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Reliable classification of classroom practices using lecture recordings

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Outline

- Background
- Project overview
- Results
- Future directions

Background

Classroom practices

- Freeman et al. (2014)
- Active vs traditional

PNAS

CrossMark

Active learning increases student performance in science, engineering, and mathematics

Scott Freeman[a,1], Sarah L. Eddy[a], Miles McDonough[a], Michelle K. Smith[b], Nnadozie Okoroafor[a], Hannah Jordt[a], and Mary Pat Wenderoth[a]

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Edited* by Bruce Alberts, University of California, San Francisco, CA, and approved April 15, 2014 (received for review October 8, 2013)

To test the hypothesis that lecturing maximizes learning and ... 225 studies in the published and unpublished literature. The active

> "Second-generation research could also explore which aspects of instructor behavior are most important for achieving the greatest gains with active learning" (p8413)

COPUS	PORTAAL	FILL

validated teaching practice in regular classrooms.

constructivism | undergraduate education | evidence-based teaching | scientific teaching

Lecturing has been the predominant mode of instruction since universities were founded in Western Europe over 900 y ago

rates were 21.8% under active learning but 33.8% under traditional lecturing—a difference that represents a 55% increase (Fig. 1 and Fig. S1).

Significance

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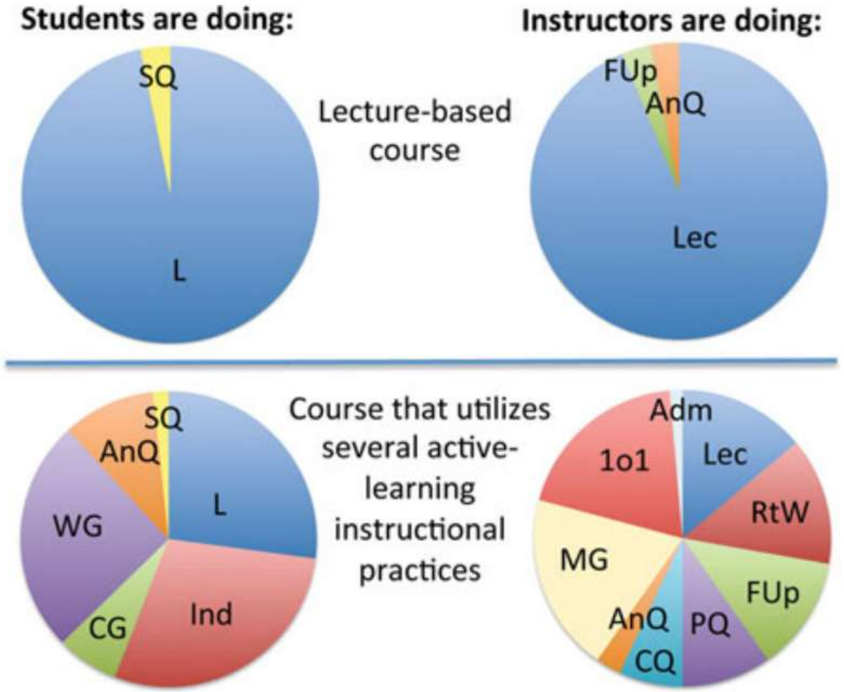
COPUS

	1. Students doing													2. Instructor doing												Comments:
min	L	Ind	CG	WG	OG	AnQ	SQ	WC	Prd	SP	TQ	W	O	Lec	RtW	FUp	PQ	CQ	AnQ	MG	1o1	D/V	Adm	W	O	
0 - 2																										
2-4																										
4-6																										



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Smith et al. (2013)

1

Using COPUS

“to verify the fidelity of the instructor to their assigned/chosen approach”
(Maciejewski, 2015, p191)

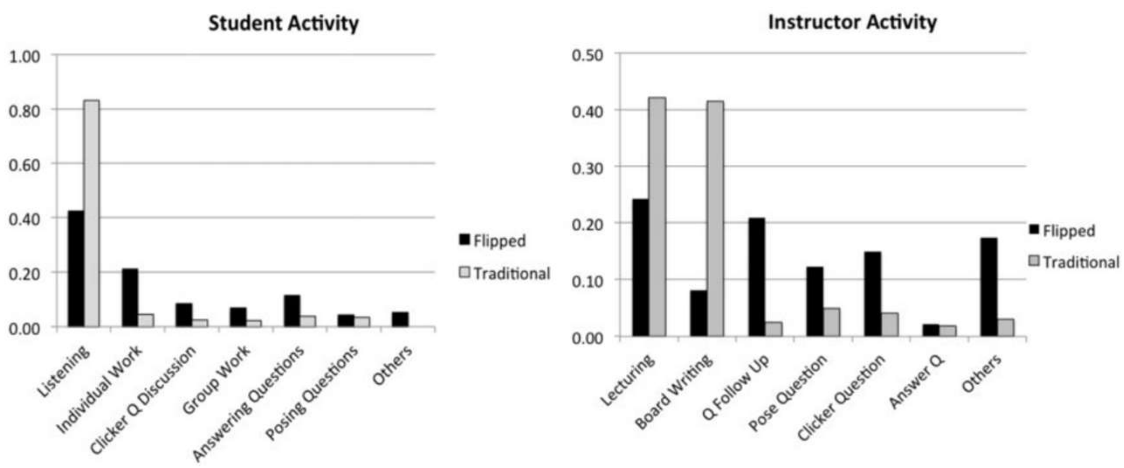

FIG. 2. Summarized COPUS classroom observation data.

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Flipping the calculus classroom: an evaluative study

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[Submitted July 2015; accepted November 2015]

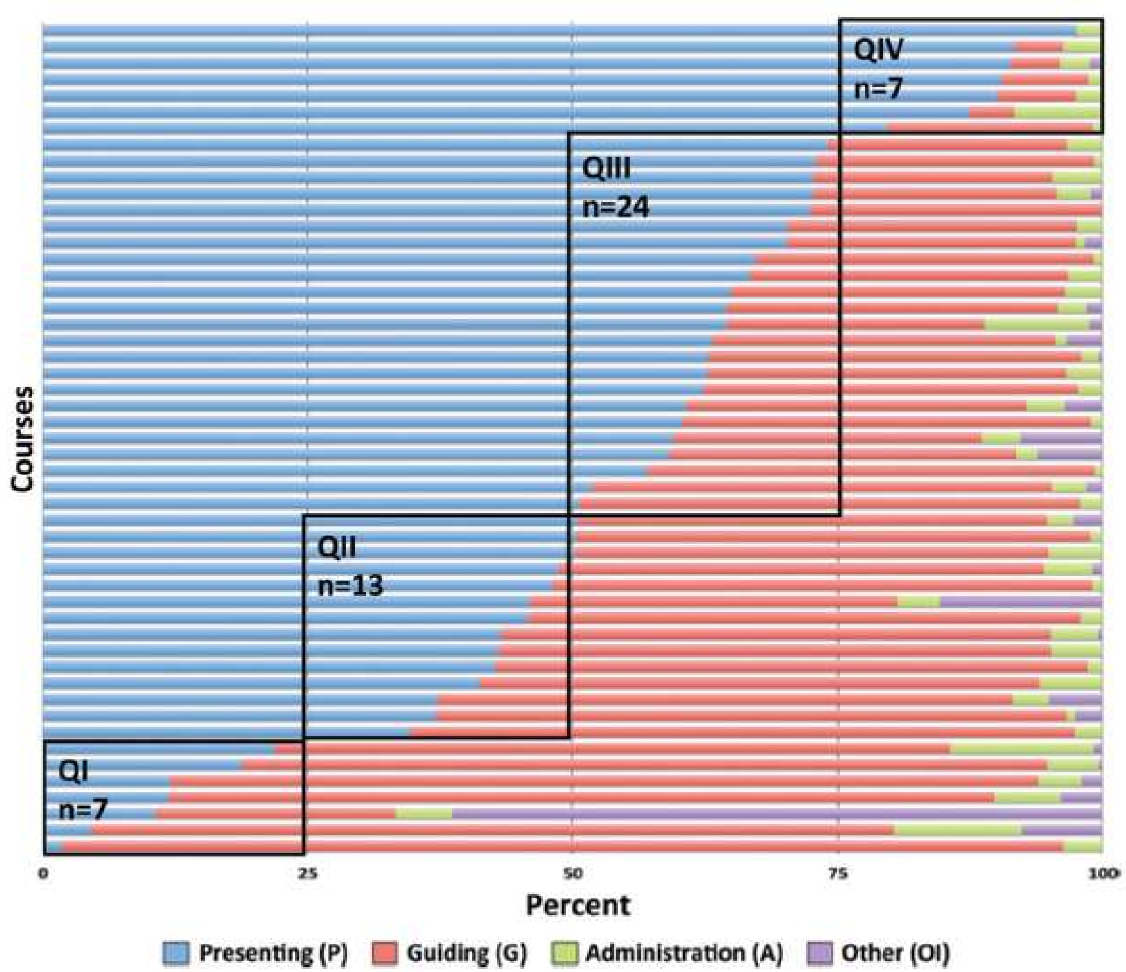
Classroom flipping is the practice of moving new content instruction out of class time, usually packaging it as online videos and reading assignments for students to cover on their own, and devoting in-class time to interactive engagement activities. Flipping has garnered a large amount of hype from the popular education media and has been adopted in a variety of contexts. Despite this high amount of interest, few studies have evaluated the effectiveness of classroom flipping on student academic outcomes. Specifically, no rigorous studies of the effects of flipping a mathematics course on students' mathematical understandings and achievement appear in the literature. This article reports results from a control group study of flipping a large (N = 690), first-year university calculus course for life sciences students. Students in the flipped course sections on average outperformed their counterparts in the traditional sections on the final exam, though only by approximately 8%. A more detailed analysis reveals the true beneficiaries in a flipped classroom—those with high basic mathematical ability and low initial calculus knowledge. Gains for this group are considerable: approximately 10% on the final, with an effect size of d = 0.56, and comparable gains on an independent measure of calculus concept mastery. This study positions classroom flipping as an effective practice in undergraduate mathematics and calls for further research into the mechanisms behind its effectiveness.

