Teaching engineers of the future

THE CASE OF CHALLENGE-BASED LEARNING AT TU/E

Dr. Antoine van den Beemt

Eindhoven University of Technology

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Changed requirements

Defining Challenge-Based Learning

CBL at TU/e

Best practices

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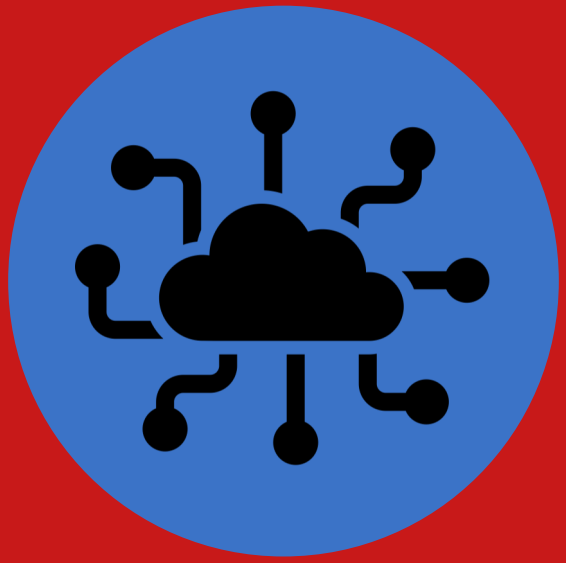
Changed requirements



“apply acquired knowledge and solve problems in **new or unfamiliar environments**”

“apply acquired knowledge and solve problems in **new or unfamiliar environments**”

“manage technical actions and **integrating knowledge and making judgements from incomplete information**”

Defining Challenge-Based Learning (CBL)

Challenge-Based Learning (CBL) as a case of educational innovation

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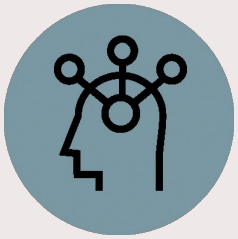
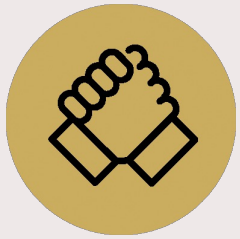
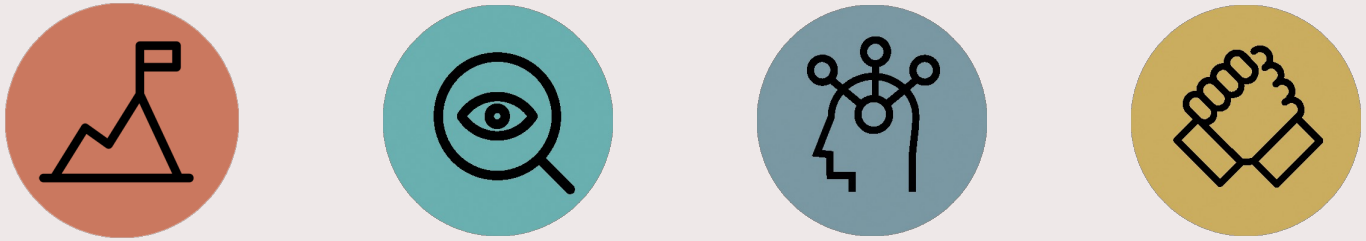



