Holistic Approach of ICT-Education

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About me

- More than 20 years experience in ICT teaching
- Professor of Programming in the University of Apllied Sciences Emden/Leer
- Visiting lecturer/professor in a number of universities
- Baden-Württenberg didactic certification in 2003
- STIMEY-Platform
- Coordinator of MaCICT-Project (Erasmus+)
- Partner of Think4Jobs-project

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Motivation

Is computer science hard?

Short answer—it depends on the student.

(https://www.northcentralcollege.edu/news/2021/03/24/computer-science-hard)

- Why ICT is so hard to study? (Intellectual capabilities, complex topics)
- What can be done to make ICT less harder study without any reduction, i.e. making it easier?

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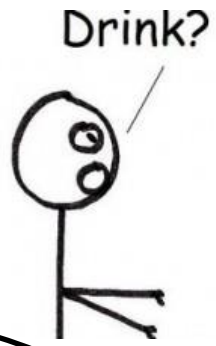
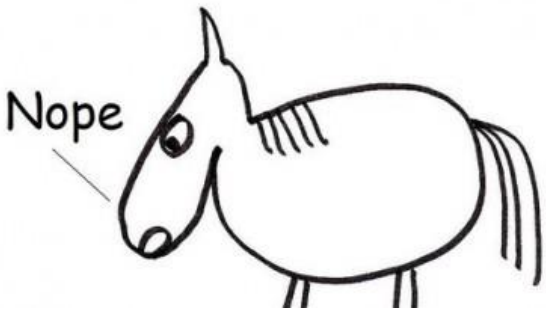
Precondition for any educational process

You can lead the horse to the water, but you cannot force it to drink. Drinking is his thing. But even if your horse is thirsty, it cannot drink as long as you do not bring it to the water.

To bring it to the water is your thing.





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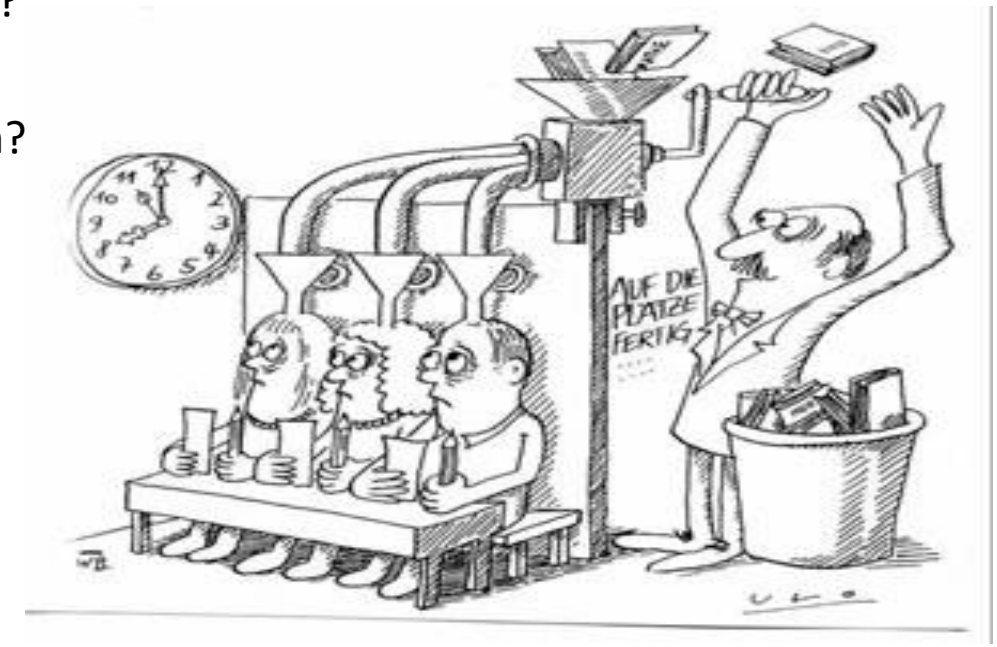
When is a lecture a good lecture? From the learning perspective...

When no other way of knowledge transfer is better at the moment.

Why do we teach?

How do we teach?



Economic goal of teaching: Efficiency - maximum result in limited time.

