

Flipped Classroom: Lessons from an experience in first-year statistics

R.Nazim Khan

School of Mathematics and Statistics

The University of Western Australia

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1. Challenges of teaching First Year Mathematics/Statistics

- Service unit—so usually not considered relevant or important by students.
- Compulsory unit—so added resistance, unwilling students.
- Poor mathematics background—usually the lowest for a large proportion of the class. Partly the institution is to blame for continually lowering entry requirements.
- Variable background—both mathematics and majors. So difficult to find right level: too high for many to understand, and too low for the rest to be engaging.
- Low student engagement—since this is not an area they are majoring in.

1. Challenges (ctd)

- Low student attendance—typically 30%, can range from 7% to 70% for larger first year classes.
- Several reasons for missing classes—bad lecturers, bad lectures, it is recorded, work, laziness, lack of engagement,...
- Attendance is key to performance
 1. Nyamapfene: attendance is “the key determinant for academic performance”, in a study for courses with online lecture notes.
 2. Purcell: 10% increase in lecture attendance resulted in 3% increase in examination performance for civil engineering students.
 3. Rico: less well attended classes had higher failure rates.

1. Challenges
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3. Previous teaching methods
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6. Student Performance
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- Large first-year business statistics unit, 1100 students per year over two semesters.
- Compulsory unit for all majors in the business school.
- Typical setting for most large first-year mathematics and statistics units.

3. Previous teaching methods

- Until 2012 semester 2, traditional teaching method, based around lectures and a two-hour combined tutorial-laboratory session.
- Tutorial-lab classes were focused on theoretical concepts and problem solving, data analysis using Excel and interpretation of results.
- Both types of sessions were run in the traditional sense—exposition in lectures, and tutor-driven tutorial-lab session.
- Some interaction in lectures, more in tutorials.

4. Issue with teaching regime

- Lecture attendance declined after a few weeks to about a third of the class by mid-semester.
- Students attended the tutorials classes simply to get the marks for the assessed question. There were reports from tutors that participation in the tutorials was low and students did not attempt the questions beforehand.
- Student engagement was low and many students did not attempt semester assessments. Several students who failed by only a few marks would have passed if they had attempted a few more of the semester assessments, and in particular if they had attended a few more tutorials.

5. Flipping the class!

Motivated in order to address the issues raised in the last section and to improve student engagement and participation as well as enhance understanding of course material. Specifically:

1. To improve student participation in teaching and learning activities.
2. To improve student engagement and improve participation in assessment tasks.
3. To increase student attendance in tutorial and laboratory classes.
4. To provide more learning opportunities in classes.

Totally flipped lectures—Eric Mazur style.

- Provided full lecture notes as a Unit Reader. Students were required to read the notes and submit an online concept-based quiz before each lecture. 1% per week as incentive.
- Lecture was used to highlight key aspects and clear problems identified in the quiz responses.
- A wifi-based in-class response system was used to reinforce concepts. After submitting a response, the class discuss their response in groups of three or four and then re-submit a response.
- ALL assessments were open book.

- Students did not read the lecture notes beforehand!
- Students did not like the quiz per lecture—too onerous.
- After a few weeks this relapsed into almost traditional lectures with some interactions.

Online survey at the end of the previous semester, 300 responses, revealed:

- Students overwhelmingly (80%) preferred open book assessments. Similar to findings by other researchers.
- In-class response system was favoured. Similar to findings by other researchers. It allowed students to consolidate concepts immediately, and also allowed me to correct any misconceptions.
- The quiz per lecture was very unpopular!

Partial flip.

- Unit Reader contained partially filled lecture notes, containing most of the “theory”.
- Cover only one or two examples in lectures, and then let class work in groups to work out other examples and problems—peer instruction.
- The idea is not breadth, but depth in lectures.
- Once key concepts are understood, the students and peer groups can take it from there.
- Tutorial-lab session need to follow similar styles.

- Some students are unwilling.
- These usually fall in two groups: the very good and the very bad students.
- It takes lecturer skills, encouragement and persistence/insistence to get these to comply.
- But that is the whole idea of peer learning! Those who know teach those who don't.