Educational concept
Evolution
Active learning - Constructivism



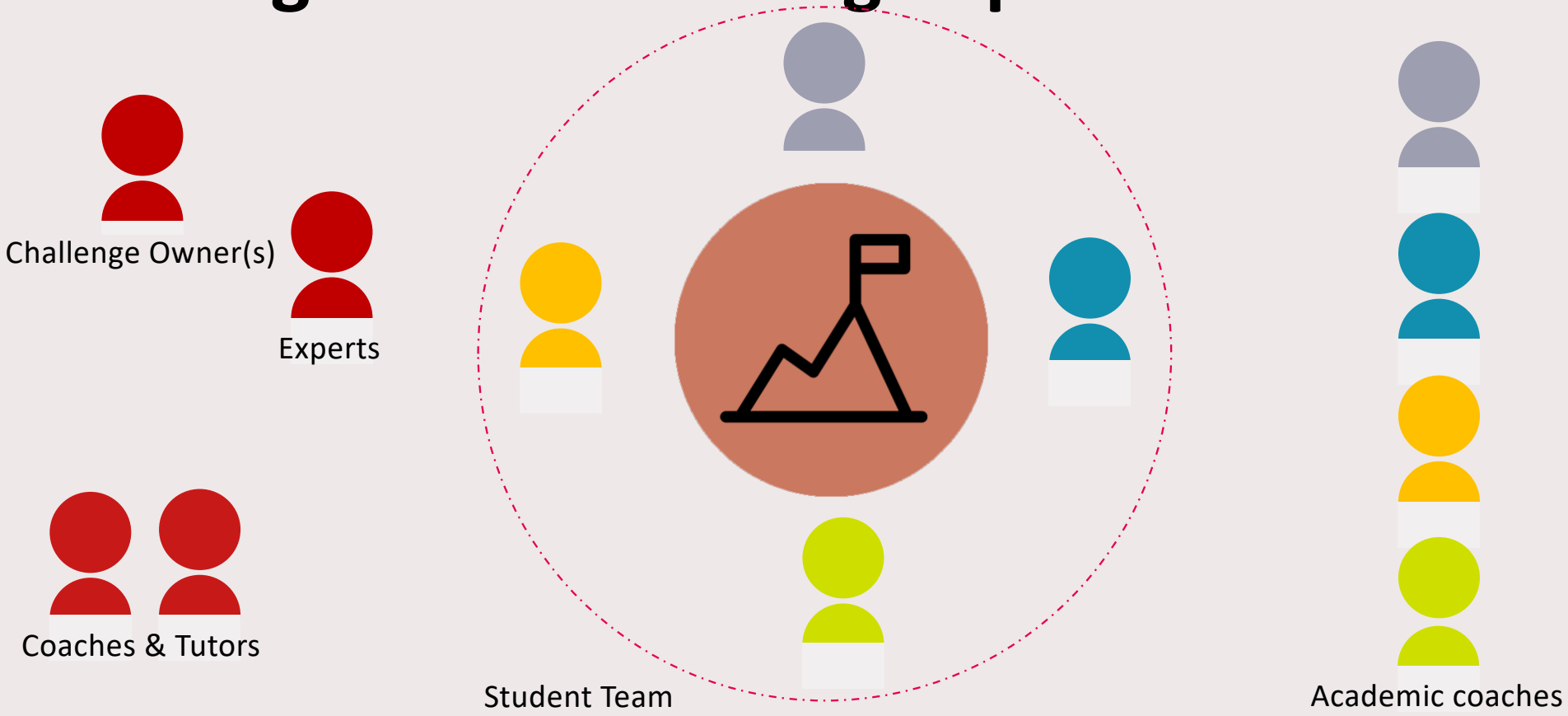
Self-directed work scenarios

Define and address the problem

Work towards a solution

Tangible or proposal for a solution

Challenge-based learning in practice



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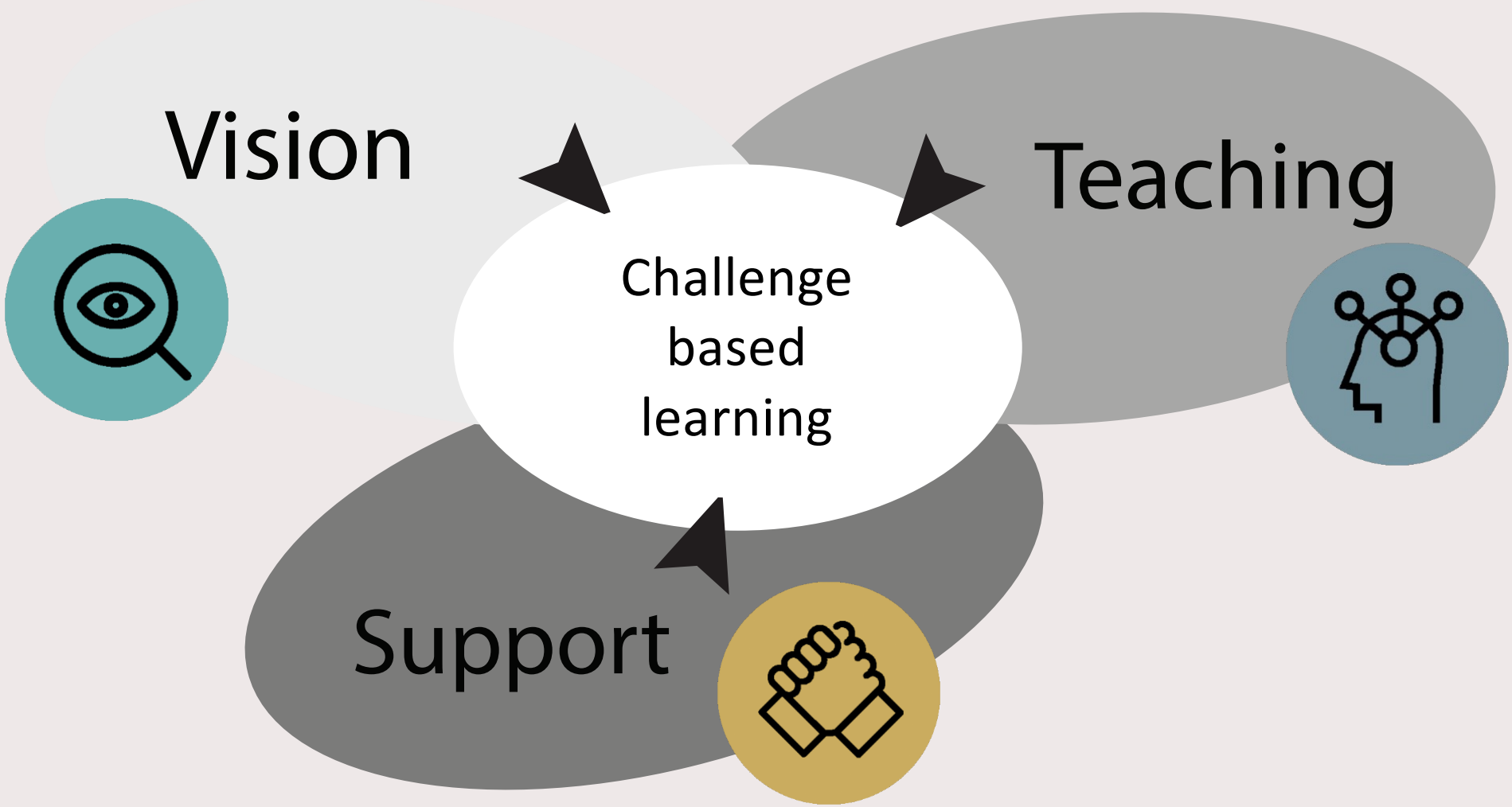

