2023-10-27

Interdisciplinary Projects – Moving from Transfer to Transformation in Learning

Anette KOLMOS
Aalborg University, ak@plan.aau.dk

Recommended Citation

Kolmos, A. (2023). Interdisciplinary Projects – Moving from Transfer to Transformation in Learning. European Society for Engineering Education (SEFI). DOI: 10.21427/Q6RM-ZJ04

Plenary Presentation

Anette Kolmos

Professor in Engineering Education and PBL

Founding Director Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability

Aalborg University

Interdisciplinary Projects – Moving from Transfer to Transformation in Learning?

SEFI ANNUAL CONFERENCE
11-14 September 2023
TUDublin, Ireland

Interdisciplinary projects – moving from transfer to transformation in learning?

United Nations Educational, Scientific and Cultural Organization

AALBORG UNIVERSITY

Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability under the auspices of UNESCO

Anette Kolmos

ak@plan.aau.dk

SEFI ANNUAL CONFERENCE 11-14 September 2023 TU Dublin

ENGINEERING EDUCATION FOR SUSTAINABILITY

POUL DUE JENSEN / GRUNDFOS FOUNDATION

New book and article (in review)

Point of departure:

- Increasing complex problems and challenges
- Need for system thinking and interdisciplinarity as a key in complex problem solving and systems.
- Understanding the variation of interdisciplinary collaborative learning

POUL DUE JENSEN GRUNDFOS FOUNDATION

Jette Holgaard, Henrik Routhe, Maiken Winther, Dennis Friederichsen and external professors

Interdisciplinary project types in engineering education

Anette Kolmos, Aalborg University, Thomas Manns Vej 25, DK-9220 Aalborg Ø. Corresponding author ak@plan.aau.dk
Jette Egelund Holgaard, Aalborg University
Henrik Worm Routhe, Aalborg University
Maiken Winther, Aalborg University
Lykke Bertel, Aalborg University

In review

Abstract

Problem- and project-based learning (PBL) is often highlighted as a valuable approach for addressing the need for interdisciplinarity in engineering education and preparing engineering students for the large-scale challenges. However, studies indicate that applied projects in engineering education tend to be limited to a single discipline and delivered within a single course. This article presents a new project typology which can be applied in engineering education. The typology is based on an action research study in which projects in a systemic PBL environment have been co-constructed and analysed using qualitative data. The model presented has two dimensions: a) the complexity of teams, ranging from single team to networks of teams, and b) the complexity of interdisciplinarity, ranging from disciplinary projects to broad interdisciplinary projects. This results in the identification of six different project types. This typology can be used as a conceptual framework for interdisciplinary learning throughout engineering education. The project types embrace both single-team projects and larger projects consisting of multiple teams working together on complex problems.

Habbal et al, 2023 (fourthcoming); Kolmos et al., 2023 (in review)

Why? https://www.megaprojects.aau.dk/

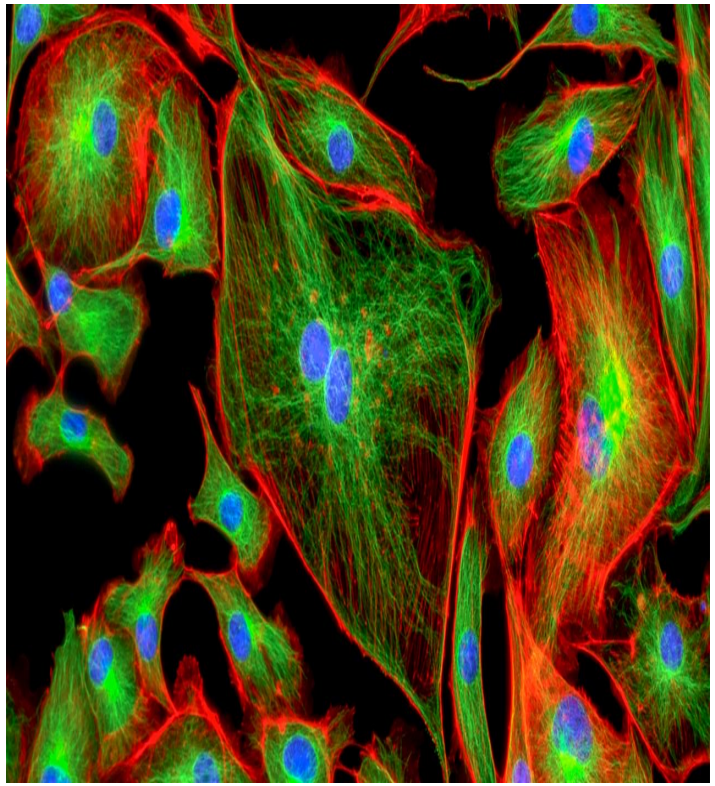
- PBL facilitates **deep learning of knowledge and generic competencies** in disciplinary projects

- **BUT** students do have difficulties in applying their learning experiences from disciplinary projects in the interdisciplinary projects

How do we understand interdisciplinary projects and how does it impact the future curriculum?

Points

- Framework (no tools) for variation of interdisciplinary projects
- The concept of transfer and transformation to help understanding students' learning of interdisciplinarity
- Variation of learning methodologies is a key for curriculum development
- A transformation perspective in curriculum is the learning of working in and on boundaries



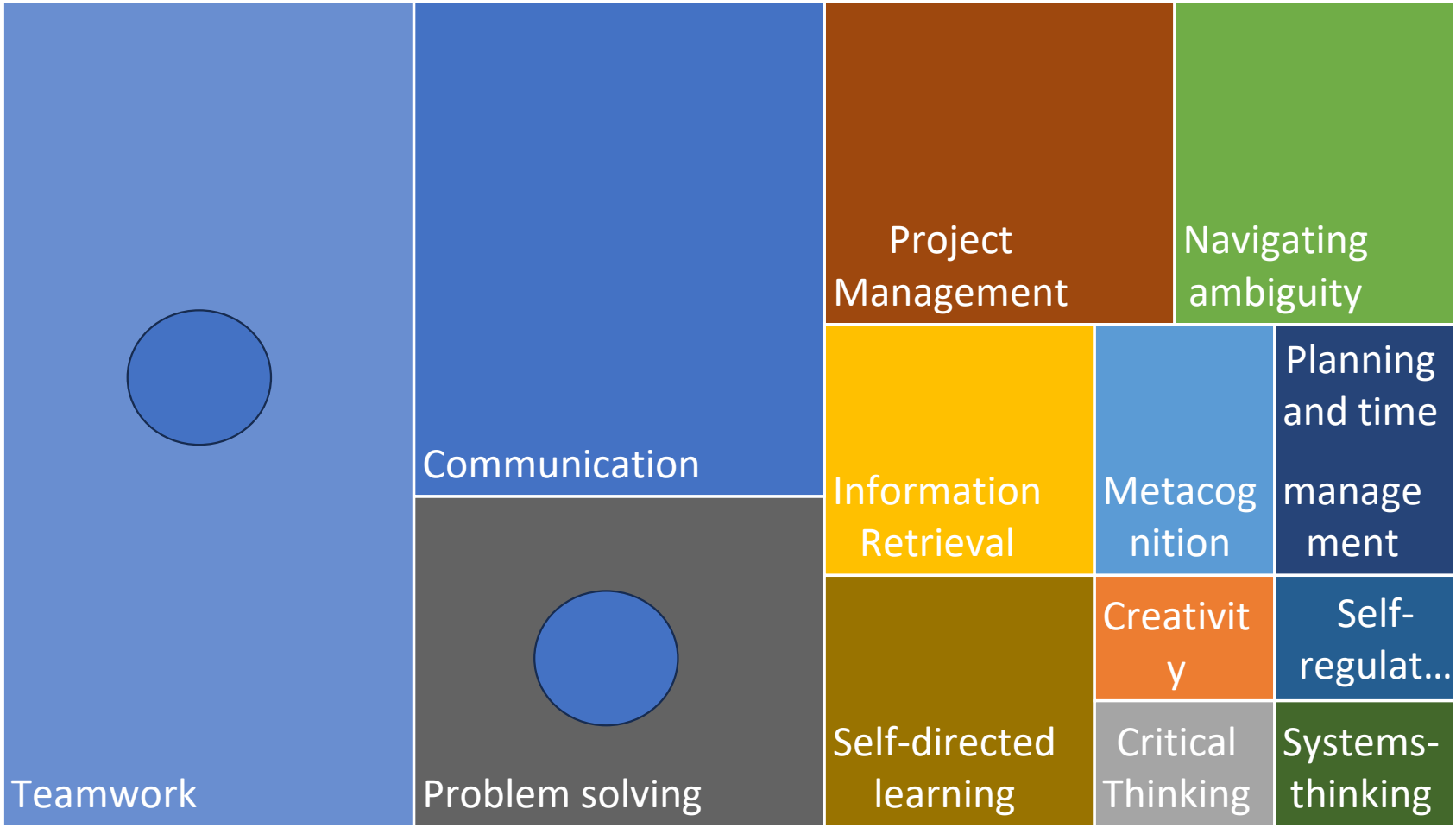
Bovine pulmonary artery endothelial cells
https://biology.ucdavis.edu/news/dean-gratitude-years-end

Definition af transfer, transformation and transformative learning

	Transfer	Transformation
Energy	Energy transfer is the movement of energy from one location to another.	Energy transformation is when energy changes from one type of energy to another.

	Transfer	Transformation	Transformative learning
Learning	Transfer is a concept for applying learned knowledge, skills and competences from one situation to a similar situations.	Transformation involve the ability to recognize and apply knowledge, skills, and competences in new situations. It involves the ability to recognize, re-contextualise and activate existing knowledge, skills, and competences.	Transformative learning is a theoretical framework developed by Jack Mezirow, which describes the process of profound personal change and identity developments that occurs when individuals critically reflect their assumptions, beliefs, and values.

The what – the context in this keynote:
Transfer and transformation of generic ID PBL competences learned by experiences and comparative reflection



Review on PBL competences in disciplinary teams
Boel et al, 2021

Project types

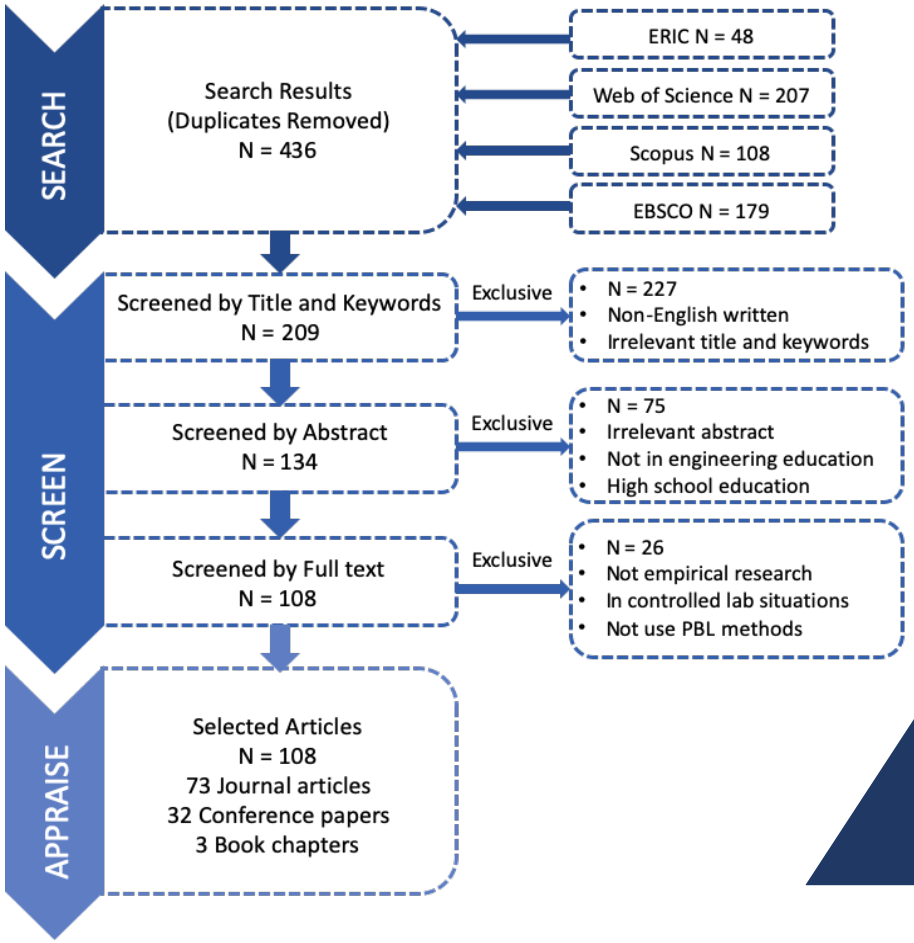
(Kolmos, 1996)

