Crisis and catalyst:

the impact of COVID-19 on global practices in engineering education

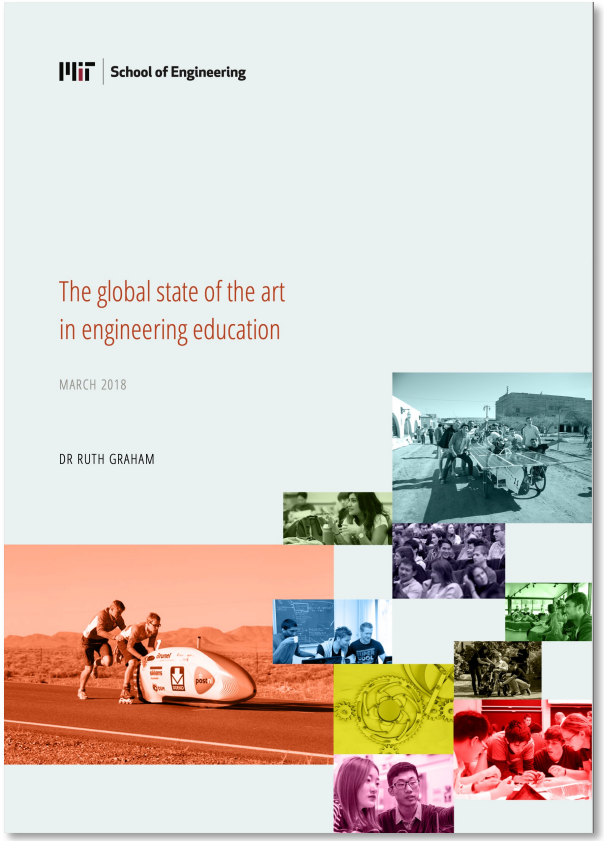
27th January 2023

Dr Ruth Graham

The global state of the art in engineering education

March 2018

“the study feedback suggested that the engineering education sector is entering a period of rapid and fundamental change”



March 2018:

study anticipated systemic educational change in engineering schools worldwide

March 2020:

almost all universities worldwide pivoted online to emergency teaching due to COVID-19

Context: what was the state of the art in engineering education prior to March 2020?

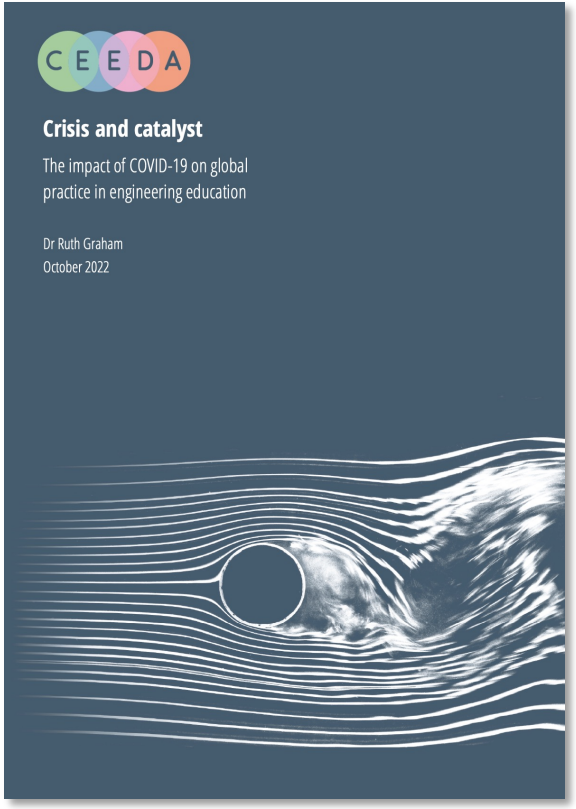
What have we learnt from this period of emergency teaching and how will it impact engineering education for the future?

