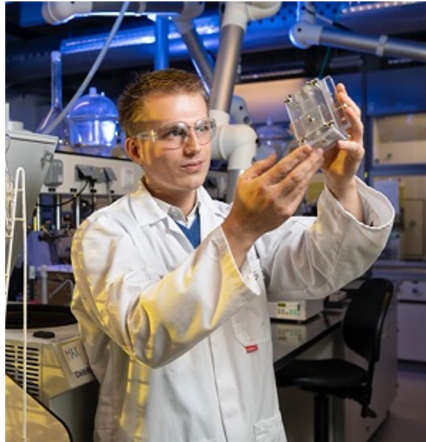


Challenge Based Education at TU Delft and Beyond

A 4TU perspective Renate Klaassen

IGNITION SEMINAR 15 March
Waterford, Ireland



Who Am I

- Senior Researcher 4TU CEE/DIAM -EEMCS
- **Programme Coordinator 4TU- CEE**
- Educational Advisor Support staff TU Delft
- Assistant Professor Fac TPM, TU Delft
- Phd EDUTEC/DiDO TU Delft



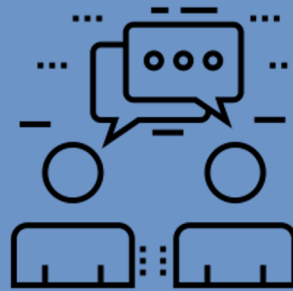
approximate FACTS FIGURES 2018-2021

- **TU Delft: 26,978 studenten**
- TU/e: 12,906 studenten
- Twente: 12,903 studenten
- WUR: 13,153 studenten

TU Delft 16 BSc , 30 MSc programmes
TU/e 15 BSc/ MSc 46 mater tracks
Twente MSc 41 track 5 deptm.
WUR 19 BSc/ 31 MSc

Staff in FTE
TU Delft: 6347 fte
TU/e: 3640 fte
Twente: 3363 fte
WUR: 6420 fte

What is Challenge Based Education?





Discuss with your Neighbour
or table 3 key characteristics
of CBE?

What is your Challenge in
starting, implementing or
executing challenge based
education

Send @ACUNIZ to 0970 1420 2908

Context

Curricular

Extra- Curricular

Type of Challenge

Learning

Outcome

Impact

Educational Paradigm

Formats

Assessment

Space

CBL design principles



3 Design principles about CBL vision

Put central in CBL **a real-life challenge** that needs an **interdisciplinary perspective** and requires the **development of a concrete solution** that students need to produce. The challenge needs to present a certain level of **ambiguity** and **avoid a pre-defined solution**.



12 Design principles about CBL Teaching and Learning

Define as precisely as possible **learning goals, both easy and difficult to measure** including knowledge acquisition and application, transversal skills and social attitudes



3 Design principles about CBL Teacher Support

Develop a teaching team and ensure **appropriate training and alignment of all teaching staff**. During the course create **peer feedback sessions of more and less experienced teachers to support each other**

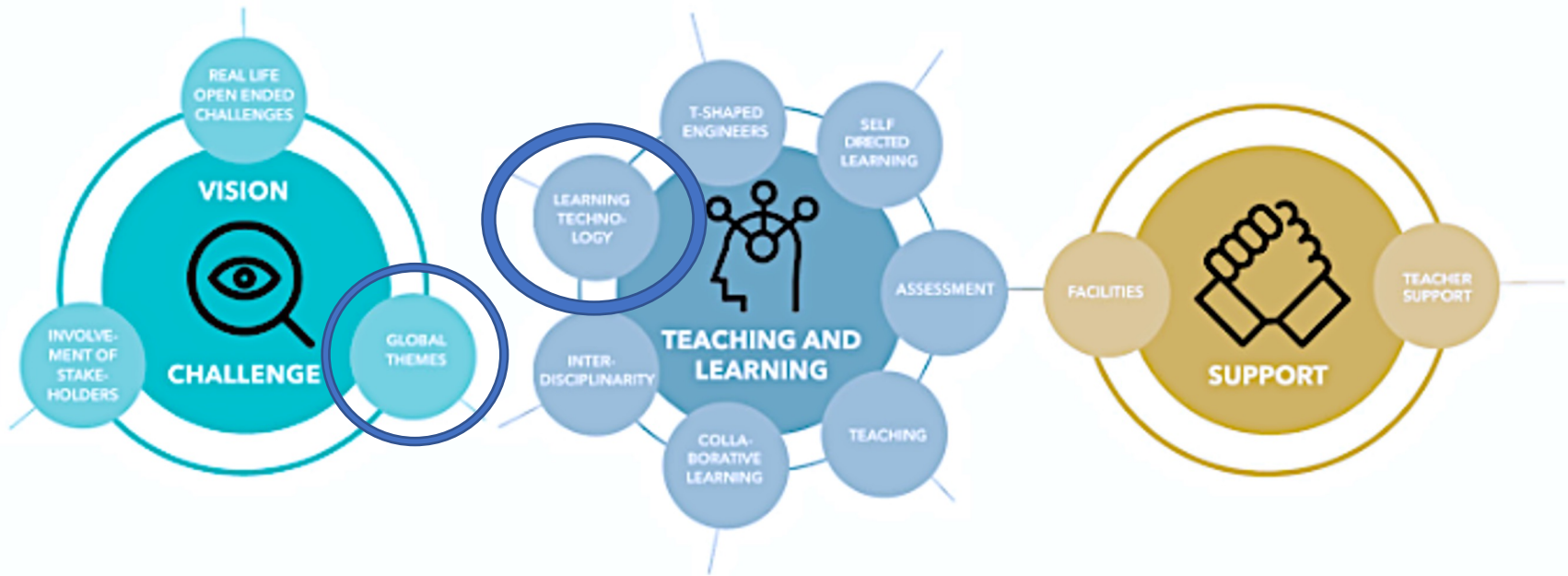


Figure 1. Dimensions of challenge-based learning.

