

# Designing a master level course from scratch – *where to start and how to proceed?*

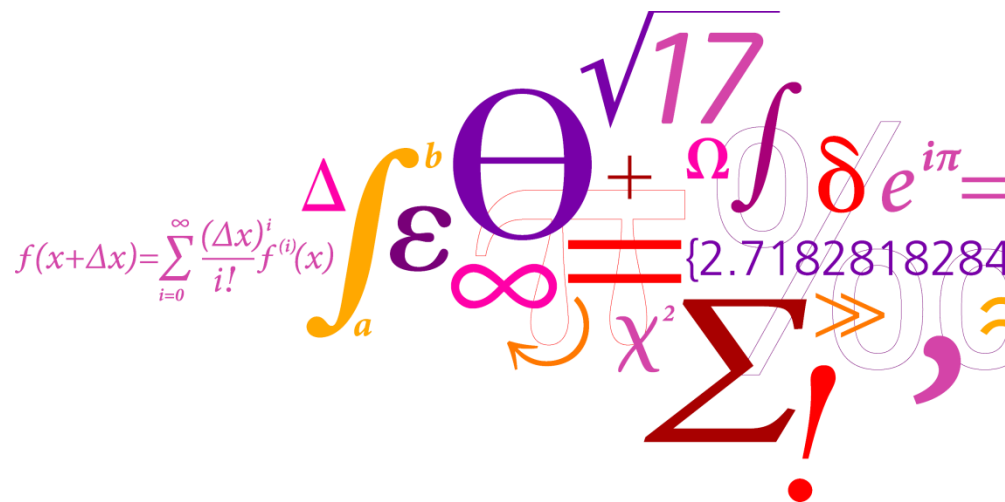
## Experience from course 31783

*DTU Biennial for Teaching & Learning (17-11-2016)*

*Mattia Marinelli, Researcher ([matm@elektro.dtu.dk](mailto:matm@elektro.dtu.dk))*

*Center for Electric Power and Energy*

*DTU Risø Campus*



# Content

- The importance of the learning objectives with reference to course design
- My approach in designing course 31783 (Integration of wind power in the power system)
- Course content, teaching methods and student assessment
- Discussion points... back to learning goals and course design

# About me

- **Research areas**

- transmission and distribution networks modeling;
- wind and solar power integration analysis;
- distributed generators and electrochemical storages modeling;
- demand side and electric vehicles management;

- **Working at DTU as postdoc/researcher since 2012** (and responsible for course 31783 since 2014)

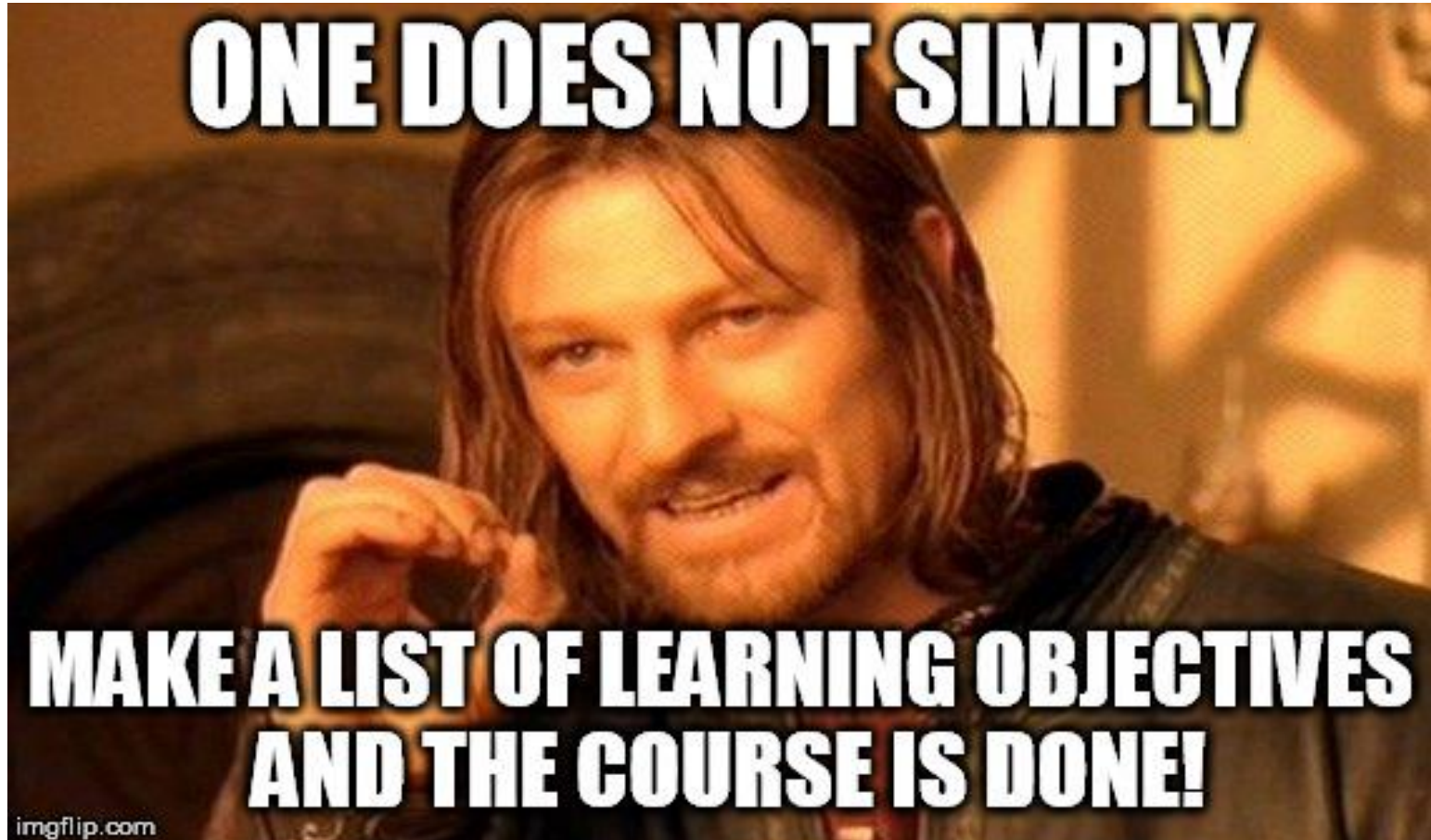
- **Education in electrical engineering – specialization in power systems**

