

# Statistics I - Analysis Report of the Flipped classroom Concept

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## Abstract

This document shows the positive impact of the flipped classroom concept on the course Statistics I. We demonstrate it through participation and results of facultative activities offered to the students: Auto-Evaluation Quiz, Surveys, Wooclaps, Bonus Exams, pre-class preparation. We show a positive relation between these measures and the final grade.

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## ANNEXES

## Statistics I - Flipped classroom concept

Statistics I is a mandatory course for the second part of the GSEM bachelor. 422 students, mostly in their second year of study, are registered to the Moodle page. 370 of them have taken the final exam.

This year, we implemented the concept of “flipped classroom”:  
each week, the course content is furnished in advance and in a very detailed manner (theory, examples, videos, references, etc.). The students have to prepare it for the next lesson.

With the use of SpeakUp, a forum-like platform, and quizzes, the teacher has a real-time overview of the students progress and can adapt his next lesson.

The lesson becomes an interactive Q&A to identify and explain encountered difficulties with the course material.



# 1 Auto-Evaluation

## 1.1 Auto-Evaluation attempts & grades during the semester

Each week we submitted to the students a quizz of approximately 10 questions. They had to complete the quizzes on their own without any control from our part. Due to their self-assessment nature, these quizzes have been named “Auto-Evaluation” (or AE for short). The Auto-Evaluation quizzes were left open for practice; each student could freely re-attempt them.

The Auto-Evaluation 14 was a special one: it regrouped all the previous ones in a random draw of 20 questions. This Auto-Evaluation was put on a scale from 1 to 6 and presented as “the final test” with a custom feedback to assess the student’s readiness for the final exam. We presented it to the students with a special name : R.E.A.D.Y., short for “Random Exercises Accurately Designed for You”.

You can see the attempts and results of the 14 Auto-Evaluation quizzes during the semester. The quizzes were all re-scaled from 1 to 10 points.

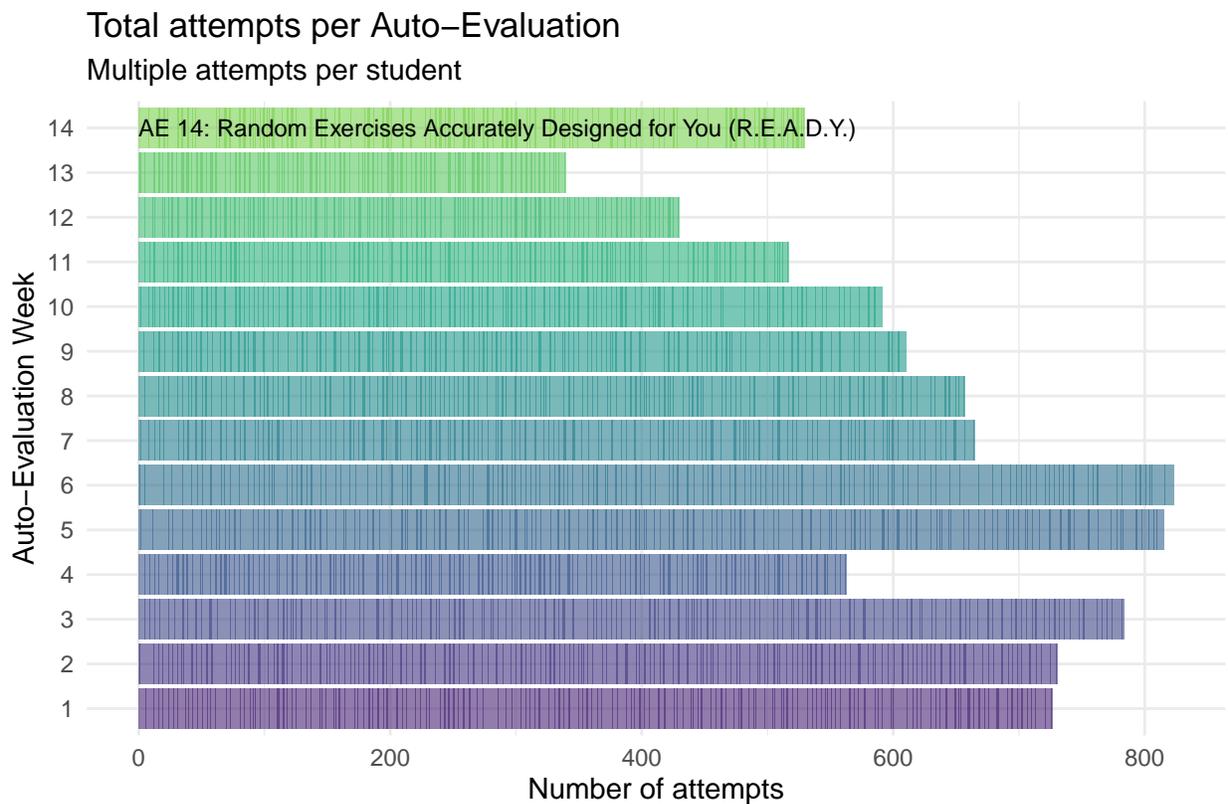


Figure 1: Auto-Evaluation Total Attempts

## Unique attempts per Auto-Evaluation

One attempt per student

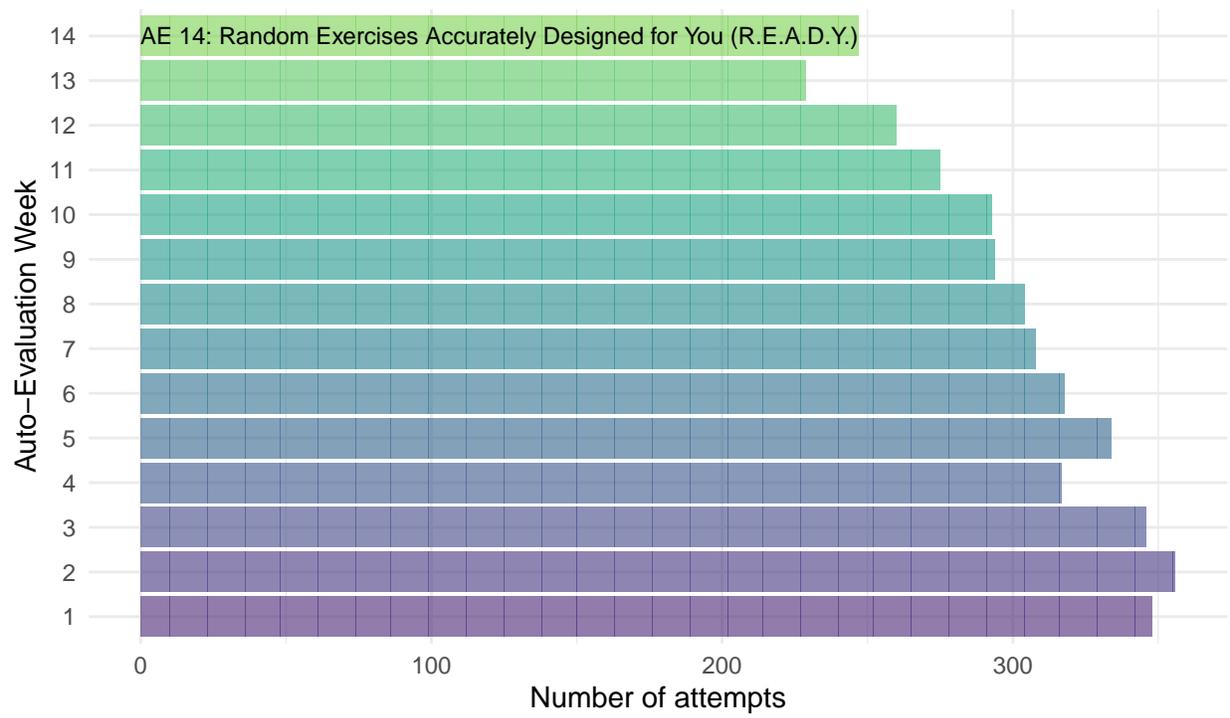


Figure 2: Auto-Evaluation Unique Attempts

# Behavior of Auto-Evaluation best grades per week

One grade (the best) per student per Auto-Evaluation

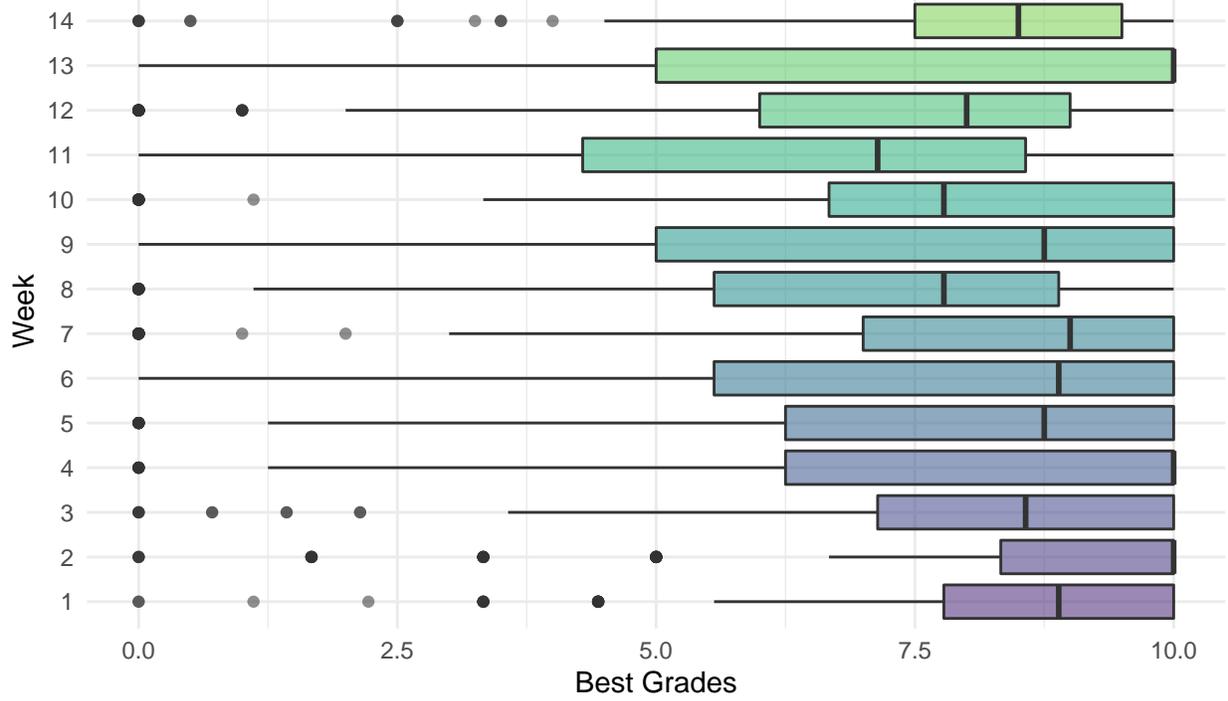


Figure 3: Auto-Evaluations Boxplot

### Distribution of the mean of best grades All Auto-Evaluations cumulated

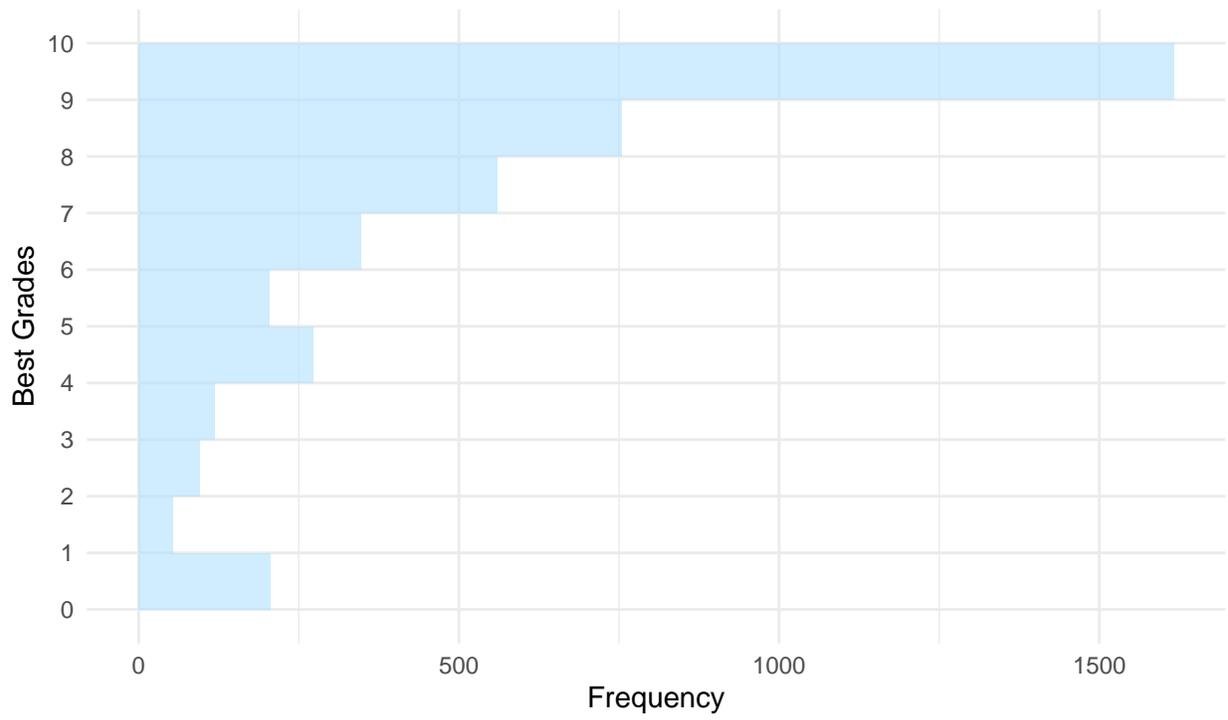


Figure 4: Auto-Evaluations Grade Distribution

## Distribution of the mean of best grades

One histogram per Auto-Evaluation

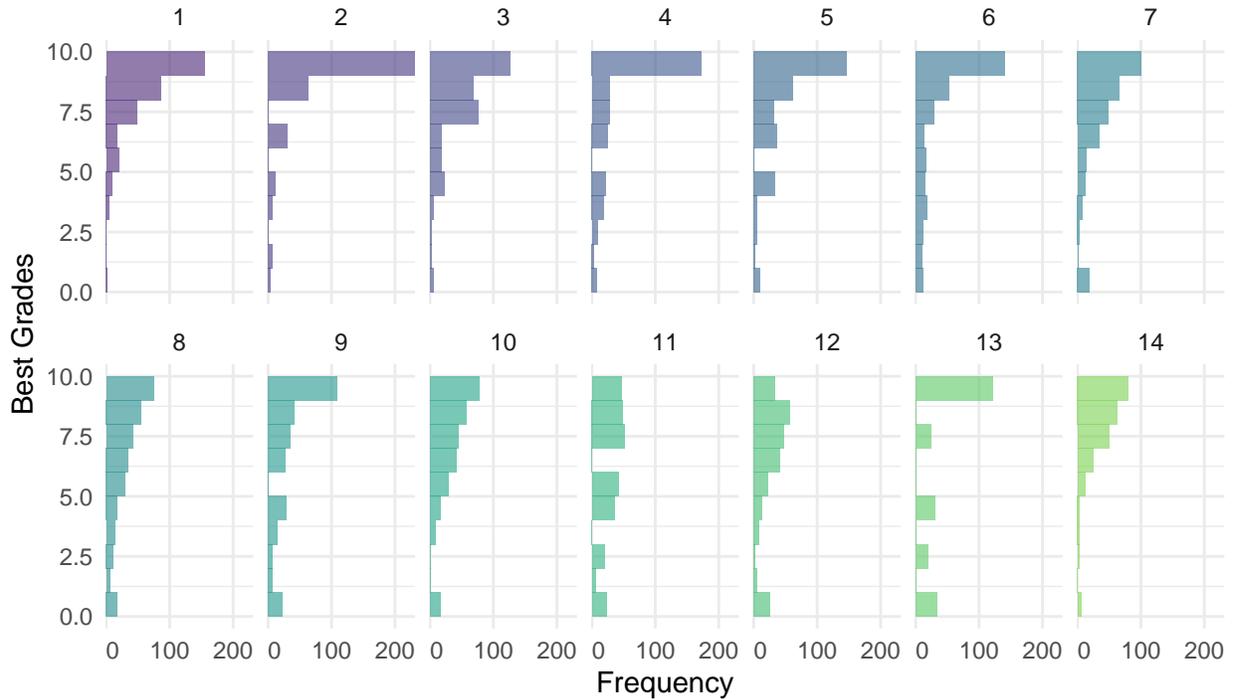


Figure 5: Auto-Evaluations Grade Distribution per Week

### 1.2 Interaction between the average of best attempts and participation for the Auto-Evaluation quizzes

For each student, we measured his participation to the 14 Auto-Evaluation quizzes in the following ascending order:

Number of AE done	Level
]0;11]	ae_level_1
]11;13]	ae_level_2
[14]	ae_level_3

If the student tried less than 11 AE, he falls in the category “ae\_level\_1” ; if he tried between 11 and 13, he falls in the category “ae\_level\_2”; if the student did the 14 AE, he falls in the category “ae\_level3”.

