



## The implementation of interdisciplinary employability skills in a futureproof materials science curriculum: a case study

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**UHASSELT**

KNOWLEDGE IN ACTION

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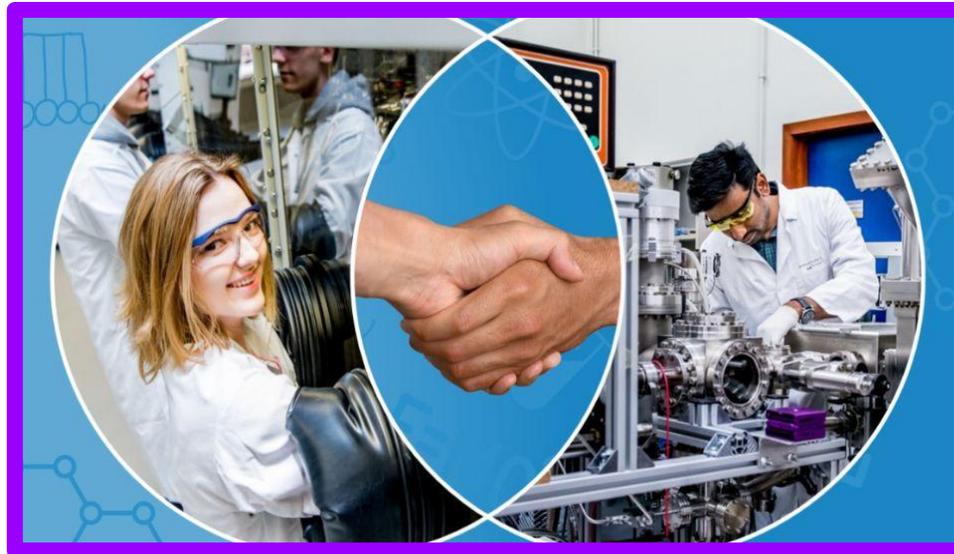
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# Outline paper presentation

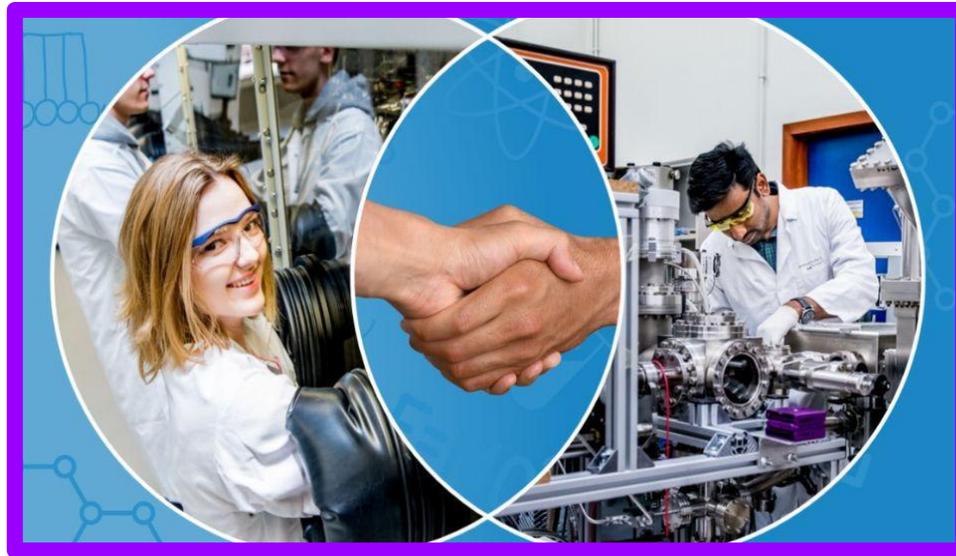
1. Context: New Master of Materiomics
2. Interdisciplinary learning line
3. Mentoring program
4. Focus groups with educational teams
5. Conclusion and outlook



# Outline paper presentation

## ▶▶ **Context: New Master of Materiomics**

2. Interdisciplinary learning line
3. Mentoring program
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5. Conclusion and outlook