Van den Beemt et al., 2020, 2023a

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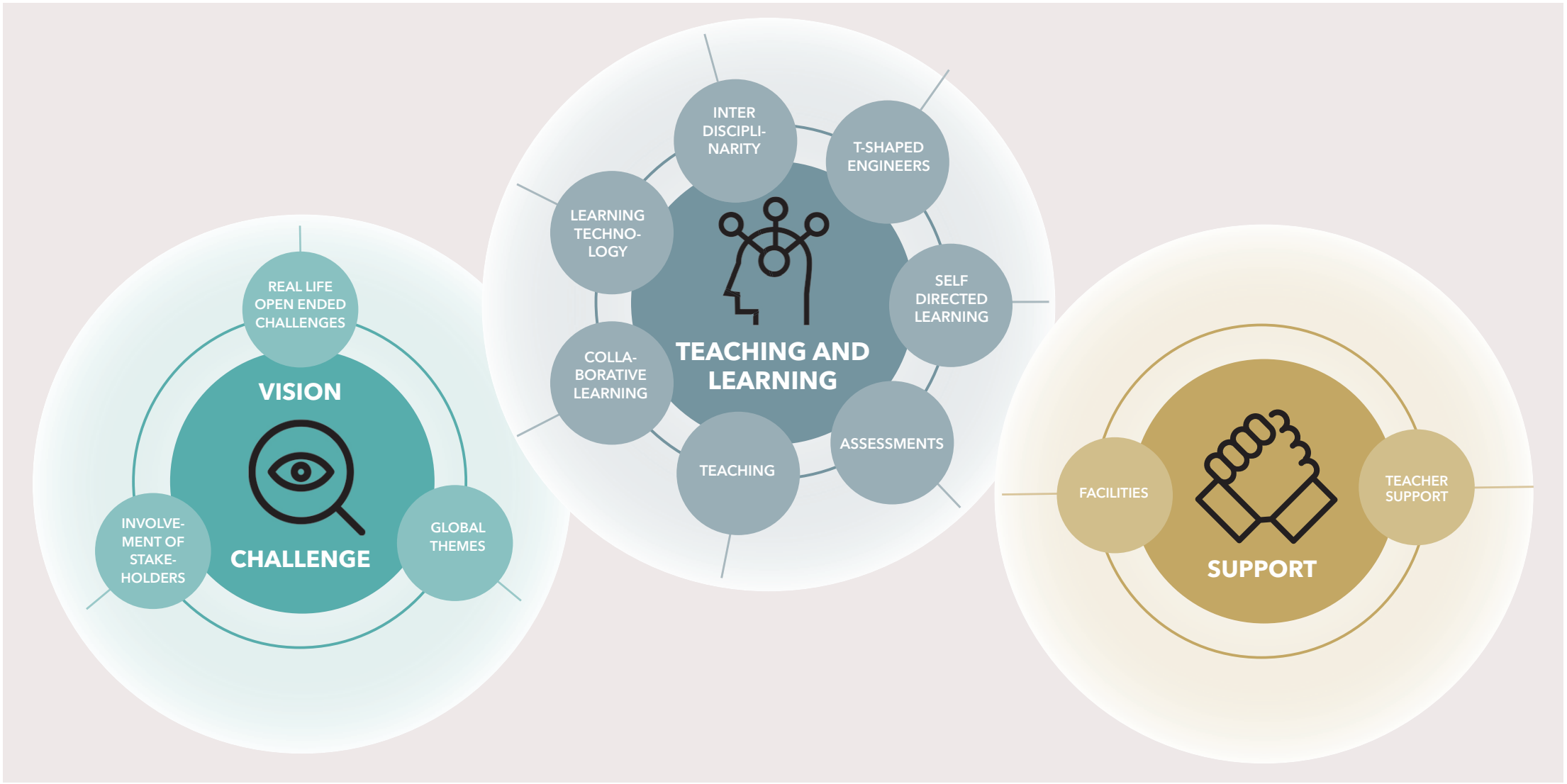

Van den Beemt et al., 2020, 2023a

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Van den Beemt et al., 2023

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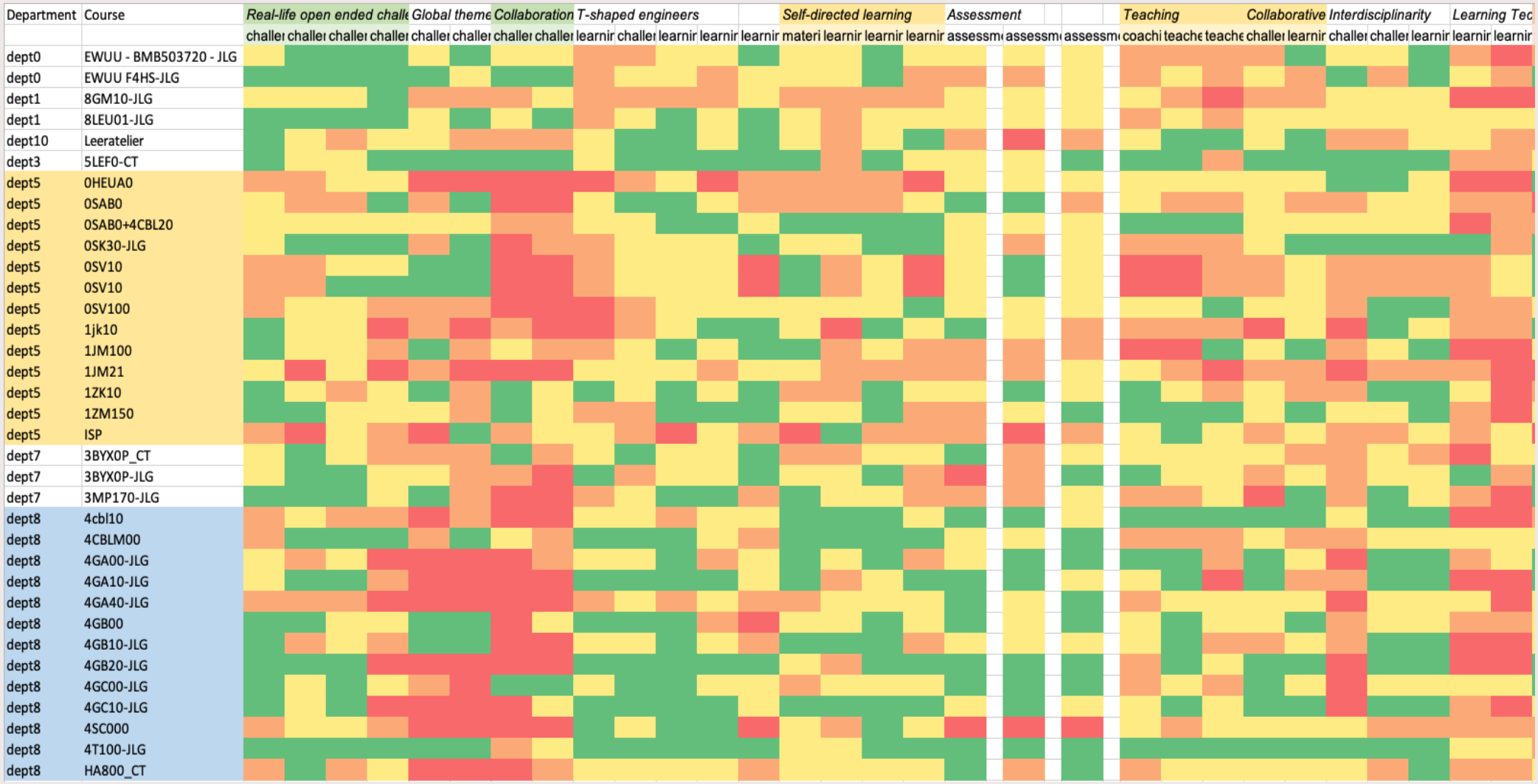
TU/e CBL-compass



Department	Course	Real-life open ended challe				Global theme		Collaboration	T-shaped engineers					Self-directed learning				Assessment				Teaching			Collaborative	Interdisciplinarity			Learning Tec	
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dept1	8GM10-JLG																													
dept1	8LEU01-JLG																													
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dept3	5LEF0-CT																													
dept5	0HEUA0																													
dept5	0SAB0																													
dept5	0SAB0+4CBL20																													
dept5	0SK30-JLG																													
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dept5	ISP																													
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CBL at Eindhoven University of Technology