We also registered his best attempt per AE quizz and computed the mean:

Mean of best grades	Level
]0;7]	ae_mean_low
]7;9]	ae_mean_medium
[10]	ae_mean_high

If the student had 7 or less, he falls in the category “ae\_mean\_level\_low”. if the student had between 7 and 9, he falls in the category “ae\_mean\_level\_medium”; if the student achieved the best grade (i.e. 10) in all

14 AE, he falls in the category “ae\_mean\_high”.

However, some of the students never participated. It may be because they never opened a quizz or never connected to the moodle page. You can see here the proportion of students not participating:

Total number of students	Participating students	Percentage
370	355	95.95%

You can see below the interaction between participation and mean of best attempts.

### Proportion of mean of best attempts for each level of participation

Each column sum to 100%

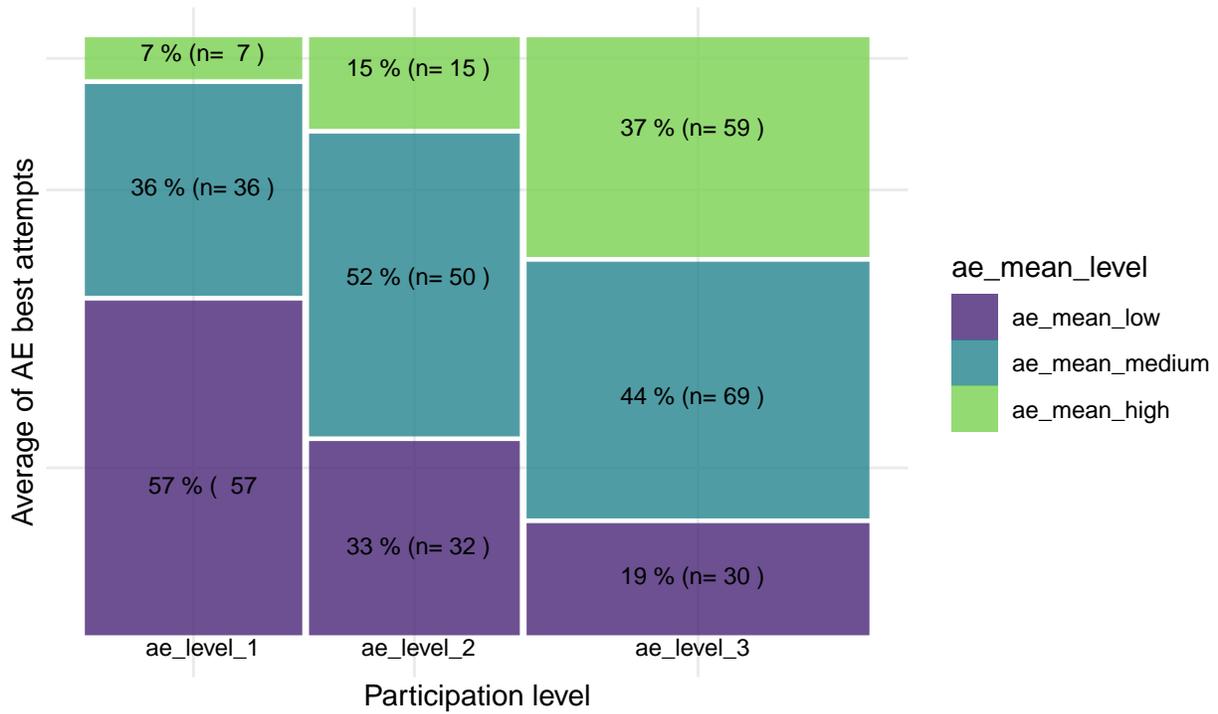


Figure 6: AE Mosaicplot

### Auto-Evaluation mean of attempts and Auto-Evaluation participation Ascending order of participation

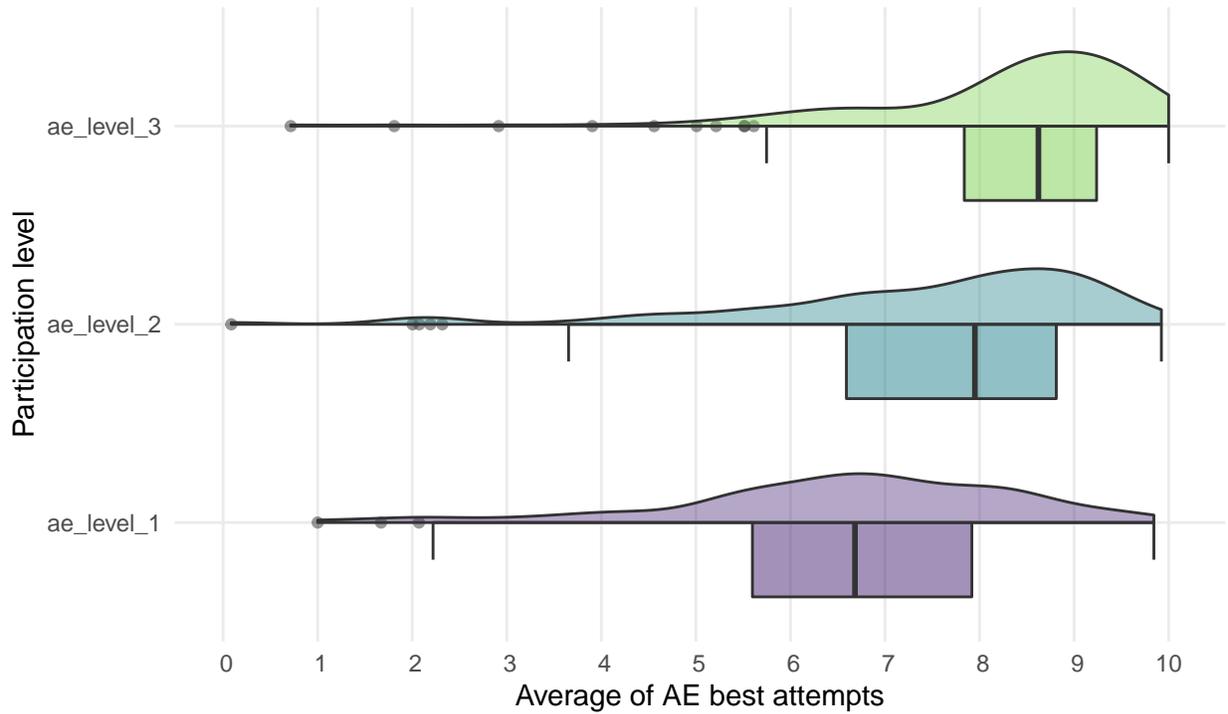


Figure 7: Auto-Evaluations Violinplot

### 1.3 Impact on final grade (before bonus) of Auto-Evaluation grades&participation

Using the same levels described above, we show here the relation between the participation to the Auto-Evaluation quizz (ae\_level), average of best attempts (ae\_mean\_level) and the final grade.

### Final grade (before bonus) and Auto-Evaluation participation

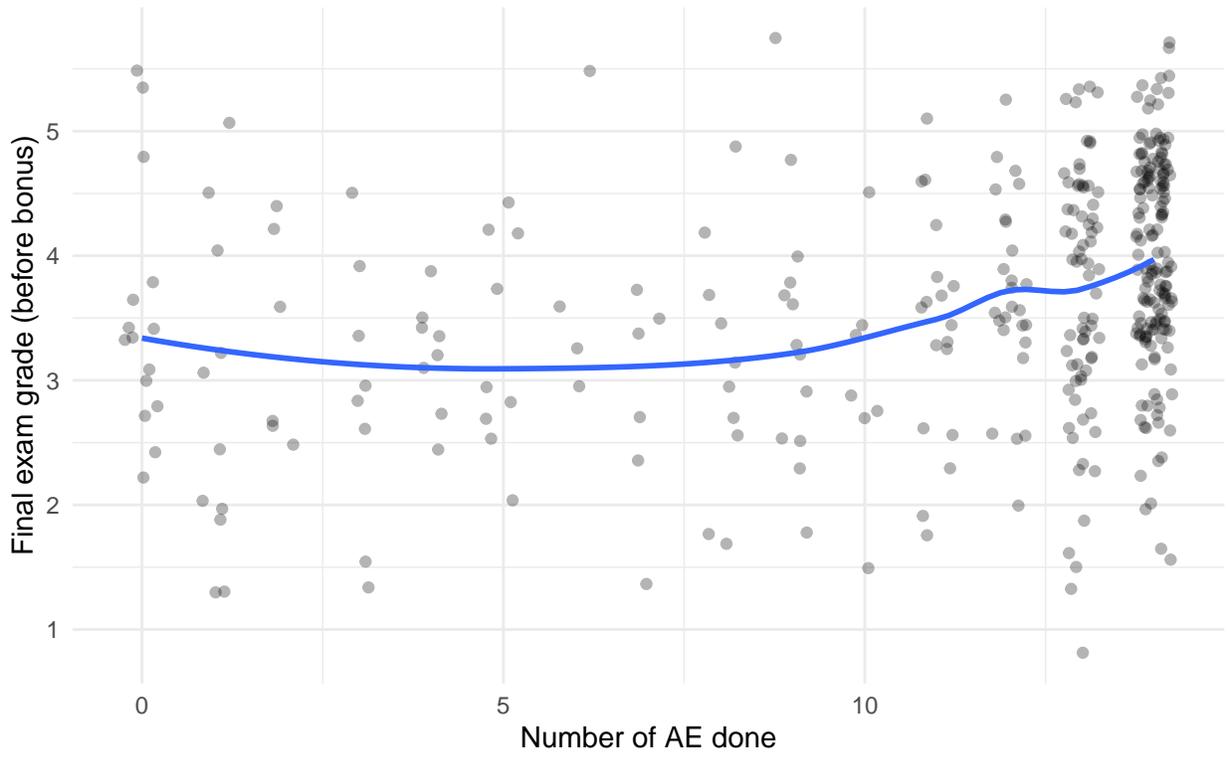


Figure 8: Auto-Evaluations Participation Scatterplot

Final grade (before bonus) and Auto-Evaluation mean of best grades

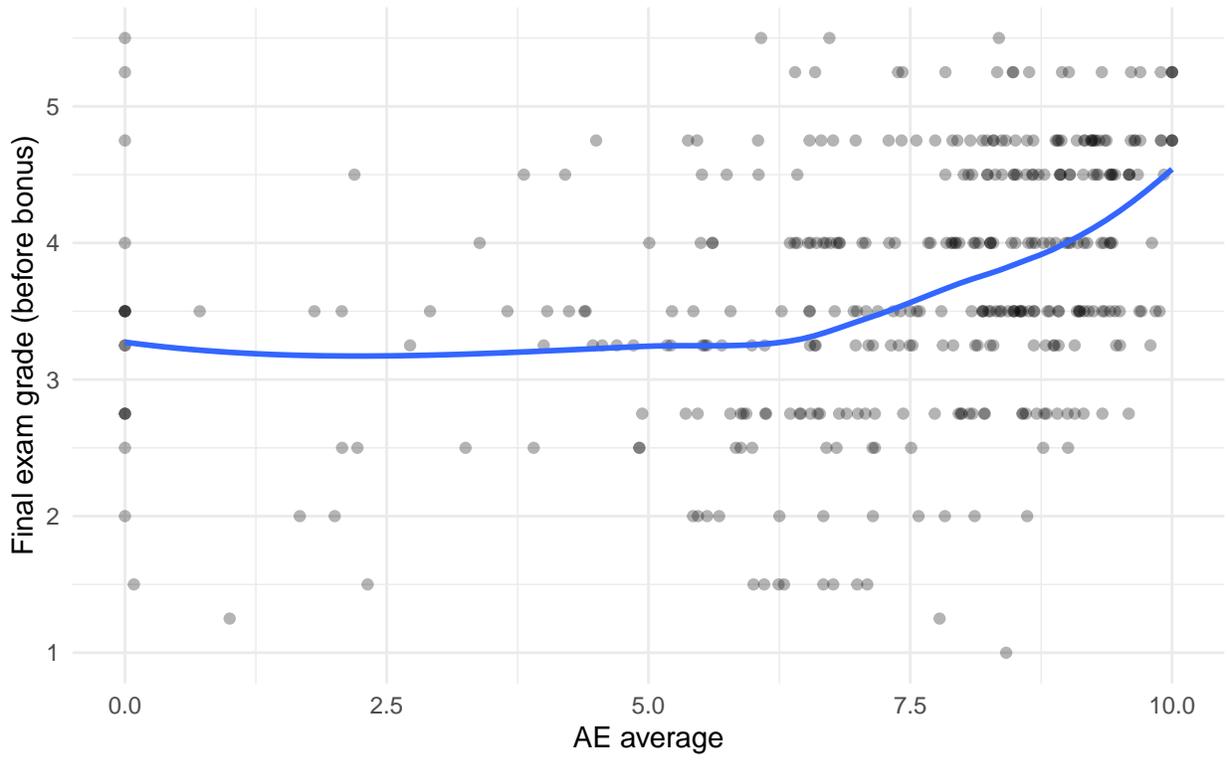


Figure 9: Auto-Evaluation Grade Scatterplot

Final grade (before bonus) and Auto-Evaluation participation  
Ascending order of participation

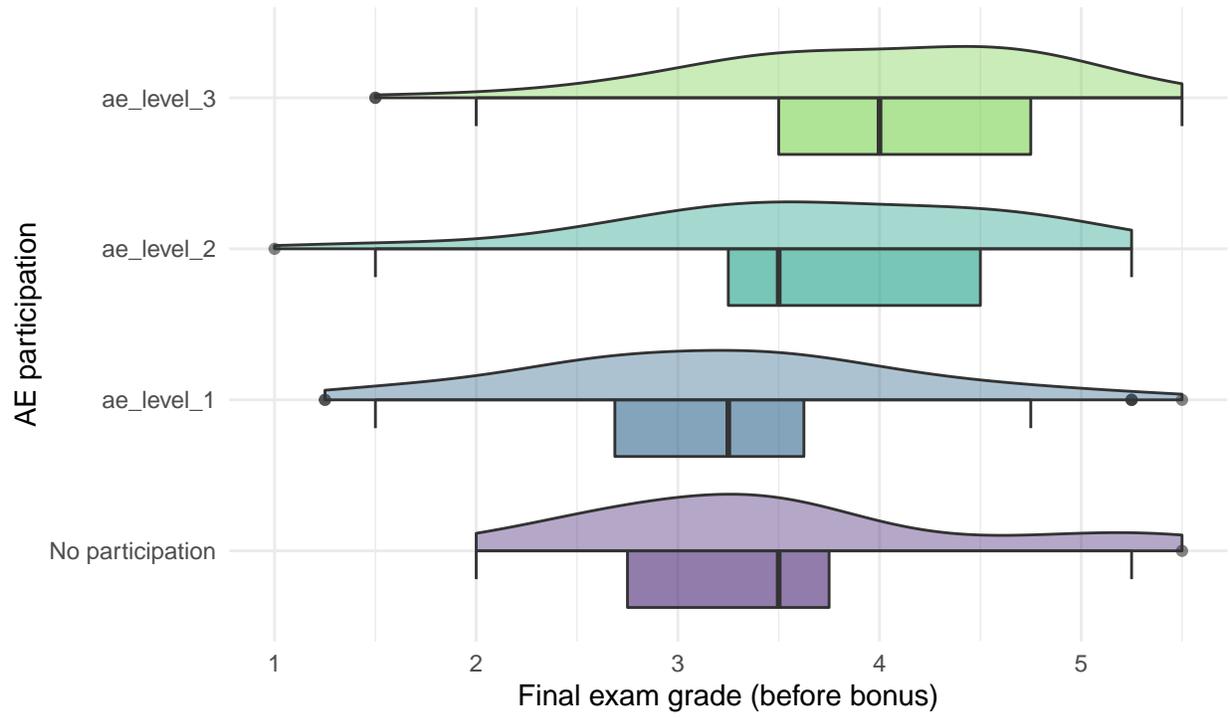


Figure 10: Participation Impact Violinplot

Final grade (before bonus) and Auto-Evaluation mean of best gr  
Ascending grades