Introduction

ssroom flipping is a mode of course delivery where content instruction takes place outside of class :, while in-class time is devoted to conceptual practice and interaction. The classroom-flipping lel acknowledges that most technical mastery can occur with little direct interaction with an ructor and should therefore be de-emphasized in student–instructor encounters. Concurrently, con-tual development is facilitated with social interaction, whether with peers or an instructor, and this ht to be the focus of class time.

1 Smith et al. (2014)

- 51 STEM courses
- 13 departments



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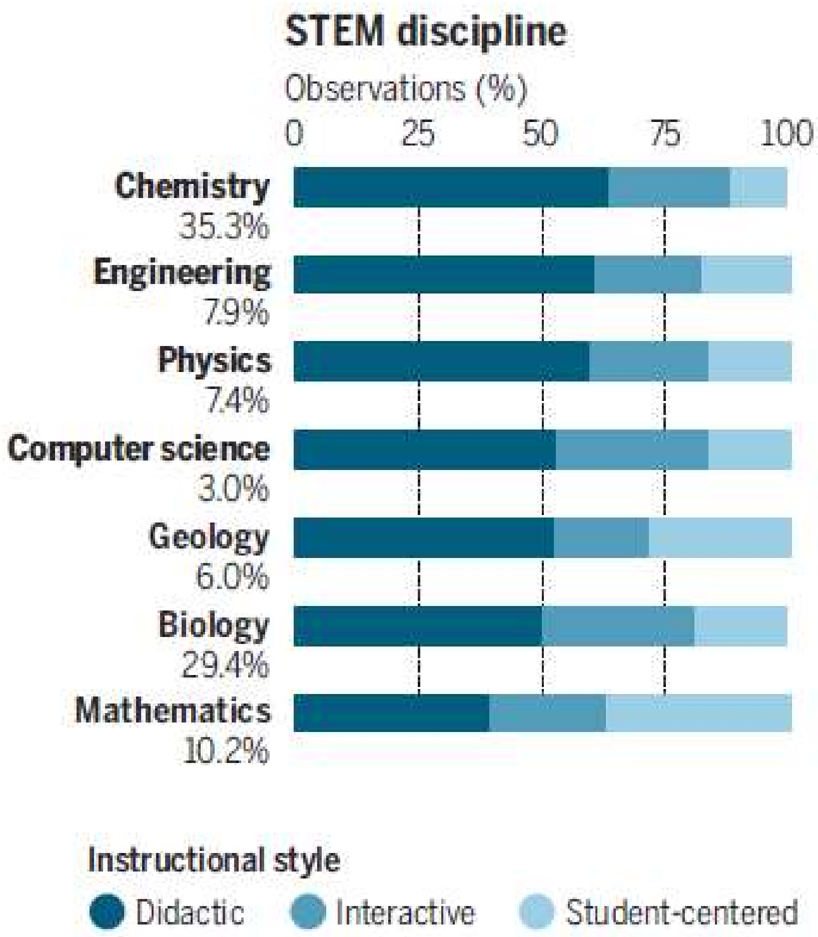
1

Stains et al. (2018)

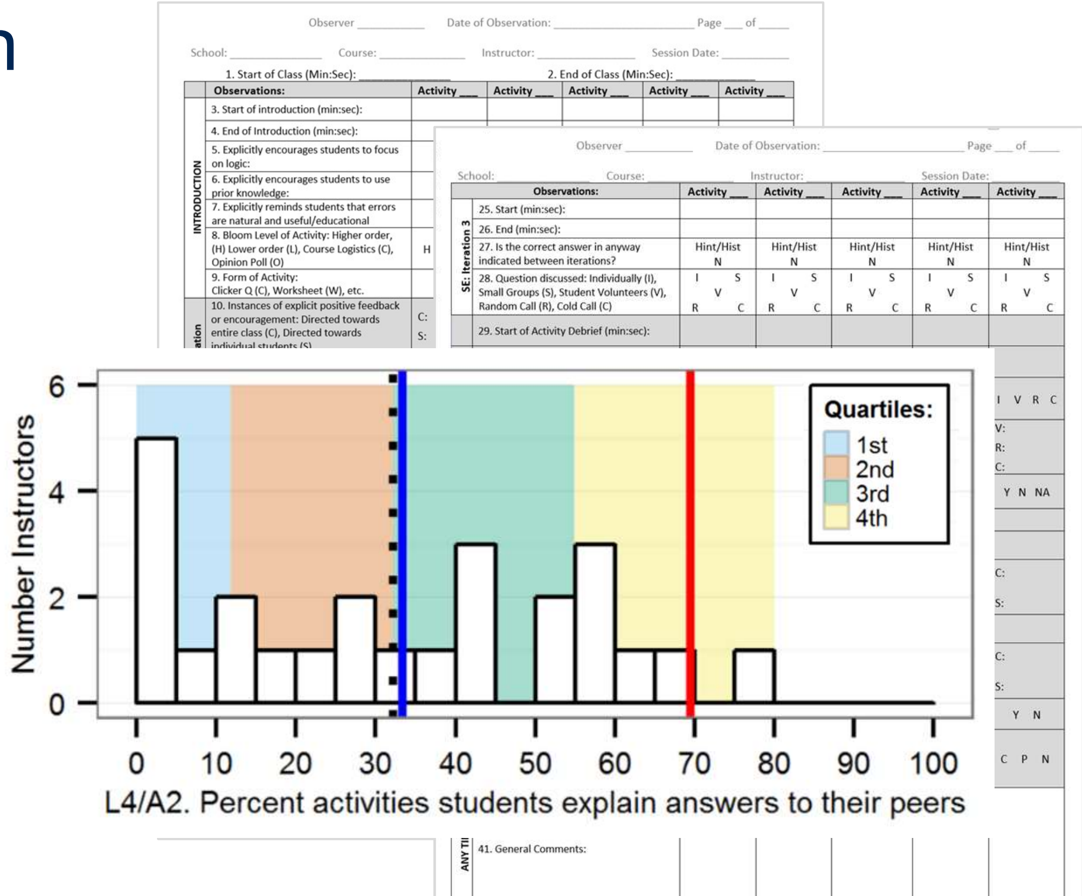
- 2008 STEM classes
  - 709 courses
  - 548 faculty
  - 25 institutions
- Cluster analysis gave 7 clusters, grouped into:
  - Didactic
  - Interactive lecture
  - Student-centred



2

PORTAAL

- Developed from literature on active learning
- Observations about distinct “activities”
- Generates scores for 21 elements, grouped into:
  - practice,
  - logic development,
  - accountability,
  - apprehension reduction.



Eddy et al. (2015)

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FILL

- Flipped classroom with Peer Instruction
- Timeline of codes, 1 second resolution

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH **12**, 010140 (2016)

Characterizing interactive engagement activities in a flipped introductory physics class

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(Received 17 February 2016; published 30 June 2016)

Interactive engagement activities are increasingly common in undergraduate physics teaching. As research efforts move beyond simply showing that interactive engagement pedagogies work towards developing an understanding of *how* they lead to improved learning outcomes, a detailed analysis of the way in which these activities are used in practice is needed. Our aim in this paper is to present a characterization of the type and duration of interactions, as experienced by students, that took place during two introductory physics courses (1A and 1B) at a university in the United Kingdom. Through this work, a simple framework for analyzing lectures—the framework for interactive learning in lectures (FILL), which focuses on student interactions (with the lecturer, with each other, and with the material) is proposed. The pedagogical approach is based on Peer Instruction (PI) and both courses are taught by the same lecturer. We find lecture activities can be categorized into three types: interactive (25%), vicarious interactive (20%) (involving questions to and from the lecturer), and noninteractive (55%). As expected, the majority of both interactive and vicarious interactive activities took place during PI. However, the way that interactive activities were used during non-PI sections of the lecture varied significantly between the two courses. Differences were also found in the average time spent on lecturer-student interactions (28% for 1A and 12% for 1B), although not on student-student interactions (12% and 12%) or on individual learning (10% and 7%). These results are explored in detail and the implications for future research are discussed.

