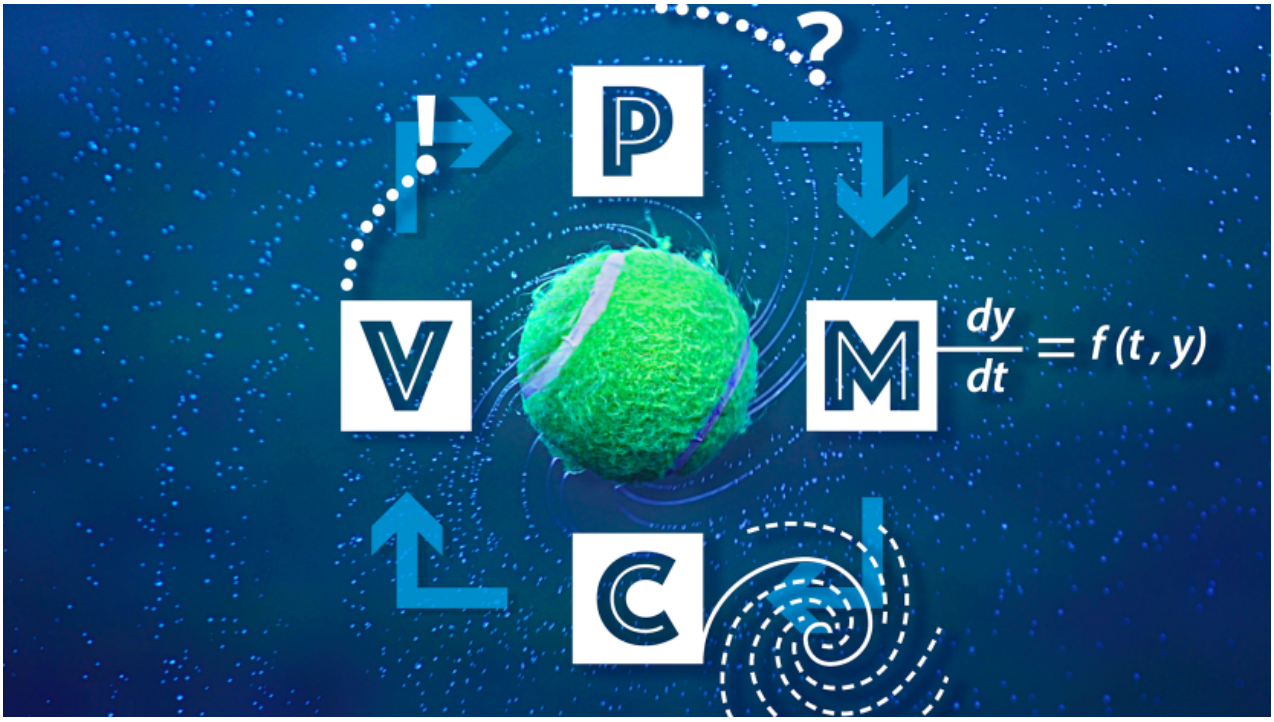
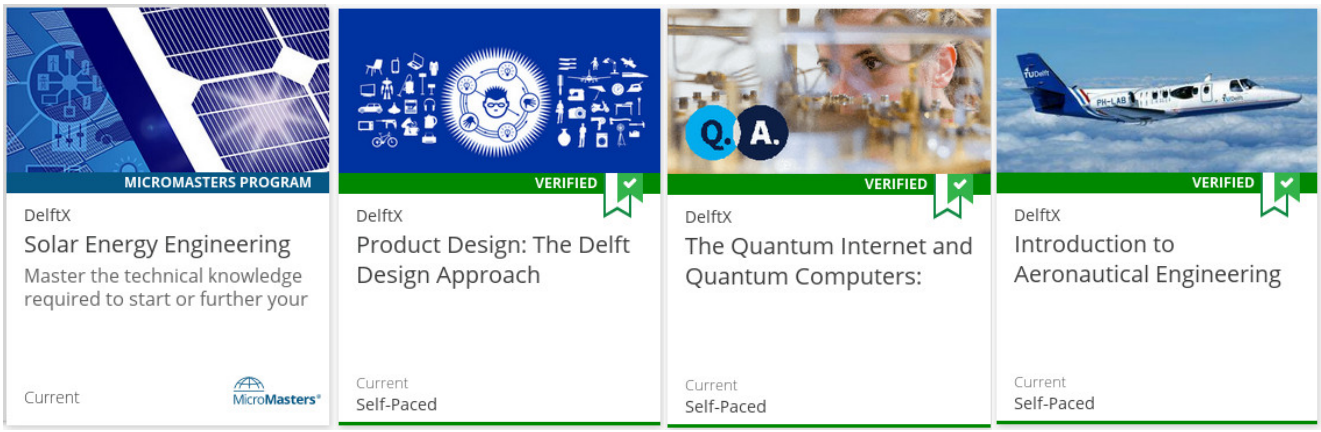
EdX-MOOC Mathematical Modelling Basics