- Ph.D. (2011), M.Sc. (2007), B.Sc. (2005) from University of Genova, Italy

# The importance of learning objectives

- What are the **most important concepts** (ideas, methods, theories, approaches, perspectives, and other broad themes of your field) that students should be able to **understand, identify, or define** at the end of your course?
- What would constitute a "firm understanding", and **how would you assess this?**
- **What questions should your students be able to answer at the end of the course?**
- What are the **most important skills that students should develop** and be able to apply in and after your course (quantitative analysis, problem-solving, critical thinking, asking questions, knowing how to learn, etc.)?
- How will you help the students build these skills, and how will you help them **test their mastery of these skills?**

<https://vptl.stanford.edu/teaching-learning/teaching-practices/evaluation/stanfords-new-course-evaluations/writing-learning>

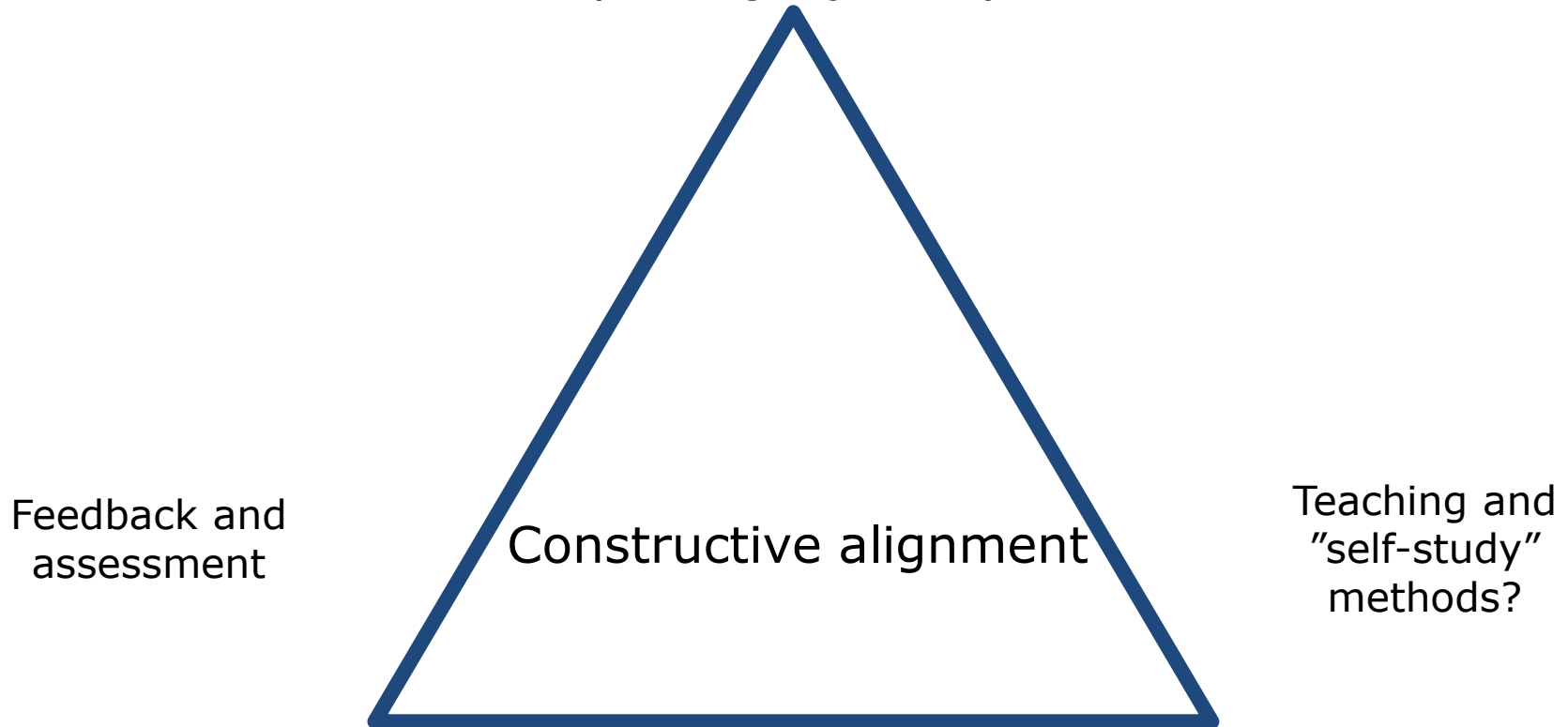


# Learning Objectives



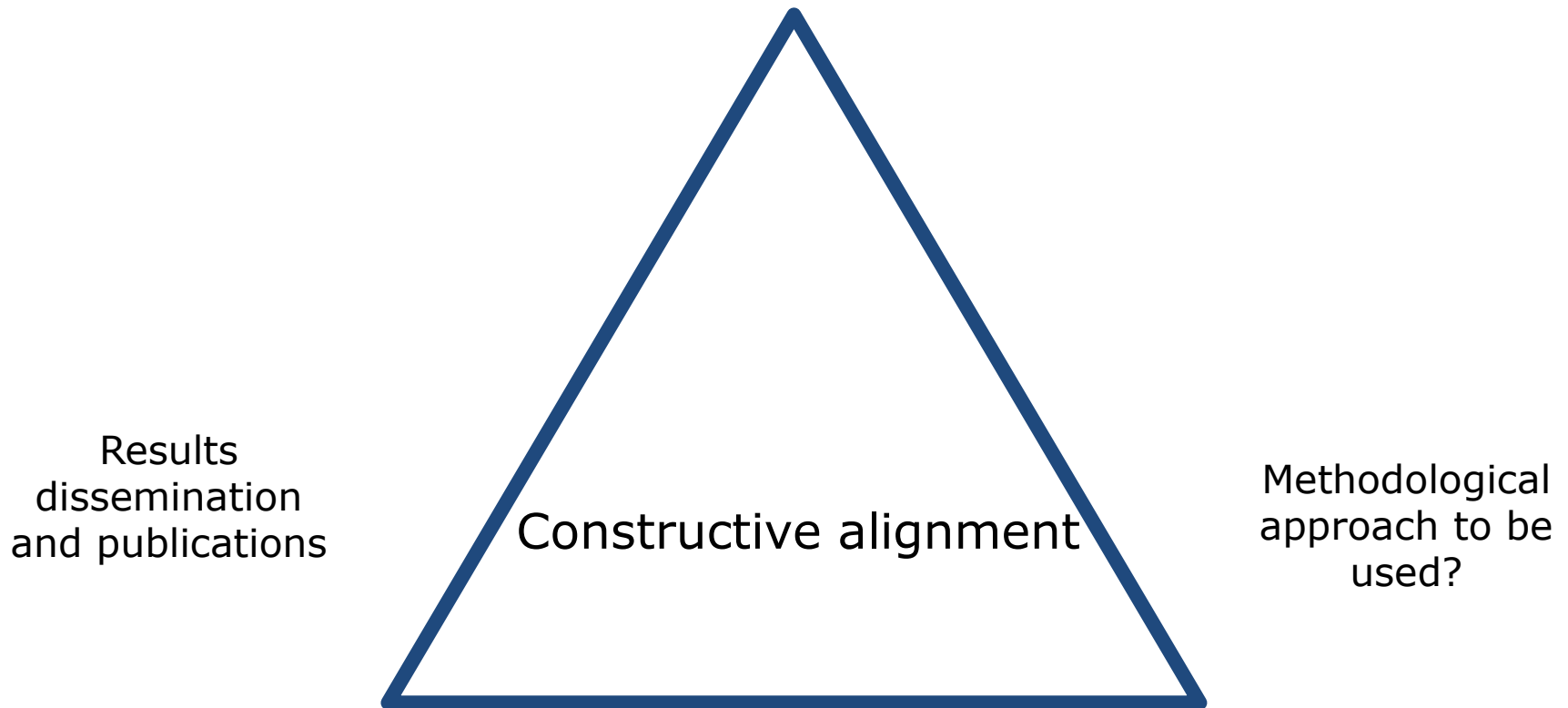
# Constructive alignment

What will students be capable of doing  
after having completed this course?  
(learning objectives)



