WICKED PROBLEMS:
a pedagogical tool for integrating sustainability into engineering education

Johanna Lönngren

Department of Science and Mathematics Education,
Umeå University

Teaching & Education Day, 2020-08-20

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QUALITY SYSTEM FOR EDUCATION AT UMEÅ UNIVERSITY

1) Research links

2) Internationalisation

3) Equality

4) External collaboration and links to working life

5) Sustainable development

6) Student influence and student-centered learning
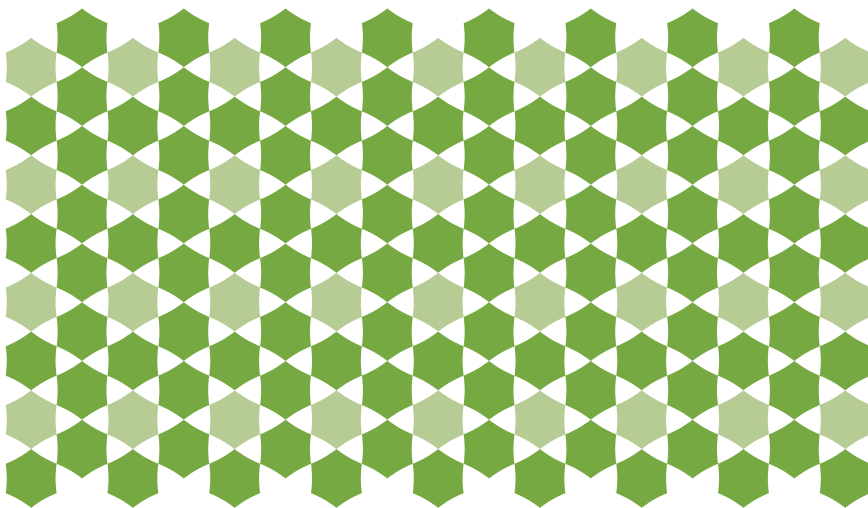
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Why bother changing?

Universitets och högskolors
arbete med att främja
en hållbar utveckling

En tematisk utvärdering, del 1

"Umeå University's process for working with sustainable development needs to be developed further."

Why bother changing?

The global state of the art
in engineering education

MARCH 2018

DR RUTH GRAHAM

> "For years and years, there was endless talk about why engineering education needed to change, lots of statements and reports about what needed to be done. And nothing changed. [But in recent years,] things are happening in places you have never even heard of, all over the world. **Doing the same old thing is suddenly not going to be good enough**."

Why bother changing?

The global state of the art
in engineering education

MARCH 2018

DR RUTH GRAHAM

"**a greater focus on solving human challenges and the problems facing society** [will] emerge as hallmarks of the world's best engineering programs"

WHAT IS EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD)?

Upon graduation, **students shall be "able to work to realise the UN's sustainable development goals."**

(Quality System for Education at Umeå University)

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SUSTAINABLE DEVELOPMENT GOALS

1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS

APPROACHES TO ENVIRONMENTAL AND SUSTAINABILITY EDUCATION

- Facts-based environmental education

- Normative environmental education

- Critical/pluralistic: **Education for sustainable development (ESD)**

Common basic values
- Democracy
- Legality
- Objectivity
- Free formation of opinion
- Respect for all
- Efficiency and service

Öhman (2009). Att utbilda för hållbar utveckling – ett pluralistiskt perspektiv.
Statskontoret (2018). Den statliga värdegrunden - professionella värderingar ...