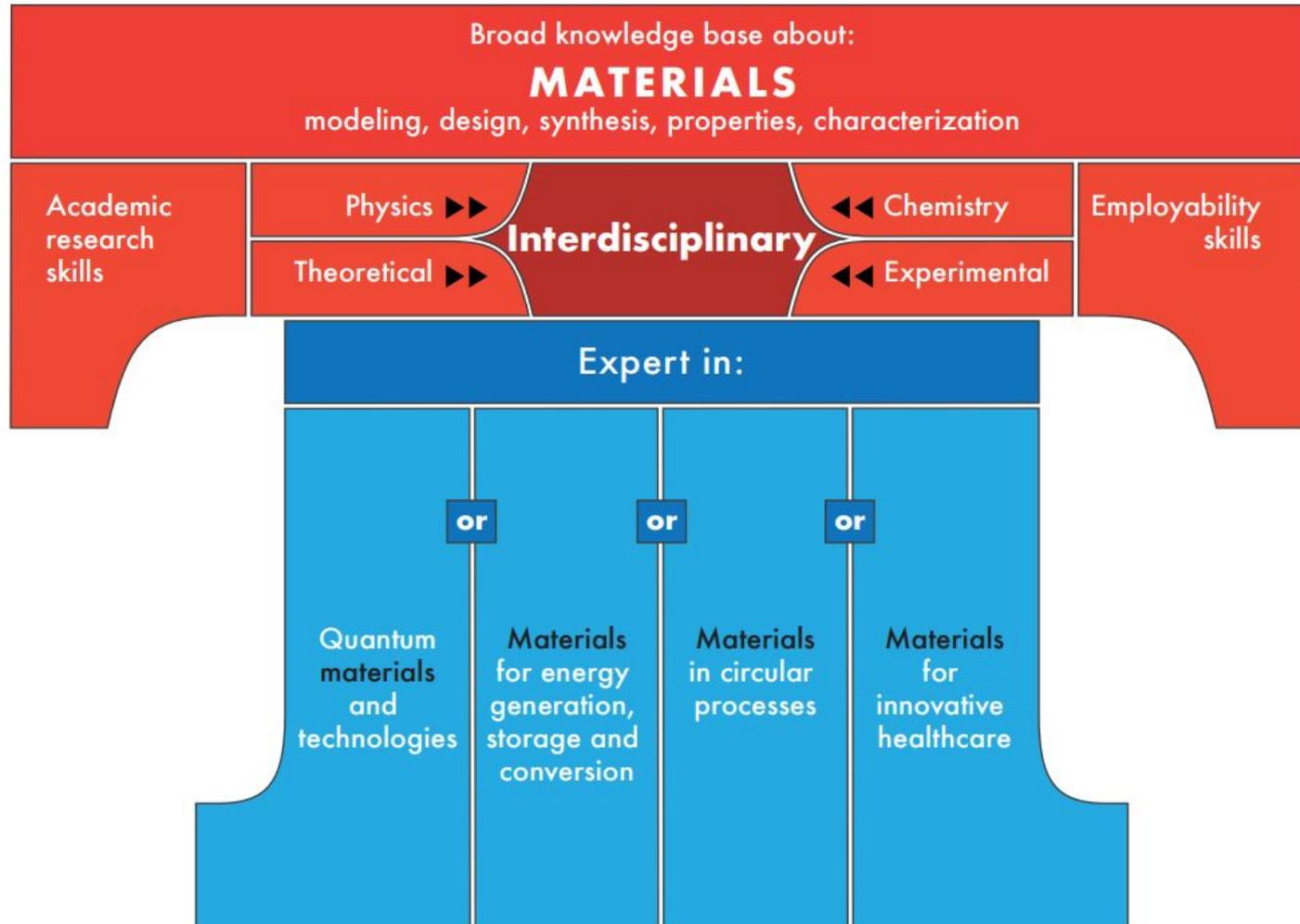


# ? Master of materiomics?

- ★ Unique combination of **chemistry and physics of materials**
- ★ Focus on sustainable and innovative functional materials
- ★ Basis of computational AND experimental approaches
  - ⇒ Interdisciplinarity to solve societal grand challenges
- ★ 4 possible areas of specialization: materials for
  - **Energy**
  - **Quantum**
  - **Circularity**
  - **Health**
- ★ Strongly embedded with research expertise of UHasselt's **Institute for Materials Research** (imo-imomec)



# Profile of the Master of Materionics: Interdisciplinary T-shaped professional



# Outline paper presentation

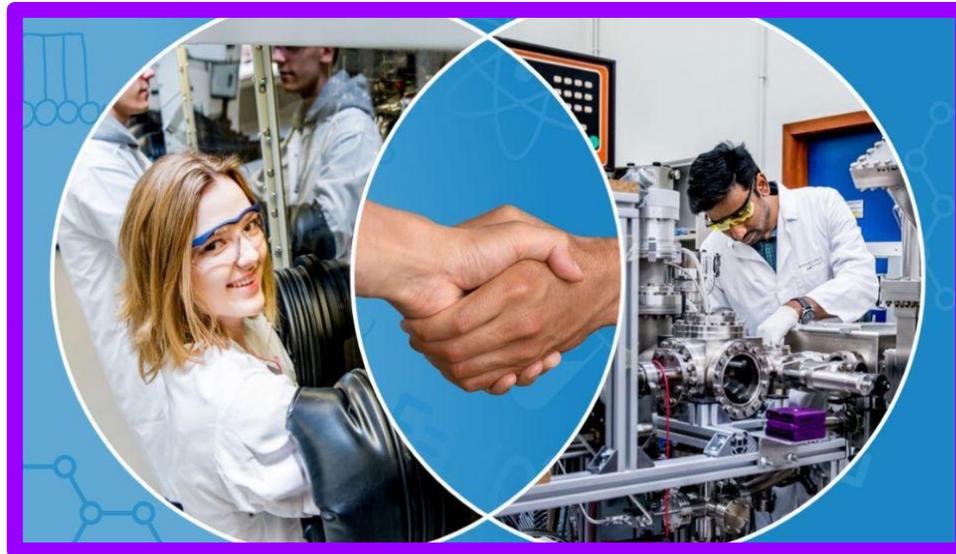
1. Context

▶▶ **Interdisciplinary learning line**

3. Mentoring program

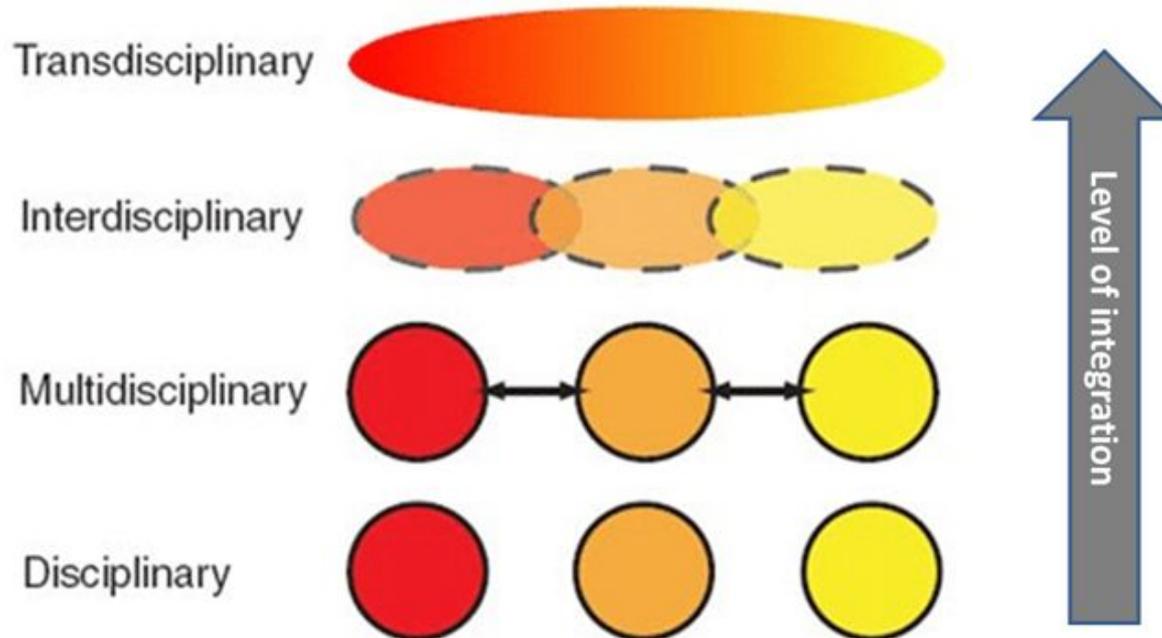
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# Interdisciplinary educational approach

