

# Lessons from online teaching and the new normal



Digital Transformation and AI in Higher Education  
Project VISION  
28 June 2023

# Lessons from online teaching and the new normal



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Project VISION  
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Weekend long reads



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Life & Arts

# Yuval Noah Harari: the world after coronavirus

This storm will pass. But the choices we make now could change our lives for years to come

Yuval Noah Harari MARCH 20 2020

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- 
- 
- 

Humankind is now facing a global crisis. Perhaps the biggest crisis of our generation. The decisions people and governments take in the next few weeks will shape the years to come. They will shape not just our lives but the world we live in. We must act



Many short-term emergency measures will become a fixture of life. That is the nature of emergencies. They fast-forward historical processes. Decisions that in normal times could take years of deliberation are passed in a matter of hours. Immature and even dangerous technologies are pressed into service, because the risks of doing nothing are bigger. Entire countries serve as guinea-pigs in large-scale social experiments. What happens when everybody works from home and communicates only at a distance? What happens when entire schools and universities go online? In normal times, governments, businesses and educational boards would never agree to conduct such experiments. But these aren't normal times.



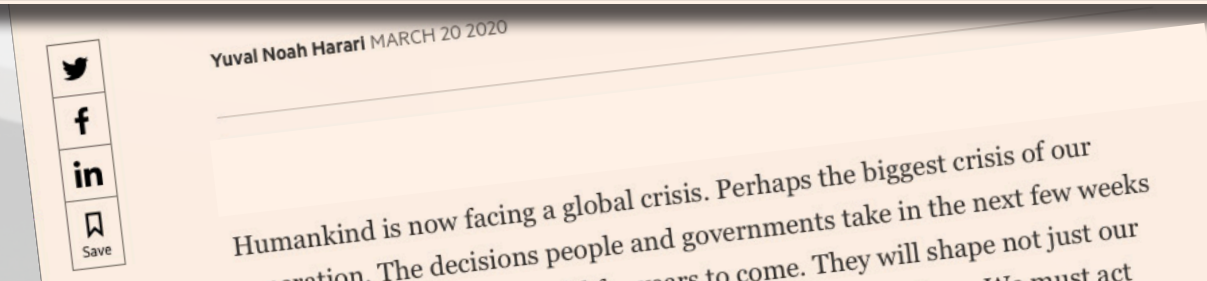


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## Will online teaching become a fixture of life?

What happens when everybody works from home and communicates only at a distance? What happens when entire schools and universities go online? In normal times, governments, businesses and educational boards would never agree to conduct such experiments. But these aren't normal times.





# The Results Are In for Remote Learning: It Didn't Work

The pandemic forced schools into a crash course in online education. Problems piled up quickly. 'I find it hectic and stressful'

Lucia Curatolo-Boylan supervises the online schooling of her four children, ages 4 to 10, in Staten Island, N.Y. KEVIN HAGEN FOR THE WALL STREET JOURNAL

lkbeat

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IDEAS

# Remote Learning Is a Bad Joke

My kid can't handle a virtual education, and neither can I.

AUGUST 18, 2020

**Emily Gould**

Author and essayist



RECOMMEN  
READING

Put Anthony Fauci in  
Dunk Tank

CONOR FRIEDERSDORF

Why Millennials Can  
Up

A group of students is gathered around a white circular table in a classroom or computer lab. Several laptops are open on the table, and students are looking at the screens. In the background, other students are working at desks. The scene is brightly lit with natural light from windows. A large, bold, black text overlay is centered over the image.

**The reason? Bad pedagogy!**



**information  
transfer**

**sense-making**

# Traditional model

**class**

**information  
transfer**

**home**

**sense-making**



# Traditional model

**class**

**information  
transfer**

instructor-paced  
synchronous  
lecture

**home**

**sense-making**

self-paced  
asynchronous  
homework/study

# Traditional model online

**class**

**information  
transfer**



**home**

**sense-making**

instructor-paced  
synchronous  
lecture

self-paced  
asynchronous  
homework/study

# Traditional model online

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lecture

home

information  
transfer

instructor-paced  
synchronous  
**online** lecture

home

sense-making

self-paced  
asynchronous  
homework/study

# Traditional model online

class

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transfer

instructor-paced  
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home

information  
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instructor-paced  
**asynchronous**  
**recorded** lecture

home

sense-making

self-paced  
asynchronous  
home work/study

# Traditional model online

class

information  
transfer

instructor-paced  
synchronous  
lecture

home

information  
transfer

instructor-paced  
**asynchronous**  
**recorded** lecture

home

sense-making

self-paced  
asynchronous  
home work/study

**all alone!**

A group of students in a classroom or computer lab, with the text "Small wonder!" overlaid. The scene shows several students sitting at desks with laptops, engaged in various activities. In the foreground, a student is looking at a laptop screen displaying a website. Other students are visible in the background, some working on laptops and others talking. The overall atmosphere is one of active learning and collaboration.