Crisis and catalyst:

the impact of COVID-19 on global practice in engineering education

Sponsored by university consortium

NTNU Norwegian University of Science and Technology
Olin College of Engineering
Aalborg University Denmark
EPFL
Pontificia Universidad Católica de Chile
Royal Academy of Engineering
MIT School of Engineering
MIT Sloan School of Management
SUTD Singapore University of Technology and Design
Tecnológico de Monterrey
UCL
4TU. Centre for Engineering Education



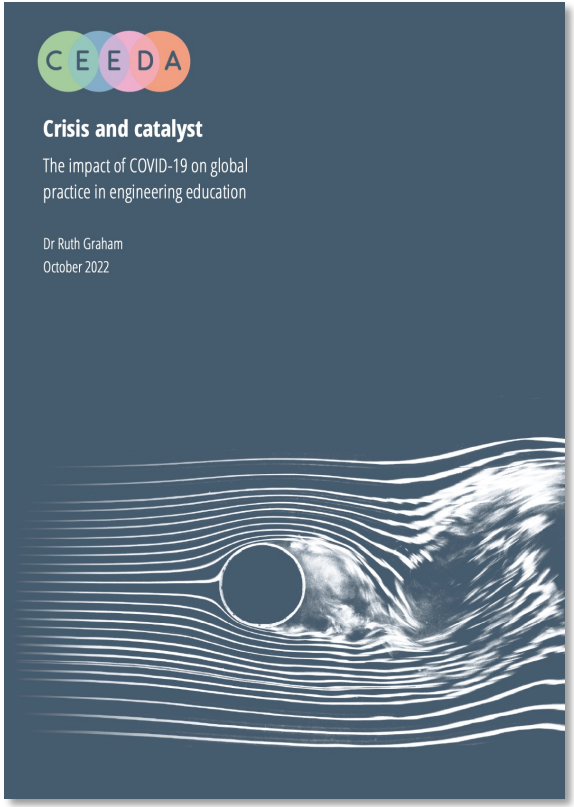
Informed by one-to-one interviews with 226 individuals from 36 countries

Crisis and catalyst:

the impact of COVID-19 on global practice in engineering education

1. Experiences of the engineering education community during ‘emergency teaching’

2. The impact of ‘emergency teaching’ on global practices in engineering education



Outline of talk

1. What were the experiences of the engineering education community during ‘emergency teaching’?

2. How will the systemic shock of COVID-19 impact the direction of travel for the engineering education sector?

Major challenges faced during emergency teaching

- **Inequality of digital access:** the quality of the institutional IT infrastructure and the capacity of students to access IT devices and reliable internet
- **Student mental wellbeing and isolation:** challenges in three areas:
    1. understanding course expectations and managing workload
    2. building trusting, supportive and collegial relationships with peers
    3. fostering student motivation and combatting anxiety
- **Faculty exhaustion and wellbeing:** the toll taken on instructors and university leaders from prolonged uncertainty and exhaustion during the months and years of emergency teaching

Outline of talk

1 What were the experiences of the engineering education community during ‘emergency teaching’?

2 How will the systemic shock of COVID-19 impact the direction of travel for the engineering education sector?

- Changes to global best practices
- Challenges facing the sector

Two particular effects of COVID-19 and emergency teaching on cutting-edge programmes:

A. accelerated and enhanced some of the innovations already in train

B. precipitated new practices and priorities that may not previously have emerged but for the ‘systemic shock’ of COVID-19

Hallmarks of future leaders (MIT report 2018):