Van den Beemt et al. 2022
(TU/e)

Key characteristics of CBL@WUR

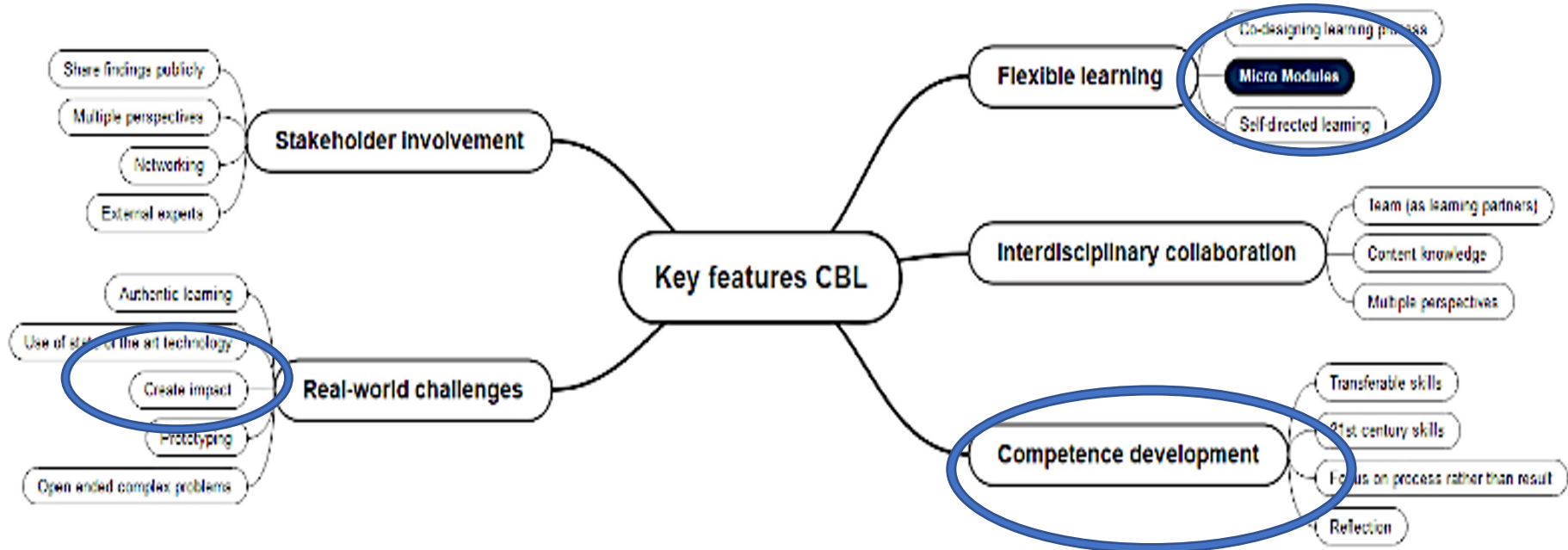


- 1 The challenge is on a complex problem that does not have a right answer; multiple solutions are possible.
- 2 CBL provides opportunities for students to develop their personal & professional skills.
- 3 Students work in multi-disciplinary groups.
- 4 Coaches are available for individual, team and/or process support.
- 5 The challenge is a real-life problem from an external client/commissioner.



Baggen et al. submitted 2022
(Cassandra Tho - PhD)

Twente University



TUD	Real-world challenges	Interdisc. problem	Collaborative	Knowledge + skills	Competition	Aiming for solution-action	Interaction with community	Technology to communicate to outside world	Extended learning community (feedback from outside world)

Grand challenges of Earth Science	X	X	X	X	-	-	-	-	-
Innovation Lab	X	X	X	X	-	-	-	-	-
Eye.Oculus	X	X	X	X	-	X	-	-	-
Societal Challenge Project	X	X	X	X	-	-	X	-	-
Joint Interdisc	X	X	X	X	-	X	X	X	X

Poll: Wooclap

In your institution Challenge based Education includes:

- 3rd Party stakeholder involvement
- Real life Challenges
- Multi/inter/transdisciplinary collaboration
- Open, Dynamic and Complex problems
- Personal Development activities
- Professional skills development
- Competition
- Student driven
- Curricular
- Extra Curricular

What is the effect of
Multi/inter/transdisciplinary problem solving
on the innovation impact of the institution?
(is the investment worth it)





4TU.IMPACT

Ambt ion

1.000 new research positions
393 miljoen Euro triple helix (3P)
collaborations
600 miljoen Euro (o.a. EU/ H2020) funds
collected
137,5 miljoen Euro for applied
implementation with small businesses

327.600 new jobs in small businesses in NL
1.000 validated business cases,
500 startups, 100 spin-offs, 30 scale
ups,

20.000 students education with an
entrepreneurial mindset.



4TU.IMPACT

- Civic University – Private – Public Partnerships driven by TOP sectors in the Netherlands (impulse)
- Living – labs for Innovation in research and education in self regulating teams
- Business Value creation and entrepreneurship
- (Economic) Seed funding

TU Delft

TU/e Technische Universiteit
Eindhoven
University of Technology

UNIVERSITY
OF TWENTE.

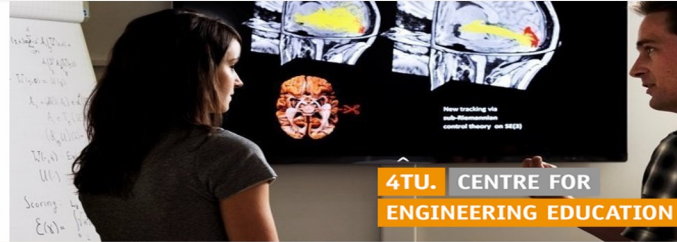
WAGENINGEN
UNIVERSITY





4TU.Centre for Engineering Education

Innovating engineering education for tomorrow's engineer.



4TU. CENTRE FOR ENGINEERING EDUCATION



When is a challenge for learning created with multiple stakeholders relevant?
Cheap labour or opportunity for professional growth?