Teaching considered as knowledge transfer

Knowledge Transfer: "The effective sharing of ideas, knowledge, or experience between people, companies, or organizations"

Critic: one-way process – interaction aspects included:
"knowledge transfer and exchange"

practitioners' and educational professionals' beliefs of knowledge have an effect on our conceptions of education: forms of learning, pedagogy and assessment in the curriculum. (Magrini, 2000)

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Lecture. A talk by which the notes of the professor become the notes of the students, without passing through the minds of either..
(Mortimer J. Adler)

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Purpose of the education

- The main purpose of education is to provide opportunities for learners
  - to construct knowledge through their own personal experiences and interaction with the outside world,
  - to shape behavior, or to make knowledge meaningful and
  - help learners in organizing new information in their cognitive schemas (Agarhar, 2019).

Conceptualising learning and teaching

- **The nature of teaching:** Teachers
  - directly instruct their students
    - **teacher-centered** – based on instructivism
  - encourage and support students as they learn and construct knowledge for themselves
    - **student-centered** – based on constructivism

Teachers‘ role

- Teachers are among the most powerful influencers in learning.
- Teachers need to be directive, influential, caring, and actively engaged in the passion of teaching and learning.

The use of various tools and methods for teaching

Students point of view: make the studies more interresting, not monotonous; structure the teaching material; ...

Teachers point of view: helpful to create classes; prepare learning materials;...

The quality of education depends on the quality of teachers.
(Aktan, Toraman and Orakcı, 2020)

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Constructivism

- Theory about human learning (not about teaching!)
- Learners construct knowledge rather than just passively take in information.
  - Cognitive constructivism (Jean Piaget (1983)): learning can only occur to the extent that new information links successfully with a learner's prior knowledge and experience
  - Social constructivism (Lev Vygotsky (1962, 1978) : learning is greatly enhanced by collaborative social interaction and communication – in other words, discussion, feedback and sharing of ideas are powerful influences on learning.

Teaching methods based on constructivism

- **Student-centered approach**
- Focus primarily on learners playing the active and major role in acquiring information and developing concepts and skills while interacting with their social and physical environment.
- The role of the teacher becomes one of facilitator and supporter, rather than instructor.

- The importance of social interaction, language and communication is recognised in constructivist classrooms and therefore much group activity, discussion and cooperative learning is encouraged.

Examples of constructivistic methods

- Inquiry Based Learning
  - Learners pose their own questions and seek answers to their questions via research and direct observation
- Project Based Learning
  - Students applying course knowledge to produce something
- Problem Based Learning
  - learners acquire knowledge by devising a solution to a rela world problem.
- Cooperative Learning
  - Students work together in small groups, interdependence among group members

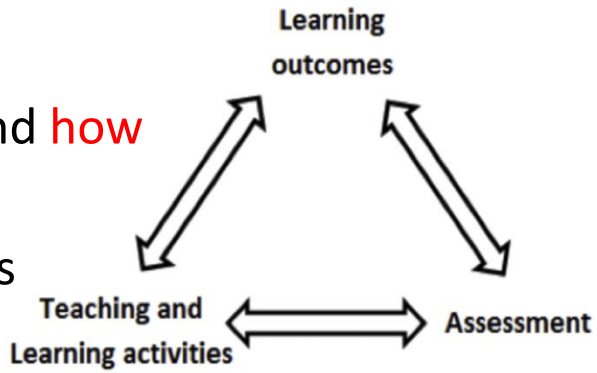
Assumption of constructivist rationale

- “Constructivist approached … require that students are self-motivated, capable of thinking and reasoning, and in possession of sound independent skills.“ (Westwood, 2008)
- Lessons require eliciting relevant prior knowledge

Critical consideration of constructivist approaches

- Unstructured discovery-type activities where learners must independently acquire or construct essential information are very inefficient. (Construction of misconseptions) (Pressley and McCornmick 1995)
- Students make much better progress when they are taught explicitly and directly
  (de Lemos 2004; Ellis 2005; Mastropieri et al. 1997).
- How well a learner makes sense of new information (and contributes usefully to collaborative group work) depends greatly on his or her prior knowledge and experience; and these two prerequisites differ greatly from one learner to another. (Westwood 2008)

Outcome-Based Teaching and Learning (OBT)



- Keep in mind:
  - focus on what students are expected to learn and how it becomes measurable through assessment.
  - Various teaching methods and learning activities
- Outcome-based Assessment
  - collection of (most relevant) evidence of student learning based on outcomes
- OBT requires
  - Planning (content+ activities), Assessment, Grades Calculation schema

Objectives of ICT Education

- Soft/transferable skills
  - efficient interpersonal communication;
  - critical thinking;
  - flexibility;
  - intercultural communicati
  - team-building & team-working,
  - negotiation, collaboration,
  - project management.
- Disciplinary skills
  - tworking. ...
  - Cloud computing. ...
  - Technical support. ...
  - Linux. ...
  - Programming languages. ...
  - User experience (UX) ...
  - Machine learning. ...
  - Quality assurance
  - ...

