10

Activate students in large classes and enable lasting motivation for students after lectures using digital learning tools

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Justification and goal

Problem motivation and justification: The lectures in the course are frontal lectures and allow less sophisticated interaction with 230 students. The project aims to increase the degree and intensity of interaction and student activity in the lecture. Furthermore, it seems that the students' engagement rapidly drops after leaving the lecture hall. The students are IT affine and already involved in online tools for collaboration and learning.

The goal of the activity: Higher intensity of students' interaction and involvement in the lecture by using digital learning tools.

Background and setting

My course is a first-year bachelor toolbox course with 15 ECTS in block 3 and 4. I teach theoretical and abstract contents in my lecture and their application in tutorials. We structured our exercises in a way that we initially do not allow any freedom and students, in the end, have a maximum degree of freedom and responsibility. Students have the first four weeks individual exercises with personal feedback from teaching assistants to achieve the similar knowledge and skill level for all students. Then, students start to work in groups of three students on a project in which they easily extend an existing system by applying their knowledge from the lecture. In block

4, students are working on a project with a given goal, which is also part of their exam. The exam is summative and consists of a written group report on their block 4 project with individual contributions, an oral presentation on the group results, and an individual oral discussion about the project and course content.

We have 230 students attending our course and are two teachers (25%, 75%) as well as nine teaching assistants. The lecture is mostly presentation slide-based with frequent orientation slides and self-tests.

General problems, constraints, and challenges of my course and the project are: *(1) the students are not socialized to the university life; (2) there is no textbook which covers all aspects of the lecture; (3) students are in a transition phase in which they have to develop their learning strategy; (4) computer science students do not read the curriculum material; and (5) the auditorium in Universitetsparken 1 is suboptimal for modern lectures (acoustic, physical access, etc.).*

My goal is to increase the interaction in the lecture between topic, student, and teacher as well as getting immediate feedback on their learning progress by using a student-response system (SRS). The students are used to the system and participate in quizzes. My conclusion on the questions in the quizzes is that they have to be even more precise and challenging. Even though, about 60% of the students in the lecture participated in SRS activities.

Each lecture starts with an overview of the intended learning outcome (ILO) (Rienecker, Jørgensen, Dolin, & Ingerslev, 2015) and views on a topic map to locate the current lecture topics. I provide three ILOs per lecture (2x45 minutes) which students can use for their exam preparation.

The teaching-learning activities (TLAs) are now sequential form, which might be desirable from a didactic point of view. The TLAs are clustered around guiding topics and form a sequential structure. Lectures and assignments are directly linked because the assignments consist of two groups of exercises. The first group has a direct relation to the lecture content on an abstract and isolated topic and has to be done by individual students. The second group builds on top of the first one and applies the specific ILO to their practical project as group work. Exercises contain an individual analysis and synthesis part in which students will apply their knowledge. Additionally, we use a cognitive anchor for the content in block 4, because the exploratory projects in block 3 fail in most times. The group project in block 4 is successful because students can apply the content from Block 4 and avoid the mistakes done in block 3. Exercise assignments can be included as examples in the lecture to tighten the linkage between both learning activities.

The lecture uses the exercise assignments published before the lecture as examples, presents and discusses their solutions. Furthermore, cognitive anchors, e.g., self-experienced project failures or problems, are used to link lecture and exercise content to practical experience of the students. Guiding examples throughout the lecture series are the student projects.

I would like to increase the dialog with a broader audience in the lecture by giving the students more time, e.g., 2-5 minutes, for answering my questions, and also repeat and rephrase questions to include more students in the dialog. Summing-up the activity results and reuse throughout the lecture offer many potentials to support the learning activities. Walking-around through lecture hall during these activities gives me feedback on the individual learning progress.