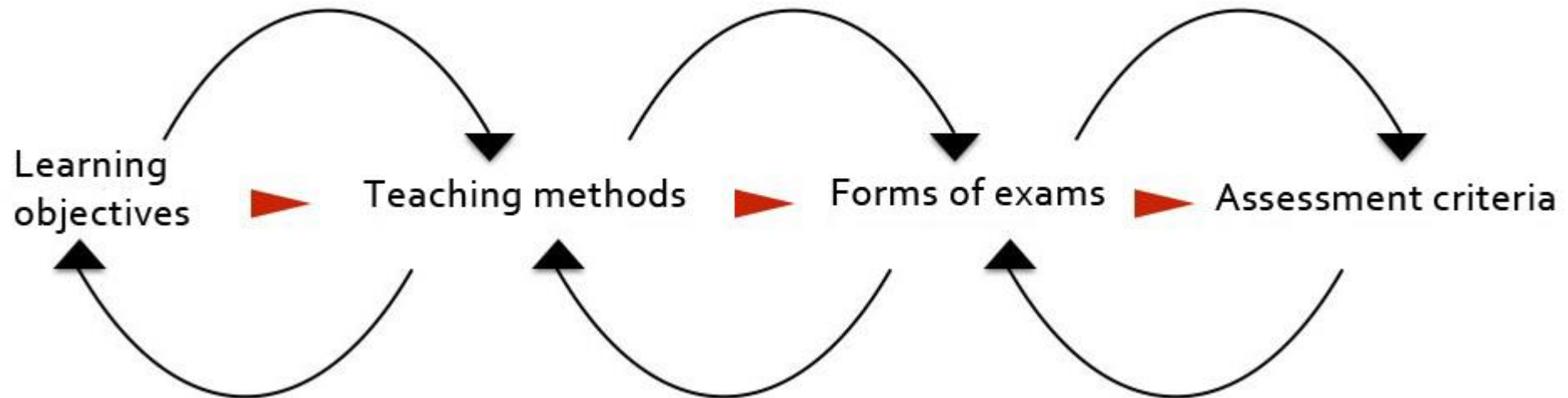
# Constructive alignment... with reference to (research) projects

What will the project deliver (= new results)?





# Constructive alignment flow



<https://innovationenglish.sites.ku.dk/planning/>

# Designing the course – the approach used

- *What would I like to learn if I were to take this course (**student perspective**)?*
- *What can I, as an early stage teacher, offer to the students that are taking this course (**teacher perspective**)?*

# Designing the course – student perspective

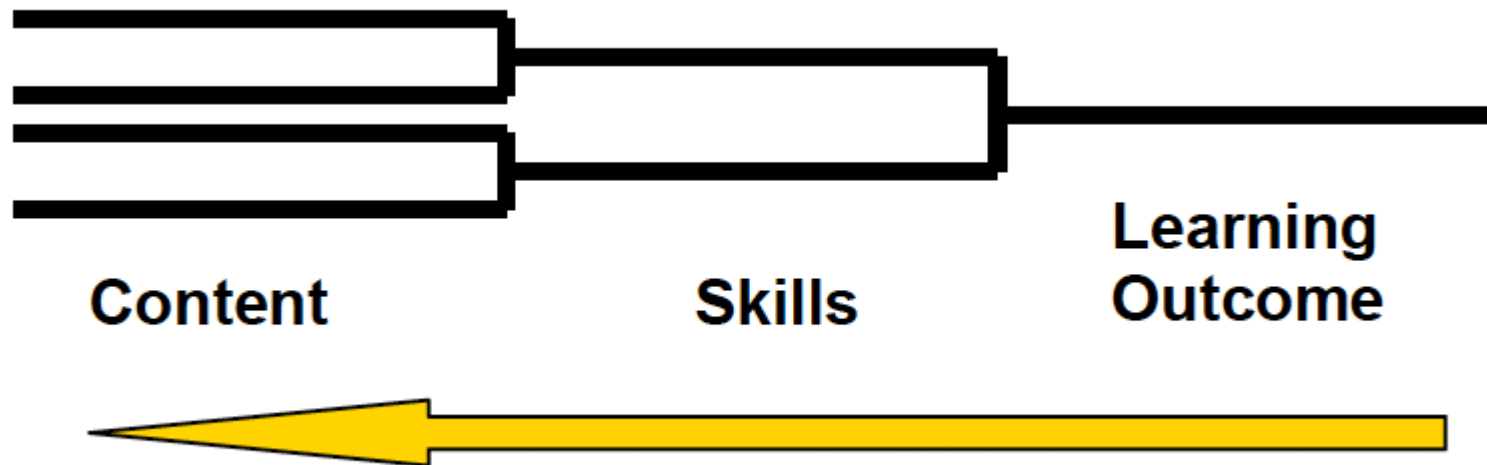
- As a student I would like to know more about wind power and what are the **challenges** in increasing the share in the system.
- Also, I would like to know how I can analyze this in some analytical ways, possibly **using professional software** which is popular and powerful so that I can spend the competence acquired during the course in my **future working life**.

# Designing the course – teacher perspective



- For answering the second question, I have been trying to list what are my strong points as teacher and as researcher.
- I have been trying to **align the course objectives to my existing scientific knowledge** and eventually filling in gaps by revising some subjects, which I was not use to deal with, in my daily working life.