DOI: 10.1103/PhysRevPhysEducRes.12.010140

I. INTRODUCTION

Interactive engagement activities developed through physics education research (PER) have been widely embraced by the physics teaching community [1]. Often used synonymously with the term "active learning," interactive engagement (IE) covers a range of different types of activities from individual problem solving, to working with peers, to interacting with a tutor, and there is now substantial evidence that these teaching approaches lead to better outcomes compared to traditional methods [2,3]. For example, a meta-analysis of 225 studies [3] found student performance on examinations and concept inventories increased under active learning compared to traditional lecturing.

Perhaps the most influential work in this area is a study conducted by Hake involving over 6000 students studying in 62 different introductory Newtonian mechanics courses [2]. Hake measured learning through recording the normalized gain on the Force Concept Inventory (FCI) for each course, and found that those classes which could be described as involving IE methods had substantially higher gains than those in more traditional instruction [2].

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However, Hake's results also show that even when courses involve IE, a large FCI gain is not guaranteed. He found that the gains for IE courses ranged from 0.22 to 0.70, whereas the gains for traditional courses ranged from 0.12 to 0.28. This means that for a small number of courses using IE techniques, the gain was actually smaller than the best gain achieved for the traditionally taught courses. This degree of variation implies that the exact implementation of IE can have a large influence on how successful it is. One reason for this may be the way in which instructors implement the pedagogies; for example, Dancy and Henderson found that between a quarter and one-half of instructors deviate significantly from the established design of evidence-based teaching approaches [4]. These results imply that a much more detailed understanding of IE teaching is needed if progress is to be made in optimizing outcomes from these strategies. Research on the efficacy of active learning approaches, such as those described, generally uses a broad definition. For example, Freeman *et al.* [3] describe it as something which

> *"engages students in the process of learning through activities and or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work."*

Similarly the definition of "interactive engagement" given

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FILL

Code	Description	Interactivity
Ltalk	Lecturer talking	Non-interactive
LQ	Lecturer question, student answer	Vicarious interactive
SQ	Student question, lecturer answer	
S-Thinking	Student silent thinking	Interactive
Feedback	Feedback on PI voting	
SS-Disc	Student-student discussion	

Wood et al. (2016)

3

FILL

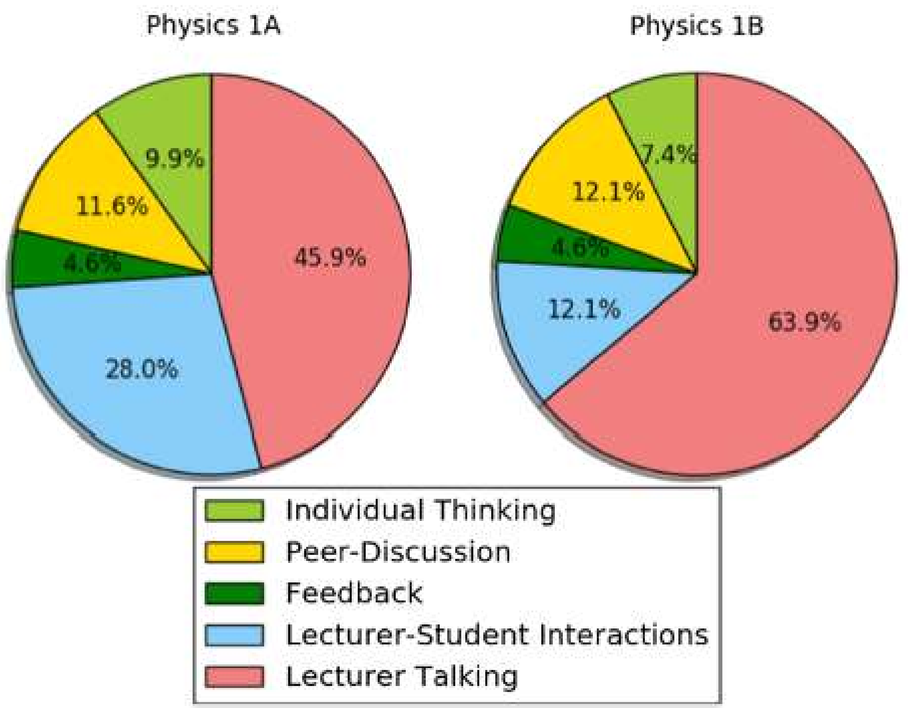

FIG. 2. Types of interaction for 1A and 1B.

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Wood et al. (2016)

Project overview

About the project

Mathematics	George Kinnear
	Pamela Docherty
Physics	Ross Galloway
Veterinary Science	Jill MacKay
	Susan Rhind
	Steph Smith

+ Ross Anderson, Thomas Gant

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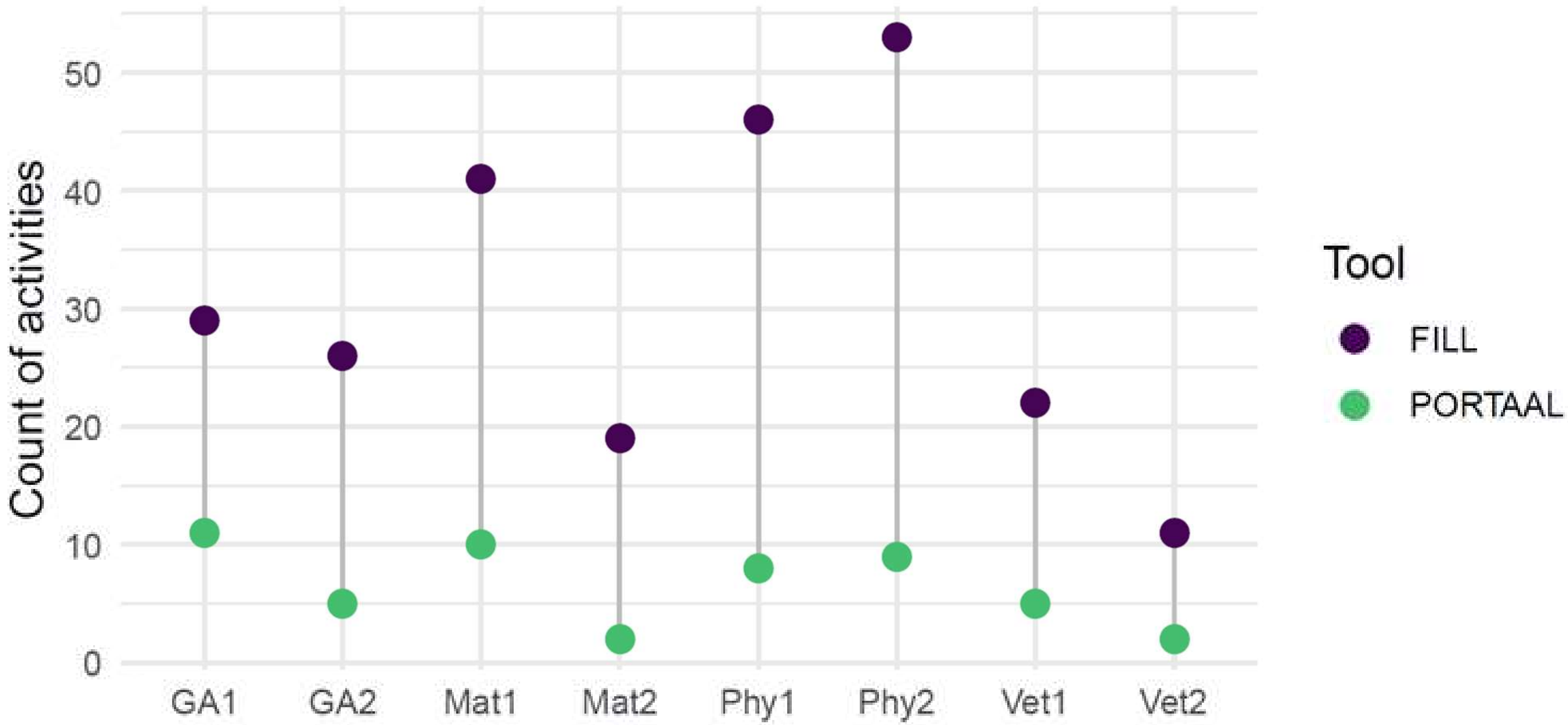
Research questions

1. To what extent do FILL and PORTAAL align (and apply across disciplines)?
2. Can classroom observation be carried out reliably using lecture recordings?
3. What patterns of classroom practices are in use at the University of Edinburgh?