Description of activity

Project activity: I decided to do an empirical study on the parameters of a digital learning activity. The study is restricted to the same course but offering the advantage of comparable results. I borrowed from the idea of peer instruction (Crouch & Mazur, 2001; Mazur & Hilborn, 1997; "Peer Instruction", 2018). Peer instruction is an interactive teaching technique by Eric Mazur. He developed his version of this practice to address his students' struggle to apply factual knowledge to conceptual problems. In his technique, multiple-choice conceptual questions are posed at key parts of the lecture. If the majority of the students' responses are incorrect, they are asked to turn to their neighbor to convince them of their answer. Peer instruction works on the theory that students at similar cognitive levels can at times explain content where educators may experience the "expert blind spot" (Wiggins & McTighe, 2006). Mazur claims his technique works best if students prepare before class and then test their application of knowledge in a class where they have opportunities for rich feedback (self, peer, and teacher).

My motivation to use peer instruction are: Mazur (Crouch & Mazur, 2001; Mazur & Hilborn, 1997) has reported substantial learning gains. It has been successfully transposed from Physics to other disciplines, e.g., humanities. Peer instruction is considered a form of the flipped classroom and provides a structured way to guide student preparation, in-class active learning and rich feedback opportunities.

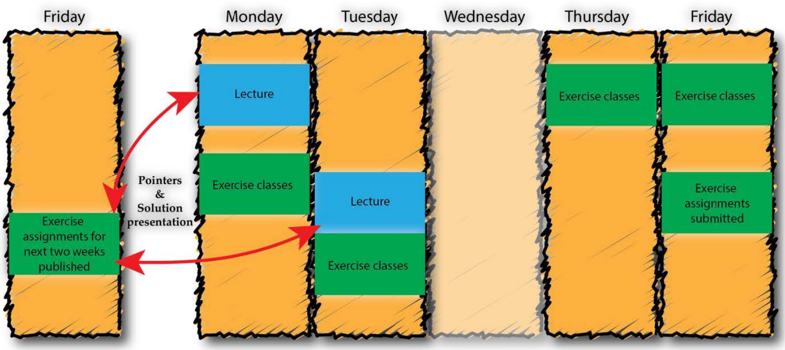

Fig. 10.1. General week plan for learning activities

I designed the activities according to the following guidelines ("Peer Instruction Tipsheet", 2018):

1. Students are provided with materials in the week before the actual lecture for preparation (cf. Figure 10.1: General week plan for learning activities).
2. After a brief lecture (10-15 minutes) I asked students a challenging conceptual question.
3. Individuals think for 1-2 minutes and groups think for 2-12 minutes.
4. Ask students to vote on their answer (SRS, Mentimeter).
5. If under 30% are correct then revisit the concept. Ask individuals to think and revote.
6. If 30-70% are correct, engage in peer discussion (pairs or small groups), then students re-vote. If over 70% are correct, then explain the answer and move on. If they are still struggling, revisit the concept (e.g., mini-lecture with backup slides) and repeat the process.
7. Remind students of the relevance of the activity to broader outcomes (industrial applications or use cases).

The biggest challenges I had with the peer instruction were: design sufficiently challenging conceptual questions to promote higher order thinking. Students need to prepare before class and have sufficient background knowledge to take on the challenging questions. The hardest task personally was not to give away the answer too soon and allowing for students to think, debate, and discuss.

I designed the questions according to the "Taxonomy of Clicker Questions" ("Taxonomy of Clicker Questions", 2018) based on Derek Bruff, "Teaching with Classroom Response Systems: Creating Active Learning Environments, 2009" to define characteristics of good questions fitting to the intended learning outcome. I adjusted the degree of difficulty incrementally based on a higher abstraction in Bloom's taxonomy.

Students were allowed to enter questions to the teacher and the audience during the lecture using Mentimeter. I picked up these questions in regular time intervals and discussed them with the broad audience. It also provided a good way to interact with students and deviate from the form of multiple choice questions. During the break between block 3 and 4 students could work on an ungraded software project with predefined tests which acted as automatic feedback to the students.