(AERO) SPACE
IN 2020:
HYDROGE



SMART
INDUSTRY &
SOCIETY 4.0



HEALTH &
BIOBASED

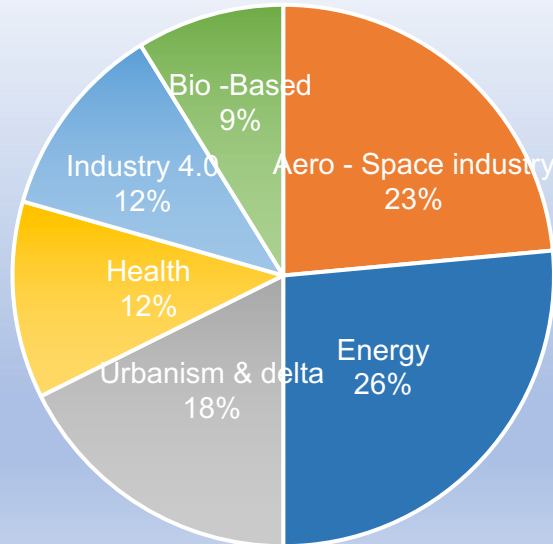


ENERGY
TRANSITION



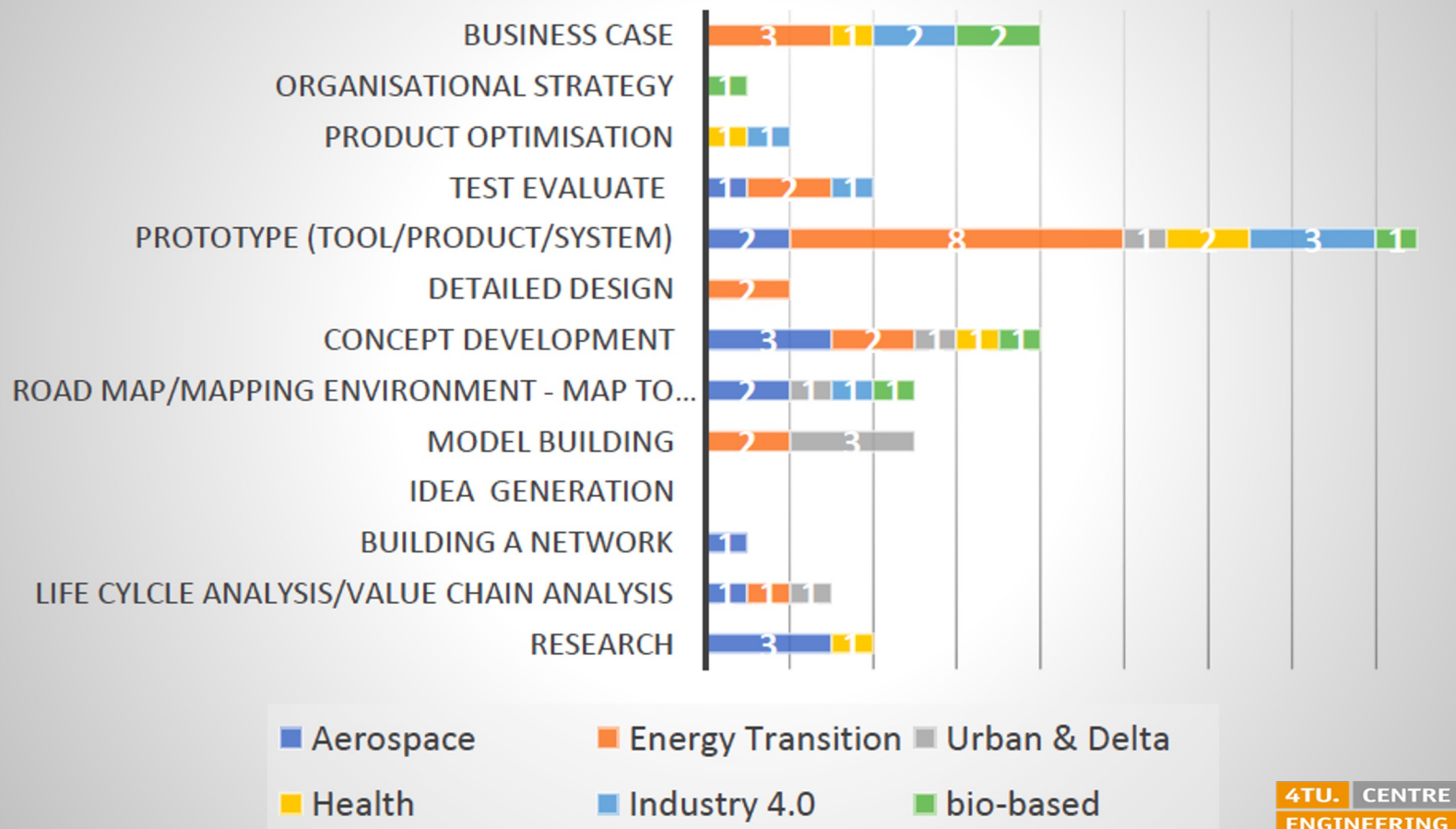
URBANISM/
DELTA/ GLOBAL

Number of challenges 2020/21 – 36



- Aero - Space
- Energy
- Urbanism & delta
- Health

Expected Deliverable



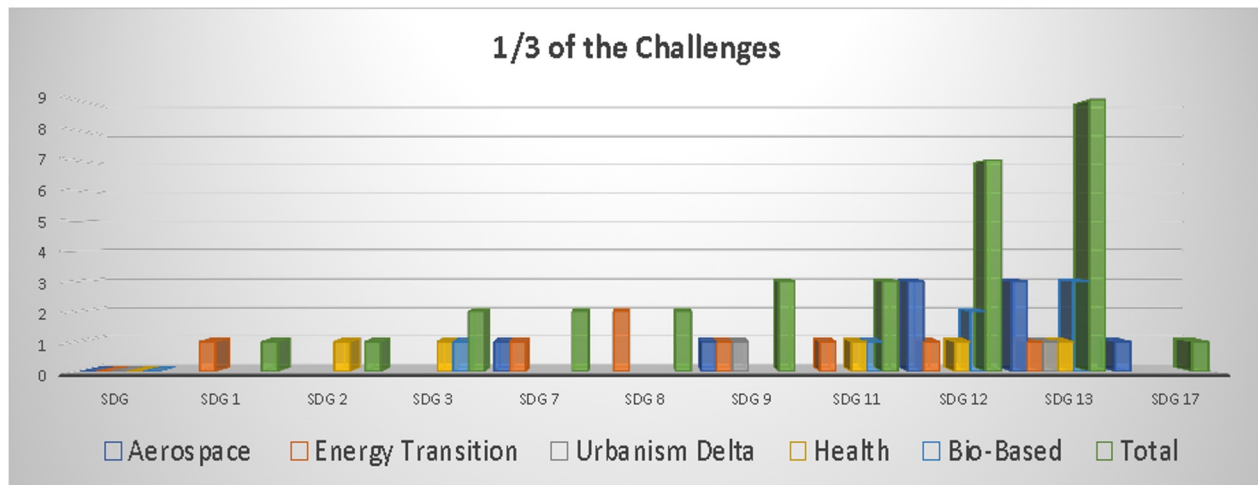
What student should bring according to the company (JIP)

- Value Creation
- Sociale impact is not the primary concern
- Attention for Sustainability & Climate
 - Share holders/ regulation and policymakers demands, company needs to be swayed
- Value of participating stakeholders:
 - Creative Solutions /Interdisciplinary teams (not available in the company)
