

# The ATLAS Initiative

STEM教育におけるアクティブラーニングの大量採用を目指して

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KYUSHU UNIVERSITY



# Self-introduction

**~Present** Contract Associate Professor  
**~2016** Research Assistant Professor  
**~2013** Post-doctoral researcher  
**~2010** Post-doctoral researcher  
**~2009** PhD  
**~2005** MPhys

Kyushu University Japan  
University of Tokyo Japan  
University of Tokyo Japan  
Sogang University Korea  
University of Surrey UK  
University of Surrey UK  
(USA, Germany)





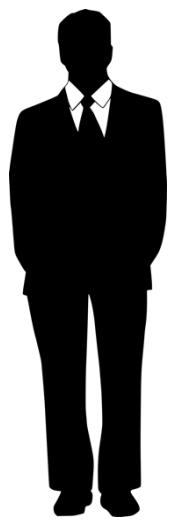
# Plan

- 自己紹介(みなさん)(10秒)
- 発表
- Q&A
- グループワーク
- グループ代表者の発表(1分以内)
- Final Discussion



# 自己紹介

- 10秒
- お名前・所属
- 参加のモティベーション等





# Presentation Contents

1. Initial motivation
2. Introduction to CBAL and the School of Engineering ATLAS Initiative
3. First implementation of Challenge-Based Active-Learning (CBAL)



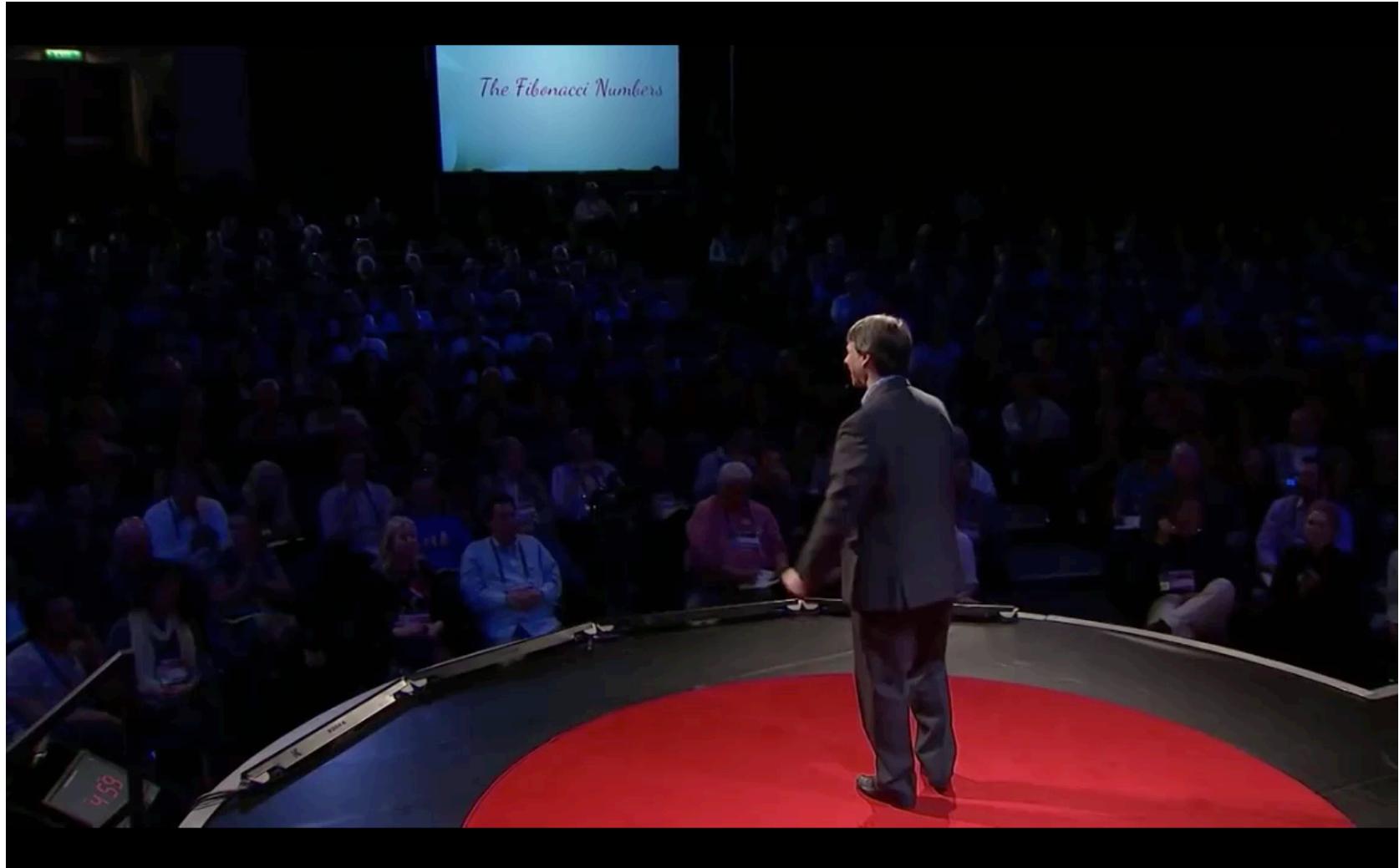
# Part I

Initial motivation



# What is the aim of this TED talk?

TED talk on Fibonacci numbers





# Lecture for Inspiration; not knowledge transfer

## Student inefficiencies

- Lecturing is a poor method of information transfer
- Homework is a poor method of instruction – teacher is not around when they need help the most!

## Lecturer inefficiencies

- Attrition & duplication of resources (instructor changes, multiple sections)
- Time spent checking student work (marking homework without feedback)



## Lectures Aren't Just Boring, They're Ineffective, Too, Study Finds

By [Aleszu Bajak](#) | May. 12, 2014 , 3:00 PM

<http://www.sciencemag.org/news/2014/05/lectures-arent-just-boring-theyre-ineffective-too-study-finds>

Are your lectures droning on? Change it up every 10 minutes with more active teaching techniques and more students will succeed, researchers say. **A new study** finds that undergraduate students in classes with traditional stand-and-deliver lectures are **1.5 times** more likely to fail than students in classes that use more stimulating, so-called active learning methods.

"Universities were founded in Western Europe in 1050 and lecturing has been the predominant form of teaching ever since," says biologist Scott Freeman of the University of Washington, Seattle. But many scholars have challenged the "sage on a stage" approach to teaching science, technology, engineering, and math (STEM) courses, arguing that engaging students with questions or group activities is more effective.

To weigh the evidence, Freeman and a group of colleagues analyzed 225 studies of undergraduate STEM teaching methods. The meta-analysis, published online today in the *Proceedings of the National Academy of Sciences*, concluded that teaching approaches that turned students into active participants rather than passive listeners **reduced failure rates**.

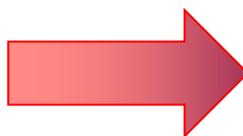




# Introducing new methods of teaching

Research

Must be world-leading



Highly visible



No incentive to innovate

Teaching?  
Faculty evaluated on  
research quality,  
not teaching quality

Efforts are invisible

How can faculty introduce innovative teaching strategies when research is so much more visible and brings so much more funding and career advancement?

