Experience in teaching a course in Fully-flipped-classroom style

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Together with my TA Malvin Gattinger, I was teaching the course "Introduction to Modern Cryptography" in the Master of Logic at the University of Amsterdam, in February/March 2016. I had given this course 3 times before in a standard front-lecture form, the last time also with Malvin as TA: http://homepages.cwi.nl/~schaffne/courses/crypto/2015/

This year, about 15 people signed up for the course, and 10 showed up eventually at the first meeting. In the end, 8 students finished the course, obtaining a grade. 6 were from the Master of Logic, one first-year master of Computational Science , and one first-year master of mathematics.

Setup

The course was assigned 2-hour slots on Tue morning, Wed afternoon and Thursday evening. In discussion with Malvin, we decided to have arrange it so that students experience a flow of information which was as linear as possible. So, a new topic "started" every week on Monday (with precise description of the material to be covered in the book, and homework exercises to be handed in until Monday 9:00 am the following week). Malvin spent his whole Mondays correcting the homework in order to be able to hand it back in the "exercise session" on Tuesday morning. We skipped the Wednesday session entirely, and made Thursday evening a "interactive learning session".
As **interactive learning environment**, I was fortunate to be able to host the course on a Moodle-server administered by a Swiss friend of mine. We have used the Moodle platform extensively, in particular for the multiple-choice reading questions, handling homework submissions and grading, the forum for class announcements and students to discuss problems, a database for security-related news, a wiki for preparing the topic of the final presentation.

Forum post explaining the setup to students:

For you as students, the biggest difference to conventional lectures is that you have to **prepare yourself before attending classes**, as it is assumed during classes that you have studied the material already. Fortunately, you are all very clever master students eager and curious to learn more about cryptography (some ILLC teacher once mentioned jokingly that one could lay down the course book on the table at the beginning of the course, and MoL students would automatically learn everything by themselves).

We will organize the course as follows:

Every week has a certain topic, consisting of reading material from the course book [KL] . The topics are illustrated by video lectures from Jonathan Katz's online cryptography course on Coursera. Students study this material on their own at home, at their own pace. In order to check the understanding of the material, **reading (multiple-choice) questions** are provided that need to be completed every week before Thursday, 15:00.

The weekly material is the basis for an interactive learning session on Thursdays 15-17. These sessions will be held by pairs of students, and count towards the final grade.

You can demonstrate the final understanding of the material by completing the homework which needs to be handed in by Monday, 9:00. You can mark exercises you'd like to present in class, and the TA selects the "speakers" for the exercise on Tuesday 9:00-11:00 where the just-handed-in homework will be discussed by the students and the TA.

Towards the end of the course, there will be a list of topics where pairs of students can choose from. They study the chosen topic and give a short presentation to the fellow students in the last week, also counting towards the final grade.

Procedure for Tuesday 9-11 Exercise Sessions

In the Tuesday exercise session, students discuss the homework they have handed in the day before with the TA. In principle, students who are confident about their solution will present it to the rest of the class at the black/white board, being helped by the TA and the rest of the students.

When handing in your weekly homework (before Monday 9:00), you can indicate the exercises you are confident about and would like to present to the class. The TA will make a selection on Monday. Every student will be required to present an exercise at some point.

Participation and presence at the exercise session is expected of every student.

Procedure for Thursday 15-17 Interactive Sessions

At the beginning of the course, pairs of students are formed. Each pair picks the topic of one of the weeks where they become the "experts" in.

In that week, the "expert" pair will be responsible to hold the interactive exercise session on Thursdays 15-17. They can assume that all students attending the session have studied that week's material and completed the reading questions. The goal of the Thursday session is to **actively work** with the material just learned. The "expert pair" is actively encouraged to experiment with possible forms of filling in this exercise session. It's your chance to design a "werkcollege" you always wanted to attend! As inspiration of possible ways of active teaching forms, you can consult this guide.