 - Recruitment
 - Building Business networks

Value conflicts industry/university

- Students as cheap labour
- MONEY more important than education
- Public money spent for private profit of companies
- Personal earning for publicly funded researchers
- No university compensation
- Unfair competitions from involvement of publicly funded partner

Societal Impact: Sustainable Development Goals

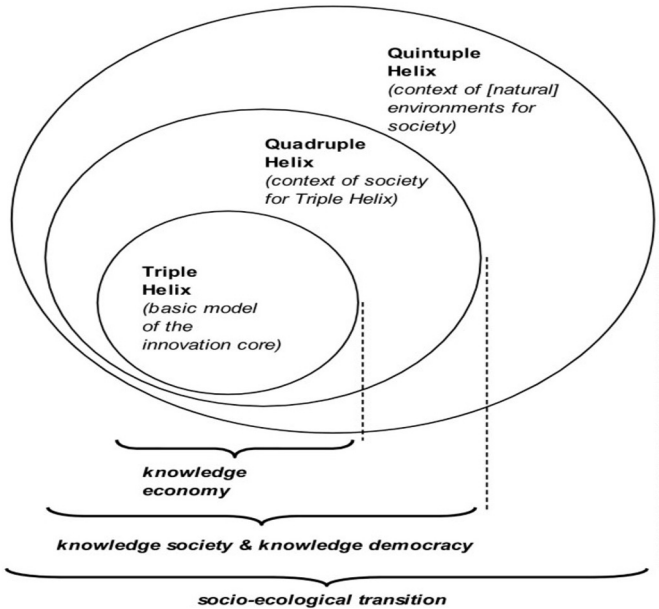


SDG 12 Verantwoorde Productie en Consumptie
SDG 13 Klimaatactie

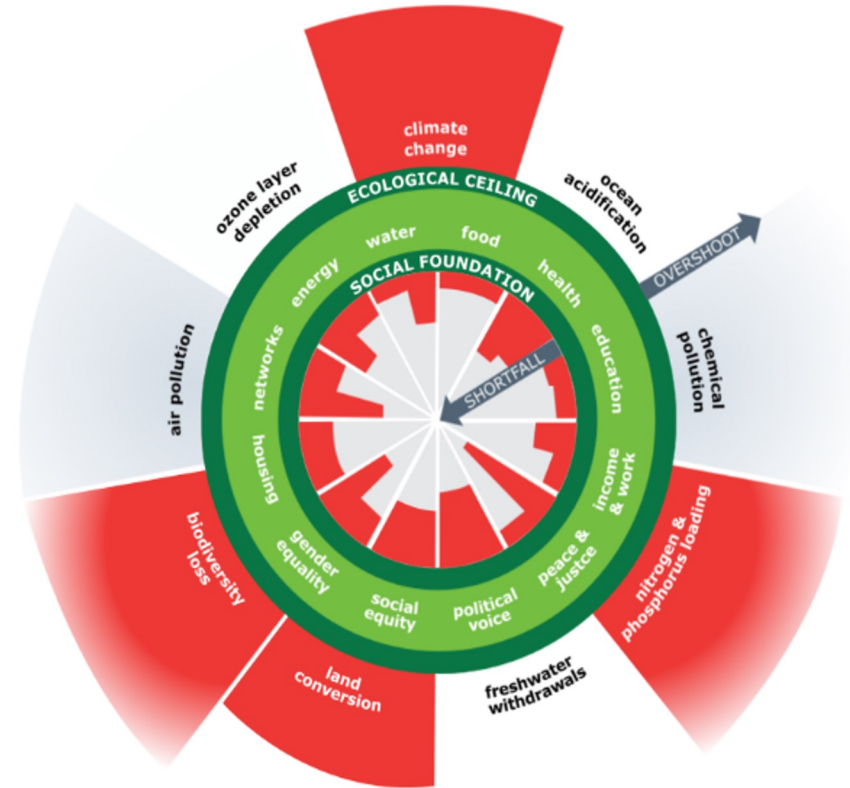
SDG 9 Sustainable Development
SDG 11 Sustainable Cities

Private – Public Partnerships

Building solutions across different knowledge systems.

