Embedding interaction in traditional mass teaching

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INTRODUCTION

In engineering education, there are conflicting trends. Importance of interaction and individual feedback has been discussed a lot. On the other hand, electronic learning environments have been found to intensify the use of teaching resources and enable ubiquitous teaching. The most workable compromise may be blended learning, which takes aspects from both approaches. In this paper, we discuss ways to combine different methods in the most efficient way.

Several studies show that large classes make students passive and give a mental permission for non-learning [1,2]. To tackle the challenge of large number of students [3] and the need for individual feedback, we seek a good balance between different methods to produce top-level teaching with limited resources. Student response systems (clickers) have been successfully used to activate students in large lecture halls [4,5,6]. Outside the classroom, current e-learning environments could offer the potential to engage students, but getting these tools to support pedagogy instead of being just administrative tools is challenging [7,8].

Interaction between teachers and students is important [1,9], but contact teaching and individual feedback require a lot of resources. We are therefore interested in the following questions: What kind of interaction is most needed? Which part of feedback could be delivered via e-learning environments and which part require face-to-face communication?

1 BACKGROUND

We are interested in students' opinion on how they experience teaching in two of our current courses, offered for first and second year students. In autumn 2015 both courses had about 160 enrolled students and the courses were implemented as follows:

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In circuit analysis, we use normal mass lectures, sometimes assisted with clicker discussions. Weekly exercises are organized in smaller groups; the work done in these exercises in not evaluated. In addition, students solve one homework problem per week and submit the solution via a Moodle-based e-learning environment. Students see the grading of these answers, and short written feedback comments are occasionally given to individual students. About 70 % of the assessment is based on exams.

In electromagnetic field theory, we use clickers more extensively on each lecture, mixing peer instruction [5] with some lecturing. Each week a short reading quiz is due before the lectures. Weekly exercise sessions in smaller groups are held after the lectures. The reading quizzes are submitted and graded electronically, while the exercise answers are returned to teaching assistants in-class, so that the assistants immediately check the solutions and give feedback to the students. The grading of the course is determined by the reading quizzes (20%), weekly exercises (40%) and two mid-term exams (40%).

2 METHOD

To find out how to produce better learning with modest teaching resources, we want to know how students experience the current teaching and which part of the interaction is most important.

We designed a web-based survey about students' opinions on three topics:

A. Use of clickers to promote discussion

B. Sufficiency of feedback and interaction

C. Electronic learning environments and student's engagement

Invitation to participate in the anonymous web-based survey was sent in January 2016 to 323 students that took the courses in autumn 2015. Ninety students answered the survey (28%). The proportion of female respondents was quite small (14%), but it roughly corresponds to the gender balance on the courses. We did not find any significant difference in the answers between the courses.

The survey included 20 questions. All mandatory questions were multiple-choice questions ("choose the closest alternative"). In addition, each topic A – C contained one optional open-ended question for free-form explanations.

3 RESULTS

As background information in our survey, the students were asked to consider their study habit preferences: whether they like to study alone or with friends, at home or at school, through net or face-to-face, independently or supervised. Based on the answers, we calculated a study habit index (SHI) where larger values indicate a more collaborative and social student. The distribution of the indices in *Fig. 1* shows that there were all kind of students from loners to collaborators. Small difference was observed in the average SHI between female (6.8) and male (8.4) respondents. The female students are slightly more solitary, which might be a consequence of the fact that they are a small minority in electrical engineering. The number of female respondents was quite small, and we did not find any other notable differences between genders.