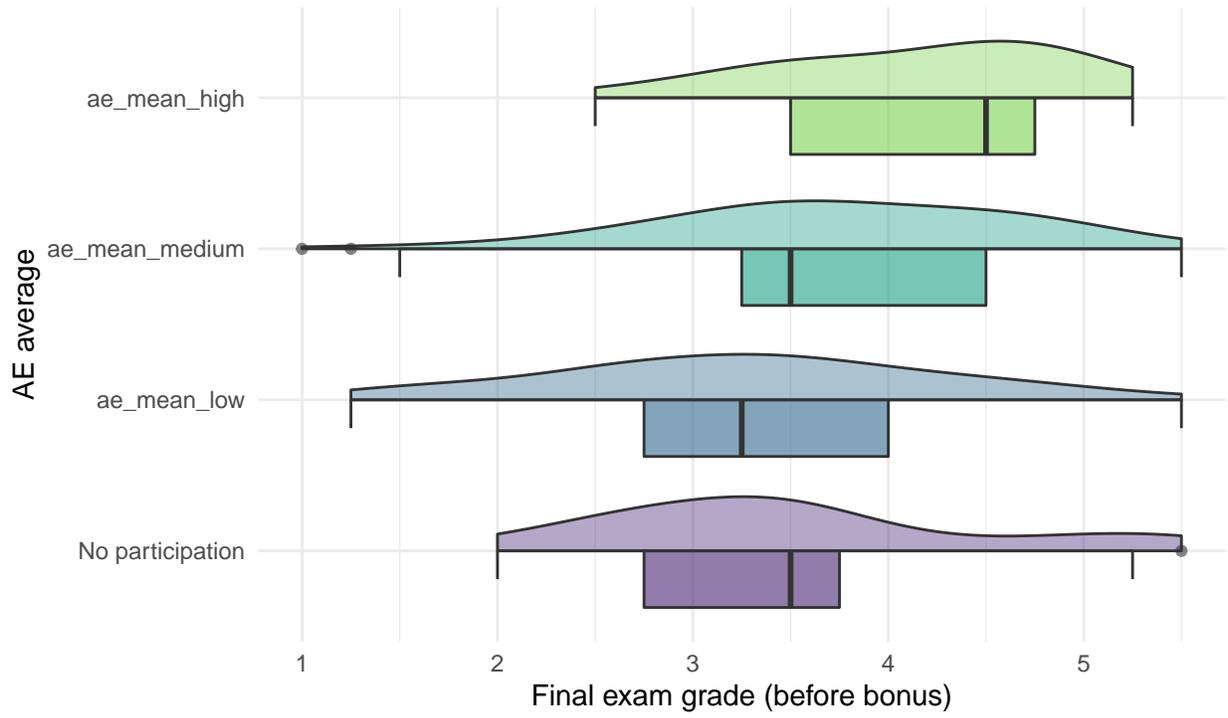


Figure 11: Grade Impact Violinplot

## 2 Preliminary Work Folder

### 2.1 Consultations per week of the folder “Preliminary Work” during the semester

Each week, we released in advance the preparatory work for the class.

The folder contained multiple PDFs and medias. The PDFs could be downloaded but not the videos: the student had to either come back or watch them at once. The number of consultations is therefore an indicator of effort put to prepare the class.

However, as the principal interest of a flipped classroom is to encourage each student to check the corresponding material before the class occurs, you can see in opaque the consultations (unique or not) that happened before the beginning of its corresponding class.

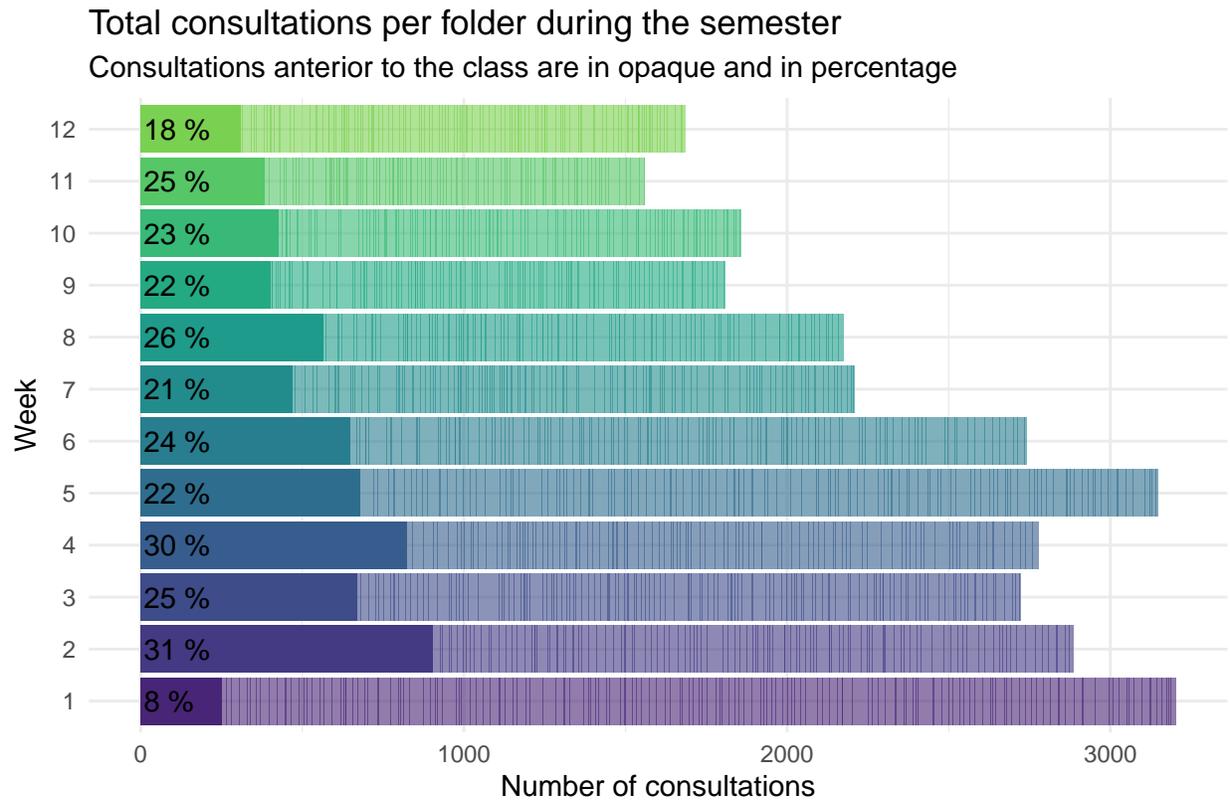


Figure 12: Preliminary Work Consultations

Unique consultations per folder during the semester  
 Consultations anterior to the class are in opaque and in percentage

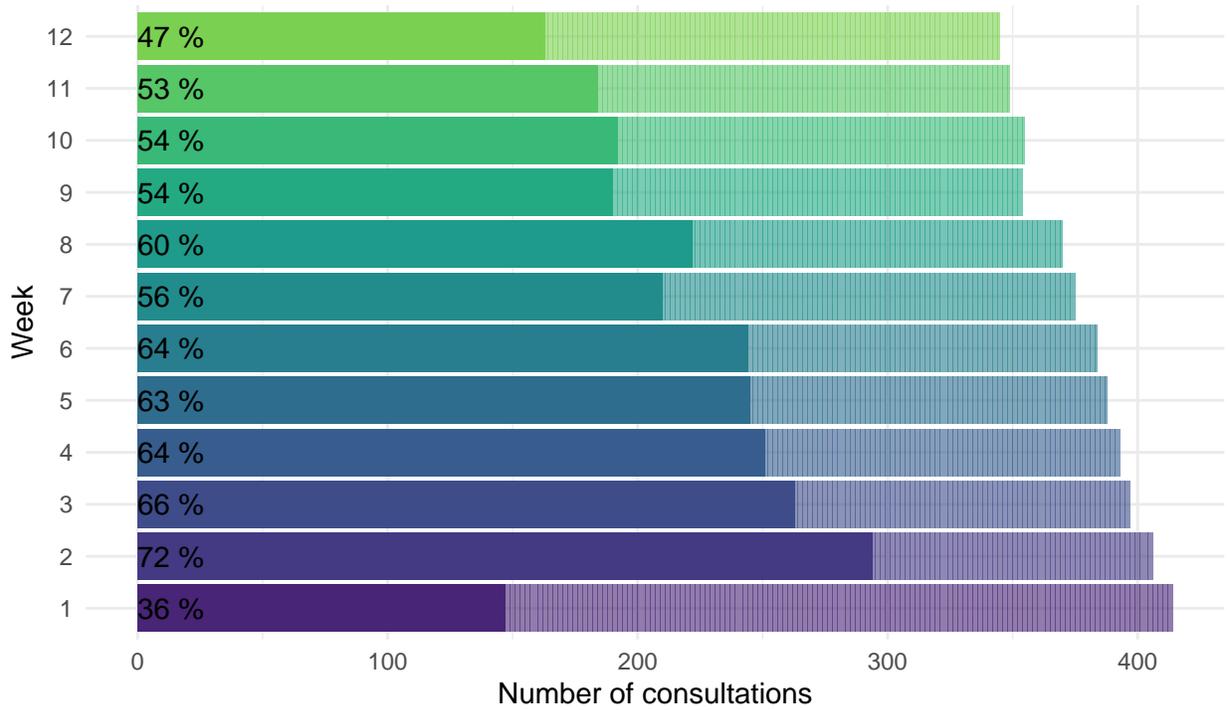


Figure 13: Preliminary Work Consultations

## 2.2 Impact on final grade (before bonus point) for consultations before the class

We show here the relationship between the level of participation (prelim\_level) and the final grade. We restricted the data to connections before the beginning of the class.

Number of weeks consulted in advance	Level
]0;4]	previous_prelim_level_1
]4;10]	previous_prelim_level_2
]10;12]	previous_prelim_level_3

The students were split in three groups dependent of their participation: “previous\_prelim\_level\_1” if they opened in advance only 4 folders or less. “previous\_prelim\_level\_2” if they opened between 5 and 10 folders in advance. “previous\_prelim\_level\_3” if they opened 11 or 12 folders in advance.

### Final grade (before bonus) and Preliminary work participation

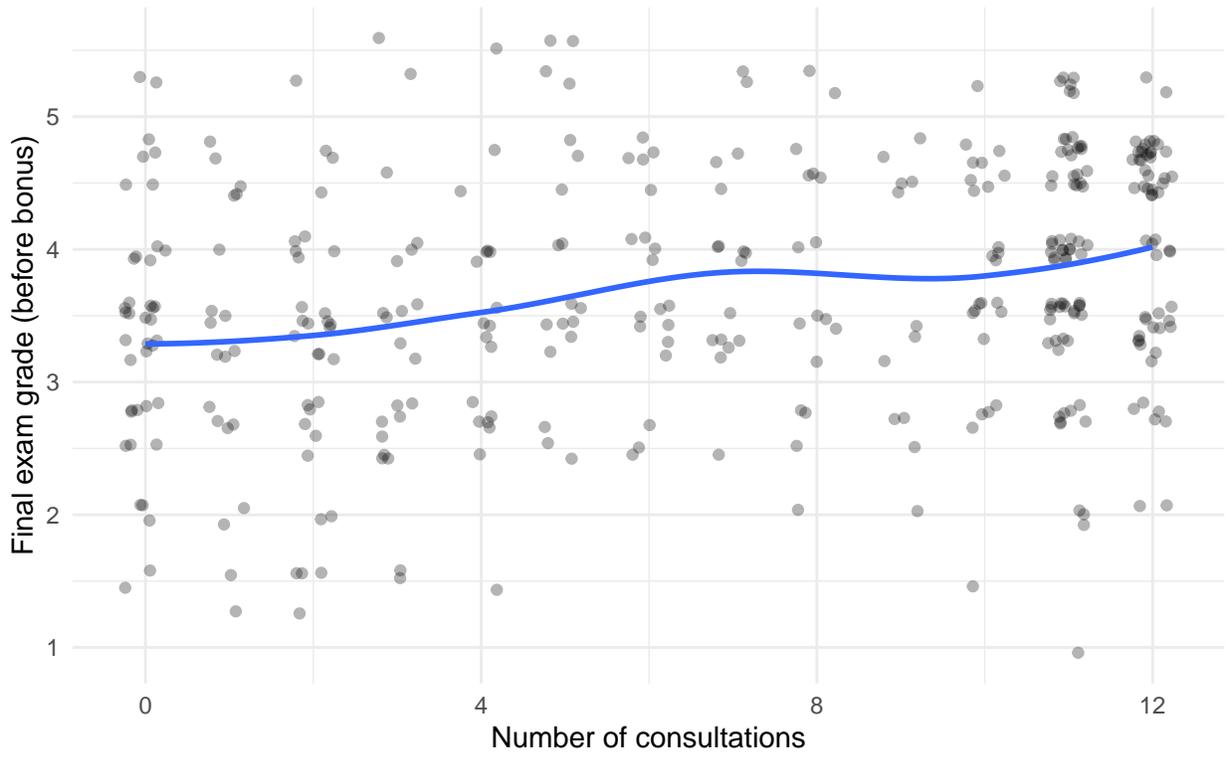


Figure 14: Preliminary Work Scatterplot

### Final grade (before bonus) and Preliminary work participation Ascending order of participation

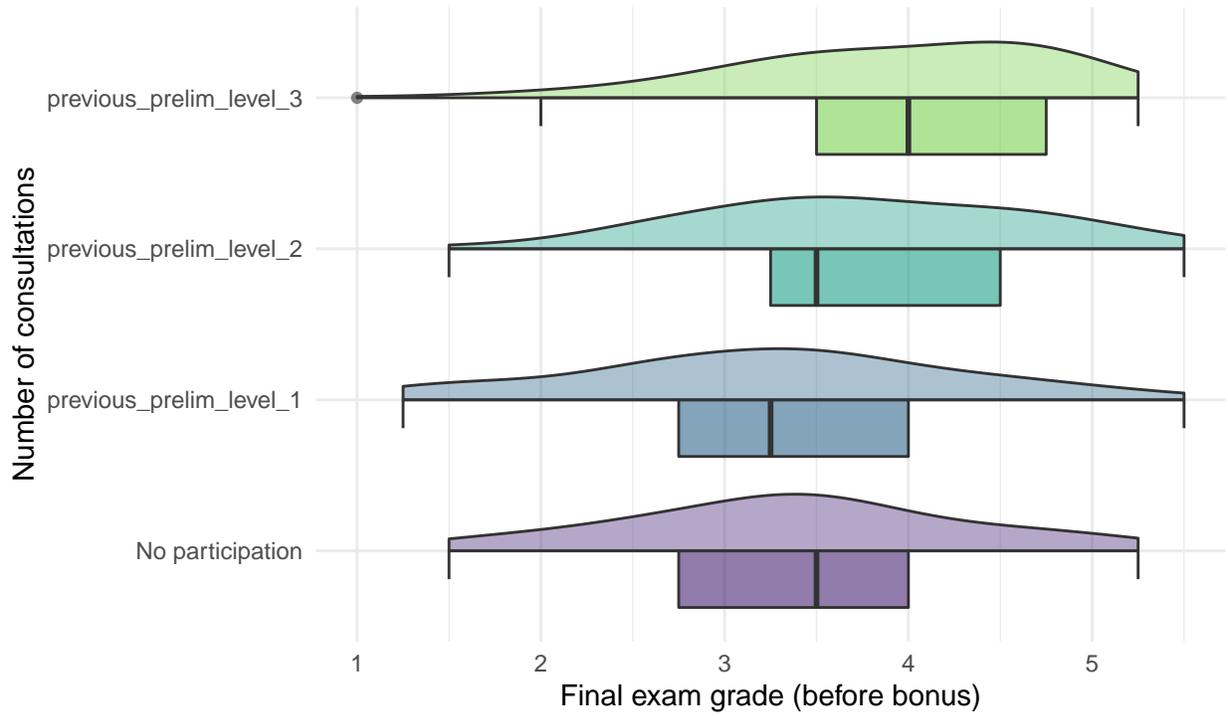


Figure 15: Preliminary Work Violinplot

### 3 Wooclap

#### 3.1 Wooclap attempts & results during the semester

During the lesson, an interactive quizz was submitted to the students using the web platform named Wooclap. The quizz was developped based on the student's results of the Auto-Evaluation quizz. For each question with less than 85% of good answers, a Wooclap question was created.

The same criterion was applied during the lesson. As long as this level was not reached, the teacher either:

- Asked the students to form groups and answer again
- Reformulated the question
- Created another question

During week 6, we decided that, after the lesson, the Wooclap quizz should be made available on Moodle to let the student practice. We show here the evolution of grades and participation to the Moodle version of these quizz.