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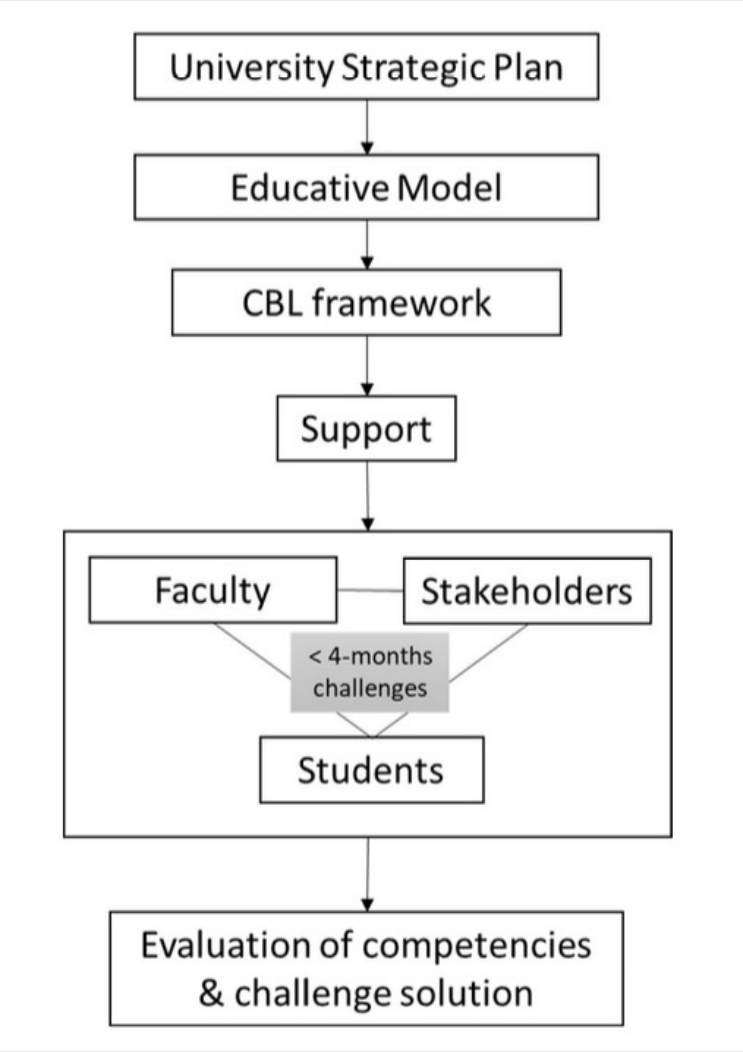

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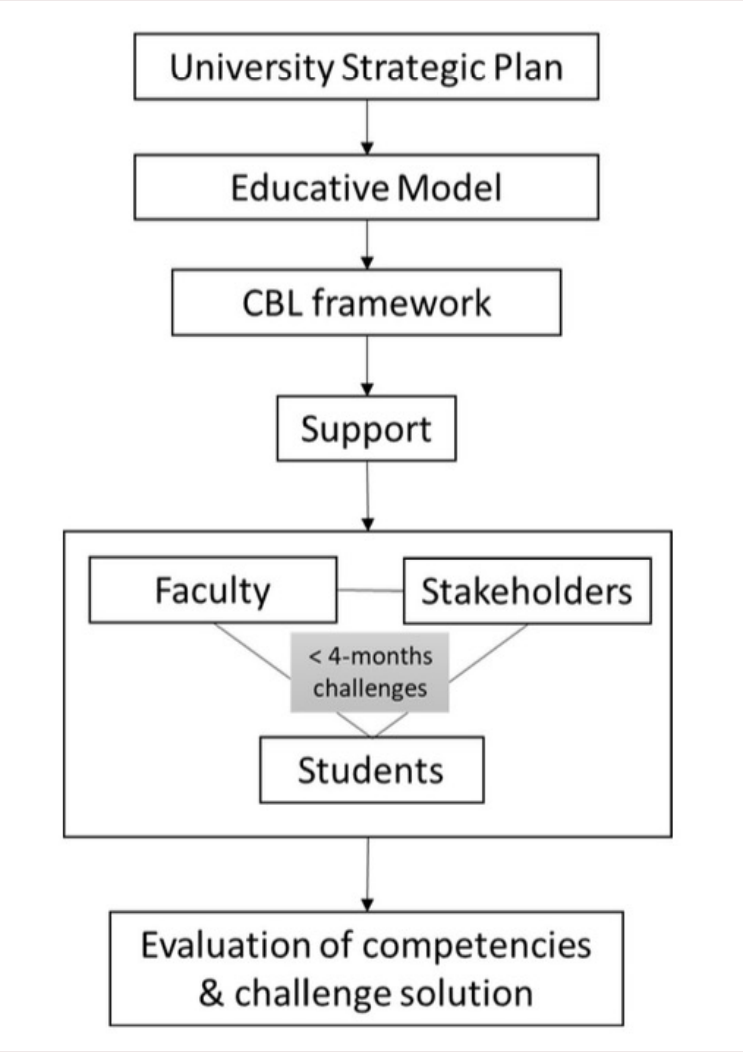