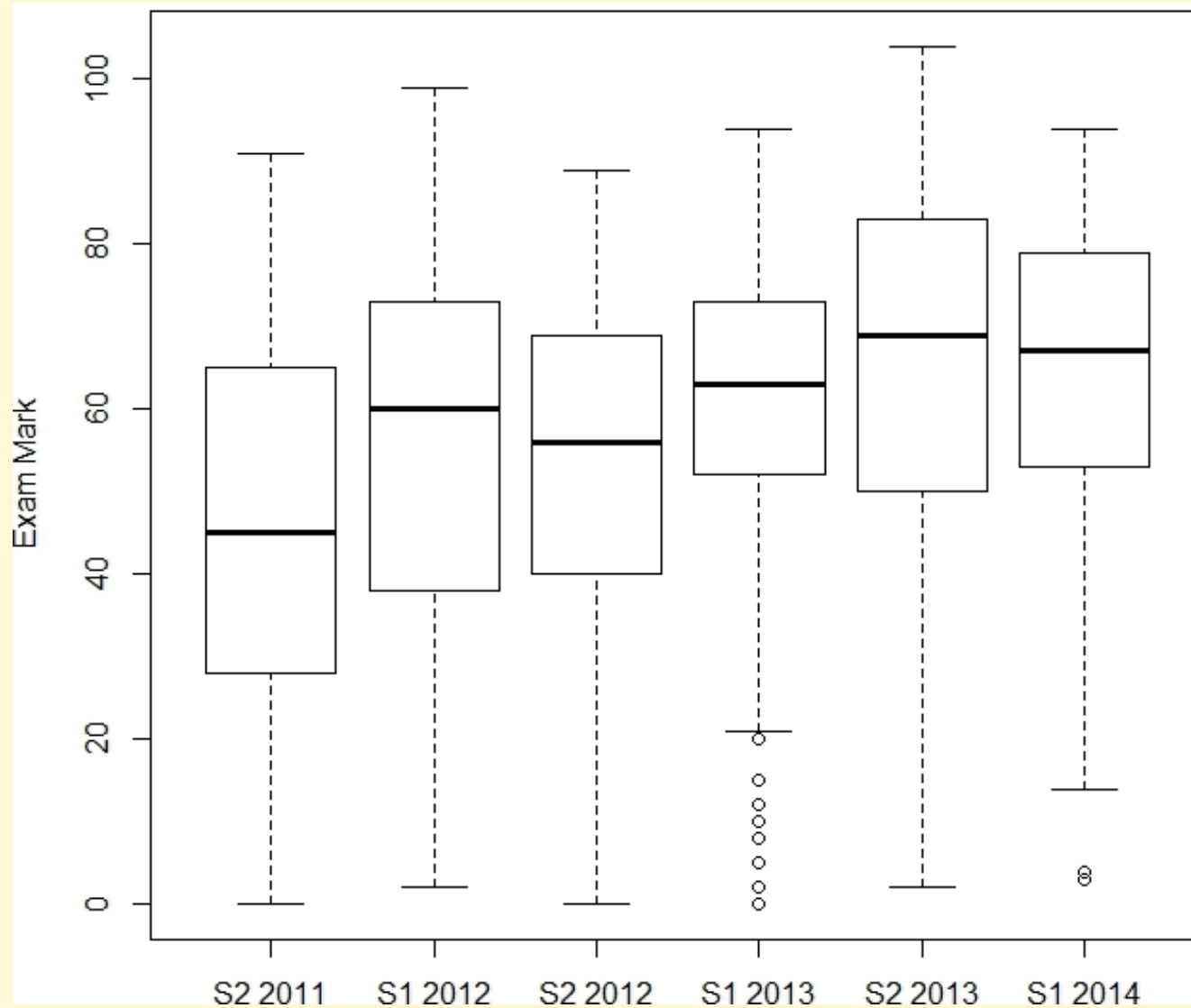
6. Student performance

	Class Size	Median	Mean (SE)	SD
Sem 2 2011 (CB)	745	45.0	45.3 (0.85)	23.1
Sem 1 2012 (CB)	342	60.0	55.5 (1.26)	23.3
Sem 2 2012 (OB, Totally Flipped)	580	56.0	53.6 (0.82)	19.7
Sem 1 2013 (OB, Partially Flipped)	454	63.0	61.1 (0.74)	16.6
Sem 2 2013 (CB, Partially Flipped)	543	64.0	64.6 (0.74)	23.4
Sem 1 2014 (CB, Partially Flipped)	303	64.0	64.2 (1.10)	19.0

Table 1: Summary of exam performance over the six semesters.

Student performance (ctd)

Figure 1: Box plots of overall marks and exam marks.



- A one-way ANOVA on Exam Marks revealed mean exam marks for the five semesters were not all equal ($p\text{-value} < 2.2 \times 10^{-16}$.)
- A multiple comparison (using Bonferroni correction) further showed that all the means were different from each other except 2012 S1 and S2 2012, and S2 2013 and S1 2014. Thus Semester 2 2011 has the lowest mean exam mark and semester 1 2013 the highest.

Mean Exam					
CB	CB	T.Flp OB	P.Flp OB	P.Flp CB	P.Flp CB
S 2 2011	S1 2012	S2 2012	S1 2013	S2 2013	S1 2014
45	55	54	61	65	64

- A Unit reader is very important, as it provided students with a more organised set of unit materials.
- In 2011 S2, no students scored at least 95 (out of 105) in the exam.
- In 2012 S1 (Unit Reader), 6 students (1.7%) scored at least 95 in the final exam.
- In 2012 S2 and S1 (totally flipped, open book), no students scored at least 95 in the final exam.
- In 2013 S1 (flipped, closed book), no students scored more than 95 in the final exam.
- In 2013 S2 (flipped, closed book), 35 students (6.4%) scored more than 95 in the final exam.
- Flipped classes produced a better performance from students.

