

# Opening-up Education: Promoting Active Learning with Students and Staff

James Denholm-Price<sup>1</sup>,  
Suzan Orwell<sup>2</sup>, Peter Soan<sup>1</sup>

School of Mathematics<sup>1</sup>  
and Centre for Higher Education Research and Practice<sup>2</sup>  
Kingston University

# Project Overview

- › Relatively small-scale “pilot project” rolling-out clickers to two schools (~500 students in total) – broadly following the guidance from *Jefferies* et al. from Hertfordshire in “Increasing Student Engagement and Retention Using Classroom Technologies”
  - Local distribution, training & academic “champions”
  - Local rather than centralised support as it’s a small-scale project
- › Focus in the first instance on “active learning” as well as “attendance monitoring” *via* clicker IDs...
- › Ethics & evaluation:
  - Students gave informed consent when they were supplied with their clicker and we’ll be presenting some cohort-level data on that basis
  - Focus groups involving students and (separately) staff were conducted near the end of the year, and a mid-year survey: all participants gave consent for dissemination of anonymous results

# Project Overview: Clickers

- › Early decision to go with *hardware* clickers based on
  - research suggesting students’ own devices are a distraction and less effective than a dedicated clicker
  - and anecdotal suggestion that it lowers the barrier to entry for busy/reliant staff (this is a *staff engagement* project as well as being student-focused)
- › This decision was eventually backed-up by our own evaluation:
  - Student survey: 50:50 divided between “happy to use own device” and “would prefer a clicker”
  - Staff focus group: “phones would be a distraction” & “[the University] should provide learning facilities”
  - Student focus group – divided: some wanted a hybrid hardware and software option, some were (like staff) in favour of hardware only for similar reasons



# Project

- › Focus on sim
- (no centrali
- One big bu

## Choose upload

Select a Module

Upload a session

No

## Step 3: processed results from your uploaded file

Success, you have uploaded your file. The feedback below is from your uploaded file.

There is a total of 31 questions in your uploaded file

There is a total of 372 responses to these questions.

There is a total of 12 clickers used.

There is a total of 0 unidentified clickers used.

The file you uploaded was created on 2014-09-23 14:32:39

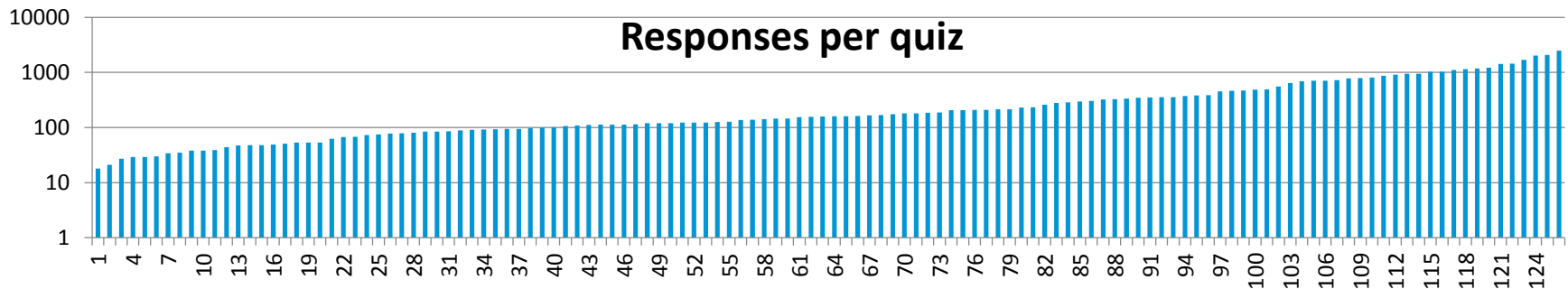
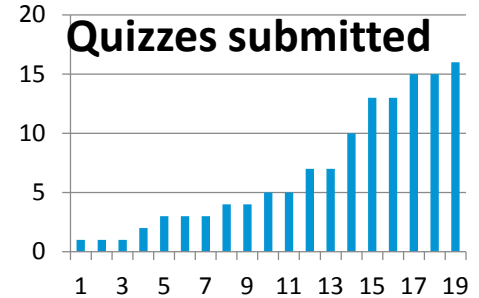
The file you uploaded was created on teaching week 0

This quiz has been assigned to module 'Introduction to Computational Mathematics' (MA4100).

This quiz has been assigned to 'Dr James Denholm-Price' (ku13043).

# Staff engagement with clickers/website

- 19 staff submitted data from a total of 127 quizzes to the database over 151 days of operation
- Quizzes generated between 18 and 2472 responses (varies by class-size & number of questions), with
- 43985 responses in total
- from 524 clickers
  - > 437 registered by students, 9 of which never used
  - > 87 unregistered