Need to introduce **methods of higher quality education** that  
*simultaneously*  
offer researchers **equal or more time for research than before**

( + Make teaching more visible)



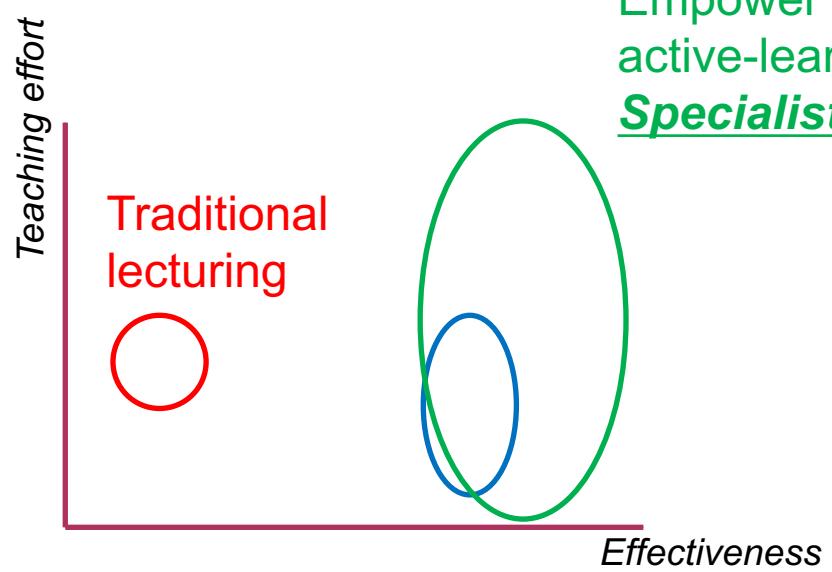
# Part II

Introduction to the ATLAS Initiative and Online CBAL

ATLAS = Active Learning And STEM

CBAL = Challenge-Based Active Learning

# The ATLAS Initiative

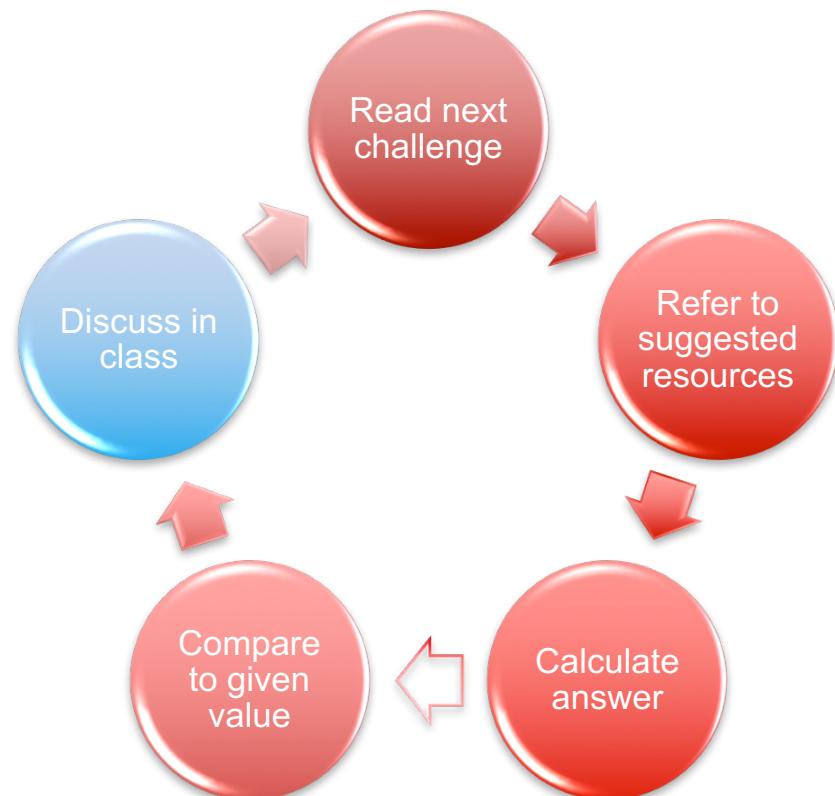


Empower faculty for individual  
active-learning based innovation  
**Specialist adoption**

Online Challenge-Based Active Learning  
**Aim for mass adoption**  
**Maintain research priorities**



# Challenge-based active learning: Students

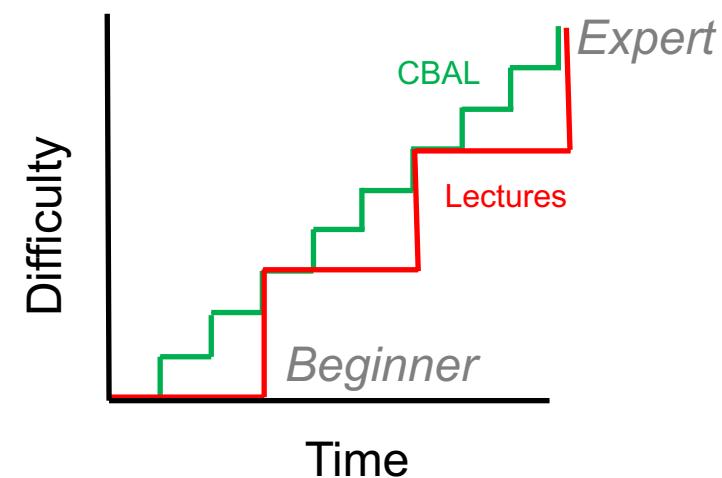
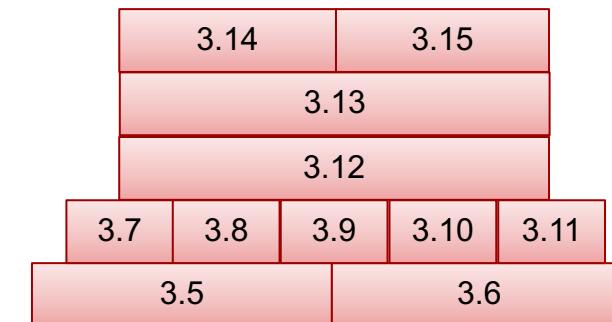


Ordinary Differential Equations course, 2016  
With kind permission of the students

# The challenge-based active-learning approach

1. Frequent rewards (small manageable challenges building upon past knowledge)
2. Mastery-based progression

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# The challenge-based active-learning approach

## 4.1 Your first Laplace Transform calculations

### Resources

- Videos: The four Khan-academy videos starting at <https://www.khanacademy.org/math/differential-equations/laplace-transform/laplace-transform-tutorial/v/laplace-transform-1>

### Comment

The Laplace Transform is a powerful technique that has many uses beyond solving ODE's. It can however appear a bit abstract at first. Becoming comfortable with controlling and manipulating the transform will help provide confidence when using it to solve ODE's. The four videos in the resources above provide an excellent starting point for getting you comfortable with this powerful technique.

### Challenge

1. Calculate  $\mathcal{L}\{1\}$
2. Calculate  $\mathcal{L}\{at\}$
3. Calculate  $\mathcal{L}\{Cos(at)\}$

### Solution

To check your answer, substitute  $s = 1$  and  $a = 2$  into your final solution.

1. 1
2. 2
3.  $\frac{1}{5}$

4. STEM requires students to learn how to engage in self-study

3. STEM requires substantial tacit knowledge that can only be obtained from practice

Handwritten notes on Laplace Transform:

Laplace Transform

$$\mathcal{L}\{f(t)\} \rightarrow F(s)$$
$$\mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$
$$\mathcal{L}\{1\} = \int_0^{\infty} e^{-st} dt$$



# The challenge-based active-learning approach

## 5. Immediate feedback about correctness of answer

The screenshot shows the WolframAlpha search interface. The query "md5 hash of \"a\_13\"" is entered in the search bar. Below the search bar, there are navigation links for "Web Apps", "Examples", and "Random". The main result section is titled "Input interpretation" and shows two options: "MDS" and "a\_13". Under "Message digest", it provides two forms: "integer form" (243948985616855047826540116201851196970) and "hexadecimal form" (b786 dd99 f17f e572 90aa cf8c 1bce 162a). At the bottom, there are links to "Download page" and "POWERED BY THE WOLFRAM LANGUAGE".