Interdisciplinary Skills

How to teach all of these skills at the same time?
Teacher-centred / student-centred approaches

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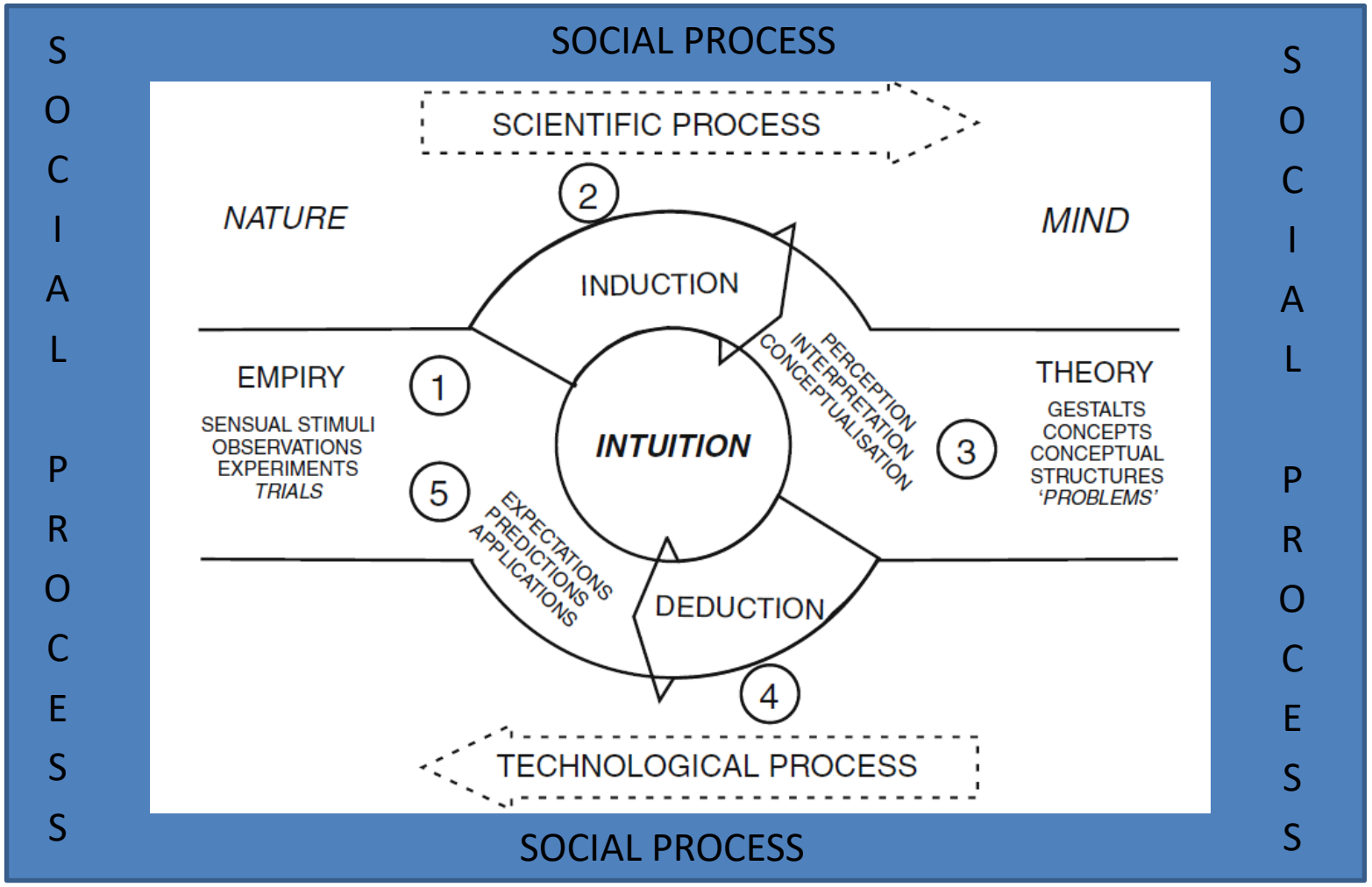
Important aspects for successful teaching