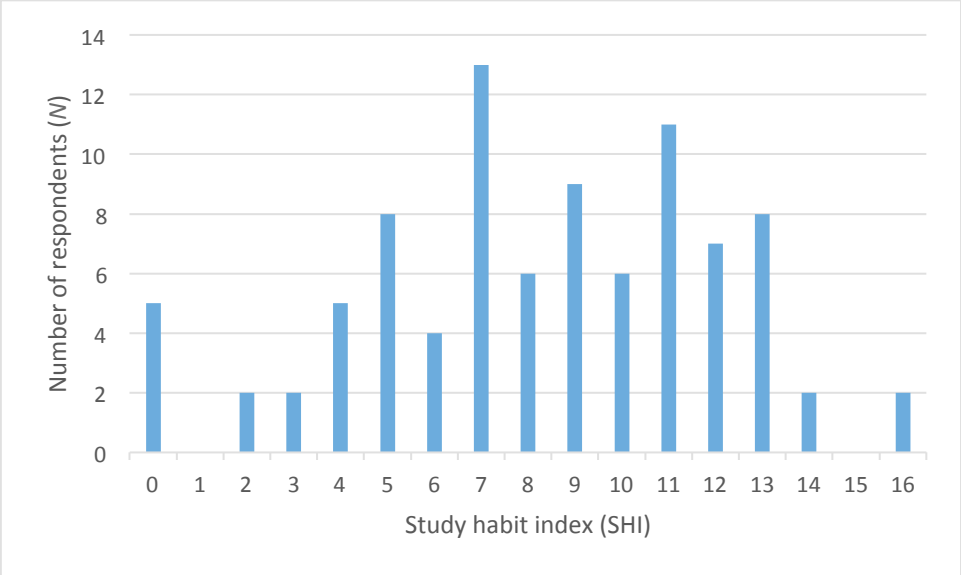

Fig. 1. The calculated SHI for the answers. Small value indicates more introvert person and large value socially oriented person.

3.1 Use of clickers to promote discussion

A large majority (77%) of the respondents agreed partially or fully that the use of clickers during lectures advanced their learning (see *Fig.* 2). The open-ended answers told us that the use of clickers was stimulating and thus helped the students to concentrate on the lectures. The discussions helped the students to grasp fundamental concepts that were needed to solve the exercise problems. Also findings in [10] highlighted peer discussion to be most useful for reflecting one's own understanding, making learning visible, and creating a sense of participation.

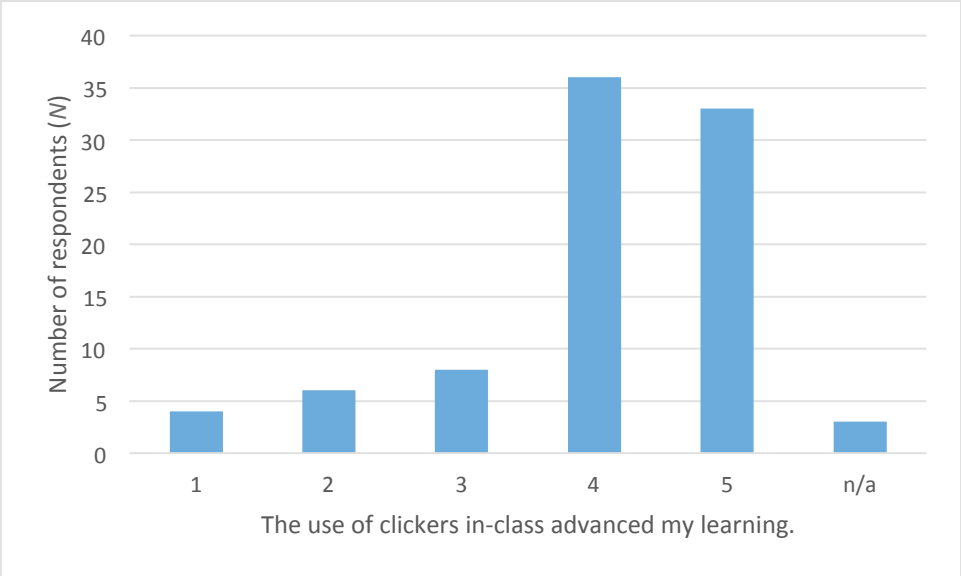

Fig. 2. Most of the students found that the use of clickers advanced their learning. (1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree, 5 = strongly agree, n/a = I did not participate in the lectures)

Feedback is more powerful when it shows faulty interpretations rather than a lack of understanding, as is concluded in [11]. This is one explanation why students find that the use of clickers advance their learning. Good clicker questions help the students to focus their attention to misinterpretations and give immediately feedback on learning. However, creating pedagogically sound questions is a key issue and requires a lot of effort. Covering the most important concepts, identifying common misinterpretations, and posing suitably challenging questions is difficult.

Engineering students are often stereotypically considered to be introverts who do not want to collaborate and discuss. However, as shown in *Fig.* 3, only 5 students out of 90 wanted much less discussions and all of them except one had the lowest possible SHI. Altogether, only 10 students wanted less discussion. This result strongly encourages using discussion-based teaching methods during lectures for engineering students, too.