Similarly, if you are given a system of 2 1st-order ODE's, you can know that it can form a single 2nd-order ODE.

### Challenge

Write the following ODE's in matrix form:

- 1)  $2y'' + 4y' - 6y = 0$
- 2)  $y'' + y = \cos(t)$

Complete exercises 1 and 2 on page 5 of the PDF.

### Solutions

To check your answers, sum the values of all the terms in your matrix  $\mathbf{A}$ .

- 1) 2
- 2) 0 (remember there is also a  $+g$  column-vector added to  $\mathbf{Ax}$  too)

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

### 4.4 L'Hôpital's rule

#### Resources

- Wikipedia: [https://en.wikipedia.org/wiki/L%C3%A9%27H%C3%A9pital%27s\\_rule](https://en.wikipedia.org/wiki/L%C3%A9%27H%C3%A9pital%27s_rule)

#### Challenge

1. Use L'Hôpital's rule to determine the limit of

$$te^{-st} \quad (4.3)$$

as  $t \rightarrow 0$ .

2. Considering the case of

$$\frac{t^n}{e^{st}} \quad (4.4)$$

if we apply L'Hôpital's rule  $n$  times with respect to  $t$ , what is the power of  $t$  in the numerator? Note that  $e^{st}$  is always constant, so by repeated differentiation we can apply L'Hôpital's rule even for  $t^n$ .

#### Solution

1.  $\text{MD5}(ww\_X) = 76c8d4\dots$
2.  $\text{MD5}(xx\_X) = 1592d7\dots$



# The challenge-based active-learning approach

6. Correction of mis-understanding leading to wrong answers
7. Creation of a positive learning environment



*Ordinary Differential Equations course, 2016  
With kind permission of the students*

- Submit feedback form ~12h before class
- Pair students to maximise peer instruction
- Teacher knows in advance where problems are

Name \*

Your answer

Student number \*

Your answer

What is the highest challenge-number that you have successfully completed? (Enter a number, like 1.6) \*

Your answer

Which challenge are you planning to work on in class? (Enter one or more numbers; comments also ok) \*

Your answer

What did you find hardest and/or enjoy most about the course this week? (optional)

Your answer



# The challenge-based active-learning approach

## 8. Iterative course-content improvement that addresses student difficulties

### 5.2 Basis for creating a system of equations from a single ODE

#### Resources

- Pages 1-4 of the PDF <http://www.math.psu.edu/tseng/class/Math251/Notes-LinearSystems.pdf>

#### Comment

Note that the notation  $y^{(2)}$  means “the 2nd differential of  $y$ ” while the notation  $y^2$  (without the brackets around the 2) means “ $y$ -squared”.

Considering the general form of an nth-order linear equation,

$$a_n y^{(n)} + a_{n-1} y^{(n-1)} + \cdots + a_1 y^{(1)} + a_0 y = g(t) \quad (5.1)$$

we substitute  $x_1 = y$ ,  $x_2 = y'$ , ...,  $x_n = y^{(n-1)}$  and  $x'_n = y^{(n)}$ .

When replacing a  $y$ -term by an  $x$  term, the  $n$  in  $x_n$  corresponds to one more than the number of times  $y$  is differentiated. So  $x_{n+1}$  corresponds to  $y$  being differentiated  $n$  times and  $x_n$  corresponds to  $y$  being differentiated  $n - 1$  times. So  $x_2$  corresponds to  $y^{(1)}$  (differentiated 1 time) and  $x_1$  corresponds to  $y$  (differentiated 0 times).

Note that  $x'_n$  is one more differential than  $x_n$ , so  $x'_n$  corresponds to  $(y^{(n-1)})' = y^{(n)}$ . So the  $n$  in  $x'_n$  corresponds to the number of times  $y$  is differentiated (ie,  $y^{(n)}$ ).

The examples on page 3 are clearer after reading page 4, so I encourage you to read page 4 before considering the examples.

Considering example (II) on page 3, you are given the equation

$$y''' - 2y'' + 3y' - 4y = 0 \quad (5.2)$$

To add a more detailed explanation to that found in the PDF: First re-write the ODE in terms of  $x$  and  $x'$ . Note that there is no “ $x'_0$ ” so we just write it as  $x_1$  in both equations.

$$x_4 - 2x_3 + 3x_2 - 4x_1 = 0 \quad (5.3)$$

$$x'_4 - 2x'_3 + 3x'_2 - 4x'_1 = 0 \quad (5.4)$$

1-on-1 interaction leads to clear understanding of *why* students have problems.

## Facilitate learning

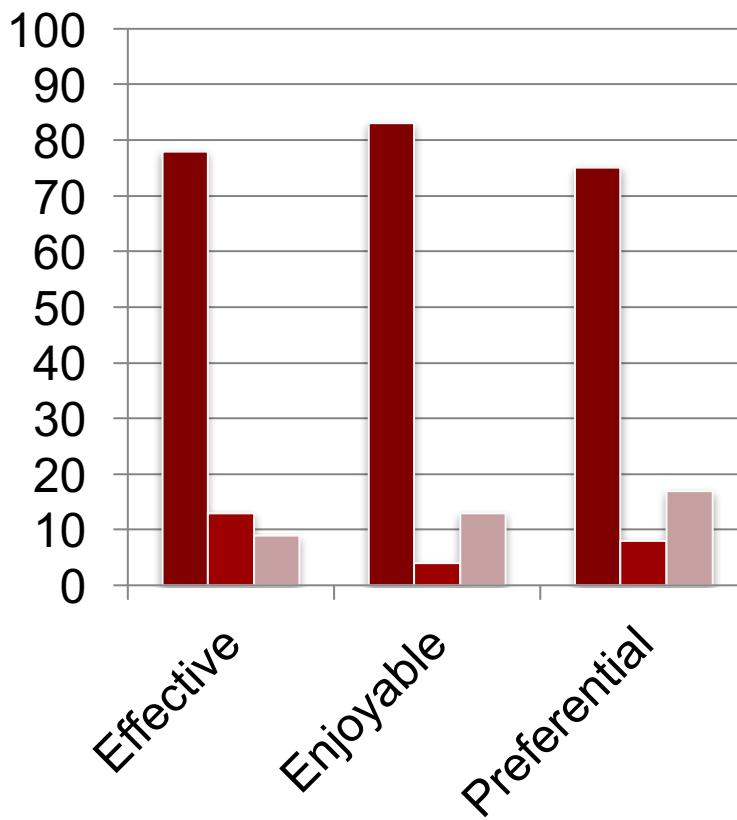
- **Online Challenge-Based Active Learning.**
- **CC-NC-BY4.0 licensed content**
- **Open access**





# Challenge-based active learning: Student perspective

% **Student survey: what do you find most...**



- Challenges
- Neutral
- Lectures

Average over 2 courses, about 30 students

This lecture gave us the opportunity to be a more responsible person in achieving our goals