- Content
  - Well structured, vizulization, tasks to get away from selective memorizing
- Teaching skills
  - Educators own expertise in teaching and learning skills
  - Presenting and demonstrating key concepts from more than one point and in multiple contexts help in building the knowledge.
  - Different kinds of classroom activities
- Motivation
  - adaptive and flexible learning environment
  - atmosphere is learning oriented and
  - Consideration of students‘ pre-knowledge and skills, attitudes and beliefs in the new situation.
  - Usefullness of the knowledge and skills for the student
- Interaction
  - Interactive teaching and learning activities that engage students in learning and cognitive development

The importance of students' pre-knowledge

- Pre-knowledge
  - helps students to bridge a gap between lecturer's expectations and students' knowledge
  - help students to develop the integrated knowledge structure
  - in interdisciplinary projects: necessary to find out each participants' initial level of knowledge and understanding related to the problem
- Awareness of the pre-knowledge necessary for
  - fruitful interaction in building interdisciplinary knowledge and
  - understanding of the problem.

Perceptional teaching approach



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The Perceptional Approach – A Practical Teaching Philosophy

- The understanding of principles of concept formation is an essential base for teaching (Kurki-Suonio 2011)
  - the individual processes of learning and scientific research are different manifestations of the same process
    - Both processes aim for understanding of the unknown of the natural and social worlds.
    - an individual develops one's own knowledge through different levels of understanding
    - scientific community develops science
  - Common for both processes: the perceptional process of learning: creation of meanings in human mind as perception.
    - perception arises from the interaction between nature and the human mind.
    - Awareness of meaning is the essence of understanding

USE CASE 1 – Perceptional Approach in teaching ICT

TEACHING CYBER PHYSICAL SYSTEMS ENGINEERING

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By academy and industry needed skills…

- Soft skills
  - Broad knowledge in multiple areas
  - Communication
  - Understand the need for life-long learning
- Technical skills
  - Physical architecture
  - Software architecture
  - Software development

Industrial projects fail mostly because of lacking social skills!

Issues to consider when teaching CPS

- Interdisciplinary nature of the topic
  - Need to consider knowledge from multiple fields at the same time
  - Soft skills
- Scenario suitable for teaching CPS
  - "education should focus on core ideas and core principals of CPS"
  - Need to be realistic and "industry-like"
  - No theory-overloading of the task
  - Opportunity for designing, communication skills development and teamwork experience
- Need for a practical and holistic approach to teach CPS.

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Our Course

Course Topic 1:
Global Distributed Software Development

Course topic 2:
Cyber Physical Systems

Source: elektronikpraxis.vogel.de

- Practical relevance of both topics for the industry of today
- Highly complex topics
- In “real life projects” the key success factors:
  - technical and social competencies

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Our Course Setting

- We teach:
  - cyber-physical systems related to real industrial setting
  - global software development in a
    - real project
    - “true” environment
  - cross-cultural experience
- The implementation
  - Kick-Off in September 2016 in ITMO
  - Project end: December 2016
  - 10 ECTS credit points (250-300 hours of work)