# Designing course backwards



- <https://teachingcommons.stanford.edu/resources/course-preparation-resources/course-design-aids/designing-courses-backwards>

# Course 31783 – integration of wind power in the power system

- **Course ID 31783 - 5 ECTS**

- General competence course, MSc. Eng., Wind Energy
- Technological specialization course, MSc. Eng., Electrical Engineering
- Technological specialization course, MSc. Eng., Sustainable Energy
- Technological specialization course, MSc. Eng., Wind Energy

- **Time slot E2A (monday 13-17)**

- 10 lectures (including group project work) in Lyngby campus
- 2 plenary sessions (last 2 lectures) in Lyngby campus
- 1 lecture/technical visit in Risø campus: SYSLAB facility and wind turbines

# Course 31783 objectives

- **General course objective**

- To give students knowledge about electrotechnical, operational and economical integration of wind power in the electrical power grid.
- The course provides the students with an introduction of the **relevant control issues of power systems**.
- It then analyzes the **different electrical wind turbines technologies** and the interaction with the grid both from the operational point of view and from the market perspective.
- **Modeling of wind turbines**, load flows and influence on **system frequency and voltages** will be investigated with the usage of the simulation software **DIgSILENT – Powerfactory**

# Concerning integration...

- **What does integration mean?**
  - *to put together parts or elements and combine them into a whole*
- **Integration of resources (wind, photovoltaic, electric vehicles...)  
with respect to power systems:**
  - Consider them as “**normal**” sources like all the others with “**honors**” (remuneration) and **duties** (ancillary services) needed in order to properly control system **voltages and frequency**.



# Course 31783 - Learning Objectives

- **Analyse power system operation principles**
- **Explain the role of voltage and frequency control in power system**
- **Describe the power market in general terms**
- Explain the main types of wind turbines
- Describe stationary and dynamic models of wind turbines
- Create wind power and power systems models in Powerfactory
- Evaluate the influence of wind power in the power system
- Assess how wind turbines can support power system secure operation in Powerfactory
- Describe the role of the smart grid in the integration of wind power
- Ability to work in groups
- Ability to define your own research questions
- Effective oral communication in public

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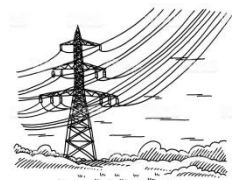
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Group project – integration of wind (w7-11)

Wind turbines modeling (w5-8)

Power system operation (w1-4)



Project hand-in (w11)

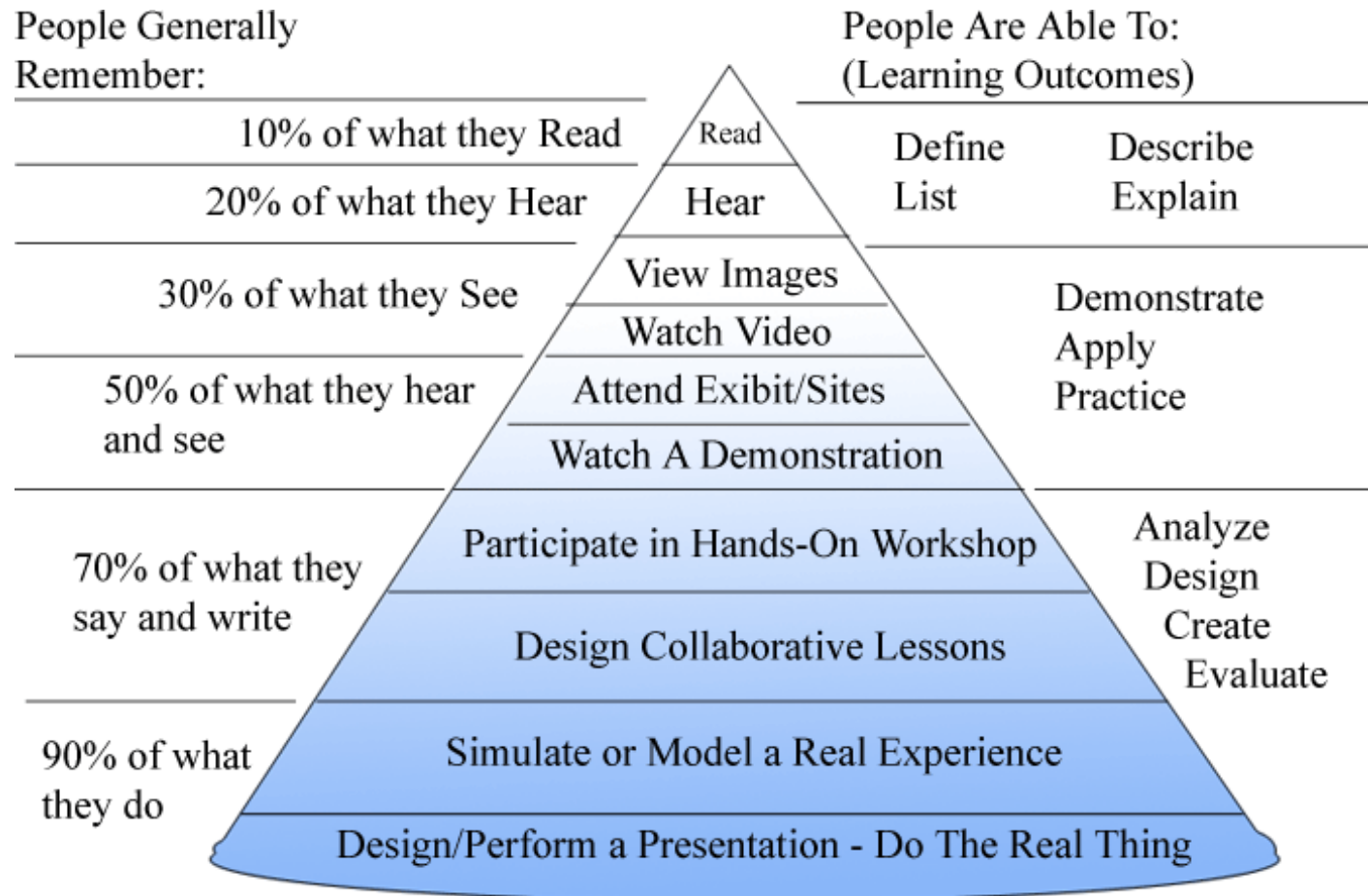
Project outline hand-in (w8)