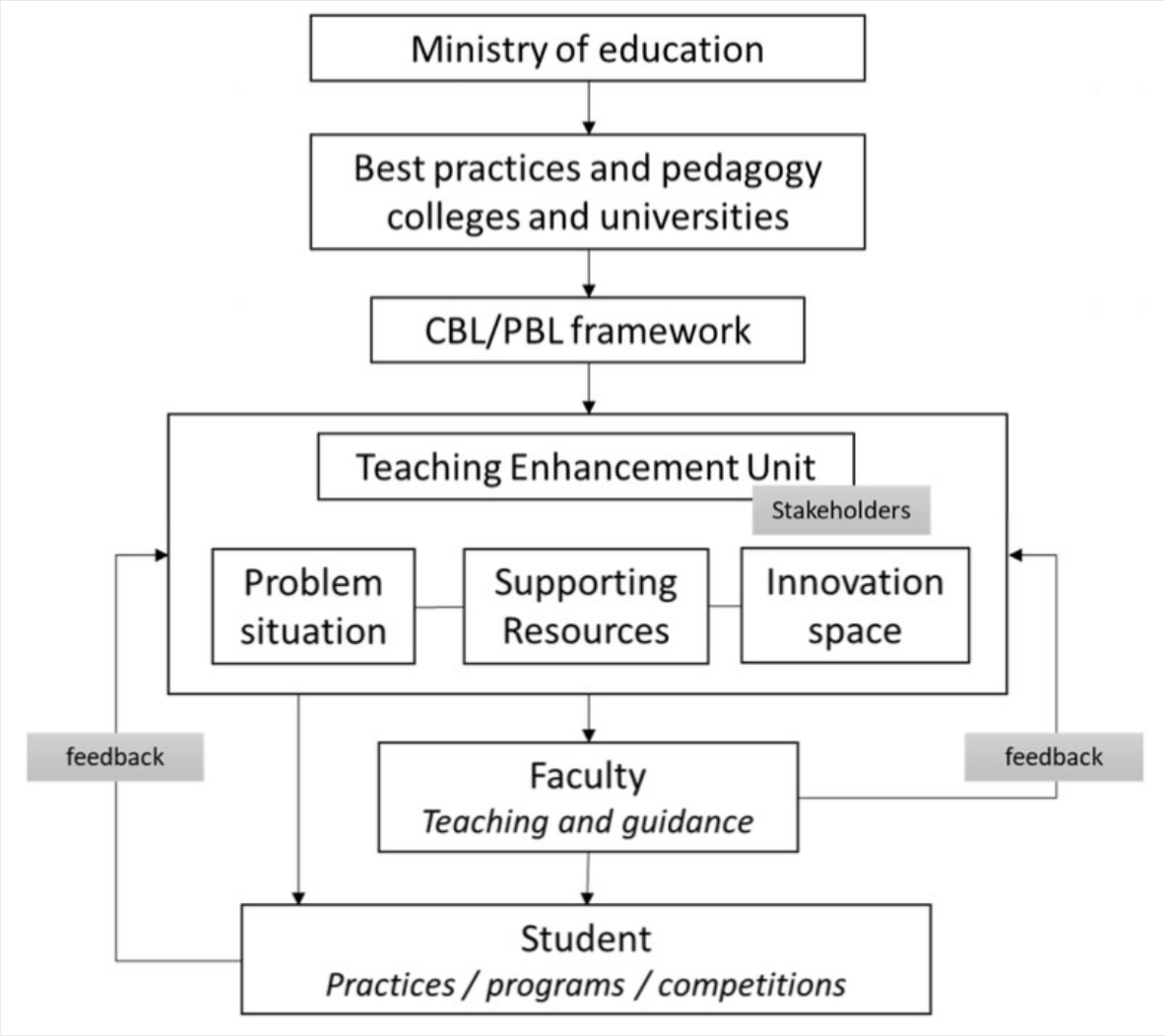

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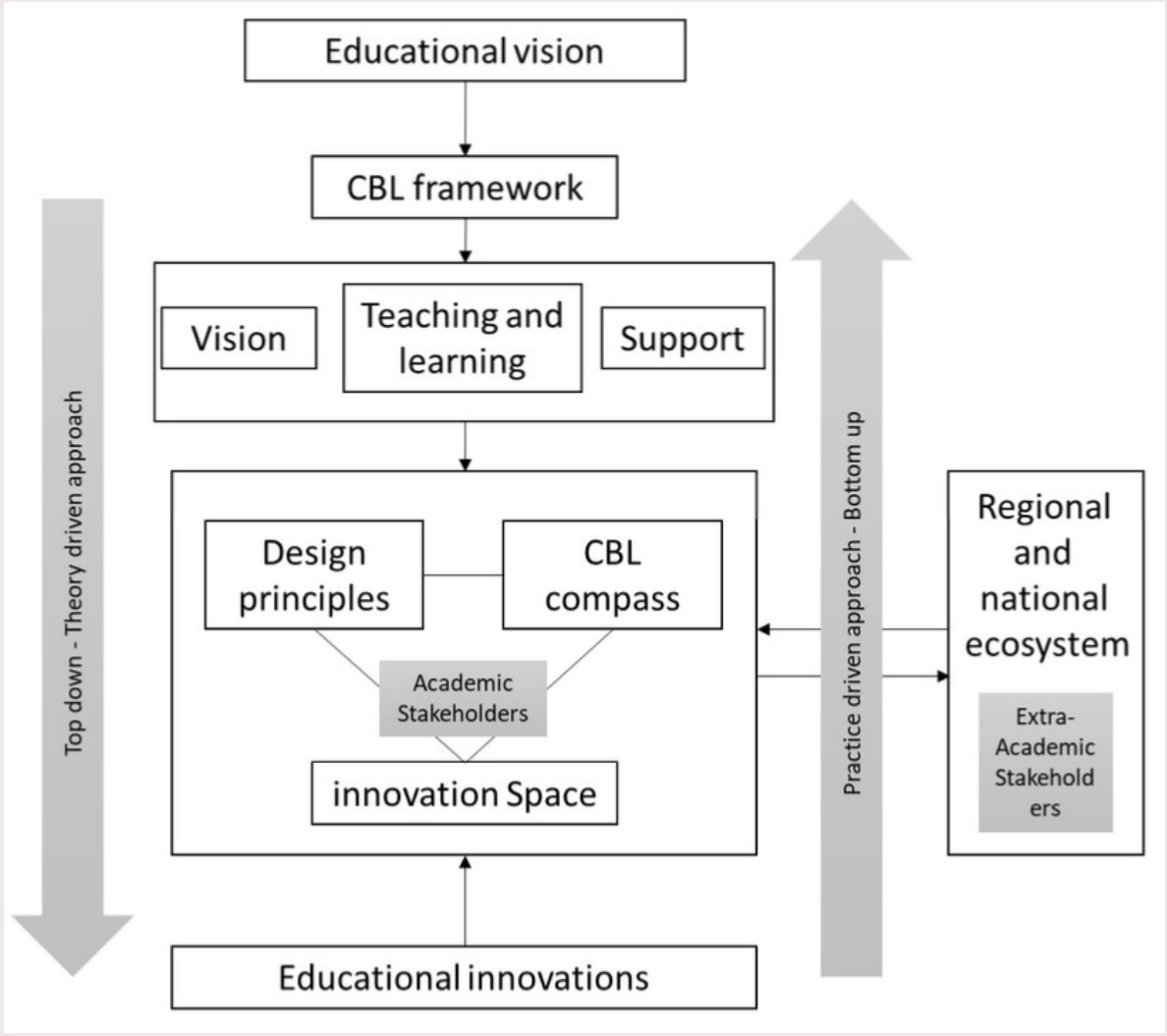