## Transdisciplinary research approach



Source: <https://www.slideshare.net/PaulJCroft/education-in-a-transdisciplinary-world>

# Interdisciplinary learning mechanisms



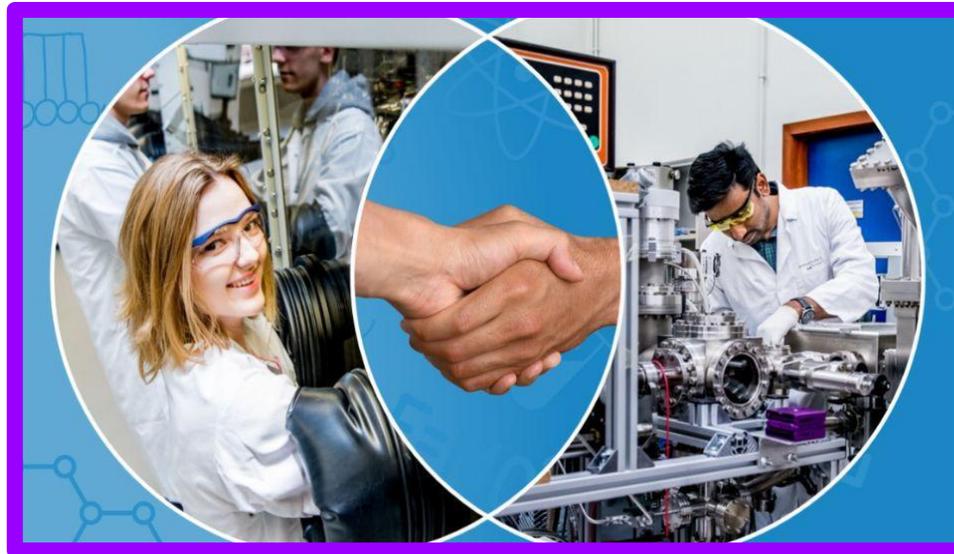
(Kluijtmans, 2019, based on Akkerman & Bakker, 2011)

# Learning mechanisms

- Identification: students are introduced to the different perspectives and approaches
- Coordination: here the focus is on making connections between the different perspectives
- Reflection : considering/learning from different perspectives
- Transformation : developing new (material) solutions by integrating different perspectives

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# Supporting development interdisciplinary competences:

## Mentor trajectory with portfolio

- Mentor = professor of the master (received guidelines)
- 3 times/year in dialogue
- Self-reflection (digital growth portfolio)
- Feedback & feed forward
  - academic skills
  - employability skills
  - interdisciplinary competences

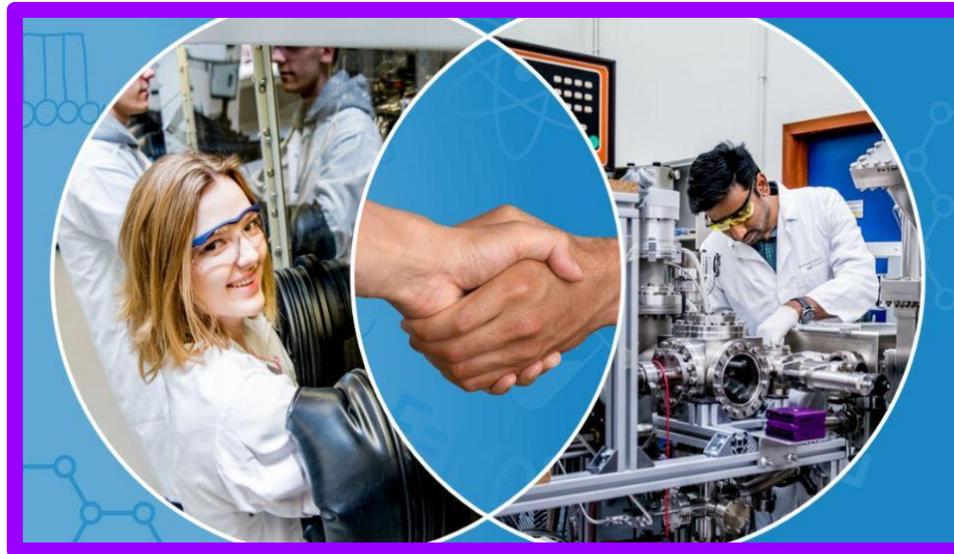
Rubric	Started	Developing	According to expectation	Competent
The student is able to relate chemical and physical concepts and methods to each other to understand materials	descriptor	descriptor	descriptor	descriptor
Interdisciplinary learning outcome 2	descriptor	descriptor	descriptor	descriptor

# Experiences students and mentors

- Students
  - not easy to prepare
  - + meeting with mentor experienced as positive
  - + sincere interest of the mentor
- Mentors
  - ~ Depending on the student (more introvert/extravert)
  - + In general positive experience
  - + Open conversation
  - + Opportunity to also discuss other topics (well-being, study load, internship,...)