The guiding idea: learning by doing

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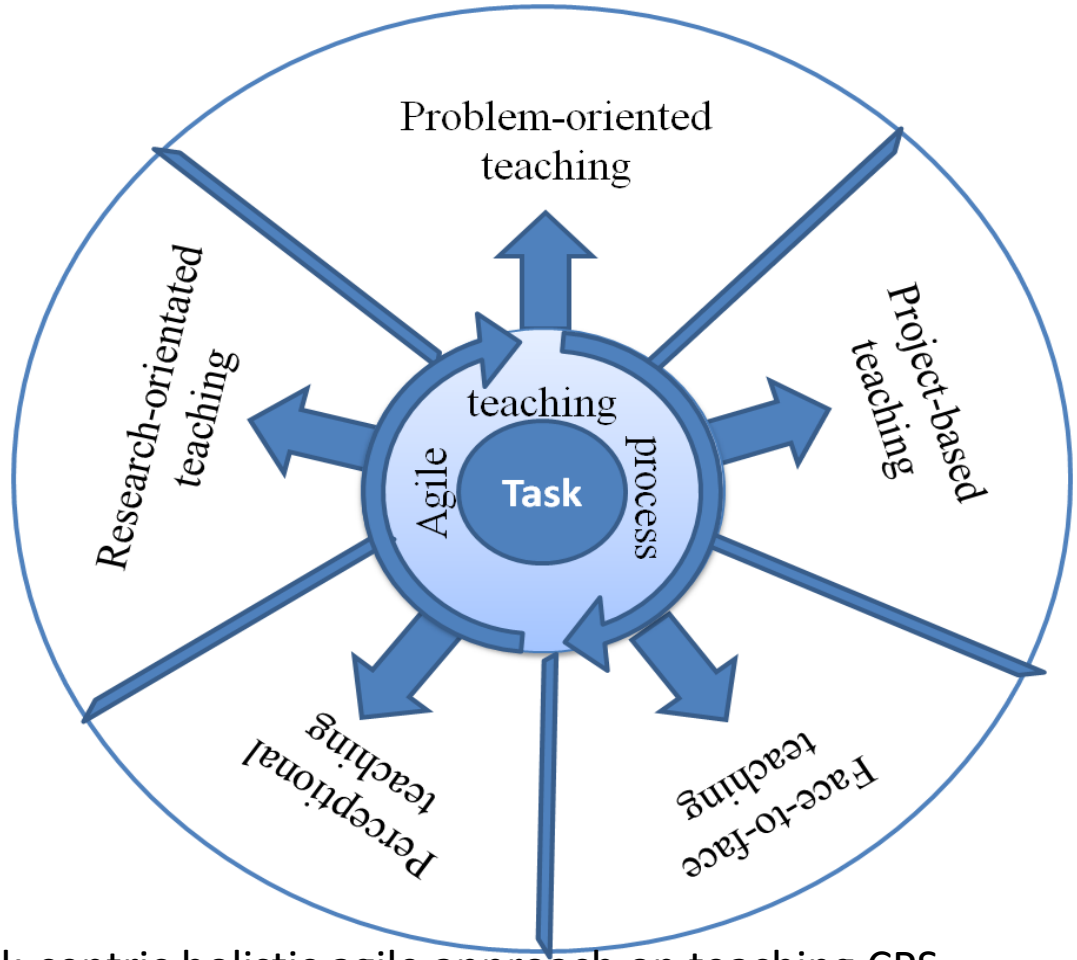
Our teaching approach



Task-centric holistic agile approach on teaching CPS

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USE CASE 2 – Perceptional Approach in teaching ICT

JAVA PROGRAMMING

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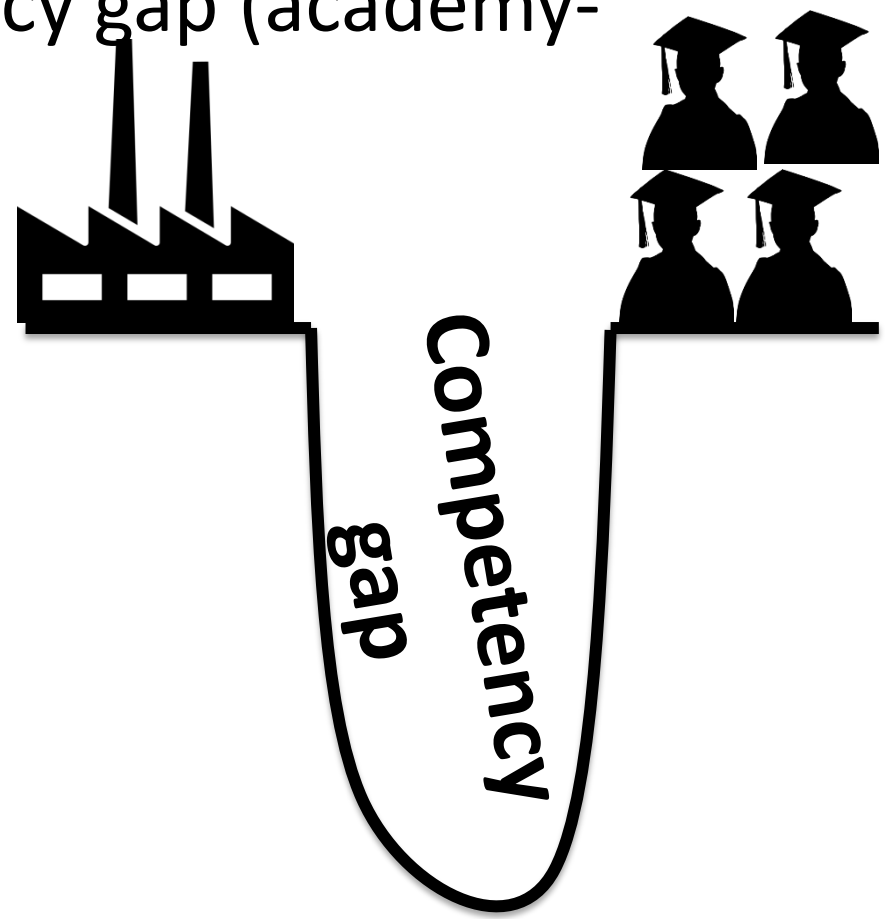
Goal