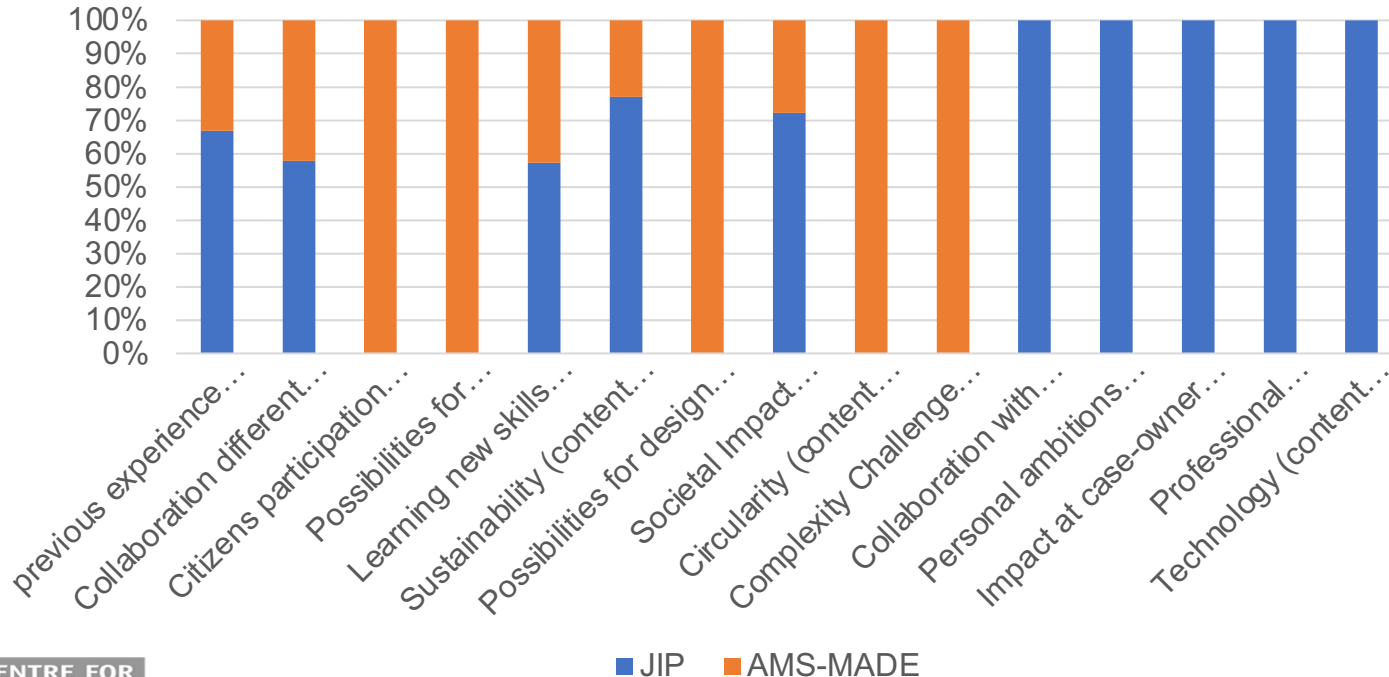


The Doughnut of social and planetary boundaries (2017)



Motivation Letters

Motivation to participate



TOP 10
JIP = 36
letters
AMS = 35
letters



"To accomplish better results, all aspects and different views should be treated with the same amount of passion and energy."

”

JIM HOOGMOED

JIP 2019 | Team Axxiflex

One significant take away from this experience is to listen to people with critical thinking, and be humble and open to the thoughts that I never heard of

”



WEIWEI LIU

JIP 2019 | Team Royal Haskoning DHV

In conclusion, I would like to say that Course X was an experience I was fortunate enough to have. We learnt various things such as camaraderie, communication, professionalism, and time management among others. It was a great opportunity and a perfect incubation centre to hone my skills. Things I learnt here like collaboration, innovation, team building are something which I couldn't have learnt in the classroom and I am glad about my choices. This exposure has broaden my mindset and thinking and I am grateful for it. Despite the current situation of pandemic that we find ourselves in, it was a delight. Thank you Staff .

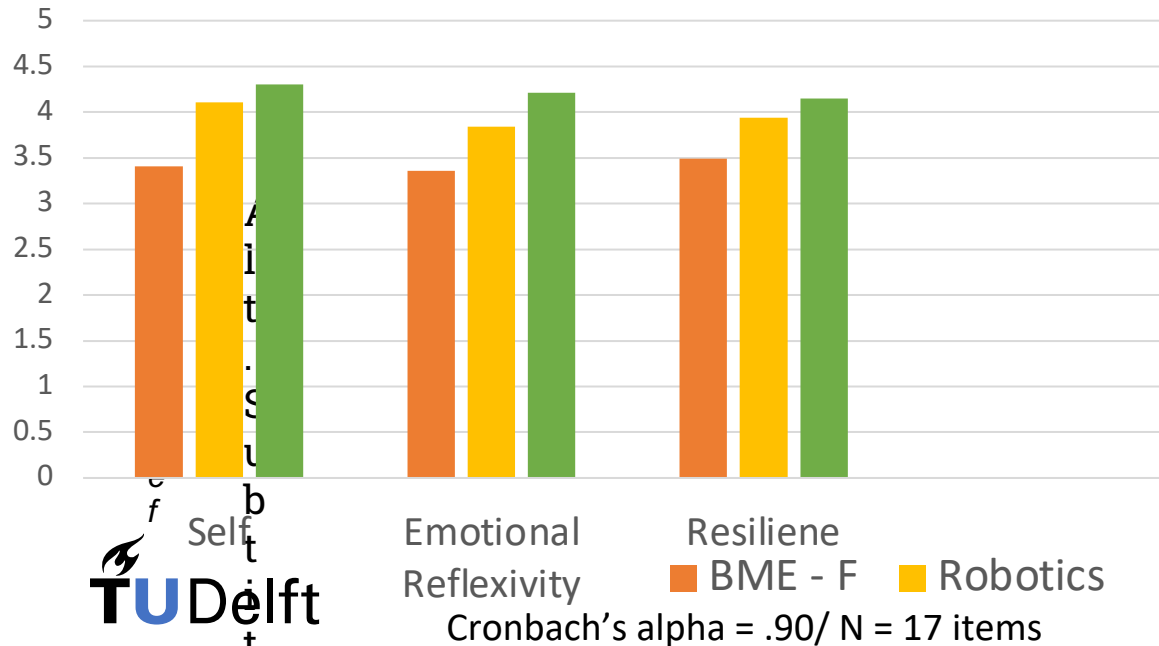
(ANOUNOMOUS STUDENT JIP, 2021)