**Small wonder!**

# Traditional model

**class**

**information  
transfer**

**home**

**sense-making**

# Flipped model

**home**

**information  
transfer**

**class**

**sense-making**



# Flipped model

**home**

**information  
transfer**

self-paced  
asynchronous

**class**

**sense-making**

instructor-led  
synchronous  
& **interactive**

# Flipped model

**home**

**information  
transfer**

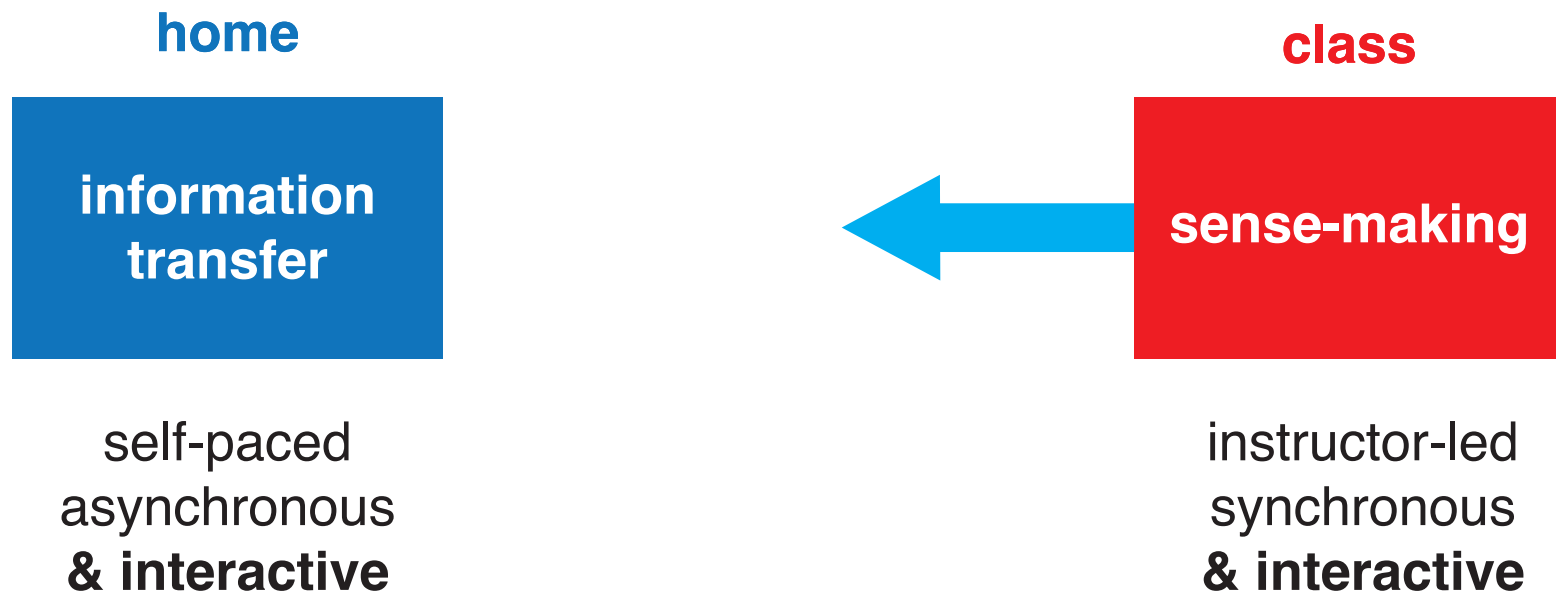
self-paced  
asynchronous  
& **interactive**

**class**

**sense-making**

instructor-led  
synchronous  
& **interactive**

# Flipped model online



# Flipped model online

home

**information  
transfer**

self-paced  
asynchronous  
& **interactive**

home

**sense-making**

instructor-led  
synchronous  
& **interactive**

class

**sense-making**

instructor-led  
synchronous  
& **interactive**

# Flipped model online

home

information  
transfer

self-paced  
asynchronous  
& interactive

home

sense-making

instructor-led  
synchronous  
& interactive

class

sense-making

instructor-led  
synchronous  
& interactive

**fully  
interactive**



# 1 pandemic lessons



**1** pandemic lessons

**2** new normal



**1** pandemic lessons

**2** new normal

**3** self-paced PI



# Optimize instructional face-to-face time

A group of students in a classroom setting, focused on their laptops and engaged in discussion. The students are seated at a round table, with several laptops open in front of them. One student in the foreground is looking at a laptop screen displaying a website with the text "learning catalysis". Other students are looking at their laptops or talking to each other. The background shows more students and a teacher standing near a whiteboard.