# Web site: Data views for staff

## Clickers Project: Attendance to week 13

### Staff summary view

#### Attendance summary for user KU13043

122 students from AM4000, MA4000, MA4100, ST4000 possible module enrolments

Student ID	Clicker	Modules: Weeks:	AM4000													MA4000													MA4100													ST4000												
			1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13
k11	-	0%													0	0	0	0	0	0	0	0	0	0	0	0	0															0	0									0	0	0
k12	-	0%	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0															0	0									0	0	0
k12	-	0%	0	0	0	0	0	0	0	0	0	0	0																												0	0									0	0	0	
k12	-	0%	0	0	0	0	0	0	0	0	0	0	0																																									
k14	61	88%	1	1	1	1	1	1	1	1/2	1			0	1	1	1	3/5	1	1/2	1	1	1	1	1	1	1	1								1	1	1	1	1	1								1	1	1			
k14	61	90%	1	1	1	1	1	1	1/2	1			0	1	1	1	3/5	1	1/2	1	1	1	1	1	1	1	1								1	1	1	1	1	1								1	1	1				
k14	61	90%	1	1	1	1	1	1	1/2	1			1	1	1	1	3/5	1	1	0	1	1	1	1	1	1	1								1	1	1	1	1	1								1	1	1				
k14	61	90%	1	1	1	1	1	1	1/2	1			1	1	1	1	3/5	1	1	1	1	1	1	1	1	1	1								1	1	1	1	1	1/2	1	1	1	1	1	1	1/2	1/2	1	1				

Clicker-derived attendance data. Blanks/dashes represent either no clicker data for that week or student not enrolled on that module.

- › “Session” data aggregated together at subject-level
- › Subject-level: Used by Tutors to visually identify students topics for discussion in group tutorial sessions
- › Faculty-level: Informed student support intervention in December/January

# Web site: Data views for students

- › Simple “widget” embedded into VLE

## Attendance summary for user k14

Student			Modules:	LS4001													LS4002													LS4003													LS4004															
ID	Name	Clicker	Weeks:	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	7	8	9	10	11	12	13			
k14		9		-	-	-	-	✓	✓	-	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	-	X	✓	X	✓	-	-	✓	-	✓	✓	✓	-	-	✓	-	✓	✓	✓	-	-	-	-	✓	-	✓	✓	-	-	✓	✓	-	-	-	-

Clicker-derived attendance data. Blanks/dashes represent no quiz data from that session.

- › Hypothesis: showing students a record of “engagement” might influence their behaviour
  - Student focus group answers: Predominantly *No!*

*“Attendance monitoring will make no difference, motivation will make a difference ... I know what I missed and I don’t need to look at my attendance”*

(Majority representative view.)

*“Having a lot of red crosses made me attend a particular module; it has motivated me to attend”*

(Just one student!)



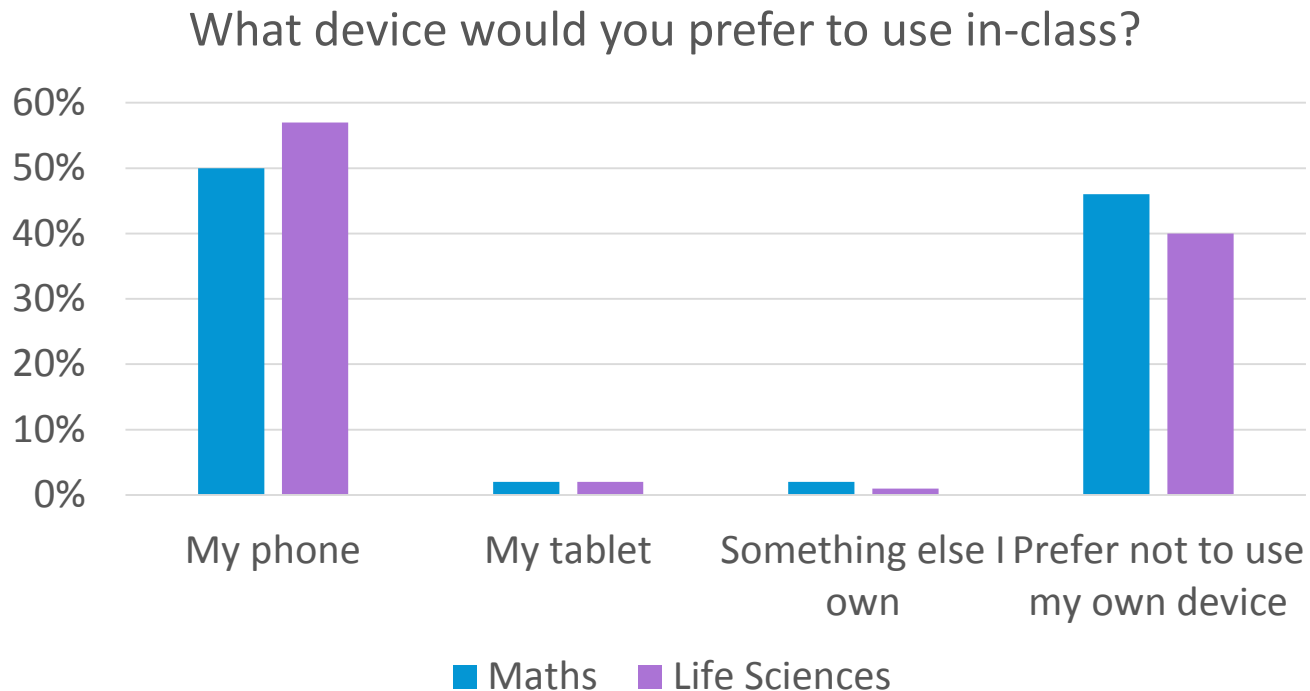
Feedback  
from staff and  
students

**SURVEYS AND  
FOCUS GROUPS**



# If you had a choice, what device would you use instead of a clicker?

- > Over 96% of responding students found the clicker easy to use.
- > 43% prefer their standalone “clickers” to phone/tablet
  - Anecdotally, it might be to separate “life” from “study” ...