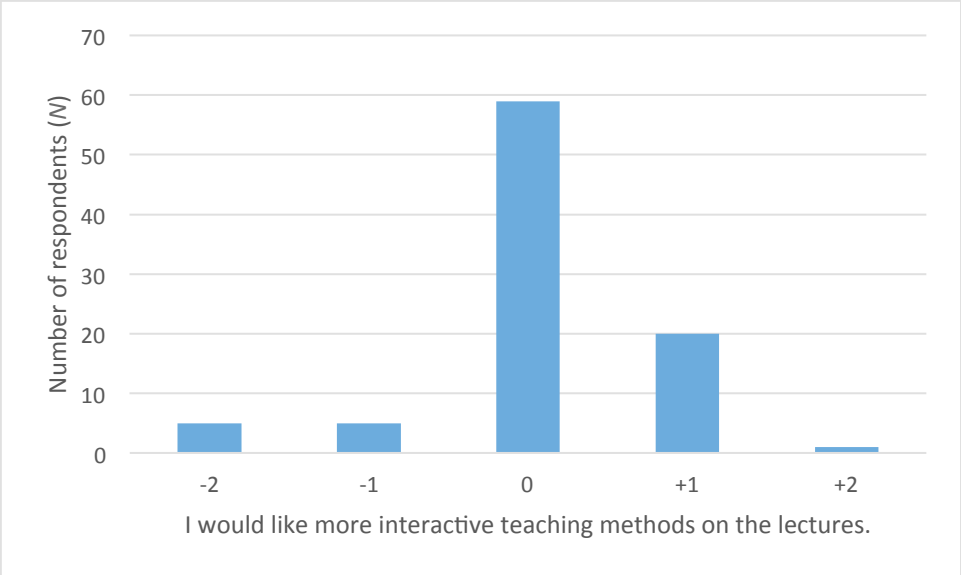

Fig. 3. The students seem to like interactive lectures. On the average, some increase in the use of the interactive methods was preferred. (-2 = much less, -1 = somewhat less, 0 = the current amount is suitable, +1 = some more, +2 = much more).

3.2 Sufficiency of feedback and interaction

Figures 4–6 analyze students' opinions on the amount and quality of the given feedback. Although 40% of the respondents experienced that the amount of feedback was scarce, only 6% found that the received feedback was not encouraging and just 7% found that the feedback was not advancing their learning. That is, although more feedback would have been welcome, a large majority found the given feedback motivating and supportive.

Based on the students' comments, many of them felt that the points and grades were the main feedback. General feedback to the whole class or to a group seemed to be disregarded: the students mainly wanted and appreciated personal feedback. The comments reveal that students have quite a narrow impression of feedback. Verification of a correct answer, showing gaps in knowledge, or introducing alternative strategies are ignored as ways of feedback [10,11]. Due to the narrow impression of feedback, students do not always realize how they could use the feedback (e.g. received via clickers) to guide their studying.

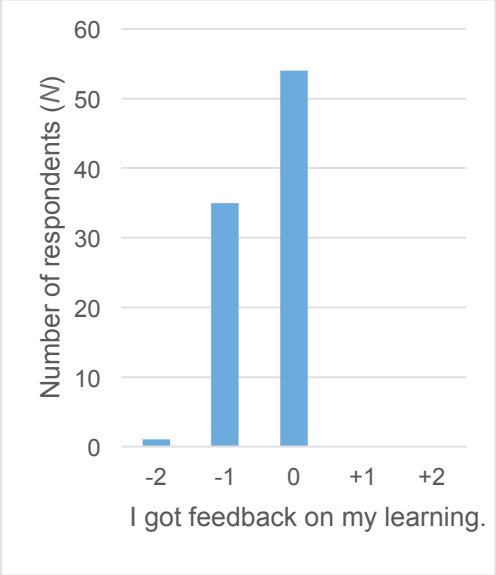

Fig. 4. The amount of feedback (-2 = too little, -1 = somewhat little, 0 = suitable amount, +1 = somewhat too much, +2 = too much)

