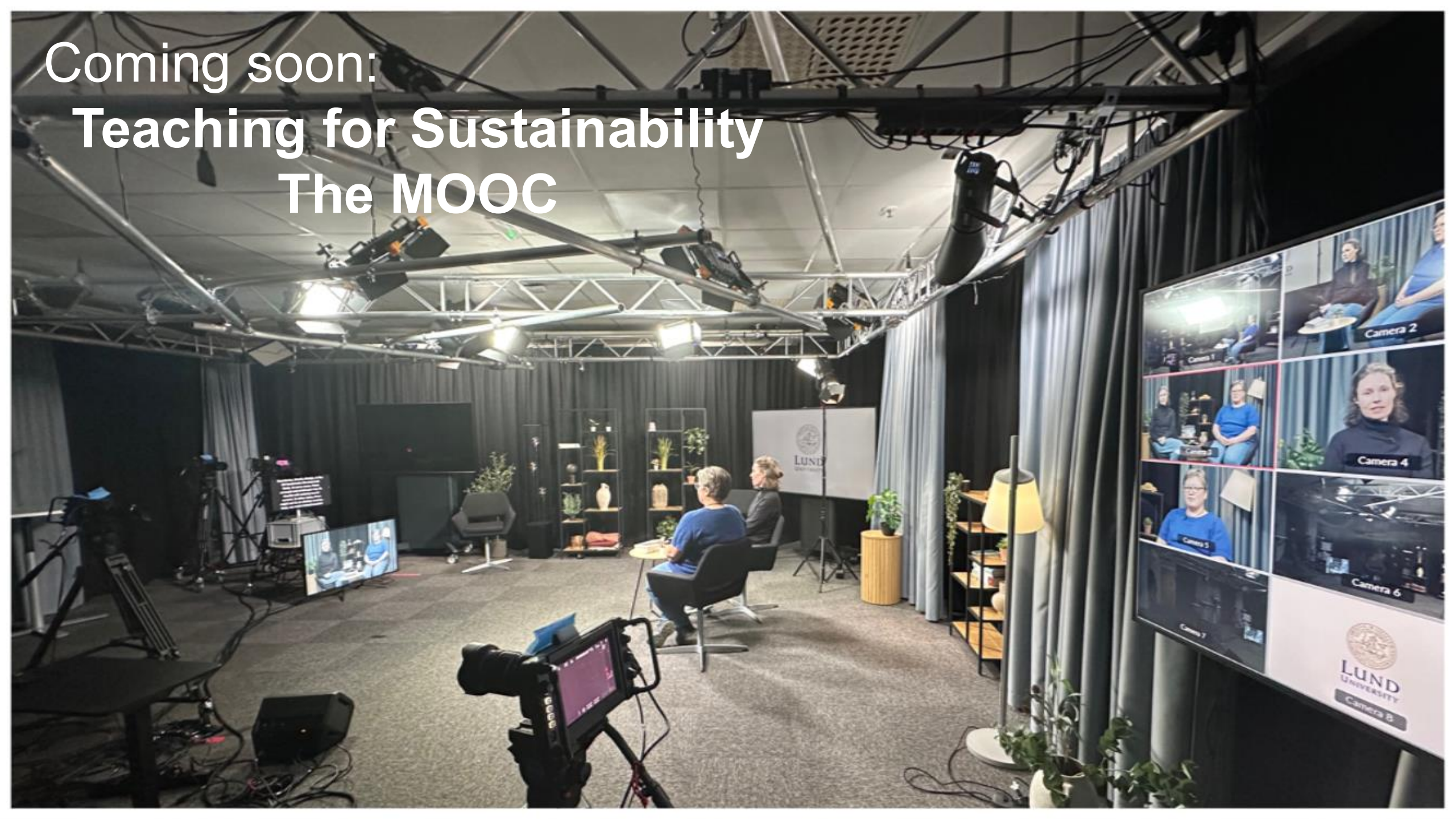
- *Place-based*
- *Equitable teaching, Liberating structures*
- *Community-based*
- *Head-hand-heart*
- *Service learning*

Pedagogy: What matters to you in learning, teaching, sustainability?