- The open book assessments had a different format: some open format (report writing) questions instead of structured as parts.
- In semester 1, 2013, since the students had seen a past OB exam, the performance in the exam was better.
- Peer instruction is very effective in improving the teaching and learning experience, and also provides another learning resource students.
- Given that most units have recorded lectures, the class room experience must change, or else lectures become irrelevant.

- 2011 S1 Traditional delivery, Closed Book, no Unit Reader: None ≥ 95 !
- 2012 S1 Closed Book, Unit Reader: 95(2), 97(2), 98, 97
- 2012 S2 Open Book, totally flipped class: None ≥ 95 !
- 2013 S1 Open Book, partially flipped class, peer learning: None ≥ 95 !
- 2013 S2 Closed Book, partially flipped class, peer learning:
95(4), 96(7), 97(6), 98(8), 99(5), 100(3), 103, 104

- I like the interactiveness of the lectures and allowing students to get to know each other while doing stats.
- He walks around the lecture theatre and helps with questions that I don't understand and he gets everyone involved in the lectures.
- I work better being able to work with others and to be able to confirm the processes of which I get my answers from with my peers so being able to work in groups has been really helpful in consolidating what I've learnt.
- Being able to work in groups when solving questions for some new concepts learnt.
- For a hard subject he makes it very enjoyable — sometimes I got to uni looking forward to his lectures.

■ **What does not work:**

- ◆ A completely flipped classroom—students are not motivated enough.
- ◆ Open book assessments for low level (and maybe higher level) statistics (mathematics) units.

