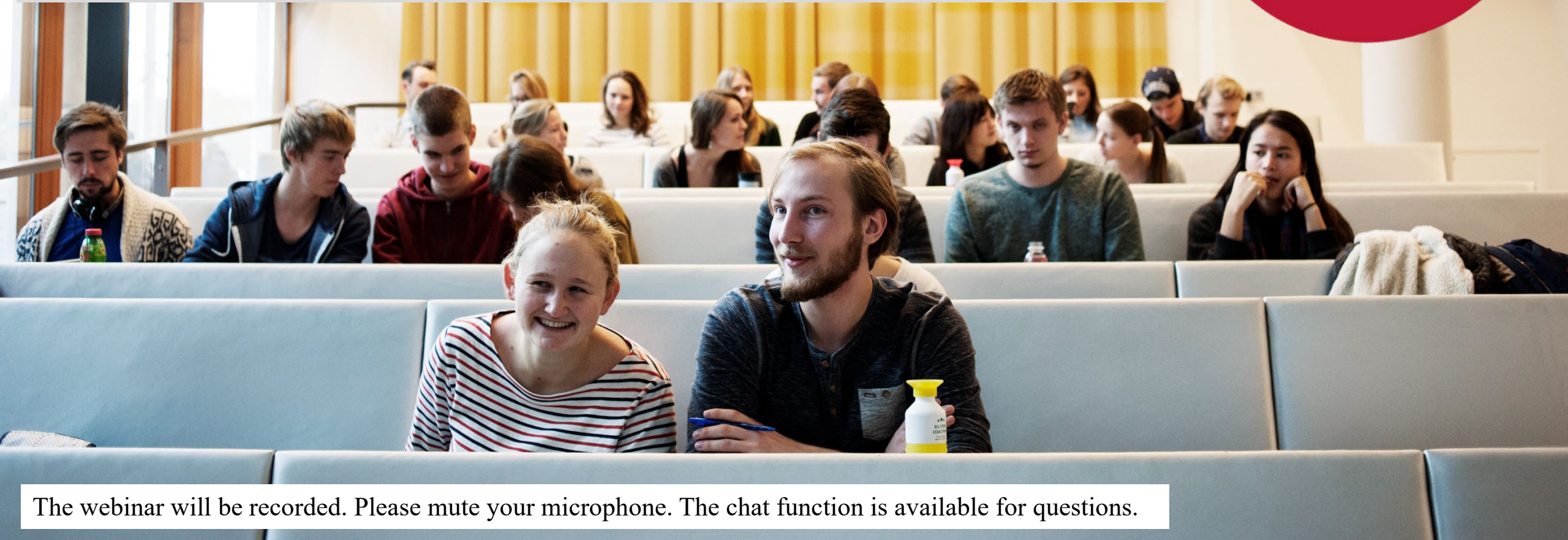




# Perusall: every student prepared for every class

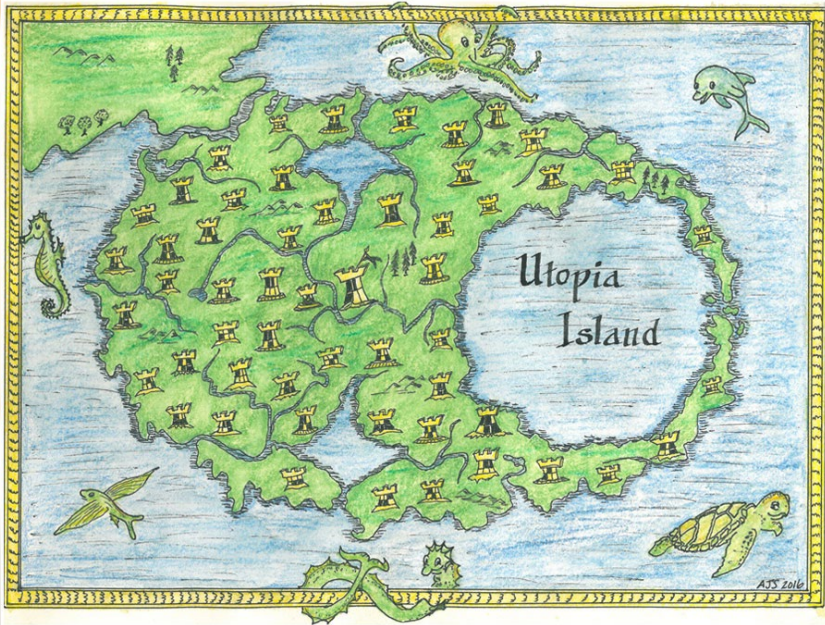
Erwin van Vliet, Natasa Brouwer, Cato Drion (FNWI) - 8 July 2020



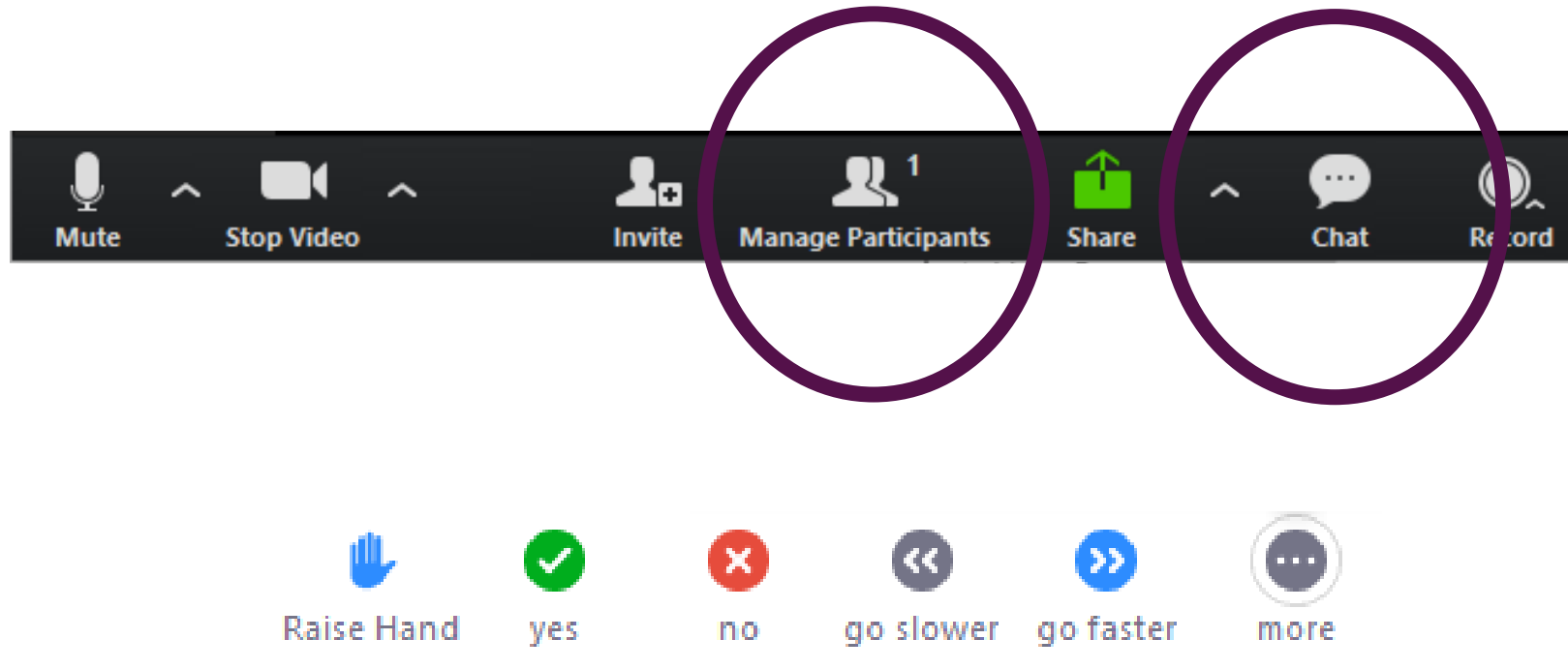
The webinar will be recorded. Please mute your microphone. The chat function is available for questions.



# All students finish the reading assignment prior to your lecture



Are more than 90% of your students prepared for every lecture?





## The COVID-19 pandemic has changed education forever. This is how

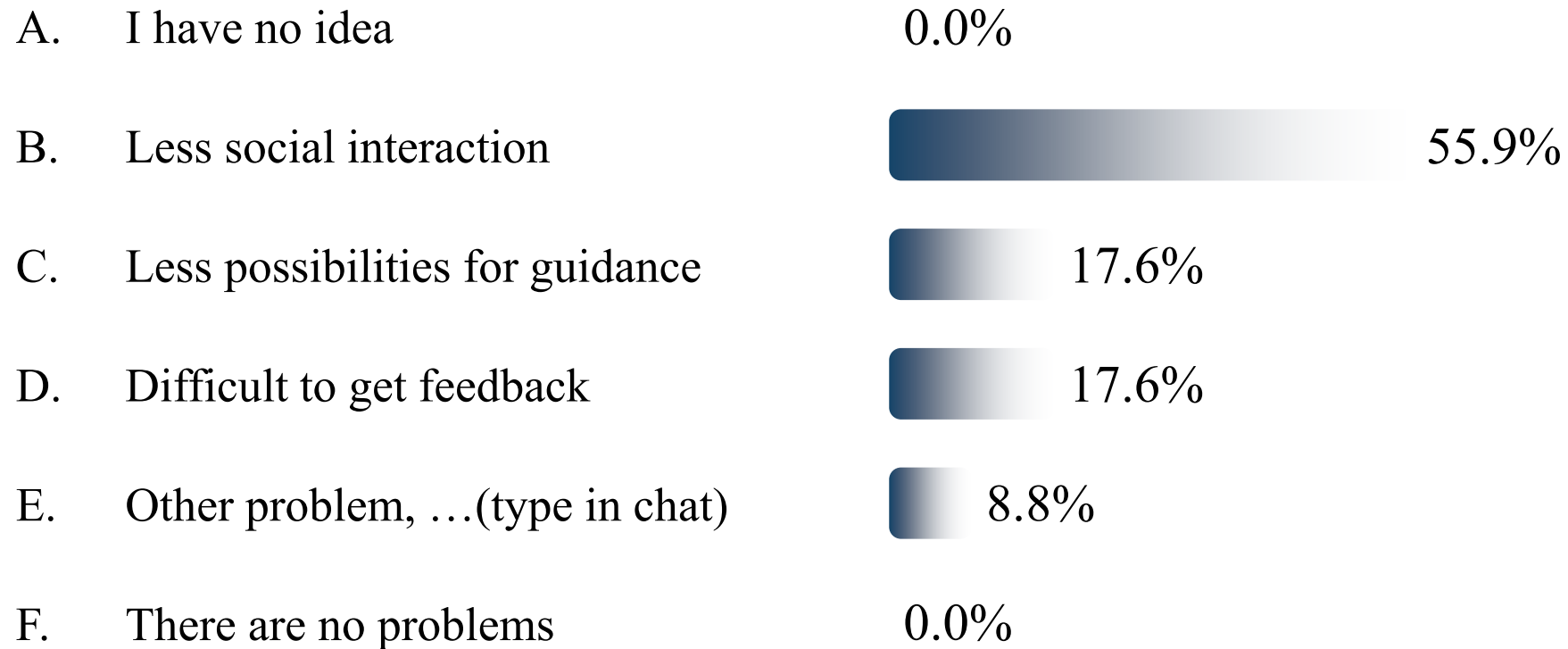


With schools shut across the world, millions of children have had to adapt to new types of learning.