- *Care & responsibility*
- *Democracy*
- *Commitment*

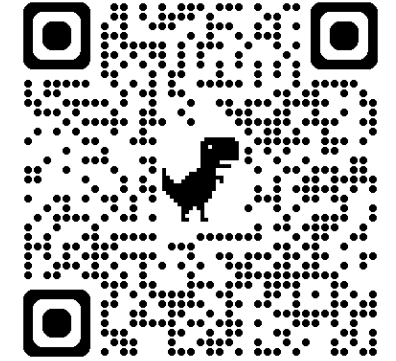


Coming soon:
Teaching for Sustainability
The MOOC



Initiative Teaching for Sustainability: Activities

I am looking for:	Information & Inspiration	Conversation & Community	Collaboration & Consultation	Visibility & Career Opportunities
Myself, on my own	<ul style="list-style-type: none"> • Read our blog • Join our MS Teams • Sign up to our newsletter 	Book us for a chat 	Book a consultation	Welcome to: <ul style="list-style-type: none"> • Write for our blog • Present at the Roundtable
Myself, and a group of my colleagues	Invite us for a presentation on: <ul style="list-style-type: none"> • Intro to Teaching for Sustainability • Key Sustainability Competencies • LU-policies 	Invite us for a workshop on: <ul style="list-style-type: none"> • Teaching for Sustainability • Transformation • Sustainability Competencies 	Book us for a: <ul style="list-style-type: none"> • Consultation • Collegial project course (LTH only) 	We support you to: <ul style="list-style-type: none"> • Offer a workshop • Initiate a discussion series
Myself, with a new group of people	Join: <ul style="list-style-type: none"> • Our workshops or courses • Our MOOC 	Join: <ul style="list-style-type: none"> • Transformation Thursdays • Our book club • Our MS Teams 	Join: <ul style="list-style-type: none"> • The Roundtable • The Coordination Team • The Serious Games group 	We support you to: <ul style="list-style-type: none"> • Offer a workshop • Try a new serious game with colleagues • Join our team