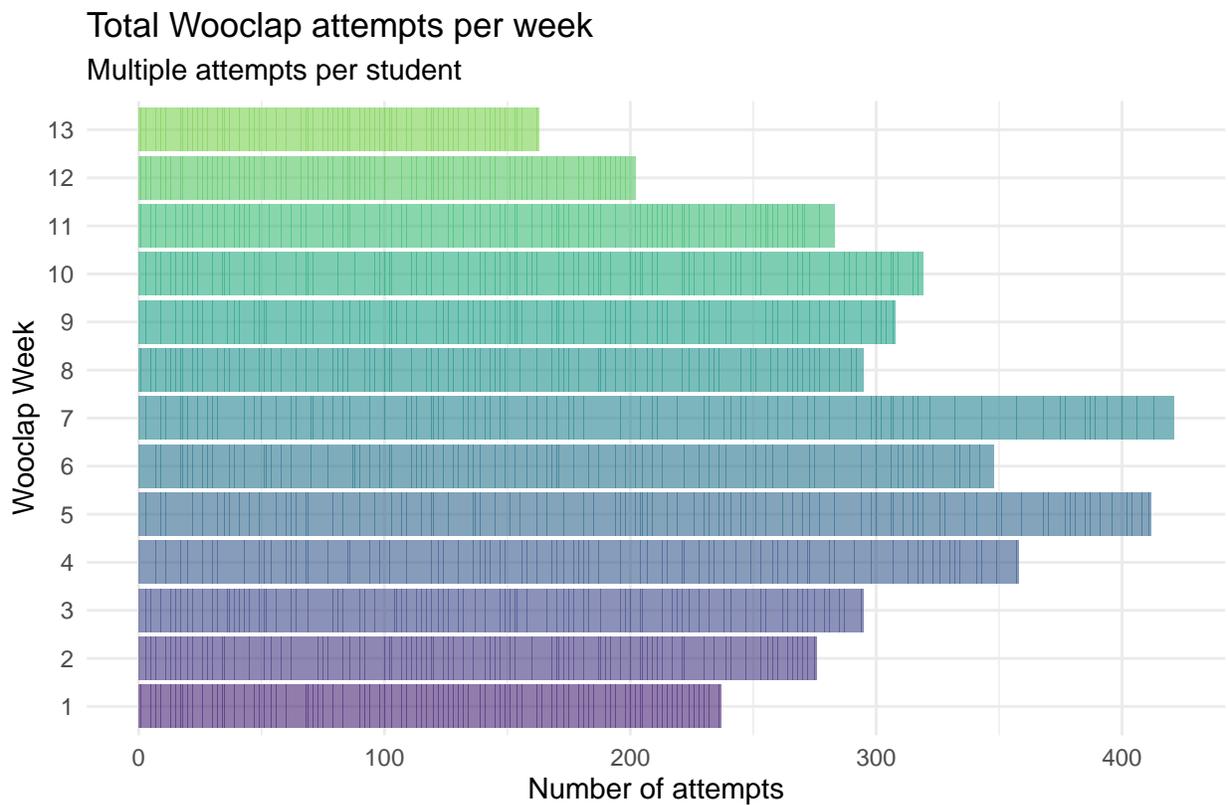


Figure 16: Wooclap Attempts

### Unique Wooclap attempts per week Only one attempt per student

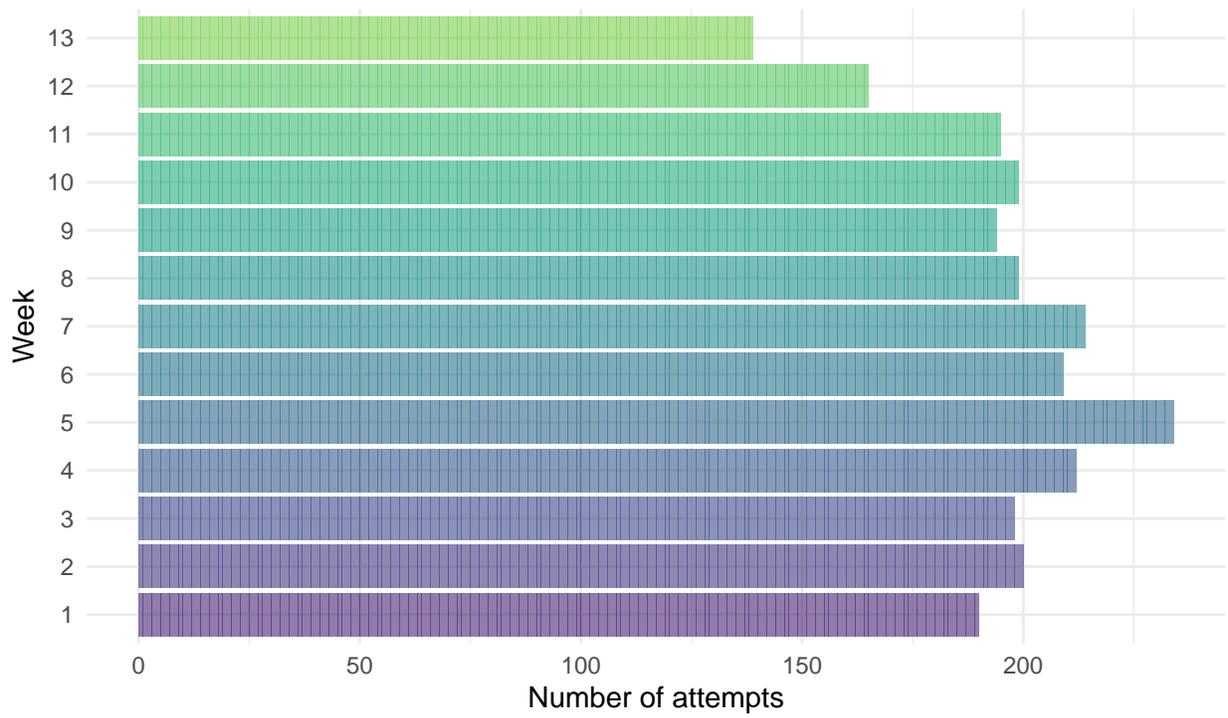


Figure 17: Wooclap Attempts

Behavior of best Wooclap grades per week  
 One grade (the best) per student per Wooclap

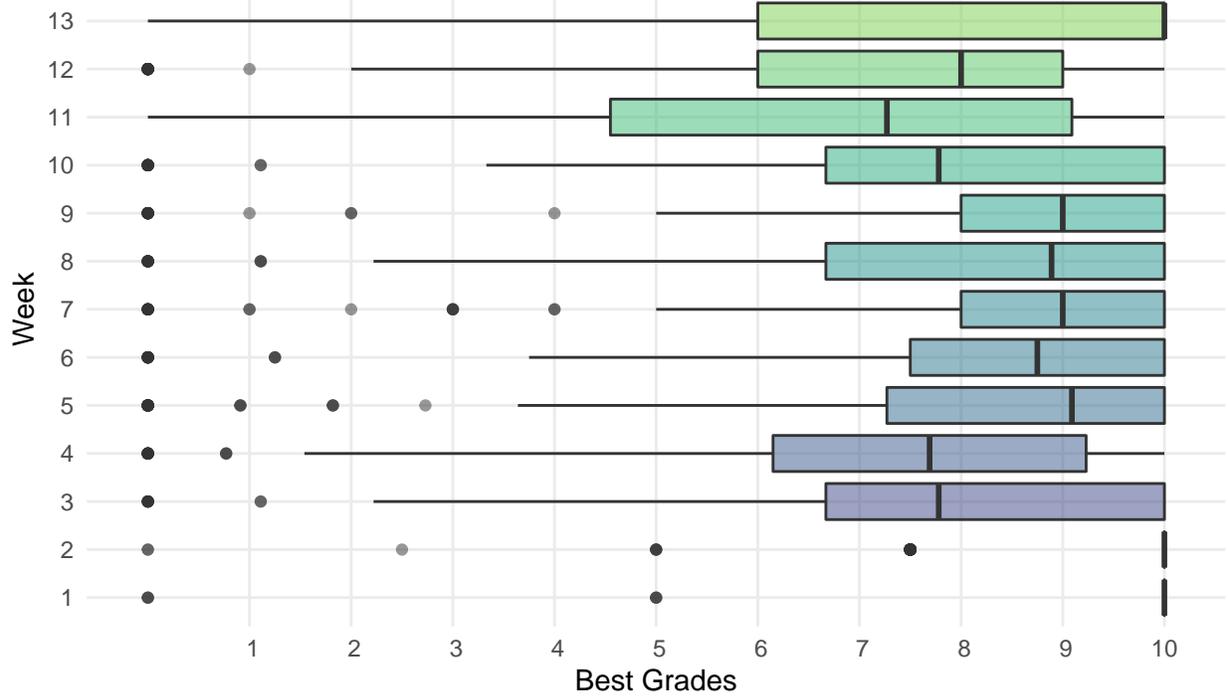


Figure 18: Wooclap Boxplot

# Distribution of the mean of best grades

All Wooclap cumulated

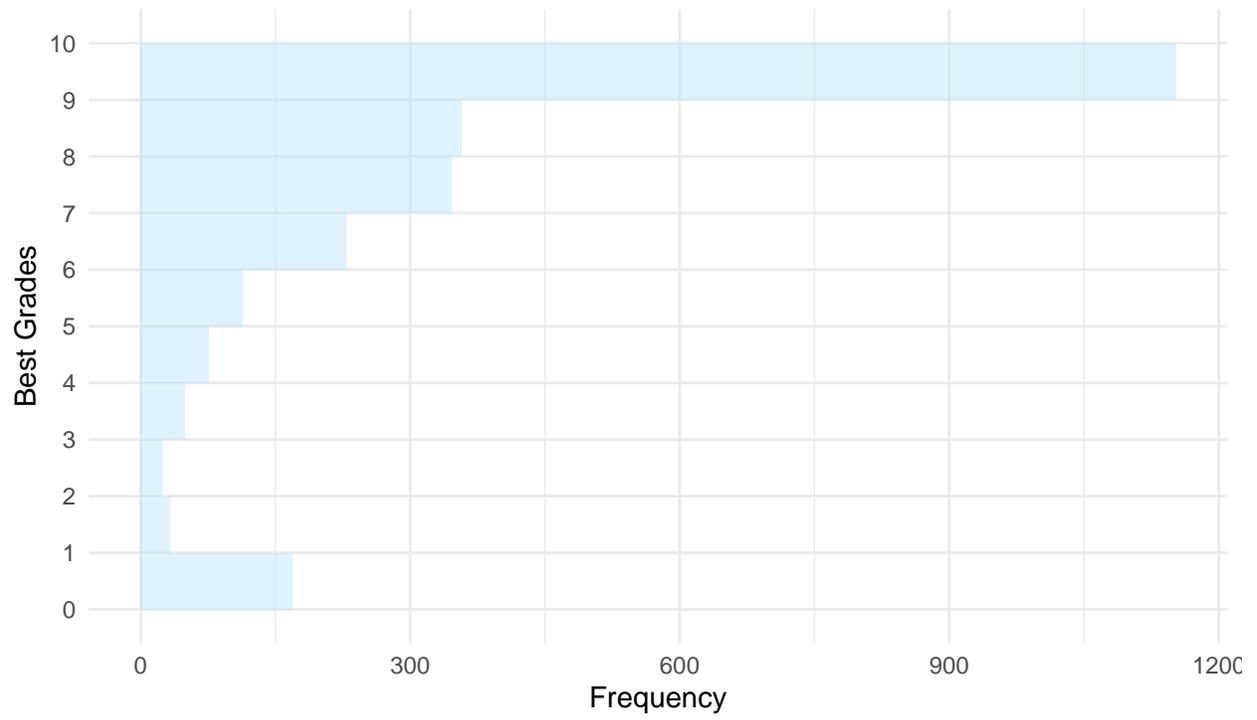


Figure 19: Wooclap Best Grades

## Distribution of the mean of best grades

One histogram per Wooclap

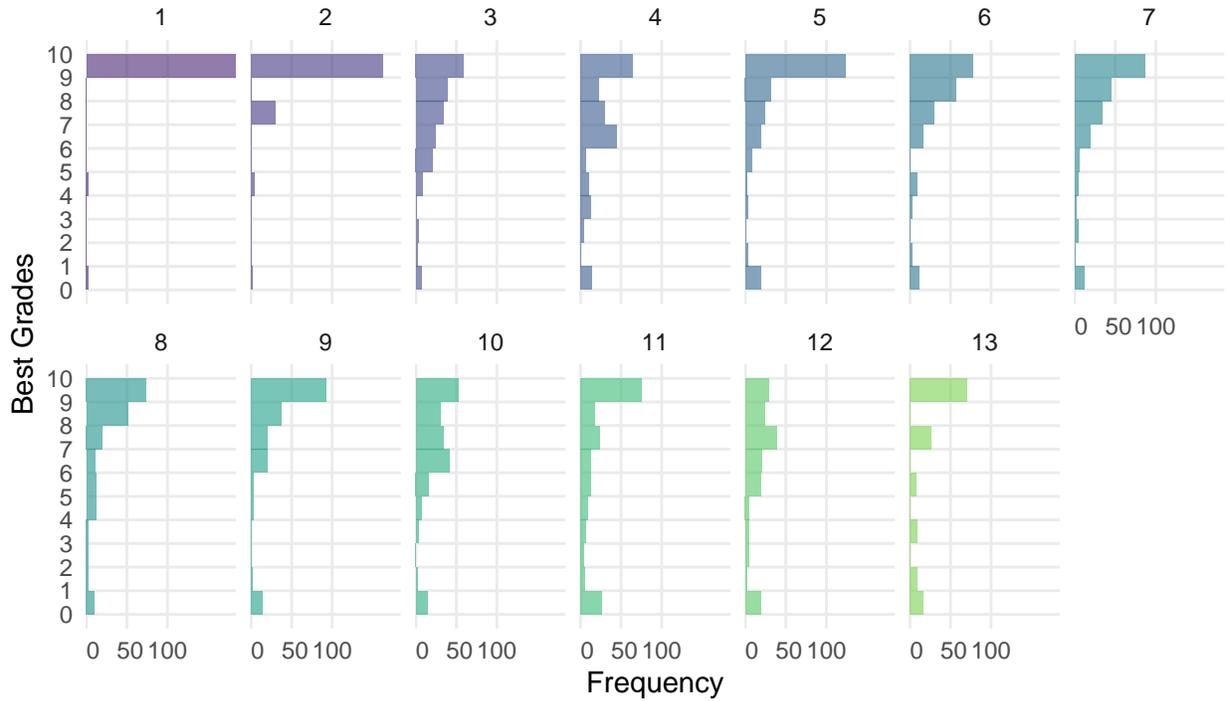


Figure 20: Wooclap Best Grades per Week

### 3.2 Mosaic plot Wooclap mean of best attempts vs Wooclap participation

As with the Auto-Evaluation quizz, we split the students to three categories depending on their mean of best grades per Wooclap and participation level:

If they did less than 7 Wooclap quizz, they fall in the category “wooclap\_level\_1”. If they did more than 7 but less than 12, they fall in the category “wooclap\_level\_2”. If they did the 12 Wooclap quizzes, they fall in the category “wooclap\_level\_3”.

Number of Wooclap done	Level
]0;7]	wooclap_level_1
]7;12]	wooclap_level_2
[13]	wooclap_level_3

If they had a grade inferior or equal to 7.5, they fall in the category “wooclap\_mean\_low”. If they had a grade superior to 7.5 but inferior to the maximum of 10, they fall in the category “wooclap\_mean\_medium”. If they completed the maximum in all quizzes, they fall in the category “wooclap\_mean\_high”.

Mean of best grades	Level
]0;7.5]	wooclap_mean_low
]7.5;10[	wooclap_mean_medium
[10]	wooclap_mean_high

However, some of the students never participated. It may be because they never opened a Wooclap quizz or never connected to the moodle page. You can see here the proportion of students not participating:

Total number of students	Participating students	Percentage
370	272	73.51%

We show here the relationship between participation and mean of best attempts.