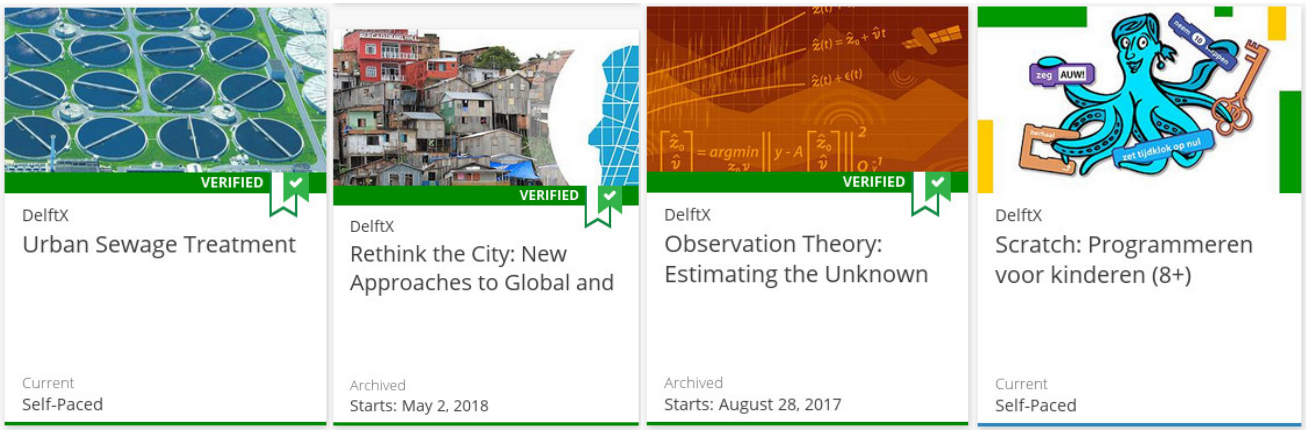
Marleen Keijzer, 4TU.AMI, June 29, 2018

DelftX MOOC



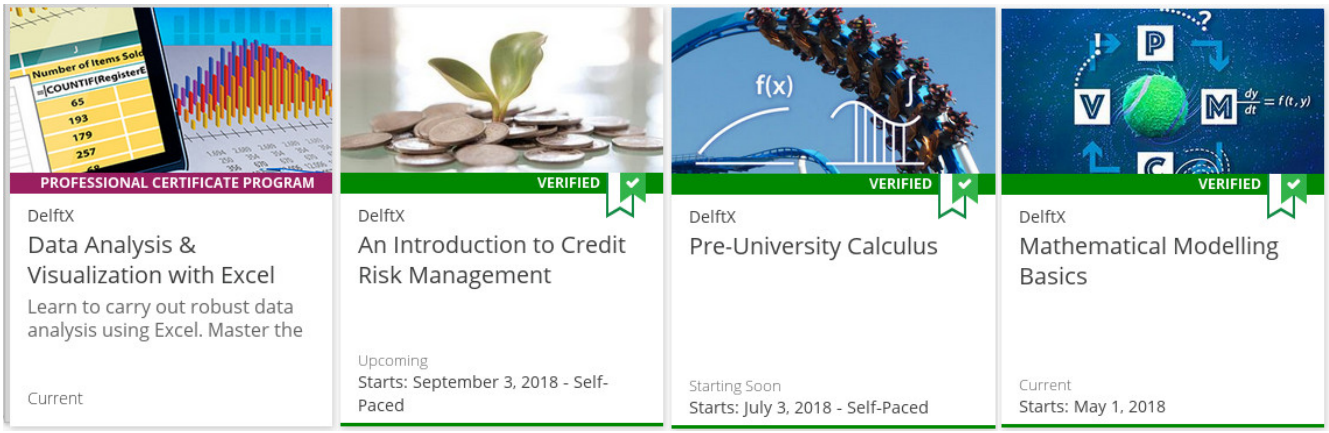
www.edx.org

DelftX MOOC



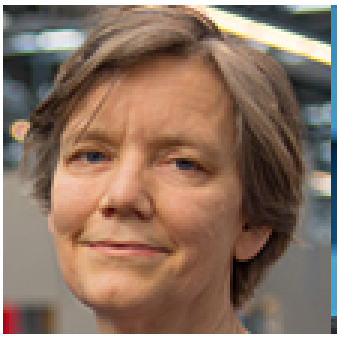
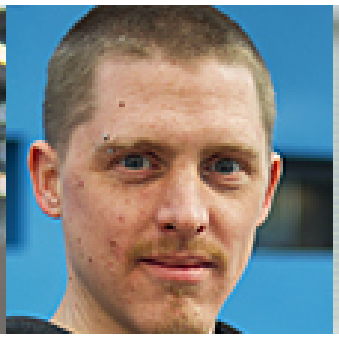
www.edx.org

DelftX MOOC

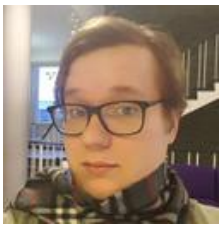


www.edx.org

Course team

Marleen Keijzer, Dennis den Ouden, Iris Smit, Kees Vuik



Esmée Vermolen Piotr Benedysiuk Myrte van Belkom
Hans de Munnik Jenneke van der Poel

Support & Input

Nelson Ribeiro Jorge, Ingrid Vos, NewMedia Center

Ingeborg Goddijn, Henk Schuttelaars, Sasa Kenjeres, ITAV

Why a MOOC?

- Promote TU Delft
- Produce material for on-campus courses
- Lure students into paid online courses
- Educate the world
- Promote mathematics
- Let staff learn to design online courses

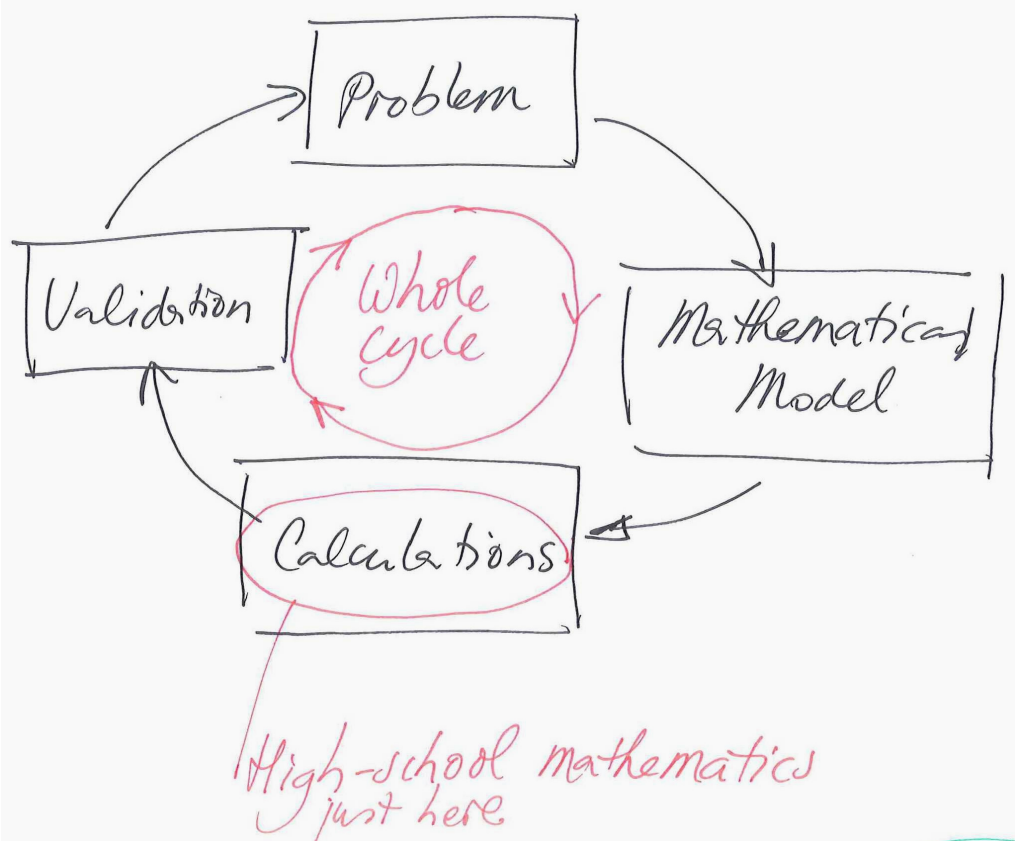
Mathematical Modelling Basics????

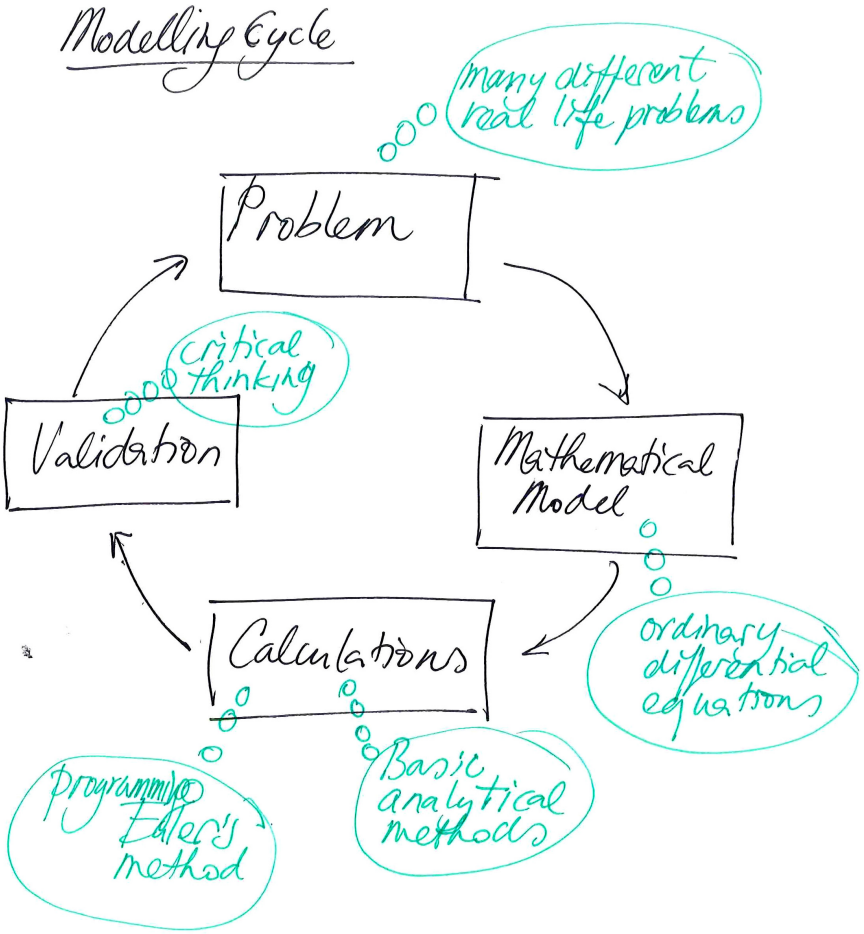
Learning objective:

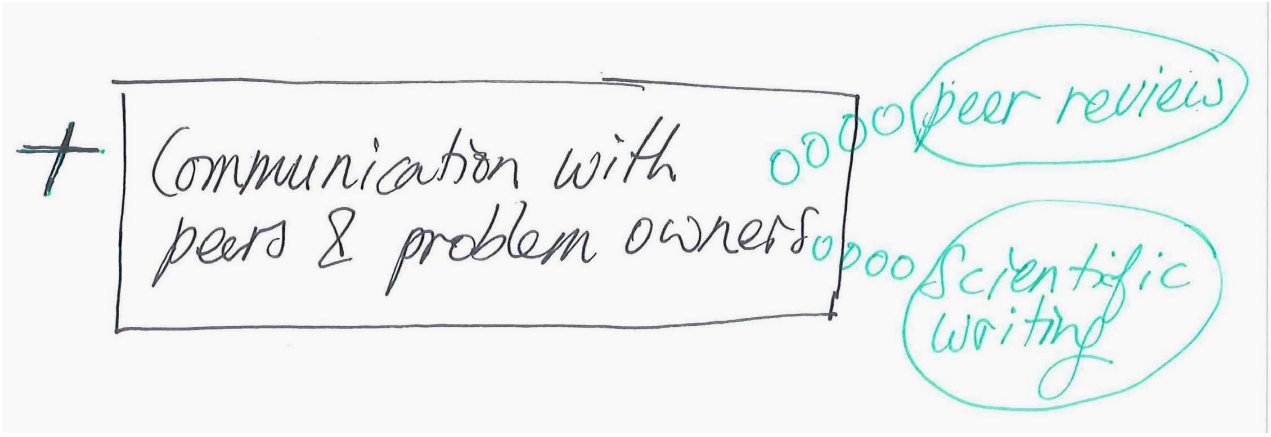
Applying mathematics to solve real-life problems

Target audience: our 1st year TU students in January

BSc students in science or engineering

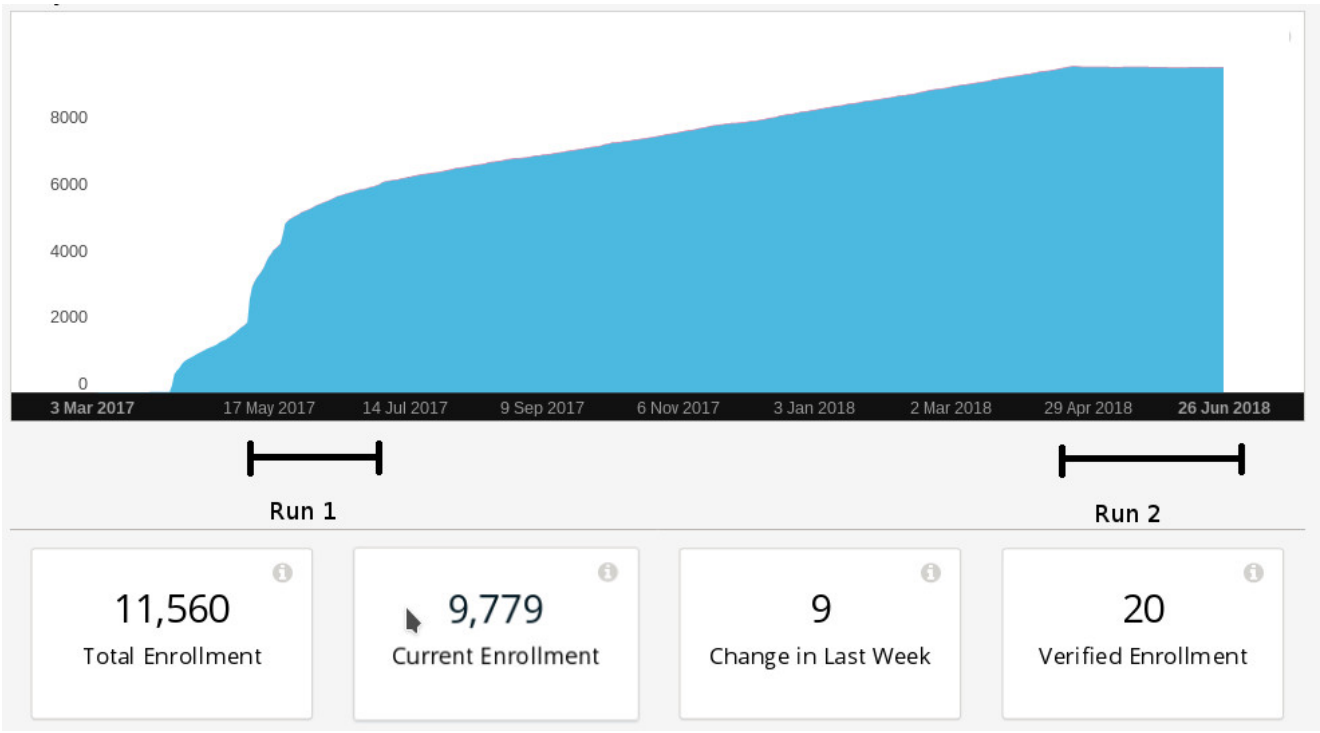

Problem
Validation
Whole cycle
Mathematical Model
Calculations
High-school mathematics just here

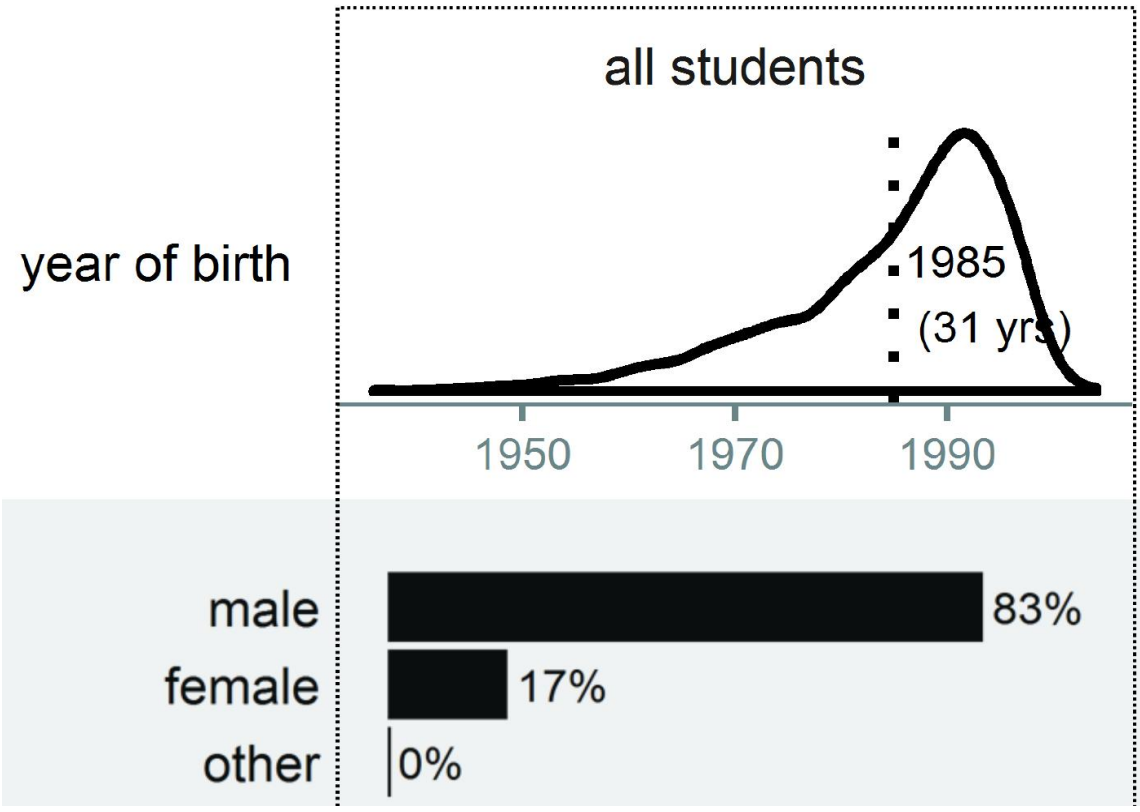

Modelling Cycle
many different real life problems
Problem
critical thinking
Validation
Mathematical Model
ordinary differential equations
Calculations
Basic analytical methods
Euler's method