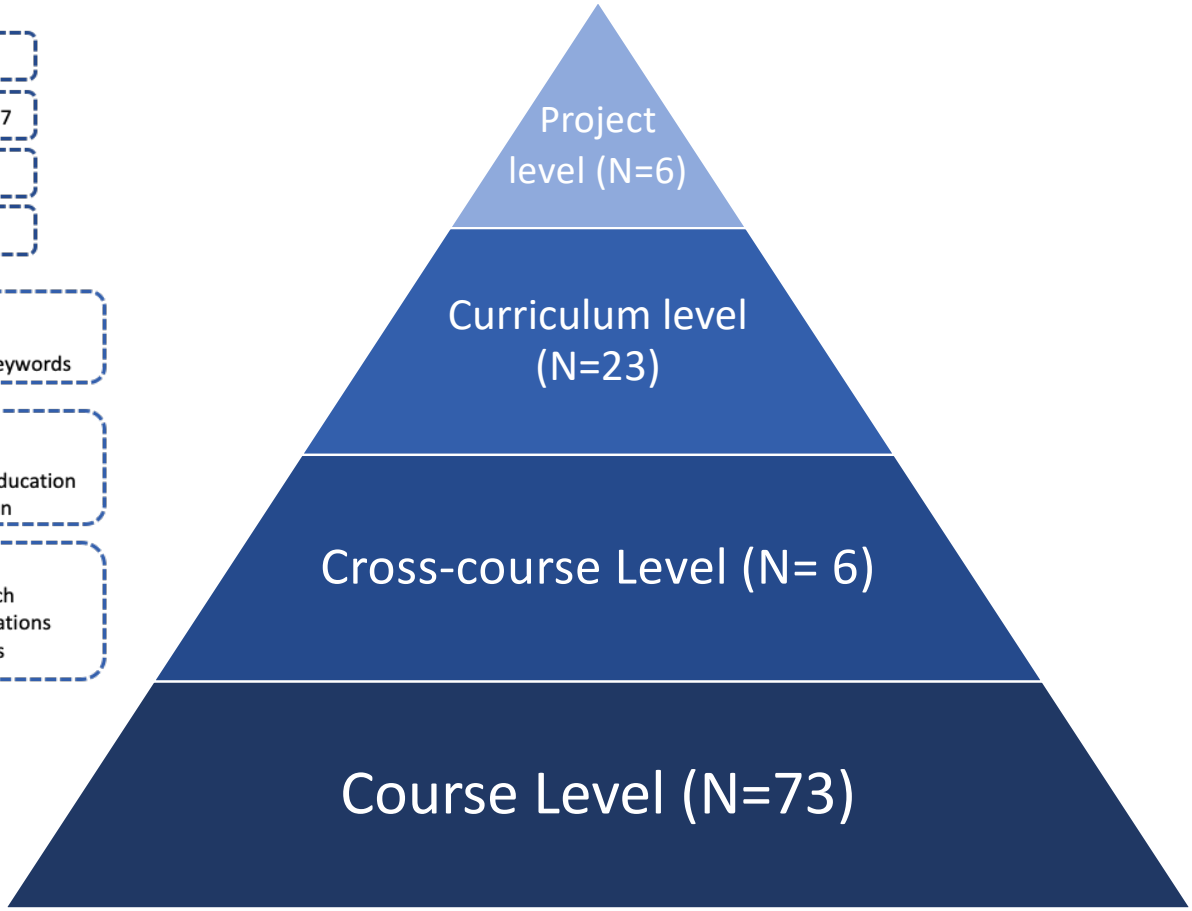
- Assignment-based project where students are getting a problem
- A discipline project where students can identify a problem within the discipline
- A problem project which is an **interdisciplinary** project and student driven

Types with inspiration from Illeris (Helle et al., 2006)

- Discipline project where students should apply knowledge and techniques;
- Real world project and being **more interdisciplinary**
- Student driven project with instructions as support to the students' learning.

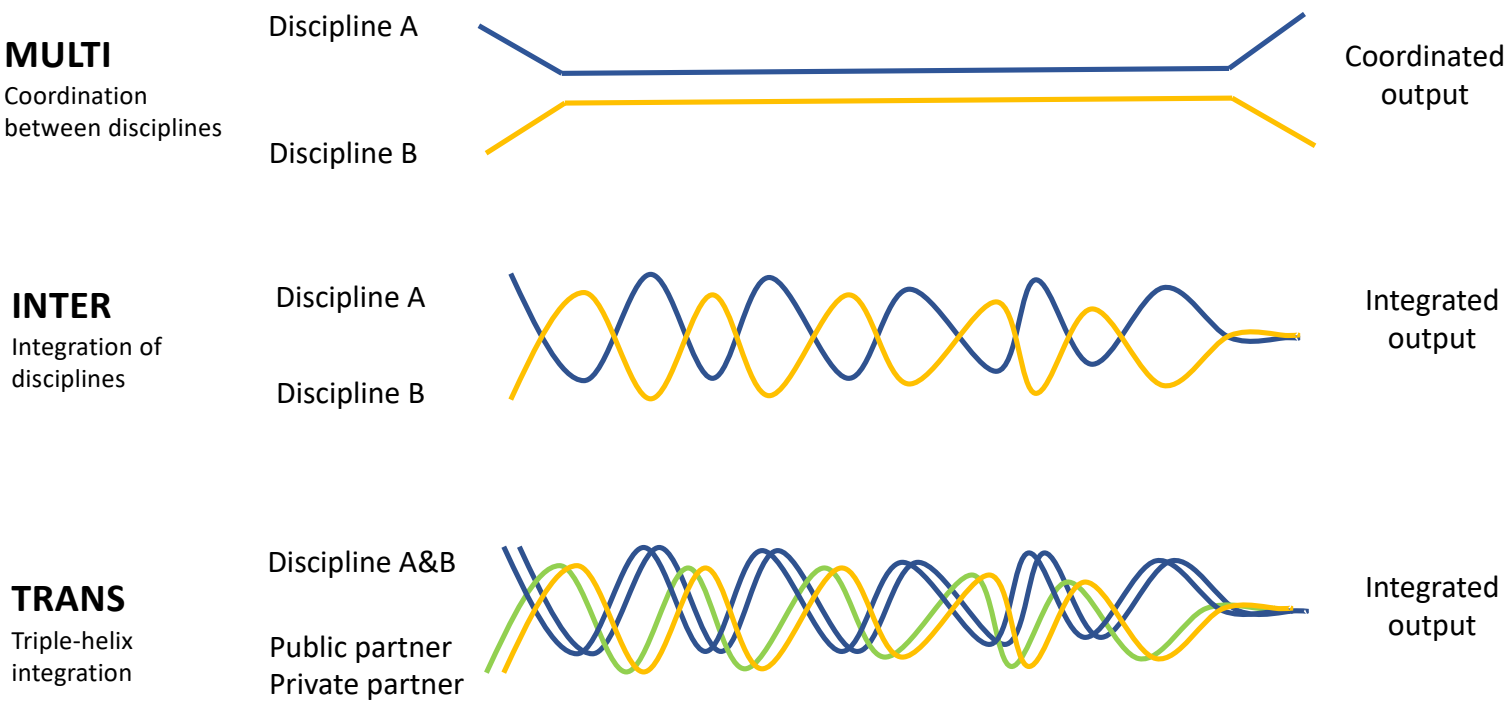
Review of PBL practice in engineering education





Chen et al., 2021

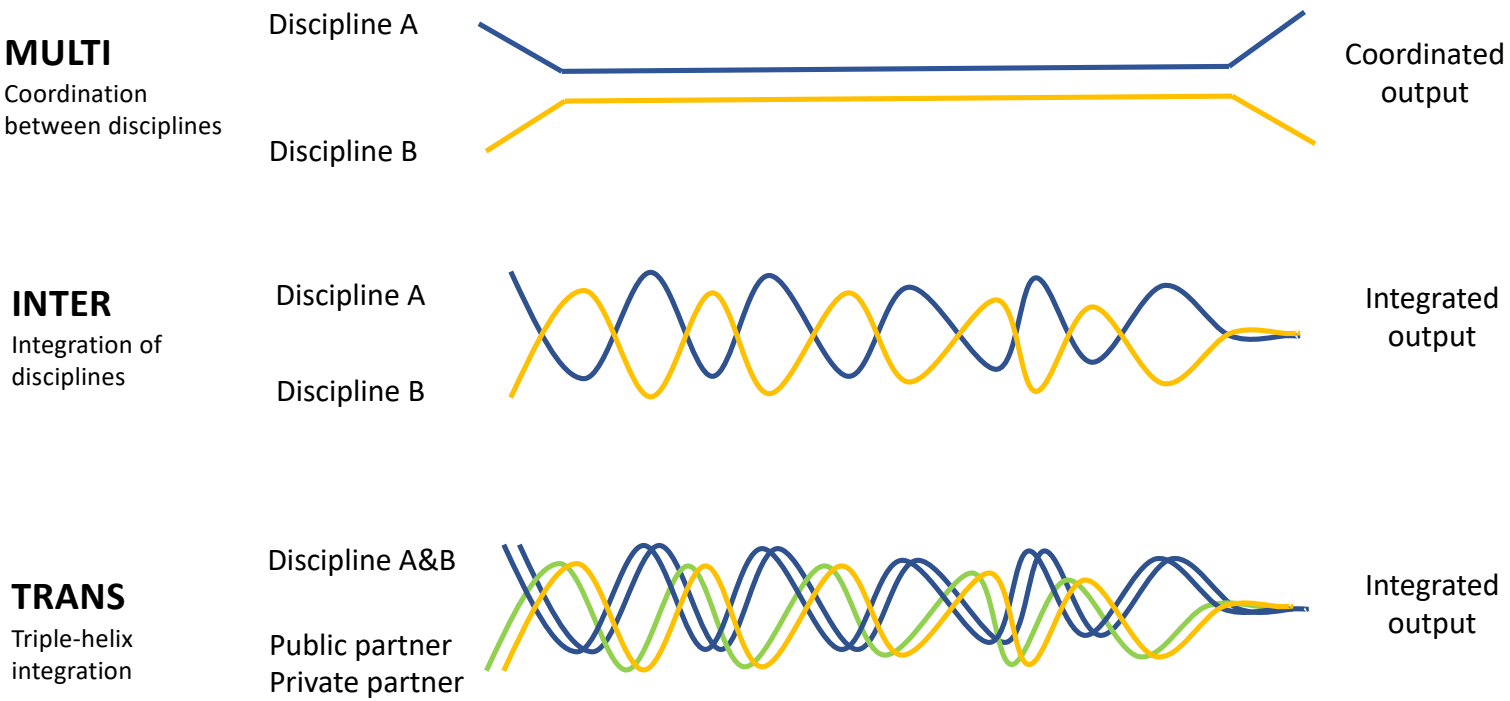
The interdisciplinary approach



Integration is a process by which ideas, data and information, methods, tools, concepts and/or theories from two or more disciplines are synthesized, connected or blended (Klein, 2006).

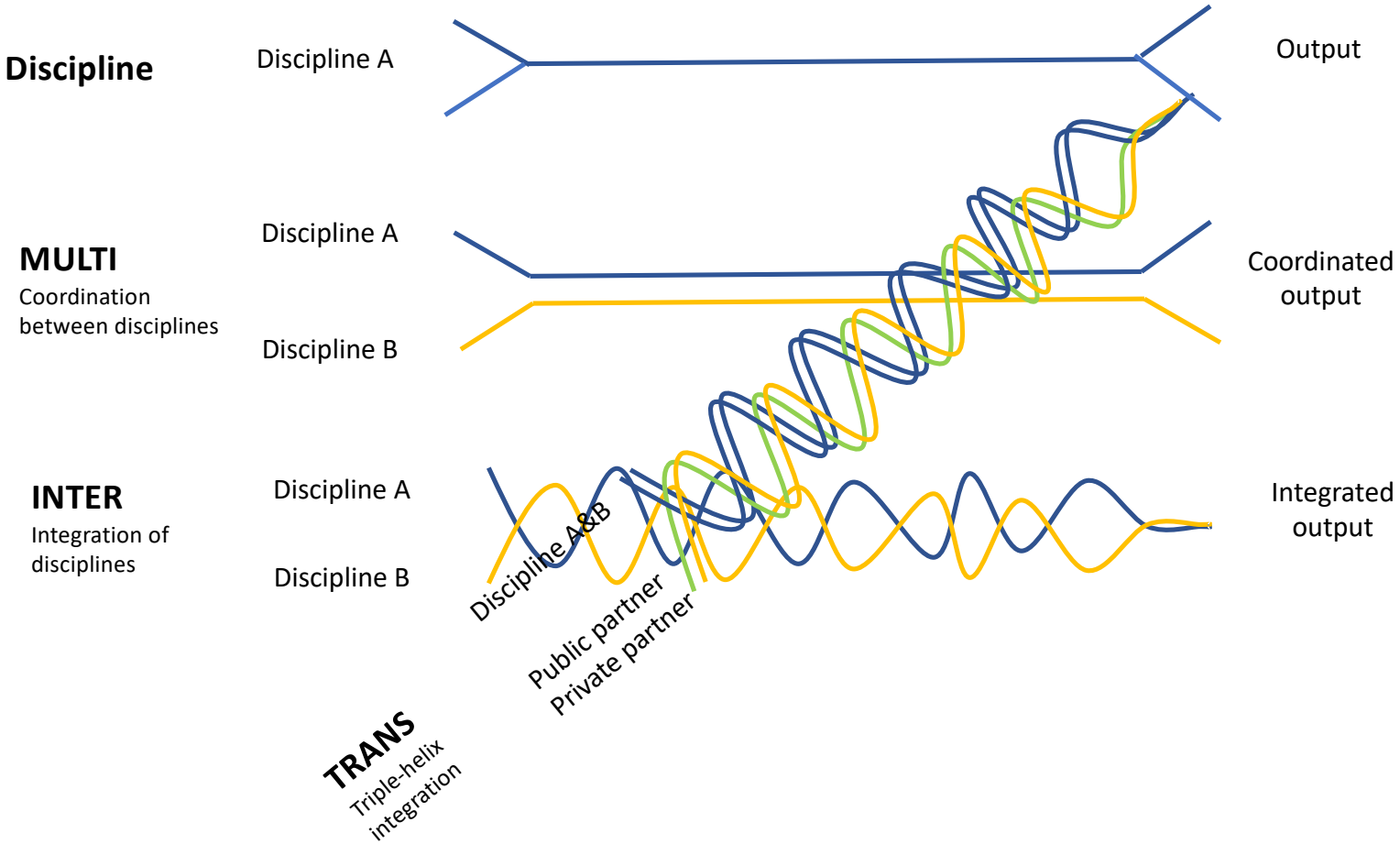
Modification of Keestra and Menken, 2016

The interdisciplinary approach



Transdiciplinarity can be defined by the presence of interaction with external partners (which can be academic, non-academic, or both) and/or of a higher degree of integration among involved disciplines/emerging new disciplines (Bernstein, 2015)

Modification of Keestra and Menken, 2016


Discipline
Discipline A
Output
MULTI
Coordination between disciplines
Discipline A
Discipline B
Coordinated output
INTER
Integration of disciplines
Discipline A
Discipline B
Discipline A&B
Integrated output
Public partner
Private partner
TRANS
Triple-helix integration