Peer discussion is fun

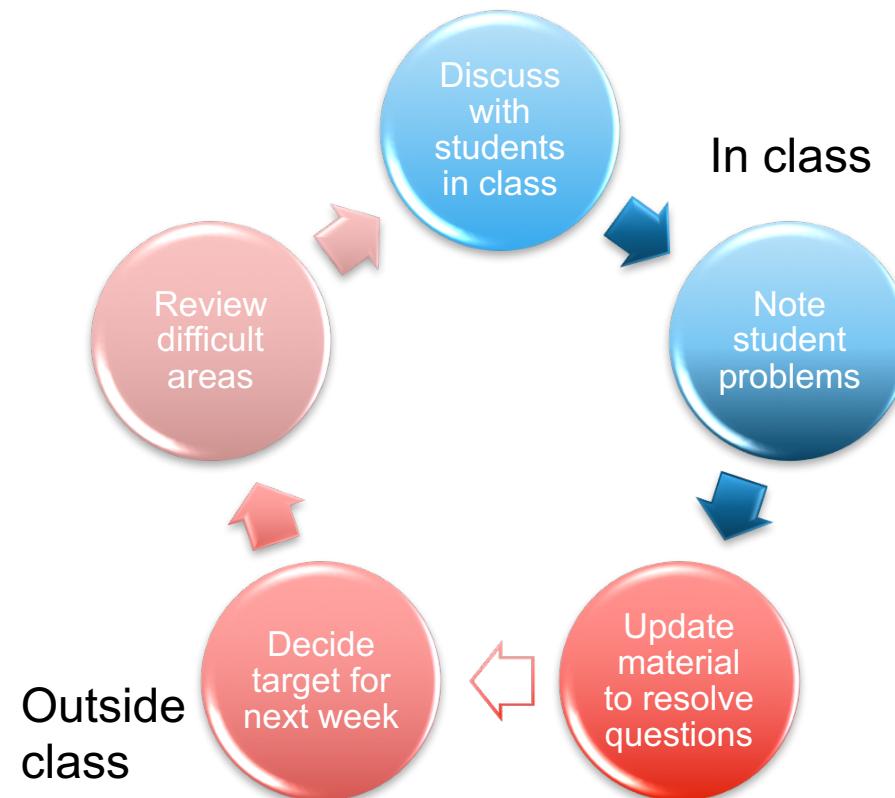
Facilitated me to acquire a deeper understanding

Enjoyed that you can focus studying your interests at your speed

I have a chance to clearly understand the theory by spotting the parts that I couldn't understand

I liked this style because it actually made me work. Otherwise I would probably start studying when exams are near

# Challenge-based active learning: Staff perspective



- Equal or less preparation time than lecturing
- More fun



# Why online Challenge-Based Active Learning?

(3 reasons)

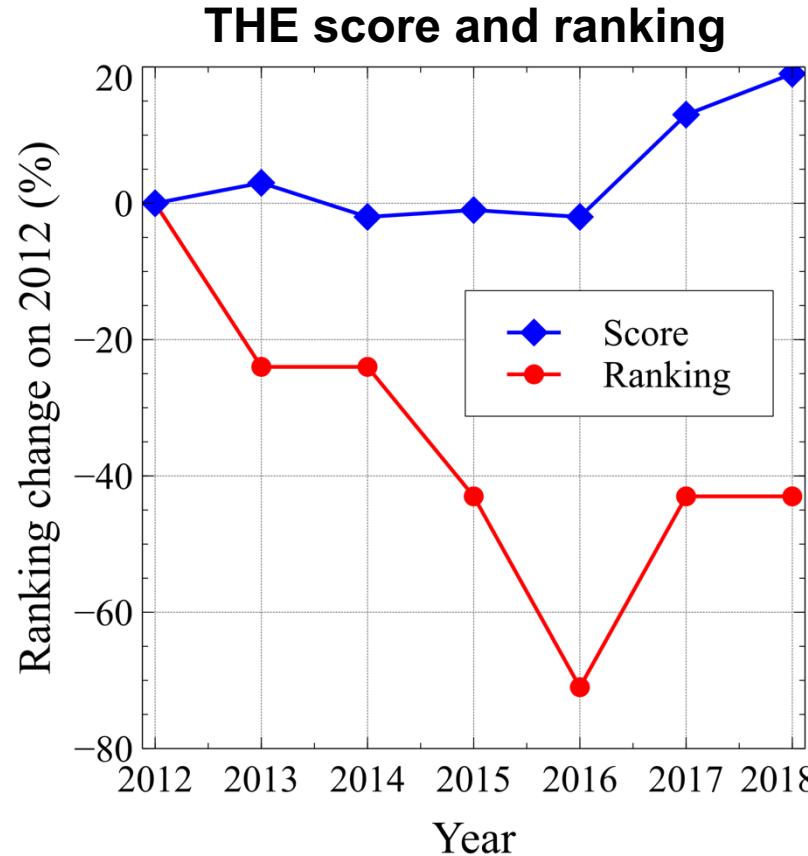


1. Increase in reputation
2. An iteratively improvable resource
3. Support internationalisation goals  
of the university



- 1. Increase in reputation**
2. An iteratively improvable resource
3. Support internationalisation goals  
of the university