ESD KEY COMPETENCES

- **Systems thinking** competences
- **Anticipatory** competence
- **Normative** competence
- **Strategic** competence
- **Collaborative** competence
- **Critical thinking** competence
- **Self-awareness** competence

Integrated problem-solving competence

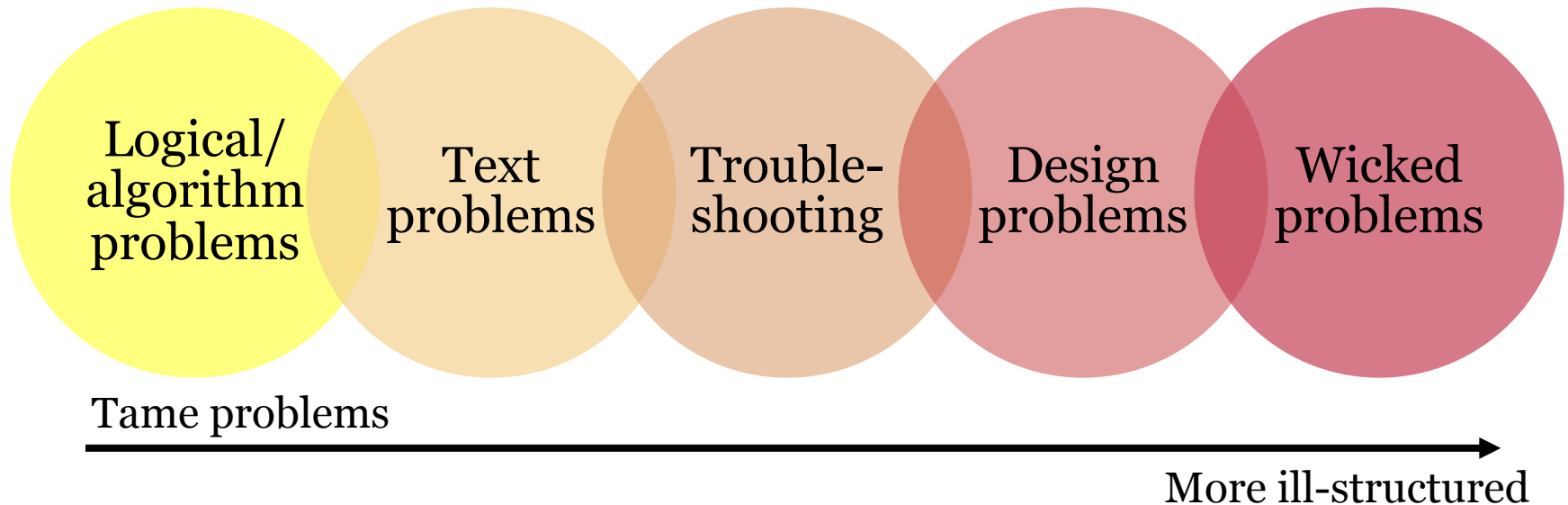UNESCO (2017). The Global Education 2030 Agenda.

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ESD PEDAGOGICAL APPROACHES

- **Interdisciplinary & holistic:** integrated throughout the curriculum rather than taught as a separate subject, across disciplines

- **Critical and transformative:** critical discussion of norms and values, explore new perspectives

- **Emancipative:** empower students to speak and act, focus on what can be done despite great challenges

- **Student-active learning:** interactive, student-centered, relevant

- **Participative decision-making:** students participate in deciding how to learn

- **Local and global:** switching between and integrating local and global perspectives

Fors et al. (2017) Universitets och högskolors arbete med att ...
UNESCO (2017). The Global Education 2030 Agenda.

WICKED PROBLEMS AS A TYPE OF PROBLEMS

Logical/ algorithm problems

Text problems

Trouble- shooting

Design problems

Wicked problems

Tame problems

More ill-structured

Adapted from Jonassen (2000). Toward a design theory of problem solving

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WICKED PROBLEMS AS A TYPE OF PROBLEMS

- High degree of complexity and uncertainty (especially value conflicts!)

