TAMPERE UNIVERSITY OF TECHNOLOGY

Experiences and Modernization on Online Courses in the Finnish National Network on Mathematical Modelling

Tuomas Myllykoski, MSc
Laboratory of Mathematics, Tampere University of Technology
tuomas.myllykoski@tut.fi

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Mathematical Competence for Engineers

”the ability to understand, judge, do, and use mathematics in a variety of intra- and extra-mathematical contexts and situations in which mathematics plays or could play a role”

SEFI (2013): ”A Framework for Mathematics Curricula in Engineering Education”

Mathematical Competence for Engineers

- Thinking Mathematically
- Reasoning Mathematically
- Posing and Solving Mathematical Problems
- Modelling Mathematically
- Representing Mathematical Entities
- Handling Mathematical Symbols and Formalism
- Communicating in, with and about Mathematics
- Making Use of Aids and Tools

Mathematical Competence for Engineers

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- **Posing and Solving Mathematical Problems**
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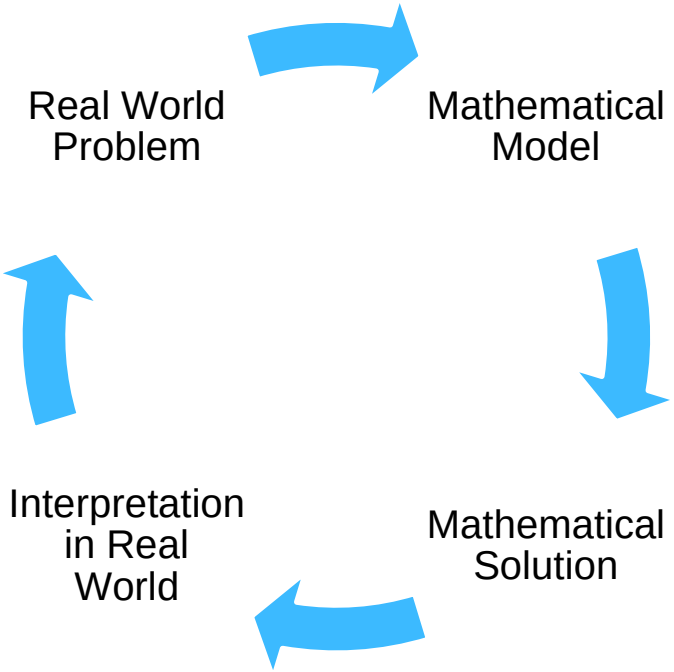
Mathematical Modelling



(Lucas, 1999)

Teaching Mathematical Modelling

- Phase 1-2: From a Real World Problem to a Mathematical Model
  - In teaching it is advisable to select relatively simple, easily modelled real-world problem, so as to not overwhelm your students
  - Students may also select the problem to be modelled themselves
  - Students should have basic skills in matrix algebra, differential equations, probability theory etc. (2^{nd}, 3^{rd} year students)
  - Students are encouraged to work in groups

Teaching Mathematical Modelling

- Phase 2-3: Solving the model and implementing computers
  - At TUT and other Finnish universities, the most common tool used is Matlab, other tools are also available
  - It is clear that students should know the basics of their computer software
  - We provide basic intro to Matlab in our course

Teaching Mathematical Modelling

- Phase 4: Validation of the Model and Interpretation of the Results
  - An important part of the solution is the reviewing of the simulation results and the accuracy of the model, likewise the assessment of the area in which the model is valid
  - The last step is the evaluation of the results of modelling, where an assessment is made of what can be stated about the phenomenon to be modelled on the basis of the simulation results
  - Students peer-reviewing each others' work is crucial here

Finnish Network on Mathematical Modelling

- A National Project in Finland on teaching and learning Mathematical Modelling
- Started as a part of the Finnish Virtual University
- Coordination is done by the Laboratory of Mathematics at TUT
- Funding:
  - 2002-2005 Finnish Virtual University
  - 2006- Funded by partners

Finnish Network on Mathematical Modelling

- Before the project, mathematical modelling teaching was spread out across the different universities in Finland, and there was no uniform study module nor any synergy and effective use of different expertise around the country.