# Optimize instructional face-to-face time

home

information  
transfer

self-paced  
asynchronous  
& interactive

home

sense-making

instructor-led  
synchronous  
& interactive

class

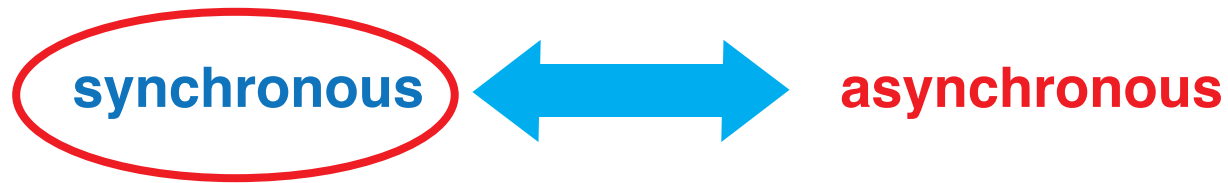
sense-making

instructor-led  
synchronous  
& interactive

# Optimize instructional face-to-face time

synchronous ↔ asynchronous

# Optimize instructional face-to-face time



**everybody together  
at the same *time***

# Optimize instructional face-to-face time

synchronous



asynchronous

instructor-paced



self-paced

# Optimize instructional face-to-face time

synchronous



asynchronous

instructor-paced



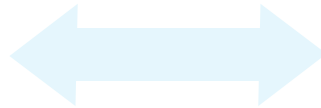
self-paced

everybody together  
at the same *pace*

# Optimize instructional face-to-face time

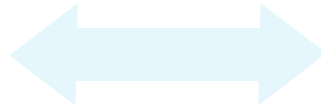
lecture

synchronous



asynchronous

instructor-paced

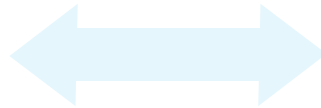


self-paced

# Optimize instructional face-to-face time

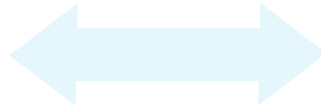
recorded lecture

synchronous



asynchronous

instructor-paced



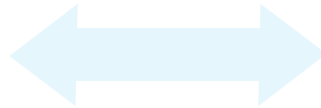
self-paced



# Optimize instructional face-to-face time

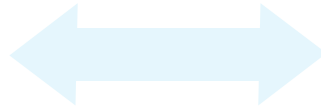
recorded lecture

synchronous



asynchronous

instructor-paced



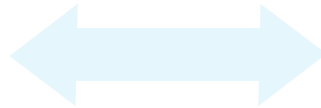
self-paced

**1.5x!**

# Optimize instructional face-to-face time

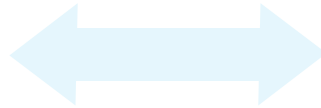
lab

synchronous



asynchronous

instructor-paced

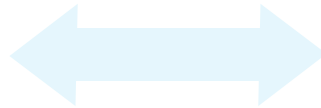


self-paced

# Optimize instructional face-to-face time

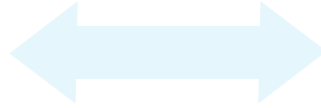
homework/study

synchronous



asynchronous

instructor-paced



self-paced

# Optimize instructional face-to-face time

synchronous



asynchronous

instructor-paced



self-paced

# Optimize instructional face-to-face time

synchronous



asynchronous

instructor-paced



self-paced

# Optimize instructional face-to-face time

synchronous



asynchronous

instructor-paced



self-paced

**more time to help students  
where it really matters!**



**Try this exercise!**

# Optimize team face-to-face time

**synchronous**

**collaborative work**



# Optimize team face-to-face time

**synchronous**

**collaborative work**

- not all students engaged
- inefficient team work
- poor use of staff time
- no quality control

# Optimize team face-to-face time

**synchronous**

**collaborative work**

- not all students engaged
- inefficient team work
- poor use of staff time
- no quality control

**asynchronous**

**individual  
work**

# Optimize team face-to-face time

**synchronous**

**collaborative work**

- not all students engaged
- inefficient team work
- poor use of staff time
- no quality control

**asynchronous**

**individual  
work**



**synchronous**

**team  
work**

# Optimize team face-to-face time

**synchronous**

**collaborative work**

- not all students engaged
- inefficient team work
- poor use of staff time
- no quality control