# Students engagement with focus groups



*“I like clickers because they give immediate feedback”*

# Our students views on clickers

*"I'm used to carrying my Clicker, it stays in my bag"*

*"A mobile phone will be too distracting, but no excuse if you forget your Clicker"*

*"A phone is a switch off from the lecture; you may miss too much if you use it instead of a Clicker"*



$\pi$

# Students engagement with focus groups

*“It’s a more personal experience  
to speak to other students  
rather being one of 200”*

*“There is never an overload; more  
questions are good for revision,  
around 5 questions for each new  
concept.”*

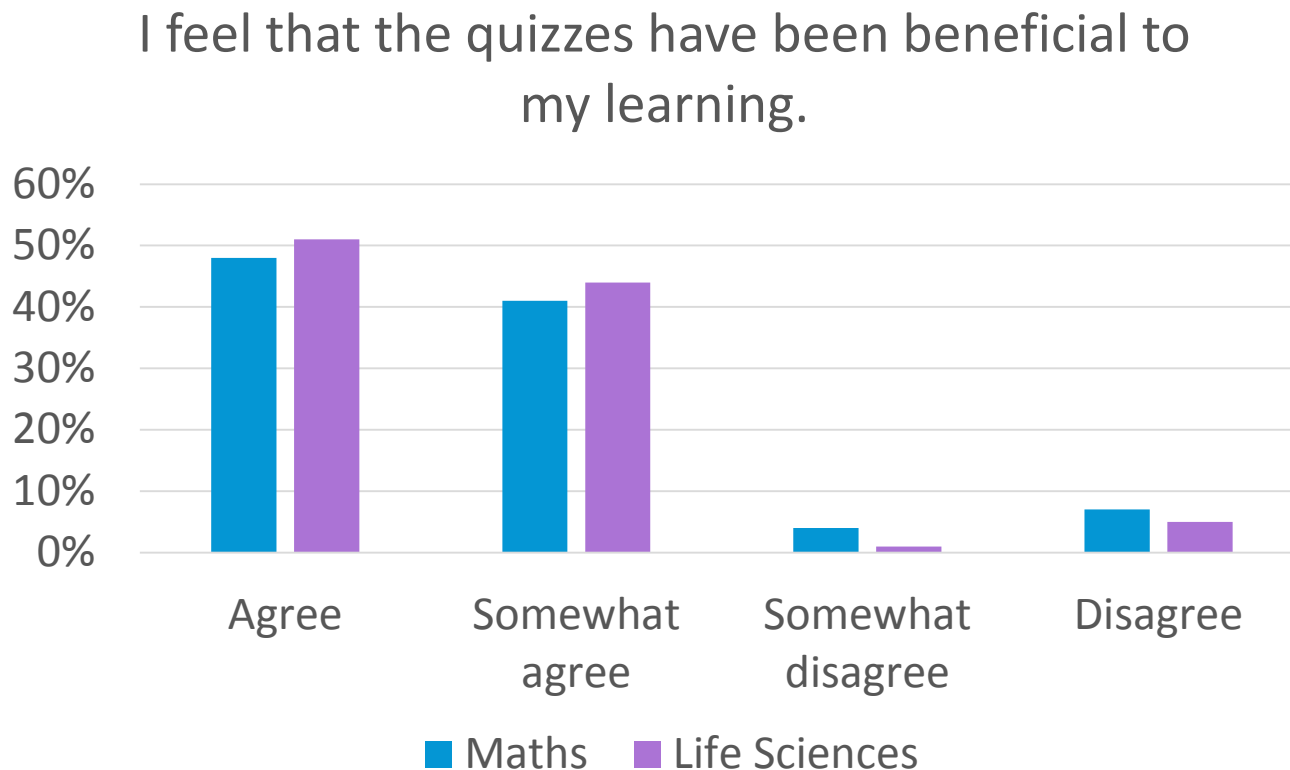
*“Talking to peers could clarify the concepts and could help,  
but only if the teacher has been teaching the right things”*



$\pi$

# I feel that the quizzes have been beneficial to my learning.

› Only 15 students somewhat/disagree out of the 216 respondents (7%)







# Our staff views on clickers

- › The staff would prefer for the students to use clickers and not their mobile phones.
  - mobile phones can distract the students
  - students may not have a mobile phone or may not be able to install the relevant app on their phone and students may not have reliable access to Wi-Fi.

*“The University should provide Clickers or whatever technology they choose, the student shouldn’t worry about it.”*

# Staff engagement with focus groups

π

*“It makes us think about how we run our sessions”*

*“With a click of a button the students can find out if they got something wrong”*

*“I can feel if the question has gone as well as I hoped, when the students are discussing and talking about the question then I know they have gone well and they are not playing around”*

# What worked

- › We engaged 19/20 academic participants
- › Staff said:
  - Encourages staff to reflect on their class content
  - Gives wider participation by students
- › Students said:
  - They liked it
  - They recognised “active learning” when they experienced it and rated it as more important than “attendance” monitoring
- › As a side-effect
  - “engagement” information becomes available for engagement assessment for individual students and intervention
  - and feeds into a faculty-wide process for doing-so



# What didn't work

- › Main metric for judging staff engagement was counting uploads (*i.e.* “Are they engaging with the data process?”) which is the wrong metric!
  - A better “metric” would have identified some staff asking non-subject/non-pedagogic questions such as “What’s your favourite colour?”
  - Metric must improve *and* pedagogic training must improve
    - › *E.g.* encourage more peer reviewing
    - › But what *is* a good metric?