- There was considerable differences in the quality and quantity of teaching received by MSc students in different universities

- Knowledge is fragmented around universities: to provide the most wide view of mathematical modelling for students, it was necessary to bring the experts from different universities together

Finnish Network on Mathematical Modelling

- Participants:
  - Aalto University
  - Lappeenranta University of Technology
  - Tampere University of Technology (Coordinator)
  - University of Eastern Finland (Kuopio, Joensuu)
  - University of Jyväskylä
  - University of Oulu
  - University of Helsinki
  - University of Tampere

Finnish Network on Mathematical Modelling

- Achievements:
  - Created a Finnish expert network for Mathematical Modelling
  - Created study modules for MM, which include video lectures, online group work, student projects and peer reviews
  - Organized and participated in modelling competitions (ECMI modelling week)
  - Developed methods for web-learning, such as pedagogy, didactics, technology, organizational development
  - Published two books: Matemaattinen Mallinnus (2010) and Mathematical Modelling (Springer, 2016)
  - The project has now reached outside of Finland by completing the first course together with the Universities of Shanxi and Hunan in China

Experiences in Organizing Online Courses

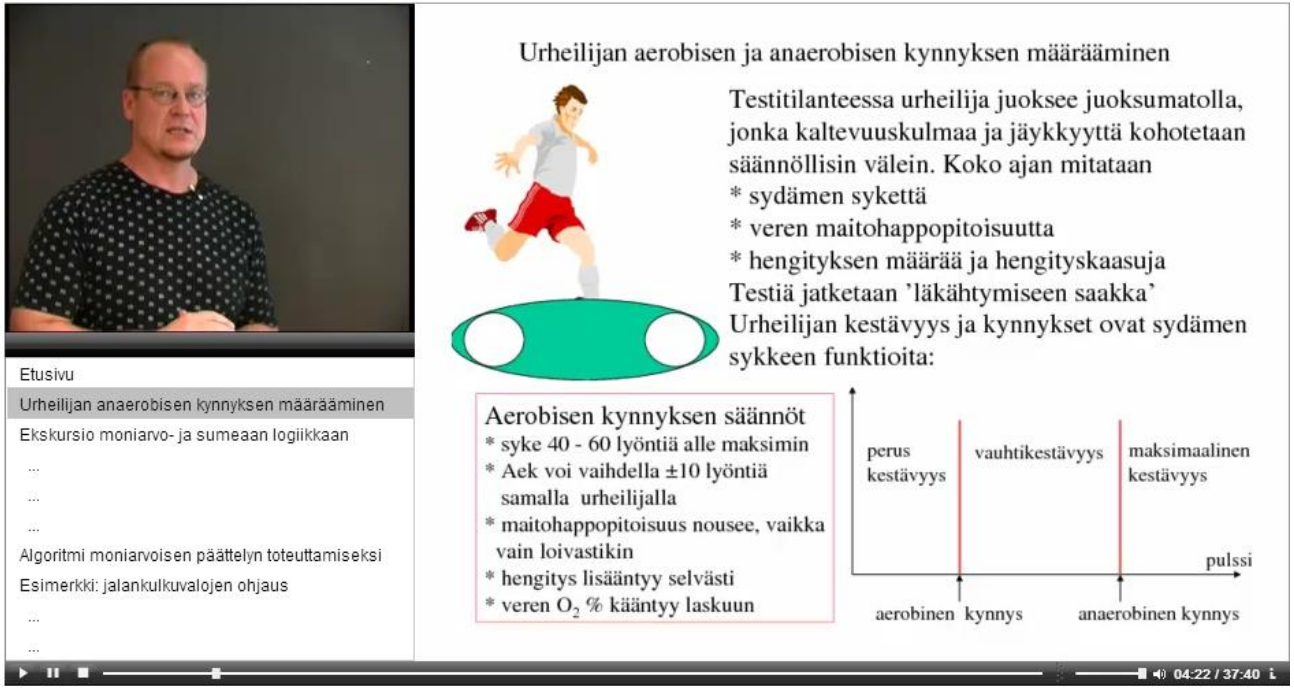
- The study plan of these courses consists of
  - Weekly lectures and assignments
  - Peer review of the students' solutions to the assignments
  - Project work
  - Seminar, in which the project work is disseminated

- One Basic Course, four different additional courses, rotated yearly
- Work is done in groups
- Grade is 40% from assignments, 40% from project work and 20% from peer reviews

Experiences in Organizing Online Courses

- Actors:
  - Students from participating universities
  - Teachers from participating universities
  - Tutors at each university
  - Technical support at each university
  - Project coordinator at TUT
- Online tools used on the course:
  - Videoconferencing for introductory lecture and project dissemination seminar
  - Moodle platform for registration, material dissemination, work upload and peer review
  - Video lectures using SMIL-multimedia