# Challenge: Kyushu University's ranking

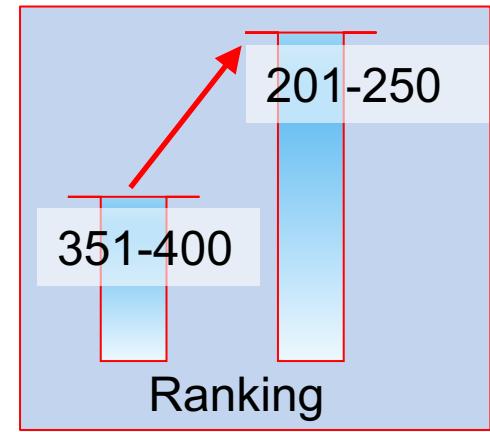
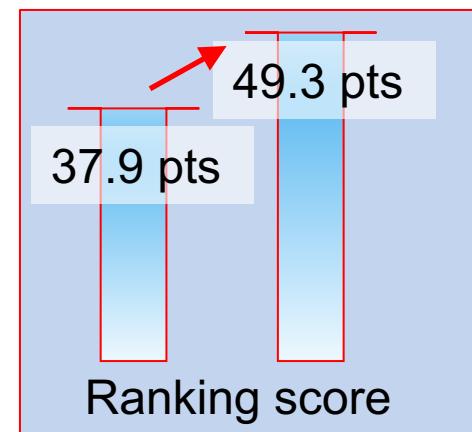
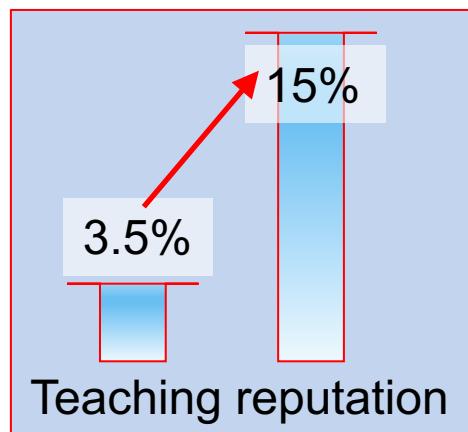
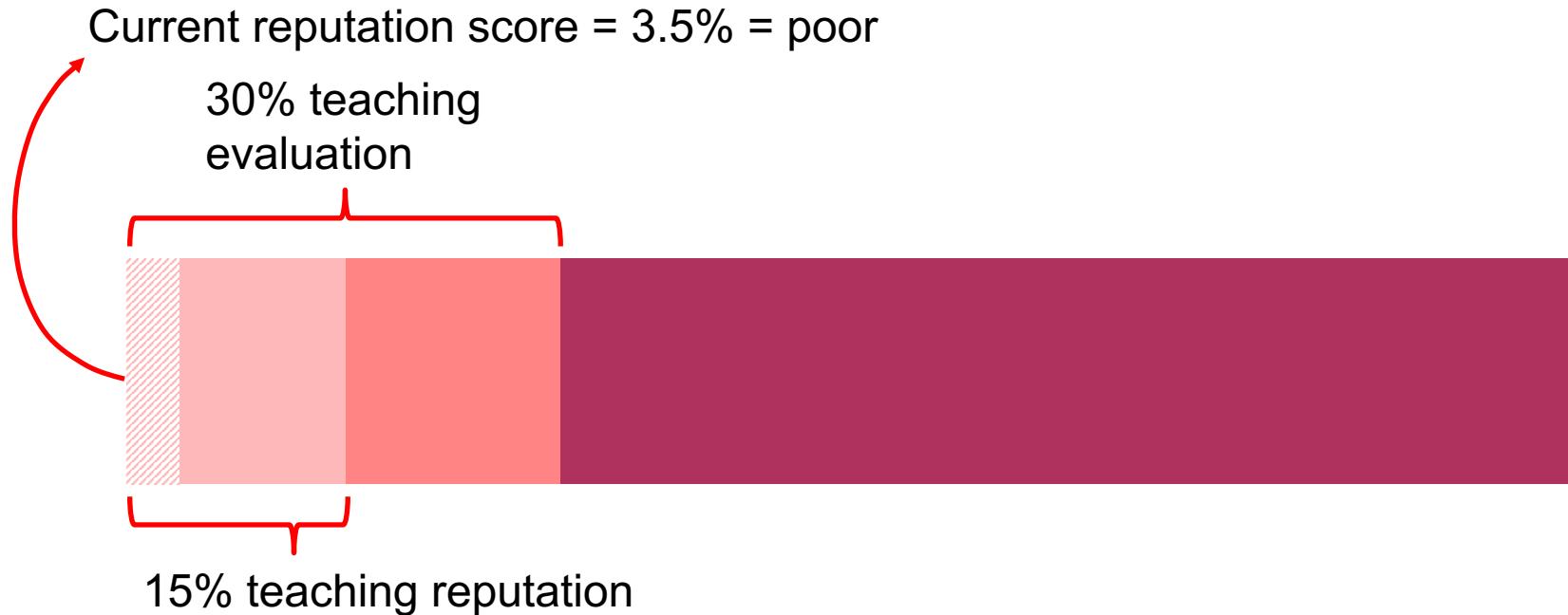


Point-score is stable  
or increasing

Ranking trend is downwards

Other universities are overtaking Kyushu University.  
Kyushu University needs to innovate just to maintain its position.

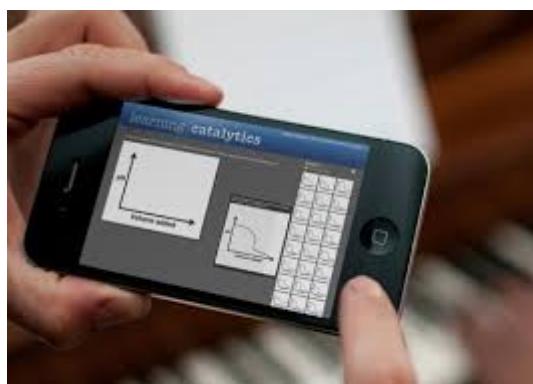
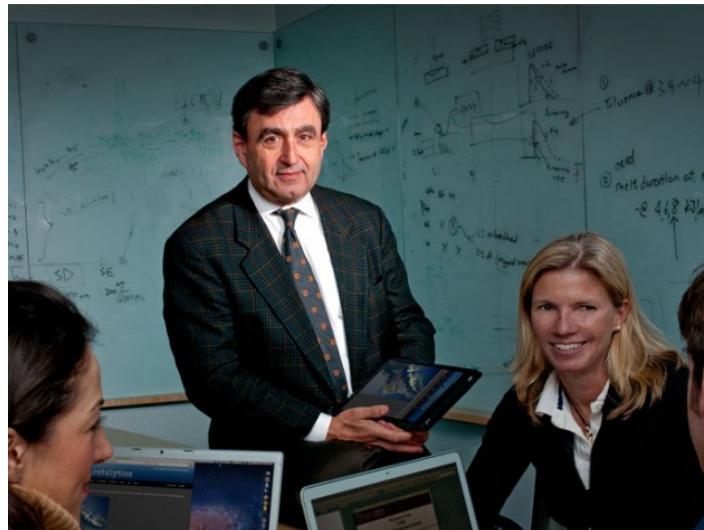
# Teaching reputation has scope for increase





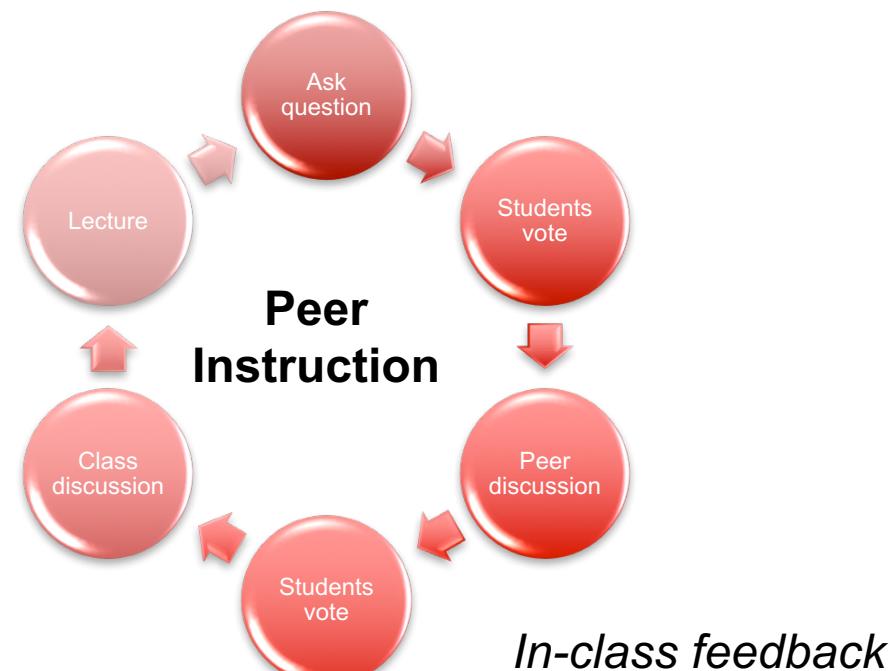
# Harvard (2018 ranking = 6)