# What is your favourite colour?

$\pi$

*“Some haven’t thought of the questions and put it for the sake of it”*

# Pedagogy...

## Are you in today?

*“I don’t agree with using clickers for attendance because it’s inaccurate, irrelevant and they should be focusing on enhancing our learning.”*

# Where's the "OER"?

## Zooming-in to one module

- The equations  $A\underline{e} - \lambda\underline{e} = \underline{\theta}$  and  $\det(A - \lambda I) = 0$  what are the right answers?
- A.  $\theta$  is a scalar and  $\underline{\theta}$  is a matrix
  - 71% B.  $\theta$  is a scalar and  $\underline{\theta}$  is a vector
  - 100% C.  $\theta$  and  $\underline{\theta}$  are both scalars
  - 0% D.  $\theta$  and  $\underline{\theta}$  are both vectors
  - 0% E.  $\theta$  and  $\underline{\theta}$  are both matrices
  - 0% F. It doesn't matter
  - 0% G. I don't know

# 1<sup>st</sup> Year Linear Algebra

## > 2012/13:

- 15 credit Linear Algebra module with 4 biweekly formative & summative randomised e-assessments (Numbas) over 10 lecture weeks

## > 2013/14:

- Revised framework => 30 credit modules, Linear Algebra reduced to just topics from introduction up to Gaussian Elimination
- 4 “Flipped Learning” weeks of one module, notes-based materials and 4 Numbas e-assessments (1% credit each)

## > 2014/15:

- Linear Algebra over 5 weeks up to Gaussian Elimination & now Eigenvalues and Eigenvectors too
- 5 “Flipped Learning” weeks, Numbas e-assessments redesigned to replace notes+quizzes (still 1% credit each)



# Numbas “OER” e-assessments

> <https://numbas.mathcentre.ac.uk/> user “jdp”

## NUMBAS

### 1.1 Introduction to Matrices

Matrices are rectangular arrays of numbers.

$$\begin{pmatrix} 1 & 2 \\ 4 & 5 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

The rows and columns of a matrix are numbered from 1 to  $m$  and  $n$  respectively.

columns.

A matrix with  $m$  rows and  $n$  columns is called an  $m \times n$  matrix.

When we refer to the  $i$ th row and  $j$ th column of a matrix  $A$ , we write  $A_{ij}$ .

A matrix with  $m$  rows and  $n$  columns is called an  $m \times n$  matrix.

**Example 1** -- Give the dimensions of the following matrices:

$$A = \begin{pmatrix} 4 & -5 \\ 9 & -8 \end{pmatrix} \text{ has dimensions } \boxed{\phantom{00}} \times \boxed{\phantom{00}}$$

**Example 1** -- Give the dimensions of the following matrices:

$$A = (8) \text{ has dimensions } \boxed{\phantom{00}} \times \boxed{\phantom{00}}$$

**Example 1** -- Give the dimensions of the following matrices:

$$A = \begin{pmatrix} -1 \\ 9 \end{pmatrix} \text{ has dimensions } \boxed{\phantom{00}} \times \boxed{\phantom{00}}$$

**Example 1** -- Give the dimensions of the following matrices:

$$A = (-6, 5) \text{ has dimensions } \boxed{\phantom{00}} \times \boxed{\phantom{00}}$$

matrix above the numbers  $\begin{pmatrix} 1 & 2 \\ 2 & 5 \end{pmatrix}$  are in the first row and first column while the numbers  $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$  are in the second row and first column.

$\times n$  (or an  $m \times n$  matrix for brevity). The actual values of the numbers in the matrix are given as the actual values of the numbers. Given a matrix called  $A$ , the  $i$ th row and  $j$ th column element of the matrix  $A$  is denoted by  $A_{ij}$ .