Plenary sessions (w12-13)  
Oral examination (w14)

ESA hand-in (w4)

Clickers sessions (w4 and w9)

# Passive vs active teaching methods



Dale's Cone of Experience

# Main assignment (group work) overview

- Students groups (5 persons) will have to come up with a title and a very short description (few lines) of the topic they would like to investigate:  
**failure to comply may result in not passing the course**
- **Groups have to be mixed both in term of study lines and powerfactory knowledge.**

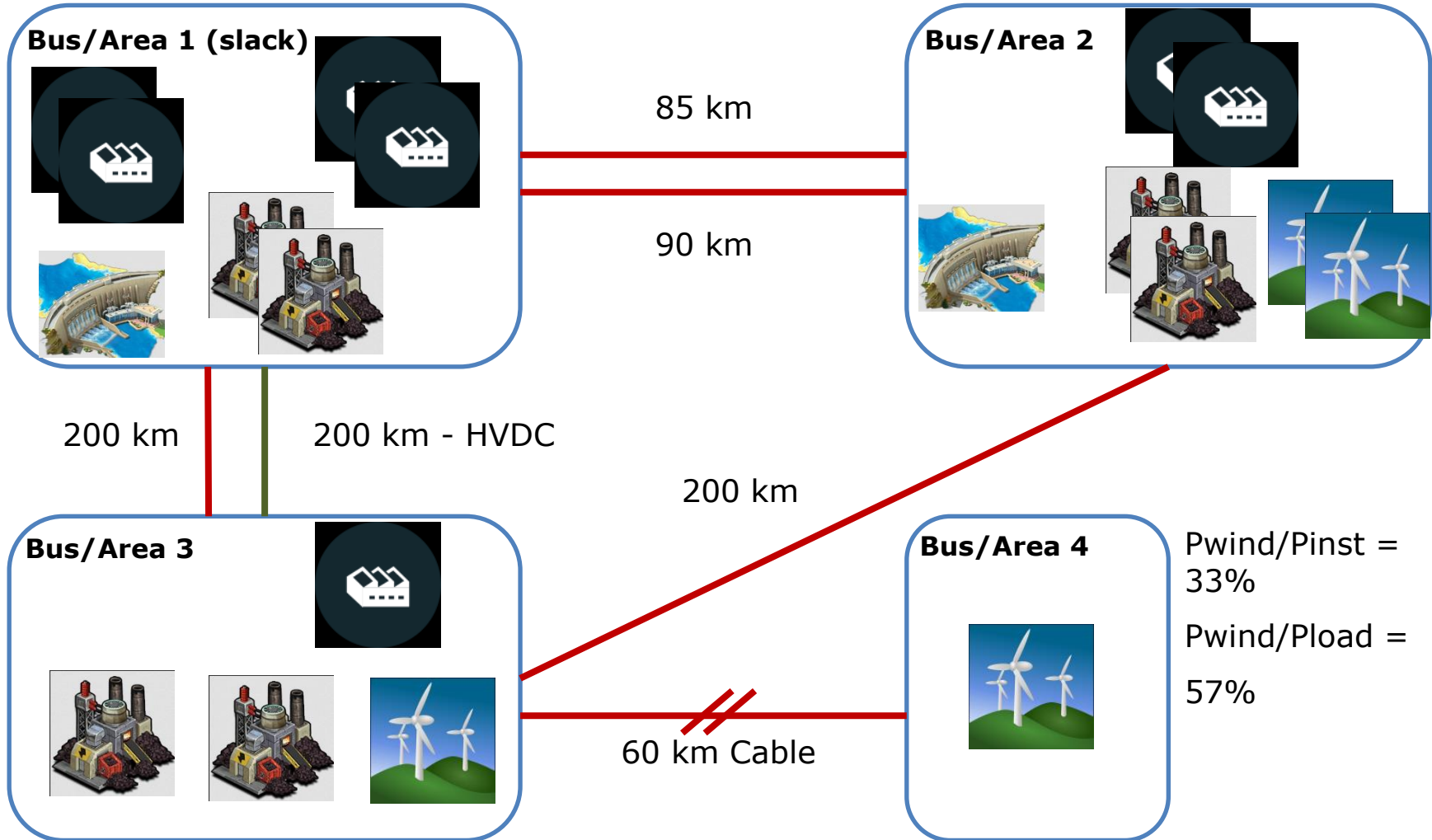