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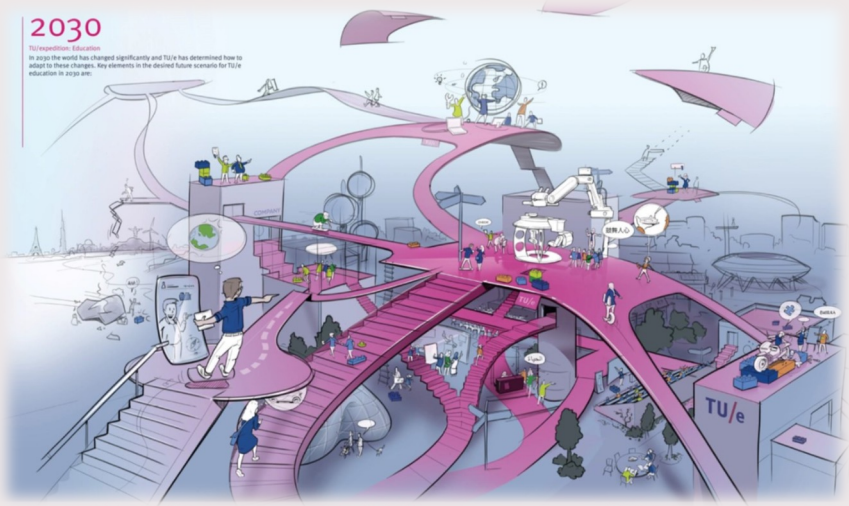

Curriculum wide implementation

Full-fledged CBL
Small-scale CBL

Variety in CBL implementation

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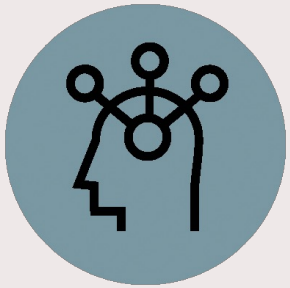
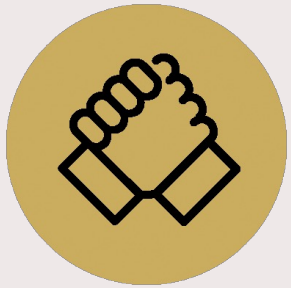
40+ research and innovation projects

Evidence?
How to align?
Topics? Investigated, forgotten?

Practical/ strategical problem	Research area/ problem definition	Dimensions	Current Projects	Need to know: research question	Need to do: research method	Need to do: implementation in educational practice	Need to do: dissemination

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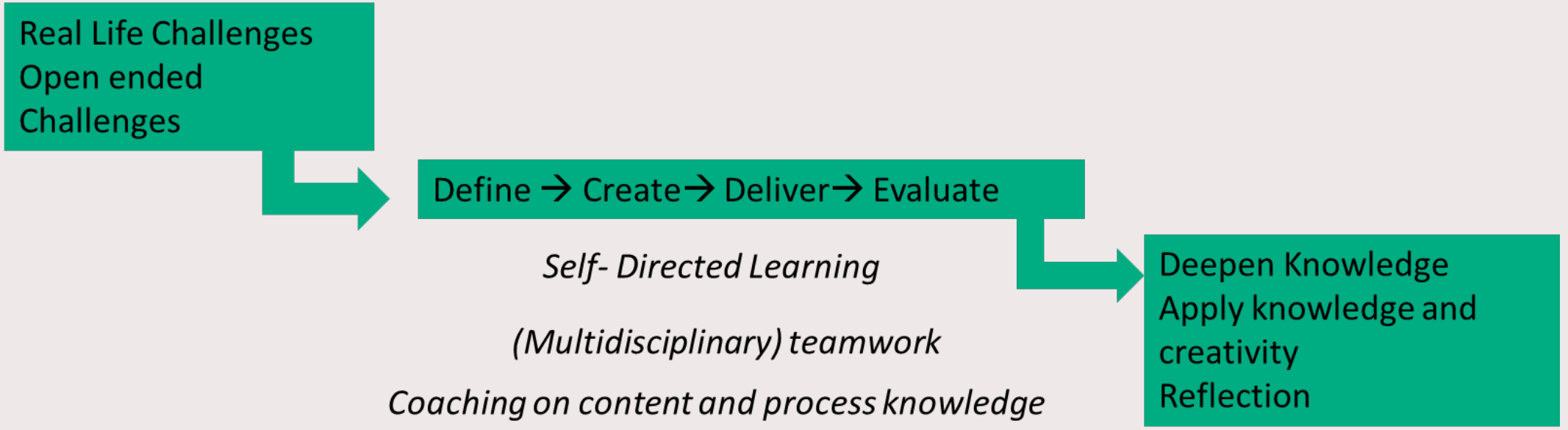

Dulougeri et al., 2022

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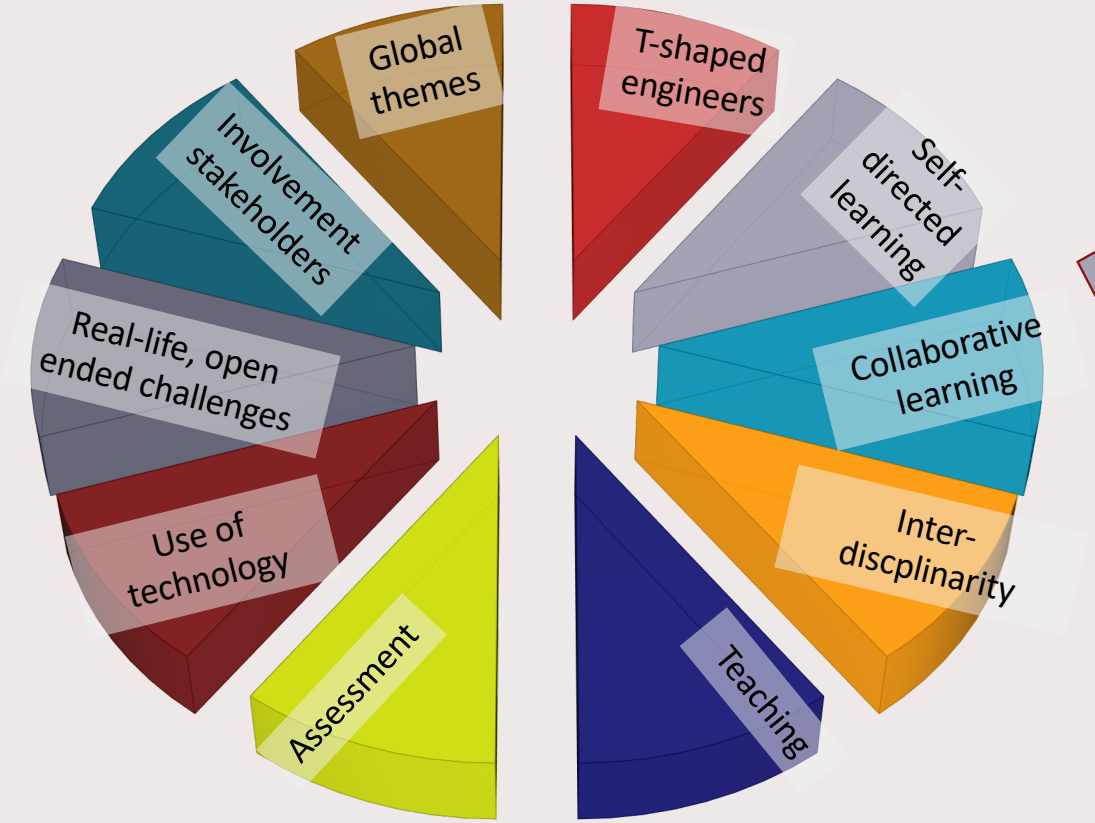
About design principles