### Wooclap participation and mean of best attempts

Each column sum to 100%

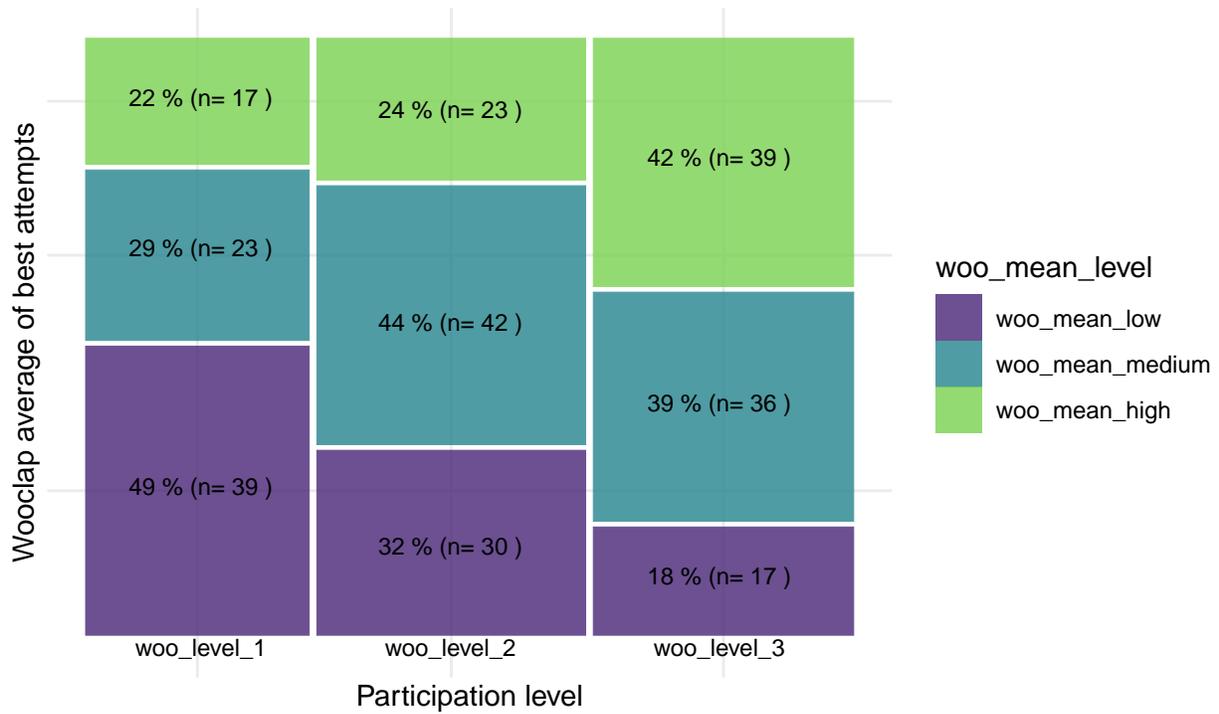


Figure 21: Wooclap Mosaicplot

Wooclap mean of participation and mean of best attempts  
Ascending order of participation

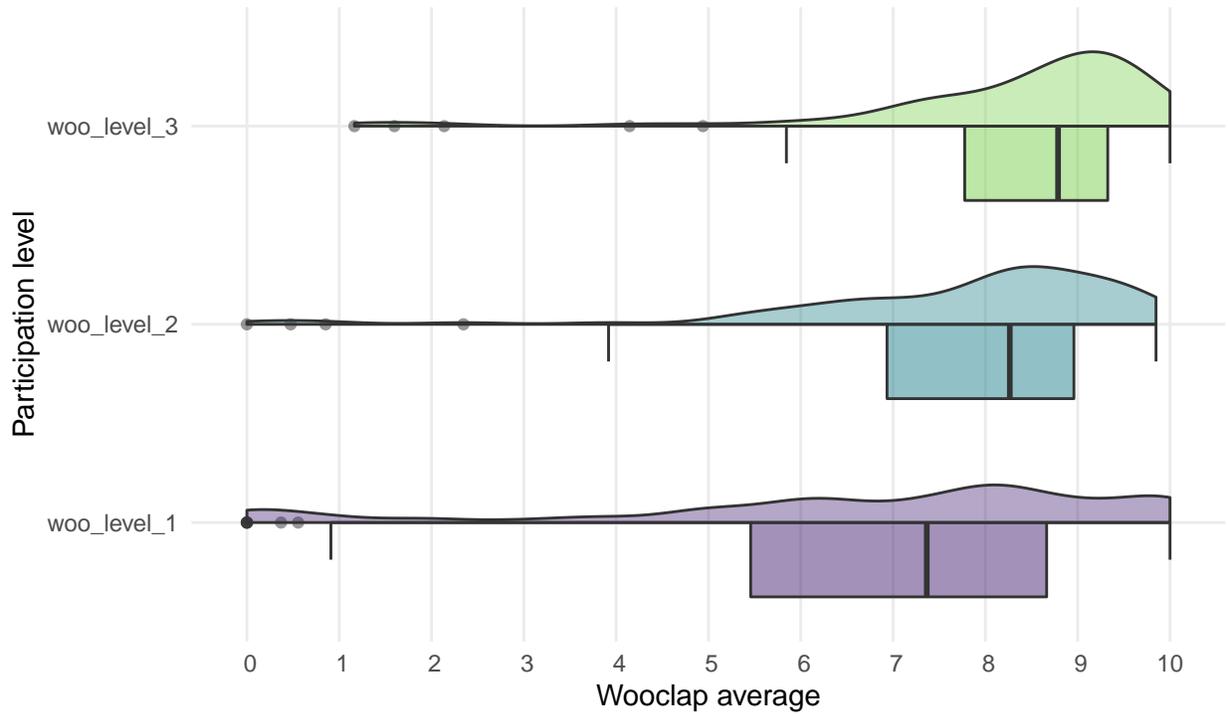


Figure 22: Wooclap Violinplot

### 3.3 Impact on final grade (before bonus) of Wooclap grades & participation

We show here the relationship between participation (woo\_level), mean of best attempts (woo\_mean\_level) and the final grade.

Final grade (before bonus) and Wooclap participation

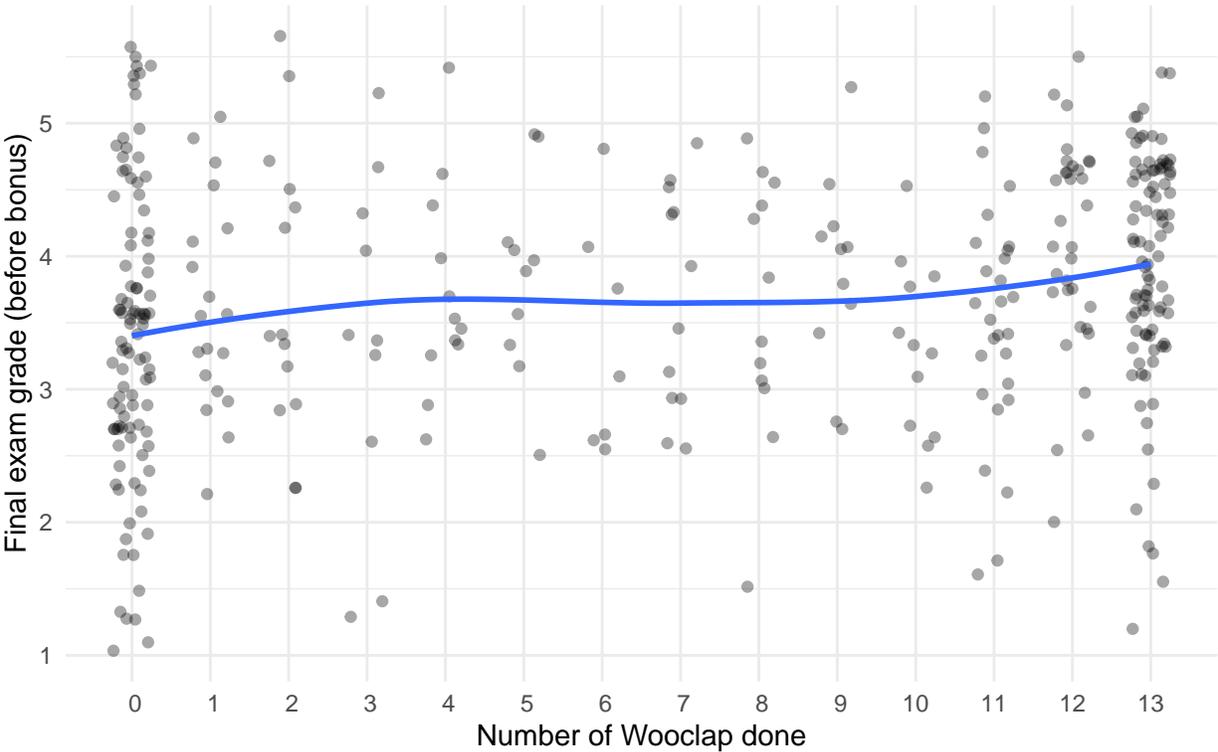


Figure 23: Wooclap Participation Scatterplot

Final grade (before bonus) and Wooclap mean of best grades

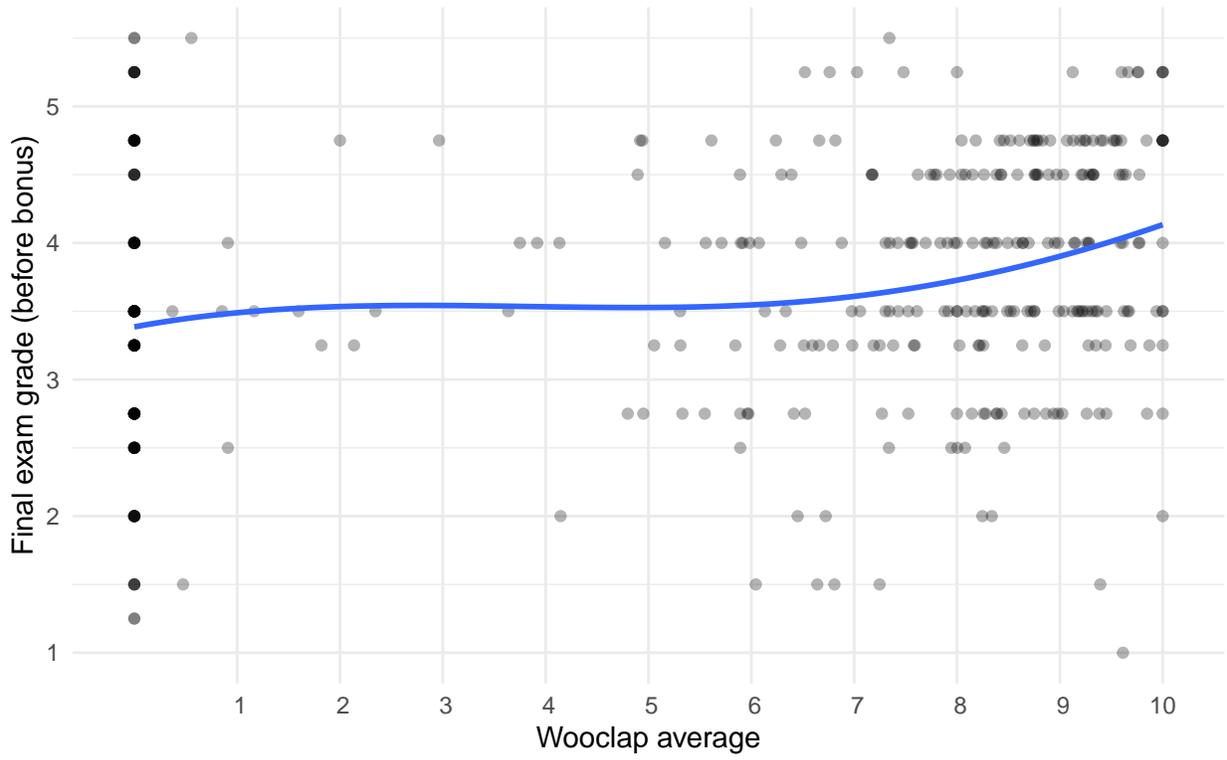


Figure 24: Wooclap Grades Scatterplot

### Final grade (before bonus) and Wooclap participation

Ascending order of participation

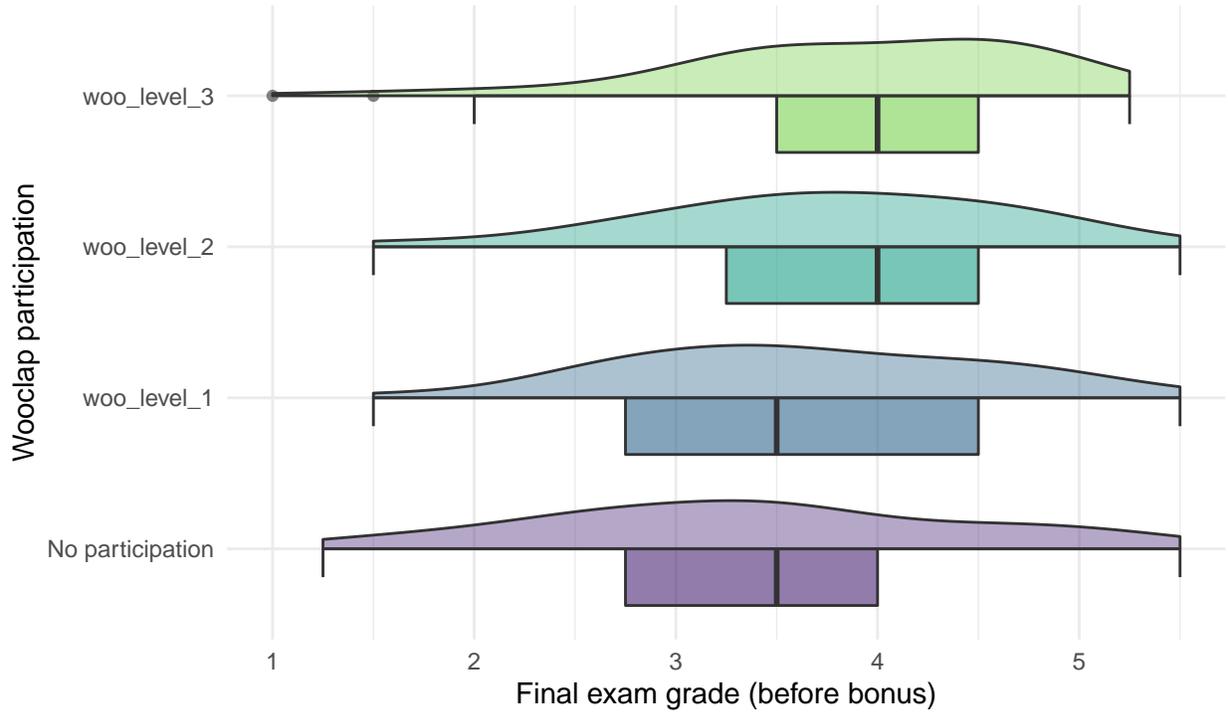


Figure 25: Wooclap Participation Violinplot

Final grade (before bonus) and Wooclap mean of best grades  
Ascending grades

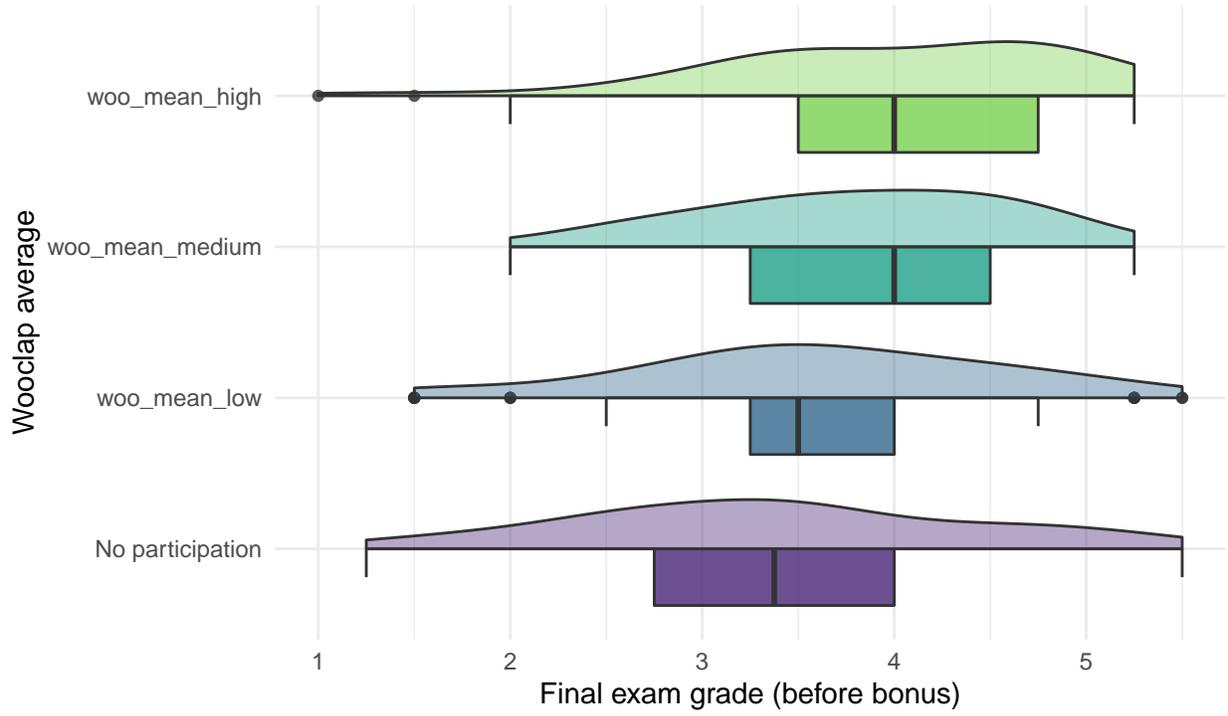


Figure 26: Wooclap Grades Violinplot

## 4 Bonus Points

During the semester, we submitted 4 bonus exams to the students on weeks 4, 6, 8 and 11. Of increasing difficulty, the students had to answer correctly 4 questions out of 7 for us to consider the bonus exam as passed.