- Filling of the competency gap (academy-industry)
  - Communication skills
  - Collaboration in team
  - Problem-solving ability
  - Critical thinking
  - Leadership
  - Creativity/Innovation
  - ...



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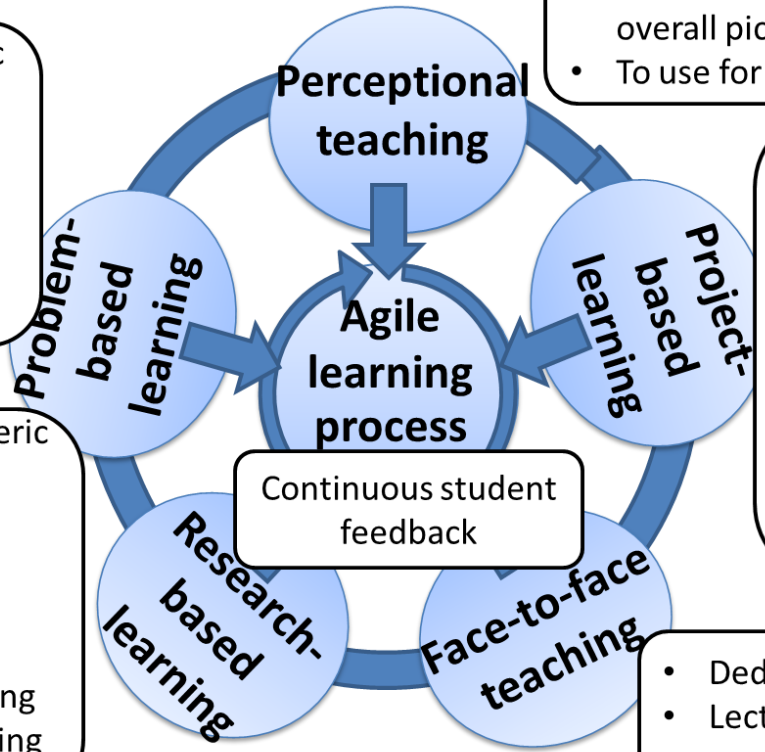
T-CHAT Teaching approach



- Inductive teaching
- Intuitive understanding of an overall picture
- To use for threshold concepts

Disciplinary competency + Generic competencies:

- Social competencies
- Problem-solving skills
- Self-directed learning
- Critical thinking
- Analytical skills

Disciplinary competency + Generic competencies:

- Social competencies
- Ability for self-assessment and assessment of others
- Leadership
- Critical thinking
- Analytical skills
- Problem-solving skills
- Project management

Disciplinary competency + Generic competencies:

- Self-confidence to conduct research and to learn
- Self-directed learning
- Lifelong learning
- Problem definition and solving
- Ability to independent working and thinking