Comparing FILL and PORTAAL



FILL+

- Same 1-second resolution as FILL
- New codes:
  - “Class question” rather than “clicker question”
  - Separating question and response

Interactivity	Code	Description
Non-interactive	AD	Admin
	LT	Lecturer talk
Vicarious interactive	LQ	Lecturer question
	SR	Student response
	SQ	Student question
	LR	Lecturer response
Interactive	CQ	Class question
	ST	Student thinking
	SD	Student discussion
	FB	Feedback

FILL+

FILL+
Training Manual

April 2020

Steph Smith
Ross Anderson
Thomas Gant
George Kinnear

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FILL+ Training Manual

Table 1: FILL+ ethogram

Interactivity	Code	Name	Description
NON	AD	Admin	Non-subject material, administration only. Examples would include discussion of upcoming assessments, or of the class timetable. Where the lecturer gives an overview of course content, e.g. what topics will be covered in this lecture (or subsequent lectures), this would be LT since it involves subject material.
NON	LT		Lecturer talking to the class. This can include discussion related to a question, e.g. how to answer the
VIC	LQ		
VIC	SR		
VIC	SQ		

FILL+ Training Manual

Table 1 continued.

Interactivity	Code	Name	Description
VIC	LR	Lecturer response	Response from lecturer to input from an individual student (SQ or SR), which may be directed to the individual student or to the whole class. This includes restating and elaborating on the SQ. However, if the lecturer response is itself a (non-rhetorical) question (including re-asking the SQ to the class), code as LQ instead. Response to input from the whole class (i.e. following a CQ) should be coded as FB. If a lecturer responds when it's not expected (e.g. offering encouragement by nodding/saying "yes" while student is talking) and it's less than a second, don't count it.
INT	CQ	Class question	Any question that invites (and gets) response from more than one student (and typically most/all of the class), using some form of audience response system such as "clickers", showing coloured cards, show of hands, etc. Starts when it is clearly apparent (to the student) that such a question is being asked, e.g. that a clicker question is going to be opened up and delivered or a lecturer starts asking a question that asks for a response from many. Transition away from this code (e.g. to ST or SD) when the lecturer has completed saying the question for the first time, unless the lecturer continues to elaborate on the question in such a way that the students would be expected to be listening rather than thinking/discussing. If the lecturer is using an audience response system and does not say the question, then start CQ when the question first appears to the students and allocate at least 1 second to CQ before moving on to the next state.
INT	ST	Student thinking	Students individually thinking about and answering a CQ when instructed to do so, whether using clickers, show of hands, etc. Ends when timer stops or lecture stops the student thinking.
INT	SD	Student discussion	Student-to-student discussion when instructed to do so. This is for interactive activities, preceded by CQ (typical after CQ/ST/FB). Ends when timer stops or lecturer stops student discussion.
INT	FB	Feedback	Response to activity that students have completed, either out of class (e.g. weekly quiz) or during class (e.g. clicker question). Addresses a question the 'whole class' had invested an answer in. Only includes discussion of student answers and does not include an explanation on how to actually answer the question (see LT). Note that the lecturer may return to FB when confirming the correct answer, after a period of LT explaining the solution.

Page **6** of **16**

3. Coding Example

The details of FILL+ described in the previous section will become more apparent by actually watching a lecture and seeing the ethogram being applied. The following video gives you an example of how to use FILL+ to score a 10 minute clip from a recorded lecture, with running commentary on why particular codes have been chosen.

https://media.ed.ac.uk/media/FILL%2B+TrainingA+Demonstration/1_tsojd73v

The original file without commentary is available to watch following this to observe the transitions between state without interruption (and with the guide of the scores given in Table 2).

https://media.ed.ac.uk/media/FILL%2B+TrainingA+Demonstration+%28no+commentary%29/1_tvcnshlg

Table 2: Example Video scores

Time started	Time finished	Time elapsed	Type of interaction
00:00:00	00:02:32	00:02:32	LT
00:02:32	00:02:54	00:00:22	CQ
00:02:54	00:03:49	00:00:55	ST
00:03:49	00:04:06	00:00:17	FB
00:04:06	00:06:57	00:02:51	SD
00:06:57	00:07:27	00:00:30	FB
00:07:27	00:09:59	00:02:32	LT
00:09:59	00:10:01	00:00:02	LQ
00:10:01	00:10:05	00:00:04	SQ
00:10:05	00:11:01	00:00:56	LR
00:11:01	00:11:09	00:00:08	SQ
00:11:09	00:11:19	00:00:10	LR
00:11:19	00:11:19	00:00:00	END

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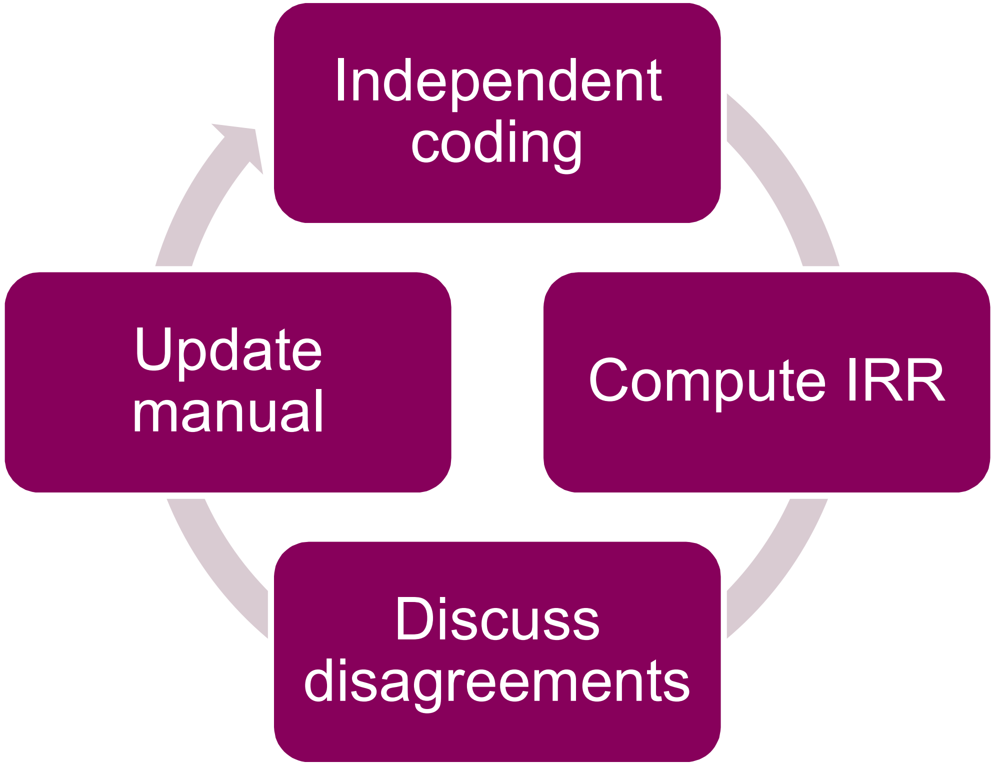
https://osf.io/vrp7m/

Data

Discipline	Course/lecturer combinations	Number of lectures
Biology	2	4
Chemistry	2	12
Mathematics	21	108
Physics	9	60
Vet Science	9	50
	43	**234**

Reliability (I)

- Three coders
- Iterative approach:
- Carried out at start, middle, end



Reliability (II)

Training ▶ **Coding** ▶ **Coding** ▶ **Coding**

Training

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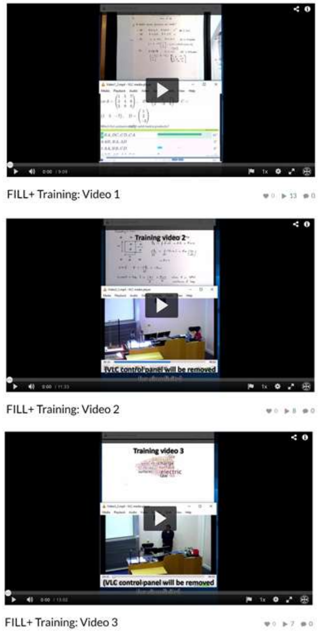


Coding

ILA 1

ILA 2

ILA 3

Coding

PFM 1

PFM 2

PFM 3

Coding

PFM 4

Results

Reliability

- Three coders by end of summer:

Measure	Percent agreement	Krippendorff's Alpha	AC1
Inter-rater	95.7	0.852	0.956
Intra-rater	96.5	0.849	0.965