Image: REUTERS/Gonzalo Fuentes



# What do students and teachers experience as main problem with online teaching?





# Corona evaluation - programme committee bachelor Psychobiology

## Students

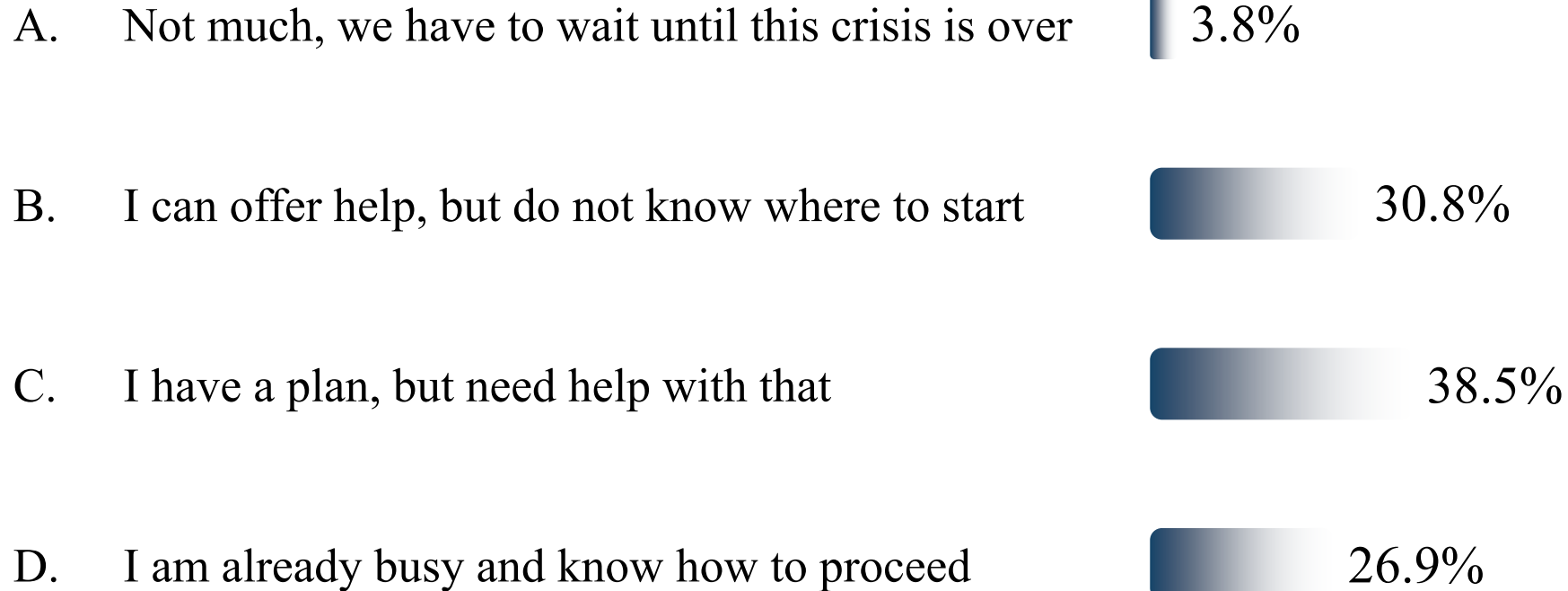
- Appreciate commitment/effort teachers
- Like to be in contact with each other
- Loneliness
- Stress (often related to exams)
- Distracted/behind with study planning
- Not much possibilities to ask questions
- Regret that practical work cannot be done
- Internships in future?

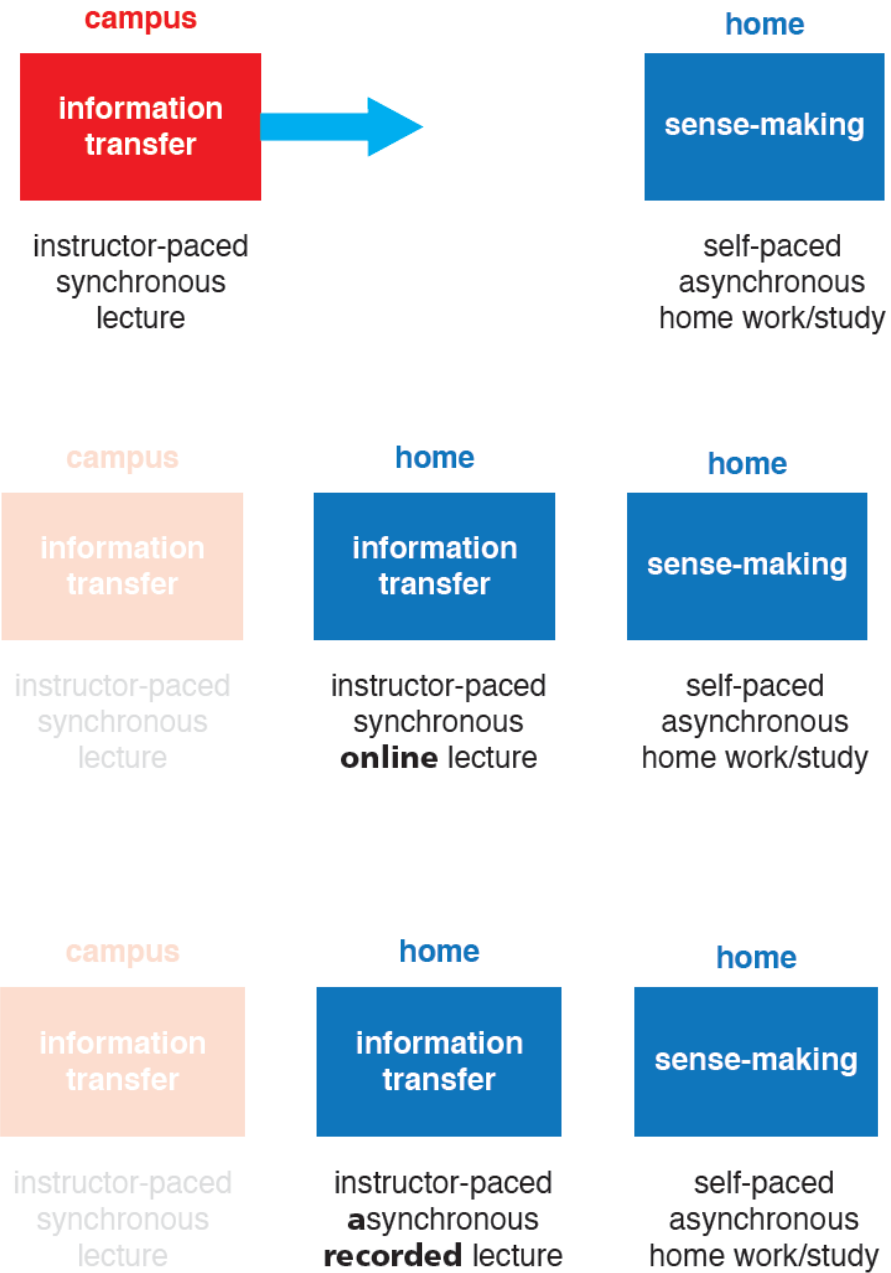
## Teachers

- High workload and tight deadlines
- Time needed to deliver high quality
- How to keep contact with students?
- Which tools to use?
- Which type of exam?