Discipline

Discipline A

Output

MULTI
Coordination between disciplines

Discipline A

Discipline B

Coordinated output

INTER
Integration of disciplines

Discipline A

Discipline B

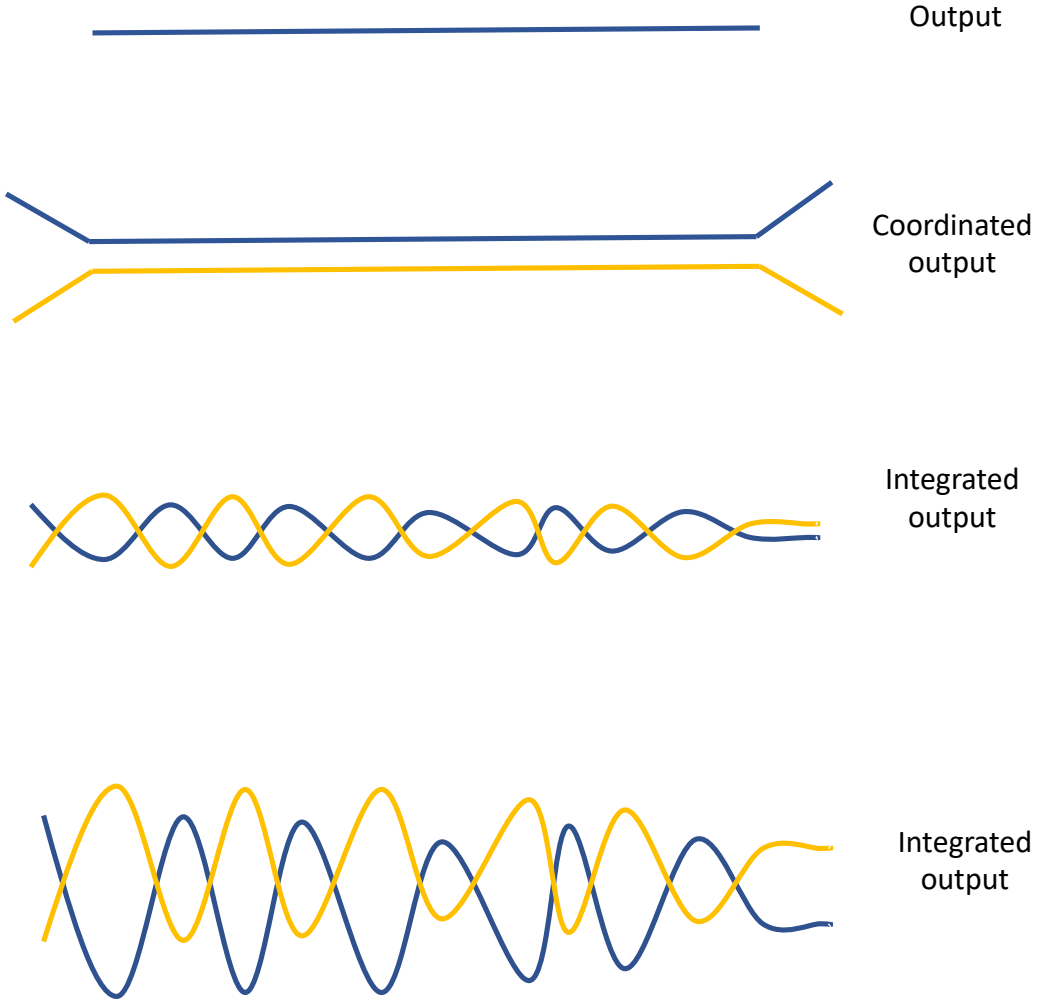
Integrated output

INTER
Integration of disciplines

Discipline A

Discipline B

Integrated output

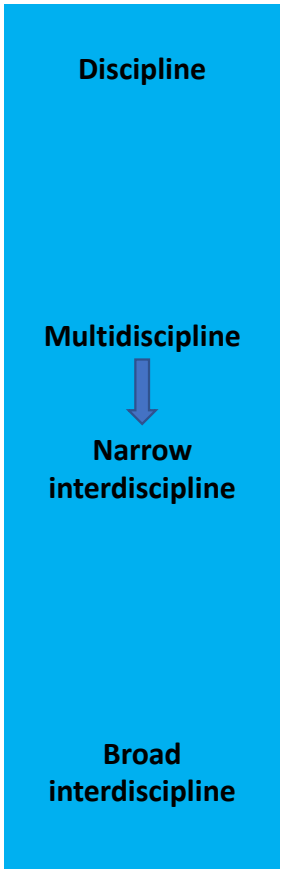


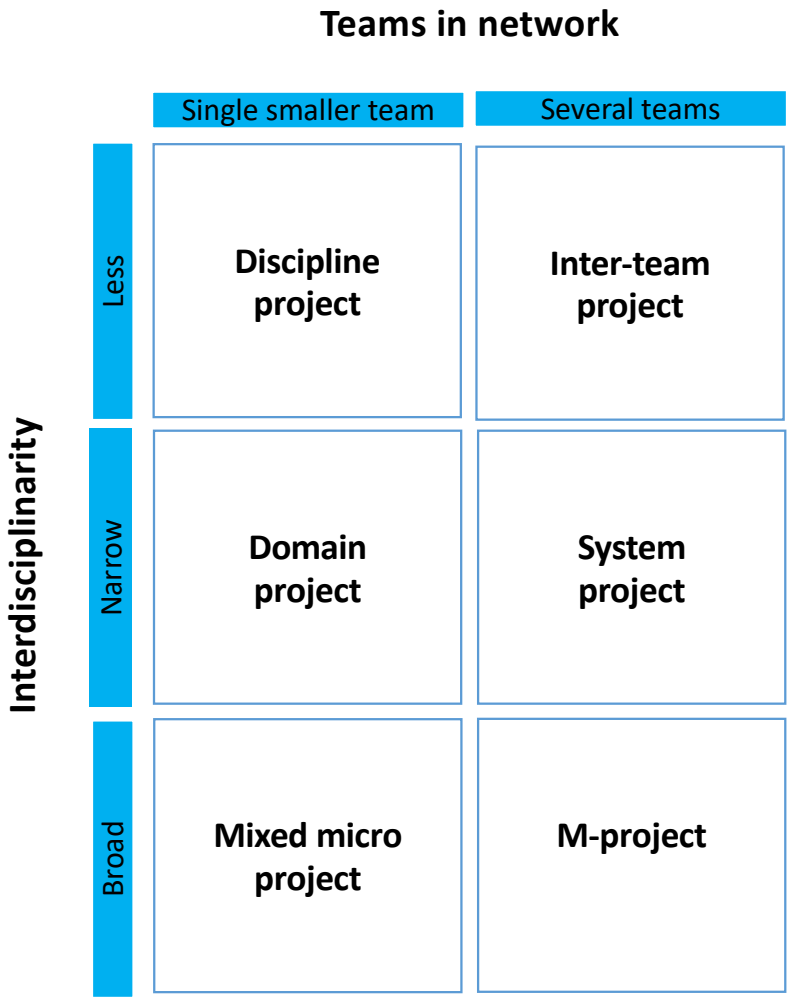
Narrow interdisciplinary Projects

Involvement of disciplines with more or less similar paradigms, methods and sharing knowledge cultures

Broad interdisciplinary projects

Involvement of many different disciplines and the presence of different paradigms, methods and knowledge cultures

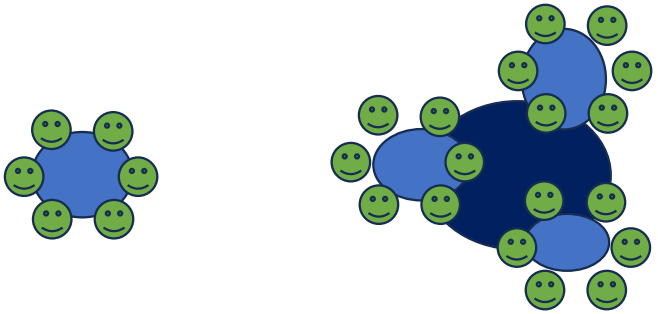
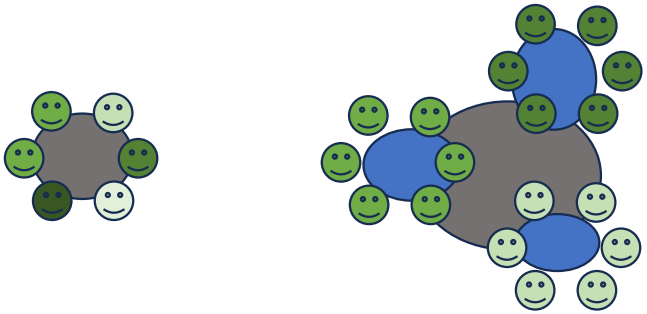
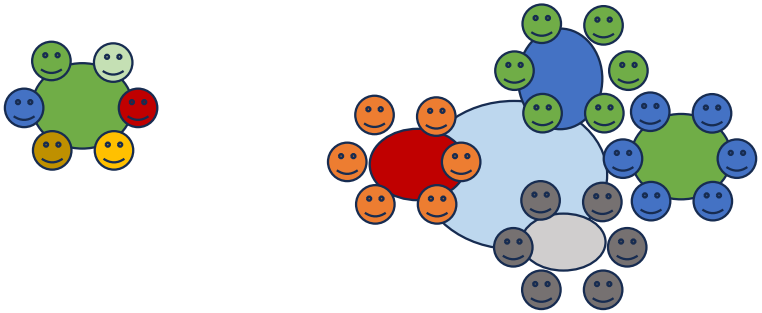




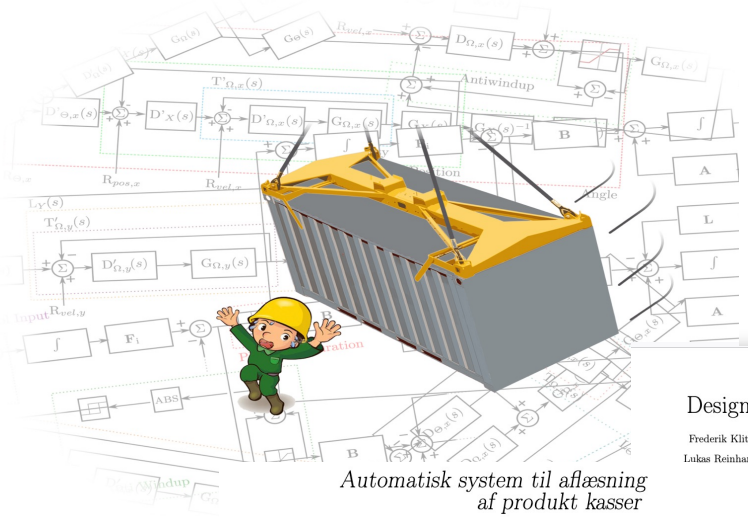
Teams in network
Engeström
Situated learning
Wenger
CSCL community

Newer concepts is multiteam systems (MTS)

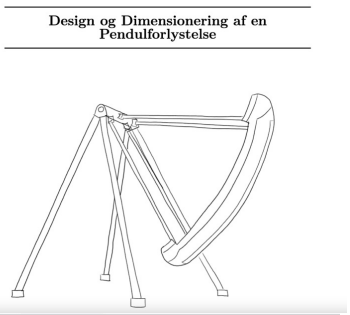
Habbal et al., 2023 in press

Interdisciplinarity	Teams in network: Single smaller team	Teams in network: Several teams	Problems	Collaboration patterns
Less	**Discipline project**	**Inter-team project**	Relatively simple problems and collaboration	
Narrow	**Domain project**	**System project**	Complicated problems and collaboration	
Broad	**Mixed micro project**	**M-project**	Complex problems and collaboration	

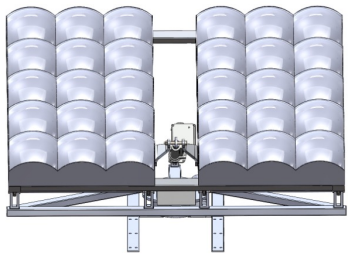
Discipline project



Automatisk system til aflæsning af produkt kasser



Design og Dimensionering af en Pendulforlystelse



Design og konstruktion af solartracker

Frederik Klitgaard, Frederik Schultz Hedegaard, Julius Aggu Peter Poulsen, Lukas Reinhardt Erichsen, Rasmus Krushave Simonsen, Valter Yde Daugberg

MP311

2. semester

Aalborg Universitet

Materialer & Produktion

AALBORG UNIVERSITY

Battery energy storage systems for wind turbines

Teams in network

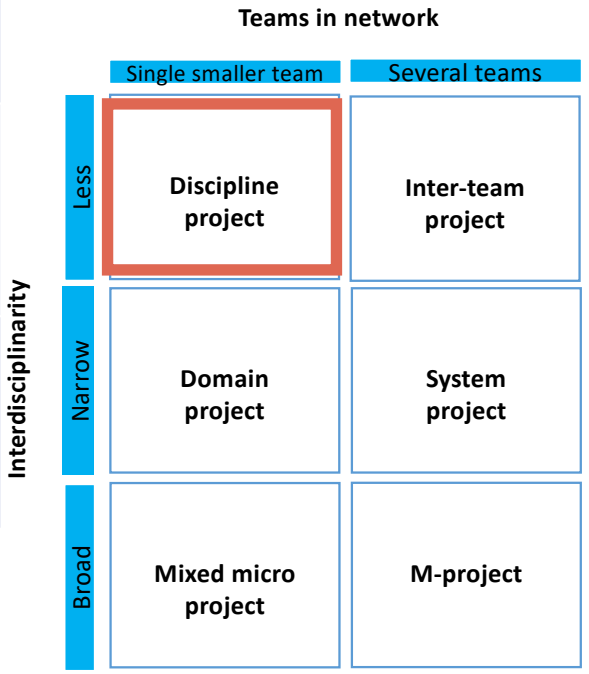
Interdisciplinarity

	Single smaller team	Several teams
Less	**Discipline project**	**Inter-team project**
Narrow	**Domain project**	**System project**
Broad	**Mixed micro project**	**M-project**

Discipline project – team success (Spliid, 2011)

Goals	Activities	Project Management	Personal issues in collaboration
Structure	Planning revisions	Time schedule Planner Top-tail Problem statement Research design	Personal motivation **Engagement** Attention
Efficiency	Decisions Task division Focus	Agenda Moderator Collaboration agreement	**Trust** **Confidence** **Awareness**
Learning	Discussions Writing Feedback	Problem Learning outcomes Peer learning log	**Ambitions** **Preparation** **Sharing**