Reliability

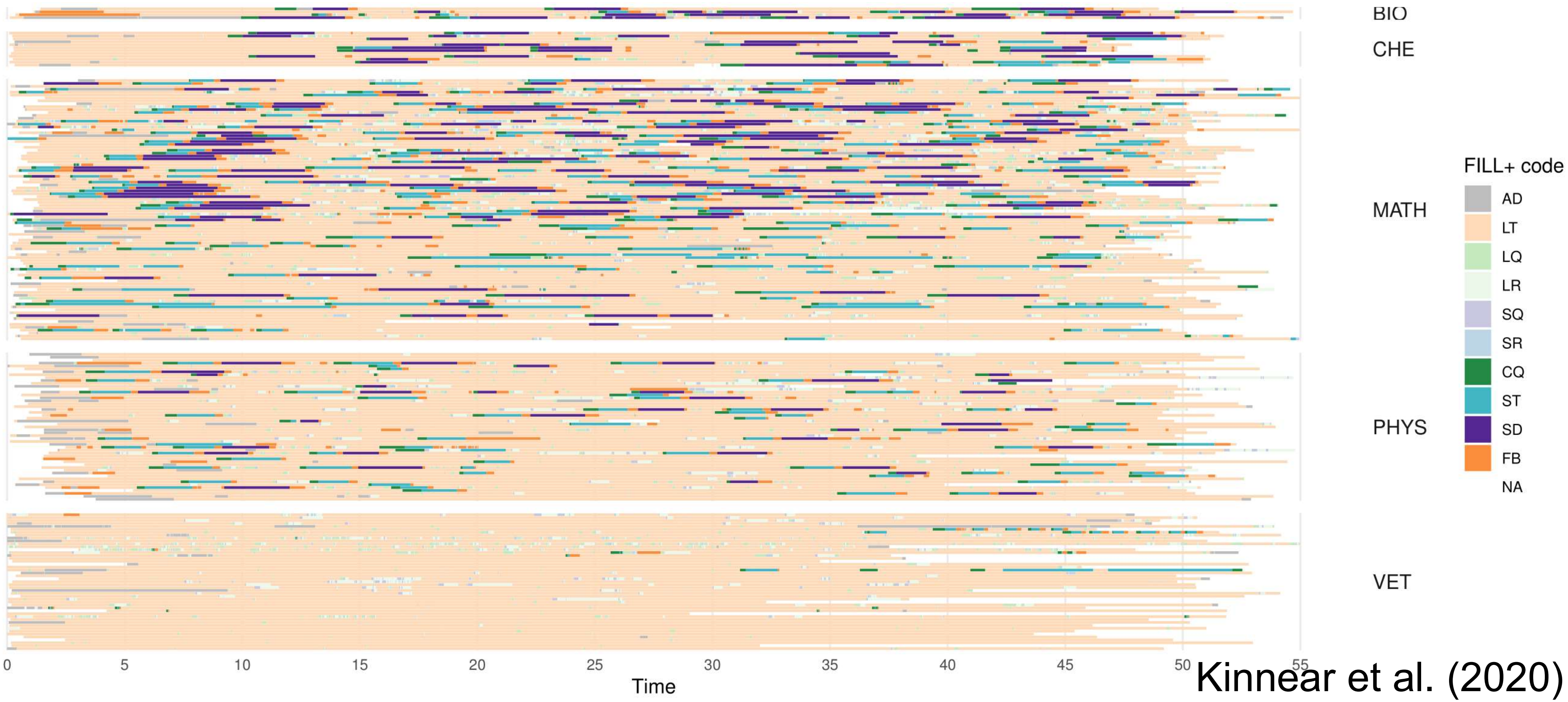
- Three novice coders:

	Training	··· ▶	Coding
Agreement with model answer	88%		93%
Krippendorff's Alpha			0.820
AC1			0.878

2. Can classroom observation be carried out reliably using lecture recordings? ✓

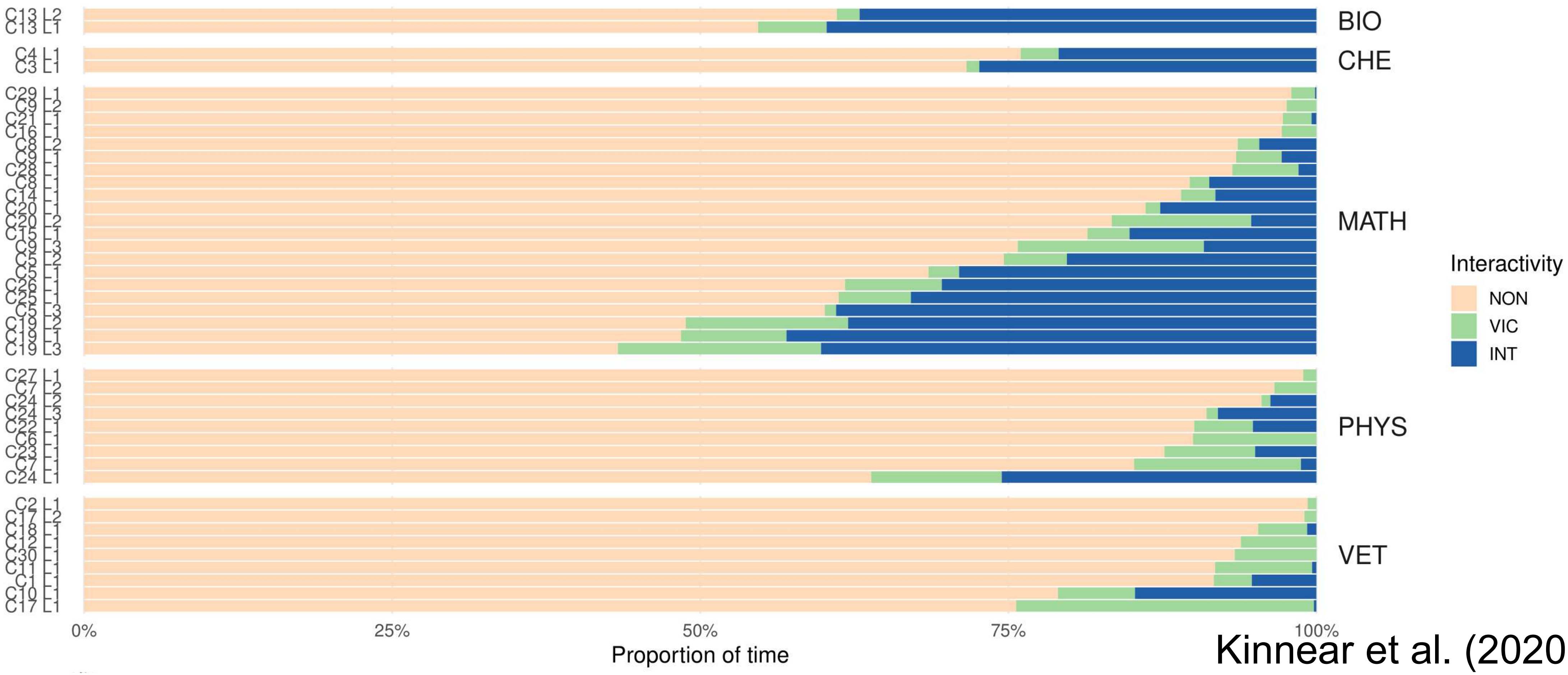
3. What patterns of classroom practices are in use at the University of Edinburgh?

Course profiles



Kinnear et al. (2020)