Erik Mazur, Active Learning Pioneer



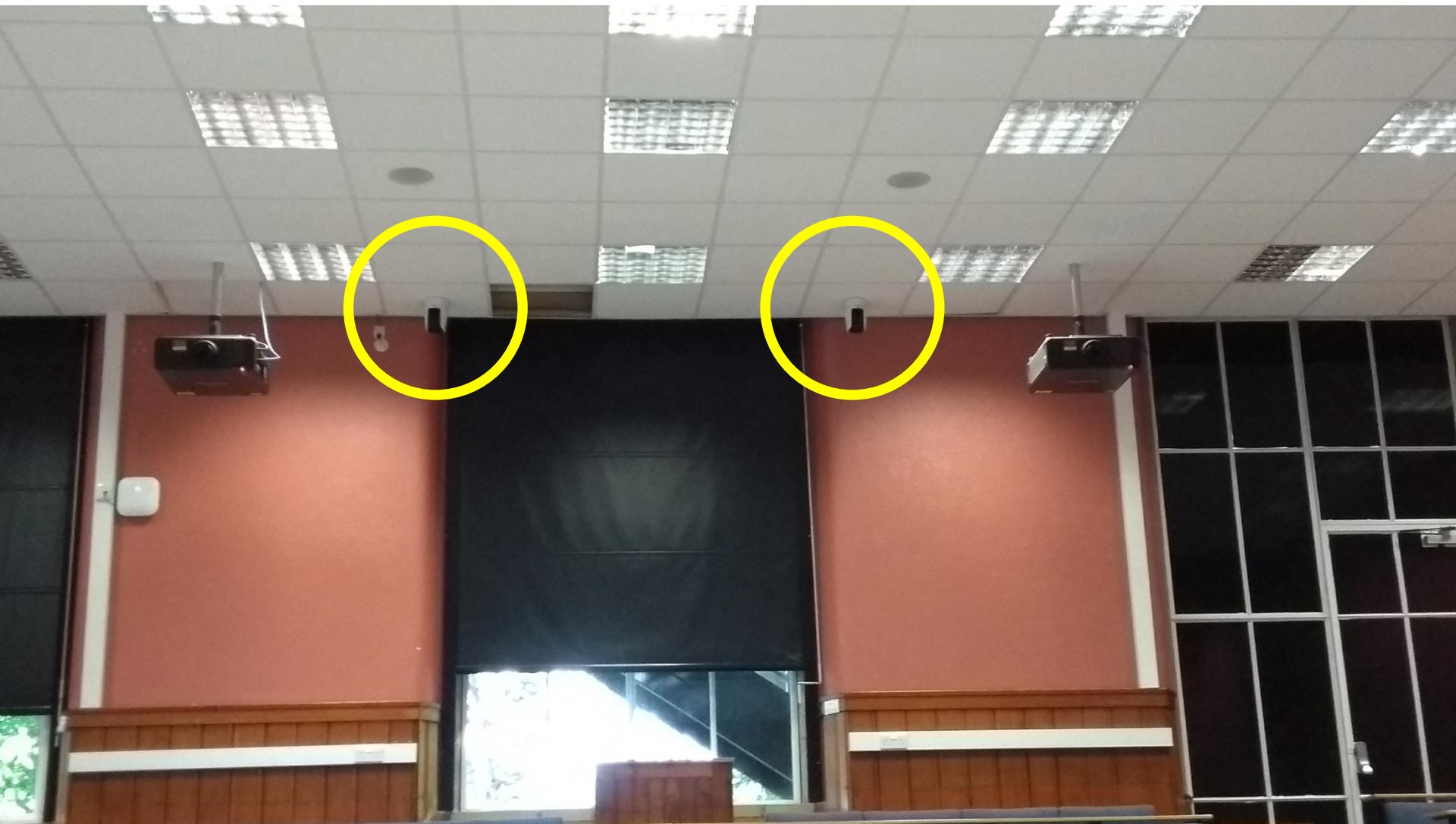
Learning Catalytics

- *Facilitate learning*
- Create a learning *environment*
- Focus on “*learning*” rather than “*teaching*”





# The University of Edinburgh (ranking = 19)

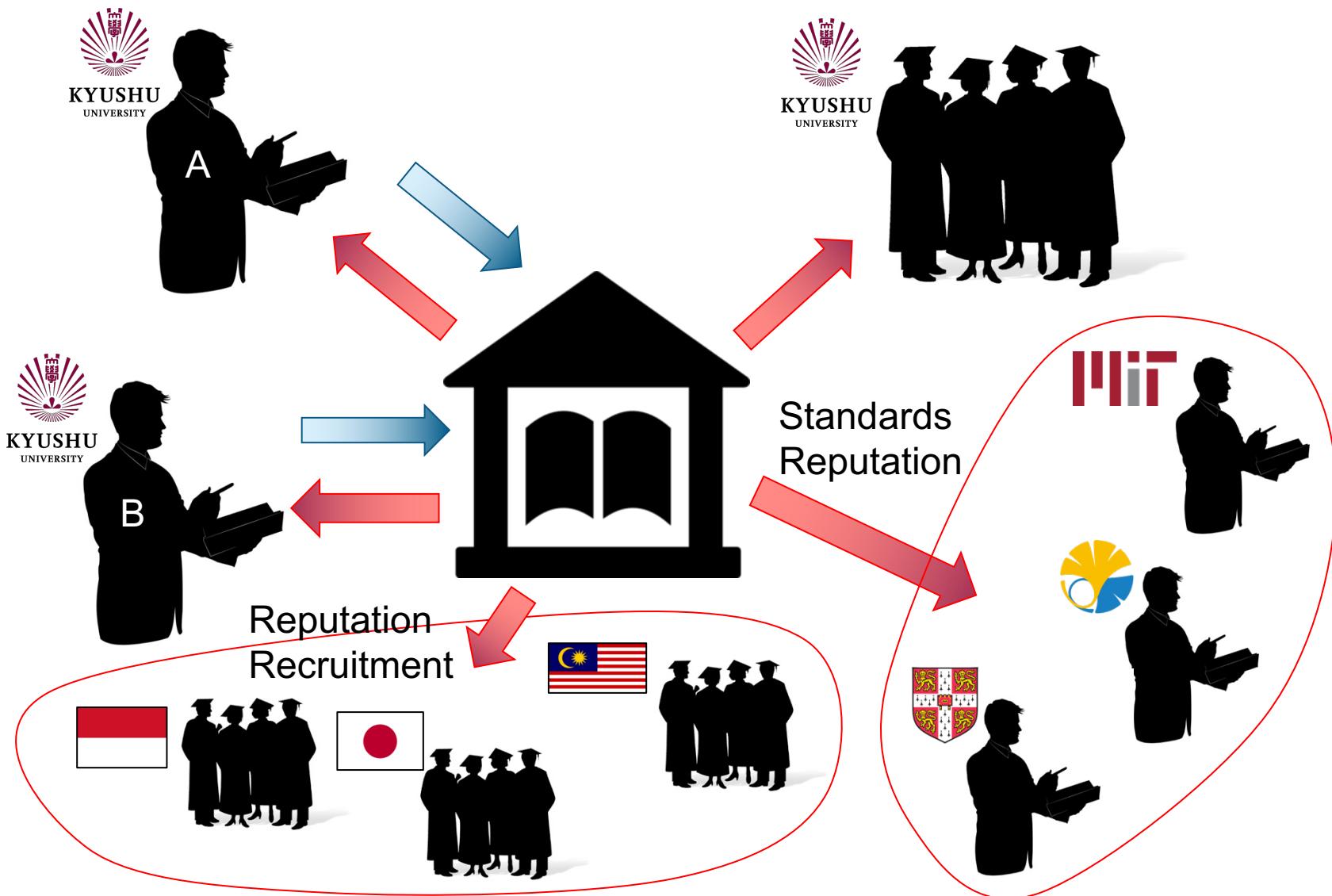




1. Increase in reputation
2. An iteratively improvable resource
3. Support internationalisation goals  
of the university



