# **ETH** zürich



### STACK at ETH, Zürich

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STACK at ETH, Zürich – work in progress Meike Akveld & Andreas Steiger, ETH Zürich

### **About us**





Meike Akveld teaches a mandatory calculus class for 300 civil engineers Andreas Steiger teaches a mandatory calculus class for 700 mechanical engineers

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## **Overview**

- Short history
- Results so far
- Future goals

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## **Short history**

- Spring 2021: ETH sets up a test server with Moodle with the STACK module, Meike starts using STACK questions in multi-variable calculus for civil engineers (on a voluntary basis).
- Fall 2021 / Spring 2022: STACK is available in the main ETH Moodle and is used in two large calculus classes (Civil and Mechanical engineers). Around 1000 students in total.
- STACK is now used for two purposes: To offer practice materials, and as a grade bonus which is obtained by solving weekly STACK questions.

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### Some results I

STACK is used on two occasions in the Analysis I / II course for civil engineers (around 300 students):

► As extra practice material (with random components).



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## Some results I - Grade bonus

- To earn a grade bonus, students need to answer a one-question-quiz every week with a set time limit and under supervision. They get 0 or 1 point based on correctness. This used to be done on paper.
- Maximum bonus achieved with 18 out of 24 questions solved correctly over the year.
- STACK questions aimed at practicing the most important computations of the course

Bestimmen Sie Menge aller Nullstellen des Polynoms  $P(x) = x^3 + 9 \cdot x^2 + 15 \cdot x - 25.$ 

Achtung: Bitte schreiben Sie Ihre Antwort in der Form  $\{x_1, x_2, x_3\}$  also z.B.  $\{8, 9, 10\}$  usw.

Prüfen

First STACK quiz in the course (zeroes of a polynomial)

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# Some results I - Numbers

Percentage of correct answers

### Fall 2020 (on paper) vs Fall 2021 (STACK)



On average 235 participants or 83.1% of all students.

Success rate improved from 60.1% in 2020 to 65.4% in 2021.

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## Some results II

STACK is also used in the Analysis I / II course for Mechanical engineers with 700 students for a grade bonus.

- Students have to solve the weekly STACK question correctly, but they can try again with new parameters if they failed
- Maximum bonus achieved with 9 out of 12 questions solved correctly in each term
- STACK questions aimed at practicing the most important computations of the course
- Open problem: Many students hand in empty solution during first try, to see the solution

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### Some results II - Sample question

Sei S die Oberfläche des Würfels

 $W = \{(x, y, z) \mid 0 \le x \le 1, \ 0 \le y \le 1, \ 0 \le z \le 1\}$ 

abzüglich der Seitenfläche in der xy-Ebene, also ohne Punkte mit z=0.

Wir berechnen den Fluss des Vektorfelds

$$ec v(x,y,z) = egin{pmatrix} x+6 \ 4\cdot y^2 + 1 \ 2\cdot z^2 + 1 \end{pmatrix}$$

durch S nach aussen wiefolgt:

(a) Berechnen Sie die Divergenz von  $\vec{v}$ :

div  $\vec{v} = 1+8*y+4*z$ 

(b) Berechnen Sie das Volumenintegral:

$$\iiint_W \operatorname{div} ec v \, \mathrm{d} V =$$
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(c) Berechnen Sie den Fluss von  $ec{v}$  durch die in S fehlende Würfelseite F (also wo z=0 ) von W weg:

$$\iint_F \vec{v} \cdot \vec{n} \, \mathrm{d}O = \ \text{-5/3}$$

(d) Kombinieren Sie die Resultate aus (b) und (c) und schliessen Sie:

$$\iint_S \vec{v} \cdot \vec{n} \, \mathrm{d}O =$$
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### Some results II - Participation



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### Some results II - Some problems were hard!



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## **Future goals**

Through ETH's teaching innovation funds, we hired a developer for this project (Hi George!)

- Create more STACK questions as practice material and set up a database for our department
- Design comprehensive training modules (e.g. integral trainer)
- Use STACK in online or computer based exams
- Extend to other areas in mathematics (e.g. linear algebra or proofs)
- Get other departments interested in STACK (we will present STACK next week at the ETH's Innovation in Learning and Teaching Fair 2022)

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### Thank you for your attention!