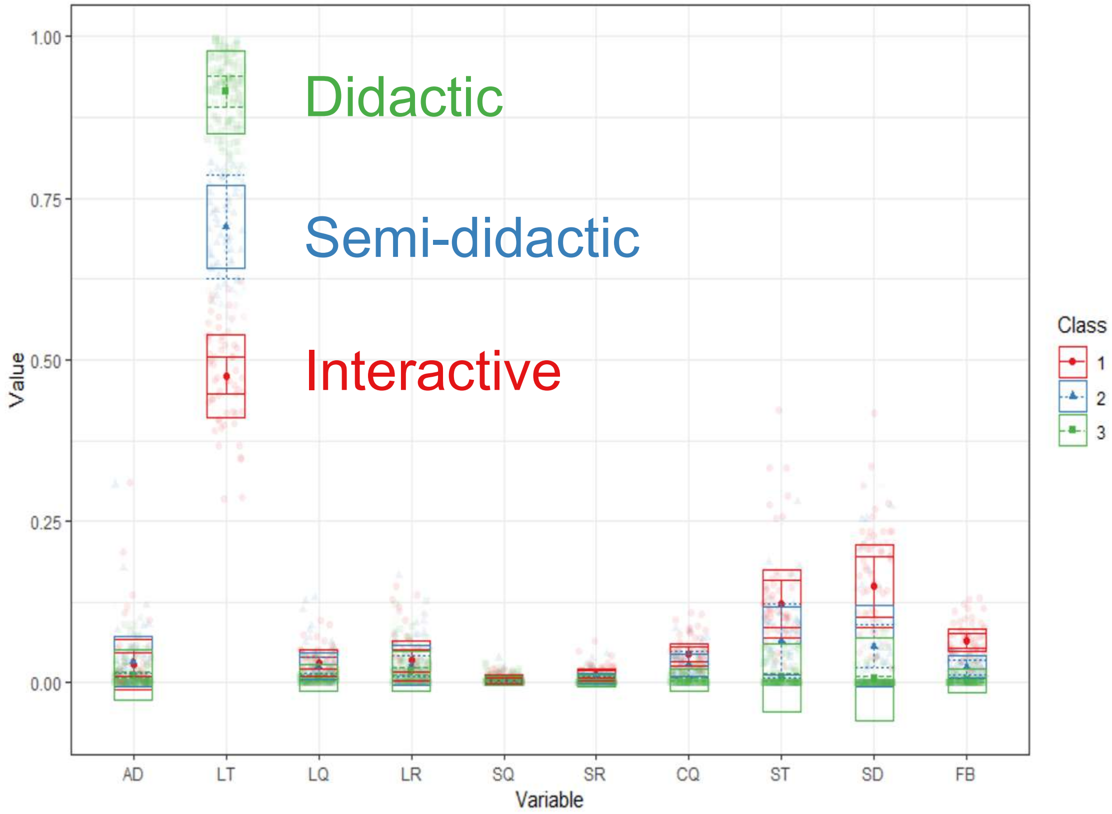
Interactivity



Kinnear et al. (2020)

Cluster analysis

- UG project group
- Replicating method of Stains et al. (2018)
- Found 3 clusters (proportion of LT high/med/low)



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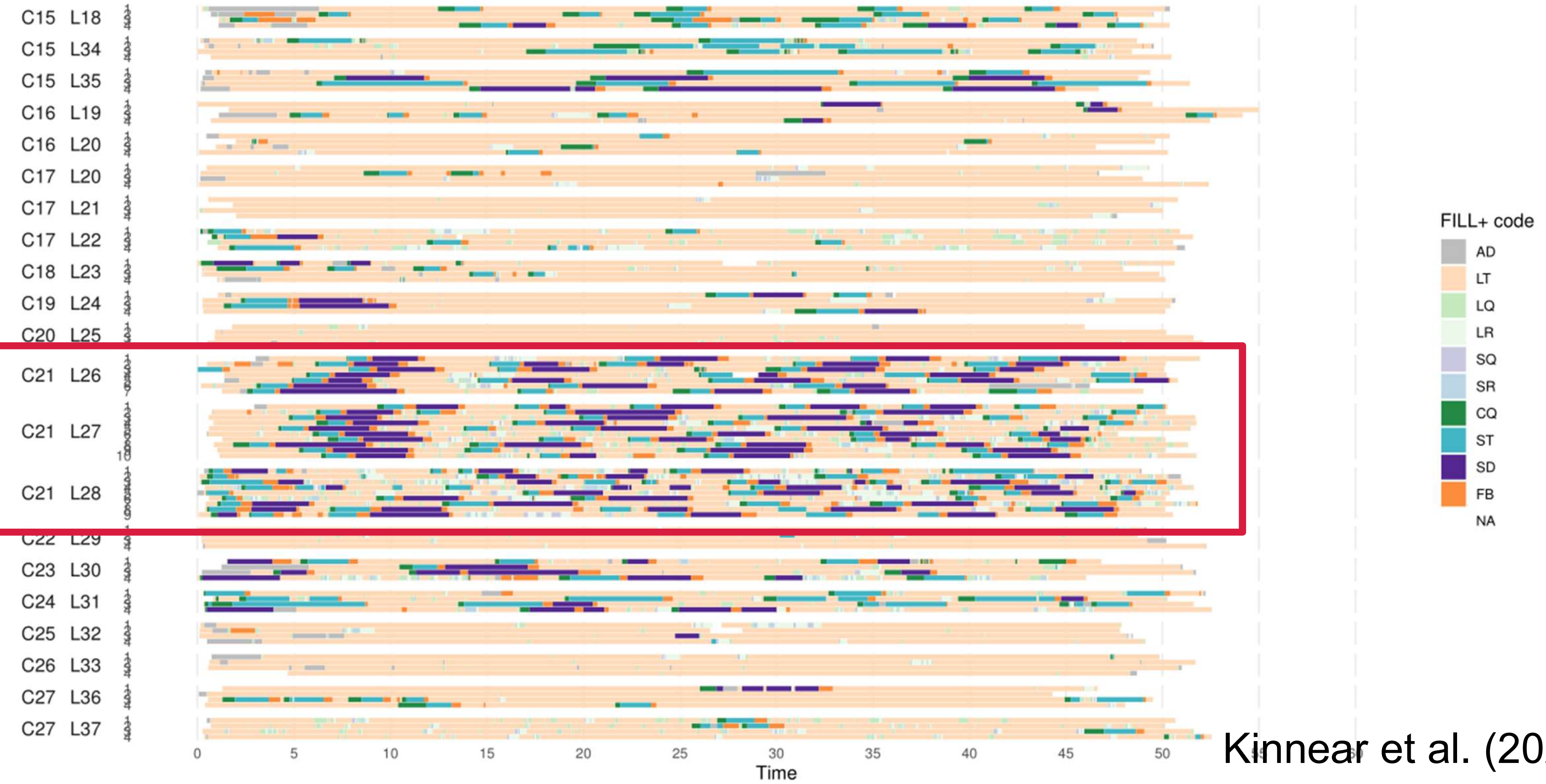
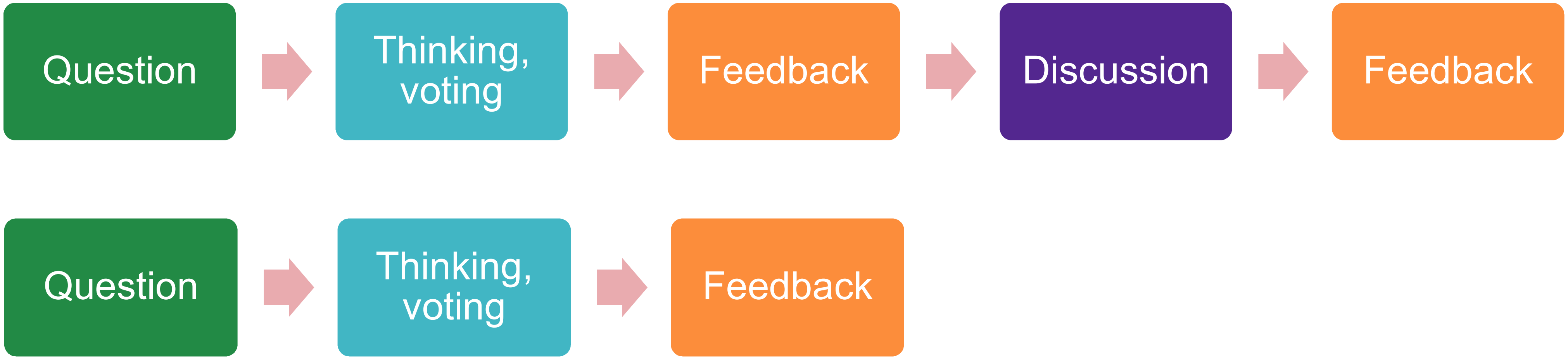
Mathematics lectures