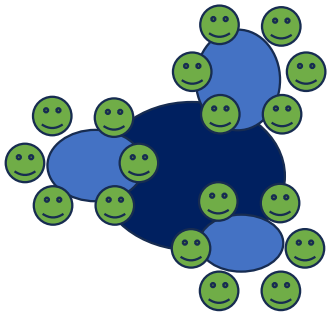
Data: analyses of students' own reflection



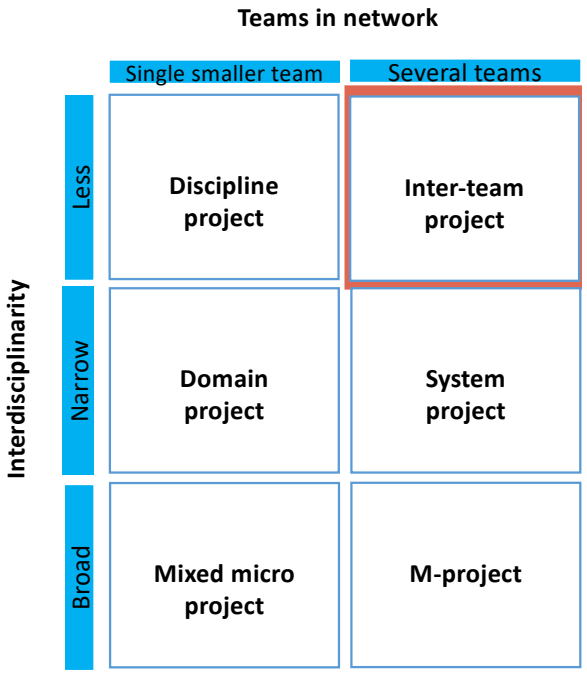
Inter-team project

https://giraf.cs.aau.dk/en/about-giraf/

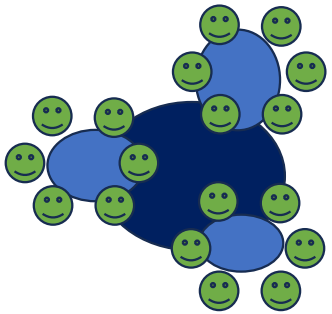
Production:
Semester
Optimizing and creating
business models prototypes



Energy:
Can be to plan
renewal energy at
an island



Inter-team project



Phase 2

Weeks 1–14

Project planning, development and delivery

Taking advice from the previous year-group, the 2020 Giraf students decided to adopt an Agile management approach. This called for specific roles to be allocated to each group. This included one 'Product Owner' group (to interface with the customer and convey their needs and priorities) and one 'Scrum Master' group (to support the development team and cross-group communication). All other groups were allocated various coding roles in the app's development.

In line with the Agile approach, the four-month project was divided into four discrete month-long 'sprints'; for each sprint, the cohort agreed specific development goals and subsequently developed, tested and released the updated app. The first of these sprints focused primarily on rectifying any errors in the existing code. Subsequent sprints focused in areas such as improving the project documentation and prototyping a new communications function for the app.

The cohort also agreed the protocol for scheduled meetings: a daily meeting for each group, a weekly meeting that brought together one representative from each group, and a meeting at the beginning and end of each 'sprint' for the full cohort. Additional ad-hoc meetings would also be held between groups as needed. After the online pivot, most meetings were held using Discord voice chat. The Product Owner group also met regularly with customers to capture their priorities, discuss developments and undertake useability testing of the app (which was conducted via Zoom calls, using a 'screen share' function).

Teams in network

Interdisciplinarity	Single smaller team	Several teams
Less	**Discipline project**	**Inter-team project**
Narrow	**Domain project**	**System project**
Broad	**Mixed micro project**	**M-project**

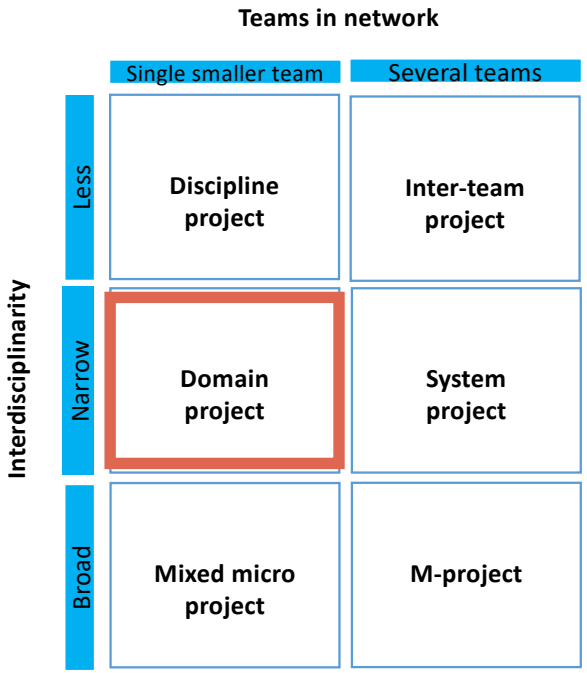
http://oastats.mit.edu/handle/1721.1/146089 Graham, 2022

Domain project

- **AAU does not have many domain projects** – for literature hard to identify data on problems, collaboration, communication, problem-solving and project management

- Typical electives within engineering education where students come in with different disciplinary domain backgrounds: studios, design courses, capstone courses or other courses using projects.

- MIT NEET program, Chalmers Track program, NTNU's Experts-in-teams, UCL, Twente, Iron Range, UTS' studio model + many more with more comprehensive and institutional approaches – not all domain projects, some in practice elements of mixed micro projects.



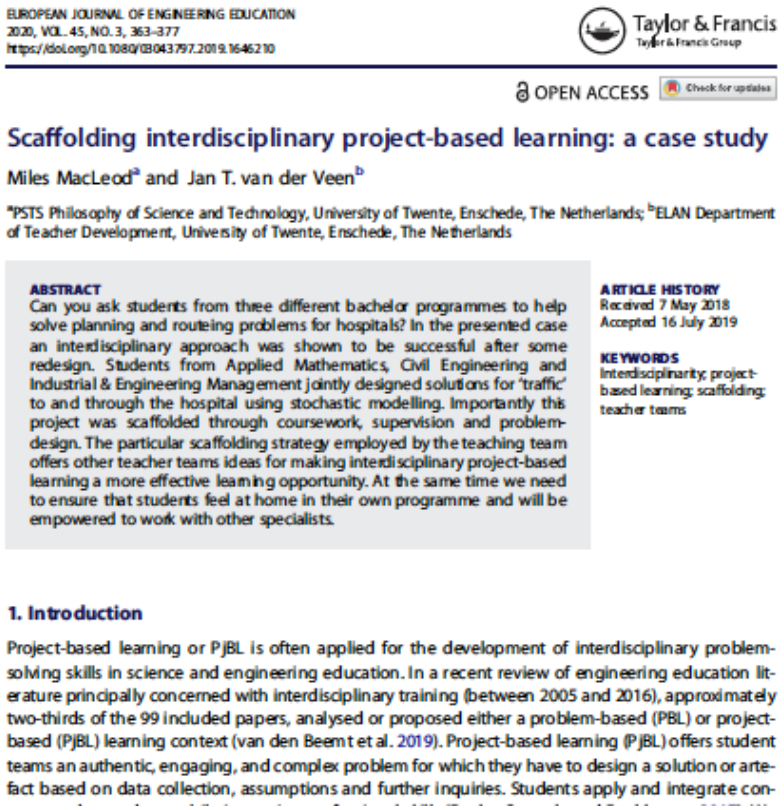
Advise for design of problems

(1) ”The problem is framed to require contributions of specialist knowledge from all three groups, and is effectively unsolvable without them.

(2) The problem is relatively decomposable into disciplinary tasks which can then be reintegrated.

(3) The problem is solvable using project elements from previous module course-work (resulting in a relatively small choice set)”

(MacLeod & van der Veen, 2019)



EUROPEAN JOURNAL OF ENGINEERING EDUCATION
2020, VOL. 45, NO. 3, 363–377
https://doi.org/10.1080/03043797.2019.1646210

Taylor & Francis
Taylor & Francis Group

OPEN ACCESS Check for updates

Scaffolding interdisciplinary project-based learning: a case study

Miles MacLeod[a] and Jan T. van der Veen[b]

[a]PSTS Philosophy of Science and Technology, University of Twente, Enschede, The Netherlands; [b]ELAN Department of Teacher Development, University of Twente, Enschede, The Netherlands

ABSTRACT
Can you ask students from three different bachelor programmes to help solve planning and routeing problems for hospitals? In the presented case an interdisciplinary approach was shown to be successful after some redesign. Students from Applied Mathematics, Civil Engineering and Industrial & Engineering Management jointly designed solutions for 'traffic' to and through the hospital using stochastic modelling. Importantly this project was scaffolded through coursework, supervision and problem-design. The particular scaffolding strategy employed by the teaching team offers other teacher teams ideas for making interdisciplinary project-based learning a more effective learning opportunity. At the same time we need to ensure that students feel at home in their own programme and will be empowered to work with other specialists.

ARTICLE HISTORY
Received 7 May 2018
Accepted 16 July 2019

KEYWORDS
Interdisciplinarity; project-based learning; scaffolding; teacher teams

1. Introduction

Project-based learning or PjBL is often applied for the development of interdisciplinary problem-solving skills in science and engineering education. In a recent review of engineering education literature principally concerned with interdisciplinary training (between 2005 and 2016), approximately two-thirds of the 99 included papers, analysed or proposed either a problem-based (PBL) or project-based (PjBL) learning context (van den Beemt et al. 2019). Project-based learning (PjBL) offers student teams an authentic, engaging, and complex problem for which they have to design a solution or artefact based on data collection, assumptions and further inquiries. Students apply and integrate con-

Domain project - collaboration

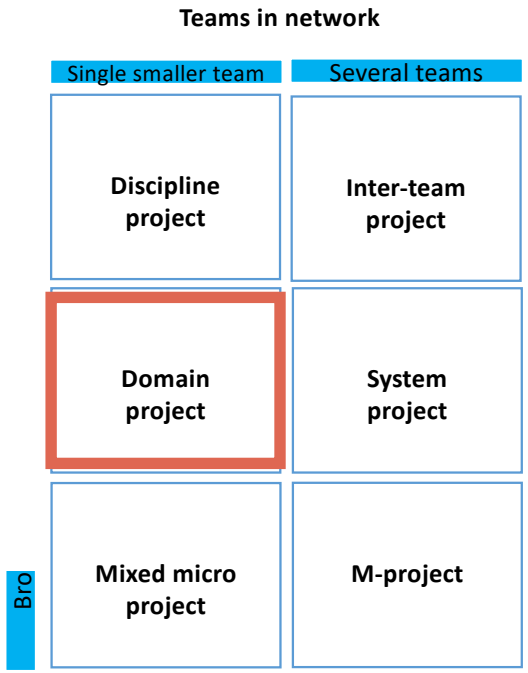
TABLE 1 *Summary of student responses*

Question	Response				
	SA	**A**	**N**	**D**	**SD**
You were well prepared for team projects.	12.5%	75%	6.25%	6.25	-
You were well prepared for interdisciplinary projects.	16.7%	62.5%	16.7%	-	4.1%
It was comfortable working as part of a team.	29.2%	70.8%	-	-	-
Our team functioned well.	8.3%	62.5%	-	29.2%	-
Team communication was good.	-	41.2%	33.3%	25.5%	-
Team organization was good.	-	49.2%	25.2%	25.6%	-

SA – strongly agree, A – agree, N – neutral, D – disagree, SD – strongly disagree.

International Journal of Mechanical Engineering Education, Volume 42, Number 2 (April 2014) © Manchester University Press

(Adair & Jaeger, 2014)



Lattuca et al 2013 – eight dimensions of ID

1. **Awareness of disciplinary knowledge**, such as being aware of disciplinary boundaries and approaches.
2. **Appreciation of disciplinary perspectives** including an appreciative attitude towards other stories and frames of reference.
3. **Recognition of disciplinary limitations** which includes critical thinking skills.

4. Appreciation of non-disciplinary perspectives, which relates to appreciation of transdisciplinary relations.

5. **Interdisciplinary evaluation** in order to increase the quality of interdisciplinary work.

6. **Ability to find common ground**

7. **Reflexivity including the ability** to reflect on one's biases and choices when handling complex problems.

8. **Integrative skill and the capacity** to integrate knowledge and modes of thinking.