$\pi$

# Co-created by a student for students

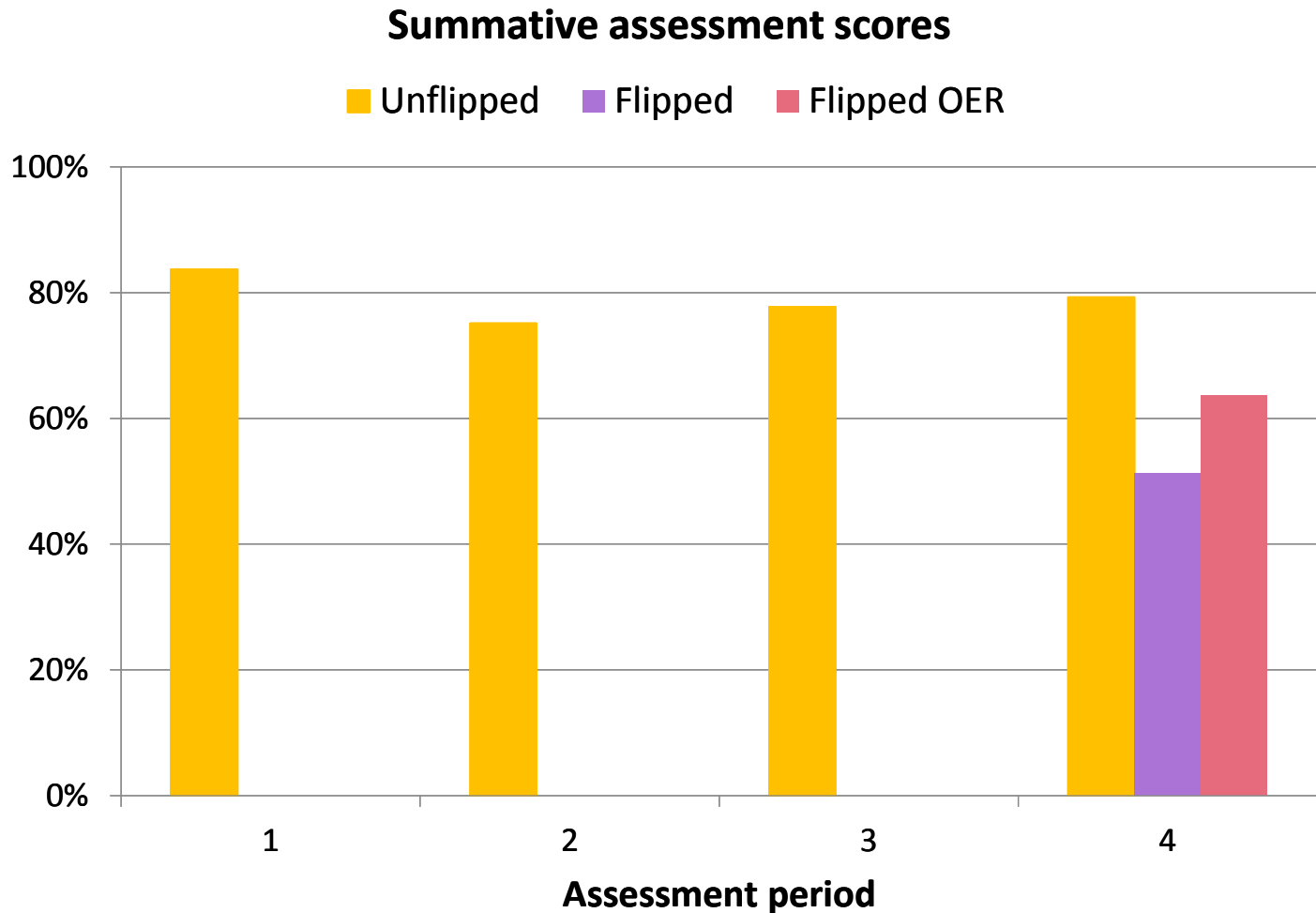
- › Summer Internship project (Faculty-funded) combined text-based “notes” with e-assessments in Numbas with embedded videos and links to other resources *in the feedback*.
- › Side-effect: He learnt HTML, LaTeX *etc.* and developed his project management skills in the process.



$\pi$

# Why go the OER/e-assessment route?

› Notes-based flipping did not work!