We split the students to three categories depending on the number of bonus exam they passed:

Number of bonus exams passed	Bonus points
[0;1]	0
[2]	0.5
[3;4]	1

If they passed less than 2 Bonus exams, they have 0 bonus point. If they passed 2 Bonus exams, they get 0.5 bonus points. If they passed more than 3 Bonus exams, they achieve the maximum of 1 bonus point.

### 4.1 Summary statistics of grades (including bonus points)

#### Histogram of Final Exam Grades (Including bonus points)

Bins include the lower limit but not the upper one (exception: the top bin includes both)

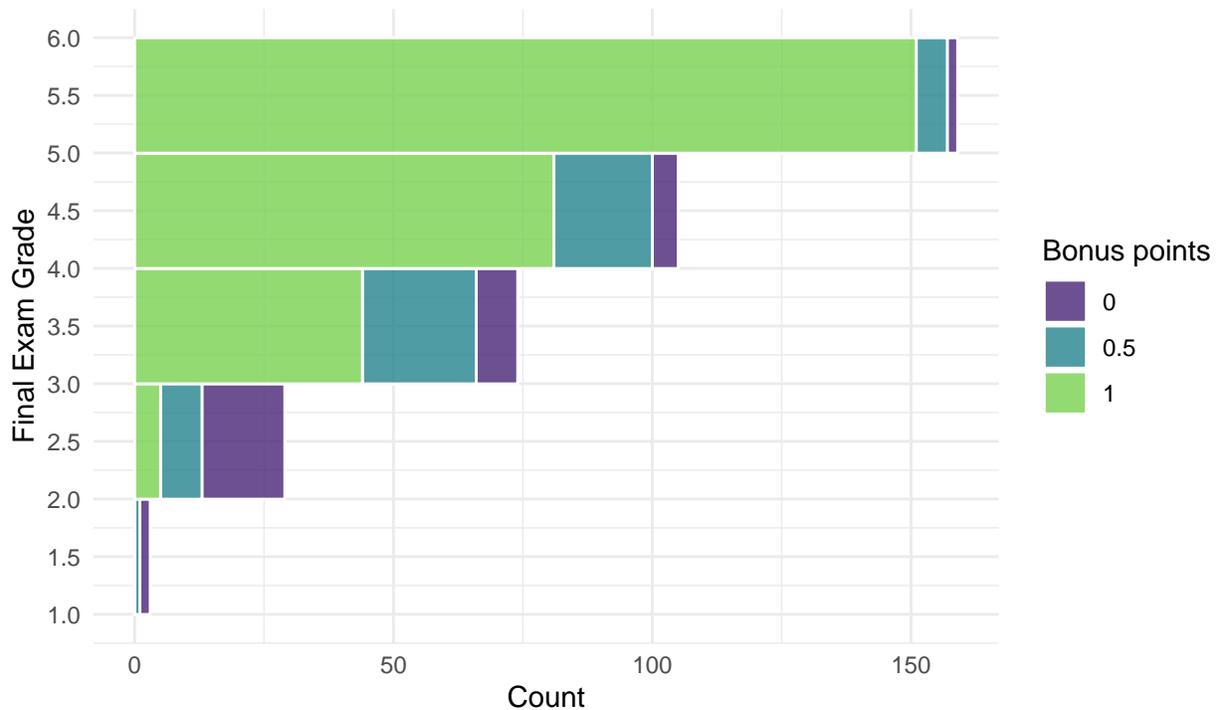


Figure 27: Bonus Points Histogram

Relationship between final exam grade and bonus points

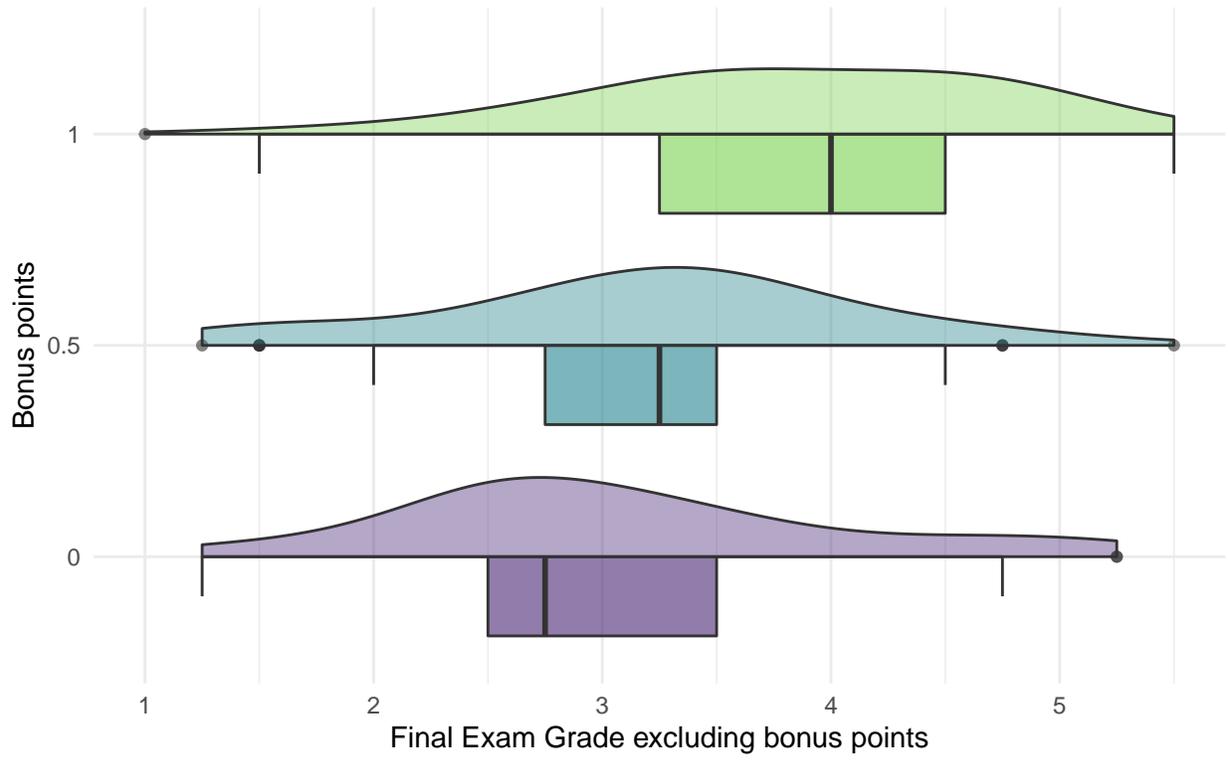


Figure 28: Bonus Points Violinplot

## 5 Surveys

### 5.1 Illustrative surveys

For the weeks 1, 4, 7 and 12, we submitted a survey to the students. The surveys were analyzed using the techniques learned in class. The surveys helped us motivate the students, increase their participation and illustrate statistical methods.

We show here the importance of having a survey with an interesting research question that can only be answered through statistical methods.

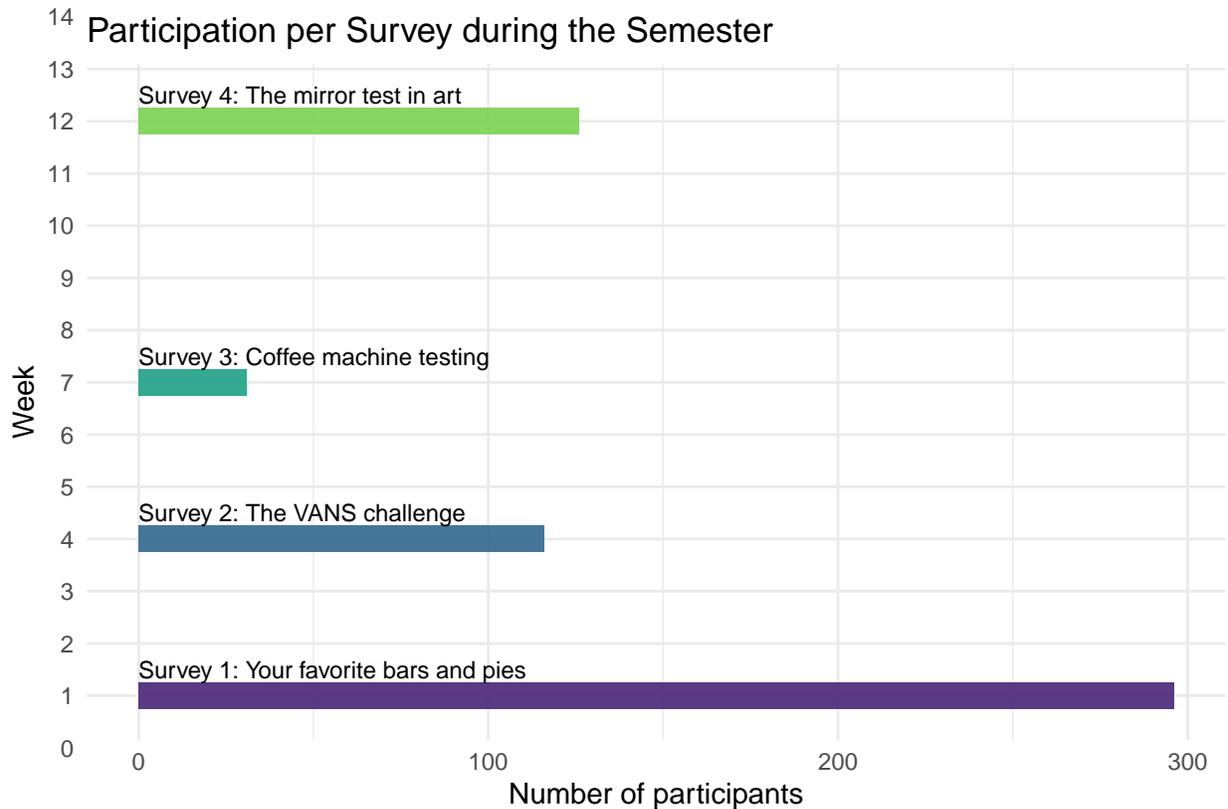


Figure 29: Survey Barplot

### 5.2 Satisfaction survey

At the end of the semester, but before the final exam, we submitted a satisfaction survey to the students. The aim is to find possible improvements as well as the students feedback on this course format.

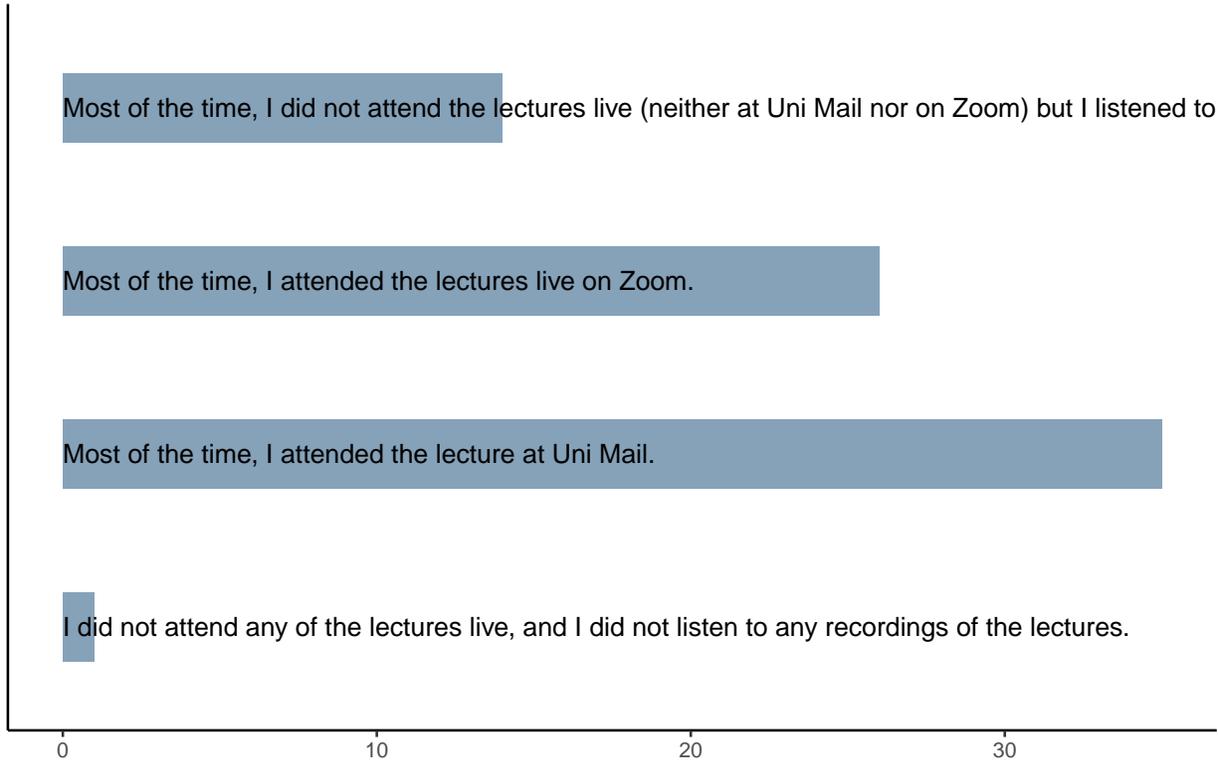
We found the followings:

- When only courses are proposed on parallel with in praesentia classes, students are split in two.
- The students use a lot the recordings but still benefit from the Zoom lives.
- The students prepared in advance for the lesson.
- The students were really satisfied with the flipped classroom concept, the AE, the surveys, the Woodclaps, the bonus exams.
- Surprisingly, the students were unsatisfied with the “classic” seminars and practicals. The aim of the practicals was to revise theory and learn the R program with an assistant. The main critic was that the practicals were too focused on R.
- Surprisingly, even if it was more used than classical AE, the READY was not as much liked. The reason is that the students expected new and exclusive exercises but instead got a random draw of 20

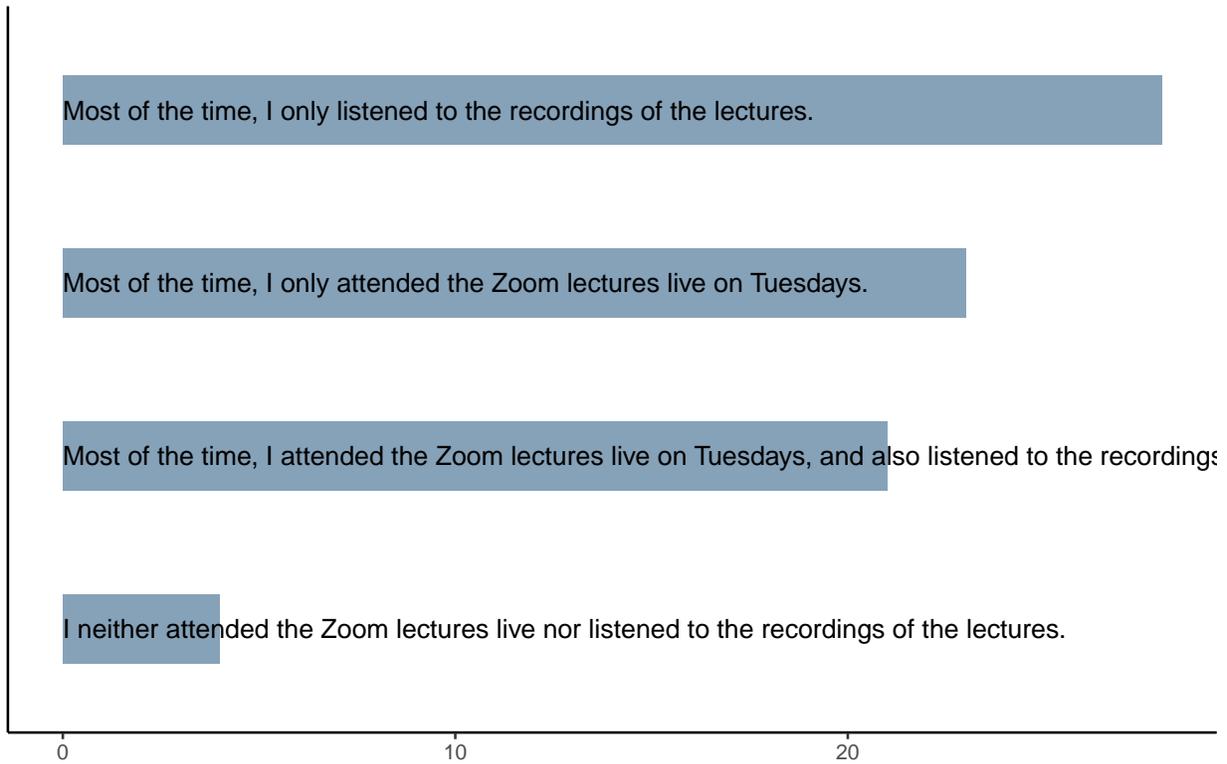
questions from a question bank of 110 questions.