Repko, Szostak and Buchberger, 2019

Mindsets

- ***Empathy***
- **Ethical consciousness**
- ***Humility***
- Appreciation of diversity
- Tolerance of ambiguity
- Civic engagement

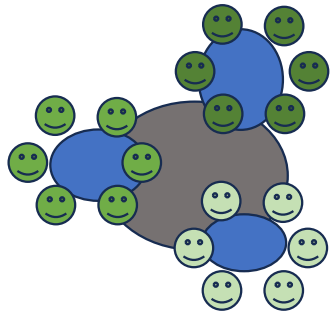
Traits

- Entrepreneurship
- ***Love of learning***
- **Self-reflection**
- **Intellectual courage**
- **Risk**

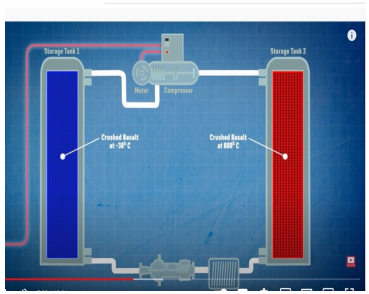
Skills

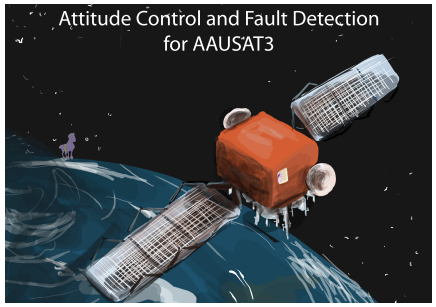
- Communicative
- **Abstract thinking**
- Creative thinking
- **Metacognition**

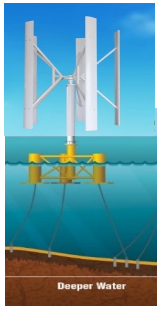
System project

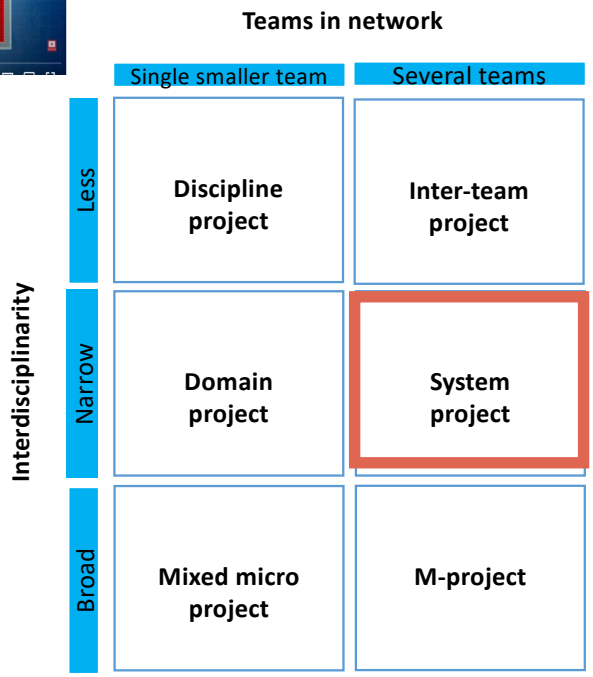


- To develop technological system solutions
- Project teams working together across disciplines and can be across semesters
- Supervisors might also work together as a team that can support the process





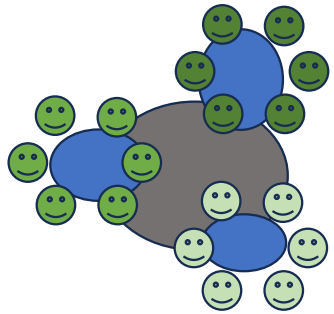




https://www.en.engineering.aau.dk/education/leadeng-projects
https://www.en.space.aau.dk/about-aau-space

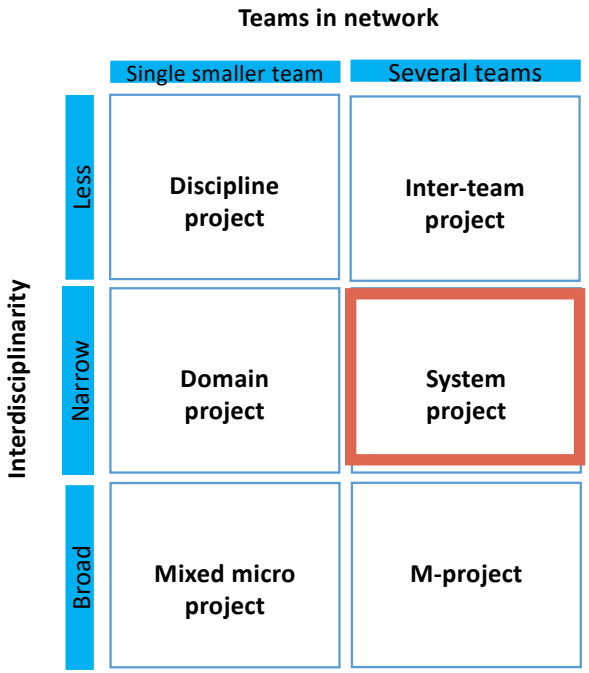
Research on collaboration

Collected qualitative data three times



- ***of course there are problems**, because they have some concepts and understandings for things that we don't have and vice versa...*
- *After all, we can talk about power and newton meters, radians per second and all that sort of thing, **without having to translate** it to each other. …*

- *It has clearly been **an extra motivation to do the project**. Keep an eye on something. So it's so real. It's definitely been the best, I think. …*
- *That thing with project management and collaboration with subject areas. It is definitely something to think about. **They don't know exactly the same as you.** They know something you don't and you know something they don't.*



Experienced Learning Outcomes

IEEE Transactions on Education - Manuscript [TE-2022-000333] Accepted to be published 2023

Experienced Learning Outcomes for Interdisciplinary Projects in Engineering Education

Henrik Worm Routhe, Jette Egelund Holgaard, Anette Kolmos

***Abstract*— *Contribution*: This research paper contributes to engineering education research with a framework for interdisciplinary learning outcomes based on students' experiences from participation in an interdisciplinary project for engineering students. A theoretical frame of reference is developed to analyze students' experience with interdisciplinary projects.**

***Background*: Engineers are important stakeholders in solving complex global challenges, and faculties have a very important role in educating engineers with the necessary competences. However, research finds many challenges when engineering students work with complex problems in an interdisciplinary setting crossing different disciplinary boundaries.**

***Research question*: What cognitive learning outcomes are experienced by engineering students when working on interdisciplinary problem-based projects across engineering disciplines?**

***Methodology*: The case study draws on insights from interdisciplinary projects involving students from different yet related disciplines (referred to as narrow interdisciplinary projects) in spring 2022. The study followed 18 engineering groups during the spring semester 2022. The students were all from The Faculty of Engineering and Science and belonging to the programs: Energy, Materials & Production, and Construction. The students worked together in clusters on different narrow interdisciplinary engineering projects (leadENG). Data was collected through 8 qualitative group interviews and observations from meetings, status seminars, etc. Interview data was transcribed and analyzed in NVivo using a data driven approach and afterwards categorized according to the model for learning outcomes.**

***Findings:* A list of intended learning outcomes was compiled for**

Based on the understanding that grand challenges are complex problems which are common to much of society, affect large populations, and are open for multiple solutions, Nowell *et al*. [3] systematically reviewed the incorporation of grand challenges in higher education courses. The review showed that the most common grand challenge topic focused on sustainability, many incentives related to design-thinking, and interdisciplinary learning was commonly discussed as a course learning objective [3].

Interdisciplinarity calls for a T-shaped engineer who can do boundary critique [4] and boundary work [5], enabling the person to consciously shape and reshape boundaries based on the situation at hand. A T-shaped engineer has an overview of the contextual landscape of the discipline enabling them to select and activate theories and methods outside disciplinary borders [6], [7].

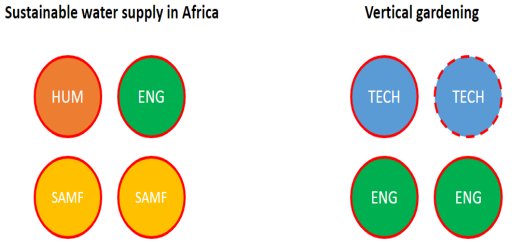
However, if future engineers need more interdisciplinary competences, these need to be reflected in the development of future engineering curricula [8-10]; the T-profile underlines that engineering candidates should not be multi- inter- or transdisciplinary, but instead they must learn to work as such while keeping their engineering identity. Therefore, this is not a question of less deep disciplinary knowledge, the question is, however, how to draw the line and how interdisciplinary knowledge and competences can be integrated in the engineering curricula to ensure the right balance.

This article will contribute to the research which seeks to

Interdisciplinary Enactment
Evaluate own practice in an interdisciplinary project in terms of how it has affected different actors and aspects of the project.
Explain how the technological system is compared to real-life scenarios.
Interdisciplinary coordination
Examplify a potential way of coordinating an interdisciplinary project.
Explain the added complexity of coordinating an interdisciplinary project across groups compared to a one-team disciplinary project.

Mixed micro projects

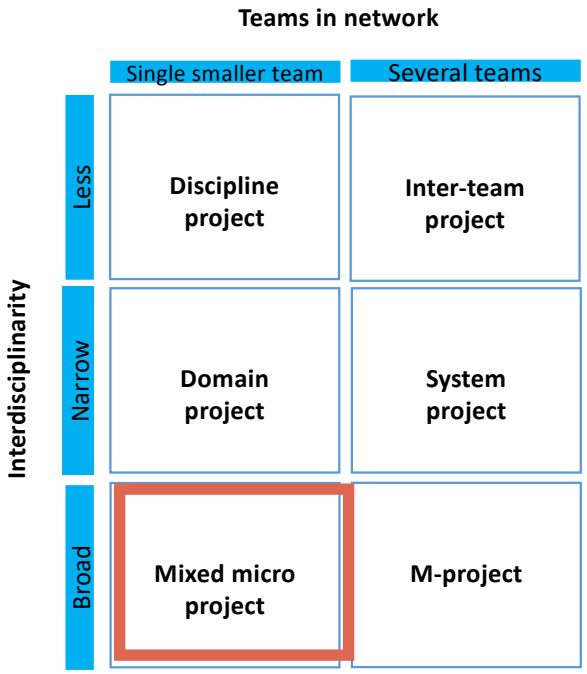
- Single small project teams with students from both STEM and SSH
- Students found it highly interesting and relevant to collaborate with Grundfos
- BUT students found it difficult to transfer disciplinary knowledge of **methods, tools and approaches for from their disciplinary settings to an interdisciplinary setting**
- **They did not have a common language**
- **The students needs to be more aware of the process of problem identification and collaboration**



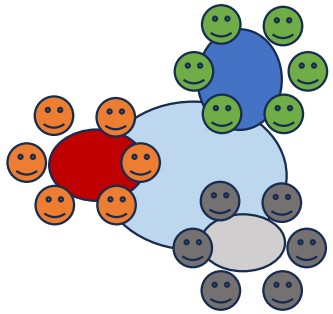
Challenges for engineering students working with authentic complex problems

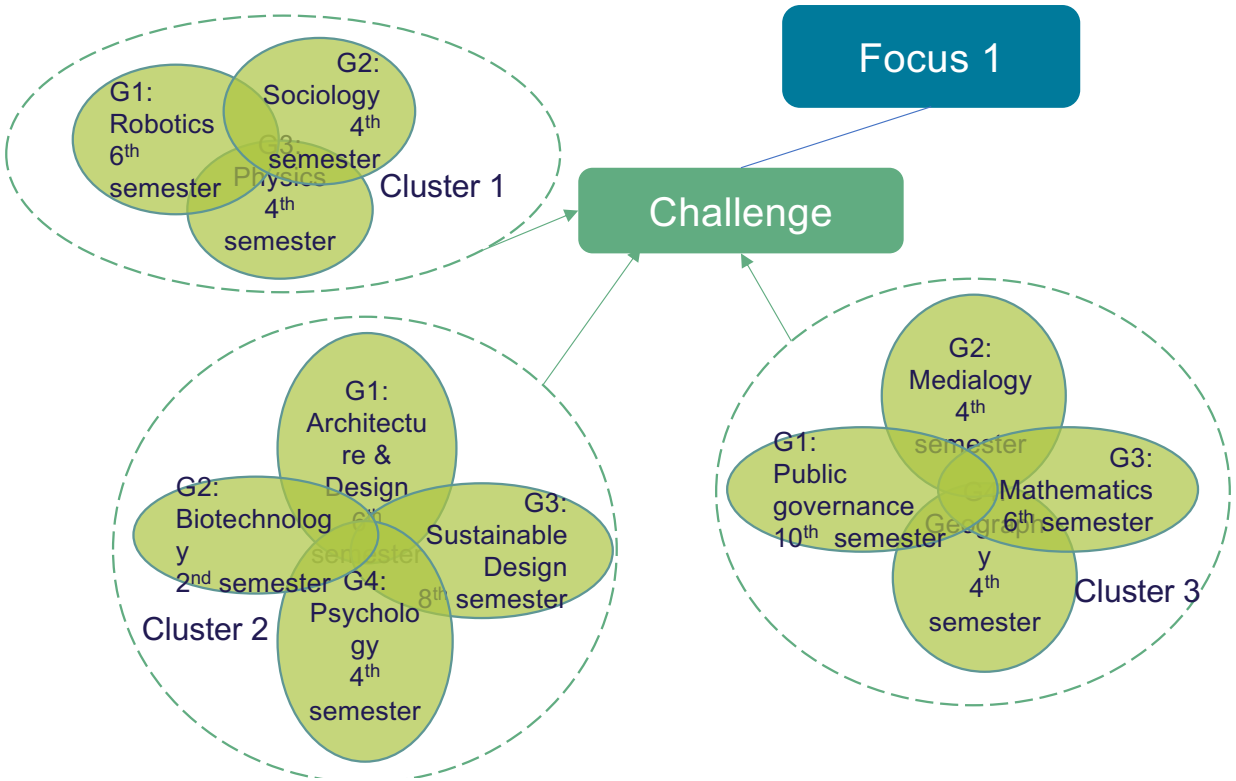
Henrik Worm Routhe[1]
Institute for Planning
Aalborg, Denmark

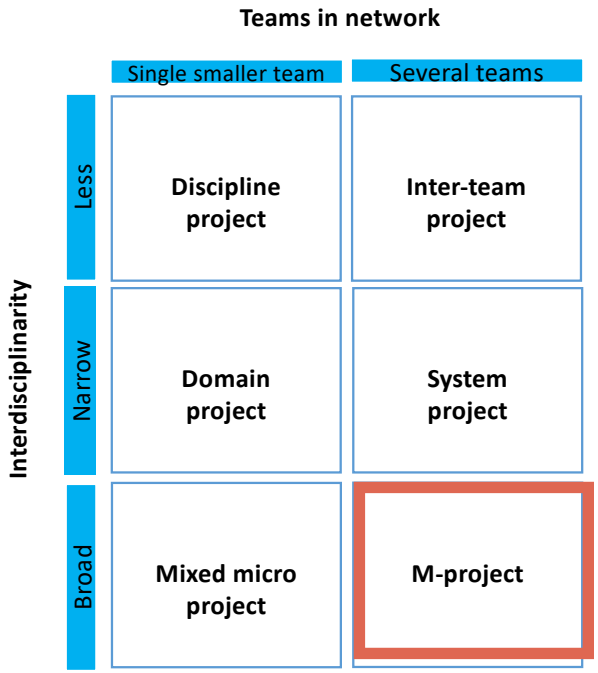
Maiken Winther
Institute for Planning
Aalborg, Denmark



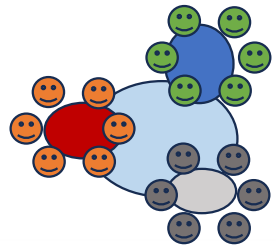
Simplifying Sustainable Living







Research results



- Organizational and curriculum structures became **barriers** for the success of megaprojects in the system.
- Students **expand** their perspective from narrow single discipline projects to large-scale complex problem-solving – but found it difficult
- More **complexity** in problems, processes and workflows require the development of new skills, including digitally supported project management, collaboration and sustainability.
- Students had **difficulties in understanding each other** and some did not find it meaningful to collaborate in the broad interdisciplinary project.
- They could step back to their disciplinary project teams – which they did…

The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1467-6370.htm

Framing and facilitating complex problem-solving competences in interdisciplinary megaprojects: an institutional strategy to educate for sustainable development

Received 31 October 2020
Revised 20 July 2021
16 October 2021
Accepted 18 October 2021

Lykke Brogaard Bertel, Maiken Winther, Henrik Worm Routhe and Anette Kolmos
Aalborg University, Aalborg, Denmark

Abstract

Purpose – Problem-based learning (PBL) has been suggested as an approach to education for sustainable development (ESD); however, the integration of interdisciplinarity is continuously challenged as it requires transfer and collaboration across disciplinary boundaries, as well as integration into an often already-overflowing curriculum. Even in formalized PBL universities emphasizing student responsibility for defining relevant problems, envisioning sustainable solutions and developing transversal competences, interdisciplinary collaboration is still often "relocated" to extra-curricular activities. This paper aims to explore Aalborg University (AAU) Megaprojects as a case for systematically integrating principles of ESD, and particularly interdisciplinarity, into PBL at scale.