Systemic/unified educational approach with connectivity across the curriculum

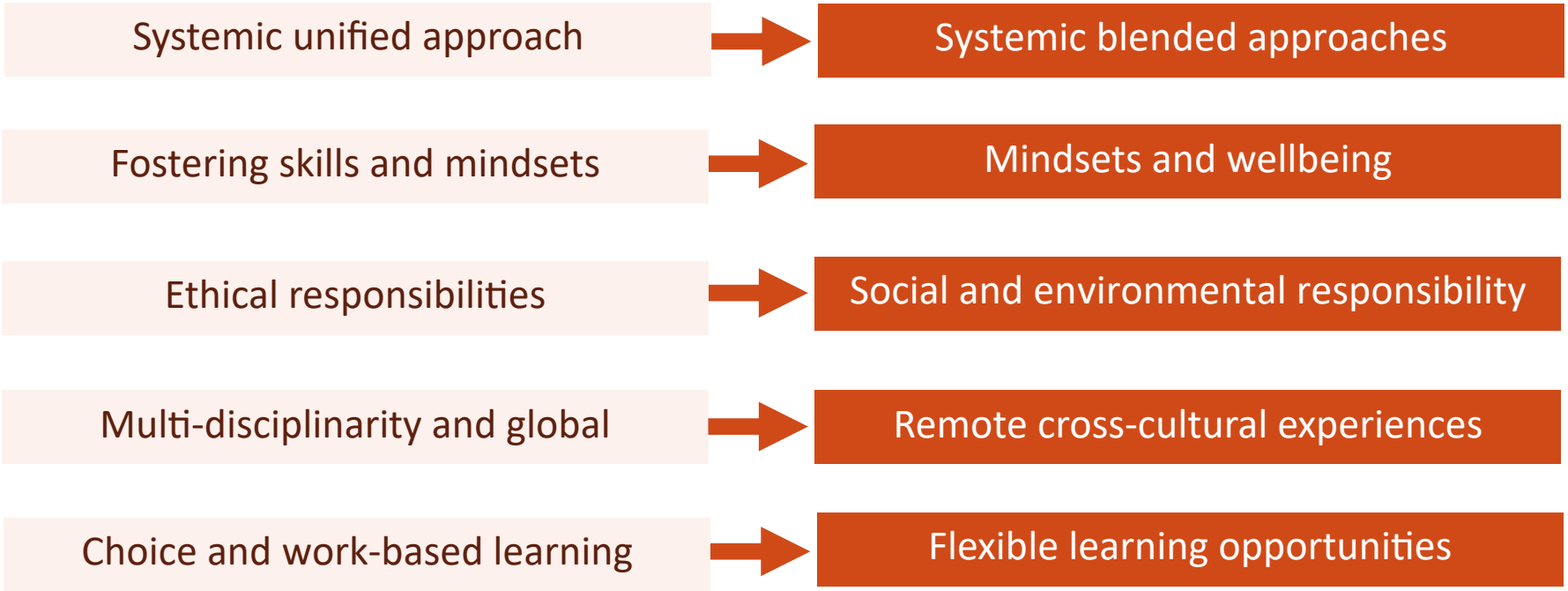
Fostering skills and mindsets, often through authentic, hands-on problem-solving