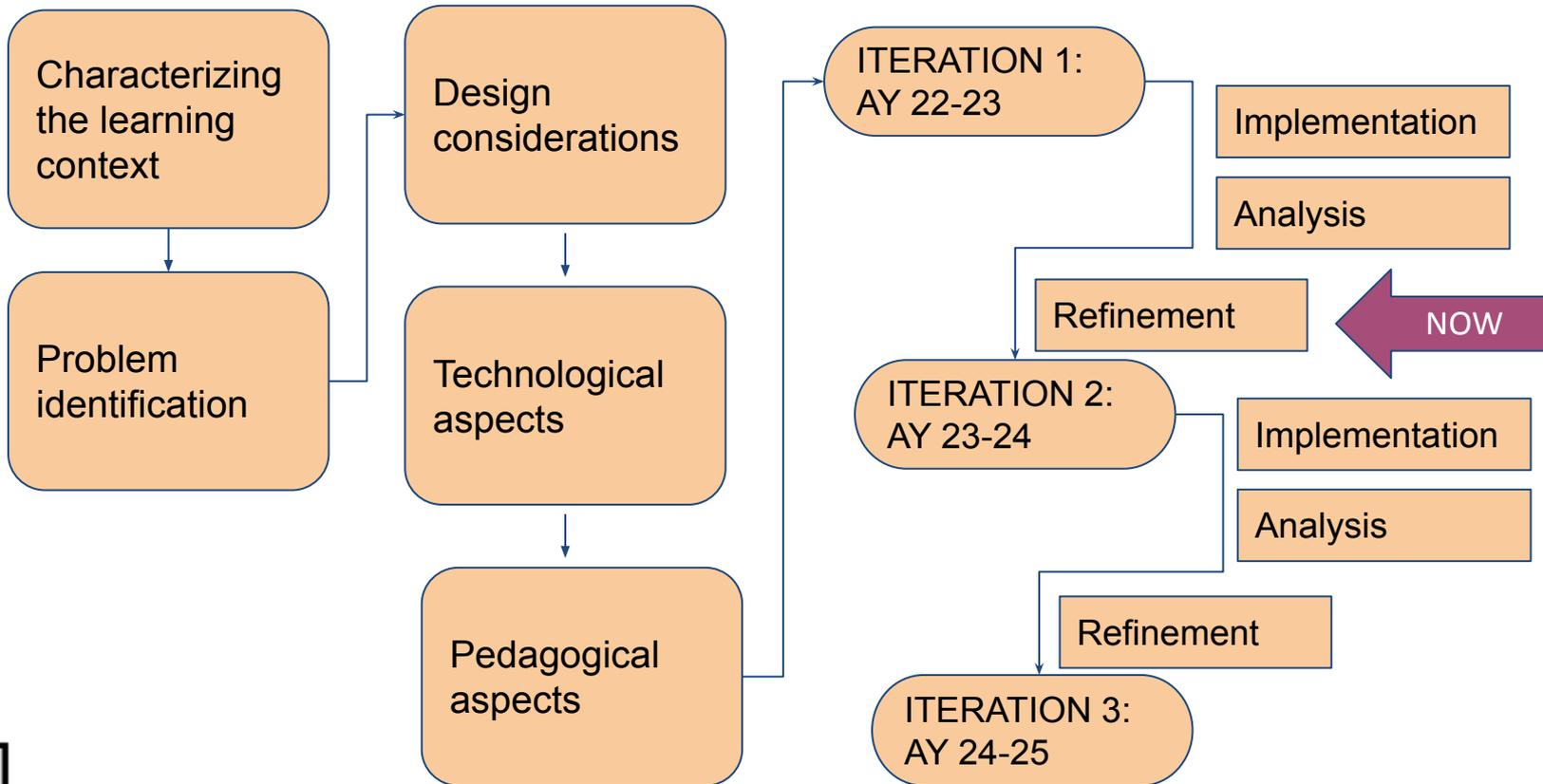
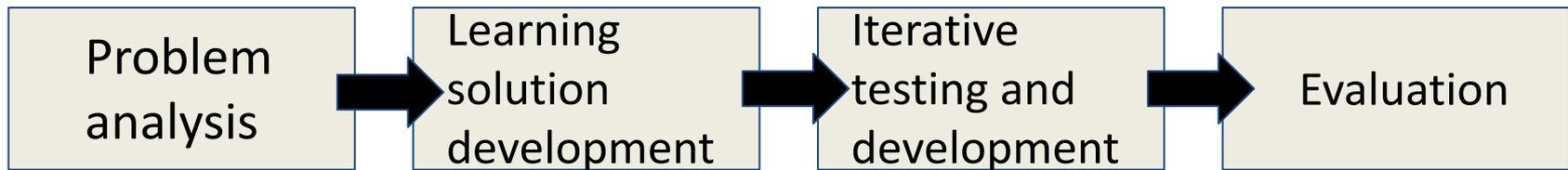
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# Design-based research process

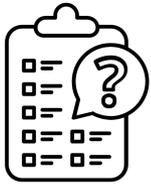
(Dissanayake et al., 2014, p. 14)



# Methodology



**Focus group interviews (total of 8) for each course of the first semester of the first master** in Materiomics, bringing together all the lecturers contributing to that specific course (min. 2, max. 6, median 4).



**Standardised set of questions about interdisciplinarity and how it is implemented in a specific course**



The interviews were held in English or Dutch



The recorded interviews were **transcribed, pseudonymised and subsequently analysed to identify recurring themes** or categories of responses



# Standardized set of questions

1. Introduction question:

Can you please explain which responsibilities you had within the course?

2. Transition question:

Can you describe your overall experience in teaching in this course?

3. Key questions:

- a. When you think about interdisciplinary education, what does it look like for you?
- b. Are you aware of the interdisciplinary approach in the curriculum materiomics and can you explain where this course is situated on this learning path? (identification, coordination, reflection, transformation)
- c. Which interdisciplinary learning goals or outcomes did you formulate for this course? What do you want to achieve with your students regarding interdisciplinarity/what will students learn in your course regarding interdisciplinarity?
- d. How did you incorporate interdisciplinary education in this course, both in teaching and evaluation? Do you have examples?
- e. What is your biggest challenge to incorporate interdisciplinary education in this course?
- f. If you see it necessary, what can be improved to incorporate (more) interdisciplinary education in this course?
- g. If you see it necessary, what kind of support would help you to incorporate (more) interdisciplinary education in this course?
- h. Did teaching in a team help/hinder you with implementing interdisciplinary learning goals? (Did you link the different modules together?)