# What can you do about this problem with online teaching?



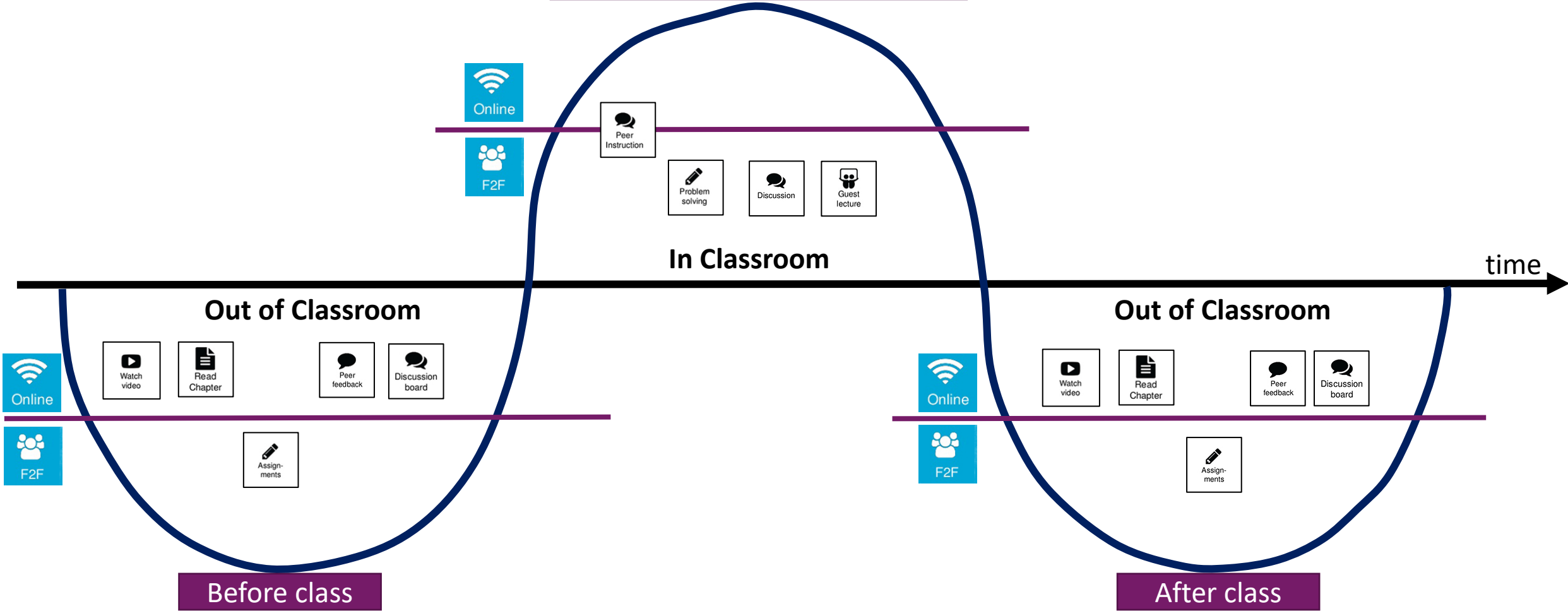






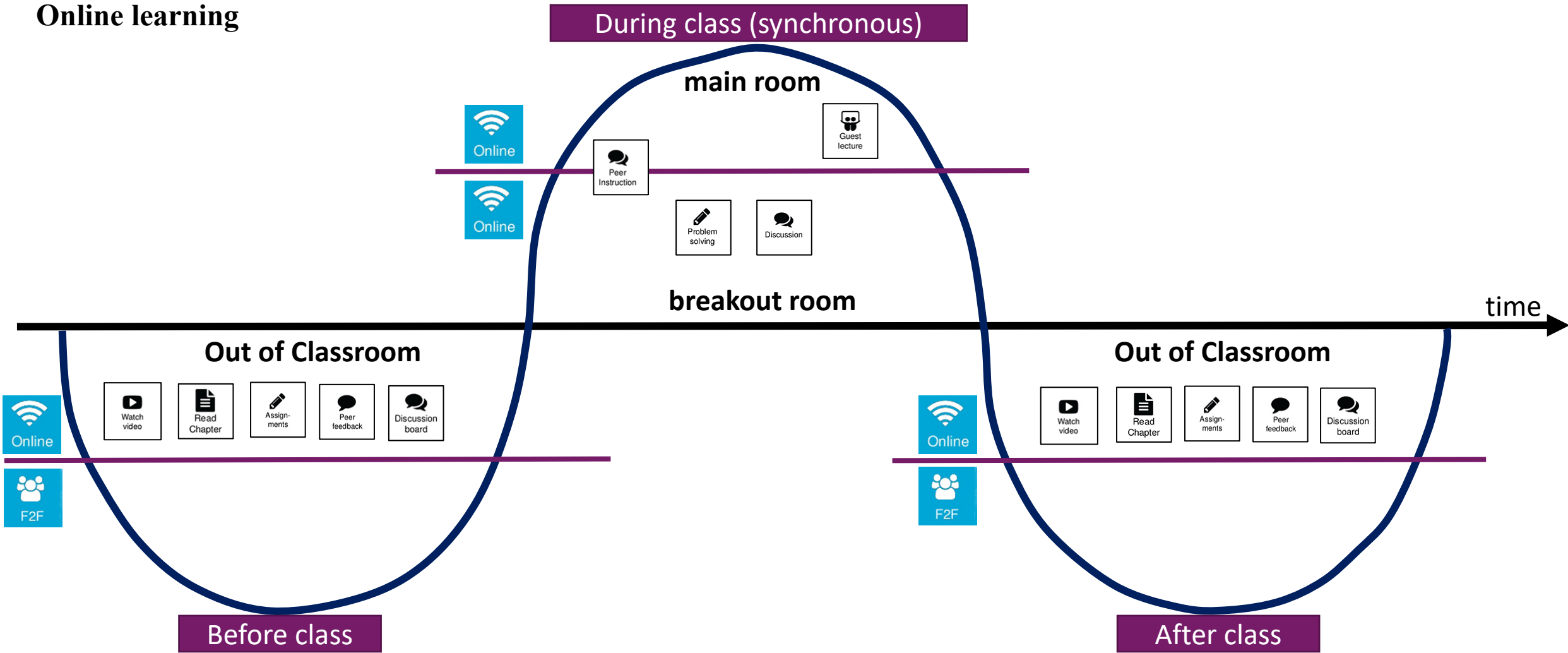
Blended learning design before Corona

During class (synchronous)



- Online quiz
- Excursion
- Lecture
- Student presentations
- Clickers
- In depth lecture
- Lab work
- Blog
- Case study
- Online brainstorm
- Discussion
- Wiki
- Difficult exercises
- project
- 
-

Online learning



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UvA Grassroot program started at FNWI in September 2019, project leader Erwin van Vliet

- prof. Eric Mazur, Harvard University
- Free, online, social learning platform to **promote pre-class reading compliance, engagement, and conceptual understanding**

**Perusal** is the activity of carefully reading, or studying something with the intent of remembering it.

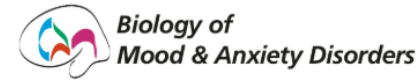
**Perusall**

# How does Perusal work?

Students:

- Read online text
- Make annotations
  - Questions
  - Answers
  - Comments

Belzung and Lemoine *Biology of Mood & Anxiety Disorders* 2011, 1:9  
<http://www.biolmoodanxietydisord.com/content/1/1/9>



REVIEW

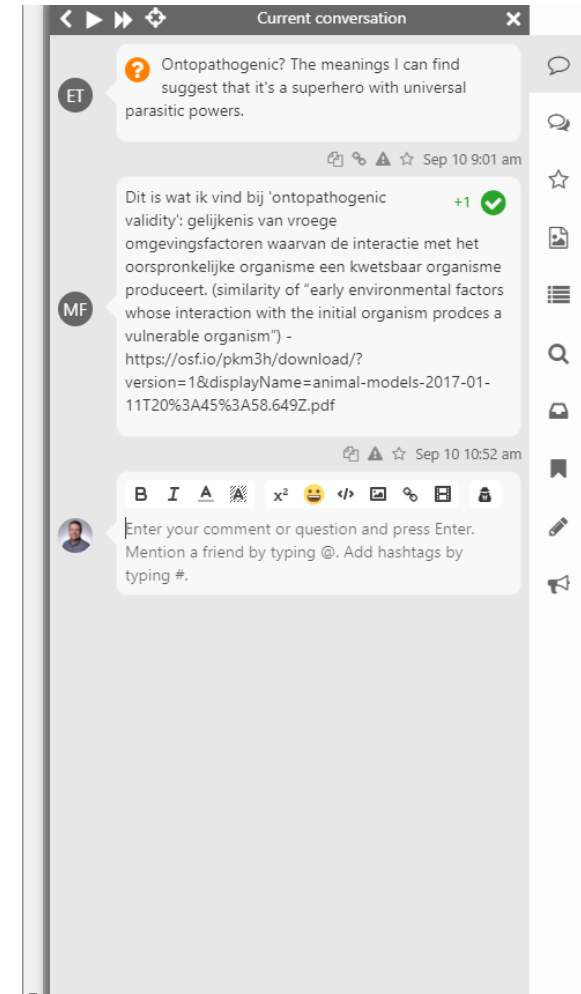
Open Access

## Criteria of validity for animal models of psychiatric disorders: focus on anxiety disorders and depression

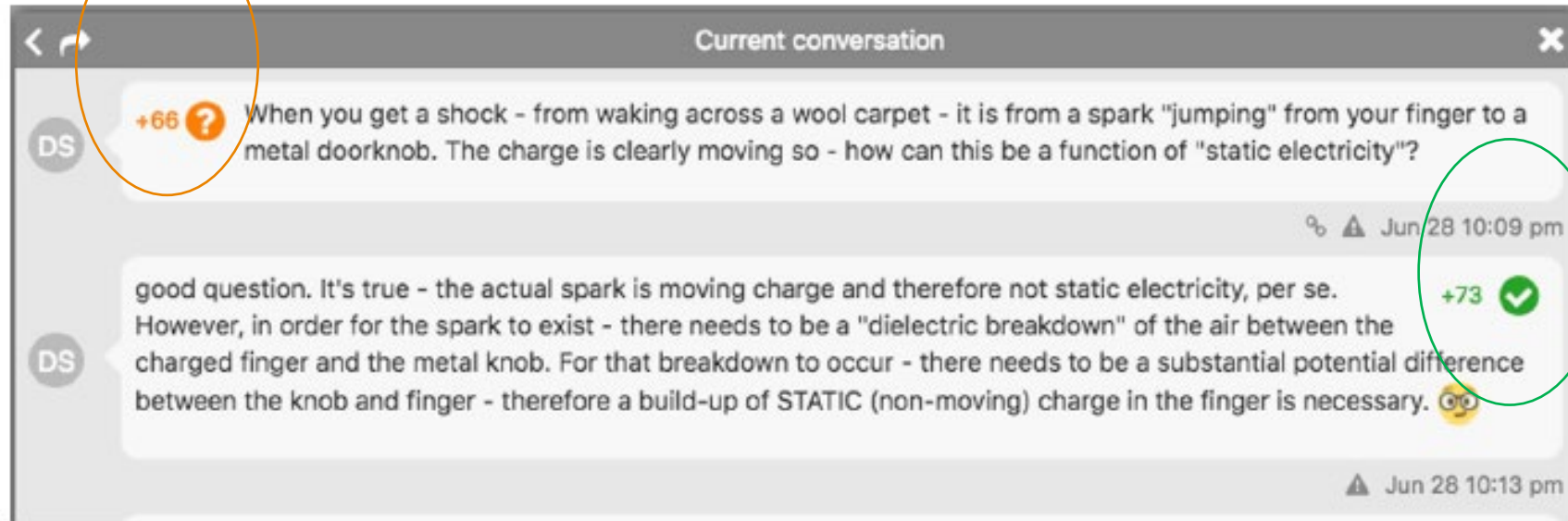
Catherine Belzung<sup>1\*</sup> and Maël Lemoine<sup>2</sup>

