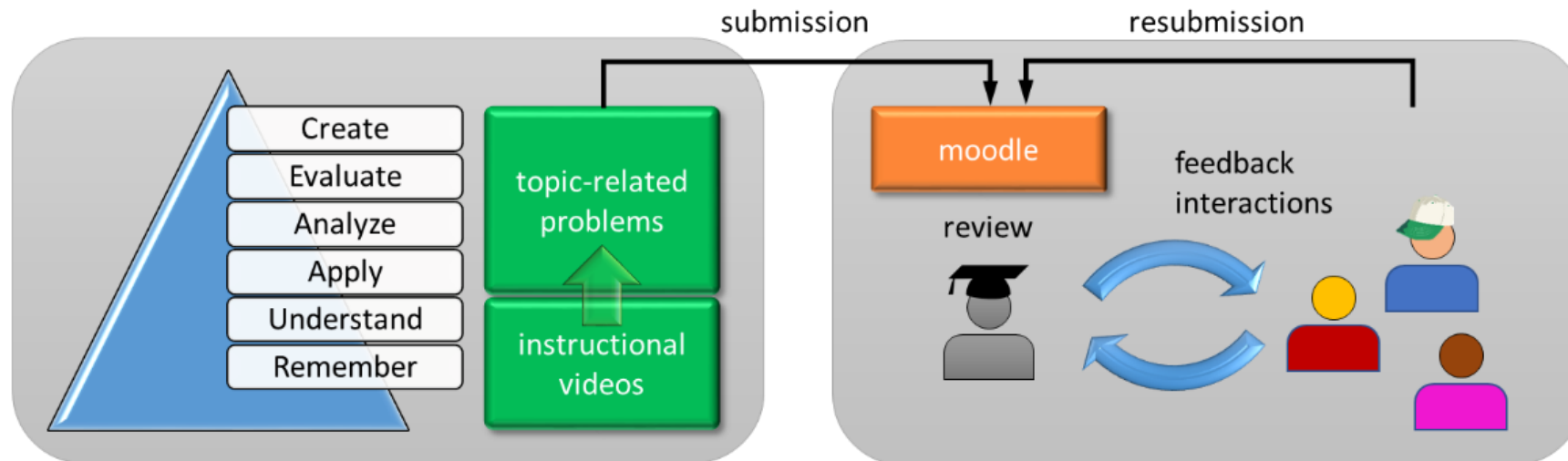


On embedding a traditional mechanical engineering course in a constructivist learning environment

Thorsten Bartel



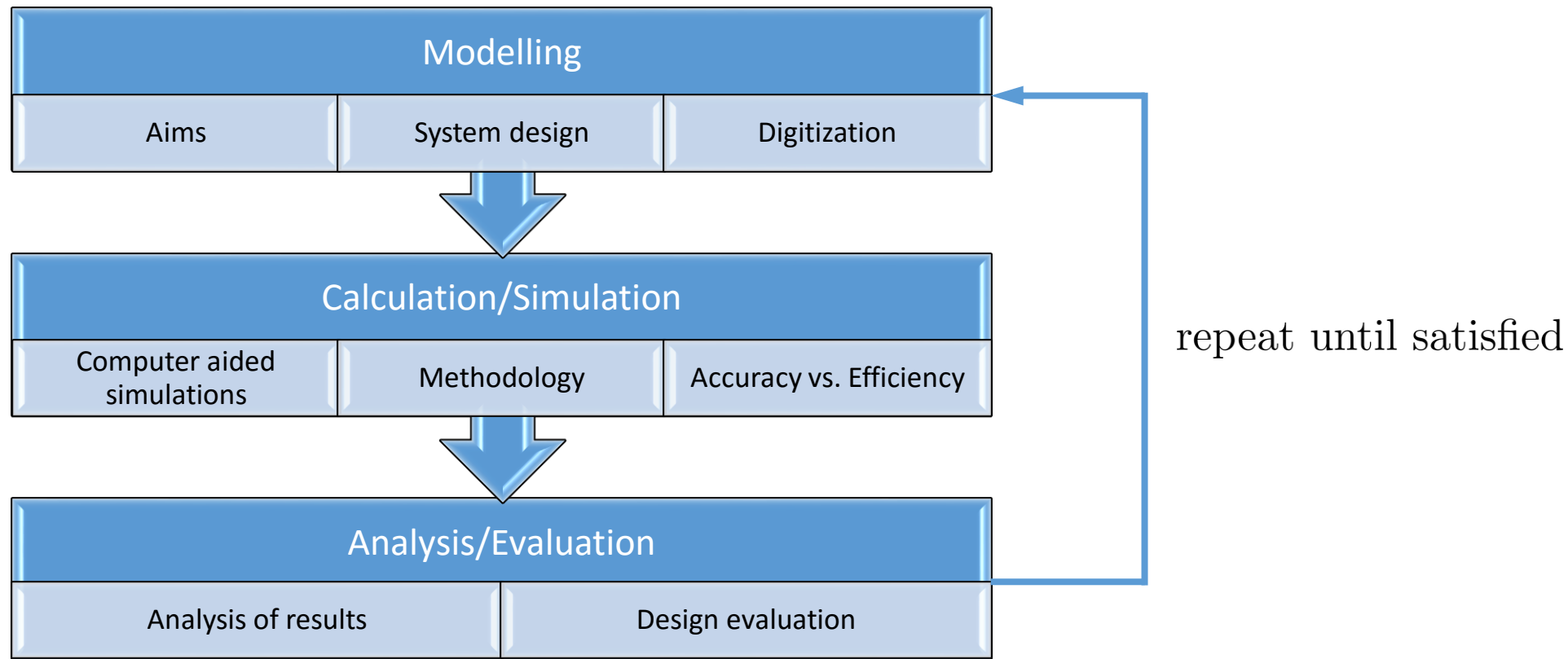
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Motivation

