WHO AM I

Programme Coordinator 4TU- CEE
Researcher 4TU CEE
Educational Advisor  Support staff TU Delft
Assistant Professor Fac TPM, TU Delft
Phd EDUTECH/DiDO TU Delft
4TU CENTRE FOR ENGINEERING EDUCATION

Mission: believes in jointly inspiring, stimulating, supporting and disseminating effective and high quality Engineering education through research and application of evidence-based innovations.

Inspiration: Tours, seminars, workshops

Innovation: Innovation map/innovation support

Investigation: Research themes Interdisciplinarity, Maker spaces, Teaching Excellence (UT), and Engineering Roles (TU-D)
IN DELFT

- Stimulating and co-develop educational innovation when linked to engineering education
- Helping find teacher solutions for problems, to which the educational advisor do not yet have an answer by doing research
- Supporting the development of educational research units in the faculty of architecture with an aim to enlarge the initiative
- Disseminate knowledge or get inspiration from outside
- Creating strategic alliances with whom to collaborate on research or innovation proposals.
OUTLINE

Interdisciplinary work package
Article Outcomes
Tools
Interactive Voting
Please ask any questions any time
Who are you?

A. Teacher/Educator 0%
B. Educational Support staff 0%
C. Policy advisor 0%
D. Researcher 0%

How many years do you have with interdisciplinary teaching? either as teacher, researcher or support staff?

- 0 years
- 0-3 years
- 3-5 years
- 5 and longer
4TU. Centre for Engineering Education

Innovating engineering education for tomorrow’s engineer.
TRENDS IN EDUCATION

20th century
- Frontal Education
- Teacher
- Disciplinary
- Knowledge oriented
- Fixed final terms
- Fixed programme
- Book information
- Study with continuing courses

21st century
- Problem / Project oriented
- Coach / advisor
- Multi/interdisciplinary
- Insight oriented
- Competences
- Flexible study tracks
- Internet & E-Learning
- Life Long Learning
FUTURE STUDENT CONTEXT

Complex problems require different approaches and expertise
WHAT DID WE DO

2014 – Interdisciplinary work package

Literature Review Study

996 Scopus and web of science journal articles (2005 – 2016) - and narrowed down on the basis of screening to 110 documents of interdisciplinary learning in Engineering Education - which were coded on the basis of a coding scheme.

8 Case Studies
The Research Questions

What **main issues** regarding Vision, Teaching, and Support have **emerged** in the field of Interdisciplinary Engineering Education?

What **points of attention** regarding Vision, Teaching, and Support can be identified as **supporting or challenging** Interdisciplinary Engineering Education?
THE FRAMEWORK

VISION – The WHY of an interdisciplinary Education Programmes

Vision
motivation for IEE, curriculum goals, system approach

Teaching
student group composition, learning goals and tasks, project work, scaffolding structures, assessment

Support
teacher support, infrastructure, institutional barriers

Interdisciplinary Engineering Education

TEACHING – The HOW and WHAT questions putting the governing VISION into practice

SUPPORT – Structures in place to realise HOW and WHAT in accordance with the WHY

Figure 1. IEE educational processes and main themes at three key levels.
Vision

- Awareness of Real world

- Socially responsible engineering
  - Entrepreneurial mindset
  - Awareness of shortcomings of one’s own discipline
  - Professionals skills learning
  - Higher order cognitive skills

- Addressing Complex Problems

Vague definitions of skills or of what should actually be taking place in interdisciplinary learning/interaction
Generic Skills learning focus

1. In depth Knowledge of their chosen discipline before they can construct knowledge together

2. Broad overview of the field before understanding the depth of their own field

3. Whole systems design, iterative design cycles between disciplinary design and broadening learning.
Lack of Institutional Support at policy level, where the system is focused on disciplinary promotion, tenure, etc

Interfaculty barriers need to break down the siloed nature of the institution

Teacher training on how to tackle interdisciplinarity very important as many lack the experience to work interdisciplinary
WHAT IS YOUR CONCERN?
OUR CONCERN

Many data points, Different Approaches, Ideas with few unifying principles
ERIC MAZUR

Learning outcomes fixed (OUTCOME)
Methodology fixed (HOW)
Often the problem is also fixed (WHAT)

Move to

Open Learning outcomes (OUTCOME)
Methodology as a toolbox (HOW)
Problem Definition open (WHAT)
Teaching Science and Engineering starts with Content

The primary driver for what we teach in Academia is Research Driven

What can we learn from interdisciplinary research that might be applicable to education
The act of integrating theory, methods – approaches of different disciplines to realise more versatile and possibly better solutions for society or on the innovative edge of disciplinary boundaries.
disciplinary research approaches: levels of integration levels Menken & Keestra 2016

**Multi**
- A
- B
- Unintegrated Multidisciplinary Results from disciplines A and B

**Inter**
- A
- B
- Integrated Interdisciplinary Results from discipline A and B

**Trans**
- A
- B
- Integrated Transdisciplinary Results
- Non academic knowledge
INTERDISCIPLINARY RESEARCH PROBLEMS

Problems originating from the real world
Problems driven by complexity
Problems (of a more fundamental nature) concerned with new knowledge and solutions beyond traditional disciplines.
Problems are in urgent need of a solution not yet known
INDUCTIVE VS ABDUCTIVE

What + How = ????