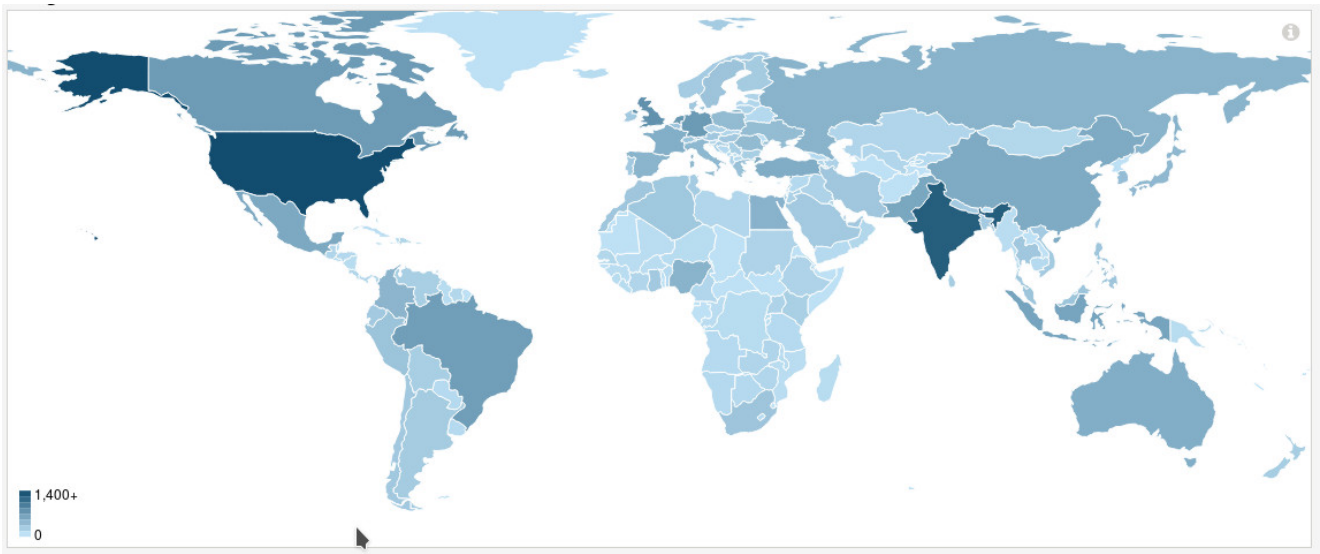
Module 1 (1 week)	Module 2 (2 weeks)		Module 3 (1 week)	Module 4 (2 weeks)		Module 5 (3 weeks)	
Form team	Specify problem		Choose values	Include interactions		Extend the model	Peer review
Mathematical Modelling	Collect information		Implement model	Explore how to extend model		Peer review	Implement feedback in final report
Fish!	More fish!		Predators!	Write short report on 1st model		Write final report	
Differential Equation	Stability	Euler's method	Systems	Scientific Writing	Mathematical Writing		
	Simulate in Python			Write with LaTeX			

Enrollment

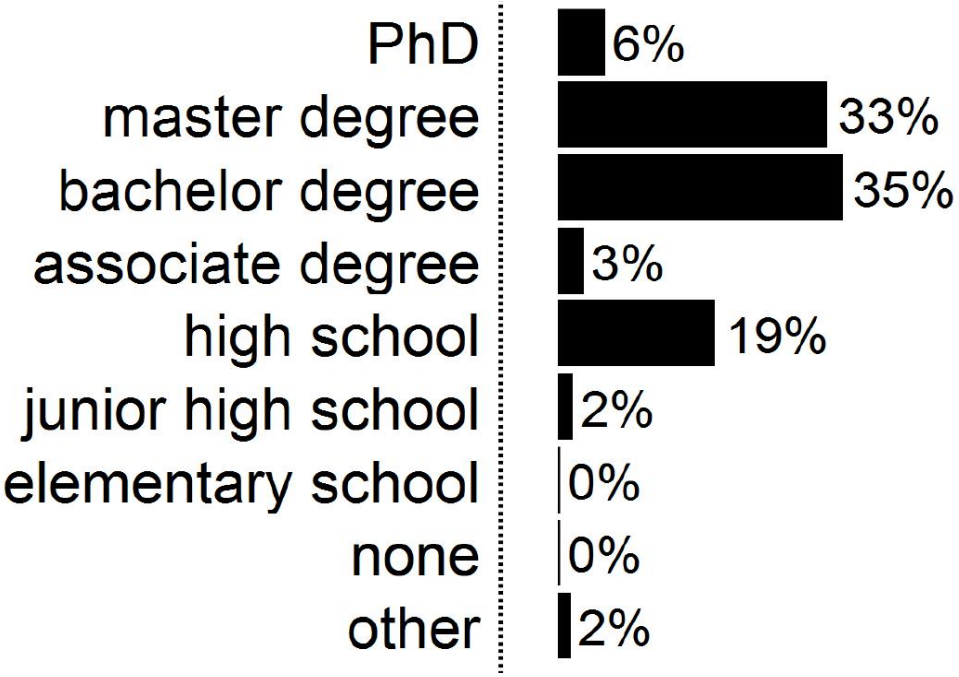

8000
6000
4000
2000
0
3 Mar 2017
17 May 2017
14 Jul 2017
9 Sep 2017
6 Nov 2017
3 Jan 2018
2 Mar 2018
29 Apr 2018
26 Jun 2018
Run 1
Run 2
11,560
Total Enrollment
9,779
Current Enrollment
9
Change in Last Week
20
Verified Enrollment

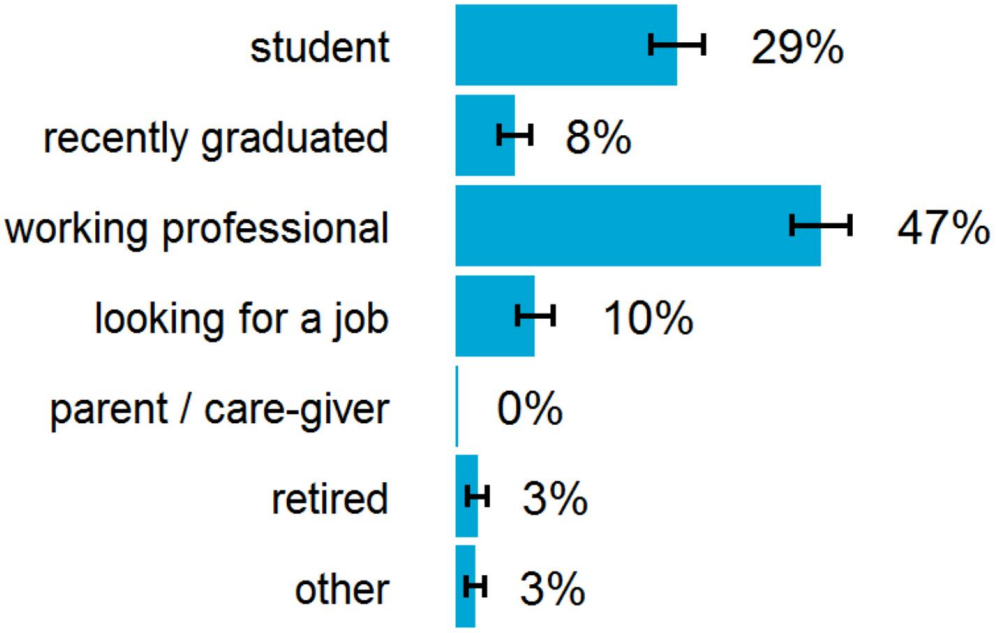

year of birth
all students
1985
(31 yrs)
1950
1970
1990
male
83%
female
17%
other
0%