### Abstract

Animal models of psychiatric disorders are usually discussed with regard to three criteria first elaborated by Willner; face, predictive and construct validity. Here, we draw the history of these concepts and then try to redraw and refine these criteria, using the framework of the **diathesis model of depression** that has been proposed by several authors. We thus propose a **set of five major criteria** (with sub-categories for some of them); homological validity (including species validity and strain validity), pathogenic validity (including **ontopathogenic** validity and triggering validity), mechanistic validity, face validity (including ethological and biomarker validity) and predictive validity (including induction and remission validity). Homological validity requires that an adequate species and strain be chosen: considering species validity, primates will be considered to have a higher score than drosophila, and considering strains, a high stress reactivity in a strain scores higher than a low stress reactivity in another strain. Pathological validity corresponds to the fact that, in order to shape pathological characteristics, the organism has been manipulated both during the developmental period (for example, maternal separation: ontopathogenic validity) and during adulthood (for example, stress: triggering validity). Mechanistic validity corresponds to the fact that the cognitive (for example, cognitive bias) or biological mechanisms (such as dysfunction of the hormonal

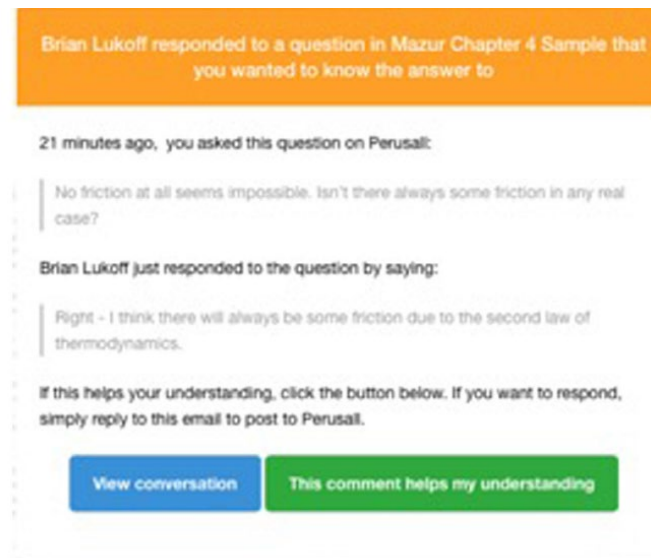


66 other students also like to know the answer



“upvote”  
For 73 other students this answer was useful

Students receive notifications via e-mail



# Automated analysis of annotations

- Time
- Number
- Text
- Distribution

Gradebook

Click on a grade to see details about the student's assignment. Copy to clipboard

Search:

Student Name	Student ID	Chapter 1	Chapter 2
[blurred]	[blurred]	3	2
[blurred]	[blurred]	3	3
[blurred]	[blurred]	3	3
[blurred]	[blurred]	3	3
[blurred]	[blurred]	3	3
[blurred]	[blurred]	3	3
[blurred]	[blurred]	1	2
[blurred]	[blurred]	0	
[blurred]	[blurred]	3	3

Release to students Release to students

0
0
0
0
2
0
2
2
1
0
0
0
0
Re

Total number of annotations	<b>36</b>
Total number of annotations submitted on time	<b>27</b>
Average quality of top 5 annotations submitted on time	<b>1.60</b>
2 = demonstrates thorough and thoughtful reading and insightful interpretation of the reading, 1 = demonstrates reading, but no (or only superficial) interpretation of the reading, 0 = does not demonstrate any thoughtful reading or interpretation	
Distribution of annotations	<b>5.0</b>
0 = clustered, 5 = evenly distributed throughout assignment	
Assignment score	<b>2</b>
scores range from 0 to 3	

# Confusion report for lecturer

- Report with top 3 questions
- One page, easy to digest
- See confusions, explain during class

## Confusion report for Making the Most of Statistical Analyses, Entire document

### Confusion 1

**Making the Most of Statistical Analyses: Improving Interpretation and Presentation**

**Gary King** Harvard University  
**Michael Tomz** Harvard University  
**Jason Wittenberg** Harvard University

Social scientists rarely take full advantage of the information available in their statistical results. As a consequence, they miss opportunities to present quantities that are of greatest substantive interest to their research and express the appropriate degree of certainty about these quantities. In this article, we offer an approach, built on the technique of statistical simulation, to extract the currently overlooked information from any statistical method and to interpret and present it in a reader-friendly manner. Using this technique requires some expertise, which we try to provide herein, but its application should make the results of quantitative articles more informative and transparent. To illustrate our recommendations, we replicate the results of several published works, showing in each case how the

We show that social scientists often do not take full advantage of the information available in their statistical results and thus miss opportunities to present quantities that could shed the greatest light on their research questions. In this article we suggest an approach, built on the technique of statistical simulation, to extract the currently overlooked information and present it in a reader-friendly manner. More specifically, we show how to convert the raw results of any statistical procedure into expressions that (1) convey statistically precise estimates of the quantities of greatest substantive interest, (2) include reasonable measures of uncertainty about those estimates, and (3) require little specialized knowledge to understand.

The following simple statement satisfies our criteria: "Other things being equal, an additional year of education would increase your annual income by \$1,500 on average, plus or minus about \$500." Any smart high school student would understand that sentence, no matter how sophisticated the statistical model and powerful the computers used to produce it. The sentence is substantively informative because it conveys a key quantity of interest in terms the reader wants to know. At the same time, the sentence indicates how uncertain the researcher is about the estimated quantity of interest. Inferences are never certain, so any honest presentation of statistical results must include some qualifier, such as "plus or minus \$500" in the present example.

**MH** Maybe there are specific examples later in this paper, but I think they would help me understand what he is suggesting. Normally, I would just report an estimate for my beta coefficient with a 95% confidence interval. But this seems to be going beyond that using simulation?

**PN** This is because we are not actually drawing from the population; rather, we are drawing multiple times from that one sample that we got from the population. So its more of a sampling distribution right? The sample we are simulating from could perhaps be thought of as a quasi-population.

**NG** Actually, this is a key distinction that has been troubling me on this week's problem set. What exactly are the interpretive differences between theta and theta hat serving as the random variable? Would be useful to review.

Show more...

### Confusion 2

**Figure 1 Probability of Voting by Age**

We applied the predicted value algorithm to predict the number of government employees in a state with six million people and an 88 percent Democratic leaning. First, we used the statistical software described in the appendix to estimate the log-linear model and simulate one set of values for the effect coefficients ( $\beta$ ) and the ancillary parameter ( $\theta$ ). Next, we set the main explanatory variables at  $X_1 = \ln(6,000)$  and  $D_1 = \ln(0.88)$ , so we could construct  $X_2$  and compute  $\hat{Y}_i = X_2 \beta$ . We then drew one value of  $\epsilon_i$  from the normal distribution  $N(0, \sigma^2)$ . Finally, we calculated  $\exp(\hat{Y}_i + \epsilon_i)$  to transform our simulated value into the actual number of government employees, a quantity that seemed more understandable than its natural logarithm. By repeating this process  $M = 1000$  times, we generated 1000 predicted values, which we sorted from lowest to highest. The numbers in the 25th and the 975th positions represented the upper and lower bounds of a 95-percent confidence interval. Thus, we predicted with 95-percent confidence that the state government would employ between 71,000 and 149,000 people. Our best guess was 100,000 full-time employees, the average of the predicted values.

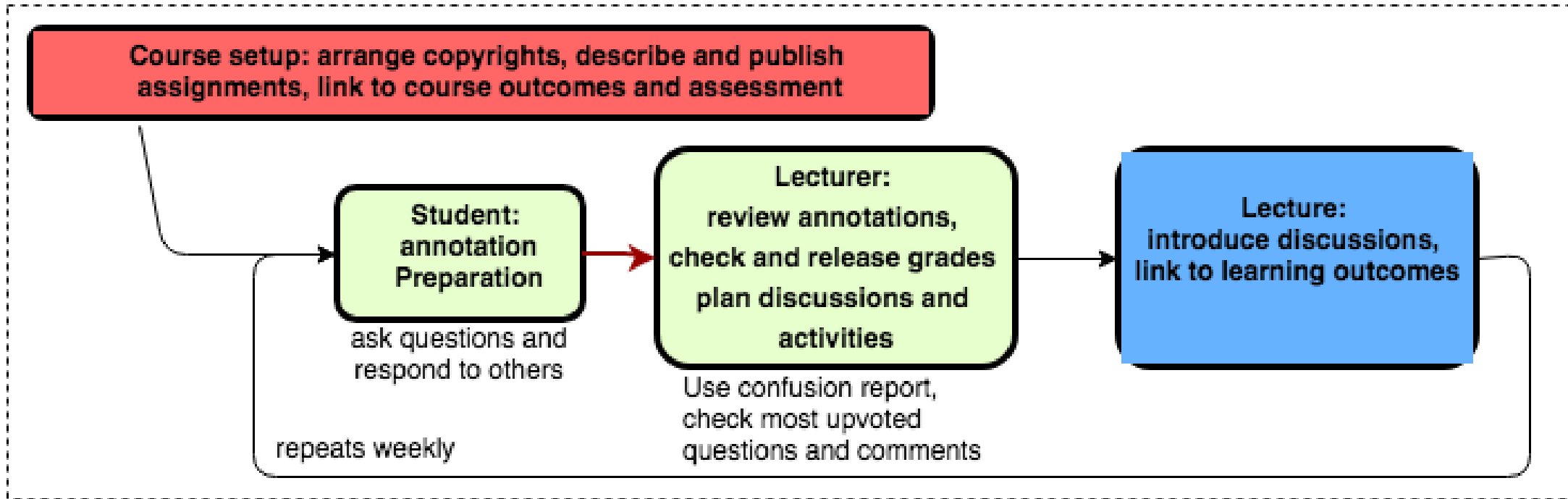
Let  $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$  be a constant and  $\sigma^2$  is a quadratic term.

**ER** What does a logit model look like and what makes it particularly useful in this case of binary data? Why would we know a logit model is better to use here than a normal distribution, for instance? Would we have to have some prior understanding of the nature of the data we are looking at to determine a logit model is optimal?

**CC** Intuitively, I have trouble understanding exactly how simulation helps us. Are we using parameters from the data to simulate potential outcomes that give us probabilities? More generally, how does the simulation relate to the actual data?