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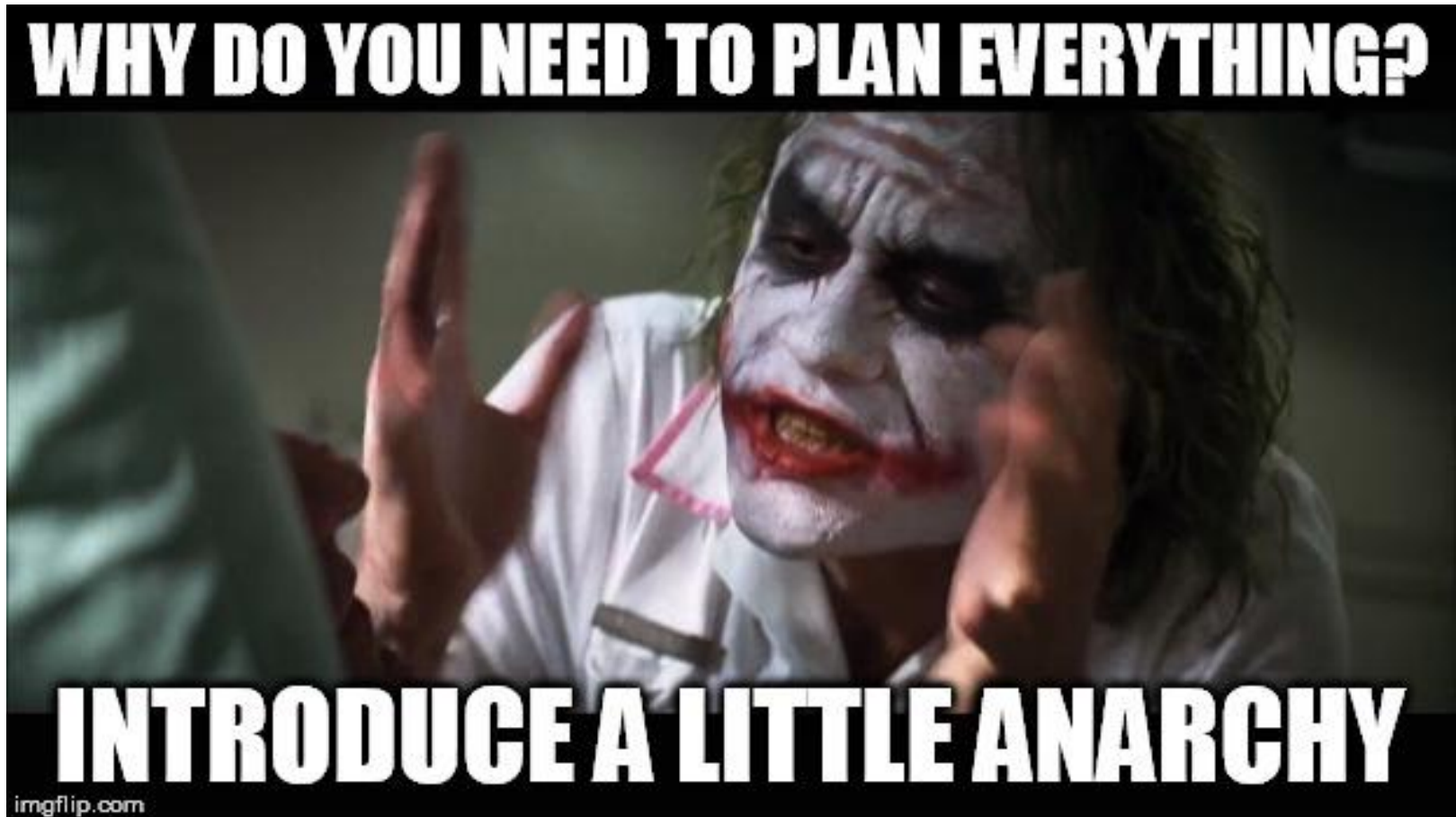
- The topic under study will include **models of wind turbines and power systems components** and will have to include a **base case** and 1 or 2 **cases where particular features from wind turbines** are adopted and analyzed.
- The comparison will be both graphical (i.e. plot comparison) and numerical (i.e. how much the voltage/losses/frequency... are changing in the different cases)
- The report (slide presentation and 10+2 pages **max** doc) has to be uploaded in campusnet: **failure to comply may result in not passing the course**