The roles, responsibilities and ethics of engineers in society

Multi-disciplinary and global learning experience

Student choice, flexibility and work-based learning

A. Acceleration and enhancement of trends already in train

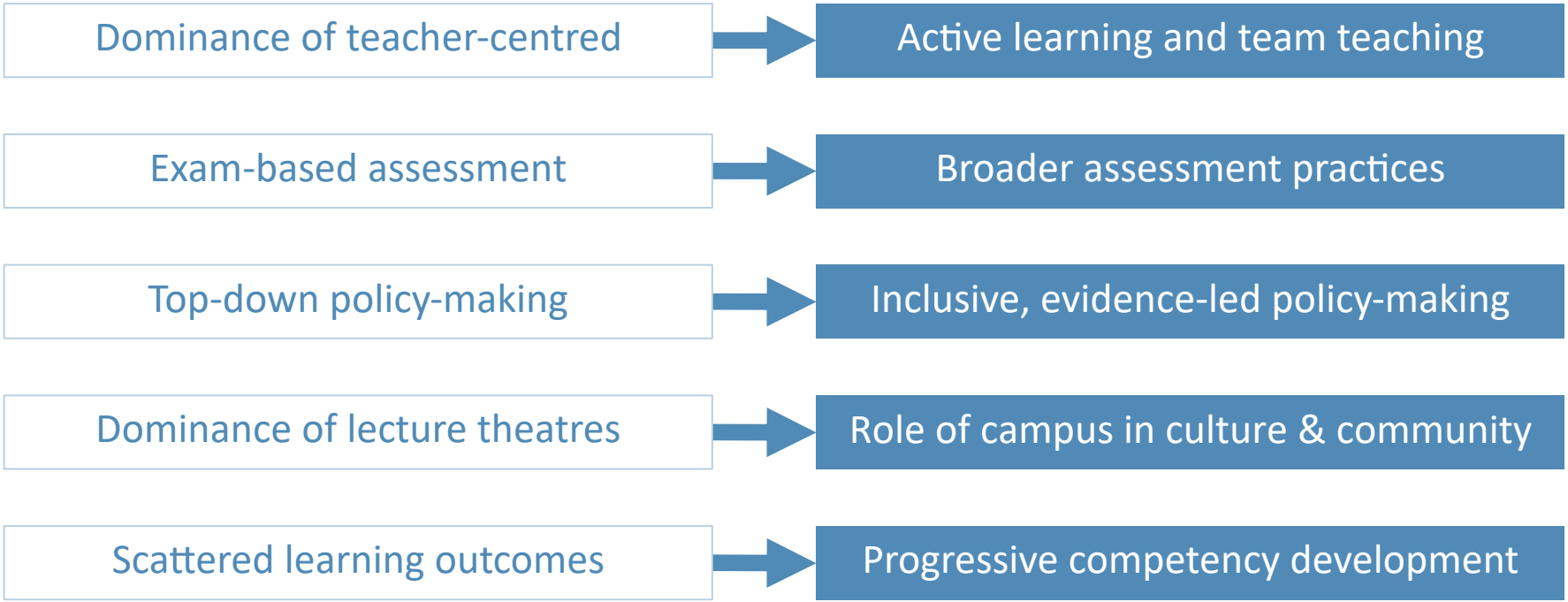


Two particular effects of COVID-19 and emergency teaching on cutting-edge programmes:

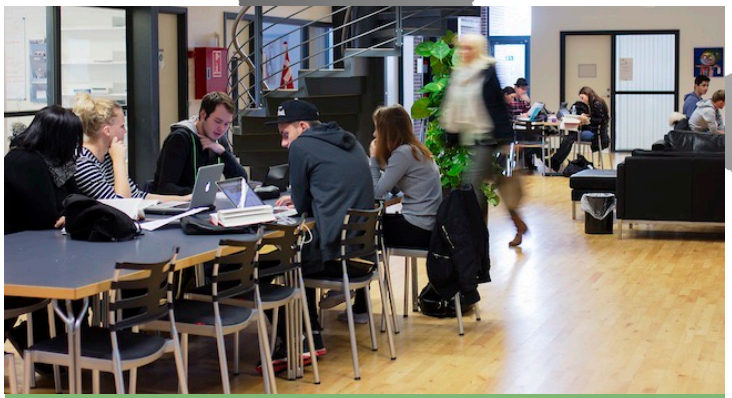
A. accelerated and enhanced some of the innovations already in train

B. precipitated new practices and priorities that may not previously have emerged but for the 'systemic shock' of COVID-19

2. New practices and priorities enabled by systemic shock



Example – Aalborg University (Denmark)

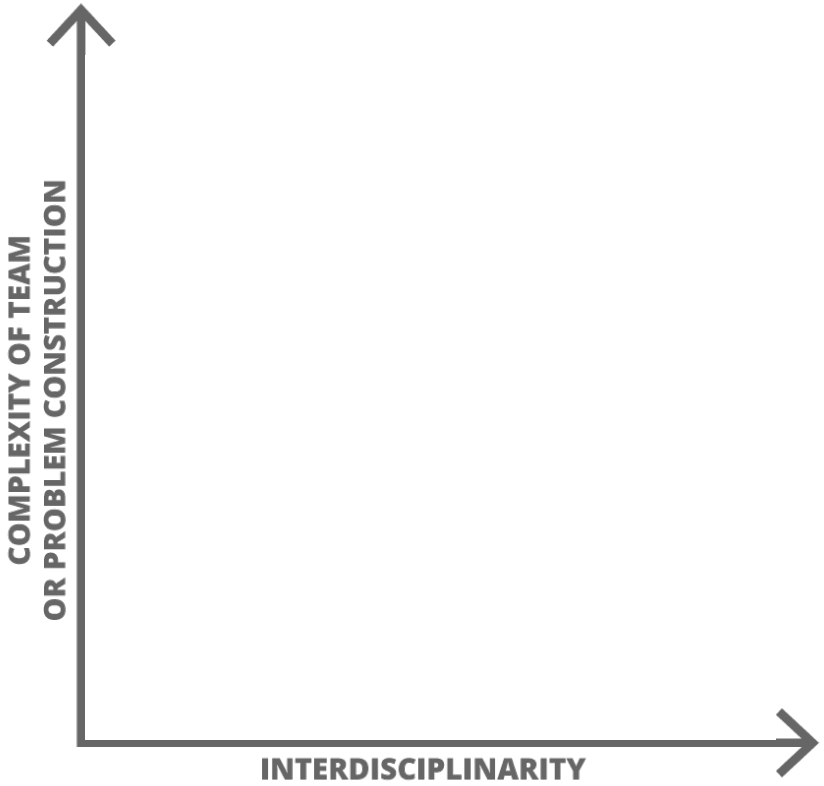


Aalborg University (Denmark)