4. End questions:

- a. Is there anything additional you would like to say about your teaching experience or interdisciplinary education in this course?
- b. Of all things discussed today related to interdisciplinary education, what do you think is the most important?



# Results

## Recurrent themes: three main categories

- (1) definition of interdisciplinary education and the formulation of course specific interdisciplinary learning goals
- (2) positioning of the courses on the interdisciplinary learning line
- (3) the interdisciplinary conceptualisation with its promoting and hindering factors



# Theme 1: definition of interdisciplinary education and the formulation of course specific interdisciplinary learning goals

“ I think there the big problem lies with the definition of what do you want to call disciplines.”

“ I am sure we had specific goals, ... , so I do not recall exactly what, which goals there were.”

“ My biggest challenge is that I don't consider myself interdisciplinary ... .”

Difficult to formulate their perception of interdisciplinary education and pinpoint the interdisciplinary learning goals connected to their course



Need for investing in **professionalisation sessions or education forums** on interdisciplinary education



# Theme 1: definition of interdisciplinary education and the formulation of course specific interdisciplinary learning goals

“*Interdisciplinary education in general would mean that you combine aspects of different disciplines within your teaching.*”



interdisciplinarity from a content perspective

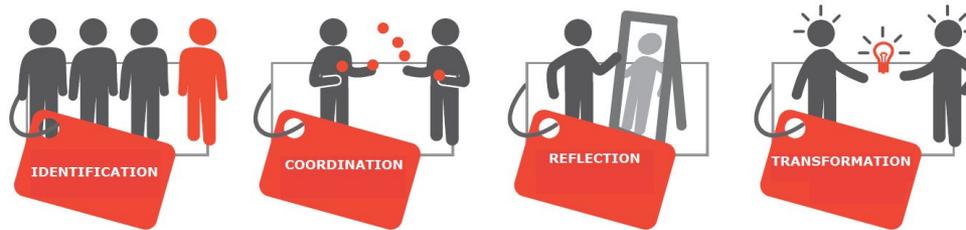
Courses at the first semester of the first master year mainly focus on **introducing disciplines, filling knowledge gaps** and getting to know the **'language'**:

“*... we should teach them enough basics, so they have antennas and can ask questions.*”

“*It is mainly the language, to allow them or to make them understand the differences between physics and chemistry. Filling the gaps in the sense that they can follow better an interdisciplinary approach where physics is a part of it. But also formulating, let's say knowledge gaps in the future.*”



## Theme 2: positioning of the courses on the interdisciplinary learning line



“That will definitely be situated at the position of **identification**. Since that the students have no background whatsoever and we are building that background in this course for a lot of different topics.”

“So they certainly did **weigh up and learn from the different perspectives**, which they actively and effectively had to do, both in preparation for the debate but also **reflecting** [um] after the outcome of the debate, and that actually got distilled into a mini-essay they then submitted.”

“... in module 2 I am also giving the same thing yet again but then from the computational point of view. So it is in there, it is the **identification but already going into the reflection** on how things are being confined and connected to different points of view.”

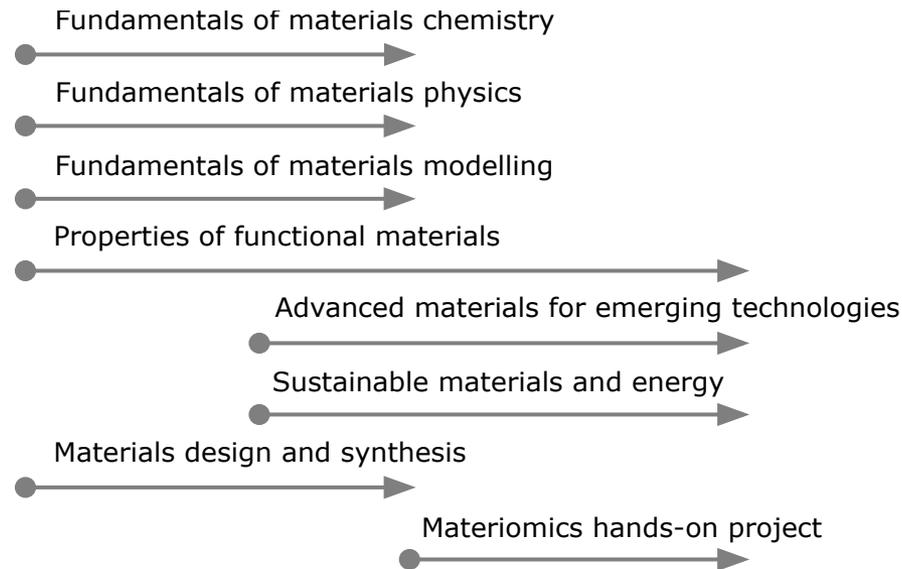
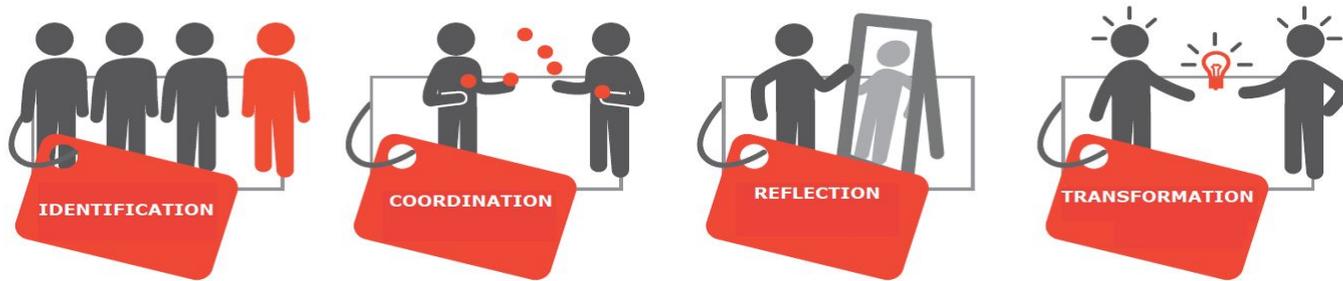
“In fact, I think **transformation** is very ambitious for a master's if they do it after their PhD, I will be satisfied already.”