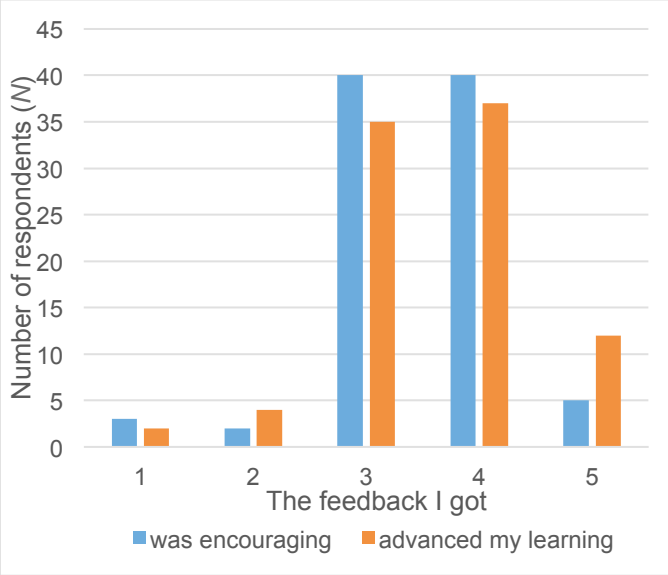

Fig. 5. Students' opinions on the quality of feedback (1 = strongly disagree, 2 = disagree, 3 = neither disagree nor agree, 4 = agree, 5 = strongly agree)

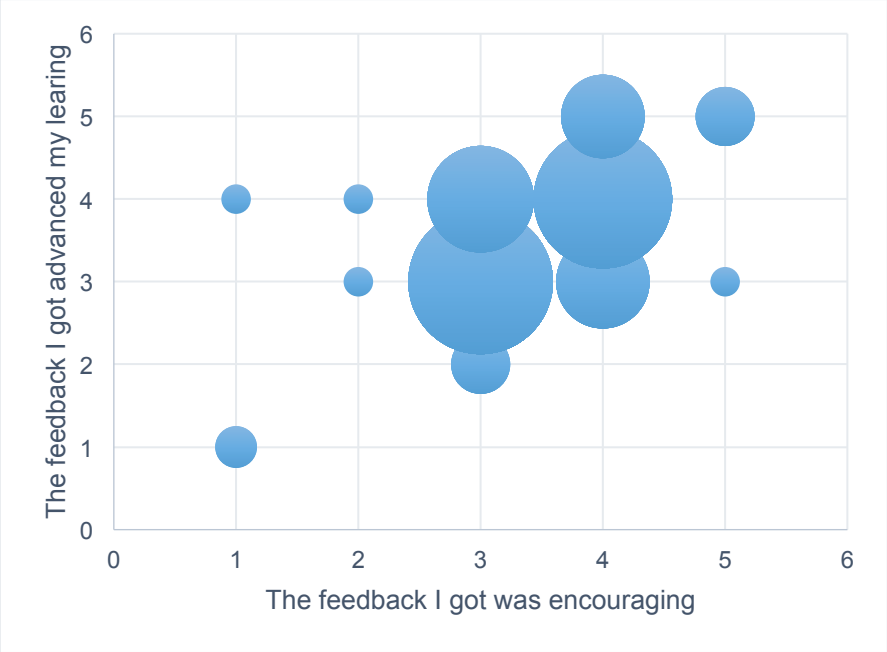

Fig. 6. Students' opinions on the quality of feedback, as in *Fig.* 5. Encouraging feedback was experienced to advance learning. The correlation coefficient is 0.57.

In mass teaching, giving personal feedback to every student is laborious. In practice, considering all aspects of feedback [11] is difficult when the focus is to provide at least some feedback to everyone. Even the small amount of feedback in our courses was experienced to be both encouraging and useful, as shown in *Fig. 6*.

3.3 Electronic learning environments and students' engagement

To advance cooperative and collaborative group learning in e-learning environments, we need to know the attitudes of students [7]. In the survey, eight of the respondents indicated that they do not use or use very little social media. However, their inactivity in social media (value 0 in *Fig. 7*) didn't correlate with their willingness (or unwillingness) to use the e-learning environment.