Professional Capabilities students

- SELF
- EMOTIONAL RESILIENCE
- INFORMED VISION
- ETHICAL BEHAVIOUR
- EVALUATIVE JUDGEMENT
- CRITICAL REFLECTION
- COMMUNICATION & COLLABORATION

Results

1. Personal development



Part 1 – Personal Development

Self

Emotional Reflexivity

Resilience

BME – Robotics – Sig > .001

Robotics – Jip – Sig .036, > .001 , .020

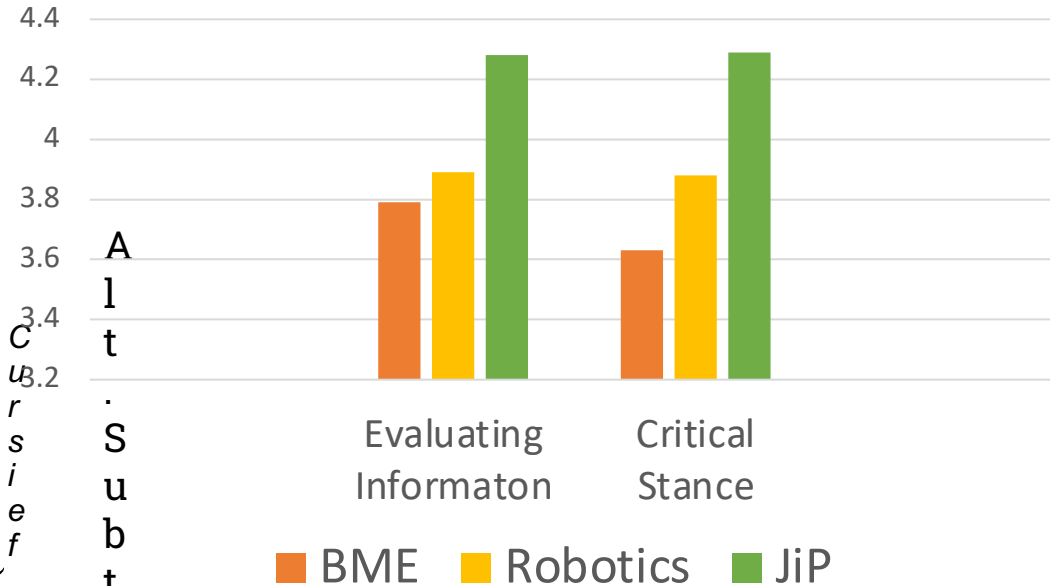
Estimated effect size cohens d:

Jip- Robotics .between .40 and .46

BmE – Robotics between .53 and .60

Results

2. Agency



Cronbach's alpha .85/ n= 9 items

Part II Agency

Evaluating Information

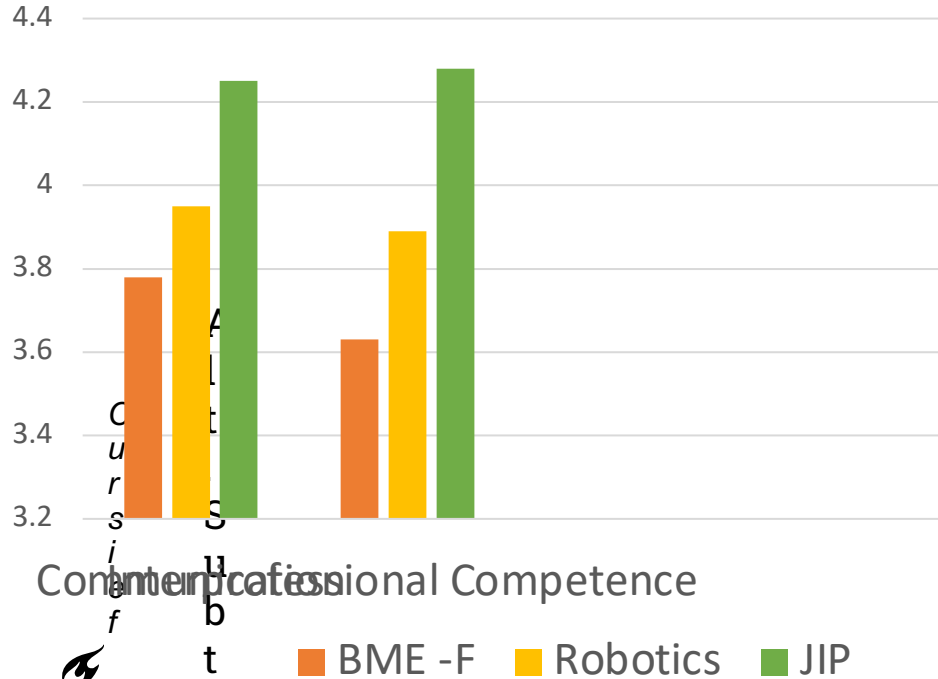
Critical Stance

JiP- Robotics/BME, sig > .001

Effect size –cohens d.: .35,.50

Results

3. Collaboration



Cronbach's alpha .86/ n= 10 items

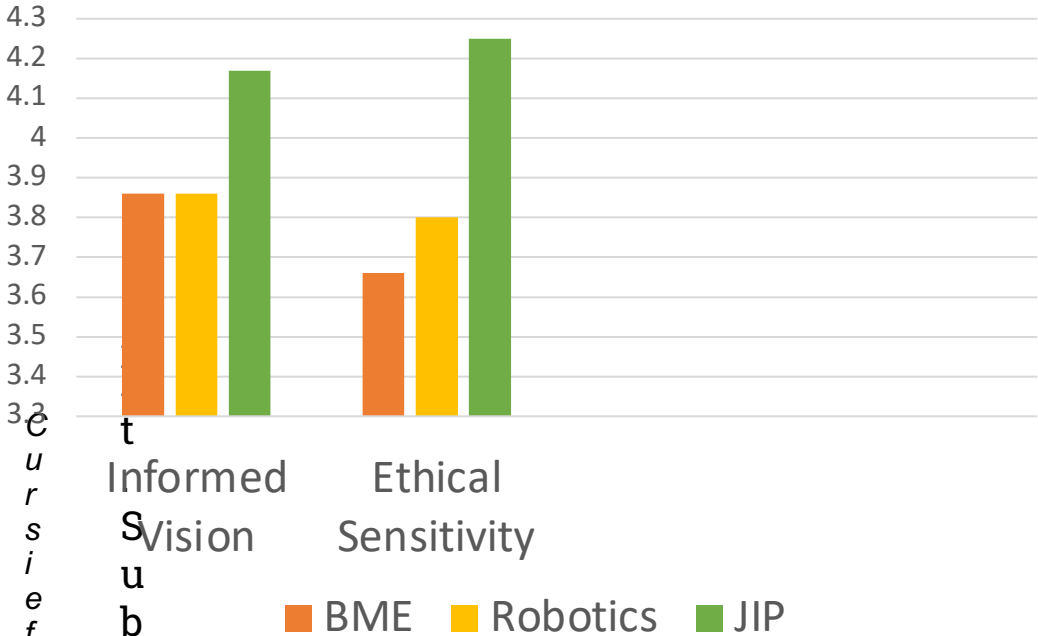
Jip – Robotic sign .006 and < .001
Robotics –BME not significant

Effect size cohens d.

Jip – Robotics: .50 and .52

Results

4. Contextual Insight Part IV



Cronbach's alpha .80/ N = 11

Part 4 Contextual insight
Informed Vision
Ethical Sensitivity

Jip – Robotics/BME sign. .001 and .002 respectively
BME/Robotics non significant

Effect size cohens d
JIP – RO .40. and .69

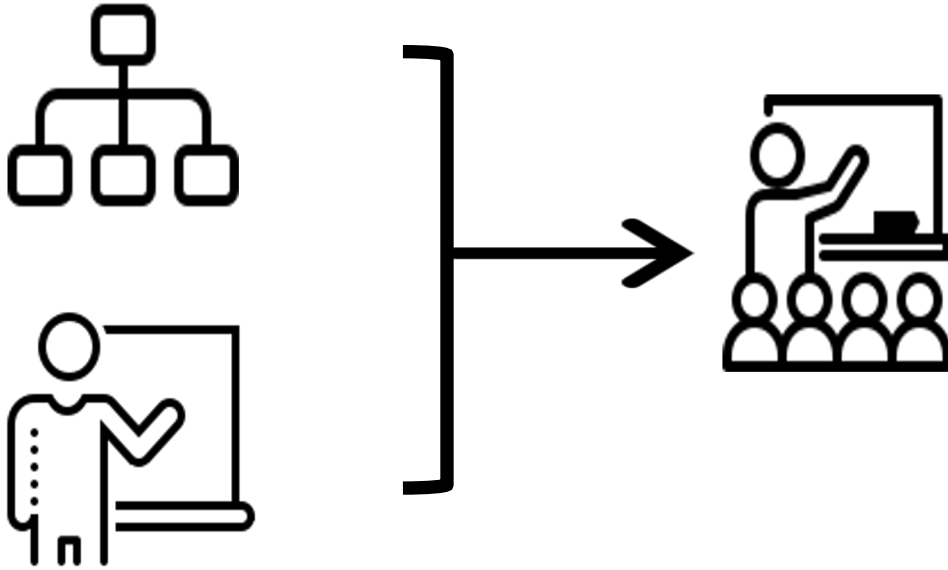


Should there be an institution wide Roadmap for stakeholder collaboration?
What should it include? (woolclap/padlet?)



Professionalisation of staff for Challenge-based education, should it be different?

RESEARCH QUESTION



What **support** (staff and organisation) do **program coordinators/lecturers** at the TU Delft need to **design and deliver interdisciplinary courses** and **breakdown the disciplinary boundaries**?

RESULTS: STAFF

Staff

Knowledge

- Profound disciplinary knowledge
- T shaped
- Process focussed
- See bigger picture

Competencies

- Enthusiastic
- Open minded towards social context and other disciplines
- Stepping out of spotlight
- Have interest in other disciplines

Experience

- Worked in industry
- Worked with multidisciplinary groups
- Deal with different opinions

Organisation

Course design

- Professional development
 - University Qualification
 - Sharing experience
 - Training on interdisciplinarity
- Course design
 - Interdisciplinary teams
 - Shared vision
 - Commitment
 - Graduation committees

Teaching

Policies

- Appraisal
 - Research focussed
 - No incentives for interdisciplinary personal or course development
 - Interdisciplinary papers difficult to publish
- Quality
 - Focus on disciplinary obligations
 - Hired for disciplinary knowledge
 - #Interdisciplinary teachers limited
 - Evaluations disciplinary focussed
- Budget
 - Disciplinary research focussed
 - Limited interfaculty budget

Should all faculties have an element of challenge based learning in their curricula?



Should all faculties have an element of challenge-based learning in their curricula?