Design principles: organizational unit for synthesizing design knowledge (Merrill 2002).

Design Principles	Design guidelines
High level starting point	Specific directives
Context free design goals	Context dependent rules for designers
Based on theories of learning & education	Based on principles

Dulougeri et al., 2022

CBL Design principles on course level (based on CBL-compass)



Example design principle SDL/SRL

Based on the open-endedness of the challenge, design the challenge-based learning experience in such a way that it includes a variety of opportunities for student agency/autonomy.

This includes making, communicating and reflecting on explicit choices in the definition of challenges, the role in teams and in the learning goals / activities they want to engage in.

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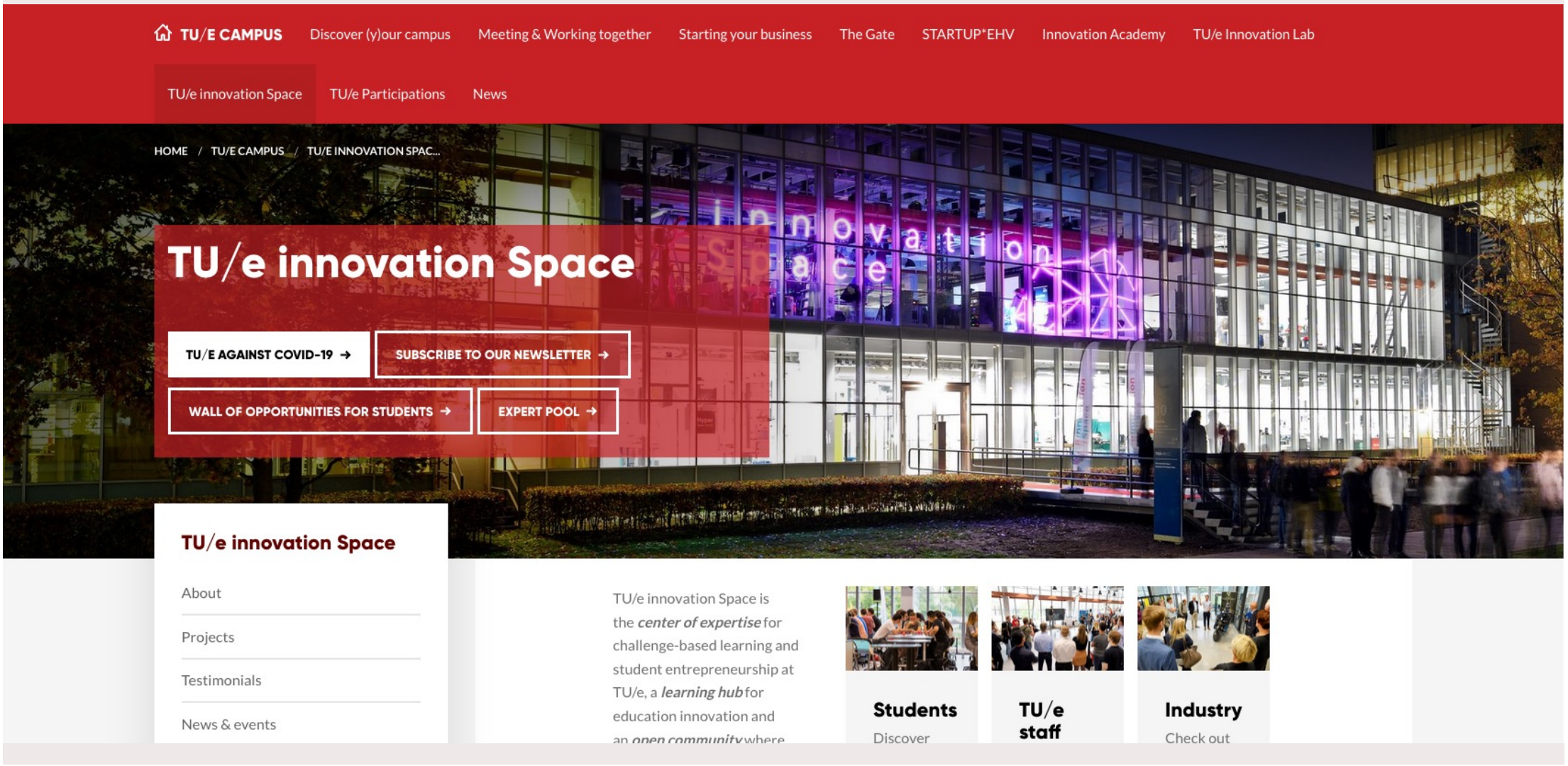
Best practice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TU/e innovation Space is the center of expertise for challenge-based learning and student entrepreneurship at TU/e, a learning hub for education innovation and an open community where
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Industry
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Interdisciplinarity in CBL

Support interdisciplinary student collaboration

Van den Beemt & MacLeod, 2021

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Integration (Huutoniemi, et al., 2010; Klein, 2010)

Learn from other disciplinary perspectives (Borrego & Newswander, 2010)

Methodological or conceptual synthesis (English, 2016)

Deepening knowledge and skills

”One language” (McNair et al., 2011)

Van den Beemt et al., 2020

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“apply acquired knowledge and solve problems in **new or unfamiliar environments**”

“manage technical actions and **integrating knowledge and making judgements from incomplete information**”