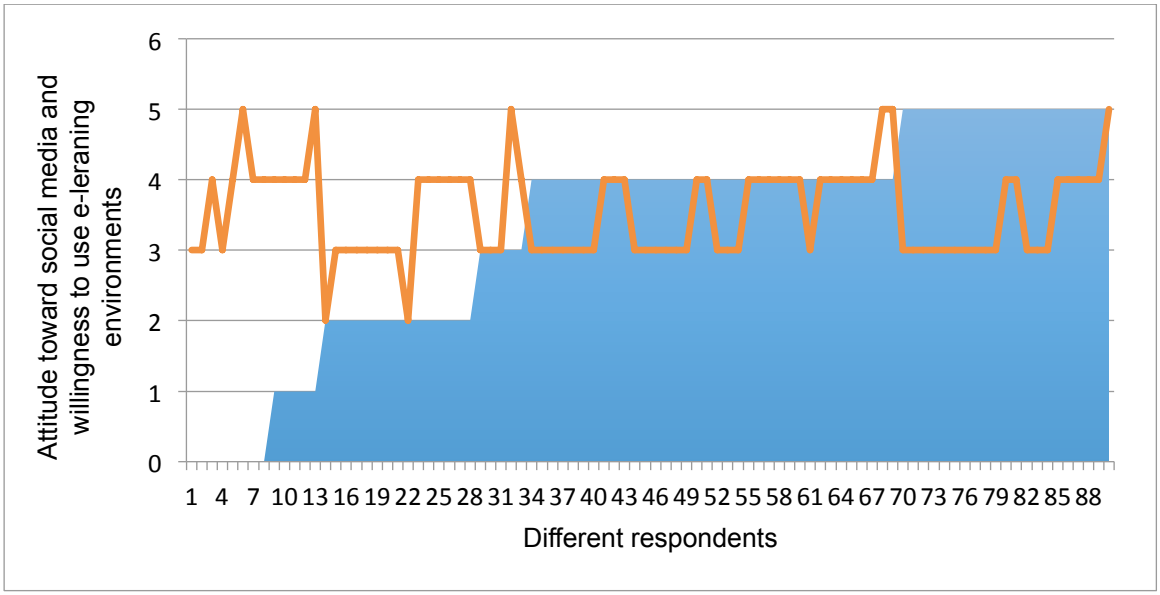

Fig. 7. The level of the filled curve describes the students' familiarity with electronic learning environments compared to social media, whereas the orange curve is the summation of students' willingness to use electronic learning environment for studies. (Larger value indicates more familiar or more willingness to use.)

The expectations toward e-learning environments strongly affect learning atmosphere and satisfaction [8]. The used e-learning environment got very mixed feedback. The environment was both praised and criticized, but in general the students wanted to increase the use of e-learning environments to do tasks and to communicate with the teachers. However, the willingness to communicate with other students via e-learning platforms varied a lot. Apparently, student-to-student interaction is easier face-to-face or through other forums, so the official e-learning environment is commonly dedicated to communication with the teachers.

The results of this part of the survey could be roughly summarized as follows: if a student wanted to use electronic learning environments, he/she wanted to use it in versatile ways to communicate with a teacher, with other students and to do assignments, but this did not correlate in any way with his/her use of social media for other purposes (*Fig.* 7).

4 SUMMARY AND FUTURE WORK

The survey revealed that clickers activate students and stimulate interaction in large classes. The students also had a slight preference for increasing the use of interactive teaching methods on the lectures. In addition, students would like to get more individualized feedback from the teachers.

Clickers have the potential to give immediate feedback on learning, both to the students and to the teacher. However, the students do not seem to recognize this as

feedback. Perhaps we should in the future express more clearly the ways we use to give feedback and support the learning process. With clicker questions, each student gets to know how well he/she has understood some the key concepts, while the teacher gets valuable feedback on how well the class as a whole has learned, i.e., how successful the teaching has been. Inventing suitably challenging questions about the key concepts is essential to benefit from the method.

More interactive teaching can also be produced using e-learning environments. Although the web is used a lot, and it offers a natural environment to enrich communication, we still seek better ways to exploit the interaction properties of the e-learning environment to support learning and collaboration. The issue is not only transferring the current teaching and the study materials to the web. Teachers should encourage interaction to support collaborative learning [8].

In addition, limited teaching resources demand us to take better advantage of e-learning environments to satisfy the students' need for personal feedback. Students' motivation may be increased presenting the collective feedback in a more personal way in an e-learning environment, e.g., by utilizing computer-aided assessment. Peer feedback might also be a part of the solution. Generally, the possibility to automate certain routine tasks gives teachers more time to focus face-to-face interaction and its quality.

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