ENG-644

Teaching STEM: a problem solving approach

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Cursus	Sem.	Type
EDOC General and external courses		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Project report
Workload	60h
Hours	**40**
Courses	10
Exercises	10
TP	20
Number of positions	

Frequency

Every year

Remark

Course given in the fall. Teaching assistants in First Year courses are the intended audience - please contact the instructors if you are not currently involved in such a course. Register by Sept 30

Summary

Problem solving is a core engineering skill. This course explores relevant heuristics, epistemologies, metacognitive skills and evidence-informed teaching strategies for developing problem solving skills that transfer from paper-based exercises to complex, real world engineering situations.

Content

Teaching engineering students how to solve problems constitutes a major objective of engineering programs. Using evidence from research in learning sciences, this course examines the specific skills, heuristics, thinking and processing that constitute "problem solving". We will explore strategies for how teaching assistants can support students to develop this broad range of thinking and reasoning skills, with specific attention to the first year maths and physics courses. While lectures are often seen as the core mode in higher education, exercise sessions are when students are actively problem solving. This makes exercise sessions an ideal time to support students to apply problem solving heuristics, metacognitive monitoring and develop their disciplinary epistemic cognition. Informed by learning sciences research, this course proposes theoretical and practical support for the effective use of 'teaching with questions' and 'process-oriented feedback' (Tormey and Isaac, 2022).
Participants will apply their developing teaching skills by assisting with the training of EPFL students, providing them with practical opportunities to facilitate interactive sessions, develop productive teaching micro routines, and receive feedback on their teaching. Participants will be prompted to reflect on their own teaching and students' learning, preparing a final report about their experience.

Note

This course is given during the Fall semester only. Please register by September 30 at the very latest.

Keywords

problem solving, teaching, first year, learning sciences

Learning Outcomes

By the end of the course, the student must be able to:

- Describe Polya's problem solving method and explain how problem solving heuristics shape how we approach problems

• Analyze characteristics of different problem solving situations (routine problems, ill-structured problems, etc.) and relevant types of practice (deliberate practice, spaced practice, etc.)

• Develop teaching interventions that align with current understanding of how we learn (cognitive and social)

• Formulate questions and feedback to guide students to develop robust, autonomous problem solving and meta cognitive strategies

• Create opportunities to support students' metacognition, ability to manage uncertainty and epistemic cognition to support their problem solving skills

• Facilitate interactive sessions with students or student assistants, employing instructional strategies that foster a climate conducive to learning

Transversal skills

• Evaluate one's own performance in the team, receive and respond appropriately to feedback.

• Communicate effectively, being understood, including across different languages and cultures.

• Take responsibility for health and safety of self and others in a working context.

• Assess one's own level of skill acquisition, and plan their on-going learning goals.

Expected student activities

Course activities - apply, discuss and get feedback on evidence-informed strategies for teaching problem solving

• ***Participate in: Teaching Toolkit for EXERCISES workshop*** (7h; before the start of the semester): An interactive opportunity for participants to practice *teaching with questions* and *process-oriented feedback* to support students' problem solving activities. Dates for SA2024: 30 Sept (full day) OR 12 Sept & 17 Sept (afternoons)

• ***Participate in: Teaching preparation workshop*** (3h; week 1/2): Participants practice demonstrating Polya's 4-step problem solving method and explore strategies for promoting interactivity and engagement during the workshops for student assistants. Dates for SA2024: 10 Sept OR 18 Sept

• ***Co-teach: Workshops for student assistants*** (5h; during the semester): Participants will co-facilitate one workshop (week 2/3) and facilitate one workshop (week 5/6 or 9/10) for current student assistants around supporting student learning and problem solving during exercise sessions. Participants will receive feedback from students and from course instructors.

Main course resources - introduction to the learning science research underpinning current understanding of how people learn

• **Facilitating Experiential Learning in Higher Education** (book) Tormey, R. and Isaac, S. with C. Hardebolle and I. Le Duc. (2022) use EPFL VPN for full access https://doi.org/10.4324/9781003107606

• **Teaching Science and Engineering** (MOOC) https://www.edx.org/course/teaching-science-and-engineering

Assessment methods

30% Teaching/co-teaching workshops (week 2/3 AND week 6/10)
70% final report (week 17)

Resources

Bibliography

Additional resources

• Hanstedt, P. (2018). Creating wicked students: Designing courses for a complex world. Stylus Publishing, LLC.

• Polya, G. (2004). How to solve it: A new aspect of mathematical method (No. 246). Princeton University press.
• Kober, N. (2015). Reaching Students: What Research Says about Effective Instruction in Undergraduate Science and Engineering. Washington, DC: National Academies Press.
• Wakeford, Richard (2003) Principles of student assessment in Fry et al. (eds.) A handbook for teaching and learning in higher education, enhancing academic practice, 2nd edition.
• Nilson, L. B. (2010) Teaching at its best: a research-based resource for college instructors. Hoboken, NY: John Wiley & Sons, Inc.
• Crawley, Edward et al. (2014) Rethinking engineering education, the CDIO approach, 2nd edition
• Entwistle, N (2009) Teaching for understanding at university, deep approaches and distinctive ways of thinking. Basingstoke, UK: Palgrave Macmillan.

Ressources en bibliothèque

- Creating wicked students: Designing courses for a complex world
- Reaching Students: What Research Says about Effective Instruction in Undergraduate Science and Engineering
- Rethinking engineering education, the CDIO approach
- Teaching at its best: a research-based resource for college instructors
- Teaching for understanding at university, deep approaches and distinctive ways of thinking
- A handbook for teaching and learning in higher education, enhancing academic practice
- How to solve it: A new aspect of mathematical method

Websites

- https://go.epfl.ch/da-training