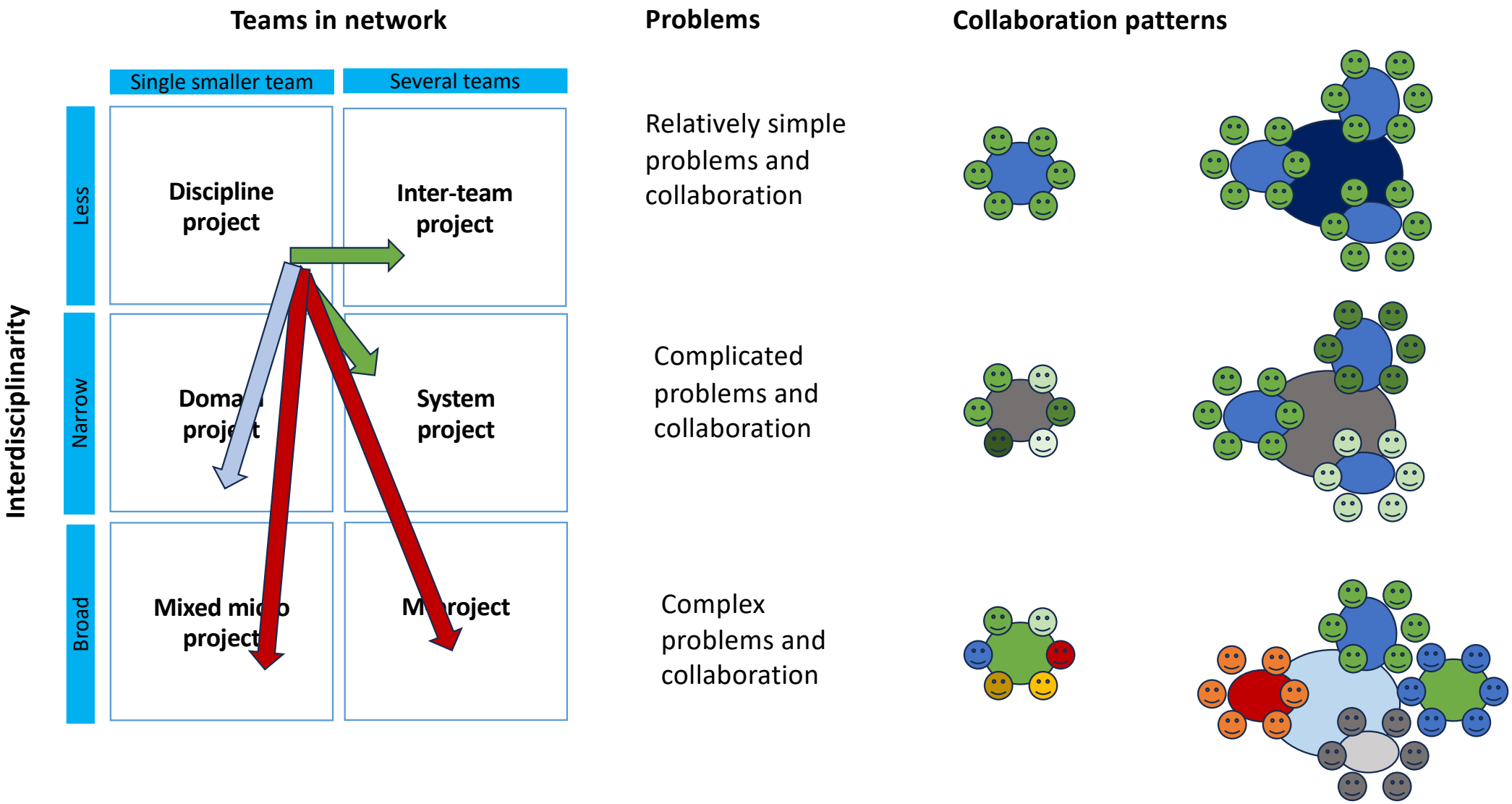
Design/methodology/approach – The paper proposes a framework for analysing potentials and challenges concerning interdisciplinary framing and facilitation in large-scale projects based on PBL- and ESD-related research and presents findings from a case study on the first three rounds of megaprojects at AAU in 2019 and 2020.

Findings – The findings indicate that interdisciplinary megaprojects have the potential to motivate students to engage in sustainable development; however, they require systematic framing and guided facilitation, particularly in the early stages, for students to take ownership, prioritize collaboration and see the contribution to and connection between disciplines. They also need prioritization at all institutional levels to succeed as an institutional strategy of ESD.

Originality/value – The paper provides insights into the potentials and challenges of framing and facilitating large-scale megaprojects as an approach to integrate the SDGs and interdisciplinary collaboration into higher education. Hence, it aims to provide new insights, concepts and practices for ESD and PBL for sustainability.

Keywords Sustainability, Megaprojects, Facilitation, Interdisciplinary collaboration, Education for sustainable de

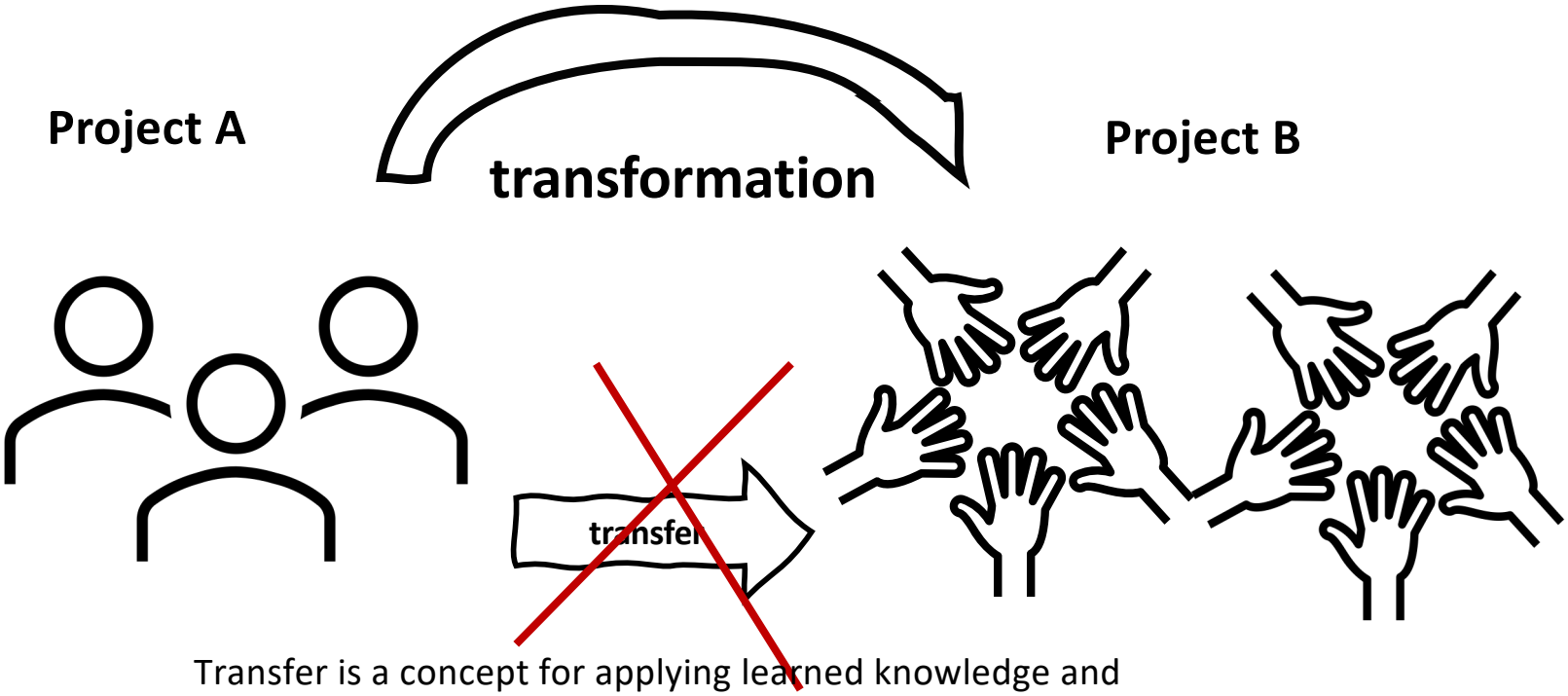
Paper type Research paper


Teams in network
Problems
Collaboration patterns
Single smaller team
Several teams
Interdisciplinarity
Less
Narrow
Broad
Discipline project
Inter-team project
System project
Mixed mi o project
roject
Relatively simple problems and collaboration
Complicated problems and collaboration
Complex problems and collaboration


Can you recognise any of the project types?
Or the issues?

Transfer and transformation - **to stick the hand in a bitue of** definitions and understandings

Transformation involves the ability to adapt and modify existing knowledge, skills, and competencies to meet new demands and contexts



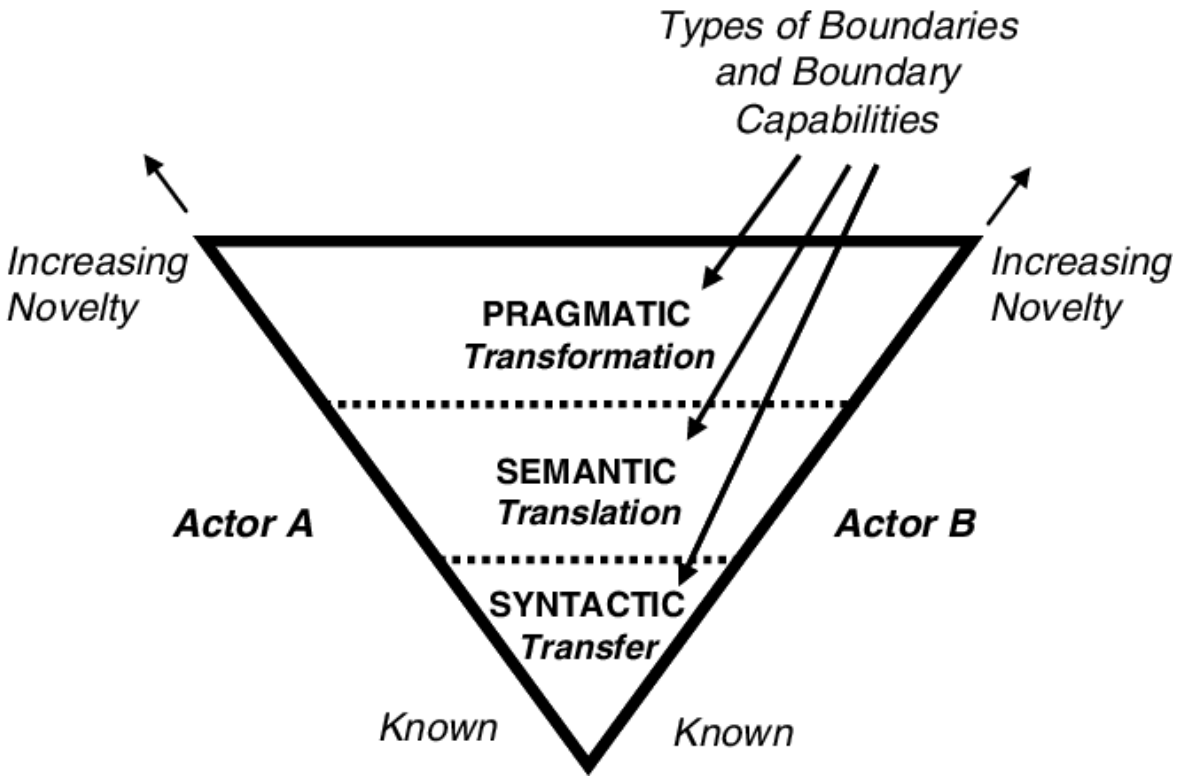
Transfer is a concept for applying learned knowledge and competences in similar situations

Theoretical approach	Key features	Theoretical approach	Key features Transfer interpreted as transformation
Behaviorism e.g. Thorndike, 1913 Individual	*Transfer results from elements in tasks or environments stimulating specific recalls of knowledge and behavior in similar learning situations*	Situated cognitive approach e.g. Lave, 1988 Individual	*Transformation of **procedures and experiences from earlier situations**, in accordance with the situational demands and possibilities*
Cognitive approach e.g. Nokes, 2009 Individual	*Transfer results **from abstraction of essential features** and mapping onto new situations on the basis of shared structures*	*Participation Approach* *Lave and Wenger, 1991* Collaborative	*Transformation happens through **participation in social contexts** where previous patterns of participation can be resituated*
		Practice Approach *Engeström, 2001* Collaborative	*Transformation happens through **boundary crossing between social practices (activity systems)**, resulting in transformation of understandings and procedures*

With inspiration from: Dohn, N.B, , Markauskaite, L., & Hachmann, R. (2020)

Boundaries as novelty increases (Carlile, 2004)

Domain



(Carlile 2004)

Domain

Continous work at the boundary

- Identification
  - Othering
  - Legitimate co-exsistence
- Coordination
  - Translation
  - Communicative connections
- Reflection
  - Perspective making and taking
- Transformation
  - Recognising shared problem space
  - Hybridisation and maintaining uniqueness of practices
  - Continuous work at the boundary

With inspiration from Akkerman and Bakker, 2011

Lobato: Transfer/(transformation) mechanisms – what triggers?

