Experiences of continuous formative assessment in engineering mathematics

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The old model: exam-based assessment

- Traditionally a course is graded based on a few exam questions
  - All topics of the course can't be covered
  - Some question types are over-emphasized
  - Once the exam is over students can forget everything they've learned
  - Students often start studying seriously only just before exams
  - The examination creates anxiety

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The new model: continuous formative assessment

- Blended learning with face-to-face interaction and computer aided assignments
- Grading the course is based on a large amount of assignments
  - The topics of the course are better covered
  - The significance of one task is not emphasized
- Workload is (hopefully) distributed more evenly during the whole course
  - This encourages deep learning (Ramsden 1992)
- Freedom to choose the time and place to work

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# Some results from course "S1"

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

The percentage of *automatically assessed* (above) and traditional (below) exercise assignments solved by students. Numbers are sorted presented by the grade given (0-5), where 0 means failing the course.

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The experimental course: Discrete Mathematics

- 12×6 exercises in total, 2/3 of which were computer aided*
- 2 optional exams
- Graded from 0 to 5, where 0 is failed and 5 is highest

*Computer aided exercises were implemented using automatic assessment system STACK

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The experimental course: Discrete Mathematics

- 90% of exercises = grade 1 (pass)
The experimental course: Discrete Mathematics

- 58 participants
- Mostly students from 2\textsuperscript{nd} to 5\textsuperscript{th} year

Degree programs

- TIK = Computer Science and Engineering
- TFM = Engineering Physics and Mathematics
- EST = Electronics and Electrical Engineering
- AUT = Automation and Systems Technology
- TLT = Communications Engineering
Evaluation of results

- Comparing results with courses of 2008 and 2009
- Questionnaire of students' experiences (Ginns & Ellis, 2007)
  - Categories: quality of STACK exercises, clarity of goals and standards, appropriateness of assessment, appropriateness of workload, student engagement, practical arrangements and blended learning (Kivelä, 2002)
  - 30 items with five response possibilities on Likert scale: 1 = strongly disagree ... 5 = strongly agree
  - Number of responses depending on question 28 - 30

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Results

- The percentage of grade 0 (failed)
  - 2008: 30%
  - 2009: 34%
  - 2010: 18%
- The percentage of grade 5
  - 2008: 27%
  - 2009: 15%
  - 2010: 45%
- Passing percentage increased noticeably

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Results

- The percentage of failed students out of all participants
  - 2008: ?
  - 2009: 35%
  - 2010: 31%

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Results

Students' exam scores in relation with exercise assignments submitted
Some students submitted a lot of exercises, but did not do well in the exams, but they were few.

<table>
<thead>
<tr>
<th>Student</th>
<th>1\textsuperscript{st} exam</th>
<th>2\textsuperscript{nd} exam</th>
<th>paper exercises</th>
<th>STACK exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>13</td>
<td>2</td>
<td>81%</td>
<td>72%</td>
</tr>
<tr>
<td>B</td>
<td>13</td>
<td>1</td>
<td>81%</td>
<td>72%</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>0</td>
<td>100%</td>
<td>55%</td>
</tr>
<tr>
<td>D</td>
<td>17</td>
<td>6</td>
<td>74%</td>
<td>80%</td>
</tr>
</tbody>
</table>
Results: questionnaire

- 43% of the respondents felt that they solved more exercises than normally
- Mean: 3.27   S.D: 1.34
- The percentage of participants, who had solved exercises (at least 1)
  - 2009: 70%
  - 2010: 91%

20) I did more exercises on this course than I would normally do on a mathematics course.
Results: questionnaire

- Students felt that solving exercises is important.

5) Solving the exercises helped me to learn things.

24) Solving the course exercises prepared well for the course exam.

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8) Instead of studying at the last minute (just before the exam) I studied during the entire course.

Most of the respondents (60%) said that they studied during the whole course.
Mean: 3,53  S.D:1,31

All of the items concerning student engagement had a mean near to neutral and a high deviation.

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6) I was less tense about taking the course exam than normally.

- On the average, the tension of taking an exam did not ease
- Mean: 3.23  S.D: 0.86
- Disagree: 17%
- Agree: 40%
- It seems that our arrangements did help some students

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Ongoing projects

- Practices used on the experimental course are being tested on a larger engineering mathematics course S3
- New and improved practices are experimented on an entirely new engineering mathematics course BTT1 (for Bioproduct Technology students)
- Some support functions are being developed to evolve students' learning skills (OTE-project)
- Customized guidelines for different learning styles

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Thank you!

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