- No unambiguous problem definition

- No right/wrong solutions

- No universally accepted criteria for evaluating potential solutions

- No "stopping point"

- Always unique, context-dependent, and connected to other problems

- Cannot be trialed in traditional ways: every attempt at solving has consequences

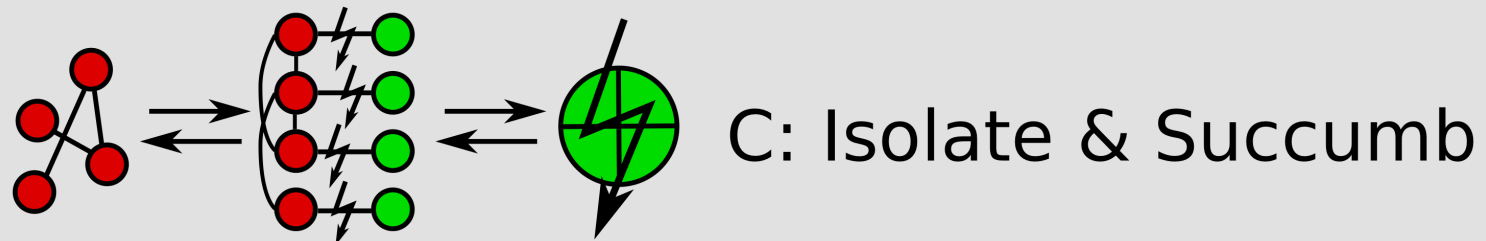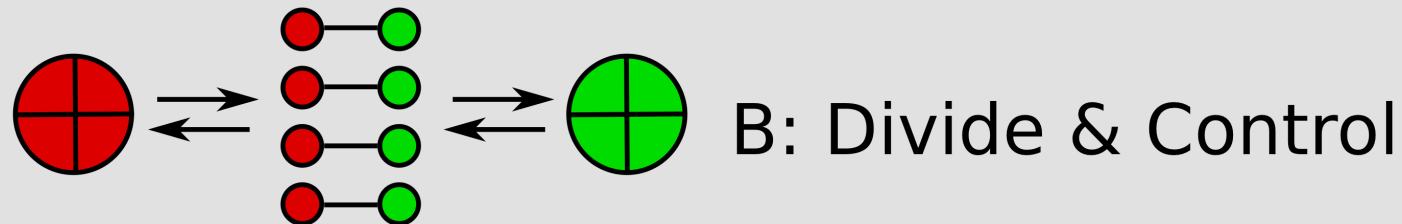Rittel & Webber (1973). Dilemmas in a general theory of planning.

WICKED PROBLEMS EXAMPLES

- Corona pandemic
- Climate change (nanotechnology, energy engineering)
- Water shortage in Jordan (nanotechnology)
- Grand Ethiopian Renaissance Dam (nanotechnology, energy engineering)
- Conflict minerals in wind turbines (nanotechnology)
- Literacy in Afghanistan (IT-engineering)
- Dengue fever in Southern Africa (IT-engineering)
- Export of poisonous mining waste (environmental health)
- Export of electronic waste (nanotechnology)

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4 WAYS OF ADDRESSING WICKED PROBLEMS

A: Simplify & Avoid

B: Divide & Control

C: Isolate & Succumb

D: Integrate & Balance

Lönngren et al. (2017). Avoid, Control, Succumb, or Balance: ...

INTENDED LEARNING OUTCOMES FOR TEACHING ABOUT WICKED PROBLEMS

Anticipatory competence

Systems thinking competence

Normative competence

- *Identify* a wicked problem one may encounter in the profession and *describe why* it is wicked.

- *Recognize* when one encounters a wicked problem and *address* the problem without taming it.

Integrative problem solving competence

Adapted from Lönngren & Svanström (2015). Assessing "Wicked …

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WICKED PROBLEMS AS A TYPE OF PROBLEMS
→ TEACHING ABOUT WICKED PROBLEMS

WP AS A WAY OF DESCRIBING PROBLEMS
→ TEACHING WITH WICKED PROBLEMS

"Wicked" or "tame" different ways of *describing* problems, not different *types* of problem. By describing a problem as wicked, we also create expectations about how it should be addressed.

Ison et al. (2015). Institutionalising social learning: Towards systemic ...

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INTENDED LEARNING OUTCOMES FOR TEACHING <u>WITH</u> WICKED PROBLEMS

Strategic competence

Systems thinking competence

Self-awareness competence

- Describe a problem *as wicked* and describe several *possible ways of addressing* the problem, without inappropriately taming the problem.