Geographic distribution learners

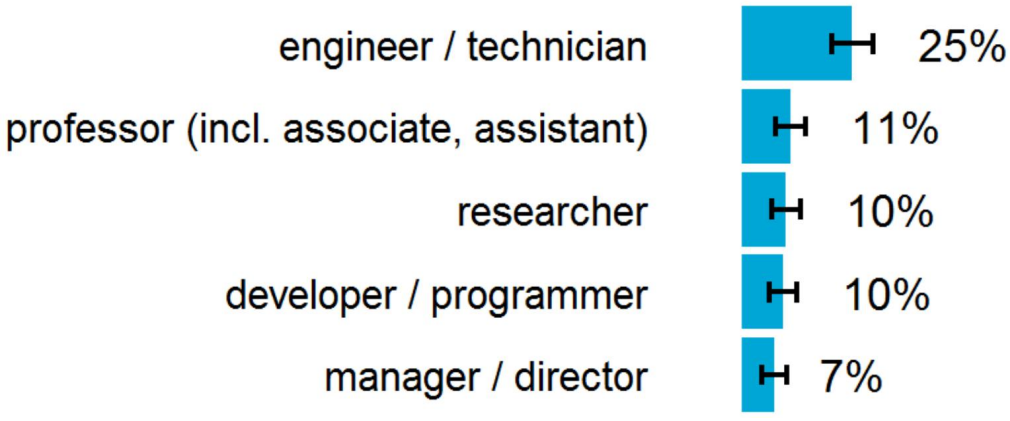


USA	1500 (15%)	Netherlands	400 (4%)	Nigeria	140
India	1200 (12%)	Brazil	300	Ghana	40
UK	400 (4%)	China	200	Nepal	40

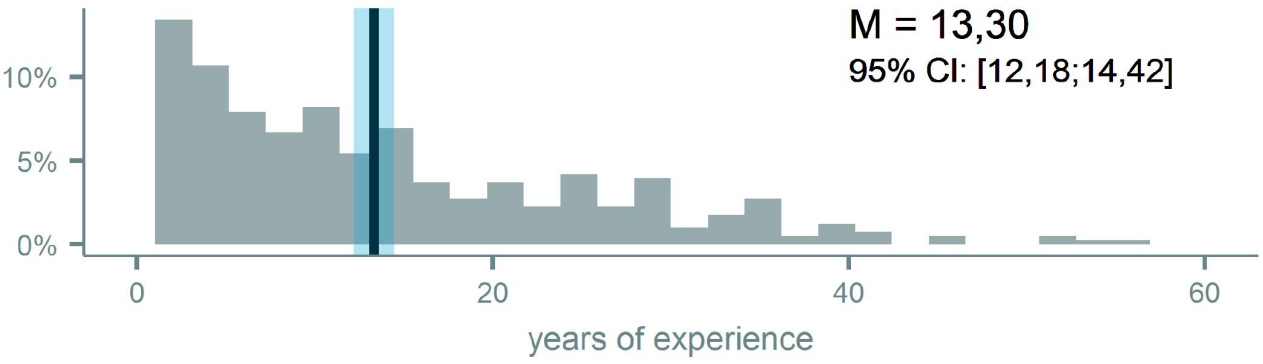




pre-survey, n=687



n=323

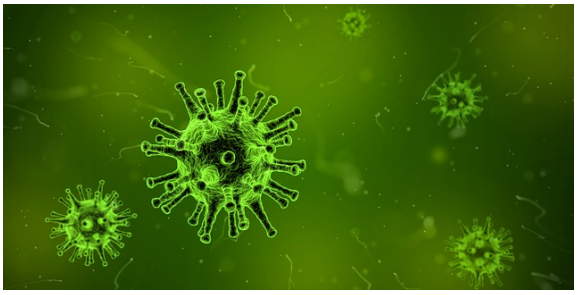


n=403

Numbers (first run Spring 2017)

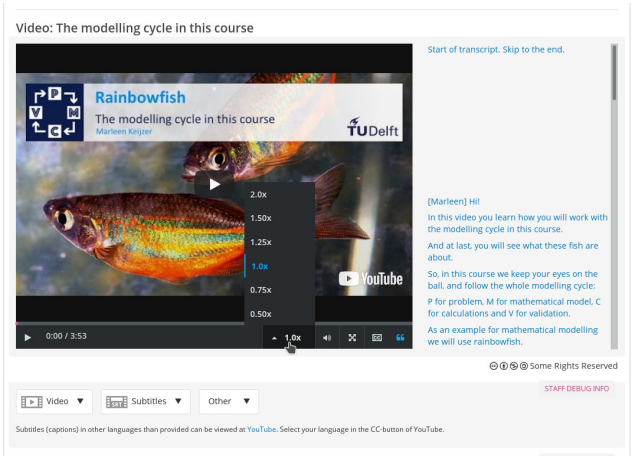
- 7700 enrolled
- 4300 started the course
- 1900 tried problems
- 380 started at least half of the 23 videos
- 30 submitted first report
- 20 submitted final report
- 20 completed the course
- 24 filled out the post-survey

Project in team of 2 or solo



Active learning

Preferably, content is discovered by the students in exercises.



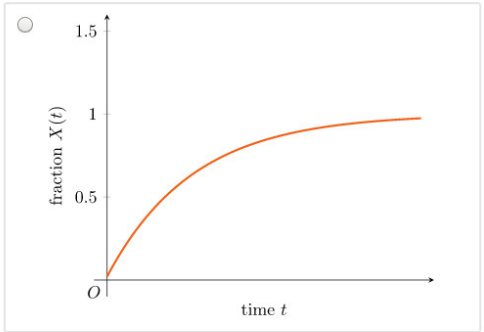
- Videos:
  short (3-6 minutes)
  and few (23)
- Texts: same
- Many formative exercises, with hints and feedback
- Consolidation in practice problems

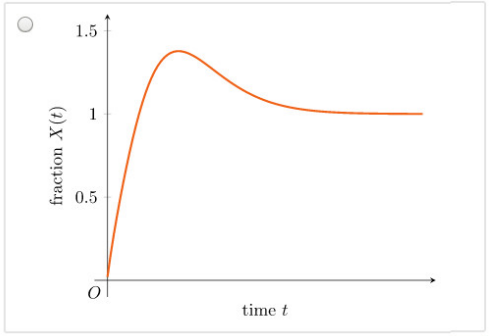
Exercises: Multiple Choice

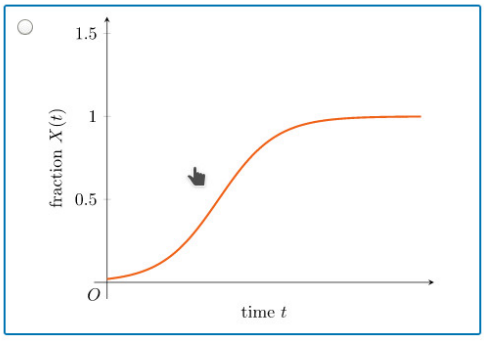
Exercise D

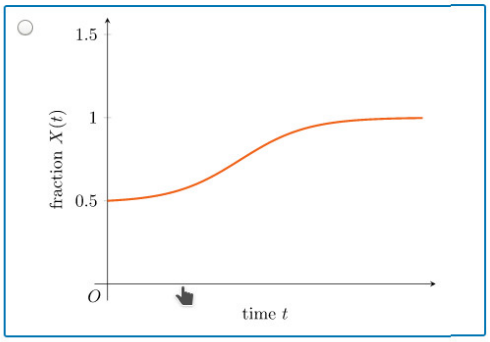
1 point possible (graded)

The graph of the solution $X(t)$ is









Submit You have used 0 of 1 attempt

Exercises: Numerical answers

Exercise C

1 point possible (graded)

Now use a smaller stepsize: $\Delta t = 0.5$, and approximate the population after 13 days.

$P(13) \approx$

Give your answer in two decimals.