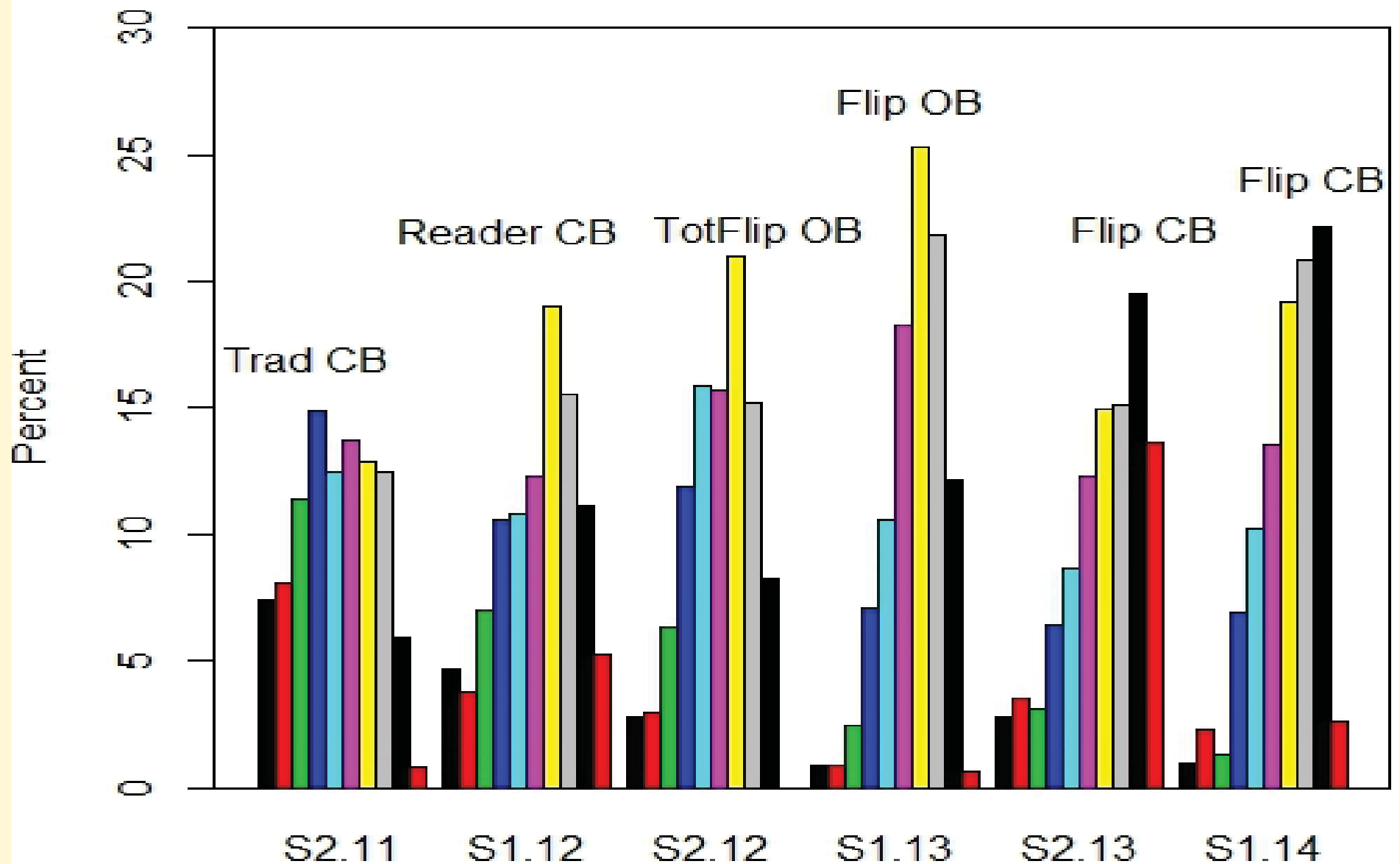
■ **What does work:**

- ◆ A partially flipped classroom.
- ◆ Peer learning was a hit. Students formed own study groups as a result of contacts formed in the lectures. It also saved me a lot of student consulting hours!

- Reduce material to be covered in lectures. This requires careful thinking about and organising materials.
- Each session needs to be planned.
- Set the tone of the lectures from the first class.
- Make sure the entire class participates in peer-instruction. Don't let anyone get away with it!
- The same format and atmosphere needs to be established for tutorial and other classes for a consistent delivery.
- Don't be tempted to fall back into “lecturing”!

Flipped versus traditional

Deciles by Semester



8. References

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