Why do we need constructivist learning environments in engineering education?

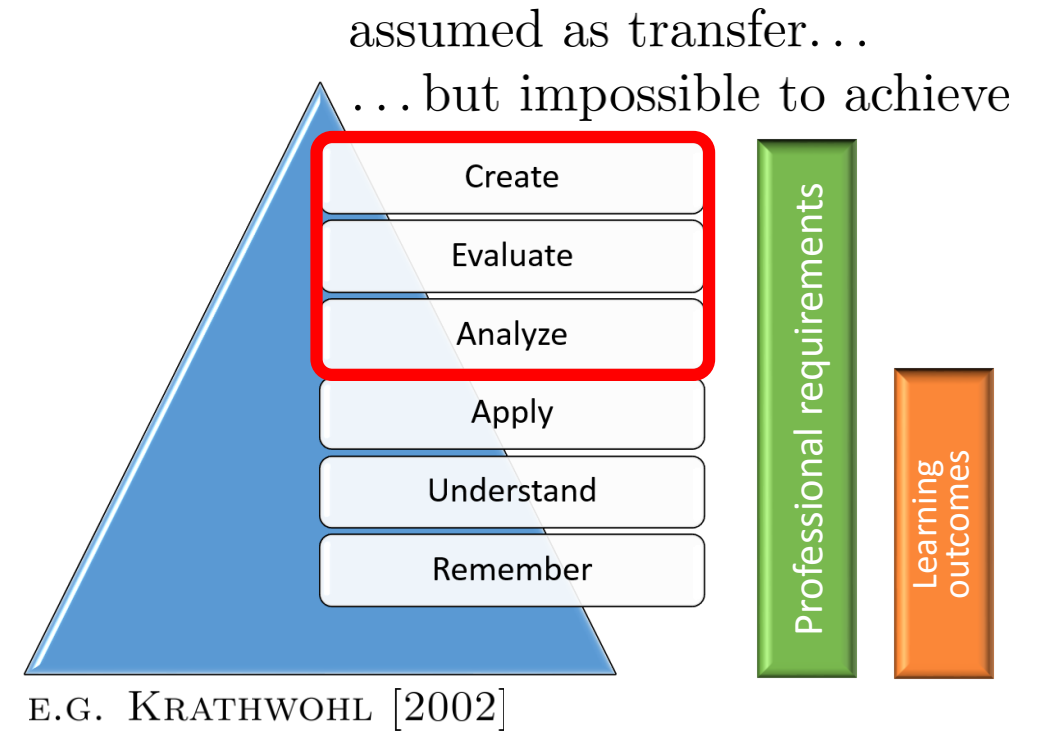
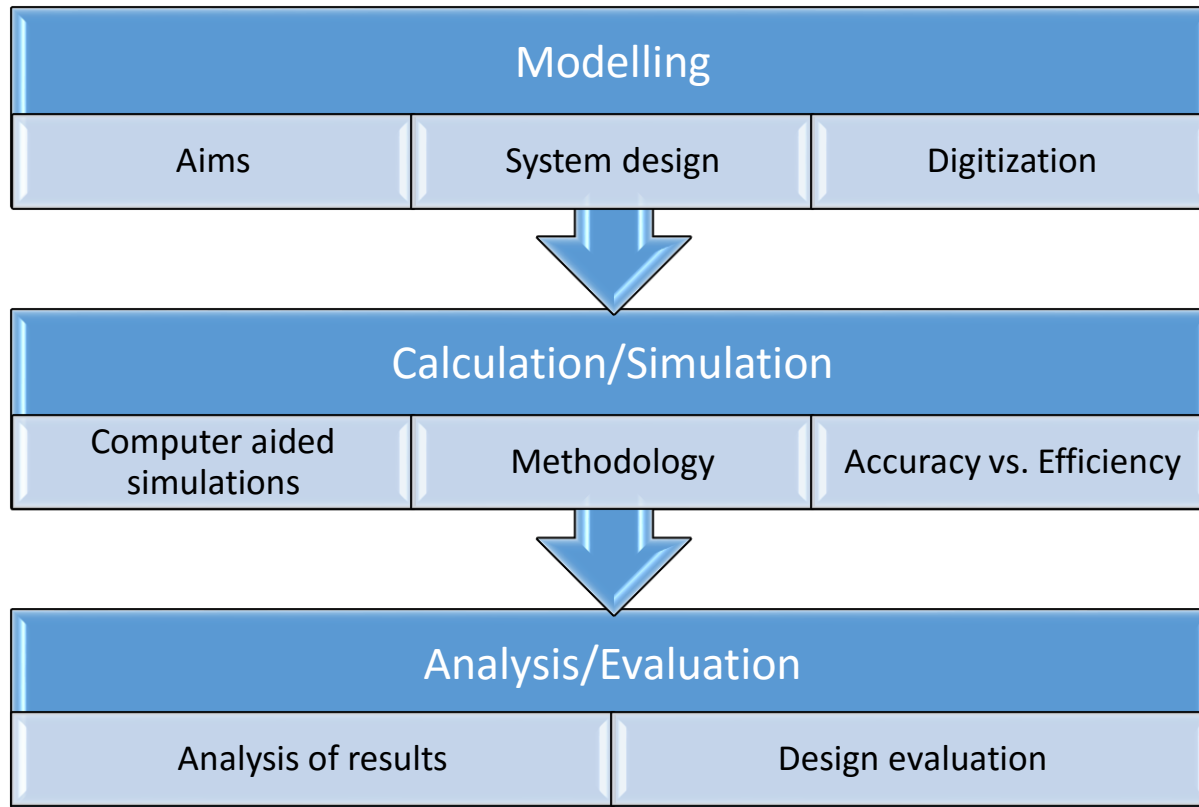
Challenges in engineering

Important steps in the solution of engineering problems



Challenges in engineering

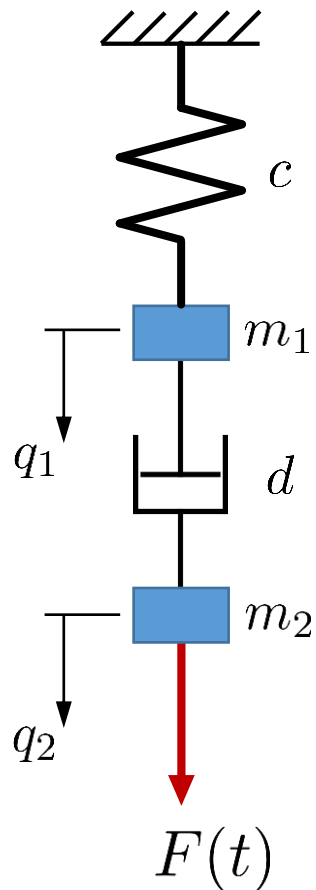
Important steps in the solution of engineering problems



Methodology and implementation

How to embed a traditional mechanics module into a constructivist setting?

“Machine Dynamics”



Main shortcomings of the former concept:

- classic monologue lecture
⇒ most students were left behind
- classic monologue exercises, presentation of sample solutions
⇒ students just learn how others would solve the problem
- considered systems without reference to real problems
⇒ abstract
- focus on manual calculations (by hand)
⇒ inefficient, questionable competence

Adapted teaching content

Expansions of the core content:

- Explicit consideration of modeling and real engineering systems
- Consideration of more complex problems
- Integration of programming languages
⇒ solution of complex equations, illustration of results, ...
- goal-oriented use of computer programs
⇒ efficient, competence-oriented



Image from https://commons.wikimedia.org/wiki/File:Plate_compactor.jpg. Copyright CC BY-SA 3.0.