Submit | You have used 0 of 10 attempts | Hint | Save | Show Answer

Exercises: Drag & Drop

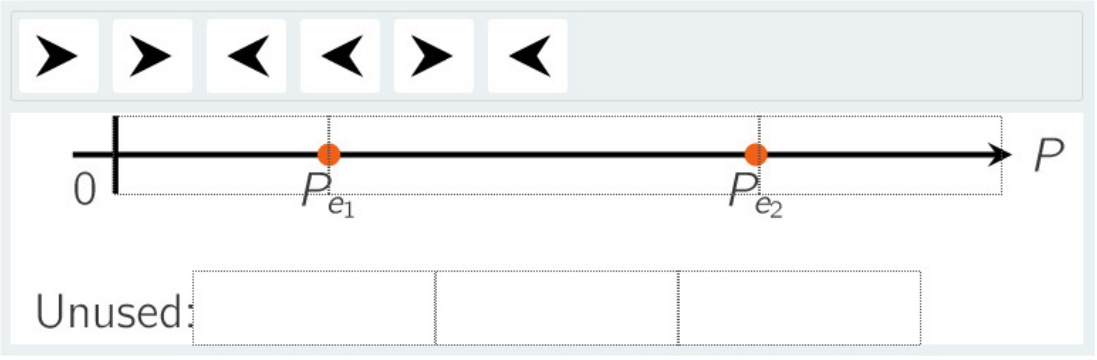
Exercise C

1 point possible (graded)

Keyboard Help

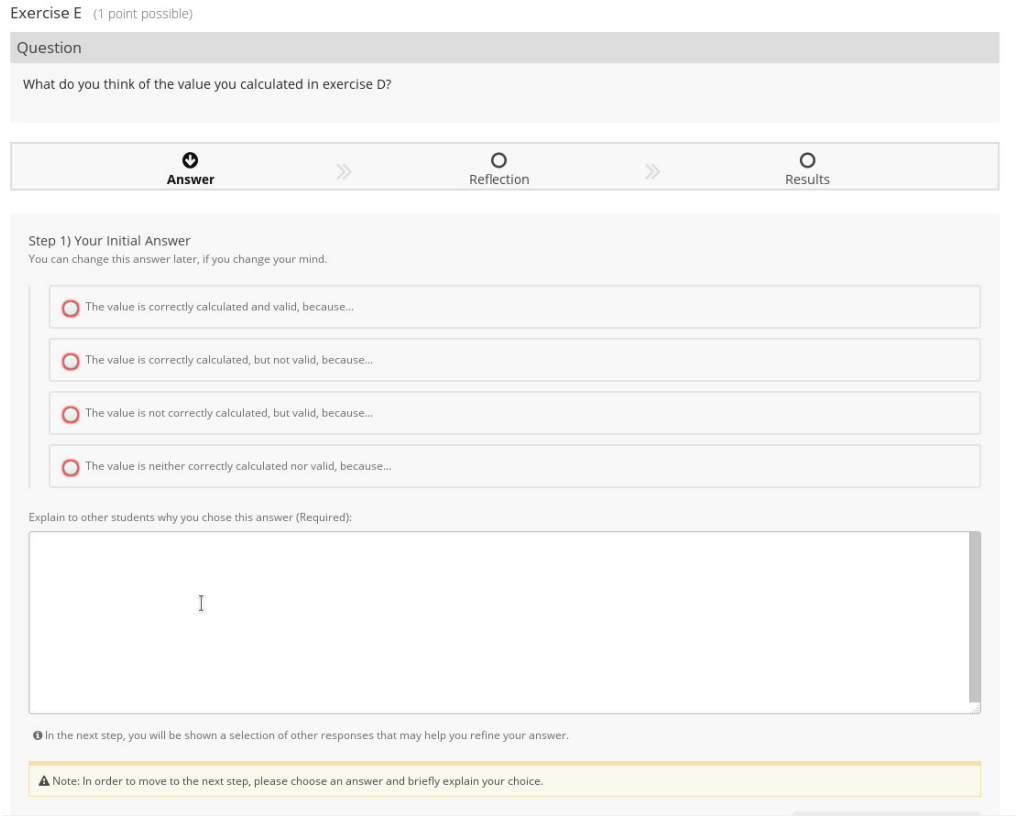
PROBLEM

Using your graph and the information from the previous exercises, construct the phase line.



Submit | You have used 0 of 3 attempts. | Reset | Show Answer

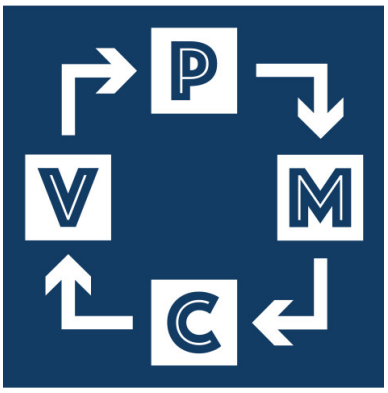
Exercises: questions with peer feedback



Compensating for no face-to-face teaching

- Extremely clear instructions
- Much personal text
- 'Glue' text
- Discussions:
  - Questions for the course team.
  - Learners helping each other
  - 'Thinking Further'
- Project work in pairs
- Peer review of the reports
- Exhibition of the reports

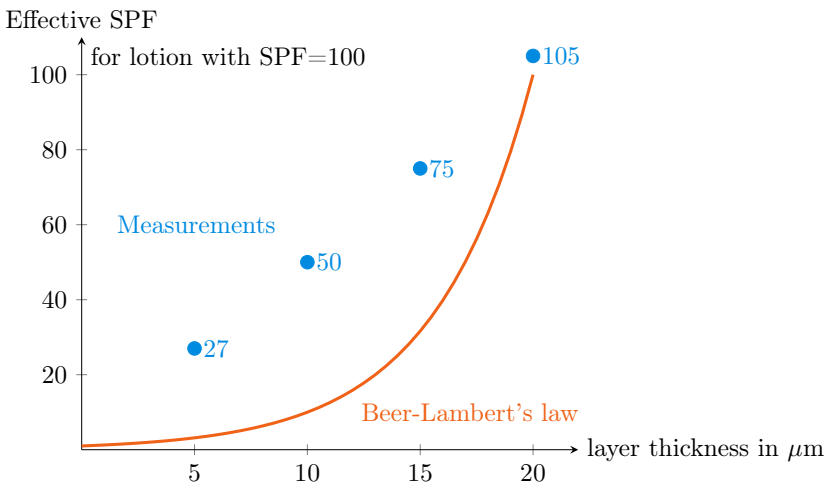
Content



$$\frac{dP}{dt} = 0.7P$$

balance equation
derivation ode

Suncream applied in too thin a layer



Mixing problem

$$\frac{dP}{dt} = 0.7P - 20$$

direction field
equilibrium points

$$\frac{dP}{dt} = 0.7\left(1 - \frac{P}{750}\right)P - 20$$

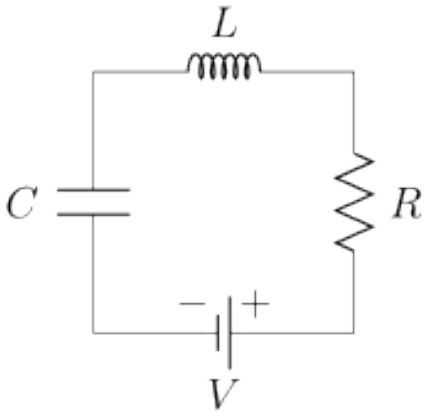
phase line
Euler's method
Python program

Flu epidemic

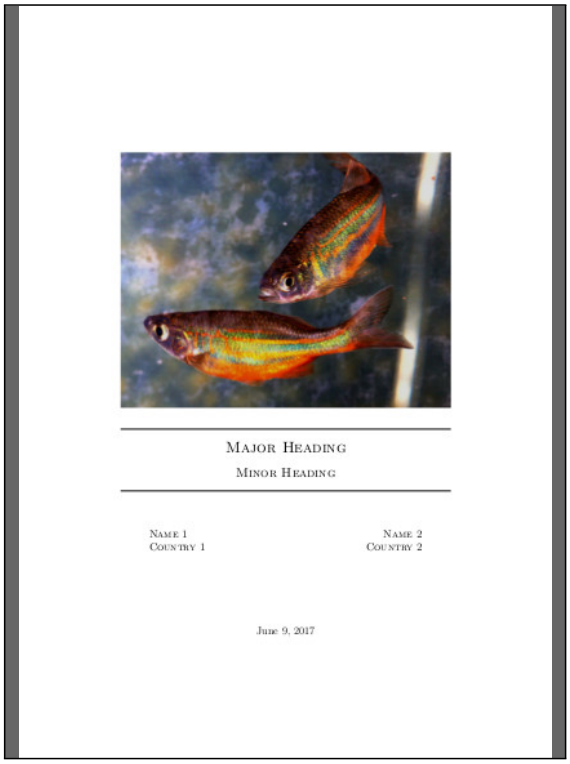
$$\begin{cases} \frac{dP}{dt} = 0.7P - 0.007P^2 - 0.04PG \\ \frac{dG}{dt} = -0.25G + 0.008PG \end{cases}$$