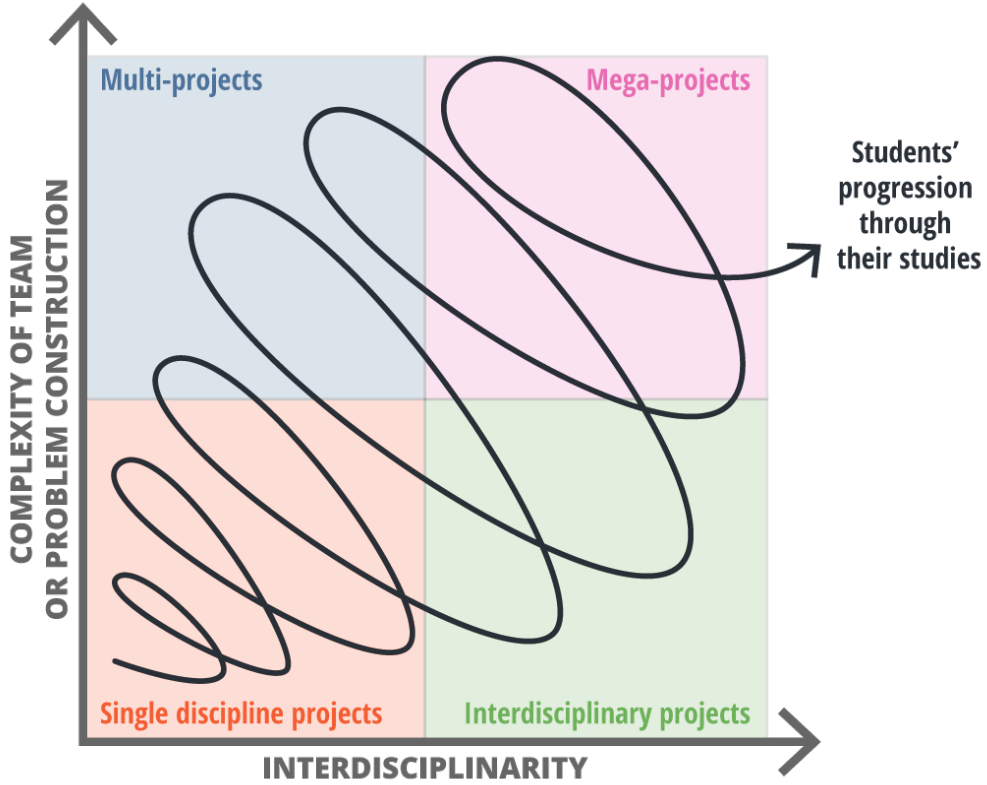
Example – Aalborg University (Denmark)

Inclusive, evidence-led policy-making	› Establishment of the *Institute for Advanced Study in PBL* in early 2022
Systemic blended approaches	› Wider adoption of blended learning with more ‘taught courses’ delivered online
Progressive competency development	› PBL Competencies built progressively along with workshops & portfolios
Mindsets and wellbeing	› Focus on mindset development, such as conflict resolution or critical thinking

Example – Aalborg University (Denmark)



Example – Aalborg University (Denmark)



Increasing project complexity

Building in complexity – technical, societal and inter-disciplinary – as students progress. Culminating in 'mega-projects' in final years of study.

Mindset development

Nurturing and tracking progressive learning outcomes (*PBL Competencies*), guided by structured self- and peer-reflection sessions.