- The students were divided regarding SpeakUp. They enjoyed the Q&A format but were disappointed in two points
  - The old questions hide the new ones.
  - They felt that SpeakUp was replacing the Zoom chat function.

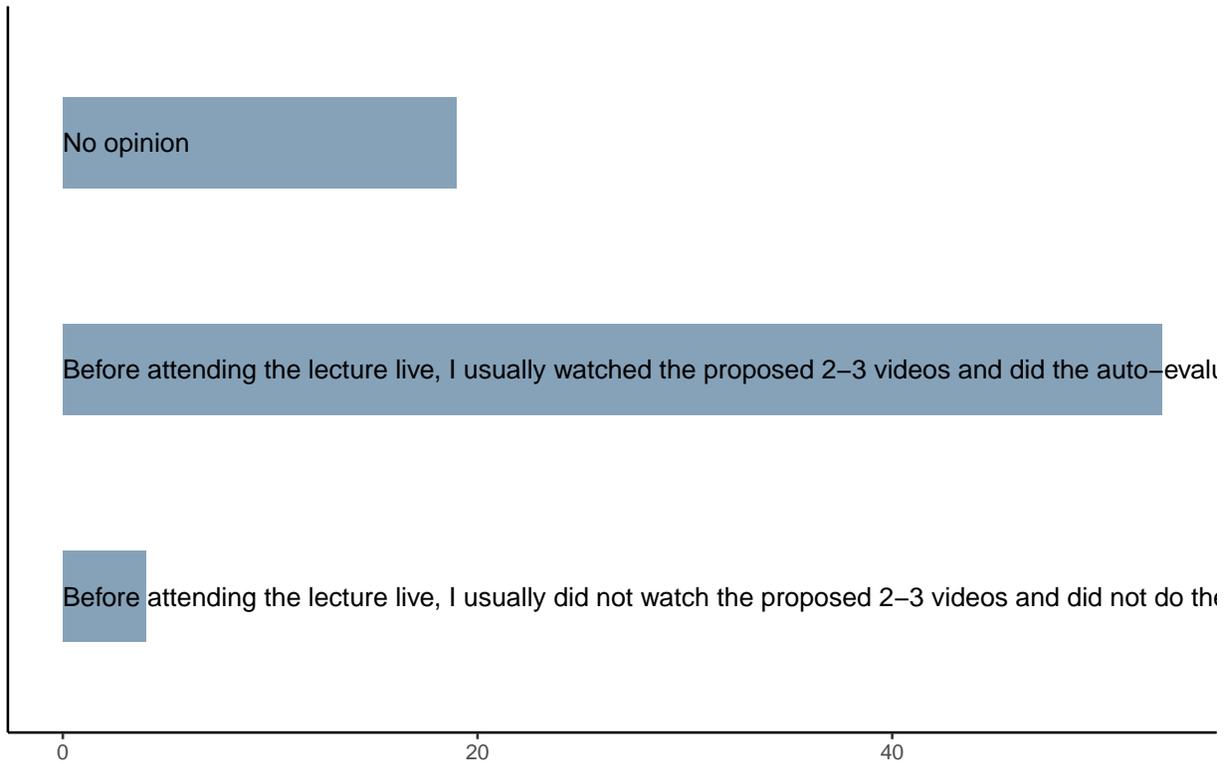
When the lectures were offered face-to-face (until the end of October 2020):



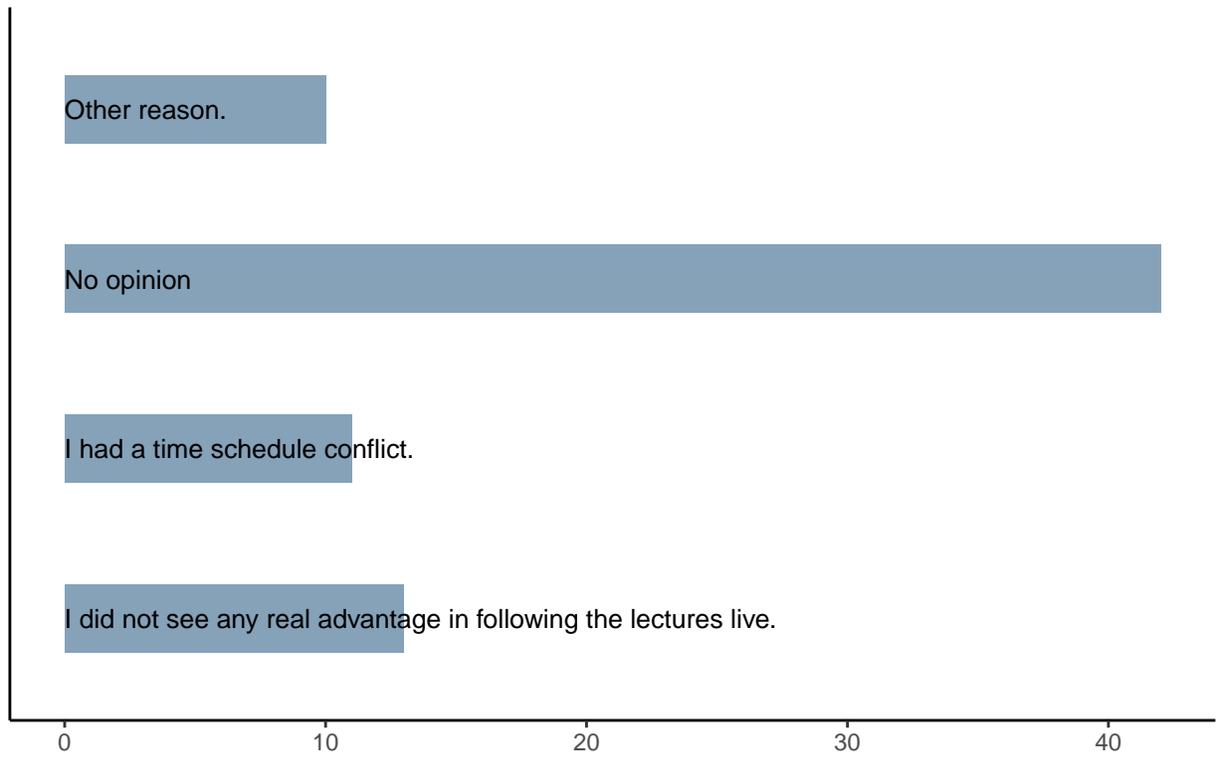
When the lectures were only offered via Zoom (starting from November 2020):



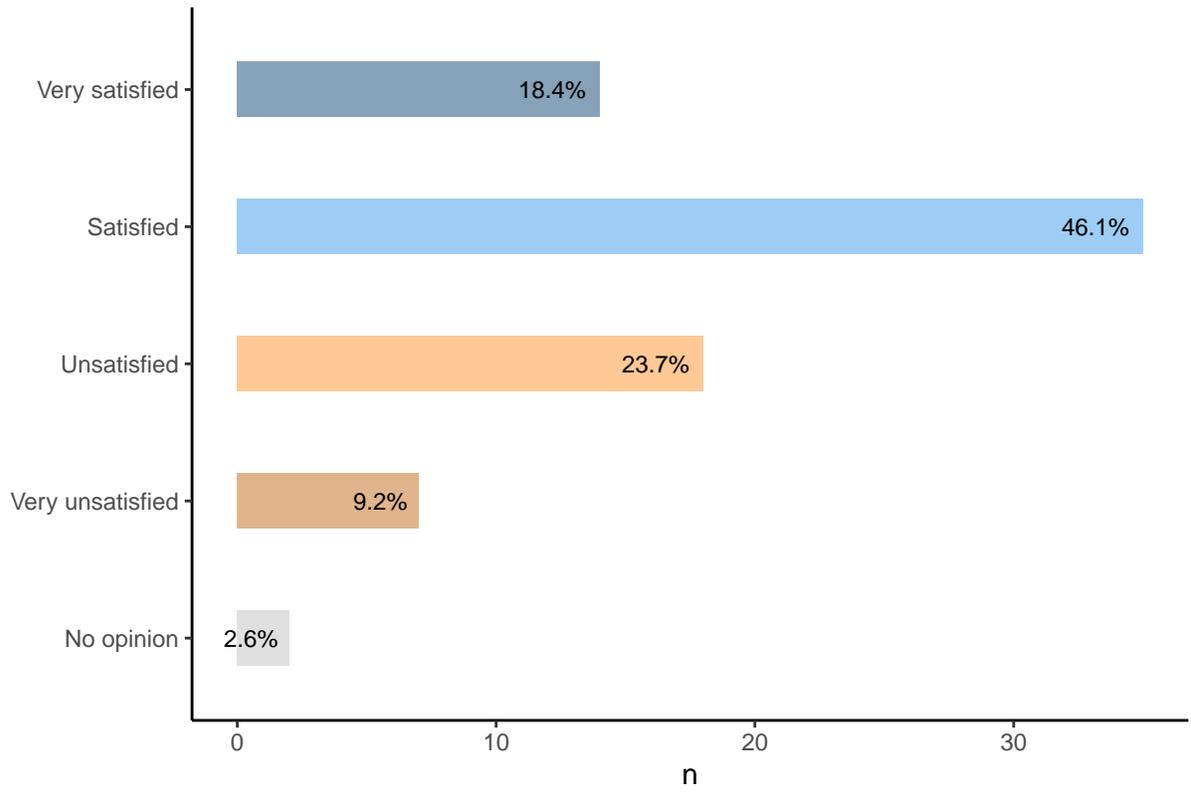
Answer this question if most of the time you attended the lectures live:



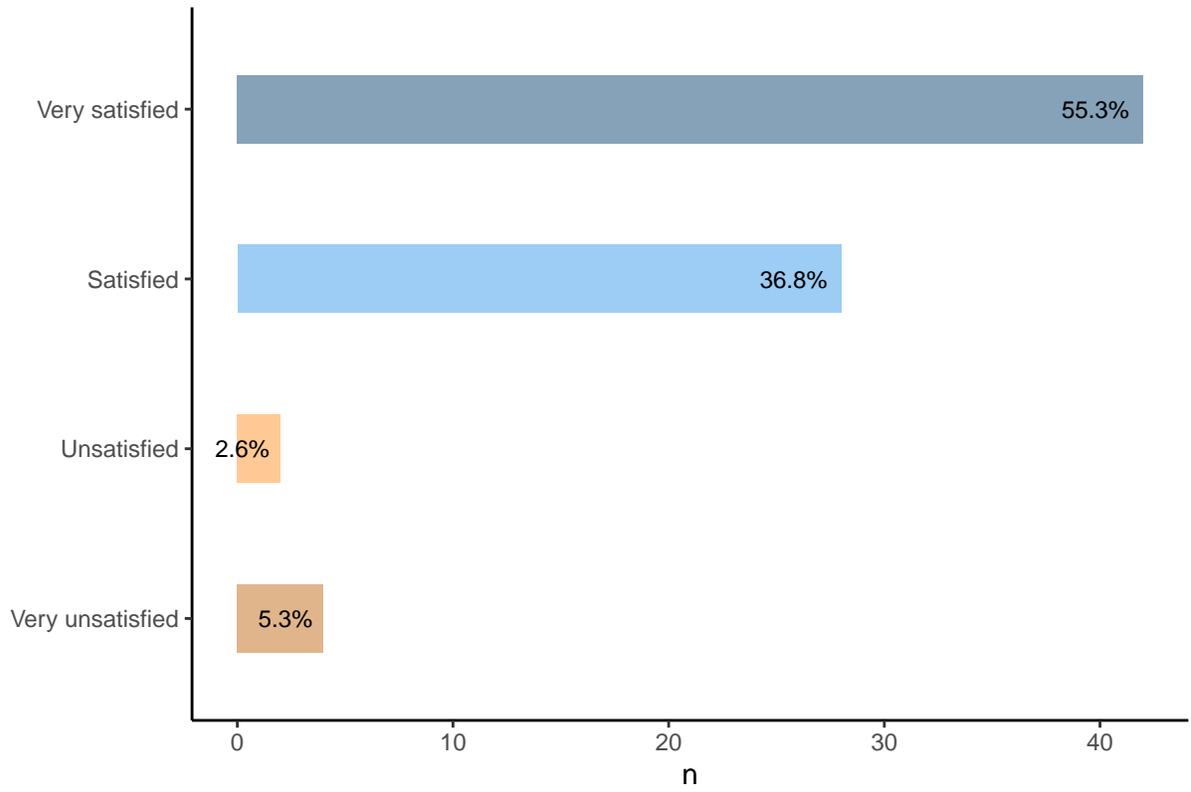
Answer this question if most of the time you did not attend the lectures live:



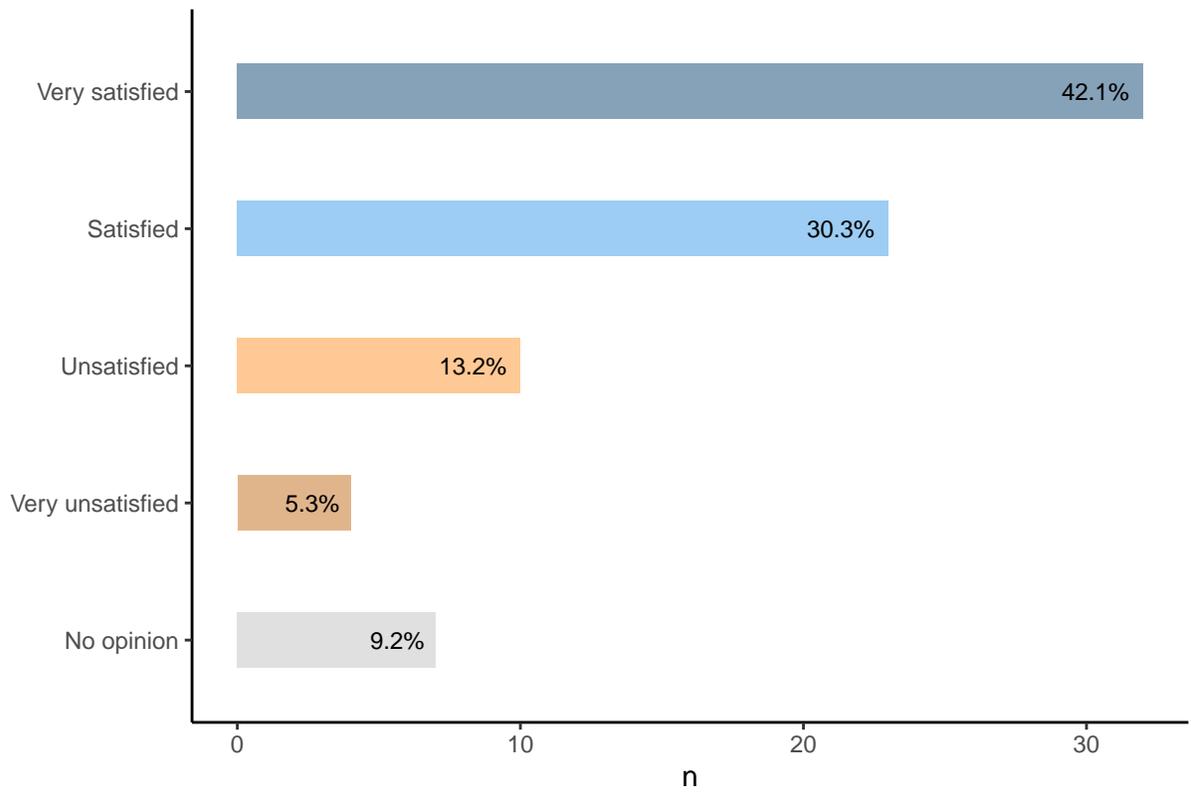
### What is your satisfaction level with the "Flipped Classroom" concept