Image from [https://commons.wikimedia.org/wiki/File:Wind turbine construction, Pougy, E10-01.jpg](https://commons.wikimedia.org/wiki/File:Wind_turbine_construction,_Pougy,_E10-01.jpg). Image cropped to the area of the tower. Copyright CC BY-SA 4.0.

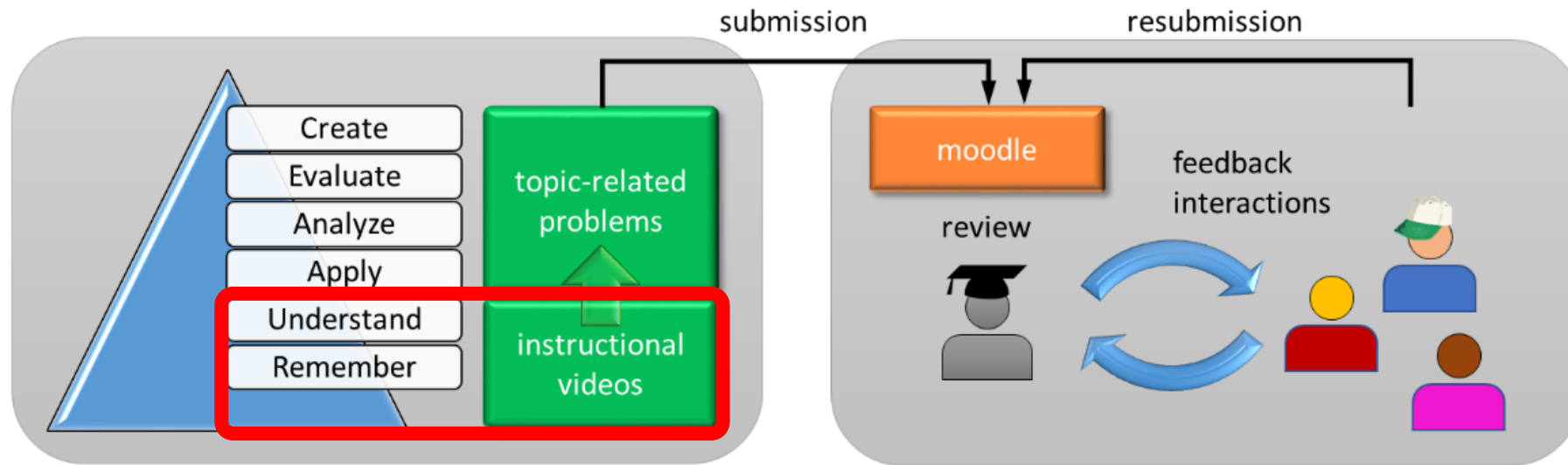


Courtesy of Svenja Drücker, Institut für Mechanik und Meerestechnik, TU Hamburg.