- Deductive teaching
- Lecture, presentation, small group teaching

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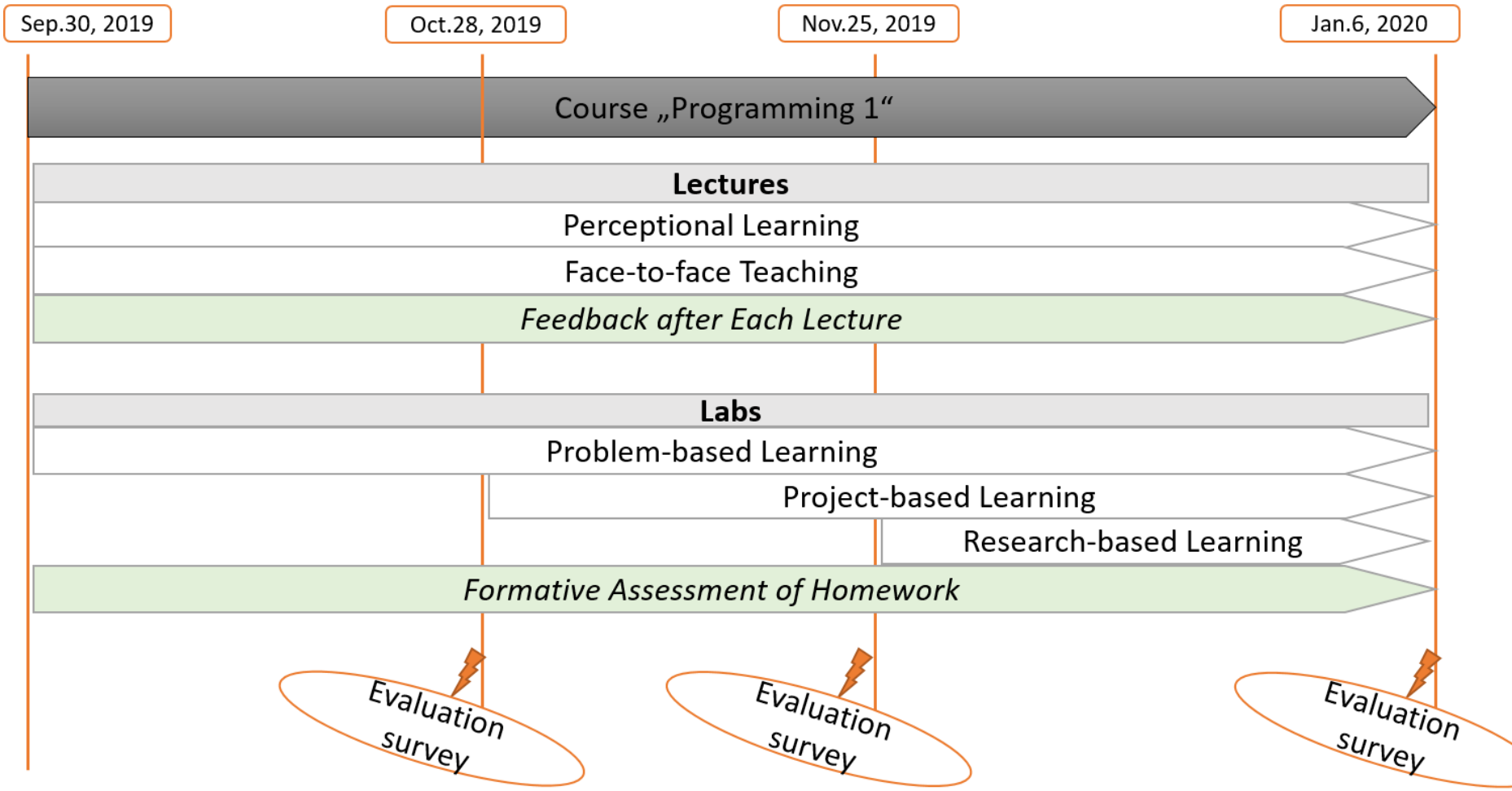
Teaching- what has changed

Originally	Using T-CHAT
Learning outcomes	
Disciplinary competencies: an ability to operate with algorithms and an ability to analyze, design, and implement software	Disciplinary technical competencies and generic competencies (collaboration, communication, problem-solving skills…)
Learning activities	
Mixing passive and active phases during lecture, lab assignments	Intuitive understanding by giving multiple discipline-typical examples; Problem-based learning in labs; Project-based learning – 2 projects.
Assessment	
Summative - final exam	Student feedback after lecture; formative assessment of homework assignments; summative – final exam


Sep.30, 2019
Oct.28, 2019
Nov.25, 2019
Jan.6, 2020
Course „Programming 1“
Lectures
Perceptional Learning
Face-to-face Teaching
Feedback after Each Lecture
Labs
Problem-based Learning
Project-based Learning
Research-based Learning
Formative Assessment of Homework
Evaluation survey
Evaluation survey
Evaluation survey

Yes we can…

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