## Perusall – course setup



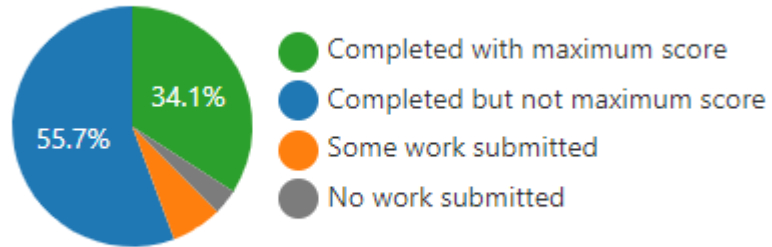
<https://www.rug.nl/e-learning/innovation-projects/faculty-projects-2017/active-learning-and-developing/perusall-active-learning-template>

# Preliminary results bachelor Psychobiology - UvA

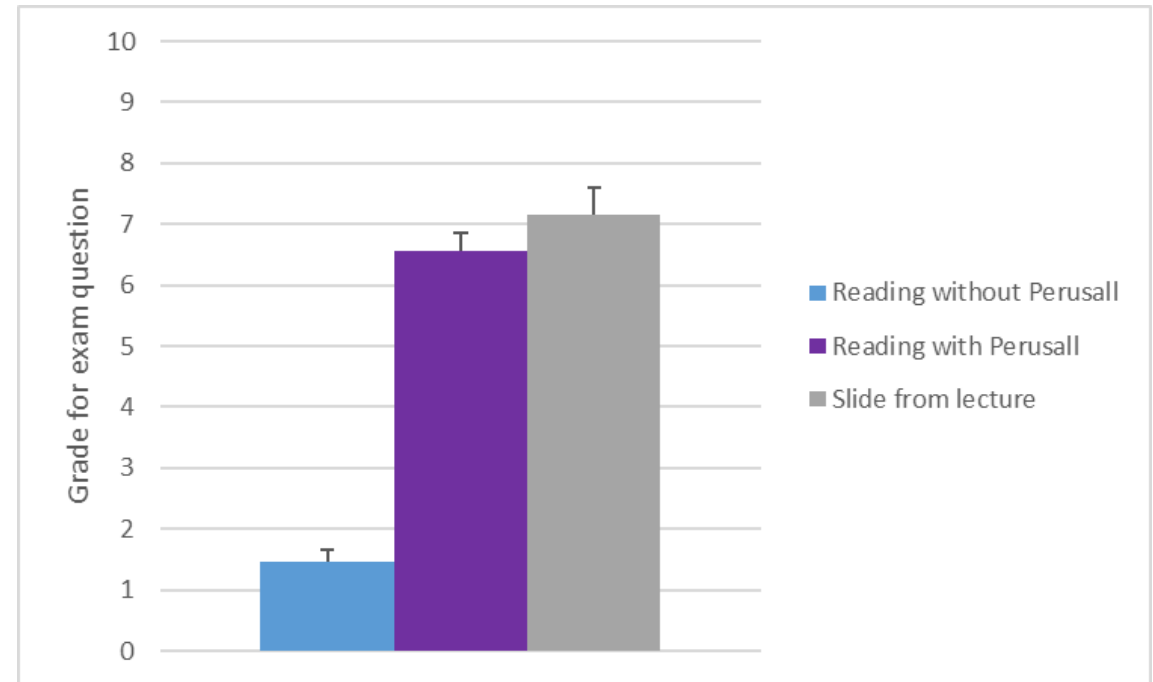
90% of the students completed the assignment (n=87)

Higher score for exam question when using Perusall

Overall assignment progress



870 comments, 298 questions, 55 unanswered questions



# Experiences and best practices





# Perusall experience from Academic Skills courses ABV 1.1 and ABV 1.2

Psychobiology Bachelor year 1  
~200 students

Cato Drion



# Setting up the Perusall assignment

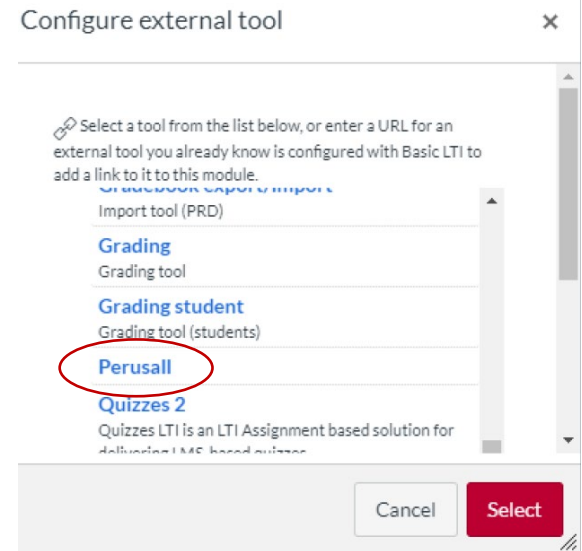
Make Canvas connect to Perusall

Upload literature in Perusall (check copyright – more info later)

Adjust settings in Perusall (example: create groups manually or automatically?)

Select grading (example: grade 1-10, or indirect grading in ‘academic attitude’)

Create the assignment for the students in Canvas with the link to Perusall





# Lessons from Academic Skills 1

~200 students of the Psychobiology bachelor (year 1)

Perusall used in “literature review” assignment: students choose from 3 possible topics (topic = set of articles)

$200/3 = \sim 65$  students read the same article. Can they help each other understand the article?

Assignment was “vague”

## **Deel 1. Perusall**

Lees het derde artikel (zie hierboven bij “Stof”) en zorg dat je de kern van de inhoud begrijpt met behulp van Perusall. Ga via Canvas naar Perusall voor het derde artikel. Stel in Perusall vragen aan je medestudenten als je delen van de tekst niet begrijpt. Geef ook antwoord op vragen van je medestudenten.

decreased axonal diameters and slightly abnormal paranodal structures, both of which can be a cause for the reduced CV. Interestingly the *plp1*<sup>Wt</sup> mice showed altered anxiety-like behaviors, reduced prepulse inhibitions, spatial learning deficits and working memory deficit, all of which are schizophrenia-related behaviors. Our results implicate that abnormalities in the neuron-glia interactions at the paranodal junctions can result in reduced CV in the CNS, which then induces behavioral abnormalities related to schizophrenia.

Introduction

Myelin is a lipid-rich multilayered structure that wraps and insulates axons, providing them with an increased conduction velocity (CV) (Waxman and Bangalore 2005). Recent studies have

vary under nondemyelinating conditions. Recently Yamazaki et al. (2007) showed that activation of oligodendrocytes could alter the CV of the axons it myelinates. Thus, the relationship between myelin and axon may not be stationary, but may in fact be dynamic. However, the cause for this altered CV, or the behavioral consequence induced by altering the CV have not yet been studied.

We have recently shown that at 2 months of age, CV in a *plp1* transgenic mouse line [*plp1* transgenic mouse line 4e hemizygote; is reduced by half, and prolonged in all 3 axonal tracts: reticulospinal/reticulospinal in the CNS (CNS) (Tanaka et al. 2003; Rasband et al., 2003). Although, at a much later stage, these mice undergo demyelination (Kagawa et al., 1994). We were curious to know what the cause of this decreased CV is, and how the abnormal conduction in the CNS would affect the behavior of

How did students do?

247 comments, 64 questions, 11 unanswered questions

1 hour, 17 minutes average reading time

with anti-Caspr antibodies and for grateful advice; and G. Yamada, R. Taguchi, and S. Yamada for technical assistance. \*H.T., J.M., and K.F.F. contributed equally to this work. Correspondence should be addressed to Kazuhiko Tanaka, National Institute for Physiological Sciences, 5-1 Higashi, Okazaki 444-8787, Japan. E-mail: k-tanaka@nips.ac.jp. DOI:10.1523/JNEUROSCI.3216-08.2009 Copyright © 2009 Society for Neuroscience 0270-6474/09/298363-09\$15.00/0

Confusion report for Tanaka et al. 2009

8364 • J. Neurosci., July 1, 2009 • 29(26):8363–8371

these mice. In this study, we performed extensive analyses on the behavior of 2-month-old *plp1*<sup>Wt</sup> mice, and found that they displayed various behavioral abnormalities indicative of cognitive dysfunction that may be interpreted as schizophrenia-like behavior. We also found abnormal neuron-glia interactions, which could provoke the abnormal conduction. This result provides a possible mechanism that describes the pathophysiology of schizophrenia.

Materials and Methods

**Animals**  
The *plp1* transgenic mouse line 4e was generated by introducing a cosmid clone containing the entire mouse *plp1* gene (Kagawa et al., 1994). For our studies, we used wild-type BDF1 mice (WT) and the hemizygous *plp1* transgenic mice harboring two extra copies of the wild-type *plp1* gene (*plp1*<sup>Wt</sup>) in the BDF1 background. These strains were maintained and propagated by mating with BDF1 mice (Charles River Japan) in the Center for Experimental Animals, National Institutes of Natural Sciences. The animal research protocol was approved by the Institutional Animal Care and Use committee.

**Behavioral analysis**  
**Experimental design.** Mice were divided into three groups. The first group of mice was used in a comprehensive battery of behavioral tests (Crawley,

*Hot-plate* test. Mice were placed on a hot-plate (40°C) and the time to fall was recorded. **Social interaction test in a novel environment.** In the social interaction test, two mice of identical genotypes, which were previously housed in different cages, were placed together in a box (40 × 40 × 30 cm), and allowed to explore freely for 10 min. Social behavior was monitored by a CCD camera, which was connected to a Macintosh computer. Analysis was performed automatically using ImageJ (National Institutes of Health). The number of total contacts, mean distance traveled (cm) were measured. **Startle response/prepulse inhibition test.** A test session began by placing a mouse in a Plexiglas cylinder where it was left undisturbed for 10 min. We used white noise as the startle stimulus that lasted 40 ms for all trial types. The startle response was recorded for 140 ms (measuring the response every 1 ms) starting with the onset of the prepulse stimulus. The background noise level in each chamber was 70 dB. The peak startle amplitude recorded during the 140 ms sampling window was used as the dependent variable. A test session consisted of 6 trial types (i.e., two types for startle stimulus only trials, and four types for prepulse inhibition trials). The intensity of the startle stimulus was 110 or 120 dB. The prepulse sound

Student feedback  
“onoverzichtelijk”  
Too many comments

Too many students?