In this discussion the lecturers often referred to **specific content, learning goals of the course, but also to teaching methods or practical organisation of the course.**



## Theme 2: positioning of the courses on the interdisciplinary learning line

Students **progress** during first semester of the first master year already **on the interdisciplinary learning line**



## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Expertise of teaching team

“... , I think it is because we have a team of three experts. That it is possible to teach these very different content, **different modules at a very high-quality level.**”



**Promoting factor**  
ensures interdisciplinarity related to scientific content

### Challenge

group of students having a background opposite from their own expertise



“Since I am from physics, so maybe someone from chemistry can join the exercise class that I gave to **give some comments** on the chemistry **side.**”

**TIP:** Having a good course coordinator is necessary:

“... the alignment between the different parts and the different people involved that that went well but that's partly also because the **line was made a bit on Blackboard** (electronic learning platform). Because there [um] ... everyone who was involved had an **overview.**”

## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Students' background knowledge

#### Challenge:

Variety in prior knowledge (different bachelor programs)

“ I saw a big differences in the topic that I presented there between the chemistry and physics students for sure. ... there were big differences between just **how quickly they picked up the content and how comfortable they were with it.**”

“ So they were probably lacking a few parts which maybe another chemistry student would have had. So that is what I mean that it really depends looking at **who is participating.**”

“ And it was challenging for my perspective to give a lecture to people from such a very different background. I found it a **balance between challenging them and pushing them to far**, was difficult to reach. ... So, finding that right balance, like bringing everybody along and **making sure that everyone learns something**, I found it challenging”

# Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

## Students' background knowledge

### Selecting course content

on the spot :

“ I posed the **question**, I think a 100 times “Is this new for you or not”. Depending on the answer I could focus on one thing or the other.”

prior :

“ I tried to look into the courses that the students had before. But that was mainly **to make references** to the courses and also the **use the correct jargon** or make connections between jargons when there is a difference.”

Challenging: balance content range ↔ content depth

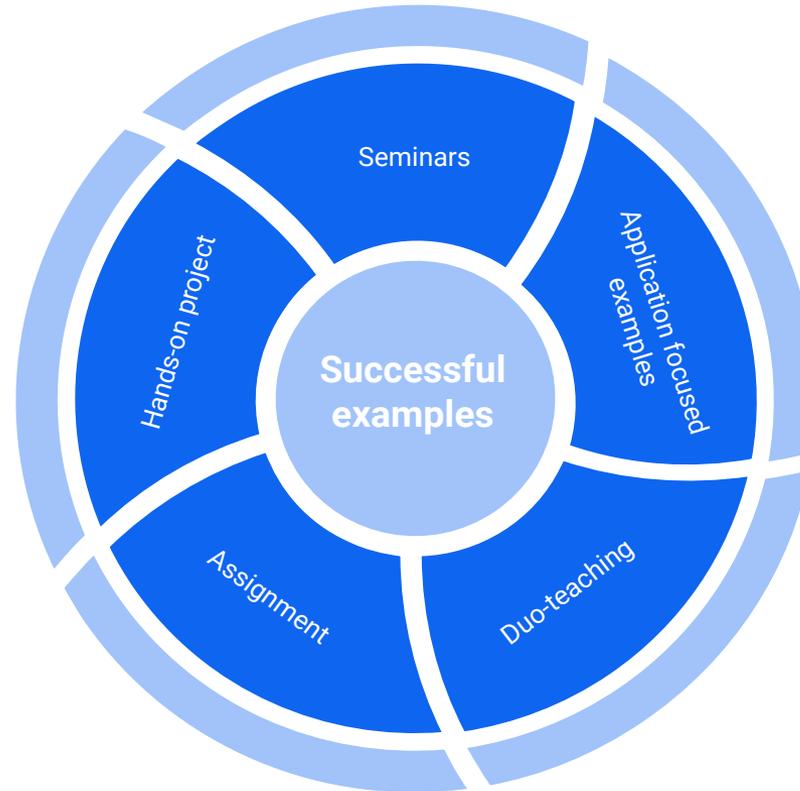


“ If you get broader than this, then two things can happen. If you combine that with a sensible level of depth then they **totally cannot handle it anymore**, then it goes too far. And if you make it broader at the cost of depth than depth wise it becomes **too trivial**.”

“ The challenge is to have **sufficient depth** but still that the slide and the courses are still **appealing for all students**.”

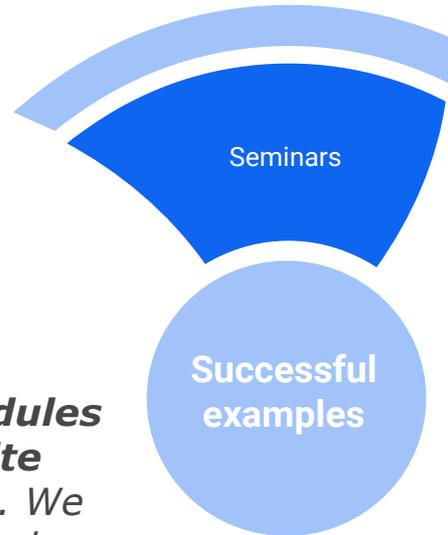
## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Bringing the interdisciplinary content in an interdisciplinary way



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### Bringing the interdisciplinary content in an interdisciplinary way



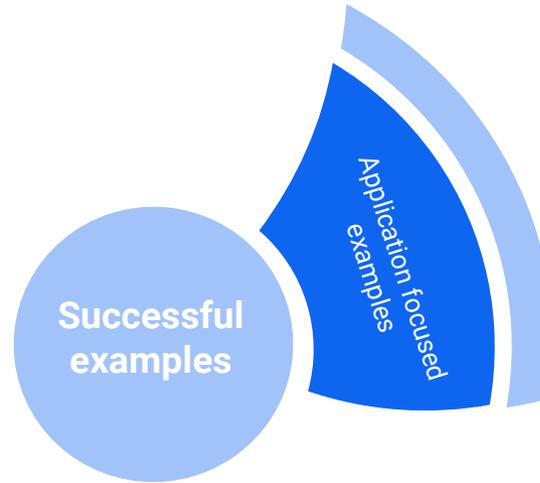
“ I think the **different modules are linked together quite well with the seminars**. We covered a fairly broad number of topics in the seminars. So really **applying the fundamental concepts** that were taught at the beginning in an interdisciplinary manner. So, all of the topics that were given in the seminars were by nature interdisciplinary.”