In order to prepare this interactive session, the "expert pair" will have the chance for a private consulting session with Malvin and Chris, usually scheduled on Tuesdays from 11-13.

Experiences from a teacher's perspective

- I made it very clear in the first meeting that this will be a very demanding course, not only asking from the students to learn all the new material by self-studying the book, but in their "expert-week", even understanding it so well to be able to make an entertaining session for the fellow students, which requires quite some didactical skills as well.
- It was very pleasant for me to work with Moodle (I have never dared to touch Blackboard, the user interface was too scary), and I am going to miss it very much for all upcoming courses where I cannot use it. There is good hope that the UvA will implement something comparable soon(ish). Setting up the reading questions

(copying over from the coursera quiz) was quite a lot of work, but hopefully pays of for future editions of the course.

- Given my previous experience in front lectures about the topic, I had the impression that the students were mostly missing the "big lines" and the "useful tricks" in the mathematical proofs. Possibly, an additional session (e.g. on Wednesday) for some extra explanations, especially in the "heavy weeks" would have been useful.
- For this kind of (highly motivated and small enough) crowd, I'm very pleased with the outcome of this flipped-classroom experiment. The students worked hard, enjoyed their learning process, and acquired a lot of new skills.
- In terms of time investment from my part, I have spent my time quite differently as with a front lecture, namely thinking about how to prepare the "interactive session" and preparing the reading questions for every week. Due to my excellent TA Malvin and his big commitment, I ended up spending slightly less time in total than for previous editions of the course.
- For the Tuesday session, it was good to let students present the exercises that they felt confident about, but it would have been even better to let them work out the exercises they could not solve, by "collective wisdom" and with help from the teacher and TA. Instead of spending time on things most people already knew how to do, we should have spent time on the stuff they found difficult instead.

Experiences from a TA's perspective

- The course was more fun and more work than others where I was a TA before, including the old "frontal-lecture" edition of this one. It was not simply more time, but also spent differently: There were more questions from students to be answered, more preparation for the interactive sessions, but less time needed for the preparation of the exercise class in which it was no longer my job to present all the exercises.
- Correcting all homeworks within 24 hours was only possible because of the relatively low number of students and because I had no other commitments on Mondays. It felt very much worth the effort because as a student myself I always disliked the mental jumping back and forth induced by discussing old homework in the exercise session while having new topics in the lectures already.
- Urging students to prepare before the class also leads to better homework submissions. In the previous course there were more submissions clearly done without proper understanding of the material but just mixing together the right words or formulas. This feels like someone is wasting my time, so now correcting was more pleasant as people were better prepared and honest.
- Moodle was very useful for multiple reasons:
  - The online submission allowed me to start grading as soon as students handed something in and to send them back the corrections as soon as I was done, including a suggestion what to present.
  - Answering questions about the exercises via the forum ensured that all students got additional hints, corrections or other information, not only those who asked.
  - The upload of bigger files than possible via e-mail. However, I did not use the PDF annotation function provided by Moodle but the similar tool Xournal and simply uploaded the corrections as an extra file. Students seemed to be happy with this, in particular with individual in-line corrections and comments.
- I was impressed by the students in the interactive sessions, both experts and participants. It was good fun to see people really understand things during the "contact hours" instead of simply reproducing material in front of them and hope that they would grasp it.
- The exercise session felt a bit old fashioned. Maybe we should make it more interactive as well, vote on which exercises are discussed at all, or form groups of people who could not solve specific exercises.

Experiences from a student's perspective

Here is some feedback we gathered from the students:

- The weekly multiple-choice reading questions (to be completed before Thursday's session) were very helpful for checking the understanding
- It was helpful to have to hold an interactive session yourself, that also motivated participation in sessions held by other students.
- Forum participation could have been encouraged a bit more from the start, it was good to be able to discuss homework exercises there
- For the Tuesday exercise session, it would have been helpful to start discussing the exercises with the worst grades first.