- **Controlled transfer**
- **Social framing – inter-contextuality**
- **Discernment of differences (Marton)**
  - *Variation and sameness*
  - *Transfer is how learning from one situation affects what the learner is capable of doing in another situation – no direct transfer*

(Lobato, 2009)

PBL curriculum

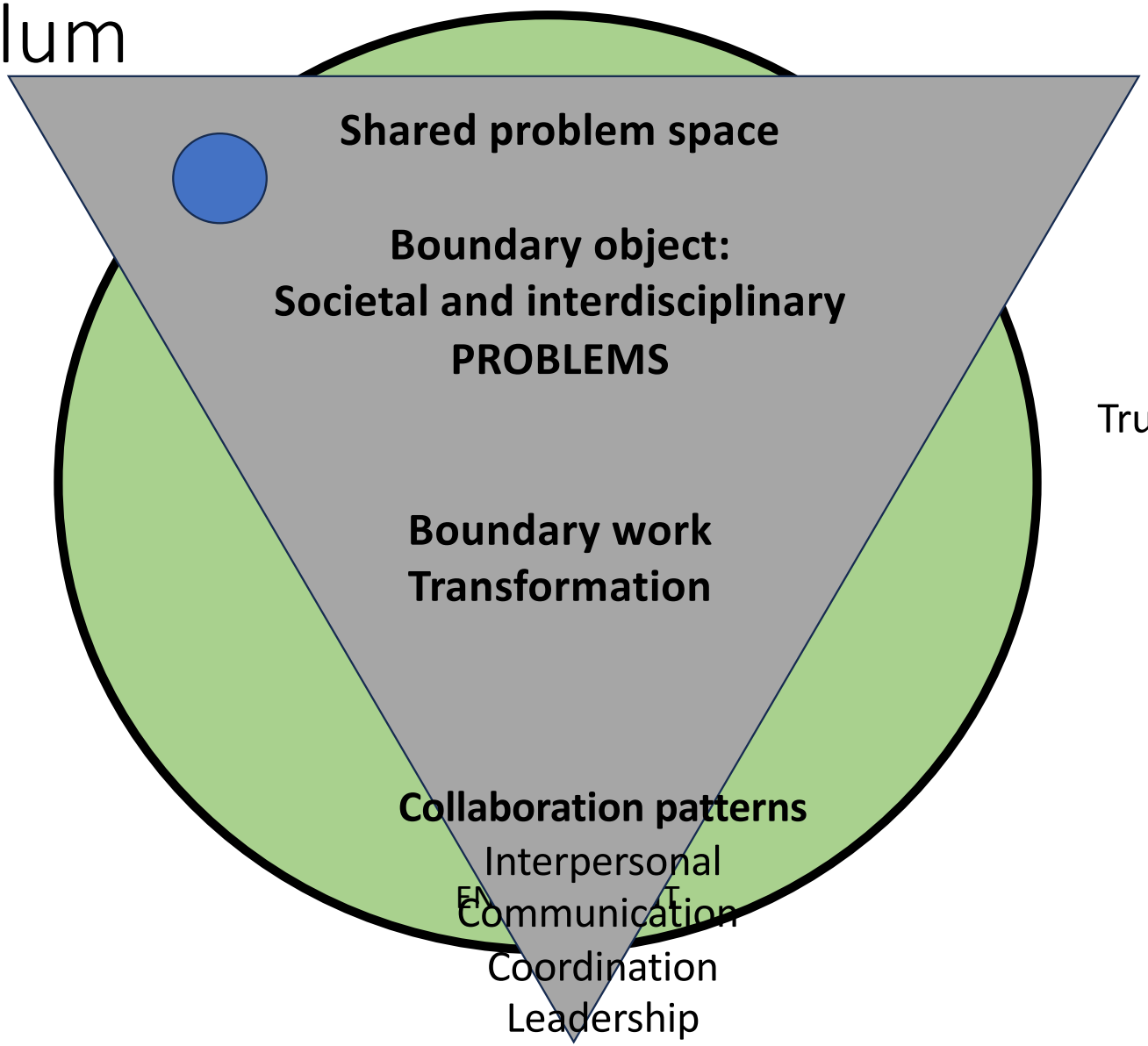
Cognition

Understanding the context

Scientific content and awareness of boundaries

Methods for problem analyses

Methods for problem solving



Motivation

Interest
Emotion
Sense making

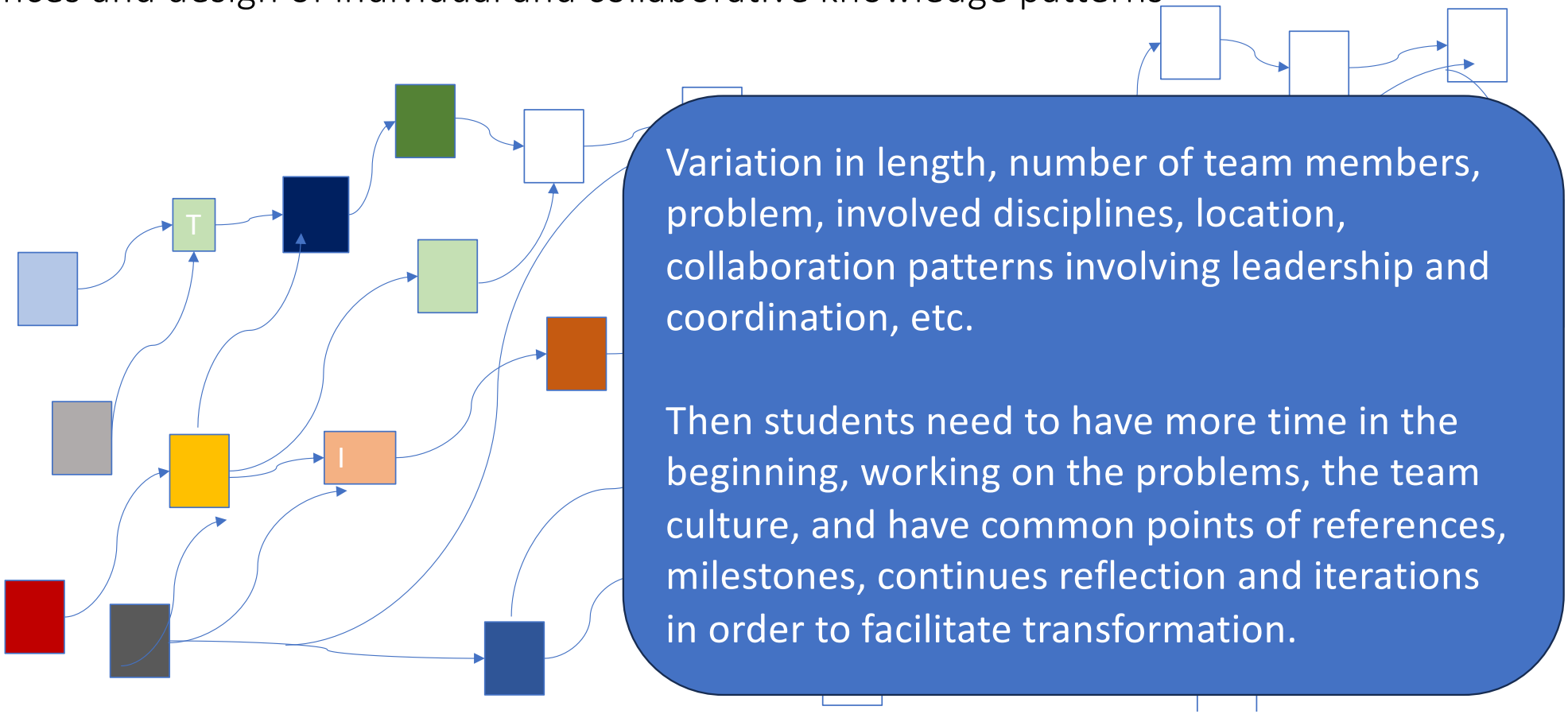
Trust and openness
Feeling of belonging

Reflection on variation of experiences

Illeris, 2015

Transfer and transformation are processual elements in combined cognitive, affective and social learning and in boundary work.

The learning of both problem and collaboration can be understood as combinations of experiences and design of individual and collaborative knowledge patterns

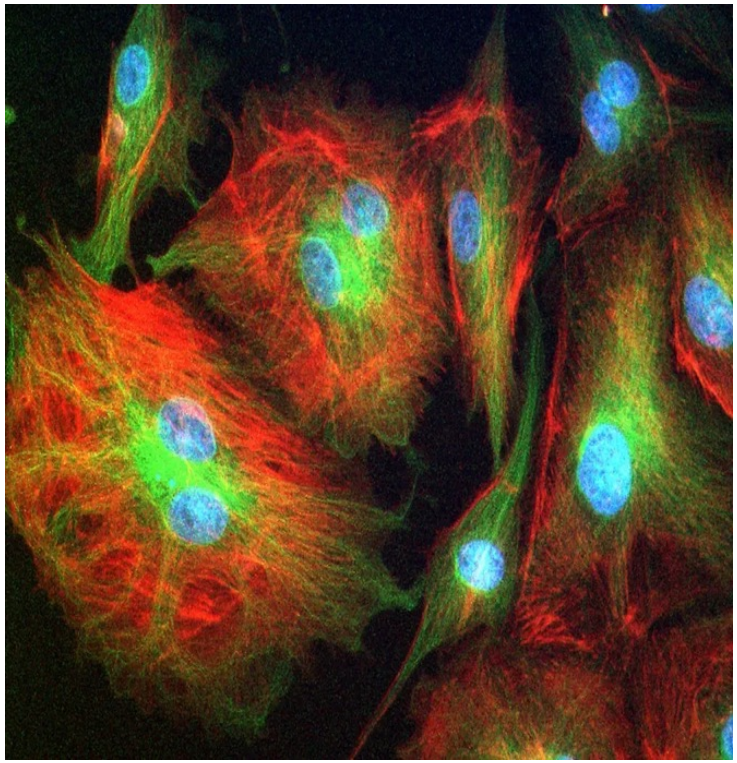


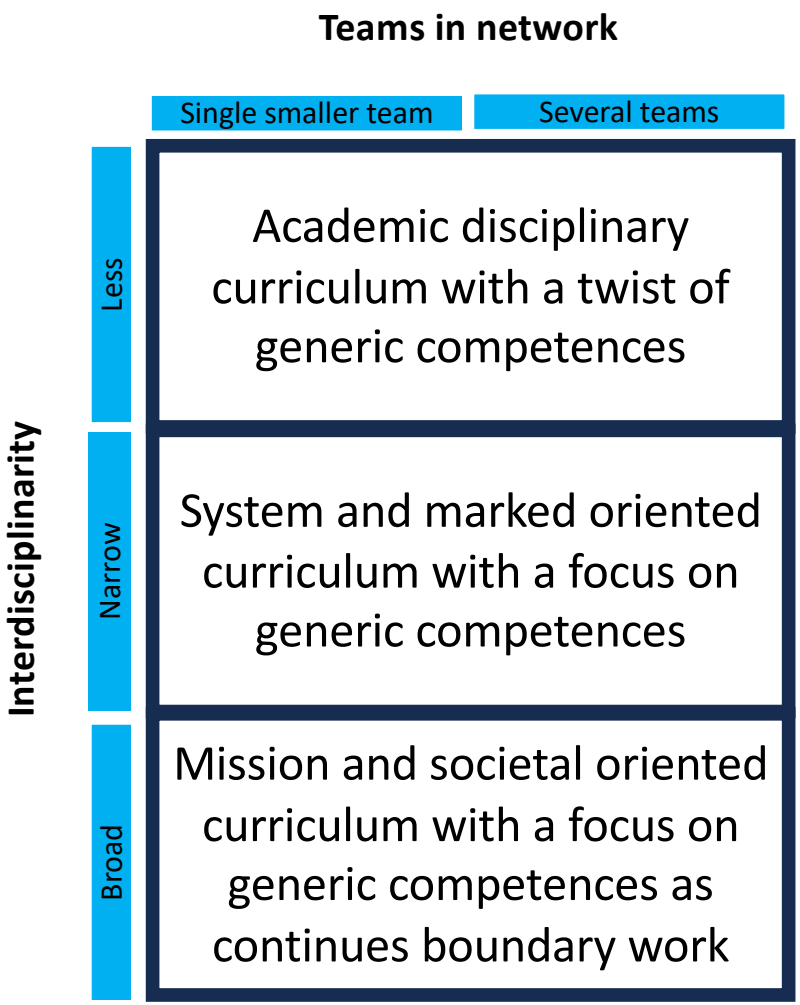
Variation in length, number of team members, problem, involved disciplines, location, collaboration patterns involving leadership and coordination, etc.