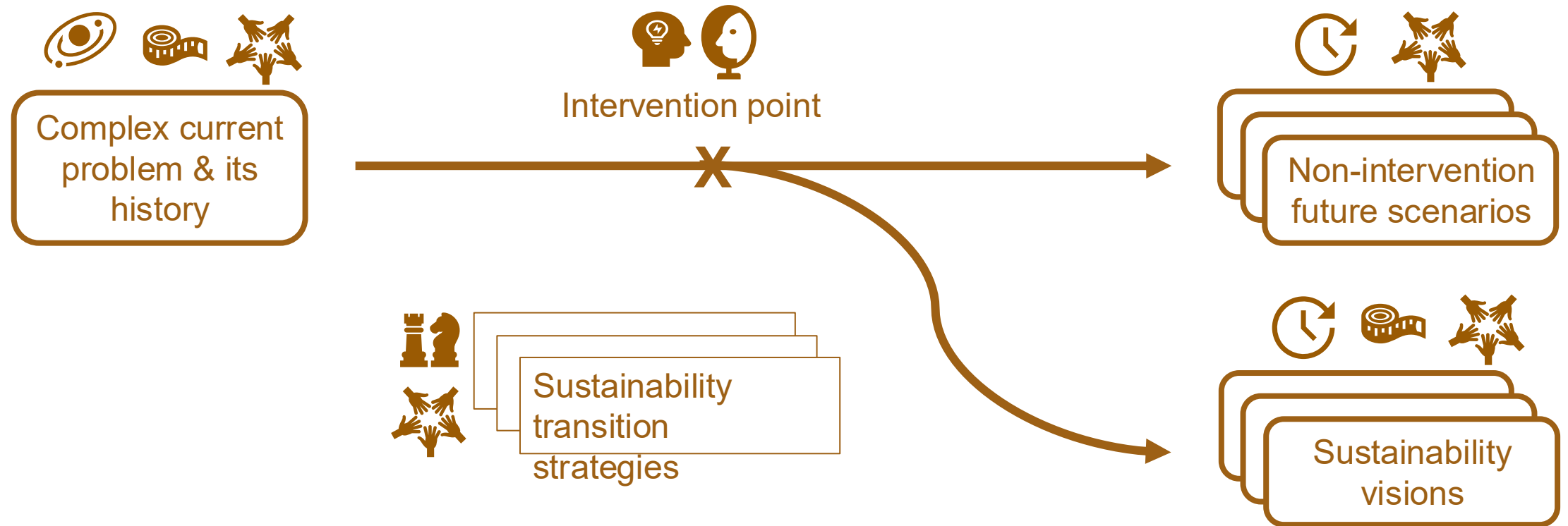




Please don't hesitate to be in touch, we look forward to hearing from you! 😊



More information: teachingsustainability.blogg.lu.se  **Contact:** education@sustainability.lu.se

Key Competencies in Sustainability

After Brundiers et al. (2021),
Wiek et al. (2011)