What + ???? = ????

Learning outcome = How + ????

Learning Outcomes = ???? + ????

Learning Outcomes = ???? + ????

Kees Dorst 2012 Frame innovation
EDUCATIONAL METHODS ALLIGNED

With respect to

1) the problem,
2) the level of integration
3) the design of the study programme via inductive or abductive approach.
DEFINING THE APPROACH

URBANISM master

DESIGN ABDUCTION
HIGH LEVEL OF INTEGRATION
THE PROBLEM IS FRAMED ACCORDING TO DESIRED OUTCOMES

WHOLE SYSTEMS DESIGN

CLINICAL TECHNOLOGY bachelor

INDUCTION
MODERATE LEVELS OF INTEGRATION
PROBLEM AT THE EDGE OF DISCIPLINES NARROWLY FOCUSED ON RELEVANCE OF SOLUTION FOR HUMAN HEALTHCARE AND TECHNOLOGY

IN DEPTH KNOWLEDGE BEFORE BROADENING THE SCOPE
EDUCATIONAL MODEL

URBANISM

STUDENT SKILLS: Open, strong personality, self-awareness, communicative skills, agile

STUDENTS FORMULATES PROBLEM

STUDENT CHOOSES FROM WIDE OFFER OF DIFFERENT EXPERTISE OFFERED

ACTIVITIES: ITERATIVE

ASSESSMENT: multiple stakeholders (CRIT)

CLINICAL TECHNOLOGY

STUDENTS ABILITIES: foundational knowledge, application this in new knowledge area

TEACHER FORMULATES PROBLEM

TEACHER DETERMINES RELEVANT KNOWLEDGE WITHIN DISCIPLINARY DOMAIN

ASSESSMENT: by disciplinary content expert
How did you or would you design your interdisciplinary course?

Points of departure

- Complex Problem definition
- Level of Integration
- Inductive problem approach
- Abductive problem approach
CONCLUSION

IT is the Content of interdisciplinary research that should be our guiding principle in designing interdisciplinary education.

I.e. The level of integration

Problem solving strategies inductive or abductive

Needed to solve a intdis. Research problem lead the way to the WHY, WHAT, HOW and OUTCOME.
4TU SHOW CASES (CURRENT RESEARCH/ACTIVITIES)

Interdisciplinary learning in minors extended framework Renate Klaassen, Nanneke de Fouw, Remon Rooij TU Delft

Team based working teachers Inke Gast UNIVERSITY OF TWENTE

Student dimensions of interdisciplinary learning Elsbeth Spelt WUR

Handson interdisciplinary learning Sonja Gomez TU/e

JIP expectations in interdisciplinary learning contexts Renate Klaaassen & Birgit de Bruin

4TU CEE – Olin Workshop on Interdisciplinary design John Geddes – Siddhartan Govindasamy

4TU CEE Innovation Map
CLOSURE

Danke Schön
Monika Rummler
Wiebke Bernt

Time for Discussion
TOOLS

Exploring the Problem – Roles Translation (Kamp & Klaassen 2016)

Integration – Negotiation of Meaning (p.Beers)
ROLE TRANSLATION

How can we develop and implement technology safely, ethically and internationally in society and industry?

How can we bring together disciplines, products or subsystems into a functioning for a complete solution?

How can we advance and optimize technology for innovations and better performance using scientific knowledge?

How can we advance and apply knowledge and use technology to develop new products for the benefit of people?

Any kind of expert from University on specific subject
MATRIX TEAM

discipline
discipline
discipline
discipline
RESULTS RESEARCH

Interdisciplinary teams

Stimulates multiple perspectives across disciplines

Provides a tool for problem definition/evaluation of design/strategic pathways for future visions or design pathways.

Role of the teacher is to:

Provide the glasses we are looking through

Heuristic questions to tackle a problem

Facilitate and stimulate coverage of different perspectives

Stimulating group dynamics by design
NEGOTIATING MEANING P. BEERS MODEL FOR EFFECTIVE NEGOTIATIONS

A States his/her view
externalization concept a

B States his/her views
Externalization concept B

Explains meaning

Meaning interpreted
A + B

Meaning interpreted
B + A

Integrated meaning created
A + B = C

Reference frame extended
NATURE COMPLEX PROBLEMS

Repko

COMPLEX REALITY

SYSTEMS THINKING APPROACH
Breaking it down in constituent parts
Identify what is addressed by different disciplines
Evaluate importance of linkage

DiSCIPLINES FOUNDATIONAL

HOLISTIC PERSPECTIVES

(Dorst, 2018)

OPEN no boundaries

DYNAMIC change over time

NETWORKED across organisations

COMPLEX many elements and relationships