# Automatic assessment in engineering mathematics: evaluation of the impact

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# Introduction

- ▶ First year studies in mathematics have been a source of difficulties for many engineering students.

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- Much of the work is based an automated assessment system (STACK). This makes testing cost-effective, and allows us to gather useful data with minimal effort.

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- We have compared the test results to the results from the first semester mathematics courses.

- We will also discuss our experiences of using the system in teaching mathematics. In particular, we will outline our experiences of using the system for continuous evaluation.

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- Our solution is to use *randomized* problems: each student gets a similar but slightly different problem.

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- Our solution is to use *randomized* problems: each student gets a similar but slightly different problem.

- The system we are using also allows us to create automatically assessed mathematics exercises, with additional benefit that the data is stored for research purposes.

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# The basic skill test

- All new students (N=704 in 2008, N=843 in 2009 and N=833 in 2010) made the basic skill test in the autumns 2008, 2009 and 2010.

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- The test problems were originally created in Tampere University of Technology (TUT).
- In Aalto University the test was implemented by using Automatic assessment system STACK (Sangwin, 2003).
- It included 16 randomized questions covering the high school topics considered to be the most important.

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# Results of the basic skill test

Distribution of the scores in 2008-2010
Mean scores      2008: 9.26      2009: 9.35      2010: 9.84

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# Results of the basic skill test

Distribution of the scores of each problem in 2010

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# Results of the basic skill test

- The Spearman's rank correlation between the results of the basic skill test in 2009 and first year mathematics courses is not very high but statistically significant ($\rho = 0.2364$, p=0.0000).

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# Results of the basic skill test

- The Spearman's rank correlation between the results of the basic skill test in 2009 and first year mathematics courses is not very high but statistically significant ($\rho = 0.2364$, p=0.0000).
- Thus success in basic skill test does not ensure success in mathematics courses.
- There must be also other factors than the basic skills that affect on how students perform in mathematics courses.

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# Basic course in mathematics S1

The percentage of automatically assessed (above) and
traditional (below) exercise assignments solved by students.

|       | 0      | 1      | 2      | 3      | 4      | 5      |
|-------|--------|--------|--------|--------|--------|--------|
| 2007  | 11, 60 | 17, 97 | 33, 02 | 31, 19 | 64, 04 | 79, 68 |
|       | 3, 78  | 7, 77  | 20, 19 | 9, 40  | 26, 84 | 61, 61 |
| 2008  | 13, 20 | 23, 62 | 36, 55 | 49, 56 | 65, 60 | 74, 89 |
|       | 4, 79  | 13, 56 | 16, 15 | 28, 85 | 56, 81 | 58, 44 |
| 2009  | 14, 62 | 23, 28 | 38, 78 | 49, 53 | 51, 16 | 78, 32 |
|       | 3, 77  | 10, 00 | 29, 20 | 50, 48 | 68, 22 | 92, 48 |

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# Discrete mathematics – the experiment

▶ Classroom lectures and face-to-face exercise sessions were held alongside the e-assessment.

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- ▶ The use of STACK was extensive: 2/3 of the exercises were computer aided.

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# Discrete mathematics – the experiment

- Classroom lectures and face-to-face exercise sessions were held alongside the e-assessment.
- The use of STACK was extensive: $2/3$ of the exercises were computer aided.
- The exercise assignments formed a significant portion of the final grade.

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# Discrete mathematics – the experiment

The grading system on the course

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# Discrete mathematics – results

Scores from exams and exercise assignments

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# Discrete mathematics – results

- ▶ Feedback was collected with questionnaire by using a five point Likert scale.

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- Feedback was collected with questionnaire by using a five point Likert scale.
- Students' experiences were positive both regarding the arrangements and the technology.

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# Discrete mathematics – results

- ▶ Feedback was collected with questionnaire by using a five point Likert scale.
- ▶ Students' experiences were positive both regarding the arrangements and the technology.
- ▶ Most of the students felt that STACK is useful to learn the basics.

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# Discrete mathematics – results

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- ▶ Students' experiences were positive both regarding the arrangements and the technology.
- ▶ Most of the students felt that STACK is useful to learn the basics.
- ▶ The general belief was that learning advanced concepts still requires face-to-face interaction.

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# Conclusions

- E-assessment can significantly increase flexibility in teaching and lead to other practical benefits.

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- E-assessment can significantly increase flexibility in teaching and lead to other practical benefits.
- Besides this, new technology enables the use of novel pedagogical solutions.

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- Besides this, new technology enables the use of novel pedagogical solutions.
- The technology described is suitable for large scale teaching.

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- Besides this, new technology enables the use of novel pedagogical solutions.
- The technology described is suitable for large scale teaching.
- Practices used in the continuous evaluation experiment are currently being applied also on course S3. Preliminary data is very promising.

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