# Lessons from Academic Skills 2

Perusall used in “research report”:  
students read 1 of 3 research articles and discuss in their own  
Course Sections (of ~17 students)

Again (200/3) ~60 students per article

→ made separate Perusall assignments in Canvas  
for the different groups of Course Sections  
(Perusall cannot import Canvas Course Sections)

So max. 20 students per paper

→ provided more detailed instructions



## Opdracht (Perusall)

Lees in *Perusall* het artikel over het glucocorticoïdligand corticosteron (Raubenheimer et al., 2006). Dit ligand ga je testen tijdens het practicum Celbiologie. Zo ga je te werk:

- Ga op de Canvaspagina van ABV1.2 naar de module: “Perusall Opdracht (WG14VO)” en begin met de informed consent.
- Als je akkoord gaat met de informed consent kun je beginnen aan de opdracht: “Perusall Opdracht (WG14VO)”. Klik op de link:

This tool needs to be loaded in a new browser window

[Load Perusall opdracht \(wg14VO\) in a new window](#)

- Ga in Perusall naar het artikel dat hoort bij jouw ligand. **Zorg dat je minimaal 3 “annotaties” maakt: stel in Perusall vragen aan je medestudenten als je delen van de tekst niet begrijpt. Geef ook antwoord op vragen van je medestudenten.**
- Als je niet akkoord gaat met de informed consent, maak je geen gebruik van Perusall en word je doorverwezen naar een alternatieve opdracht.
- Beantwoord vervolgens de onderstaande vragen.



# Feedback from students and teachers

## Students

“instruction: ‘make 3 comments’ leads to nonsense comments”

“prefer to only read the article with only my course section”

“prefer to read from pdf or print”

“Helped me to understand the article”

## Teachers










“Would like to see how students did (including confusion report) for my Course Section(s) only”

“They really help each other understand the paper, and some of the comments I’ve seen were very in-depth”

112 comments, 32 questions, 14 unanswered questions

53 minutes average reading time

### Most upvoted annotations

-  Het punt waar de productie van glucocorticoid op zijn laagst is  
-  Dus: corticosteron heeft lagere affiniteit voor GR dan cortisol --> er vindt minder translocatie van hGR naar de nucleus plaats als er corticosteron is in vergelijking met cortisol.  
-  Dit is een verschil tussen cortisol en corticosteron, een deel van het antwoord op de eerste vraag  

# A few best practices as example...



## Perusall use at the UvA

15 September 2019

- 277 users
- 4 courses, 3 in use

1 February 2020

- 763 users
- 10 courses, 7 in use

8 May 2020

- 1156 users
- 67 courses, 25 in use

7 July 2020

- 1487 users
- 122 courses, 30 in use



# How to check for copyright?



Kan ik deze publicatie gebruiken voor niet-commercieel onderwijs aan de UvA (Canvas, Perusall, readers)?

Voor docenten UvA. Gebruik deze beslisboom om na te gaan of een publicatie of een deel van een publicatie mag worden gekopieerd naar Canvas, Perusall of anderszins aan studenten mag worden verspreid.

Start de beslisboom →



Alice Doek



Harrie van der Meer  
*Library*

<https://h5p.org/node/570927>

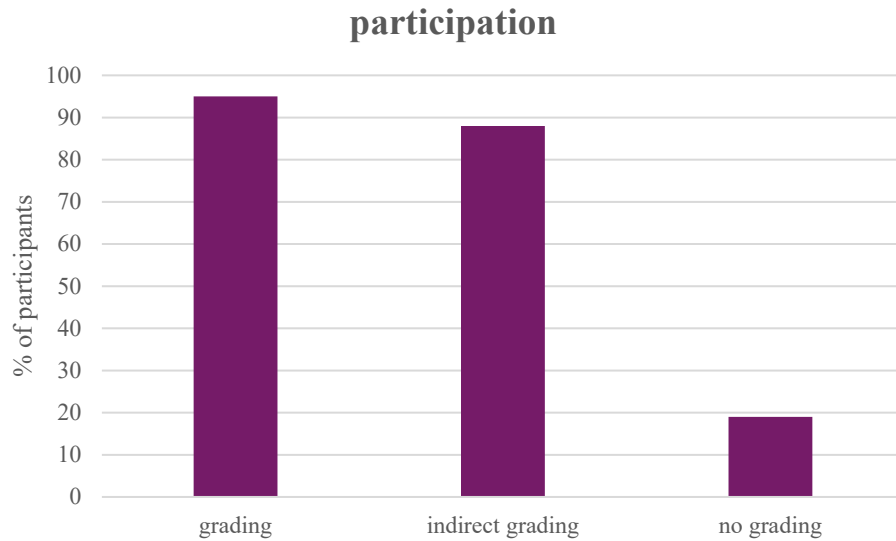
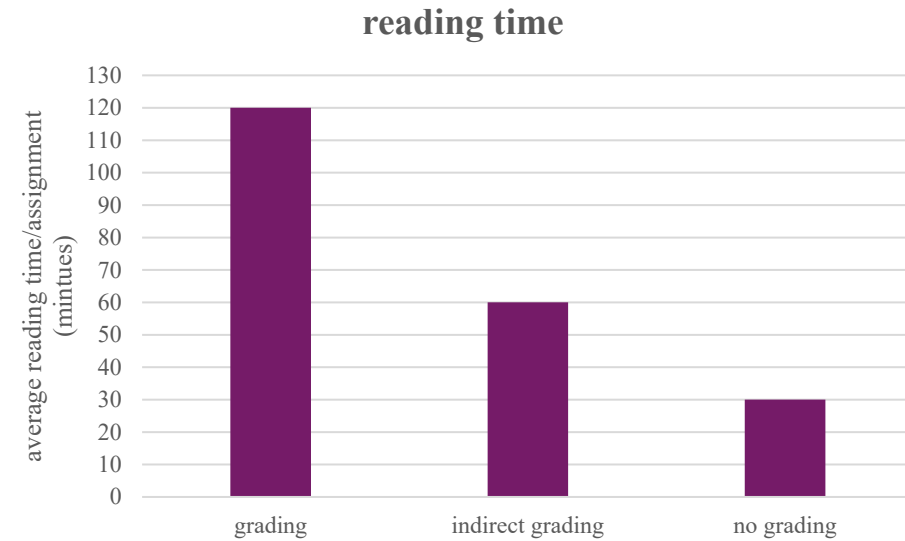
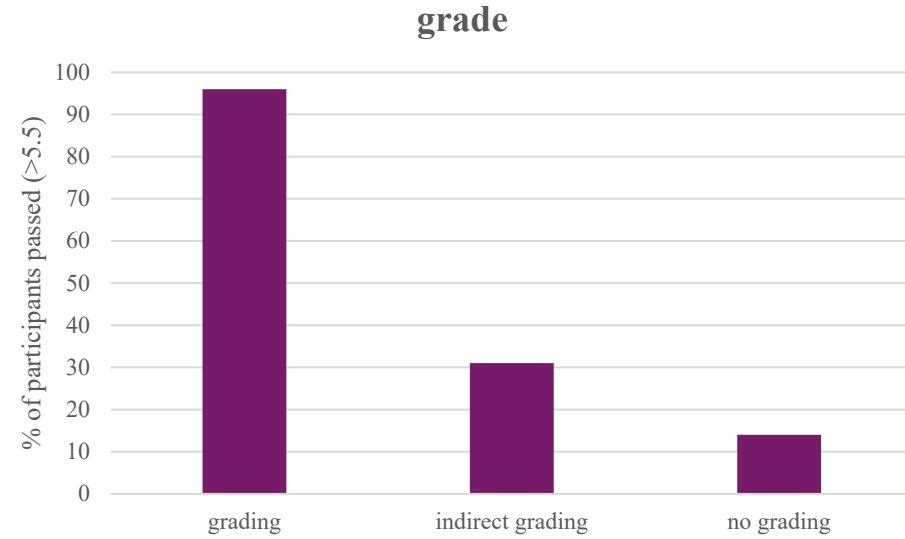


## Be clear what you expect from students

- Number of annotations
- Reading time required
- Interaction with each other
- Grading
- Deadline
- How the Perusall assignment will be used in the following lecture



# Grading or not?



Recommendation: average of all assignments counts for 2% of the final grade

around large-scale broadcast news events can inform **journalistic inquiry**. For instance: what kinds of insights, analyses, and other activities can be enabled through the support of visual analytic tools in the context of journalism? In particular, we designed and evaluated a visual analytics system, Vox Civitas, whose goal is to make the **social media** (e.g., Twitter) response to events more amenable to journalistic investigation and sensemaking.

diakop@rutgers.edu  
mor@rutgers.edu  
funda@eden.rutgers.com

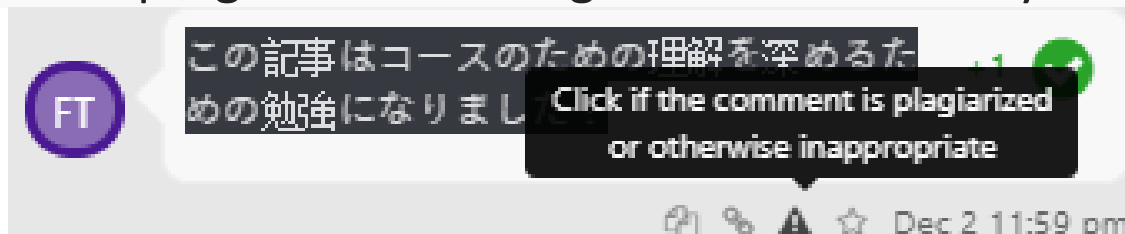
# Keep an eye what is going on

Japanese: This article has helped you to gain a better understanding of the course!