# Give learning materials a home





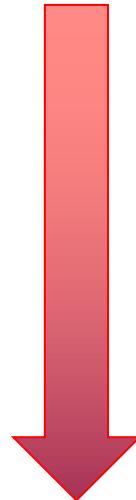
1. Increase in reputation
2. An iteratively improvable resource
3. **Support internationalisation goals  
of the university**



# Problem: Limited opportunity for Japanese and international students to interact



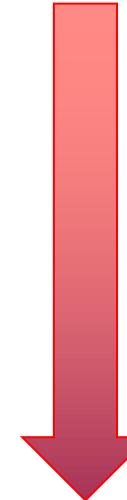
入学



卒業



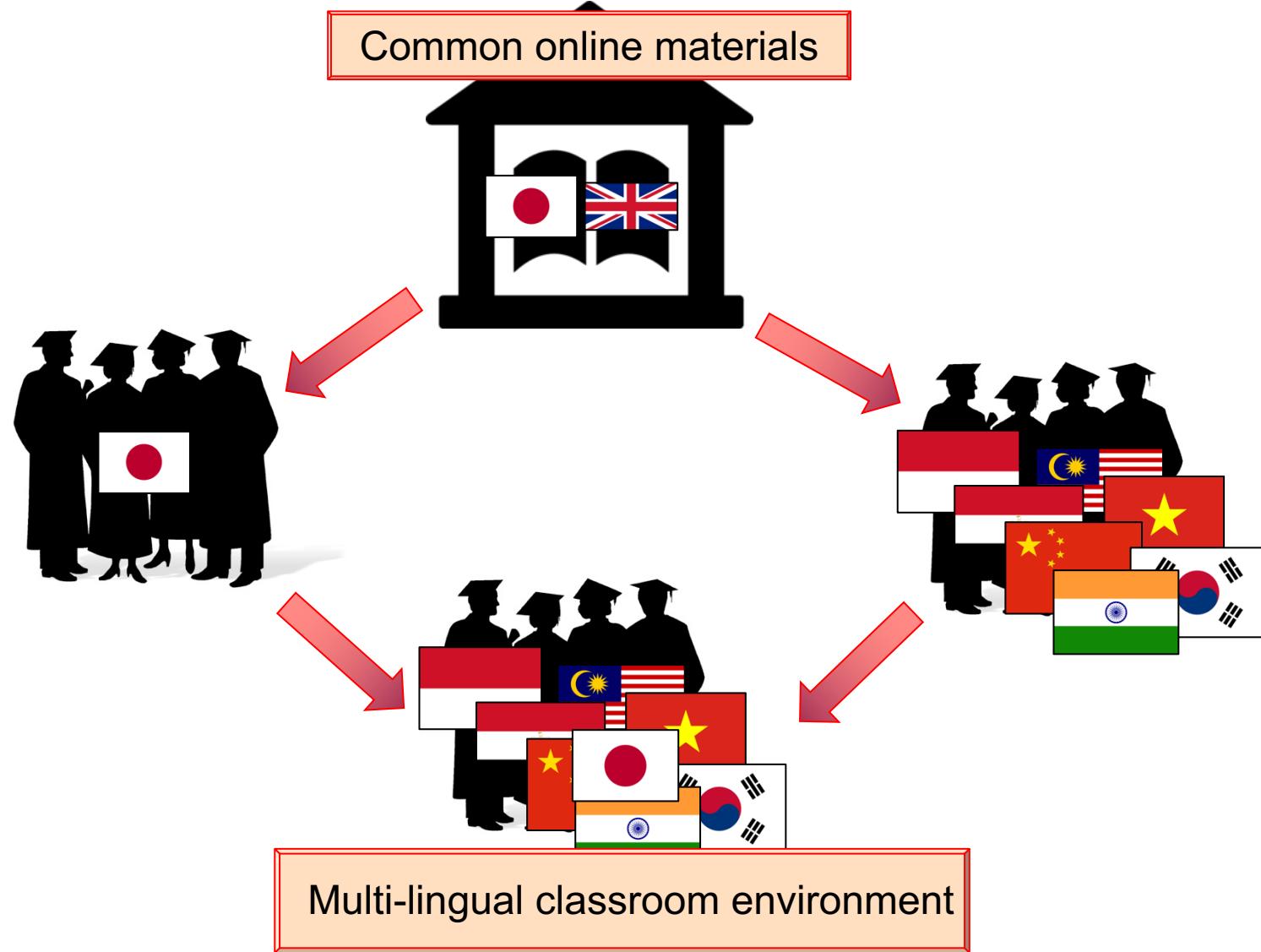
Entrance



Graduation



# Learn in your preferred language – discuss in English





1. Increase in reputation
2. An iteratively improvable resource
3. Support internationalisation goals  
of the university



# Part III

How to start?



# How to do this in practise?

1. Establish an iteratively-improvable open resource

**Latex + Github**



[www.tug.org/mactex](http://www.tug.org/mactex)



[www.latex-project.org](http://www.latex-project.org)