“ ... the other example was actually the **expert lecture**, ...”

## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Bringing the interdisciplinary content in an interdisciplinary way

“... it is very interdisciplinary with this split between fundamental concepts and then applications. So the application are really **putting all the concepts together**, I see that as the interdisciplinary aspect of the course”



## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Bringing the interdisciplinary content in an interdisciplinary way

“... in certain moments or contact moments effectively interaction between different people, **between different teachers at that time, at the same time in that work session**”

“Basically, [professors name] and me were **in the same classroom** and we talked about [scientific content], first from the physics stand-point, mine, and then [professors name] from chemistry stand-point”

“For example, through that **joint exercise session** between [professors name] and me. Because we had the intention there, yes, to present a problem where they had to **bring together both the physics side**, or what they had learned with the physics professor, and **what they had learned with me** (for your information: chemistry side)”

Successful examples

Duo-teaching

“... that you have a **supervisor from chemistry and a supervisor from physics**, that that actually works very well to let those students **see both aspects.**”

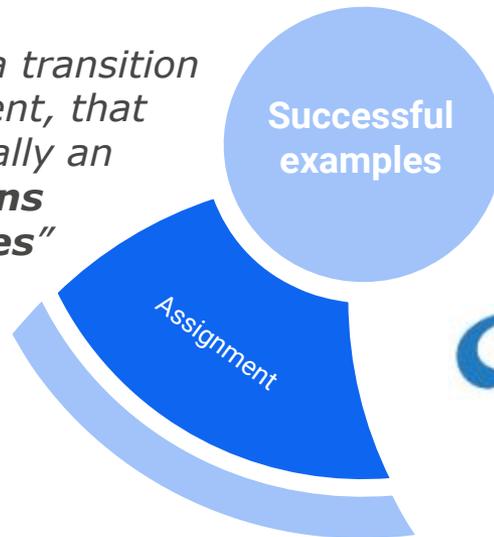


## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Bringing the interdisciplinary content in an interdisciplinary way

“After each module the students had to **read the same paper again and again and each time they got questions** and these questions came from both physical and chemical backgrounds.”

“But there is actually a transition there in the assignment, that debate sheet, is actually an **assignment that runs through the modules**”



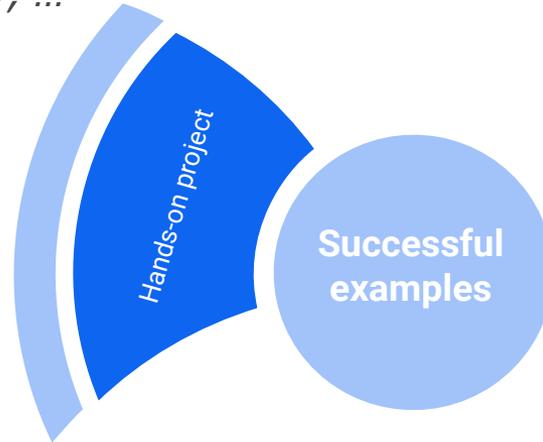
“And they had [um] a paper task on [scientific content] so there they could also **incorporated the knowledge on the different modules** they gathered along the way.”

## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

### Bringing the interdisciplinary content in an interdisciplinary way

“... , this project, this course, I think this is one of the **best methods of getting it interdisciplinary**, ...”

“... each group contained 1 chemist and 1 physicist ...”



“... how you have organised it now with those **two supervisors** in the end, that you have a supervisor from chemistry and a supervisor from physics, that that actually works very well anyway to let those students see both aspects.”

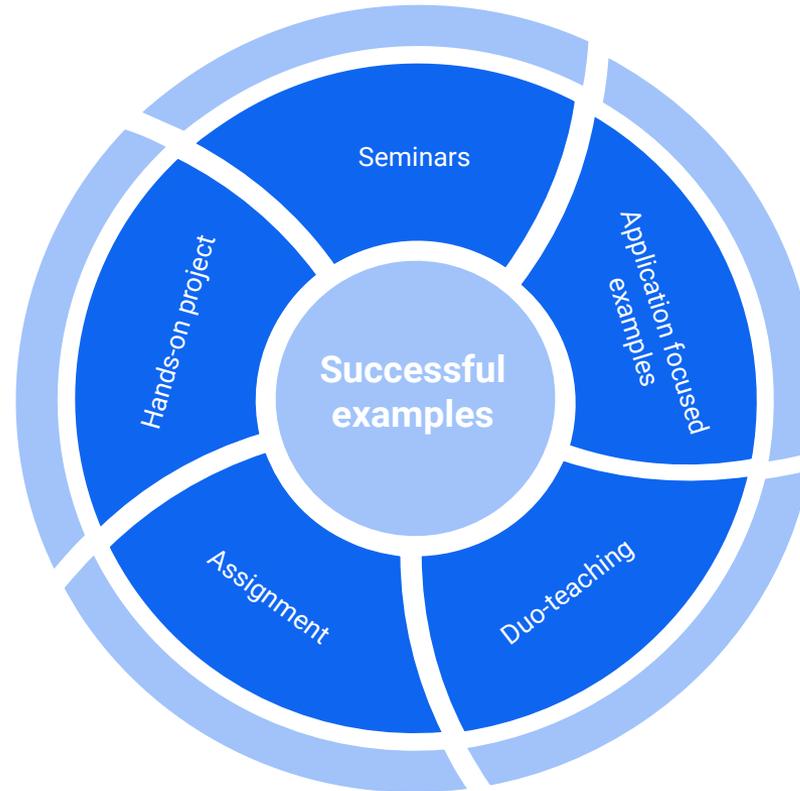
“... that they have to **write a report together**, that together they have to arrive at the result they both need, for that they have to **communicate** with each other, **understand** each other, and yes, and in the end they both have to understand the report plus they have to **present** it again to the others who then also ideally have to understand it.”