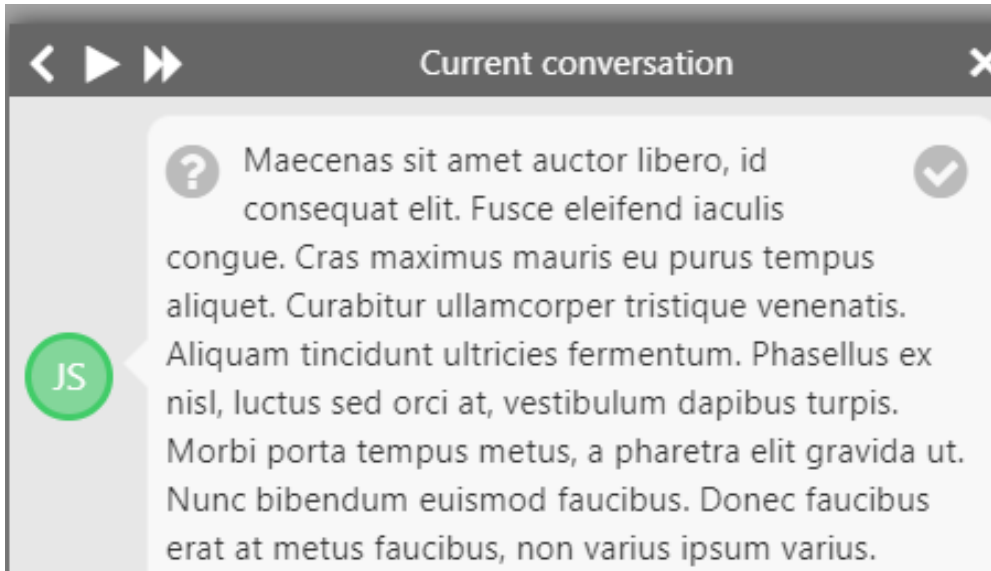
Thank you for this annotation, but what does this insight mean?

Punjabi: You thought you could get away with it easily. But let me tell you something, it works

Guys this is not ok. I don't think it's appropriate for you to annotate a researcher's email address, this shows you're taking this assignment totally not serious! In addition, you write in different languages that people hardly speak in this study, which also does not add to the learning ability. I find it very irresponsible that you deal with this progressive learning method in this way



# Keep an eye what is going on



Reset scoring settings to a preset:

Annotation content only

Holistic (recommended)

- Number of annotations
- Distribution of annotations
- Content of annotation
- Active reading time
- Number of times returned
- Getting responses
- Giving responses
- Getting upvotes
- Giving upvotes

- Recommendation: check comments and use holistic grading

# How many student can work on one assignment?

**Too much: 40 students work in one document:**

“It was chaotic due to all these comments and everything was already annotated”

**Too less: 2-5 students work in one document:**

“There were only a few comments and therefore there was not much interaction”

- Recommendation: target group size 10-20 students



# Assignment and deadline?

- Sufficient time to read carefully
- Ample of time to interact with each other
- Possibility to come back several times (read and interact repeatedly)
- Work with “fresh” mind, avoid tiredness (working until late night)

# Assignment and deadline?

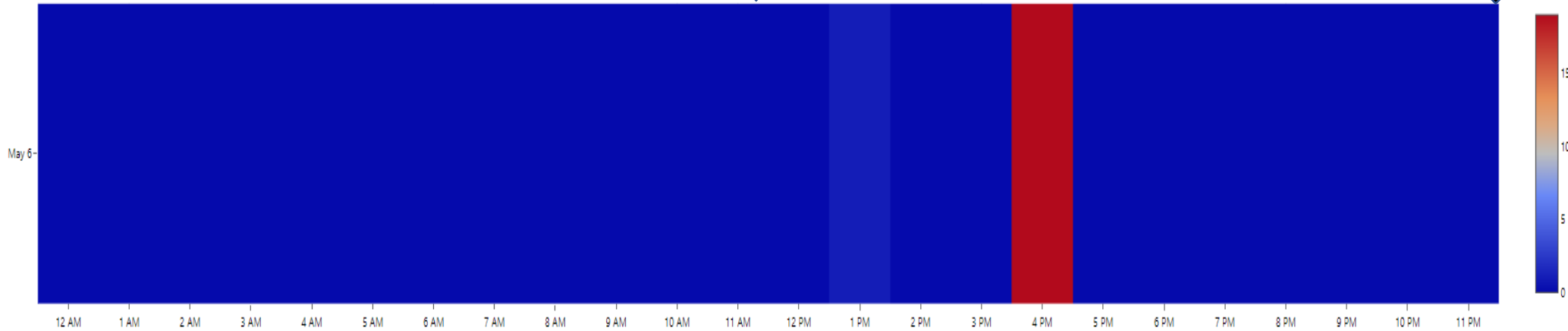
Only 1 hour of interaction



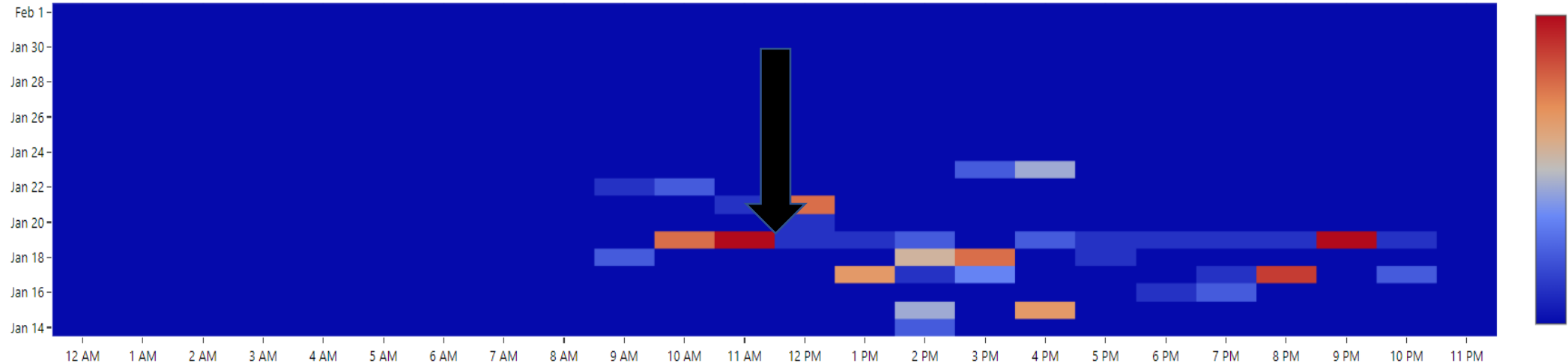
Lecture with info about assignment  
Assignment opened



deadline



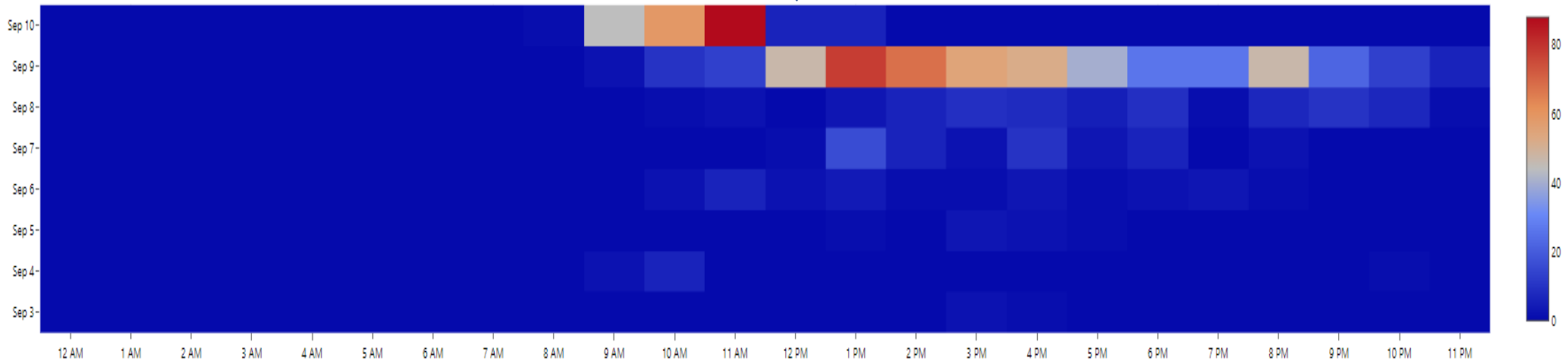
Submission after in depth lecture



# Assignment and deadline?



**Work peak around midnight**



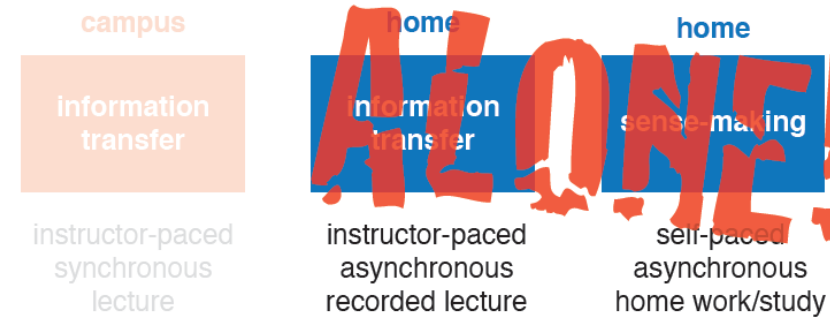
- Recommendation: open for about one week, deadline at noon (12:00 p.m.), no submission after deadline, schedule time for assignment

# Recommendations

- Be clear what you expect from students
- Use grading, but with low weight e.g. 2% of final grade
- Keep an eye on the comments made, use holistic grading
- Target group size 10-20 students
- Assignment is open for about one week, deadline at noon (12:00 p.m.), schedule time for assignment