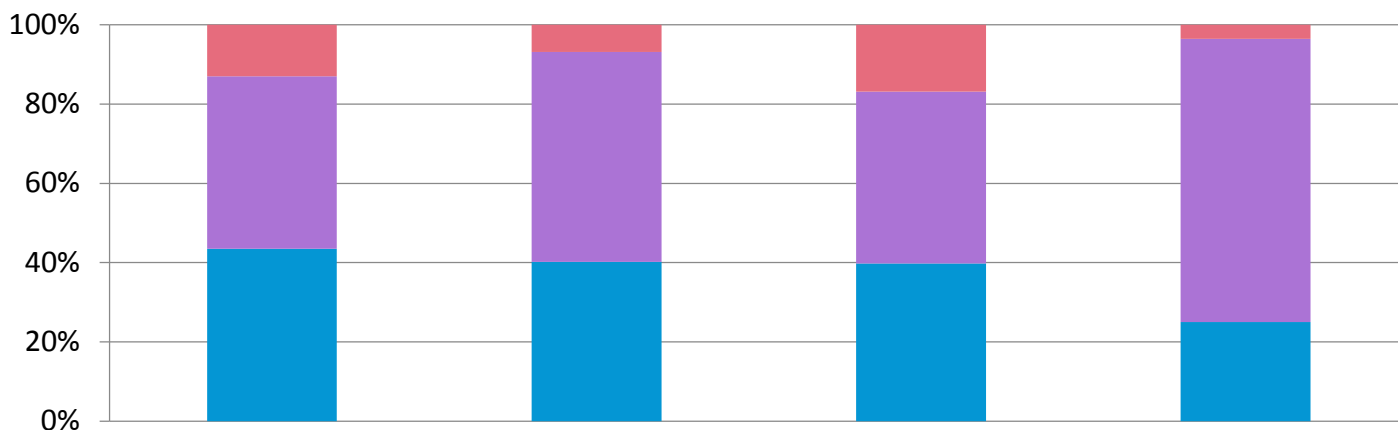




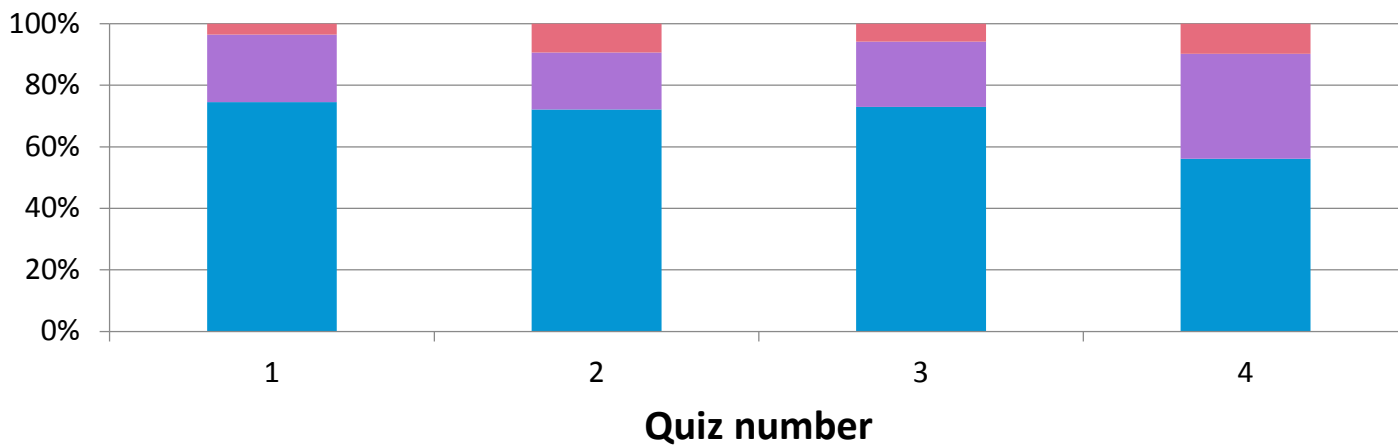
# Formative performance

■ Good scores   ■ Zero scores   ■ Other score

## Unflipped participants

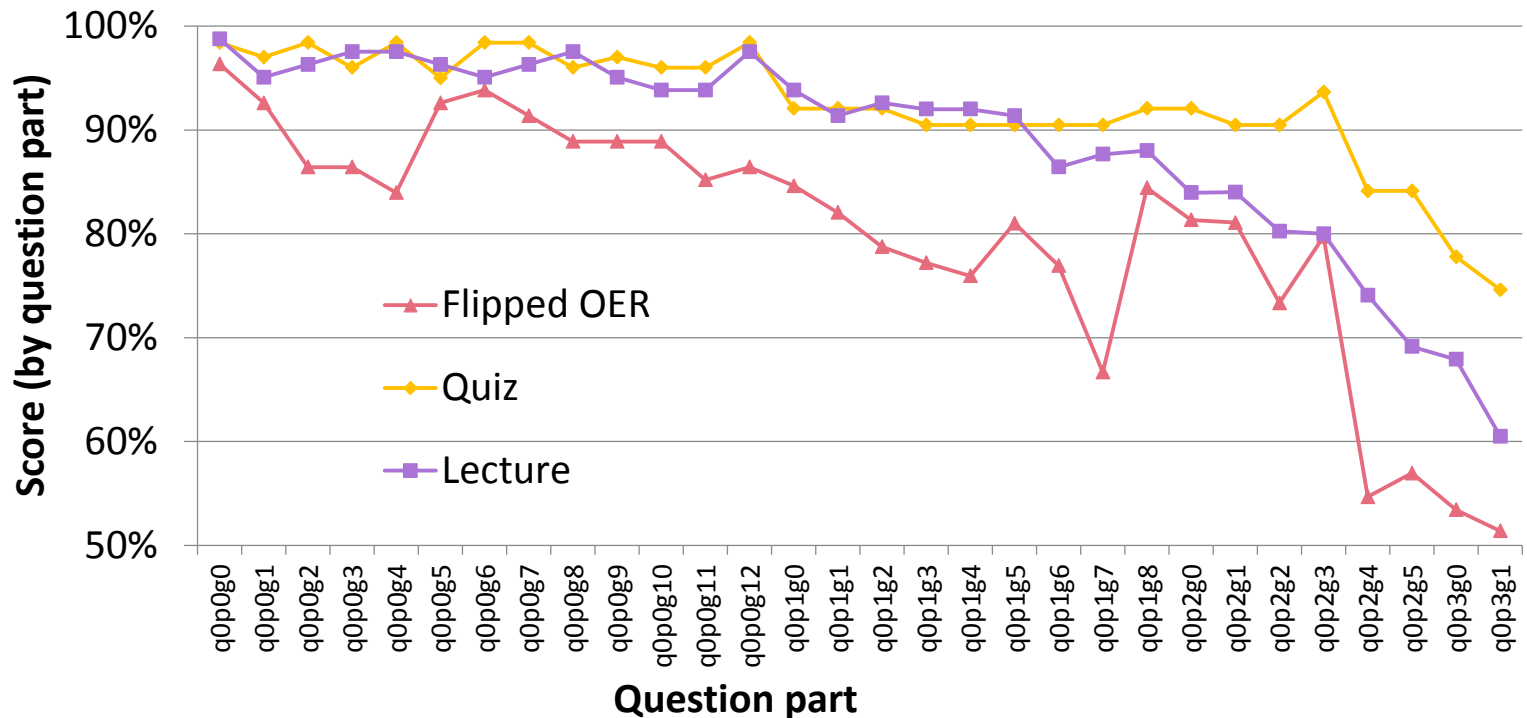


## Flipped + OER participants



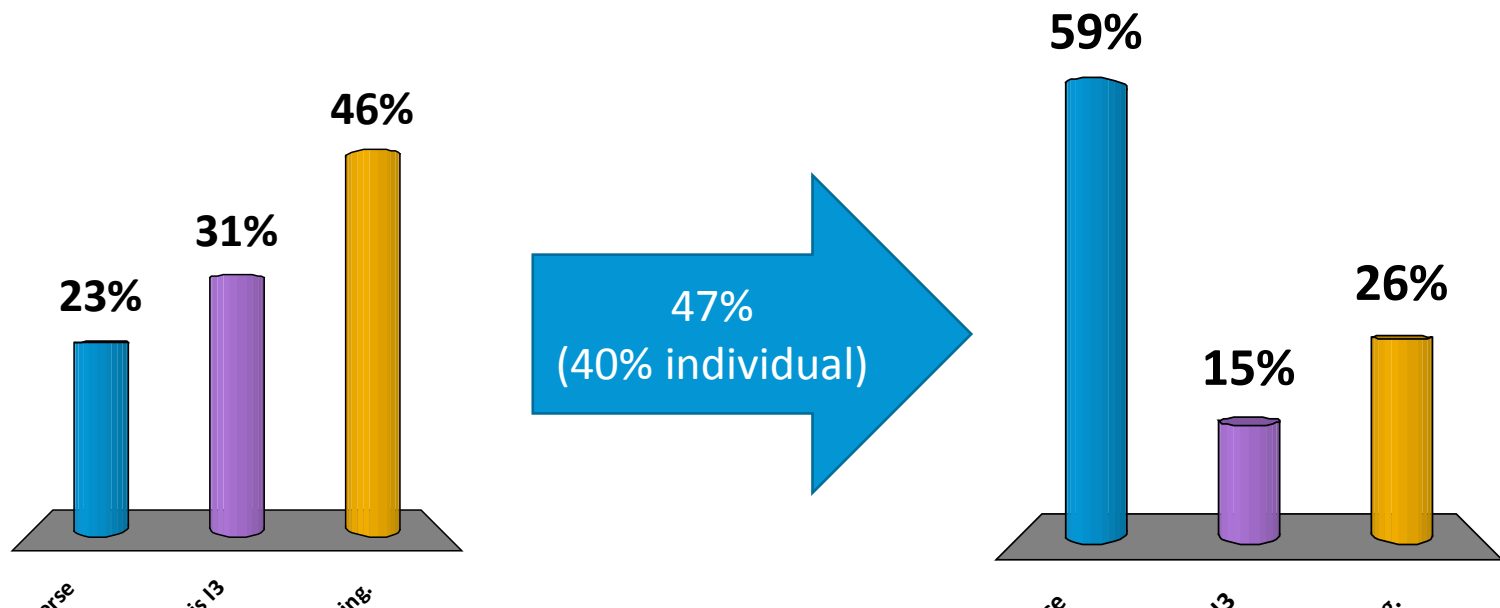