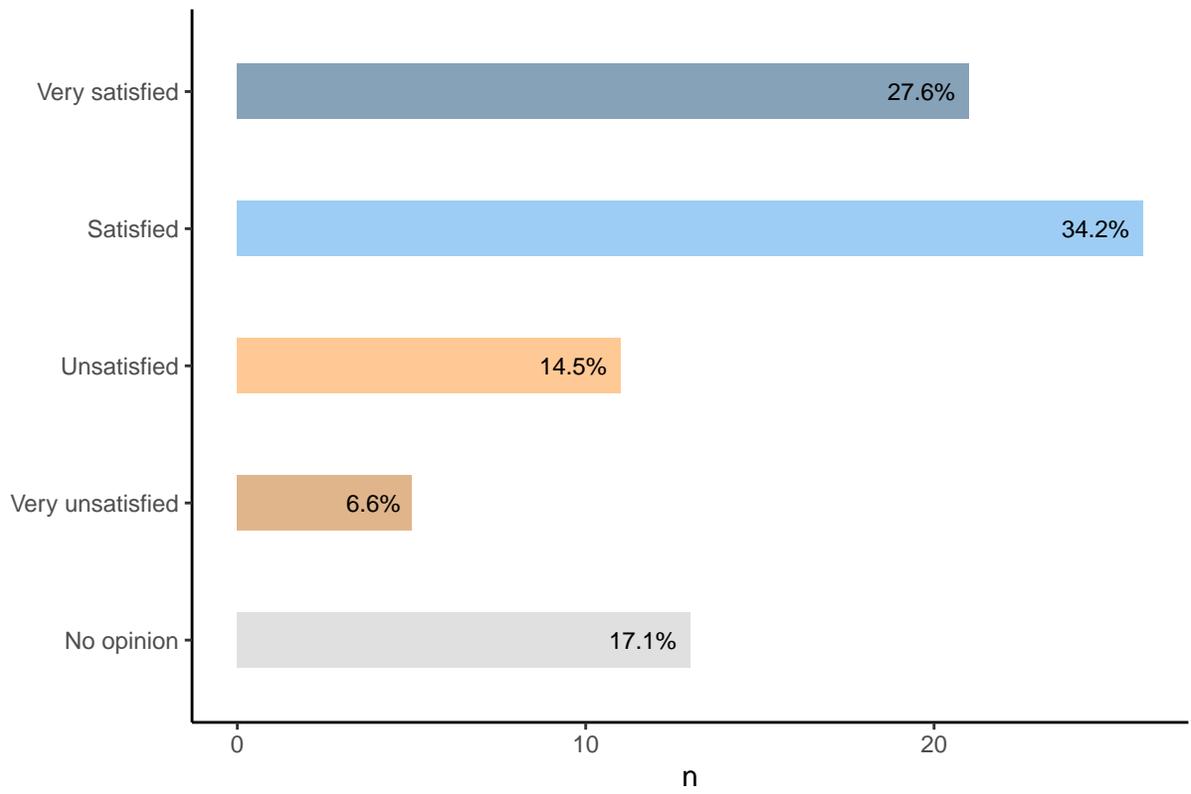
### What is your satisfaction level with the Auto-Evaluation quizzes?



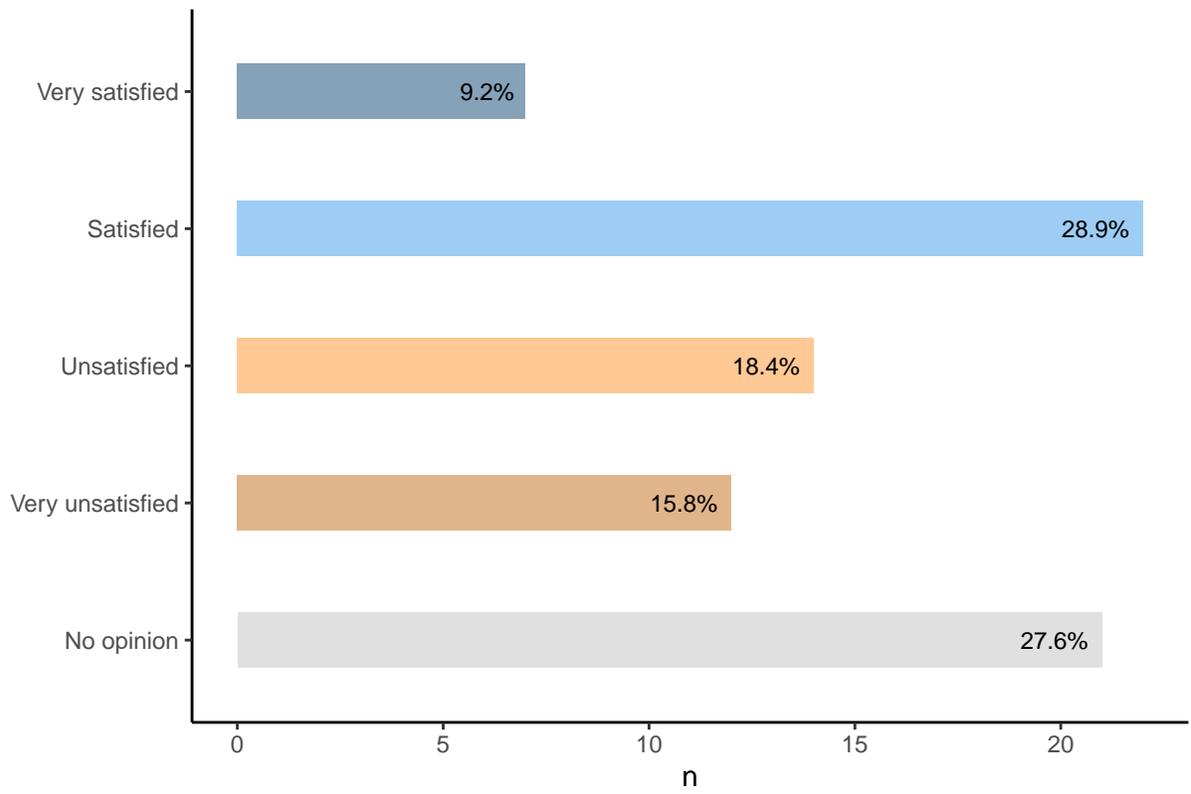
### What is your satisfaction level with the Wooclap quizzes?



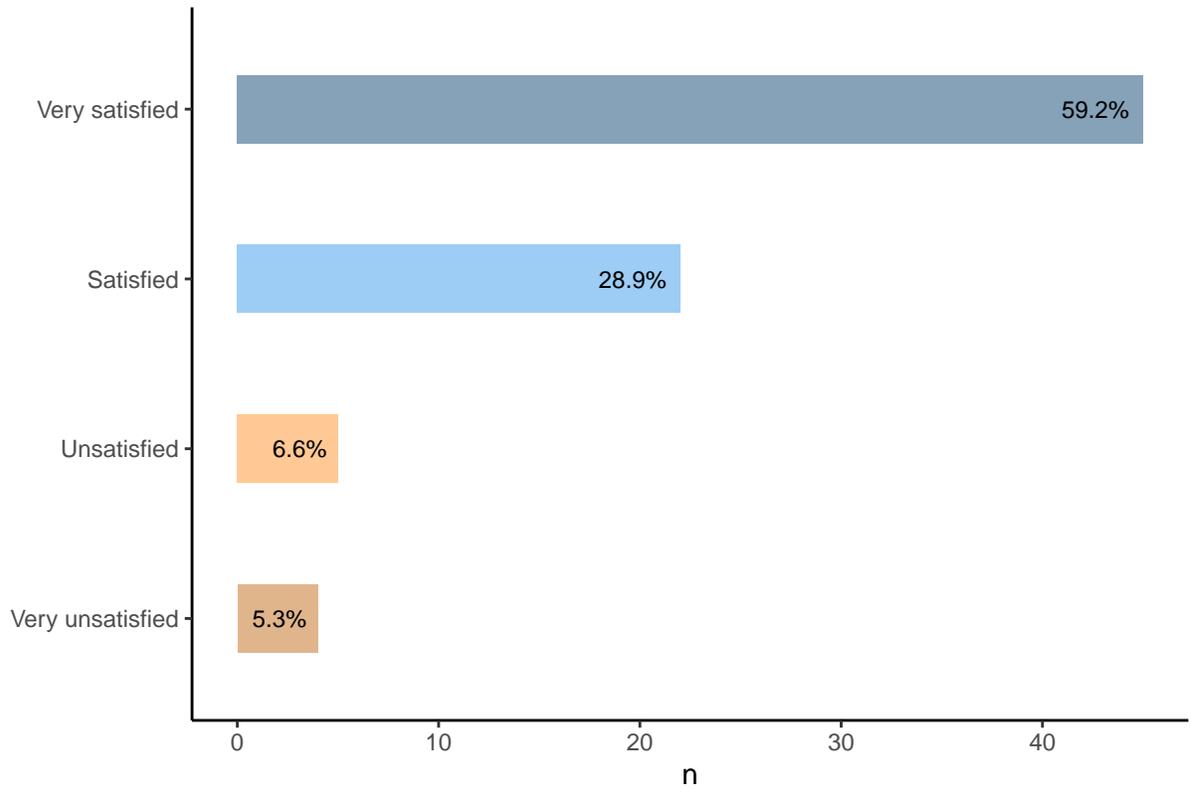
### What is your satisfaction level with the R.E.A.D.Y. quiz?



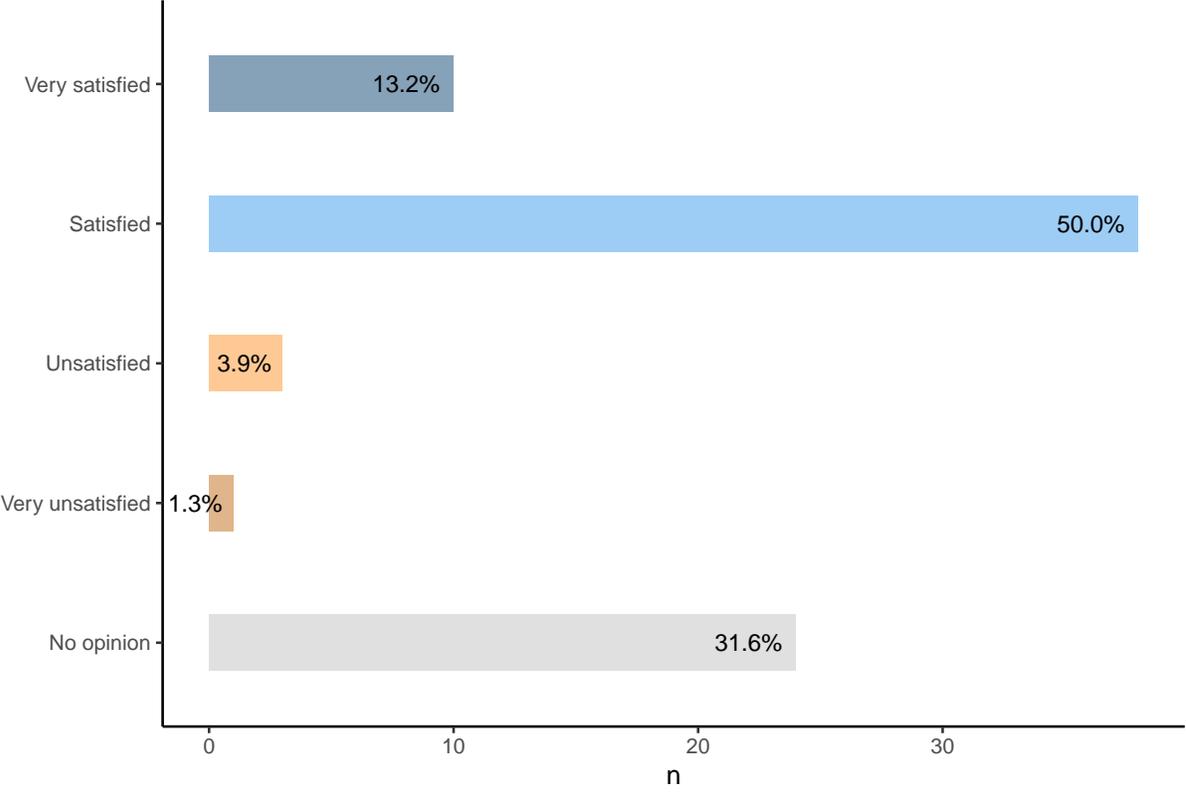
### What is your satisfaction level with SpeakUp?



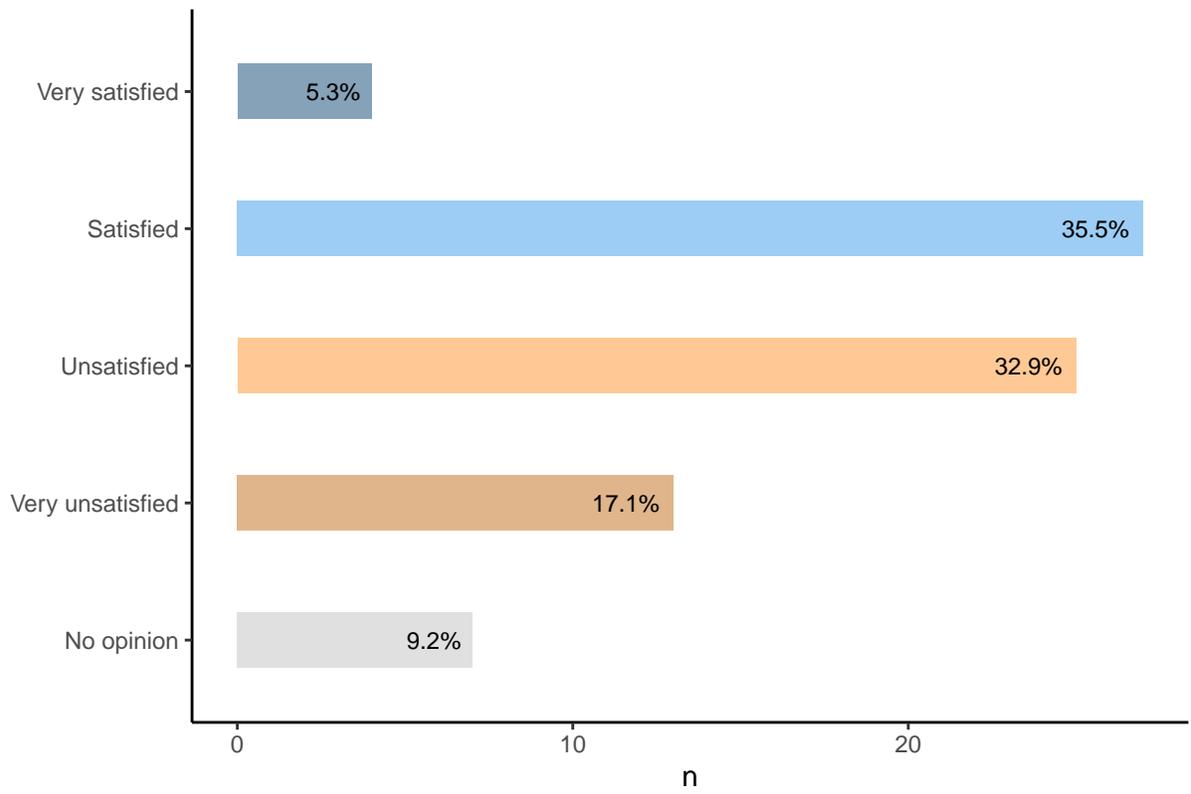
### What is your satisfaction level with the 4 Bonus Exams?



What is your satisfaction level with the 4 Surveys proposed during the sen



### What is your satisfaction level with the Practicals?



## 6 Conclusion

The success of the Flipped classroom concept can be measured in the following keypoints:

1. Pre-class preparation through consultations of the folder “Preliminary Work”
2. Participation to facultative activities (Surveys, Auto-Evaluation Quiz, Bonus Exams)
3. Grades achieved in the facultative activities

With the interesting discovery that the keypoints 2 and 3 seem correlated (Fig. 6, 7, 21, 22)

For each of these elements, we observed excellent results and a clear and positive impact on the final grade.

We see this impact both qualitatively, as the students have better grades thanks to a better understanding of the course (Fig. 8-11, 14, 15, 23-26), and quantitatively as the bonus points prevented 25% of the students to fall below the grade 4 (Fig. 27).

The students quickly understood and adapted to the flipped classroom format. We see this in the jump from a scarce pre-class participation level to an excellent one between week 1 and 2, that is to say, between presentation of the concept and its application (Fig. 12, 13).

However, we observe a decline in participation and preparation over time. It appears that such dereliction can be countered by producing supplementary activities such as surveys, bonus exams or Auto-Evaluation quizzes branded as “special” to the students. For such a strategy to succeed, we observed that the surveys had to arouse the interest of the student (Fig. 29) and the Auto-Evaluation had to be presented as a good training for the final exam (Fig. 1, 2).

In the view of this, we conclude that the flipped classroom concept has an important positive impact on the students, both in terms of results and understanding of the course.

To these measured results, we would want to add that the flipped concept gives us the capacity of knowing in real-time the level of the class and makes us able to adapt with only a one week lag.

## 7 Comments, remarks and suggestions from the students

The satisfaction survey had a free entry for comments. They are all represented here.