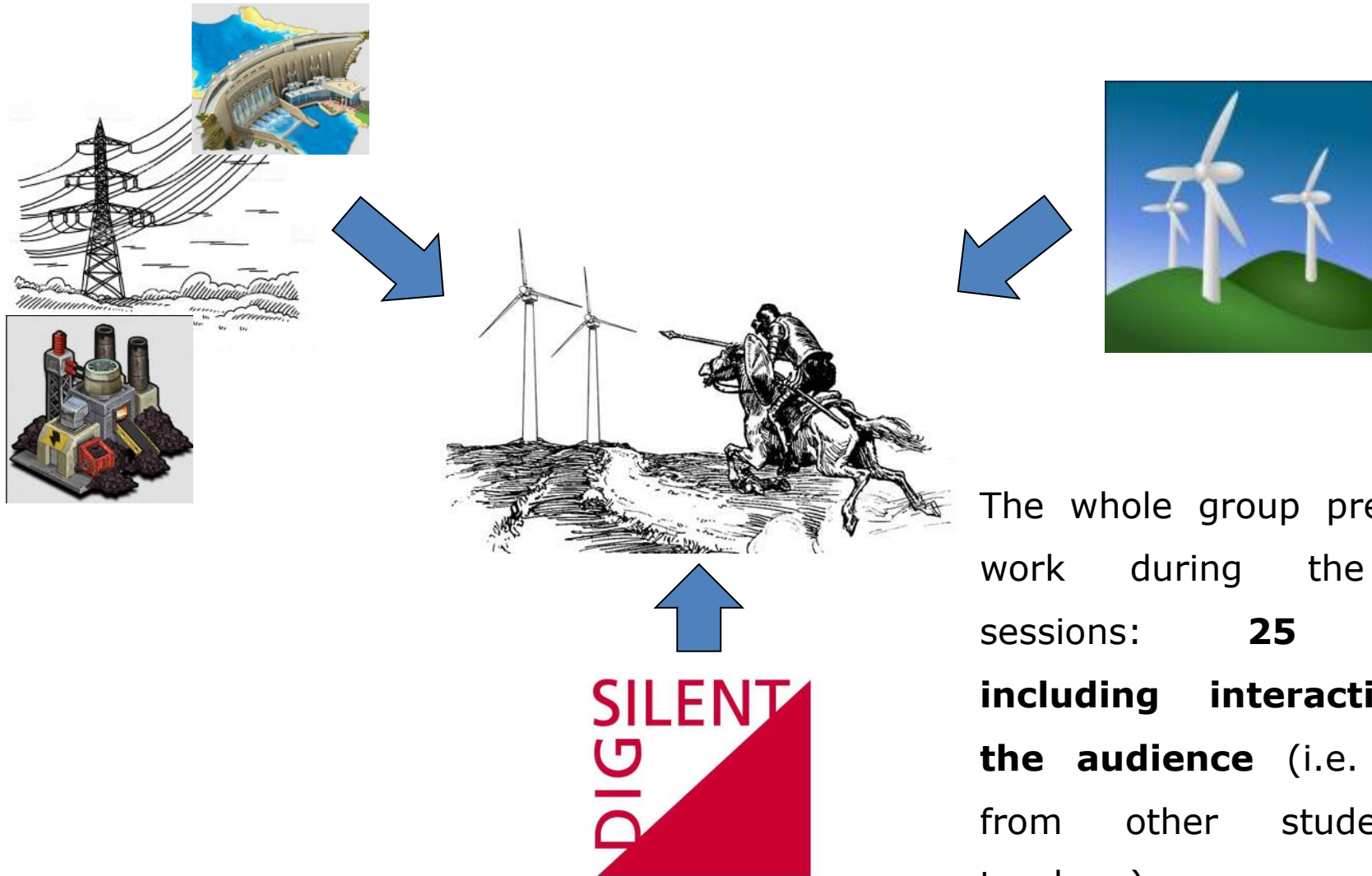


# Reference grid overview - meshed





# Student assessment: group project



# Summative assessments: oral examination

- Group project constitutes 1/3 of the final grade.
- The remaining 2/3 comes from individual oral examination (25 minutes each)
  - A set of 10 (fairly comprehensive) questions is circulated before.
  - Questions are randomly picked during the exam



# Concluding remarks: challenges

- The course is rather large (66 students in 2016 edition) and mixed audience (different background and consistent non-DTU student share): aligning students expectations.
- A fine balance between recommended exercises and mandatory assignments is ongoing.
- The group project, although stimulating and challenging, is sometime too challenging for the teacher as well (!)
- Moreover it is also sometimes difficult to set a bar (many students ask: is this enough?)
- Oral examination, although effective, is becoming time consuming due to the increasing number of students (35 in 2014, 50 in 2015 and 66 currently).

# Discussion/reflection points

- What was the approach used for designing your course(s)?
  
- What are the most important skills that students should develop and be able to apply in and after your course?

# References

- **Education in University Teaching at DTU, UDTU**
  - <http://www.learninglab.dtu.dk/english/kurser/undervisere/udtu>
- **Innovation Day 2016 (Univ. of Copenhagen) and course planning support:**
  - <http://event.ku.dk/innovation-day/>
  - <https://innovationenglish.sites.ku.dk/planning/>
- **Course design support (Stanford University):**
  - <https://teachingcommons.stanford.edu/resources/course-preparation-resources/course-preparation-handbook/course-design>