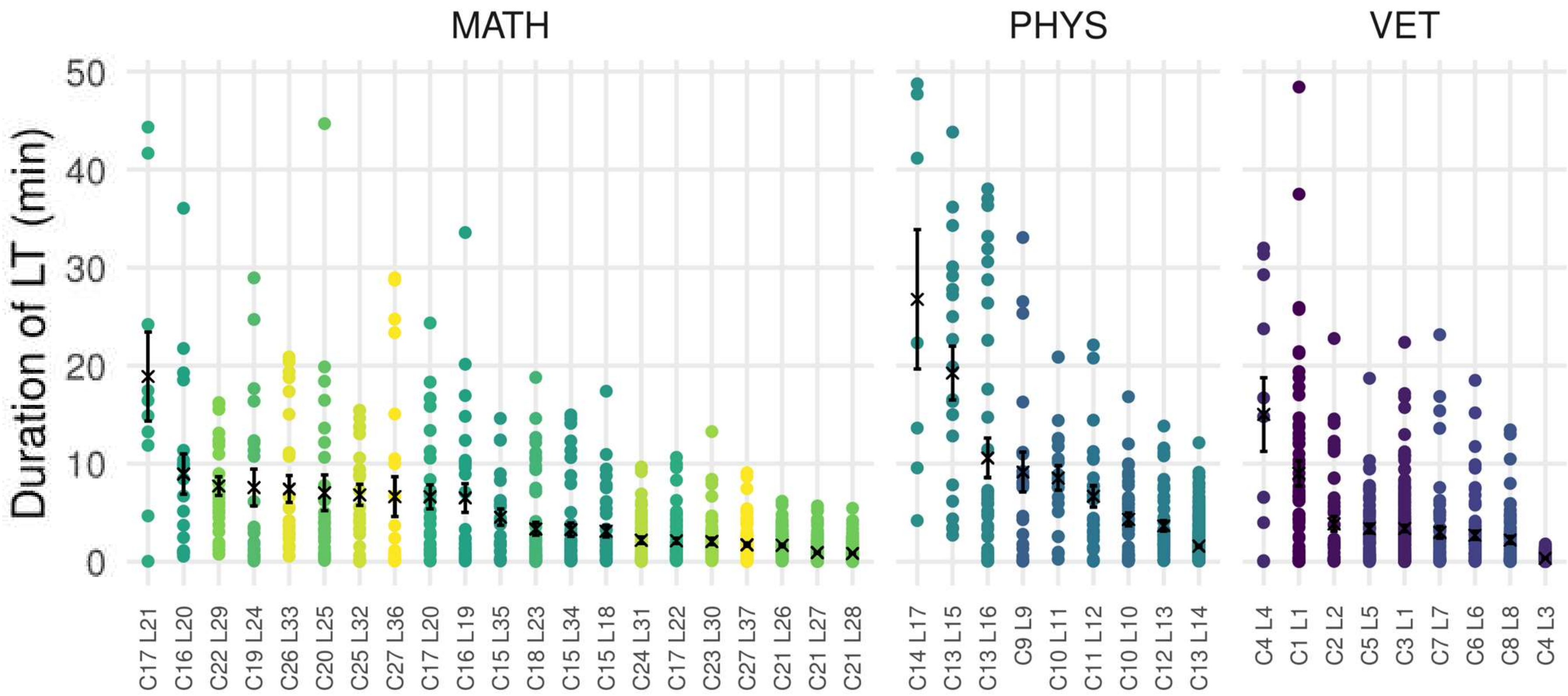


Kinnear et al. (2020)

Peer Instruction



Duration of LT



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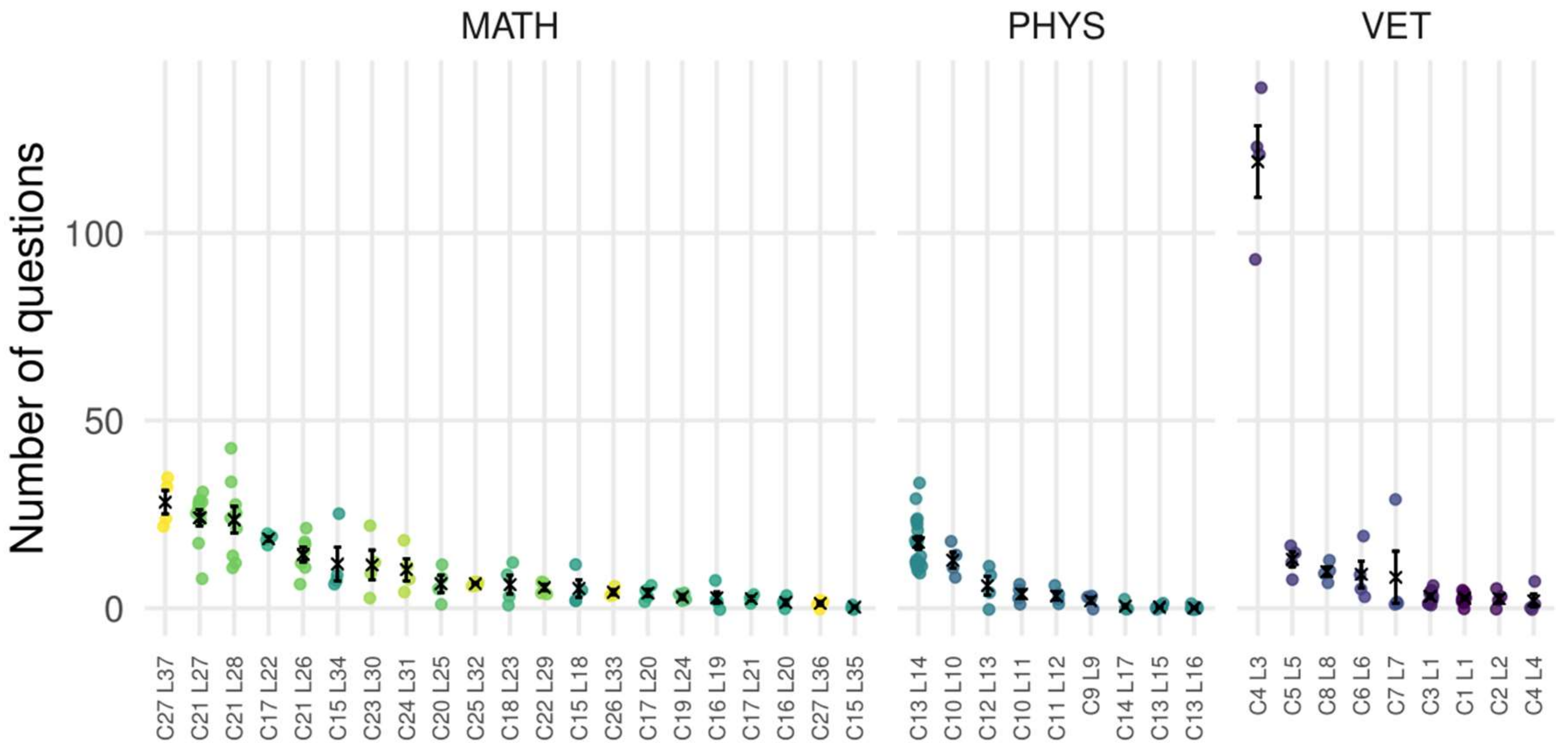
Kinnear et al. (2020)

Lecturer questions



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Kinnear et al. (2020)

Future directions

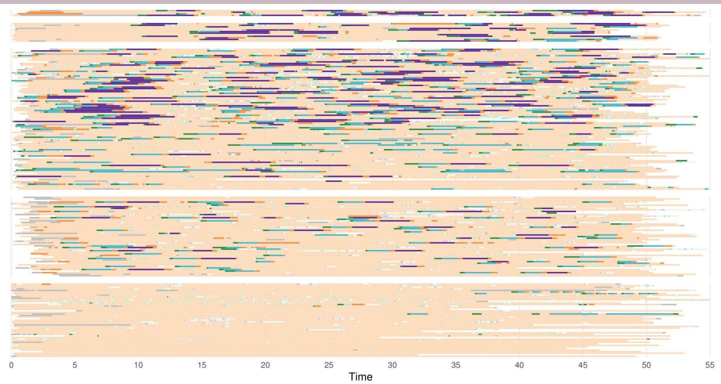
Comparison with COPUS

Questioning

Teacher intentions

Comparison with COPUS

FILL+	COPUS



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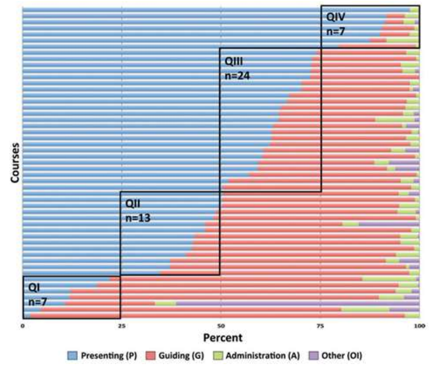
?