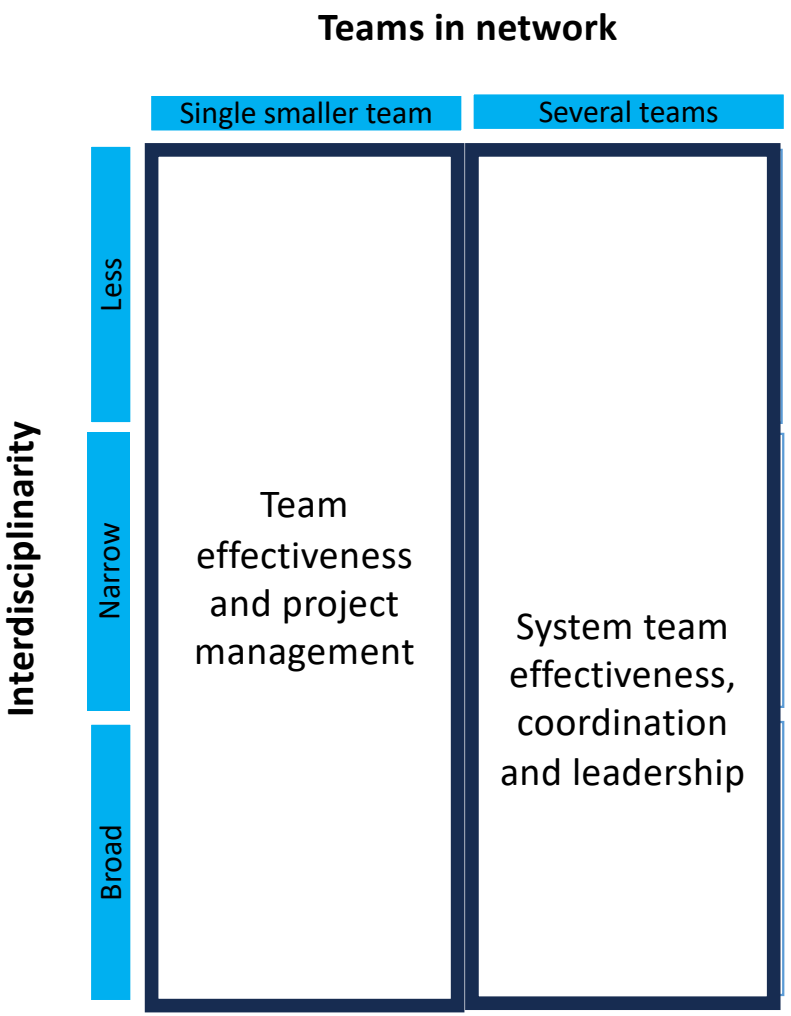
Then students need to have more time in the beginning, working on the problems, the team culture, and have common points of references, milestones, continues reflection and iterations in order to facilitate transformation.

To get there in the curriculum

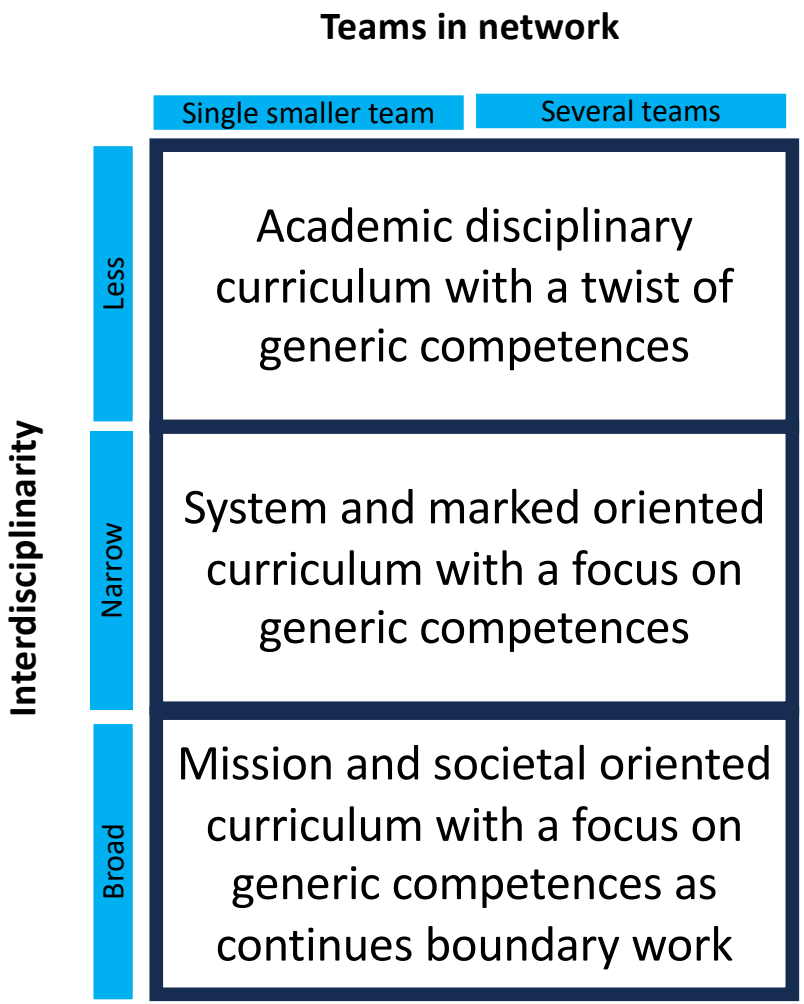
- Create variation in the curriculum – students need to experience variation and different problems, collaborative structures and patterns
- Experience of a re-contextualisation process – or accommodation process – what happens in crossing the disciplinary boundaries?
- Variation goes together with reflection – without reflection and comparison of experiences, you create chaos. Reflection on variation and sameness.
- Learning to act and live on edge – to be boundary worker which involve risks and can be learned by setting up the constant dilemma between the safety in the known discipline and the unknown.

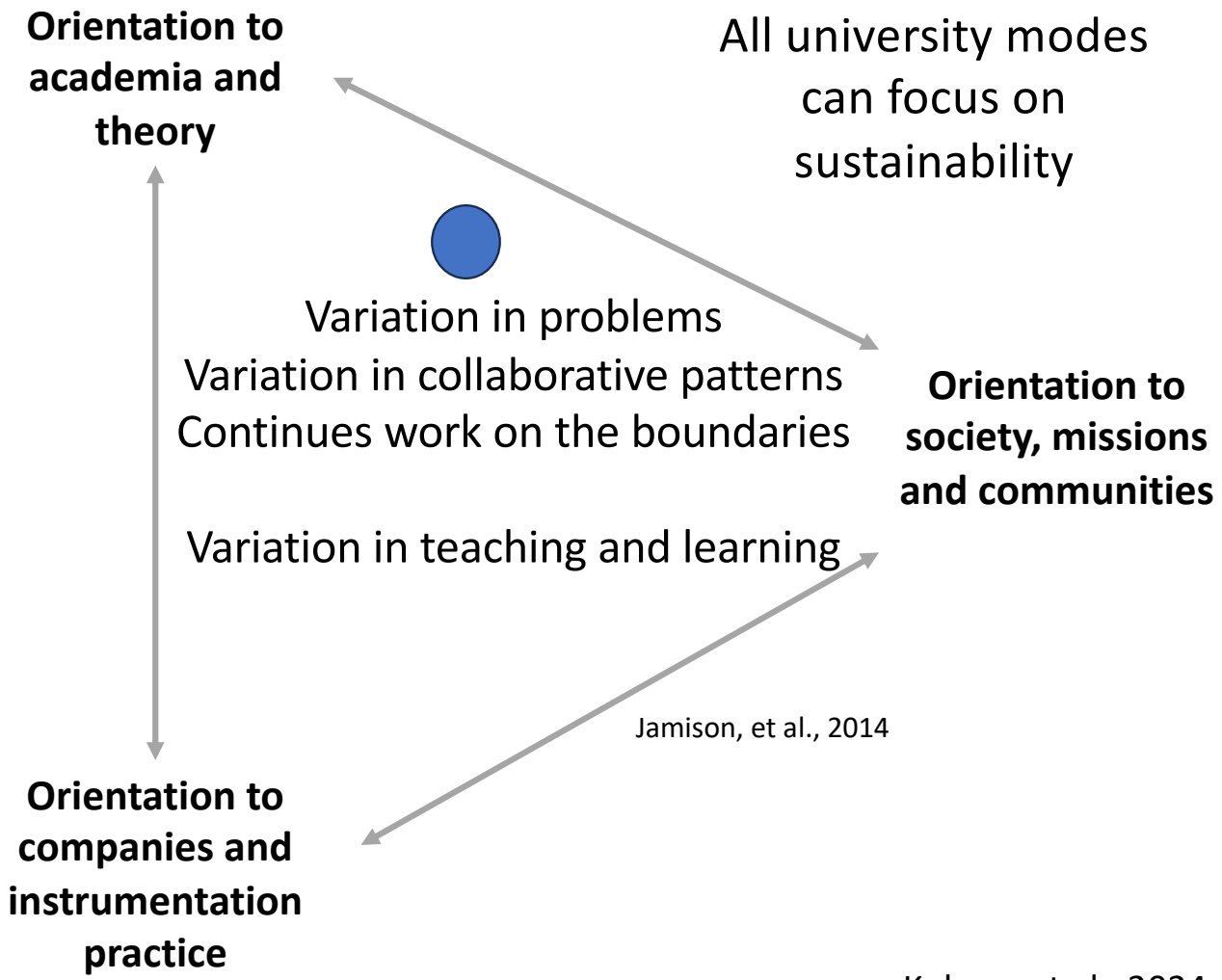






Kolmos et al., 2024





Kolmos et al., 2024

Special Issue, European Journal of Engineering Education

Interdisciplinary Learning and Transformation of Engineering Education

Guest Editors
Karolina Doulougeri, TU Eindhoven, The Netherlands
Anette Kolmos, Aalborg University, Denmark
Amitava 'Babi' Mitra, Massachusetts Institute of Technology, USA
Henrik Worm Routhe, Aalborg University, Denmark
Jan van der Veen, TU Eindhoven, The Netherlands

Submission process

- Deadline for extended abstracts – 15 January 2024
- Notification of invitation for full paper submission – 20 February 2024
- Full paper submission due date – 15 September 2024

Thank you

United Nations
Educational, Scientific and
Cultural Organization

AALBORG UNIVERSITY

Aalborg Centre for Problem Based Lear
in Engineering Science and Sustainabili
under the auspices of UNESCO

Questions?

Learning?

SEFI
ANNUAL CONFERENCE
11-14 September 2023
TU Dublin
ENGINEERING EDUCATION FOR SUSTAINABILITY

Anette Kolmos
ak@plan.aau.dk

References 1

Adair, D., & Jaeger, M. (2014). Managing the interdisciplinary approach to engineering design. *International Journal of Mechanical Engineering Education*, *42*(2), 175–184. https://doi.org/10.7227/IJMEE.0014

Akkerman, S. F., & Bakker, A. (2011). Boundary Crossing and Boundary Objects. *Review of Educational Research*, *81*, 132-169. https://doi.org/10.3102/0034654311404435

Bernstein, J. H. (2015). Transdisciplinarity: A review of its origins, development, and current issues.

Bertel, L. B., Winther, M., Routhe, H. W., & Kolmos, A. (2022). Framing and facilitating complex problem-solving competences in interdisciplinary megaprojects: An institutional strategy to educate for sustainable development. *International Journal of Sustainability in Higher Education*, *23*(5), 1173-1191.

Boelt, A. M., Kolmos, A., & Holgaard, J. E. (2022). Literature review of students' perceptions of generic competence development in problem-based learning in engineering education. *European Journal of Engineering Education*, 1-22.

Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. *Organization Science*, *15*(5), 555-568.

Chen, J., Kolmos, A., & Du, X. (2020). Forms of implementation and challenges of PBL in engineering education: A review of literature. *European Journal of Engineering Education*, 1-26.

Dohn, N. B., Markauskaite, L., & Hachmann, R. (2020). Enhancing knowledge transfer. In *Handbook of research in educational communications and technology* (pp. 73-96). Springer.

Graham, R. (2022). CEEDA case study report: Six case studies of the impact of COVID-19 on global practice in engineering education.

Habbal, F., Kolmos, A., Hadgraft, R., Holgaard, J., & Reda, K. (2023). *Reshaping Engineering Education* Springer.

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education–theory, practice and rubber sling shots. *Higher Education*, *51*, 287-314.

Illeris, K. (2015). Transformative learning in higher education. *Journal of Transformative Learning*, *3*(1), 46-51.

References 2

Jamison, A., Kolmos, A., & Holgaard, J. E. (2014). Hybrid Learning: An integrative approach to engineering education [Article]. *Journal of Engineering Education*, *103*(2), 253-273. https://doi.org/10.1002/jee.20041

Keestra, M., & Menken, S. (2016). *An introduction to interdisciplinary research: Theory and practice*. Amsterdam University Press.

Klein, J. T. (2006). A platform for a shared discourse of interdisciplinary education. *JSSE-Journal of Social Science Education*, *5*(4). (JSSE-Journal of Social Science Education)

Kolmos, A. (1996). Reflections on Project Work and Problem-based Learning. *European Journal of Engineering Education*, *21*(2), 141-148. https://doi.org/10.1080/03043799608923397

Lattuca, L. R., Knight, D., & Bergom, I. (2013). Developing a measure of interdisciplinary competence. *The International journal of engineering education*, *29*(3), 726-739.

Lobato, J. (2006). Alternative perspectives on the transfer of learning: History, issues, and challenges for future research. *The Journal of the Learning sciences*, *15*(4), 431-449.

Lobato, J. (2012). The actor-oriented transfer perspective and its contributions to educational research and practice. *Educational Psychologist*, *47*(3), 232-247.

Miles MacLeod & Jan T. van der Veen (2020). *Scaffolding interdisciplinary project-based learning: a case study, European Journal of Engineering Education, 45:3, 363-377*

Repko, A. F., Szostak, R., & Buchberger, M. P. (2019). *Introduction to interdisciplinary studies*. Sage Publications.

Routhe, H. W., Holgaard, J. E., & Kolmos, A. (2023). Experienced Learning Outcomes for Interdisciplinary Projects in Engineering Education. *IEEE Transactions on Education*, 1-13. https://doi.org/10.1109/TE.2023.3284835

Routhe, H. W., Winther, M., Nguyen, N. T., Holgaard, J. E., & Kolmos, A. (2022). Challenges for engineering students working with authentic complex problems. SEFI 2022: Annual Conference 19-22 September 2022 Barcelona,

Spliid (2011): MASTERING PROJECTS AND PROCESSES IN THE AALBORG PBL MODEL in: Davies, J., de Graaff, E., & Kolmos, A. (Eds.) (2011). PBL across the disciplines: Research into best practice. Aalborg Universitetsforlag.