AQU, 2023b

Results

Interdisciplinarity
Student motivation

Van den Beemt & MacLeod, 2021

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Interdisciplinarity

Collaboration – group learning

Integration

Van den Beemt & MacLeod, 2021

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Collaboration - Group Learning

Practice
Domain & Value Creation
Collective Identity
Organization
Hands-on – learning approach

Vrieling et al., 2016; Huijben et al., 2021

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Integration

students:
make sense of concepts,
from disciplinary perspectives

Van den Beemt & MacLeod, 2021

Integration

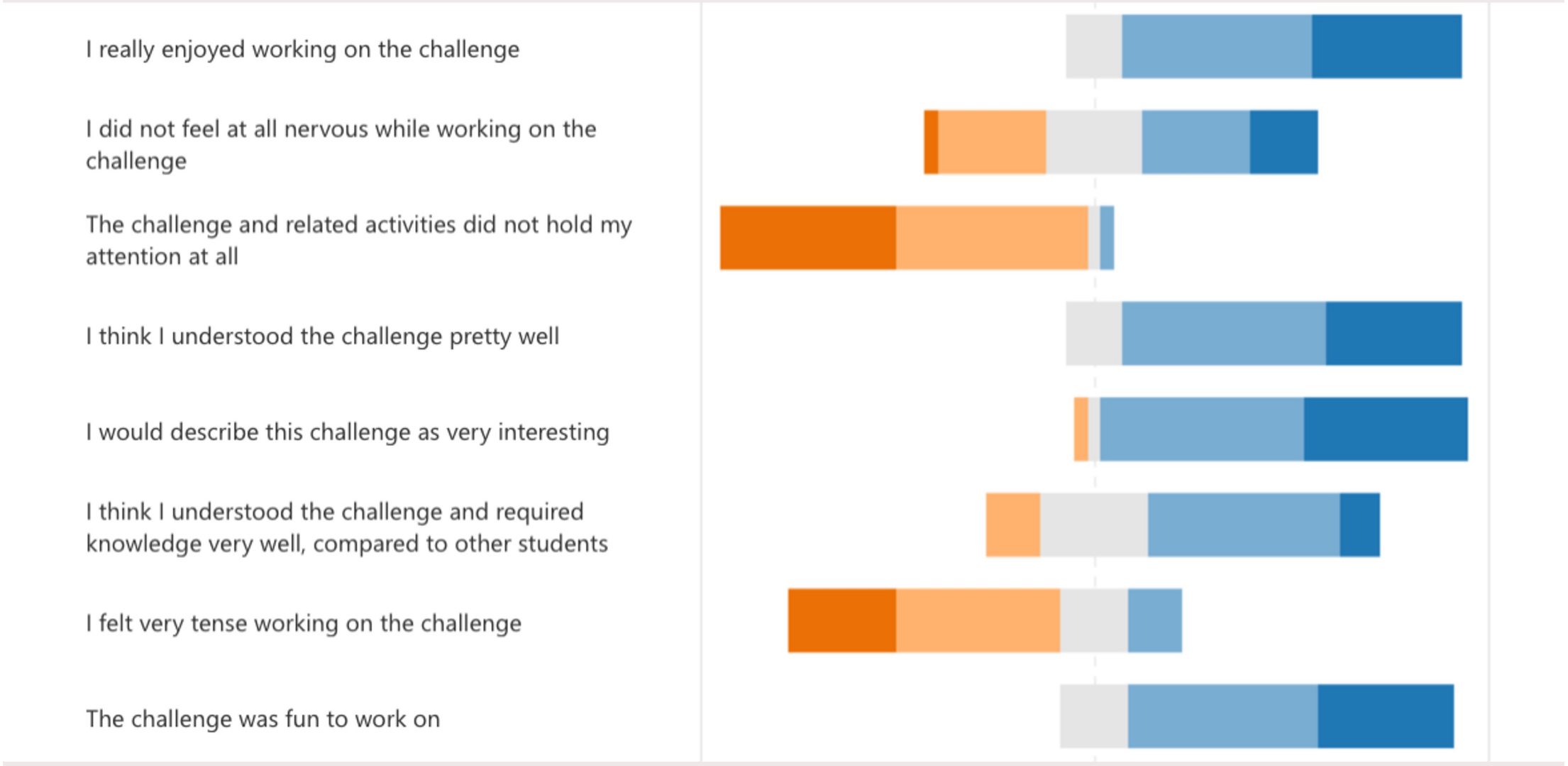
educators:
evaluation of (technical) contributions and integration by current teaching staff?

Van den Beemt & MacLeod, 2021

Motivation

Motivated to work on challenge,
Anxiety regarding challenge
Enjoyment and understanding ++

Van den Beemt & MacLeod, 2021


I really enjoyed working on the challenge
I did not feel at all nervous while working on the challenge
The challenge and related activities did not hold my attention at all
I think I understood the challenge pretty well
I would describe this challenge as very interesting
I think I understood the challenge and required knowledge very well, compared to other students
I felt very tense working on the challenge
The challenge was fun to work on

Motivation

Control and ownership of challenge well supported and scaffolded

Team development adequately supported through project plans and peer review

Van den Beemt & MacLeod, 2021

Taken together...

Integration and assessment of interdisciplinary work

Motivation, enjoyment

Anxiety

Understanding

Hands-on rather than social learning approach

Transdisciplinarity

Develop and apply knowledge and skills to real-world problems

Collaboration with extra-academic actors

Aim: enhance the learning experience
Increase in complexity of integration

Transdisciplinarity

EWUU –
social science

professional skills

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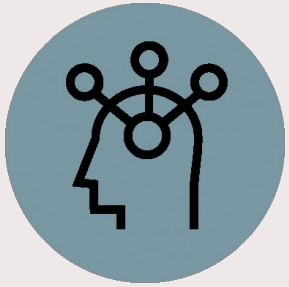
WAGENINGEN UNIVERSITY & RESEARCH
Utrecht University
UMC Utrecht

Suggestions

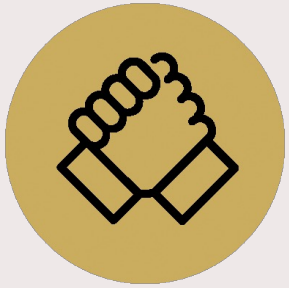
Professional development teachers/coaches

Role (extra-academic) stakeholders



Balance open-ended – structured

Social learning (learning goals, learning agenda)



Let’s keep in touch!

Antoine van den Beemt
a.a.j.v.d.beemt@tue.nl

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