# Can we reach “gold standard” performance?

- › Even students with an unlimited amount of time and a marks incentive won't necessarily get 100% on a “long” question
- › “Flipped OER” results might be able to approach the “Lecture” if recall was perfect and fatigue not an issue



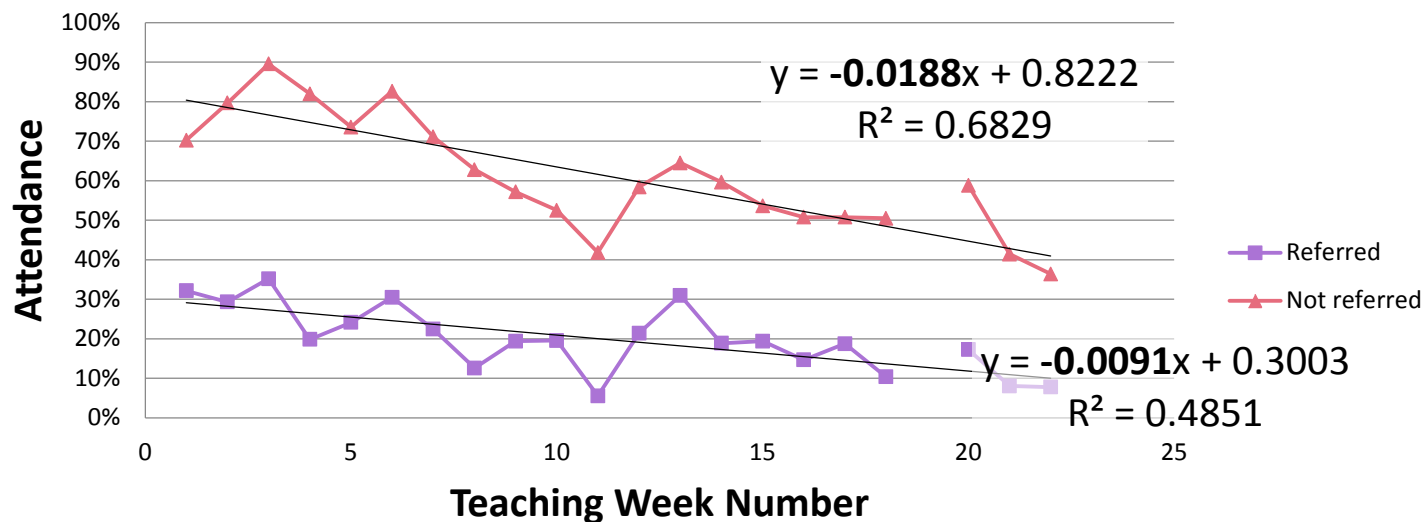
# Does Peer Instruction work? And can registered clickers do more?