 Systems thinking
 Strategic

 Anticipatory
 Normative

 Interpersonal
 Integration

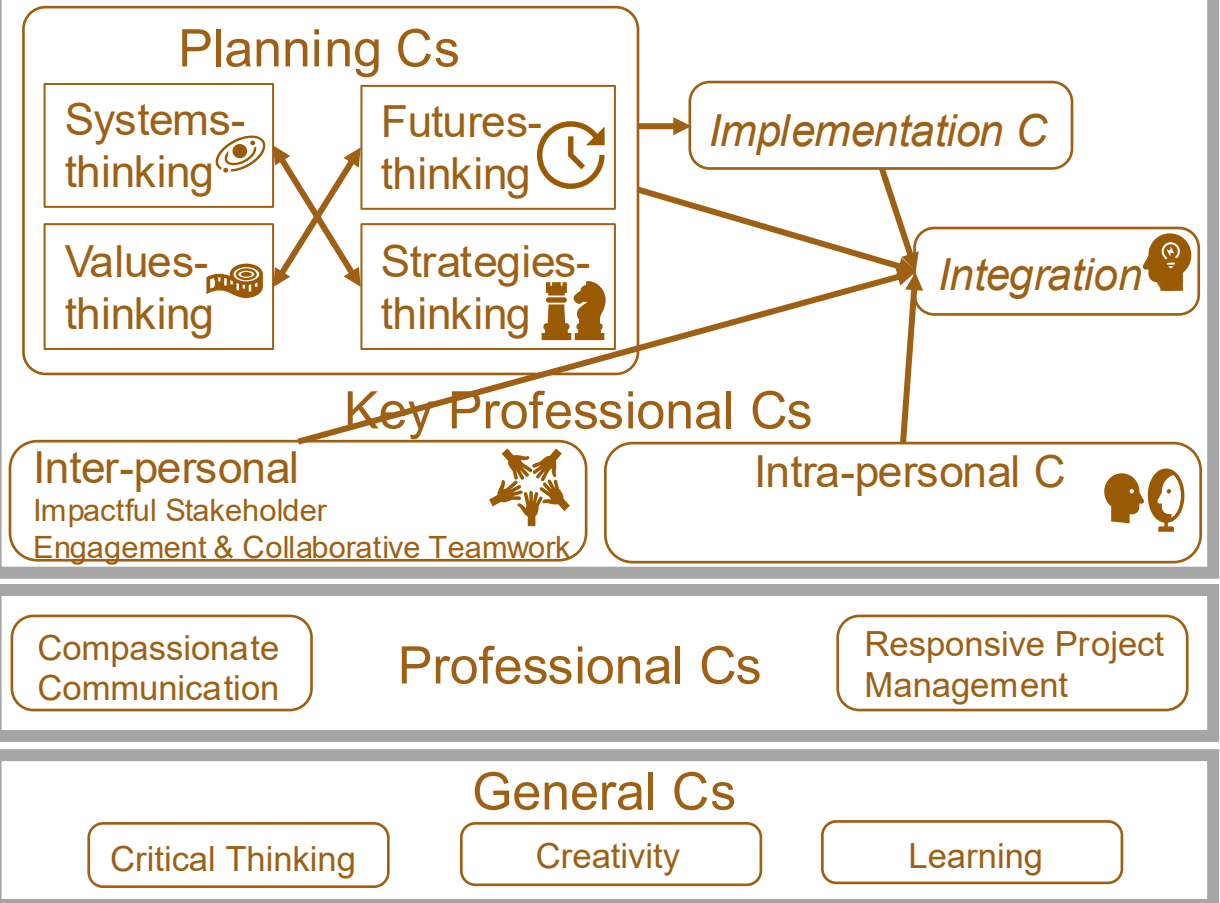
 Intrapersonal

Key Competencies in Sustainability

After Redman & Wiek (2021)

Disciplinary Cs

Key Competencies in Sustainability



Specific



Content-dependent



Content-independent

Generic



Why it is so Difficult to Talk about Sustainability: The Spiral of Silence

- 89% of respondents worldwide (97% China, 85% Sweden) want their national governments to do more to fight global heating
 - 69% are willing to give 1% of their income to fight the climate crisis (81% China, 72% Sweden) ...
 - ...but think only 43% (56% China, 44% Sweden) would be willing to do the same
- (after Andre et al., 2024)

Within communities, there is a

- **lack of confidence** to speak about topics without being an expert (and it's a wicked problem)
- perception that fewer people care than actually do ("**silence misperception**")
- **emotional resistance** to engaging with negative messages
- doubts in **who** we should engage, and **when**
- educational system does **not adequately prepare and encourage people** to have conversations about sustainability

There are political and industrial players who benefit from, and thus artificially create,

- **misinformation**
- **polarization**

Based on Crease, A., & Singhasaneh, N. (2023). *Climate Change Conversations with Children: Making Sustainability Meaningful, Tangible, and Actionable* (Doctoral dissertation, Massachusetts Institute of Technology).

- Andre, P., Boneva, T., Chopra, F. et al. (2024) Globally representative evidence on the actual and perceived support for climate action. *Nat. Clim. Chang.* 14, 253–259.
- Lidgren, A., Rodhe, H., & Huisingsh, D. (2006). A systemic approach to incorporate sustainability into university courses and curricula. *Journal of cleaner production*, 14(9-11), 797-809.
- Treen, K. M. D. I., Williams, H. T., & O'Neill, S. J. (2020). Online misinformation about climate change. *Wiley Interdisciplinary Reviews: Climate Change*, 11(5), e665.