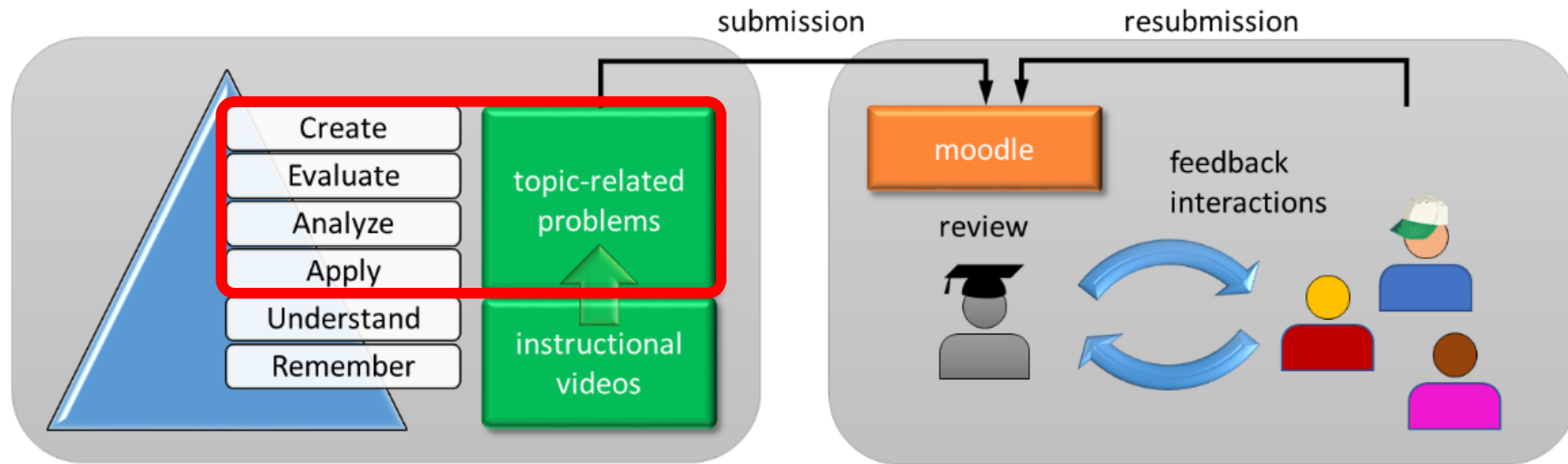
Courtesy of Fooke GmbH

Core concept



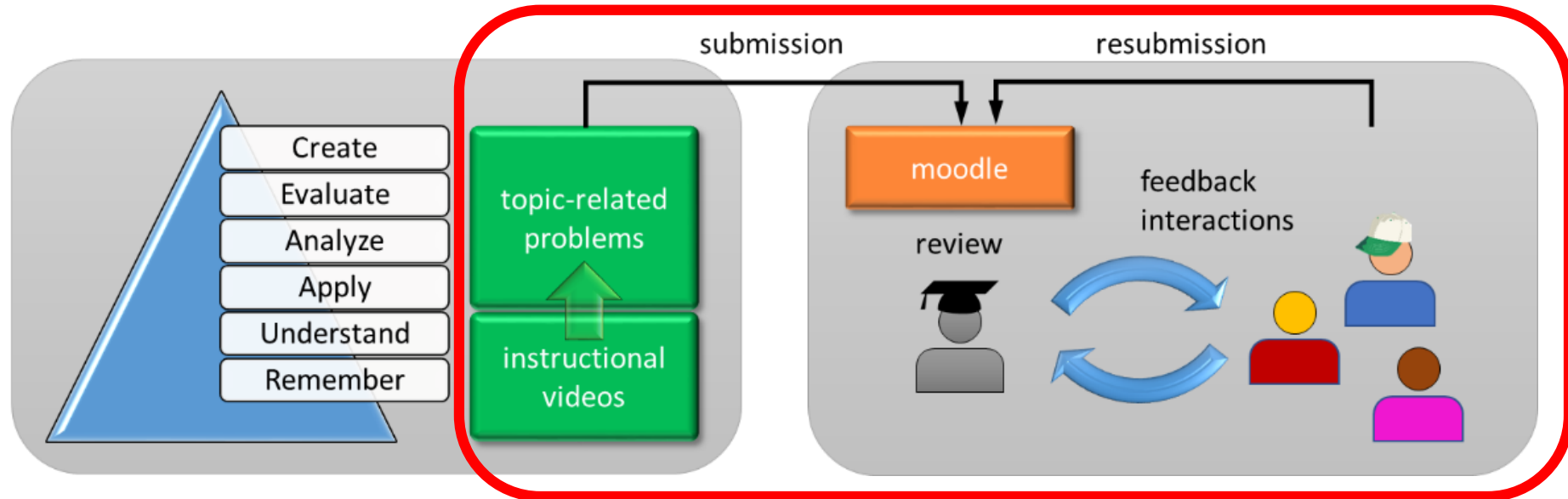
1. **Instructional videos** (total duration: ≈ 5.5 h)