“... during the presentation you might be able to assess that they can **both answer questions both on the physical and chemical part** ...”

“... and they **work in two labs** ... [for your information: chemistry and physics lab]”

# Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

## Bringing the interdisciplinary content in an interdisciplinary way



## Theme 3: the interdisciplinary conceptualisation with its promoting and hindering factors

**Success depends on student's willingness to submerge themselves in the interdisciplinary way of thinking**

“...at one point the physicist had a little bit more knowledge about the topic than the chemist and vice versa and then it was very nice to see that they were **explaining each other** in the context”

“...it was definitely not a one-way street”



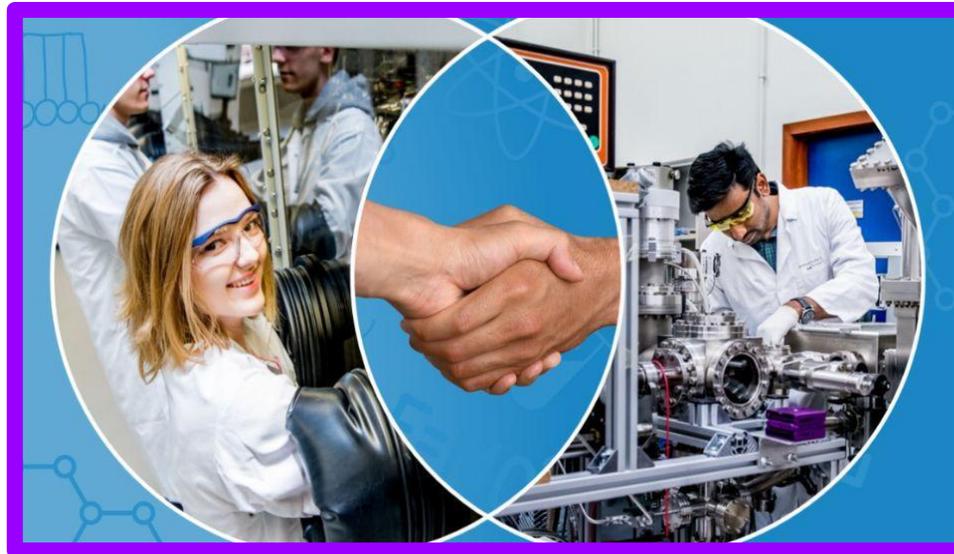
“What I also noticed, I was really surprised by that, is how **open these students were to this other discipline**. And probably this has to do with the fact that they **consciously chose Materiomics as a study**. I think if we had told this story in a traditional physics course, we wouldn't have had quite this much resonance”

“If they start this course with a **certain biased attitude** from their own discipline, it cannot work here, it is impossible. Then they won't be motivated to immerse themselves in a certain role, ... , to actively look for things, to have their own thoughts about it, ... If they don't do that, or start with a certain bias, this ... can **fail** or be much **less qualitative** anyway.”

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# Conclusion

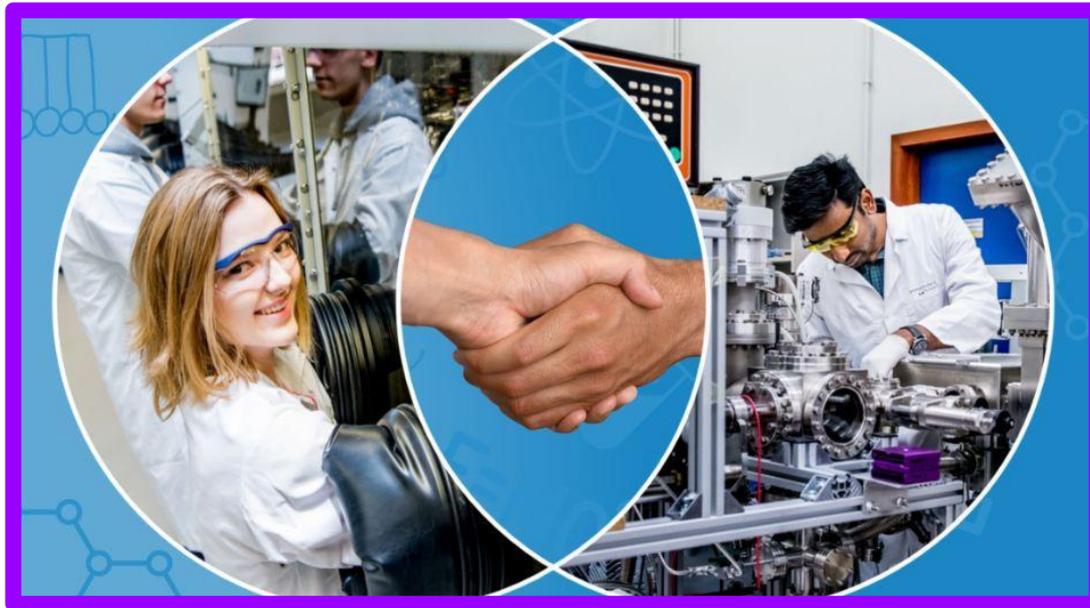
- So far, so good
- Importance of monitoring the **implementation of the interdisciplinary learning line**
- **Design-based research** to improve interdisciplinary boundary crossing further in the curriculum
  - Focus group of all courses
  - Feedback on mentoring trajectory
- In co-creation with students and lecturers

# Where to next? Materiomics...

- Supporting implementation through **design-based research** and **feedback** from students and teachers
- **Teacher professionalization** and exchange of good practices on the subject (within and outside the program)
- **Facilitating interdisciplinary teacher teams, development of interdisciplinary courses and methodologies** (e.g., applying design thinking (Melles, 2020); workshops that support the four boundary crossing learning mechanisms; Oonk, Gulikers, den Brok, & Mulder, 2022), **tools related to the evaluation of interdisciplinary competences** (Gulikers & Oonk, 2019),...

# Do you have questions? suggestions? ...

## Thank you!



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# Further reading

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research, 81*, 132-169.

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