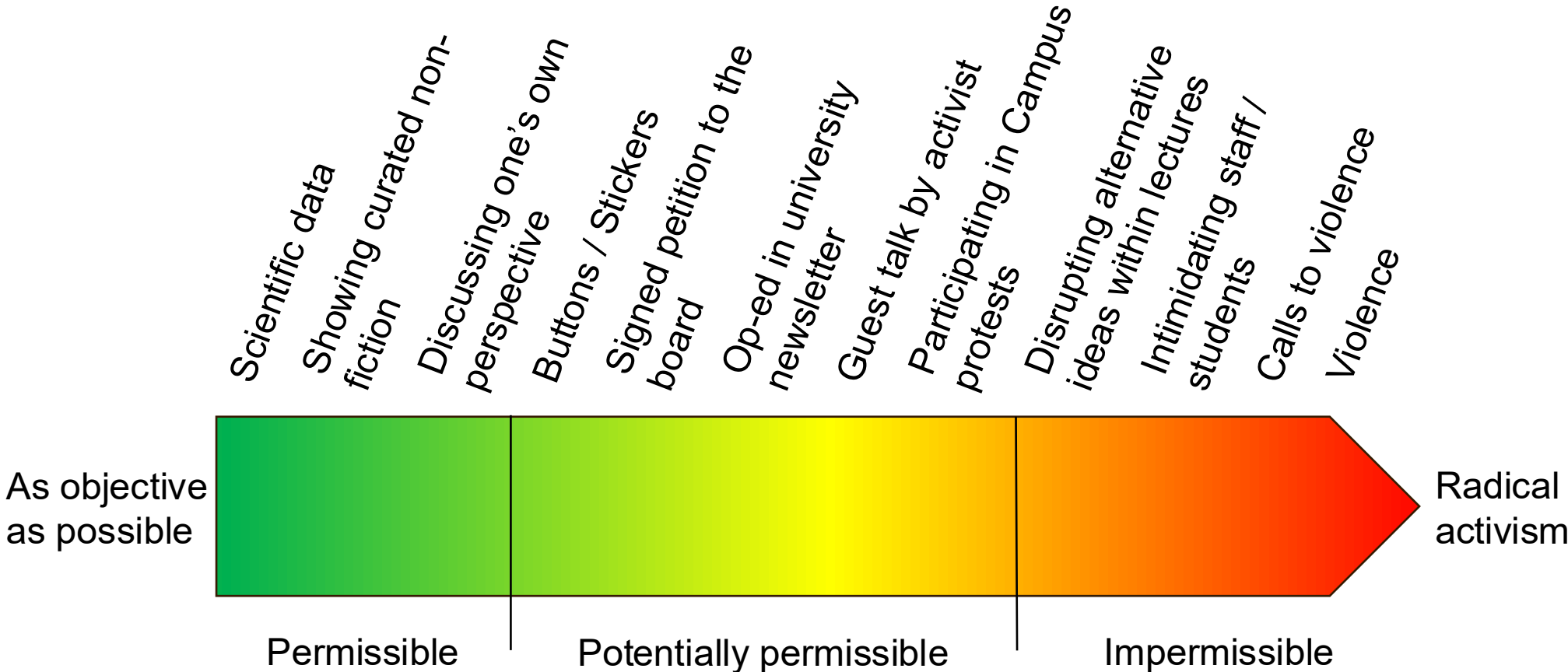
Lund University paradigms

- Miles deep, inches wide
- Knowledge should be delivered by experts
- Knowledge evolves through criticism
- A university is an institution of rationality

Lidgren, A., Rodhe, H., & Huisingsh, D. (2006). A systemic approach to incorporate sustainability into university courses and curricula. *Journal of cleaner production*, 14(9-11), 797-809.



Permissibility of different forms of academic activism (redrawn after Nooij et al. 2025)



After: Nooij, J. M., Collin, N. D. H. & van den Berg, F. (2025). "Do not leave your values at the door; the permissibility of activism in the lecture hall", Higher Education Research & Development, 44:6, 1512-1527, DOI: <https://doi.org/10.1080/07294360.2025.2514508>



Equitable teaching strategies (Tanner, 2013)

Give students opportunities to **think and talk** about the topic

- Wait long enough before giving an answer
- Give students time to write (notes, minute paper)
- Use think-pair-share
- Less is more: don't try to do too much



Encourage, demand, and actively manage the **participation** of all students



- Hand raising
- Multiple hands, multiple voices
- Assign reporters for small groups
- Do a round where everybody speaks
- Monitor student participation

Teach **all** of the students in your classroom

- Teach them from the moment they arrive
- Collect assessment evidence from every student, every class



Build an **inclusive and fair** classroom community for all students

- Learn (or have access to) students' names
- Integrate culturally diverse & relevant examples
- Work in small groups
- Use varied active-learning methods
- Be explicit about promoting access and equity for all students



Monitor (your own and students') behavior to cultivate **divergent thinking**

- Ask open-ended questions
- Don't judge responses
- Use praise with caution
- Establish classroom community and norms



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