- › 48% average “learning gain” over 5 weeks of using “Peer Instruction” with the Flipped+OER materials
  - Ranging from 16% to 80%
- › “Clickers Project” means individual responses can be traced after class and support offered to individuals clearly struggling with concepts
- › Also allows “inter-week learning gain” to be examined, *e.g.*



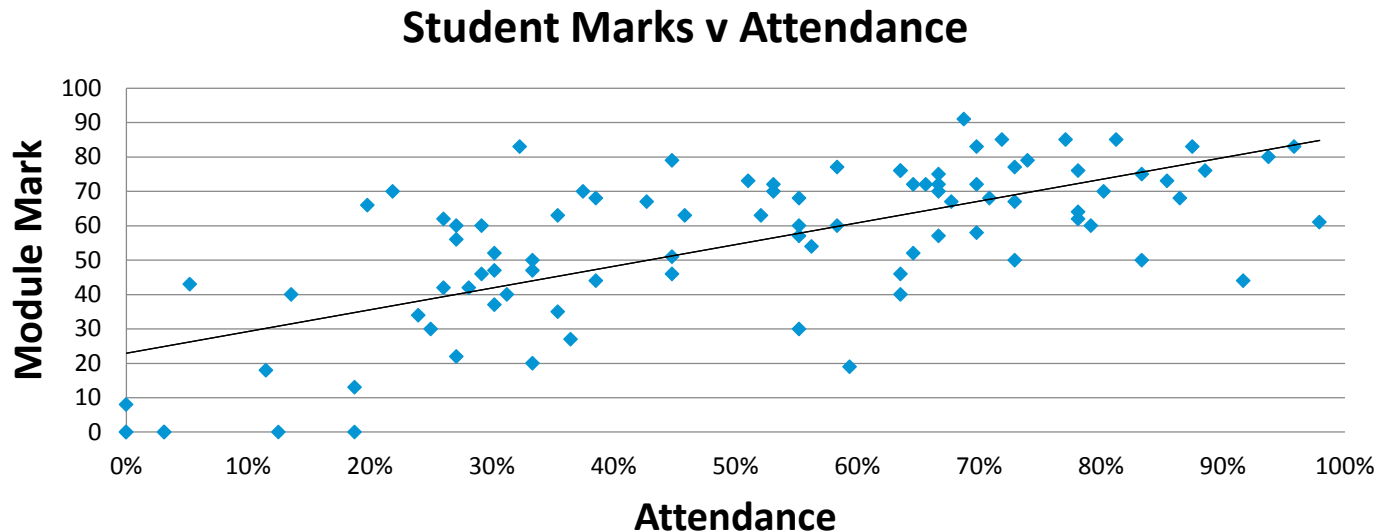
# Attendance statistics

- › Students with poor attendance were identified and referred to a workshop intended to inculcate better study habits.
- › However, in this pilot year for most students this was a one-off event
- › Nevertheless there is some evidence that the intervention did have some effect. Taken across the year the rate of decline in attendance was less for the group of students who were referred than for those who were not.



# Attendance statistics

- › For one of the first year core modules the correlation between the final results and the attendance record is fairly high (0.697).
- › The mean mark for those with less than 50% attendance is 40.5 (47.25 if zero marks are excluded) and the mean mark for those with more than 50% attendance is 66.73. (There is a statistically significant difference between the groups whatever test you perform.)
- › So we are not entirely wasting our time :-)



# Now what?

Back to the big picture...

$\pi$

# The Future

- › Pilot goes Institution-wide with
  - Level 4 this year
  - Giving students access to *quiz-level data*
  - Hybrid clicker solution (s/w & h/w option)
  - Now we're large-scale (following Jefferies *et al.*)  
3-level training & centralised support
- › Evaluation: Institution-wide focus groups covering all project “users”
  - Students as end-users
  - Academic staff as end-users and providers
  - Professional support staff (*e.g.* Library, Admin, Technical – AV support & IT support) as providers and users

# Longer-Term/Speculative Future

- › Integration with “Business Intelligence”
  - Move from a manual clickers web site upload to automated collection of “session” data
  - Supervised automation of student-level and cohort-level data analysis
- › Continuous evaluation – take advantage of students having clickers to enable
  - General feedback usually assigned to surveys *etc.* captured continuously (“how was class today?”)
  - Student support (identifying engagement issues)
  - Institutional feedback (“how was your lunch?”)



Unanswered questions:

How do you support staff to write good subject-specific questions?

How do you measure a “good question”?