Core concept



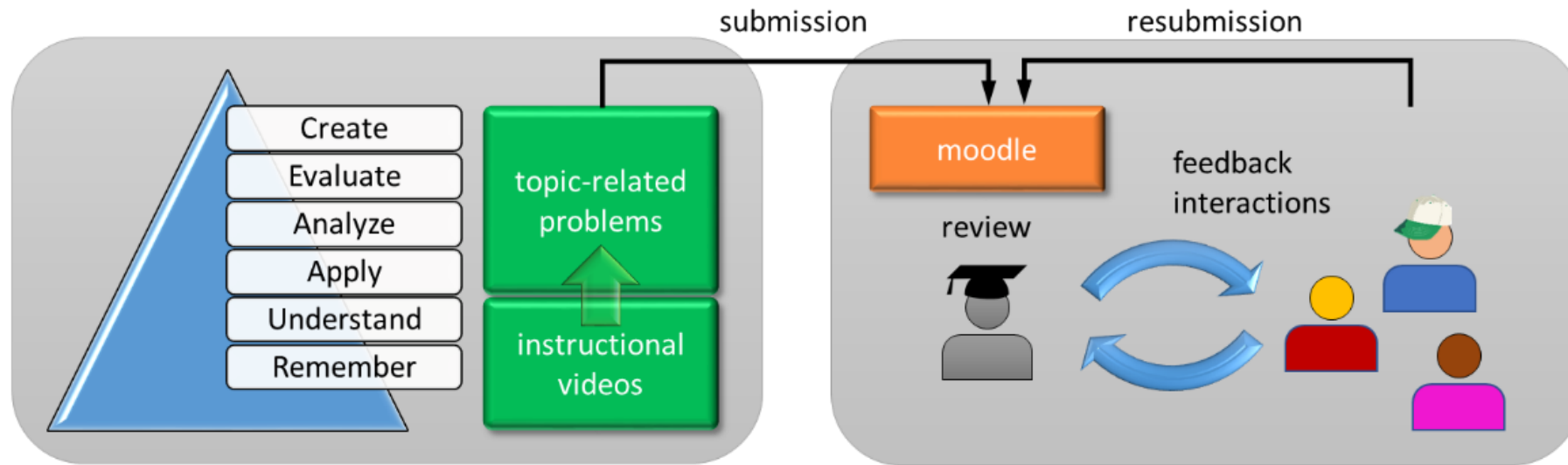
1. **Instructional videos** (total duration: ≈ 5.5 h)
2. extended by **topic-related problems**

Core concept



1. **Instructional videos** (total duration: ≈ 5.5 h)
2. extended by **topic-related problems**
3. supported by **feedback concept**

Core concept



1. **Instructional videos** (total duration: ≈ 5.5 h)
2. extended by **topic-related problems**
3. supported by **feedback concept**

No sample solutions were issued!

Data collection and evaluation

How was the new concept received by the students?

Teaching evaluation – Selected feedback

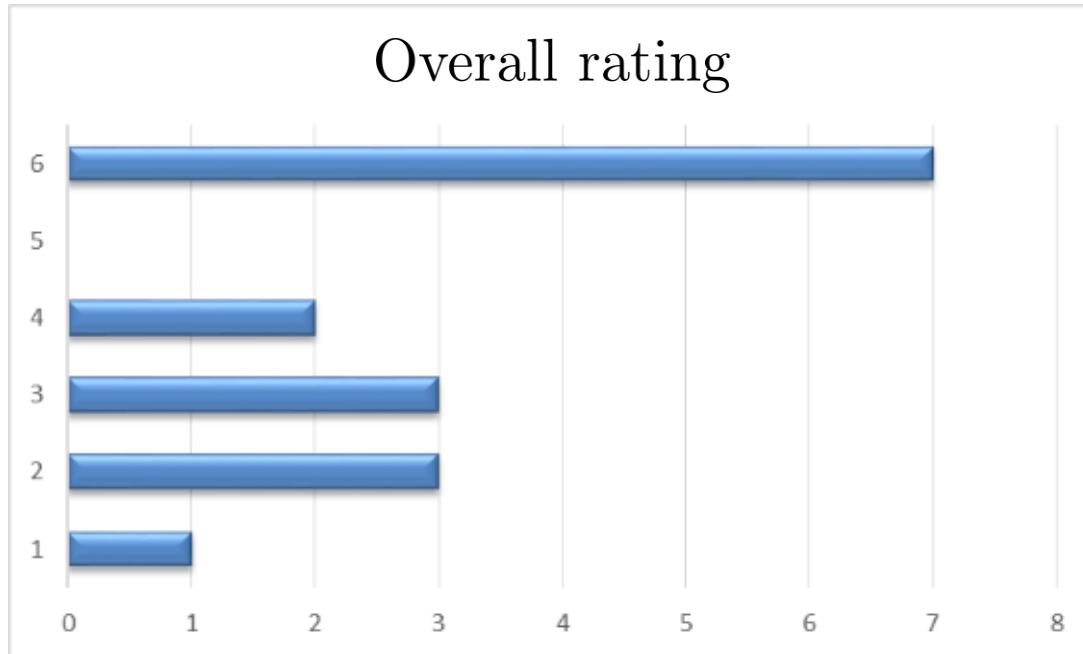
Pros:

- flexible time management
- respectful interaction
- Screencasts: well produced, compact, interesting, understandable, available at any time
- “The presence of the tutors who really help with everything and give advice”
- Meaningful competence enhancements

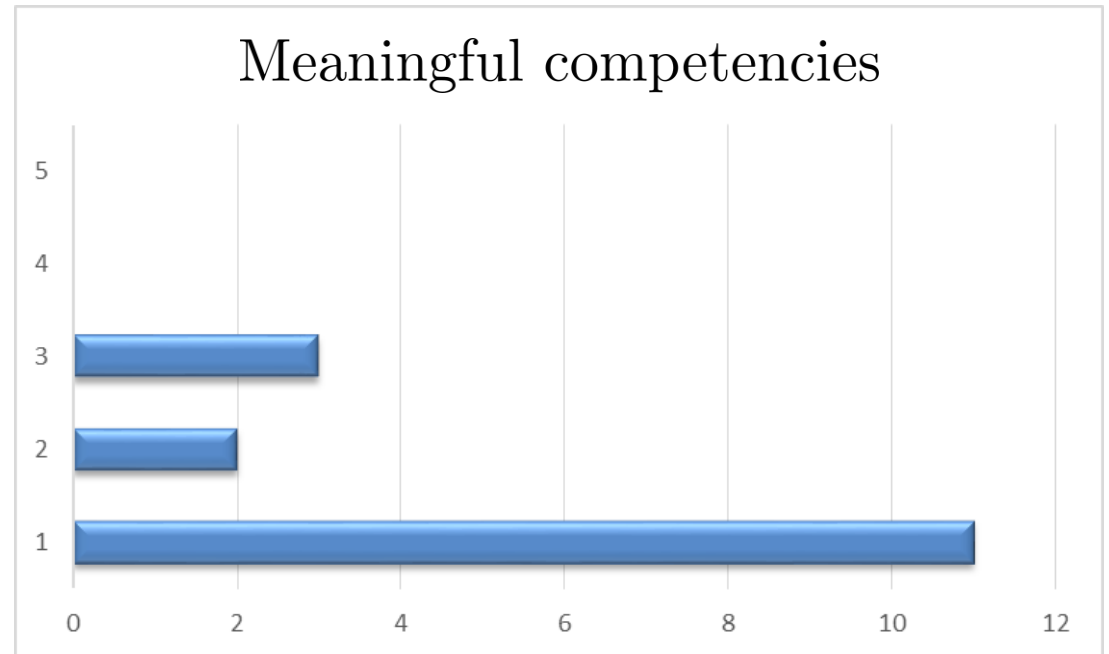
Cons:

- More material, sample solutions
- Instructional videos do not build enough understanding
- The effort is out of all proportion
- “Simply shifting the responsibility of teaching onto students is not good teaching!”
- “At least the tutor was the savior”