phase plane
stability equilibrium points
arrays in Python

Design & simulate
100mHz laptop clock



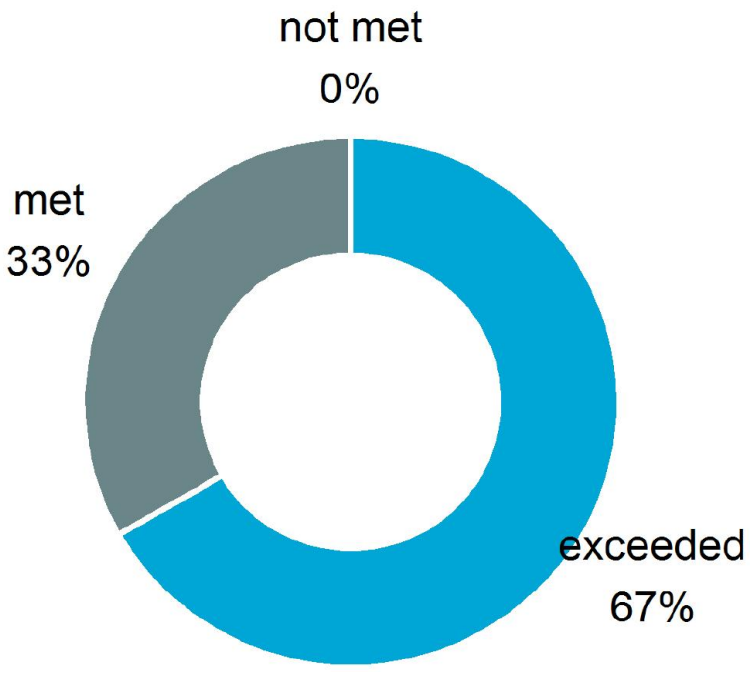
Scientific writing



- Purpose & audience
- Structure
- Components
- Wording
- References
- Figures & Tables
- LaTeX