Outline of talk

1 What were the experiences of the engineering education community during 'emergency teaching'?

2 How will the systemic shock of COVID-19 impact the direction of travel for the engineering education sector?

- Changes to global best practices
- Challenges facing the sector

Concerns and risks facing the sector

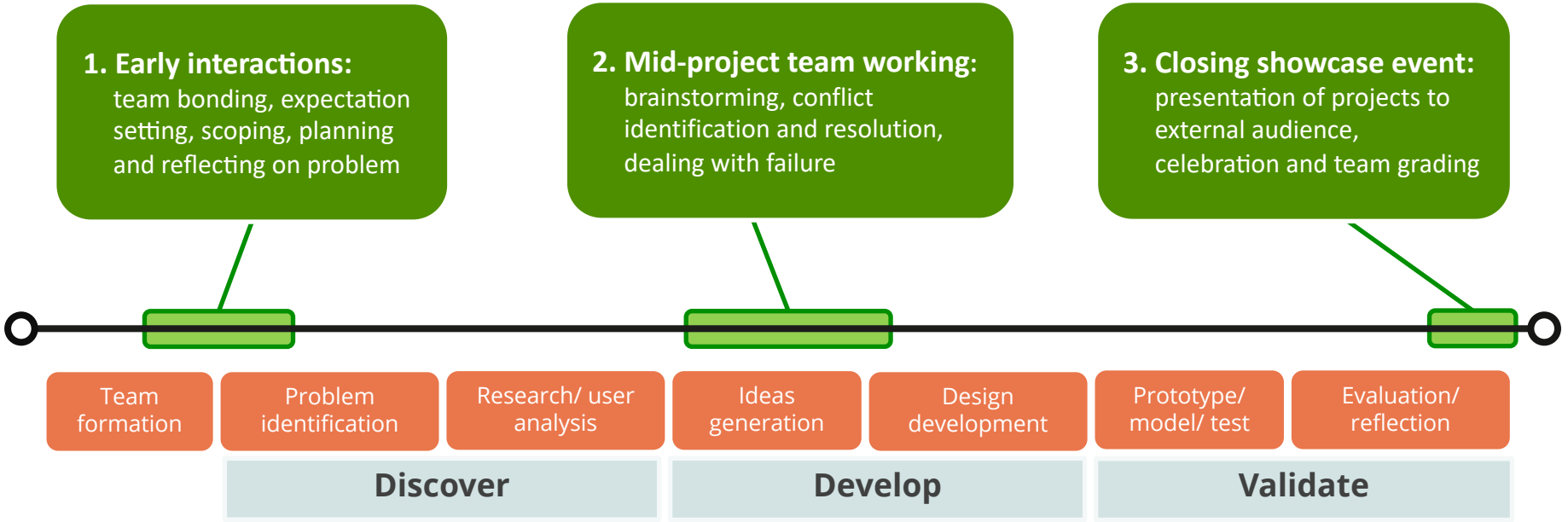
- **Institutional inflexibility:** that inflexibility will stifle innovation at some institutions
- **Exacerbation of inequalities:** that inequalities amongst students and instructors, and across institutions, may be exacerbated by COVID-19 and ET
- **Prioritisation of profit over learning:** that emergency teaching may promote a low-cost passive form of online learning that does not prioritise student learning and development
- **Risk of defaulting to the 'status quo':** that lessons will not have been learnt from emergency teaching

CEEDA: Collaborative engineering learning in the digital age

www.ceeda.org

Thank you

What is problematic to deliver online?



Stages in the project- or problem-based learning process

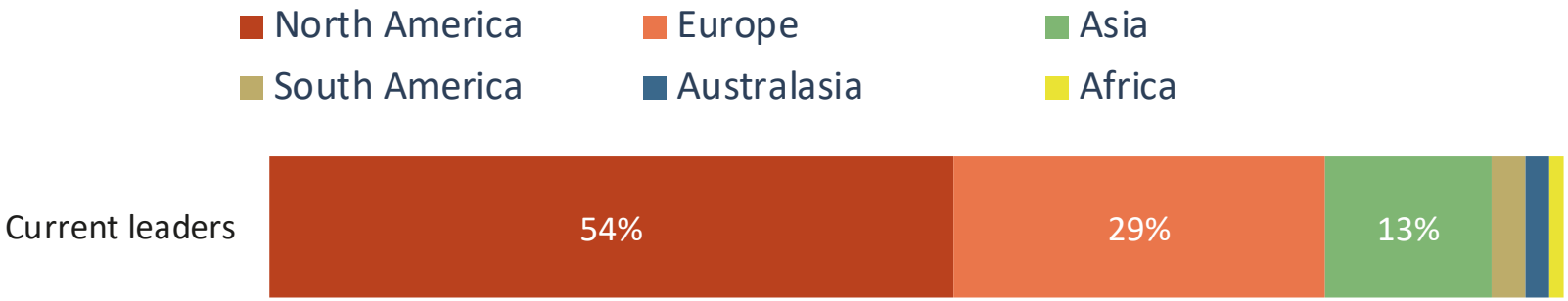
The 10 institutions most frequently identified as **current leaders** in engineering undergraduate education