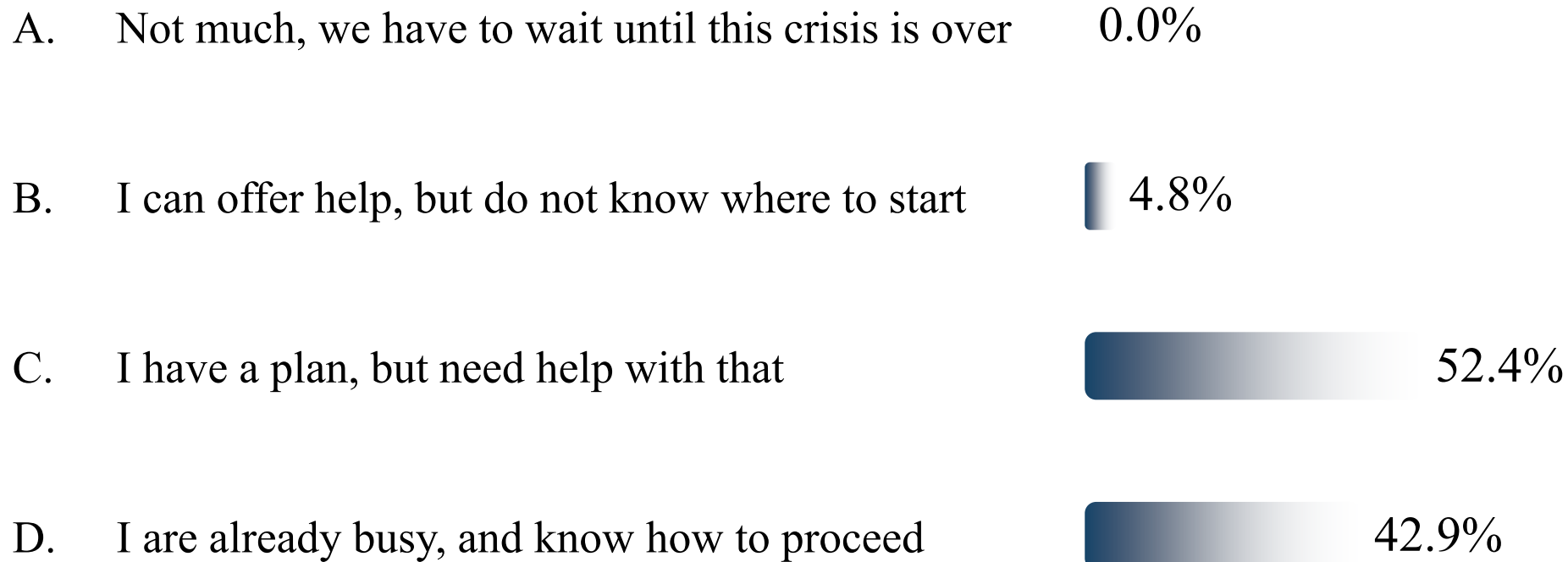
# What can you do about the problem with online teaching?



**Discuss in breakout rooms**



# What can you do about the problem with online teaching?

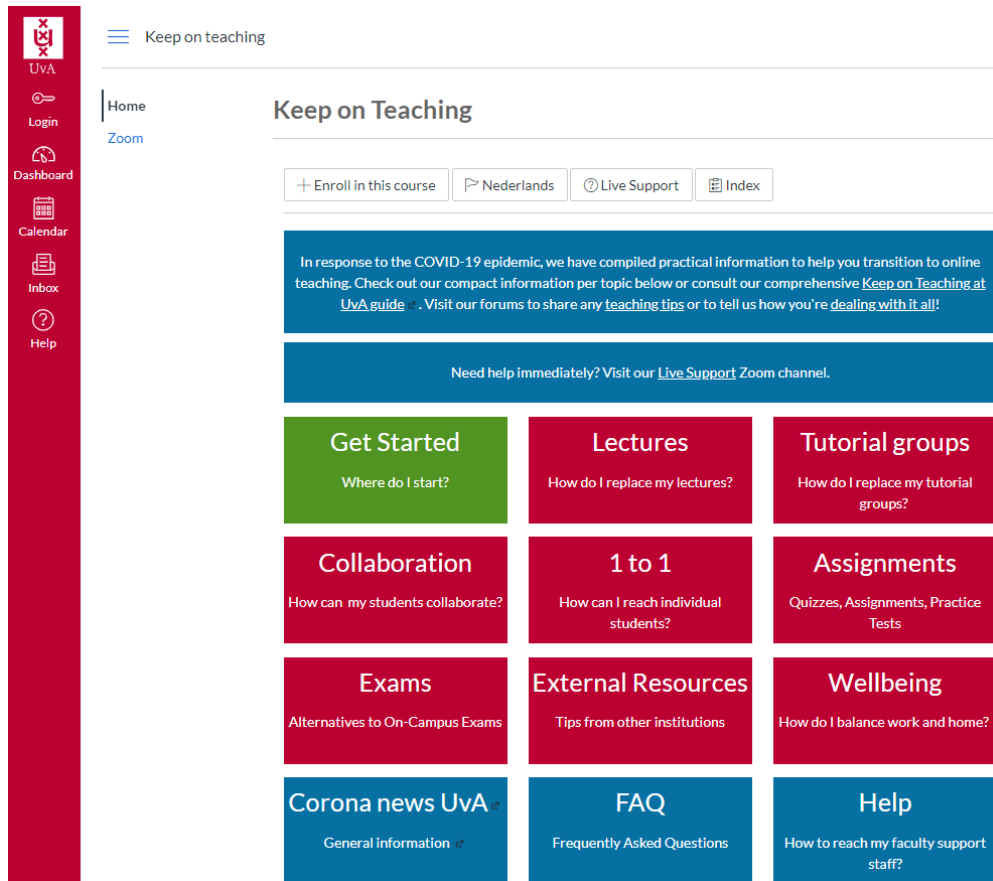


# Support for teachers



Teaching &  
Learning  
Centre

## Keep on Teaching (Canvas)



The screenshot shows the Canvas LMS interface for the 'Keep on Teaching' course. On the left is a red navigation sidebar with icons for UvA, Login, Dashboard, Calendar, Inbox, and Help. The main content area has a header 'Keep on Teaching' with a navigation menu (Home, Zoom) and buttons for 'Enroll in this course', 'Nederlands', 'Live Support', and 'Index'. Below this is a blue banner with text about COVID-19 transition to online teaching. A second blue banner asks if users need help and points to a Live Support Zoom channel. The main content is a grid of 12 red and green boxes, each representing a topic: Get Started (Where do I start?), Lectures (How do I replace my lectures?), Tutorial groups (How do I replace my tutorial groups?), Collaboration (How can my students collaborate?), 1 to 1 (How can I reach individual students?), Assignments (Quizzes, Assignments, Practice Tests), Exams (Alternatives to On-Campus Exams), External Resources (Tips from other institutions), Wellbeing (How do I balance work and home?), Corona news UvA (General information), FAQ (Frequently Asked Questions), and Help (How to reach my faculty support staff?).

## eBook Interactive Teaching Techniques



The screenshot shows the 'Interactive Teaching Techniques' eBook page. On the left is a table of contents with 18 items, including Introduction, Instructor Action: Lecture, Student Action: Individual, Pairs, Groups, Second Chance Testing, Authorized "Cheating" on In-Class, Testing Strategies, YouTube, Twitter, Mobile and Tablet Devices, Clickers, Student Responses, Creating Groups, Icebreakers, Games (Useful for Review), Interaction Through Homework, and Role-Play. The main content area features a red header with the Teaching & Learning Center logo and a photo of four students looking at a tablet. Below the photo is the title 'Interactive Teaching Techniques' and the chapter title 'Chapter 1 Introduction'. The text below the chapter title reads: 'Welcome to the ebook on interactive teaching techniques. This document is based on the Interactive Techniques PDF of Kevin Yee. Based on the creative commons licence the Teaching & Learning Centre of the University of Amsterdam is maintaining and expanding this ebook version. The full credits can be found at the end of this ebook.' The section '1.1 Interactive Teaching Techniques' follows, with text stating: 'These techniques presented in this ebook have multiple benefits: the instructor can easily and quickly assess if students have really mastered the material (and plan to dedicate more time to it, if necessary), and the process of measuring student understanding in many cases is also practice for the material—

[https://shklinkenberg.github.io/Interactive\\_Teaching\\_Techniques/index.html](https://shklinkenberg.github.io/Interactive_Teaching_Techniques/index.html)



## More information

Manual with instructions

<https://datanose.nl/#docentensite/services/perusall>

More info/interested in research: e-mail to [teaching-science@uva.nl](mailto:teaching-science@uva.nl)

Follow #Perusall on Starfish

<https://starfish.innovatievooronderwijs.nl/>

Perusall website

[www.perusall.com](http://www.perusall.com)

Eric Mazur website

[www.mazur.harvard.edu](http://www.mazur.harvard.edu)

Suggested reading

<https://www.frontiersin.org/articles/10.3389/feduc.2018.00008/full>

Collaborations



rijksuniversiteit  
 groningen



## Use of a Social Annotation Platform for Pre-Class Reading Assignments in a Flipped Introductory Physics Class

*Kelly Miller<sup>1</sup>, Brian Lukoff<sup>2</sup>, Gary King<sup>1</sup> and Eric Mazur<sup>1</sup>*

<sup>1</sup>Harvard University, Cambridge, MA, United States, <sup>2</sup>Perusall LLC, Brookline, MA, United States



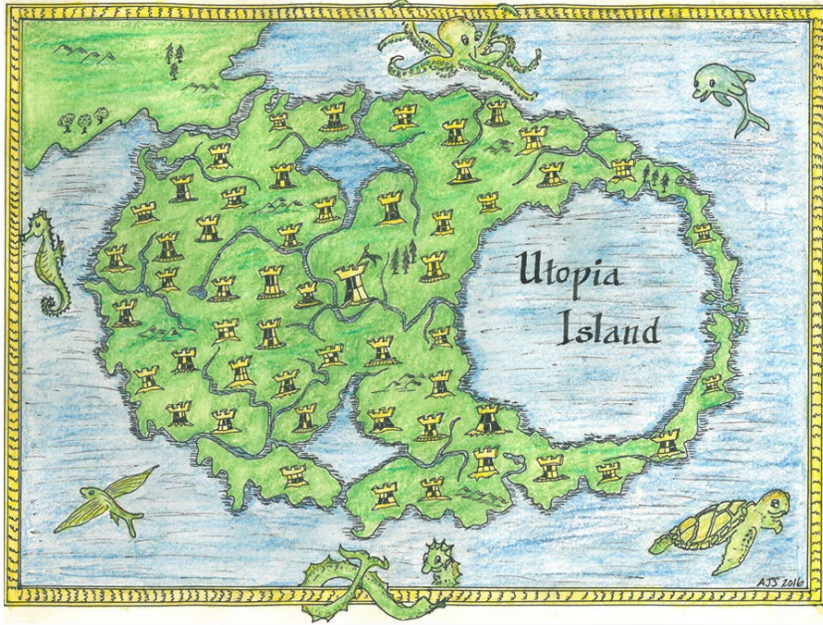


## Stay connected and keep in touch!





# All students finish the reading assignment prior to your lecture





Thank you for your attention!