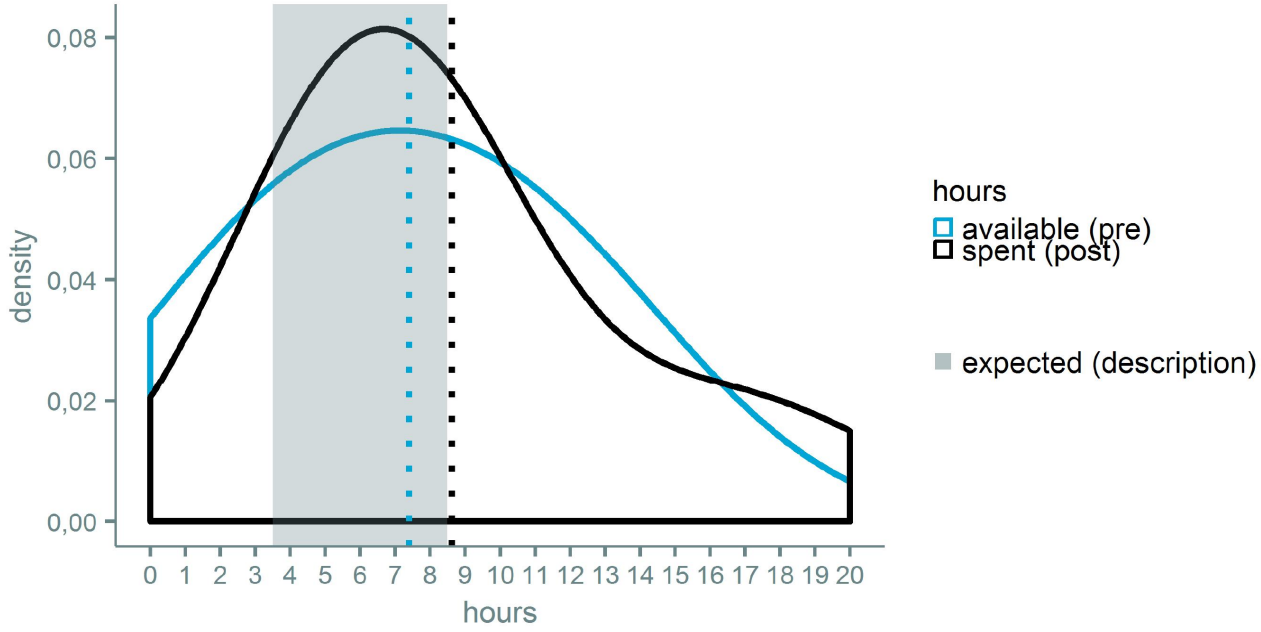
Exhibition of Reports

Learners' expectations were



n=18

Learners' available hours and hours spent

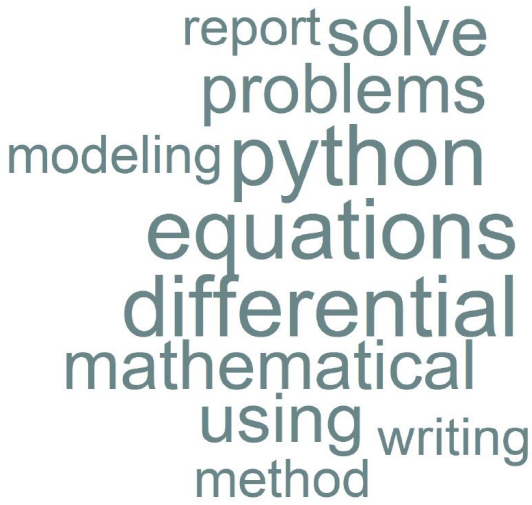


n=709

n=18

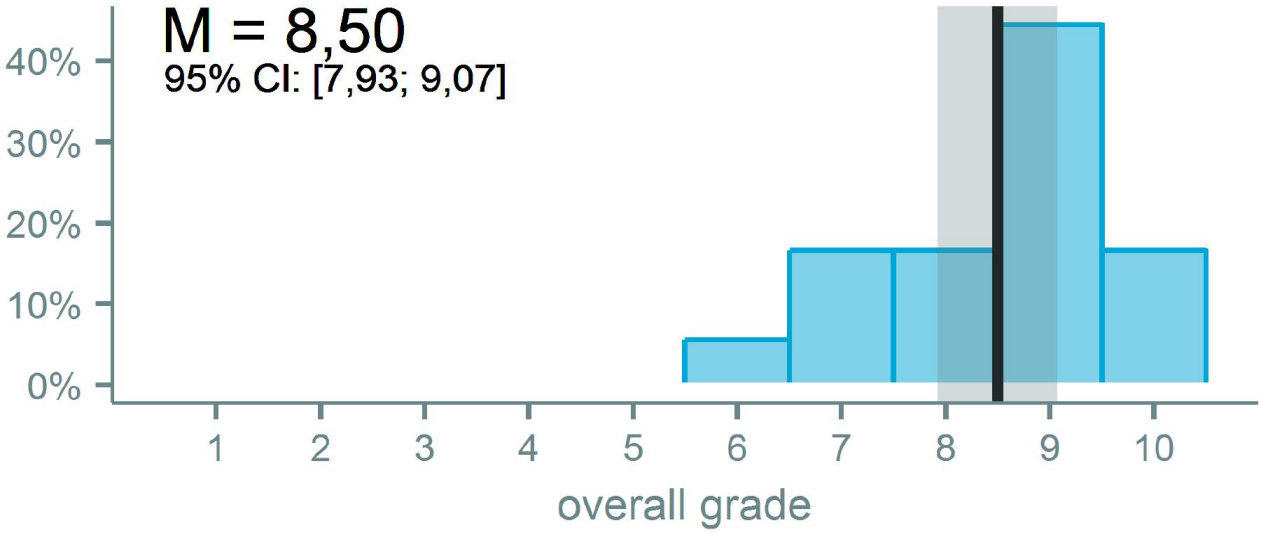
Learners liked

Learners found valuable



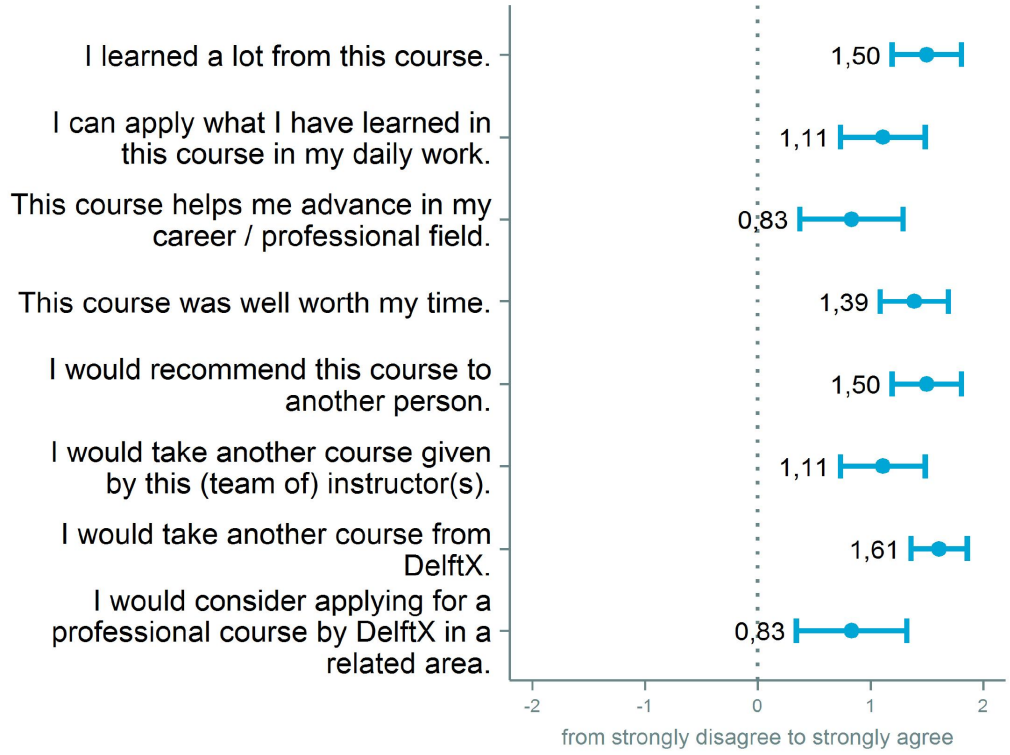
n=17-18

Learners gave the course the overall grade



n=18

Perceived value and impact

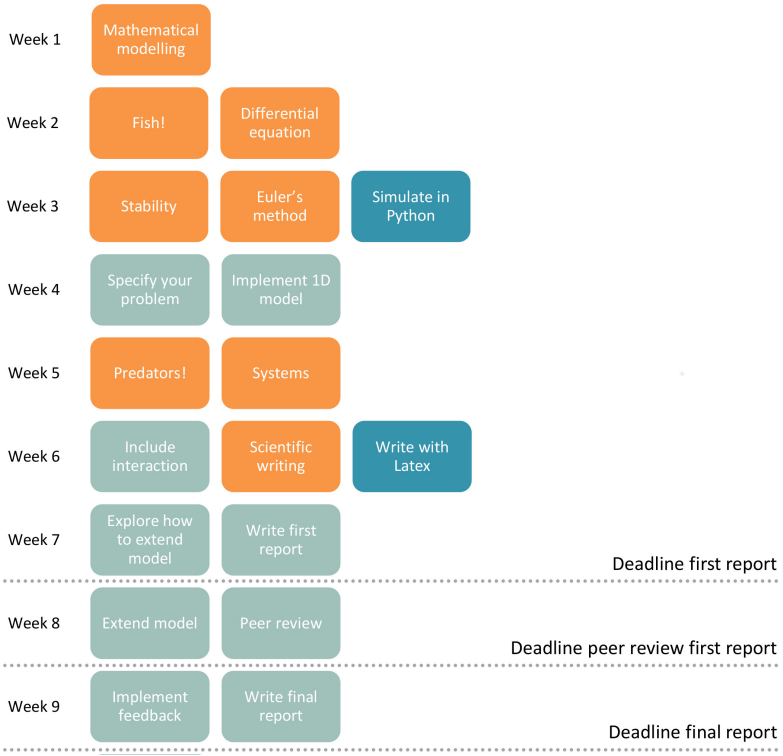


n=18

Second run, Spring 2018

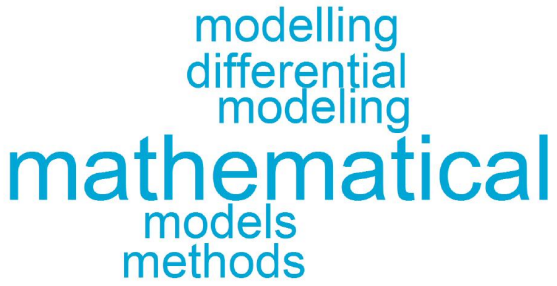
More:

- Modules
- Time for project
- Feedback on project

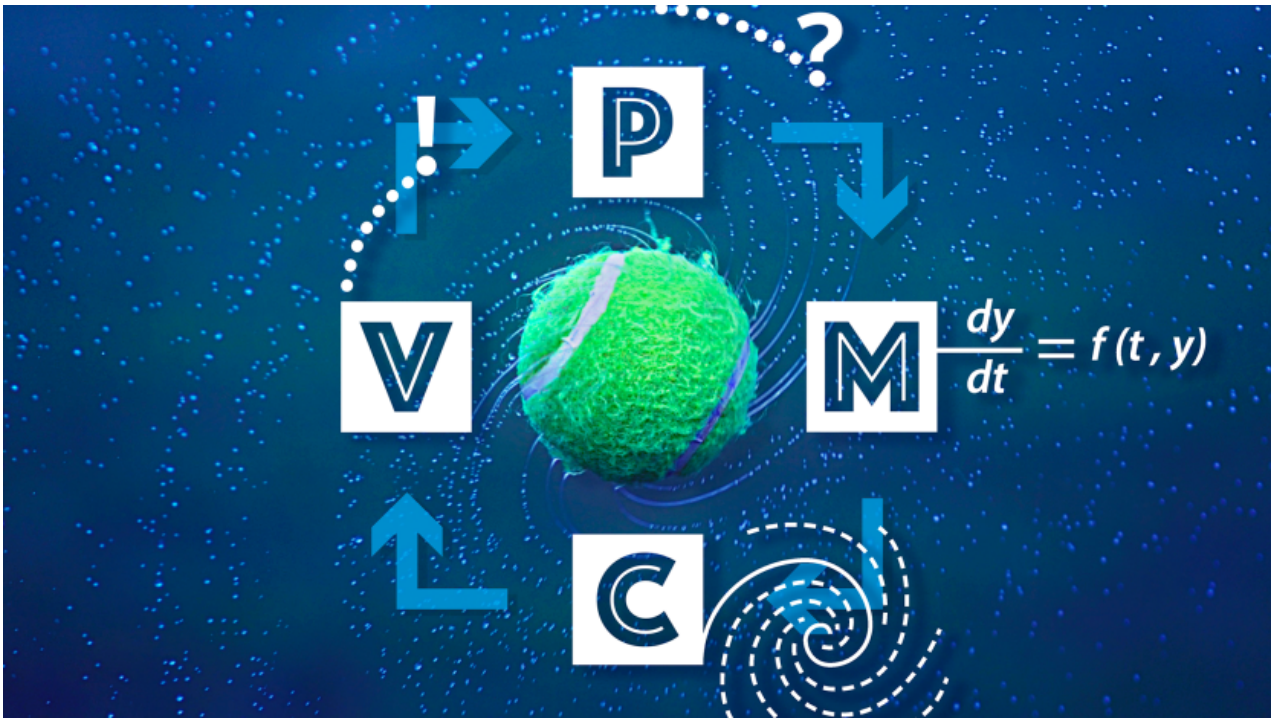


Future

Learners would like to learn next



n=17-18

- More runs
- Use in on campus practical Modelling A
- Build more MOOCs Mathematical Modelling Basics
  - Optimisation
  - Stochastic models
  - More ode & numerical methods
  - Pde

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