- Embedded in the Curriculum: InnoXspace/ Design Factory Twente/JIP
- Extra Curricular (E.g. DREAM HALL TU D)
- Impact Challenge 4TU Federation/ CEASAR/ WUR- Student Challenge
- Internships
- Hackatons
- MasterProgramme AMS- MADE



Difference PBL/CBL

International Journal on Interactive Design and Manufacturing (IJDeM) (2019) 13:1103–1113

1105

Table 1 Differences between CBL, PrBL and PBL

Technique/characteristic	Project based learning	Problem based learning	Challenge based learning
Learning	Students build their knowledge through a specific task [17]. The knowledge acquired is applied to carry out the assigned project	Students acquire new information through self-directed learning, using designed problems [18]. The knowledge acquired is applied to solve the problem at hand	Students work with teachers and experts in their communities on real-world problems in order to develop a deeper knowledge of the subjects they are studying. It is the challenge itself that triggers the generation of new knowledge and the necessary tools or resources
Focus	Confronts the students with a relevant situation and redefined problematic for which a solution is required [12]	Confronts students with a relevant problematic situation, often fictional, for which a real solution is not needed [19]	Confronts students with an open, relevant, problematic situation, which requires a real solution
Product	Requires the students to generate a product, a presentation or an implementation of the solution [19]	Focuses more on the learning processes than the resulting products of the solutions [12]	Focuses more on the learning processes than the products of the solutions [21]
Process	Students work on the assigned project so that their engagement generates products, and they learn as a result [20]	Students work with the problem in a way that tests their ability to reason and apply their knowledge to be evaluated according to their learning level [21]. Students analyze, design, develop and execute	Students analyze, design, develop and execute the best solution in order to tackle the challenge in a way they and other people see and measure
Teacher's role	Facilitator and project Manager [22]	Facilitator, guide, tutor or professional adviser [23]	Coach, co-researcher and designer [24]

Additional/embedded

Extra curricular

- Competition element present
No credits given
No grades given
Voluntary participation
Design is more open and flexible in comparison to in-curricular CBL
- Does not need to have links to study programs
- Allows students to expand their knowledge, skills, and personal interests
More opportunities for students to apply knowledge to real-world issues/problems Societal involvement and relevance stronger condition for extra-curricular CBL
- More freedom for challenge organizers (not bound to curricular structure)

In –curricular

- No competition element
Students receive credits
Students receive a grade
Obligatory participation
Design is more structured, has more guidelines and conditions (e.g., timeframe, planned structure, prescribed overall approach, form of outcome etc.)
- Topics should be directly relevant to the study learning outcomes
Should add/expand on topics covered in students' programs
- Emphasis is more on the learning outcomes in relation to the study program
Need for an external commissioner with a real problem that has relevance to society is less in in-curricular CBL
- Less freedom for challenge organizers (need to align with specific learning outcomes)



How to maintain Scientific Rigour in Challenge-based education?

Learning objective or by-product?



Type of Challenge

Learning

Learning Objectives

- Scientific Rigour
- Professional /Transversal skills: Critical Thinking skills, communication skills, leadership, reflection, system and entrepreneurial thinking, interdisciplinary teamwork skills
- Problem solving/ innovation skills

Learning Deliverables

- Prototypes
- Conceptual Design
- Modelling /tools/apps
- Presentations (Video's, Posters, etc)
- Reports
- Courses

Organisational Impact

- Start ups
- University/industry/government collaborations
- Modernisation HE
- Capacity building

Learner Impact

- Internship/job
- Elaborate Network
- Better Teamwork skills
- Professional attitude
- Identity transformation
- Leadership development
- Intrinsic Motivation

Learning Objectives JIP

Validation key to quality results

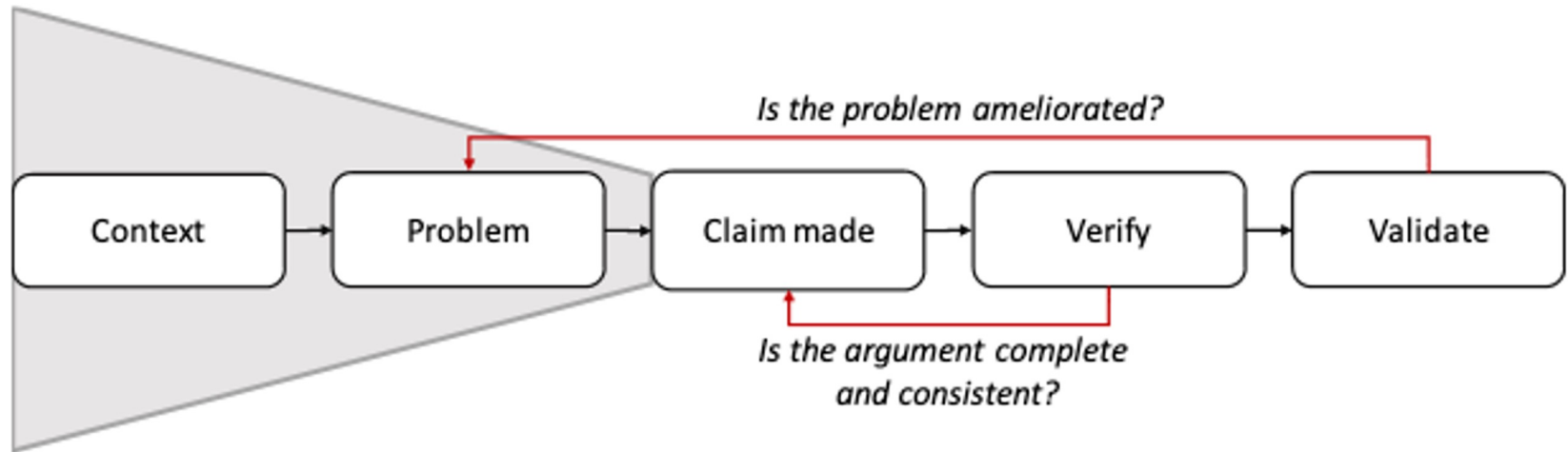


Figure 1. Focusing to enable verification and validation of the problem

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Discussion points

- Professionalisation of staff for Challenge-based education, should it be different?
- How to maintain Scientific Rigour in Challenge-based education?
 - Learning objective or by-product?
- When is a challenge **for learning** created with multiple stakeholders relevant?
 - Cheap labour or opportunity for professional growth?
- Should all faculties have an element of challenge based learning in their curricula? V
- Is a Pass/Fail assessment in these contexts “good” enough for accreditation purposes?
- Should there be and institution wide Roadmaps for stakeholder collaboration?
- What is the effect of Multi/inter/transdisciplinary problem solving on the innovation impact of the institution? (is the investment worth it) V
- - What is the impact of inter and transdisciplinary research of staff on their tenure?