1	Olin College (US)
2	MIT (US)
3	Stanford Uni (US)
4	Aalborg Uni (Denmark)
5	TU Delft (Netherlands)
6	UCL (UK)
7	Purdue Uni (US)
8	NUS (Singapore)
9	Uni of Cambridge (UK)
10	Chalmers Uni (Sweden)

The 10 institutions most frequently identified as **emerging leaders** in engineering undergraduate education

1	SUTD (Singapore)
2	Olin College (US)
3	UCL (UK)
4	PUC (Chile)
5	Iron Range (US)
6	NUS (Singapore)
7	TU Delft (Netherlands)
8	Charles Sturt (Australia)
9	Tsinghua (China)
10	Arizona State (US)

The locations of **current** and **emerging** leaders:



Emerging practices and cultures

- **Engagement with active learning:** beyond the ‘usual suspects’
- **Attitudes to teaching and learning**: including education experts and team teaching
- **Remote hands-on learning**: (i) modelling, simulation, or remote activities; (ii) at home hands-on activities; and (iii) replacement activities
- **Assessment practices**: that balances academic integrity with student wellbeing
- **External connectivity**: new connections with with external stakeholders, as well as regional/global peers
- **Faculty-student connectivity**: by forming closer, less hierarchical relationships

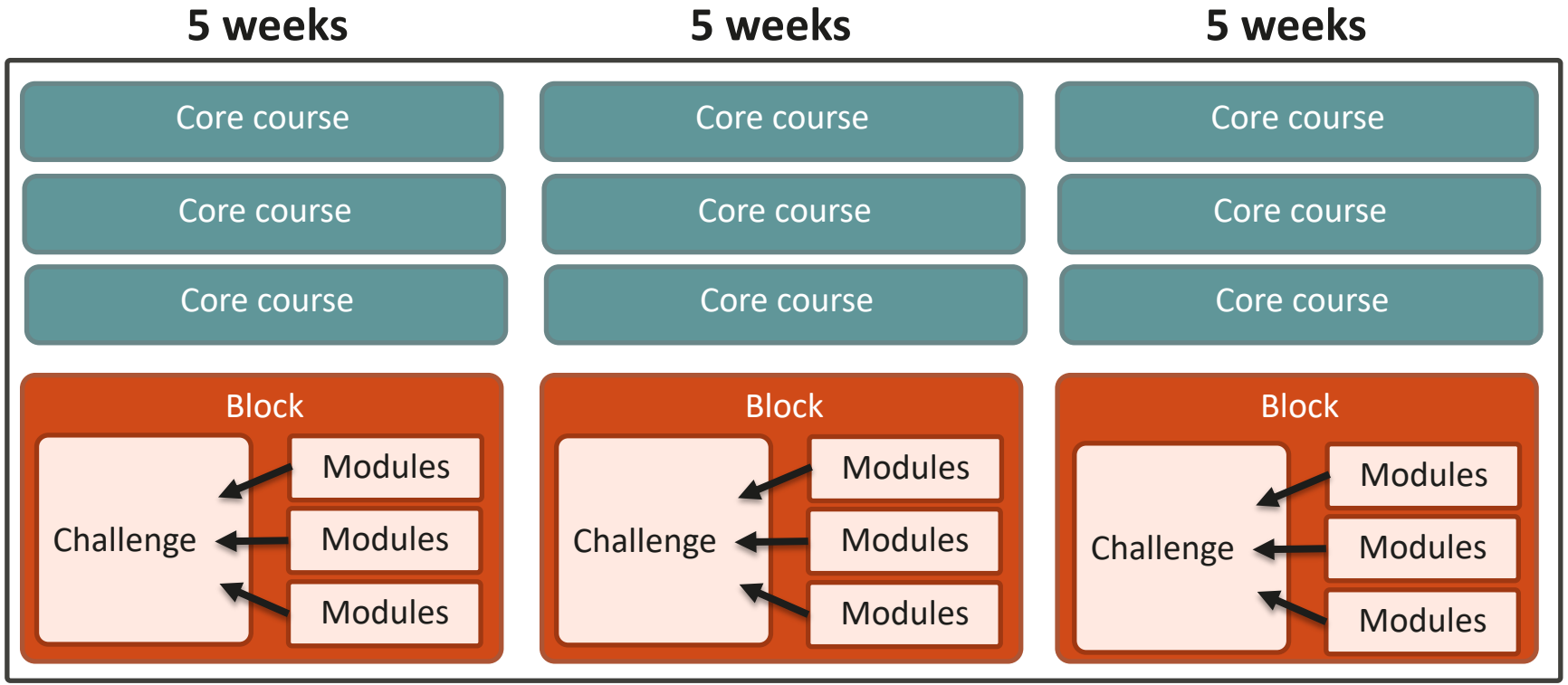
Example – Tec de Monterrey (Mexico)