Teaching evaluation – Selected feedback



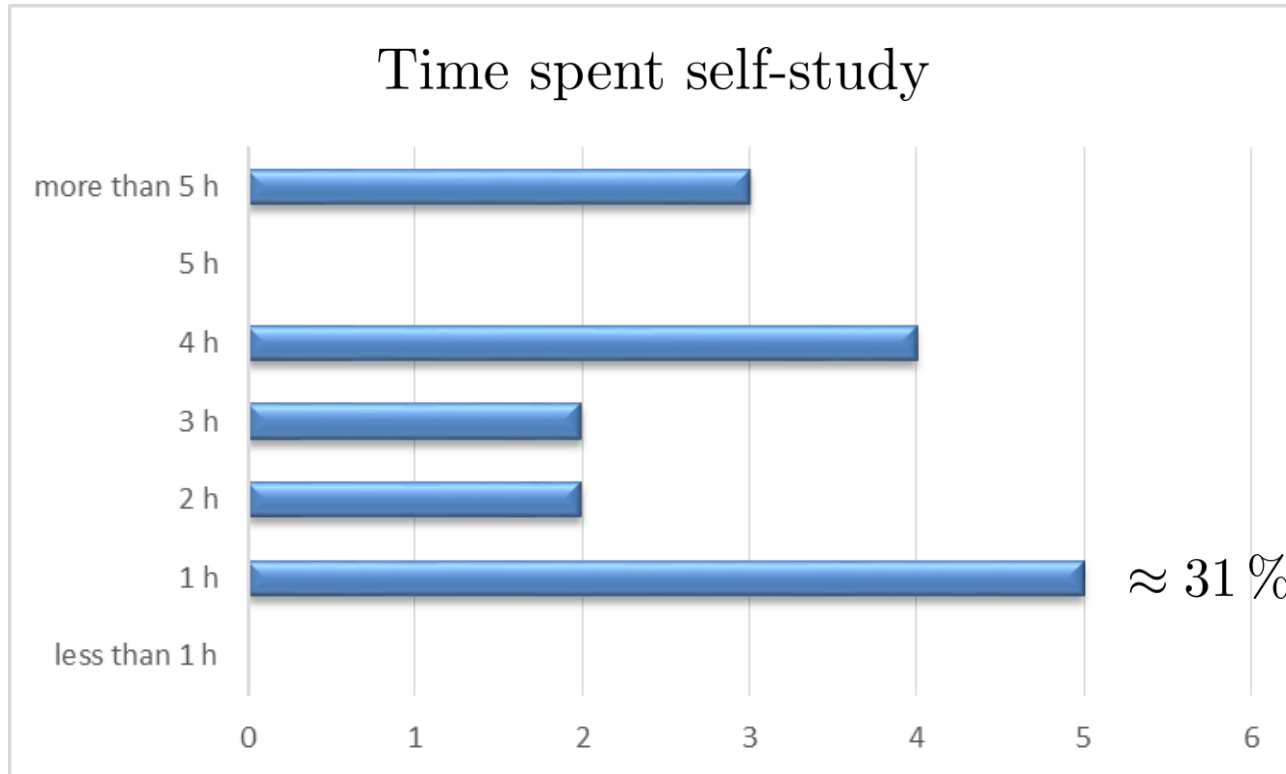
1: very good ... 6: insufficient



1: applies without restriction ...
5: does not apply at all

Remark: Very few took part in the survey ⇒ not necessarily representative

Teaching evaluation – Selected feedback



} $\approx 44\%$ } $\approx 56\%$ } $\approx 81\%$

Remark: Very few took part in the survey \Rightarrow not necessarily representative

Conclusion and outlook

Personal Retrospective

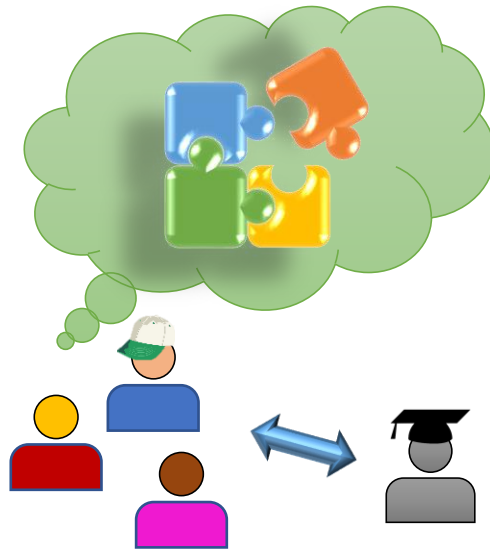
- In engineering education, we often waste far too much time...
- ...on just imparting knowledge (taxonomy levels 1 or 2)
- ...on unnecessary and redundant content
- ...and questionable (as outdated) competencies.
- Focus: competence-based and future-oriented learning outcomes
- This contribution:
 - Practical example of the implementation of sophisticated concepts
 - Unfortunately, this is still rather an exceptional case and hopefully also an incentive for other lecturers

Conclusion and outlook

- The path taken is heading into a promising direction
- 50% already recognize and appreciate constructive learning environments
- 50% express harsh criticism
- All students agreed that very important competencies are acquired
- Students must be accustomed to the fact that self-study is the main component of studying
- TO DO:
 - Sort out the teething problems of the new concept
 - Convert the summative exam to a project-based formative format.

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Acknowledgments

- Lars Rose, Hendrik Wilbuer: support for the re-design and as tutors
- Tobias Haertel, Silke Frye and Joshua Grodotzki: my coaches in the field of didactics
- Association of Applied Mathematics and Mechanics (GAMM): establishing a technical committee on didactics

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