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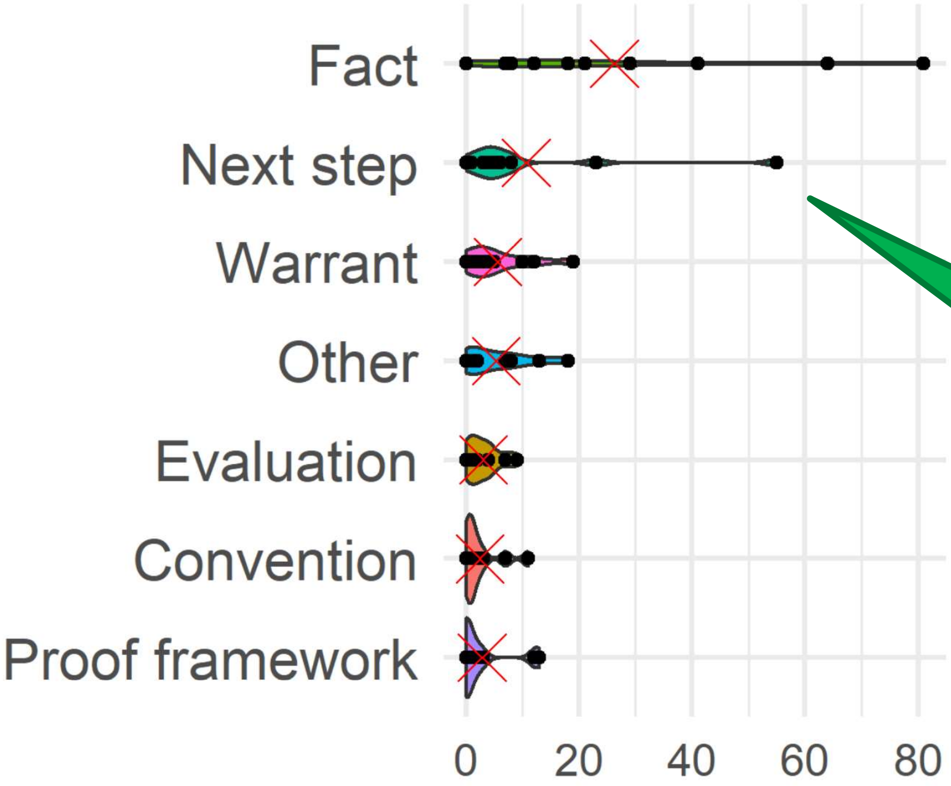
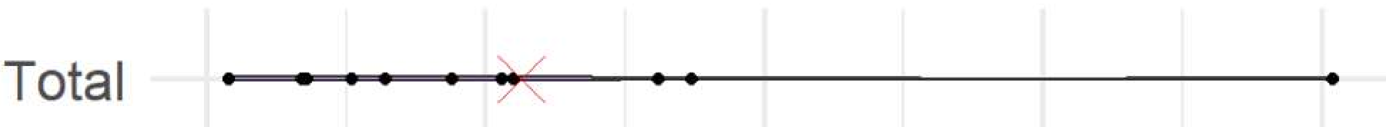
Lecturer questions





Do you remember what Cauchy means, for a sequence to be Cauchy?

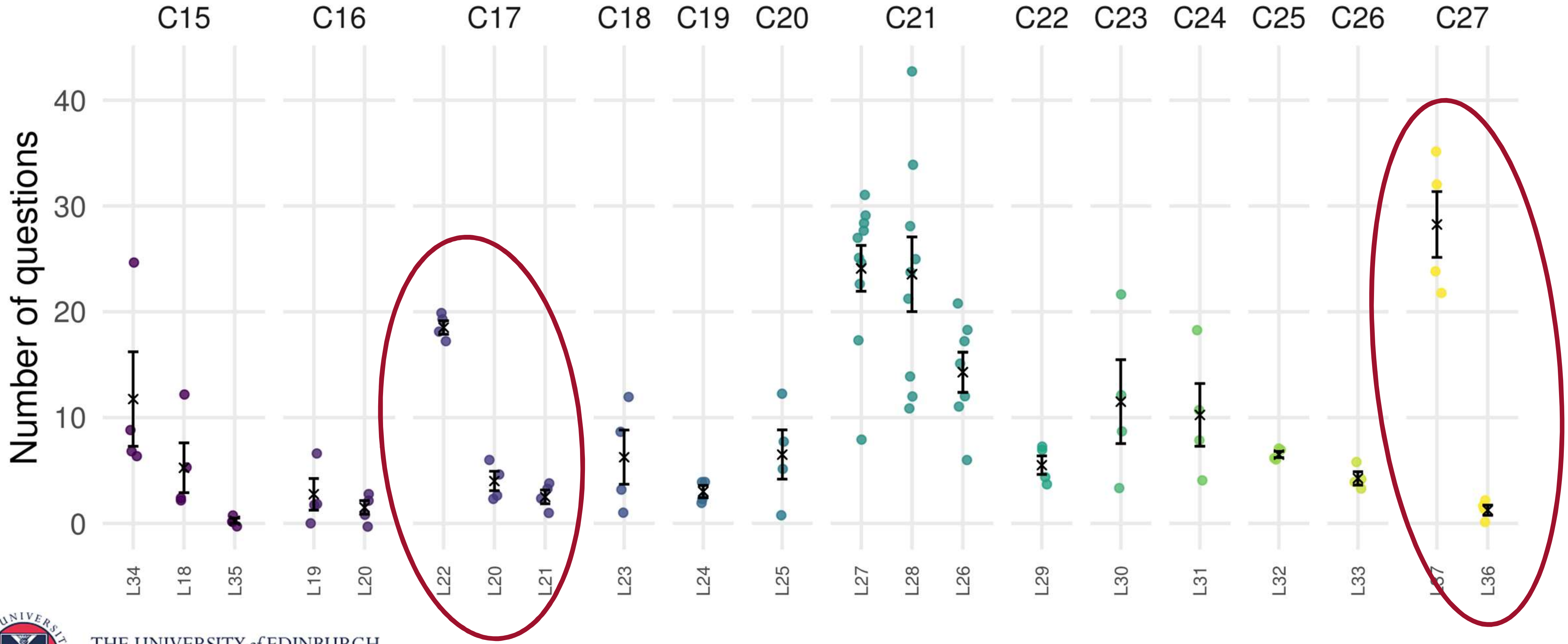
A’C′ is equal to kAC and B’C’ is equal to kBC. Therefore, now what?

Educ Stud M
https://doi.o

Teacher questioning and invitations to participate in advanced mathematics lectures

Abstract We were interested in exploring the extent to which advanced mathematics lecturers provide students with opportunities to play a role in considering or generating course content. To do this, we examined the questioning practices of 11 lecturers who taught advanced mathematics courses at the university level. Because we are unaware of other studies examining advanced mathematics lecturers’ questioning, we first analyzed the data using an open coding scheme to categorize the types of content lecturers solicited and the opportunities they provided students to participate in generating course content. In a second round of analysis, we examined the extent to which lecturers provide students with opportunities to generate mathematical contributions and to engage in reasoning that researchers have identified as
ht that, although lecturers asked
tunities for students to participate
ally, we provide several examples
generate important contributions.
research.

Lecturer questions



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Lecturer questions

Paoletti et al. (2018)	Kinnear et al. (2020)
"56 questions per 80-min lecture"	mean of 10.7 per 50-min session
0.7 per minute	**0.2 per minute**

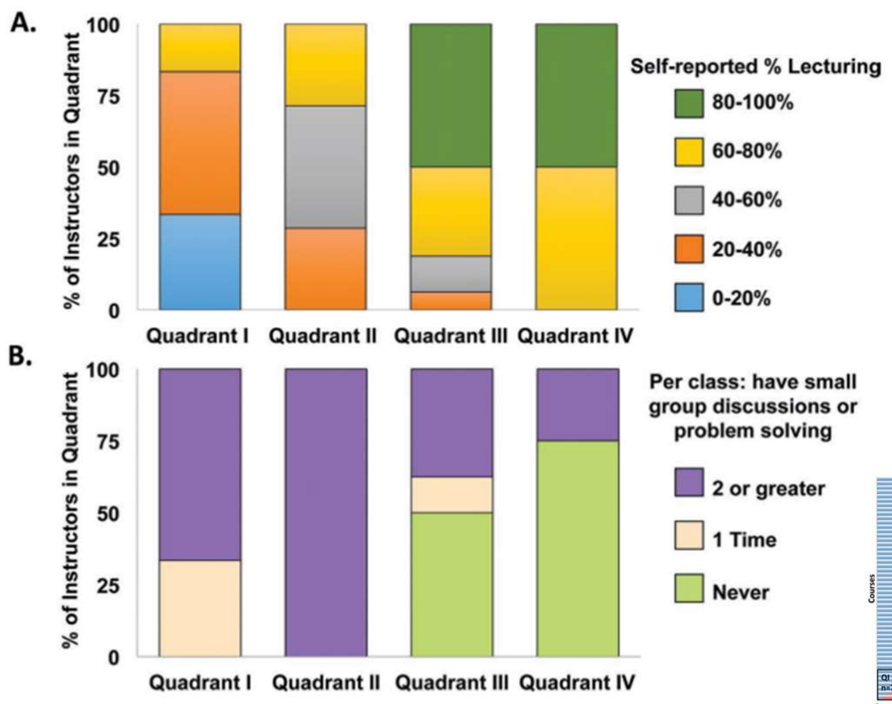
- Class size as moderator?
- Further replication of Paoletti et al. (2018)
  - question content
  - wait time

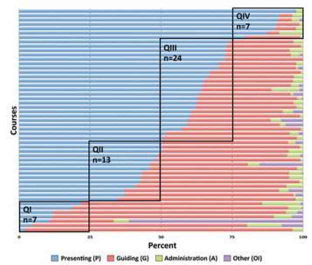
Teacher intentions

- Teaching Practices Inventory (Wieman & Gilbert, 2014)
- Comparing this with actual practice
  - Smith et al. (2014) compared with COPUS

Give approximate average number:

Average number of times per class: pause to ask for questions ____________





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Conclusion

- FILL+ is a reliable (and efficient) classroom observation protocol
- It gives a wealth of data to analyse practices in detail

Thank you!

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