- In collaboration with others *explore and develop common values* that can serve as a basis for collaboratively addressing the problem

Collaborative competence

Normative competence

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EXAMPLE: SCENARIO DISCUSSIONS & ROLE PLAY

1. Prepare at home
2. Define the problem in mixed groups
3. Preparation in stakeholder groups
4. Role play in mixed groups
5. Develop a common statement in mixed groups
6. Present and summarize in plenum

EXAMPLE: SCENARIO DISCUSSIONS & ROLE PLAY

1. **Prepare at home**
   - Read problem description/ search information online/ write a short reflection on the problem/ ...

2. **Define the problem**
   - Divide students into as diverse groups as possible.
   - Groups work together to identify stakeholders (e.g. through stakeholder analysis).
   - Groups formulate problem descriptions from the perspectives of each of the identified stakeholders.
   - In plenum, decide on which stakeholder groups to include.

EXAMPLE: SCENARIO DISCUSSIONS & ROLE PLAY

3. **Preparation in stakeholder groups**
   - Divide students into stakeholder groups, mixing groups from step 1.
   - Groups work together to formulate a standpoint for their group, arguments to support their standpoint, and discuss strategies for countering other groups' arguments.
   - Search for more information if needed and there is enough time

4. **Role play in mixed groups**
   - Divide students into groups such that each group includes at least one representative from each stakeholder group.
   - Groups discuss the problem, each student from the perspective of the stakeholder group they represent

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EXAMPLE: SCENARIO DISCUSSIONS & ROLE PLAY

5. **Develop a common statement**
   - Keep the groups from the previous step if they seemed to work well.
   - Students leave their roles and work together to develop a written/ drawn common statement (e.g. an international agreement, a roadmap for sustainable development, a conclusion from a committee, …)

6. **Present and summarize**
   - Each group presents their results
   - Other groups and teacher can comment/ ask questions
   - Discuss students' experiences and relevance of the exercise for their future professional lives

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attack

Attack och försvar

Temadag 18/5 🔗

Upplägg

08.30-09.00: Introduktion

09.00-10.00: Arbete med morgonfrågor i grupper om tre deltagare (="3-grupper")

10.00-12.30: Bearbetning av Casefrågor i 3-grupper

12.30-13.30: Lunch

13.30-16.30: Tvärgruppsredovisningar av Casefrågor i grupper om nio deltagare (="9-

E-möte

Allt arbete kommer att ske i Zoom

https://umu.zoom.us/j/9011253 755

Utvärdering

https://www.menti.com/nitjziu7ax

https://sites.google.com/gapps.umu.se/attack/startsida

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https://www.ucl.ac.uk/steapp/study/professional-education/how-change-world

EXAMPLE: MATHEMATICS

Calculate the percentage of female vs male doctoral students that go on to become a professor at your university. Are the results reasonable? How would you explain them?

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EXAMPLE: CHEMISTRY

Calculate the equilibrium pH of water at 350 ppm and 450 ppm CO_2 in the air. Compare how these two pH levels would influence marine coral reefs.

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EXAMPLE: INTERDISCIPLINARY DESIGN

Design a respirator only using materials and components that are cheap and readily available in Colombia.

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Get inspiration for—and help with—your course/program development project!

- Hear about **inspiring examples**
- **Brainstorm ideas** for course/program development
- Revise **syllabi**
- Add/revise **learning outcomes**
- Develop **teaching and learning activities**
- Build an ESD-**network**
- Get and provide **support and encouragement**

EDUCATION FOR SUSTAINABLE DEVELOPMENT – WORKSHOP SERIES

EDUCATION FOR SUSTAINABLE DEVELOPMENT – WORKSHOP SERIES

Get inspiration for—and help with—your course/program development project!

- Hear about **inspiring examples**

8 September, 13-15

Dr. Aida Guerra

Aalborg University

ESD through PBL

and encouragement

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