Tec de Monterrey (Mexico)

Example – Tec de Monterrey (Mexico)

Inclusive, evidence-led policy-making	› Establishment of the *Institute for the Future of Education* in early 2021
Systemic blended approaches	› Tec 21 curriculum, combining in-person projects with online technical courses
Flexible learning opportunities	› Choice embedded throughout Tec21 curriculum
Progressive competency development	› Tec21 embeds 'core competencies' into each semester of study

Sample semester of the Tec21 curriculum:



Example – Tec de Monterrey (Mexico)

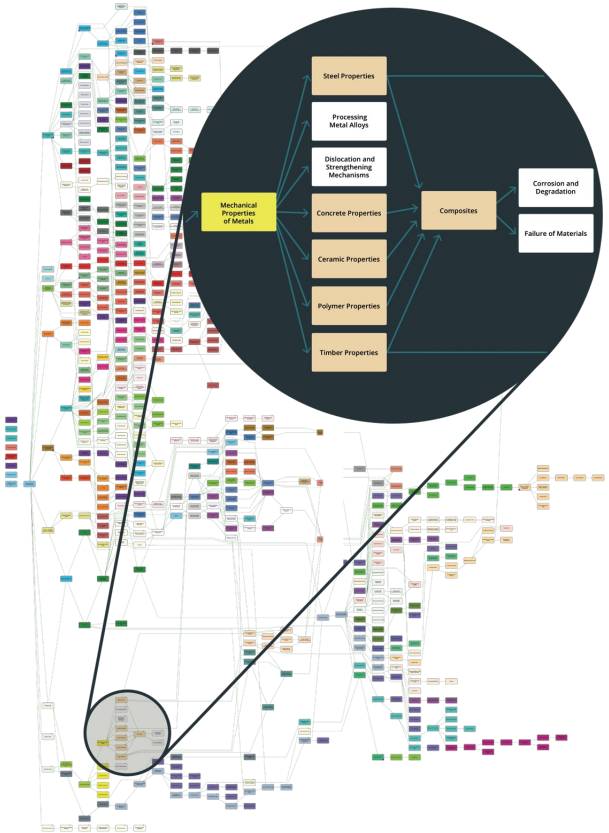
Inclusive, evidence-led policy-making	› Establishment of the *Institute for the Future of Education* in early 2021
Systemic blended approaches	› Tec 21 curriculum, combining in-person projects with online technical courses
Flexible learning opportunities	› Choice embedded throughout Tec21 curriculum
Progressive competency development	› Tec21 embeds 'core competencies' into each semester of study

Systemic/unified approach – CSU (Australia)

CSU (AU)

CSU topic tree

- core engineering concepts and skills are disaggregated into discrete three-hour topics and accessed independently online by students
- the topic tree offers a visual map of the relationships and dependencies between topics and branches of engineering
- students complete 240 topics before their work placement and 600 topics by graduation



Investment by the Chilean Ministry for Finance

CORFO

Established in 2014, the Chilean government's National Agency for Innovation and Development (CORFO) launch Engineering 2030.

Aiming to drive economic growth through technology innovation, the initiative targets Chilean engineering schools as an incubator for this talent. Over $200m (US) has already been invested, must of which is focused on educational reform.

2030 ENGINEERING STRATEGY

Case study – PUC (Chile)

PUC (Chile)

Thank you