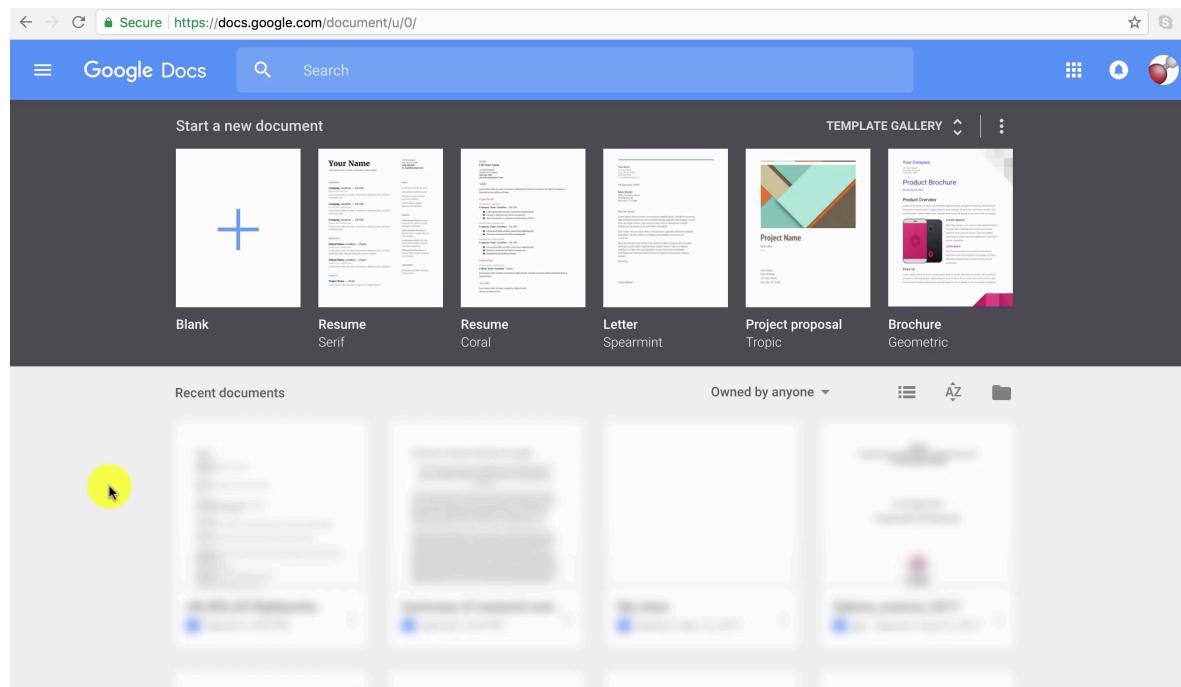
<https://github.com/NanoScaleDesign>



# How to do this in practise?

## 1. Establish an iteratively-improvable open resource

### Google docs

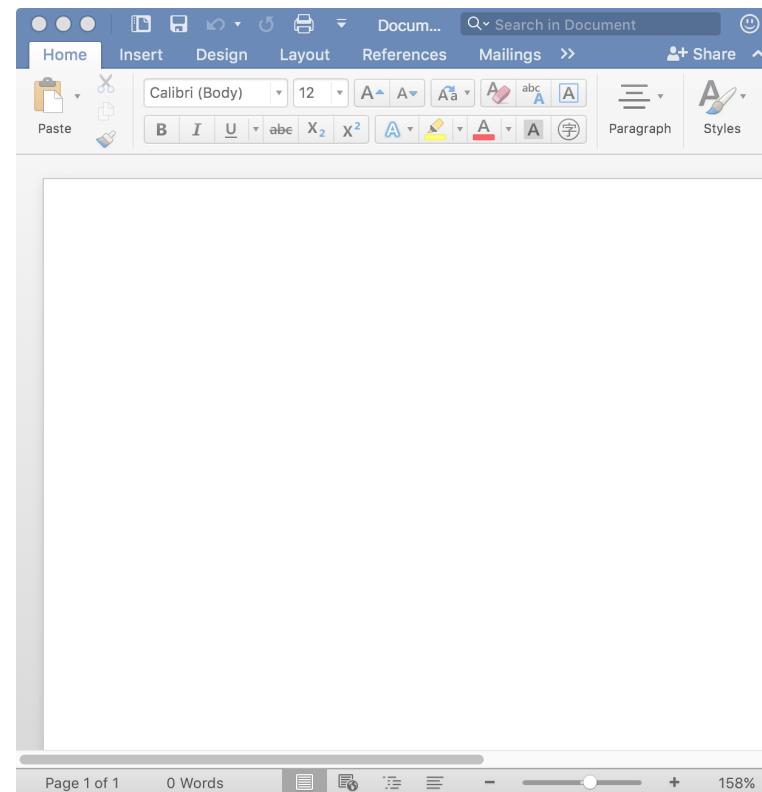




# How to do this in practise?

## 1. Establish an iteratively-improvable open resource

Word



But: Creates barrier to sharing, improvements, adoption



# How to do this in practise?

1. Establish an iteratively-improvable open resource
2. Create challenges

1. Challenge Number / Name
2. Suggest resources
3. Teacher's comment (optional)
4. Challenge
5. Solution (number or hash)

## First time

Use existing resources!

- Online resources
  - HTML pages
  - PDF's
  - YouTube
- Books



# How to do this in practise?

1. Establish an iteratively-improvable open resource
2. Create challenges
3. Upload material
  - Latex + Github – send students link and then just *add, commit, push*
  - Google docs – send students viewing link
  - MS Word / LibreOffice – Email document regularly



# How to do this in practise?

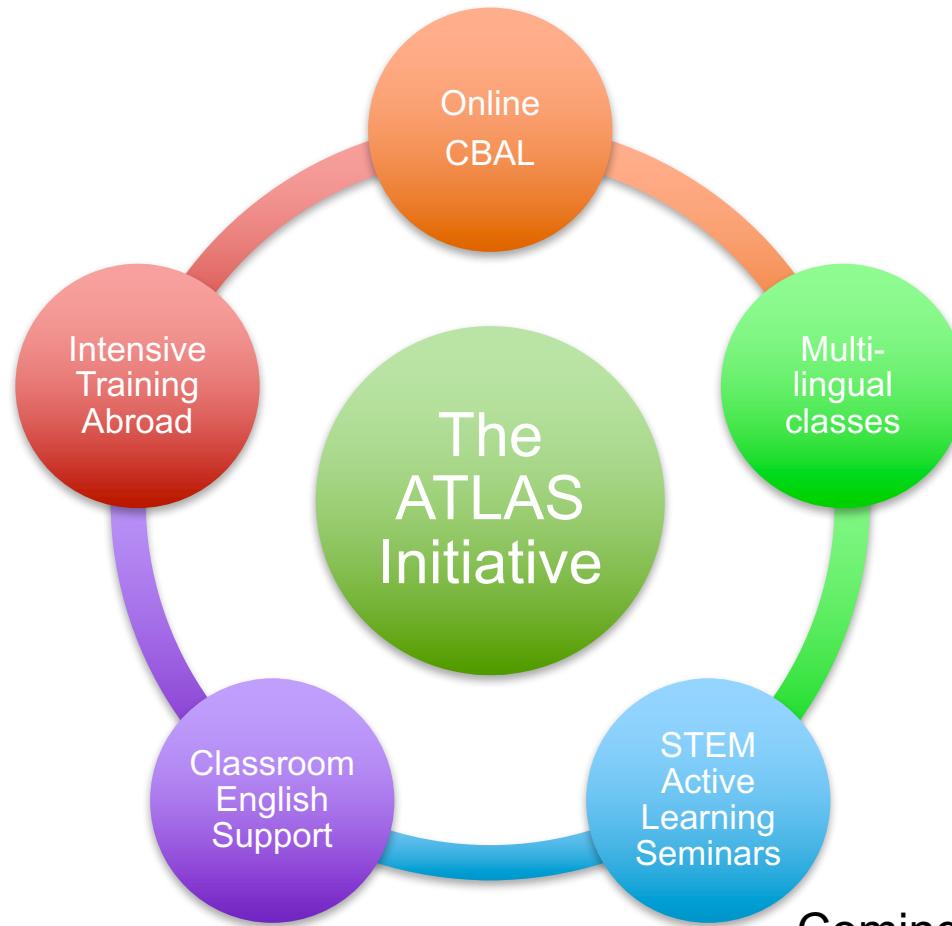
1. Establish an iteratively-improvable open resource
  2. Create challenges
  3. Upload material
  4. Update document over time
- 
- Version control: Timestamp the front of the document
  - Notify students of update by email

**Mechanics**  
Spring 2017

Last updated:  
10th July 2017 at 15:13



# The ATLAS Initiative





# The ATLAS Initiative and CBAL for...

- Lectures are great for inspiration! Not so much for knowledge transfer...
- The ATLAS Initiative and Online Challenge-Based Active Learning offers:
  - **Students** a better + more enjoyable learning experience
  - **Staff** a more effective teaching experience that preserves research-time
  - **Kyushu University** increased ranking and reputation

Interested to learn more?

Join the **ATLAS community**: [cannon@mech.kyushu-u.ac.jp](mailto:cannon@mech.kyushu-u.ac.jp)

[www.jamescannon.net](http://www.jamescannon.net)

A screenshot of a search results page from a web browser. The search bar at the top contains the query "James Cannon Kyushu University". Below the search bar is a navigation menu with links for All, Images, News, Videos, Maps, More, Settings, and Tools. A search icon is located to the right of the search bar. The main content area displays a single search result, which is a link to the homepage of James Cannon at Kyushu University.

About 40,900 results (1.09 seconds)

[James Cannon, Kyushu University: Welcome](http://www.jamescannon.net/)

[www.jamescannon.net/](http://www.jamescannon.net/) ▾

Homepage for James Cannon, Kyushu University, Japan.

 @NanoScaleDesign



# Groupwork

1. What have you learned today that you think you could apply to your situation?

2. What do you think would be difficult to apply to your situation?



**END**