During the lecture series, I modified variable parameters of the peer instruction: the number of student activities (0-3) per lecture unit, the length of the student activities (1-12 minutes), the content composition of the student activities, and classical vs. digital tools. The tools used are Mentimeter (mentimeter.com), videos, and classical non-digital activities, e.g., blackboard, pyramid activity. The experiments were conducted during block 4 for coherent sampling. Block 3 was used to introduce the tools and make the students accustomed to the selected tools in lectures on dates 6.2./12.2./19.2./20.2./19.3.2018. The relevant experiments in block 4 were:

- 5 Units in block 4 with a digital interactive tool (24.4./30.4./7.5./8.5./27.5.2018)
- 5 Units with a non-interactive digital tool (MS PowerPoint slides for student activities)

Evaluation

Results

I received the results through individual feedback and survey as well as course evaluation results. Students were very positive about introducing peer instruction in block 4 (multiple mentions in course evaluation and personal feedback).

- The students preferred *7-10 minutes* for group activities and *2-5 minutes* for the discussion.
- The individual activities had the highest participation rate with *2 minutes*.
- The number of participants was with *one and two blocks of questions* high but dropped significantly to a half for a third one.
- Students preferred an *incremental* increase of the semantic complexity of questions.
- Students had *no preference* concerning digital or analog tools used in the activity.
- Mild *variation* of the methods was mentioned as an important success factor.

As an example: in the lecture on "Code quality and awareness" on May 28th, 2018 (cf. Appendix), a group activity of 10 minutes for groups of three students as well as a shorter individual task is included. Students should collect relevant quality attributes of software/code for a use-case on office software replacement. The following collection of found quality attributes covered roughly 80% of the top-level non-functional requirements/quality attributes. An SRS (64 active students) supported to reflect on how developers in general approach risks (70% of students answered correctly).

Interpretation

The results have low validity and significance. The project only considered one course with five lectures using digital and five lecture using non-interactive tools with the same setting and task profile. Nevertheless, the comparison of the student evaluations of the course and its predecessor shows an improvement, which has been mentioned by the students. The exam results indicate a significant improvement in the student learning.

Discussion with departmental supervisor and outcome

My departmental supervisor is also co-teaching the course and has direct insights into the results. Also, my departmental supervisor and Universitetspædagogikum supervisor have attended some lectures and provided an additional objective source of feedback. Their feedback was to increase the dialog with a broader audience in the lecture by giving the students more time, e.g., 2-5 minutes, for answering my questions, and also repeat and rephrase questions to include more students in the dialog. Summing-up the activity results and reuse throughout the lecture offer many potentials to support the learning activities. Walking-around through lecture hall during these activities gives me feedback on the individual learning progress.

Pedagogical reflection

The course "Software udvikling" uses constructive alignment and enables constructive learning with aligned teaching outcomes. The course integrates teaching, learning, and assessment better than the predecessor course. The general problems and constraints of the course and its environment are under control. The assessment applies to different perspectives of the course and the encompassed study program. The feedback, which I received from my mentors and through student evaluations shows a significant improvement. I made important progress in my teaching qualities and am now more confident about my teaching methods including now peer instruction as a very natural method of using digital tools.

The project activity was not the only changes in the course. A further improvement was to break up the lecture in 7 minutes slices, systematic didactic reduction of lecture content, and the usage of topic-related, ironic comic strips for preparing the learning activities and easing the transition. Videos of tutorials and web links to further information were widely used by the students.

The usage of peer instruction, as a soft version of the flipped classroom, was an important part of the project because I would like to introduce flipped classroom as a teaching method for the coming course in which I will be the course responsible.

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Appendix

Example lecture outline ("Code quality and awareness" on May 28th, 2018)

Time in hours	**Learning activity in time slot**
0:00-0:15	Introduction code quality and awareness triggering
0:15-0:30	Group work and discussion (10 mins + 5 mins) – Product qualities for a word processor in the company
0:30-0:45	Product quality attributes
0:45-1:00	Break 15 mins.
1:00-1:10	Defects and code improvements
1:10-1:15	Individual activity (2 mins) – Prioritize product qualities for SpaceTaxi project
1:15-1:30	Software quality assurance
1:30-1:45	Binder and motivation for next lecture
1:45	Lecture end