Experiences in Organizing Online Courses



Experiences in Organizing Online Courses

- Examples of projects on the course:
  - Fountain Under a Wind
  - Overbooking Airline Tickets
  - Designing a Reflector
  - Phases of Work of a Robot
  - Population Growth Modelling
  - Lawnmower Robot
  - Falling Sandwich
  - Parlamentary Election

Experiences in Organizing Online Courses

- From 2002 to 2017, in total, 1373 students have completed the courses
- From these, 969 were completions of the Basic Course on Mathematical Modelling
- Overall student feedback has been positive, with students finding the course a bit more tasking than traditional courses, and with complaints of the material being outdated…

Modernization of Courses

- Work has begun in spring of 2018 with new video lectures being filmed
- The aim is to produce a Basic Course on Mathematical Modelling in *English*
- The Network is looking for new partners from younger professionals in Finnish universities to join the project
- Bring the total number of courses from five to three, with
  - Basic Course
  - Two different advanced courses (topics TBD)

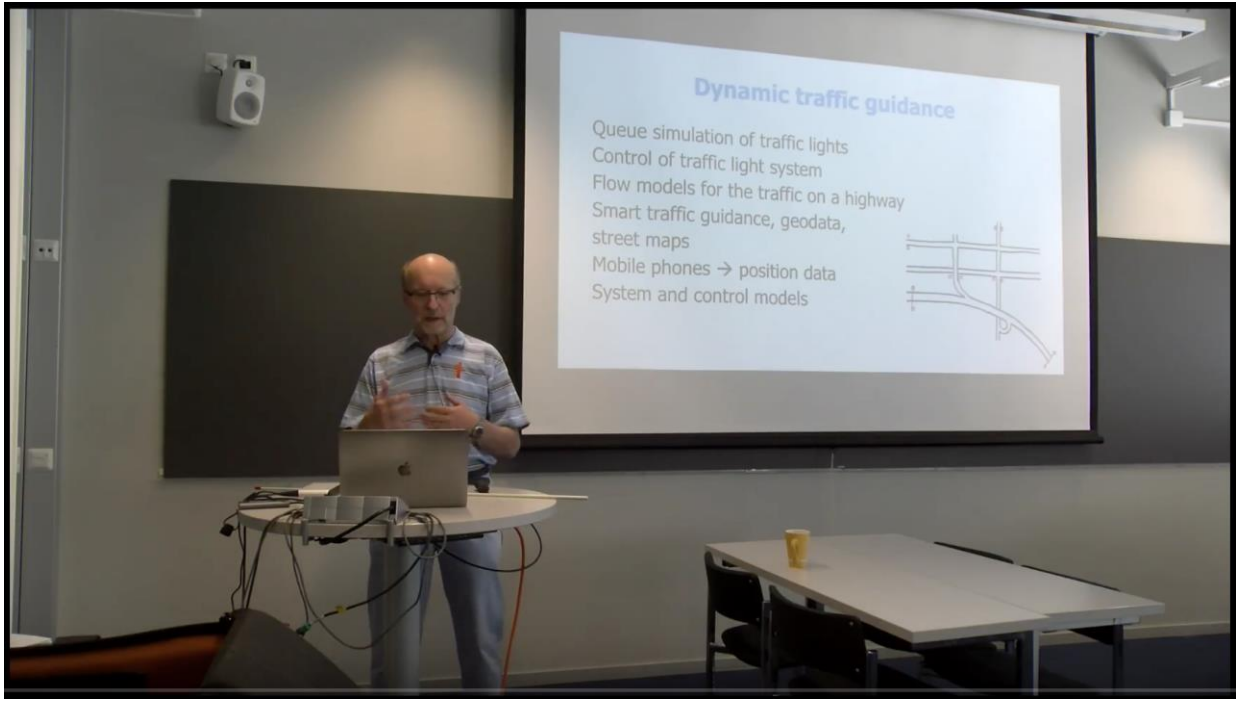
Modernization of Courses

- New videos on YouTube for better viewability on all kinds of devices
- Modern modelling problems for projects and more current topics
- Upgrade of the peer review system to smooth out teacher workload

- Possibility of partners joining the network from abroad
  - Interested? Mail us at
  - tuomas.myllykoski@tut.fi , seppo.pohjolainen@tut.fi or jussi.kangas@tut.fi
  - Participants are most welcome to the new course starting on September 10th, 2018! The course is 5 ECTS.

Modernization of Courses

- Sneak peek:



Thank you

- Questions, comments?