**asynchronous**

**individual  
work**



**synchronous**

**team  
work**



**team  
check**

# Optimize team face-to-face time

**synchronous**

**collaborative work**

- not all students engaged
- inefficient team work
- poor use of staff time
- no quality control

**asynchronous**

**individual  
work**

**all engaged**



**team  
work**

**efficient team**



**team  
check**

**quality control**

**synchronous**

# Establish continuous accountability



**Inside Higher Ed, *Yes, Virginia, there is a better way to grade***

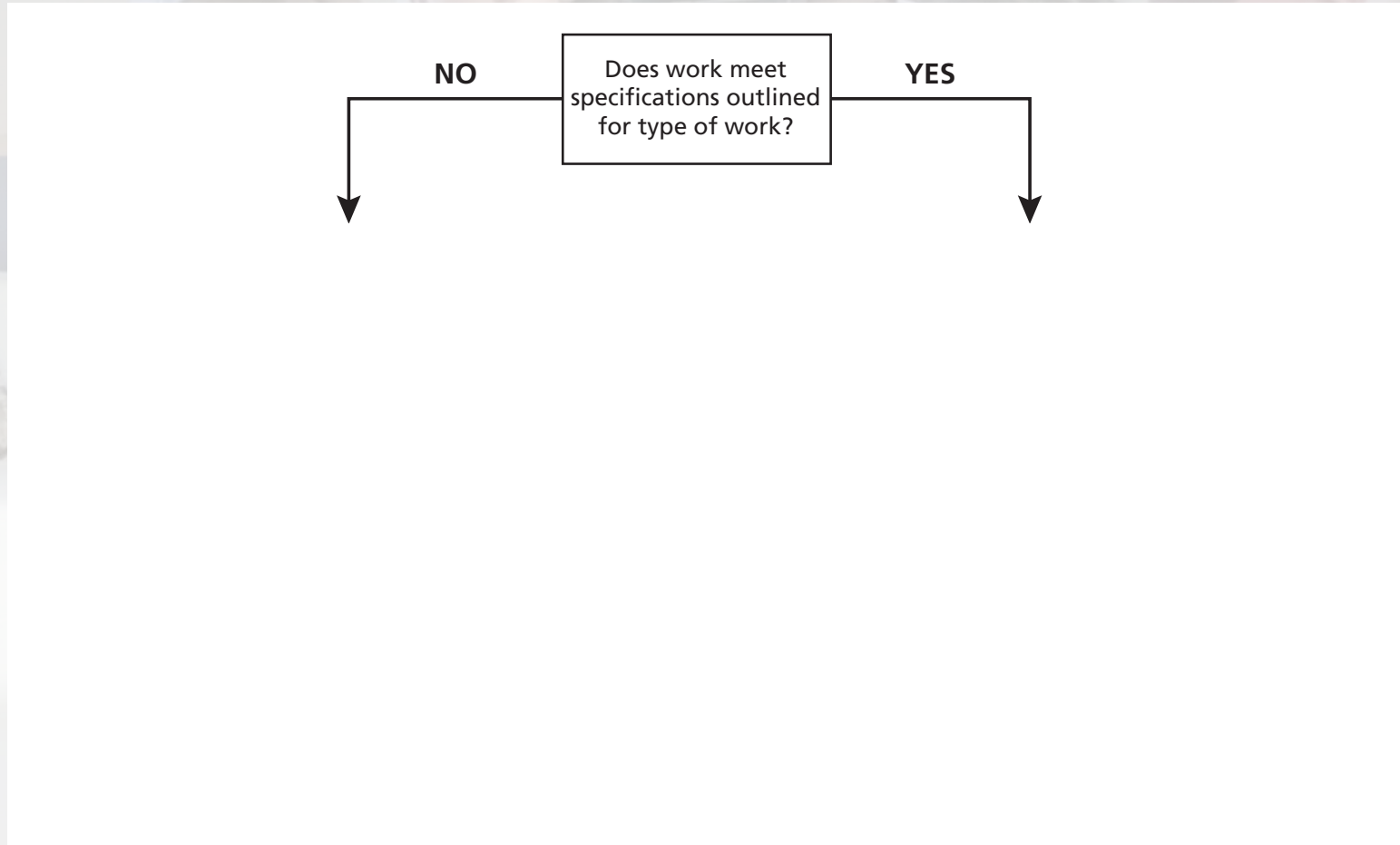


**Establish continuous accountability**

**Specifications grading**

**Inside Higher Ed, *Yes, Virginia, there is a better way to grade***

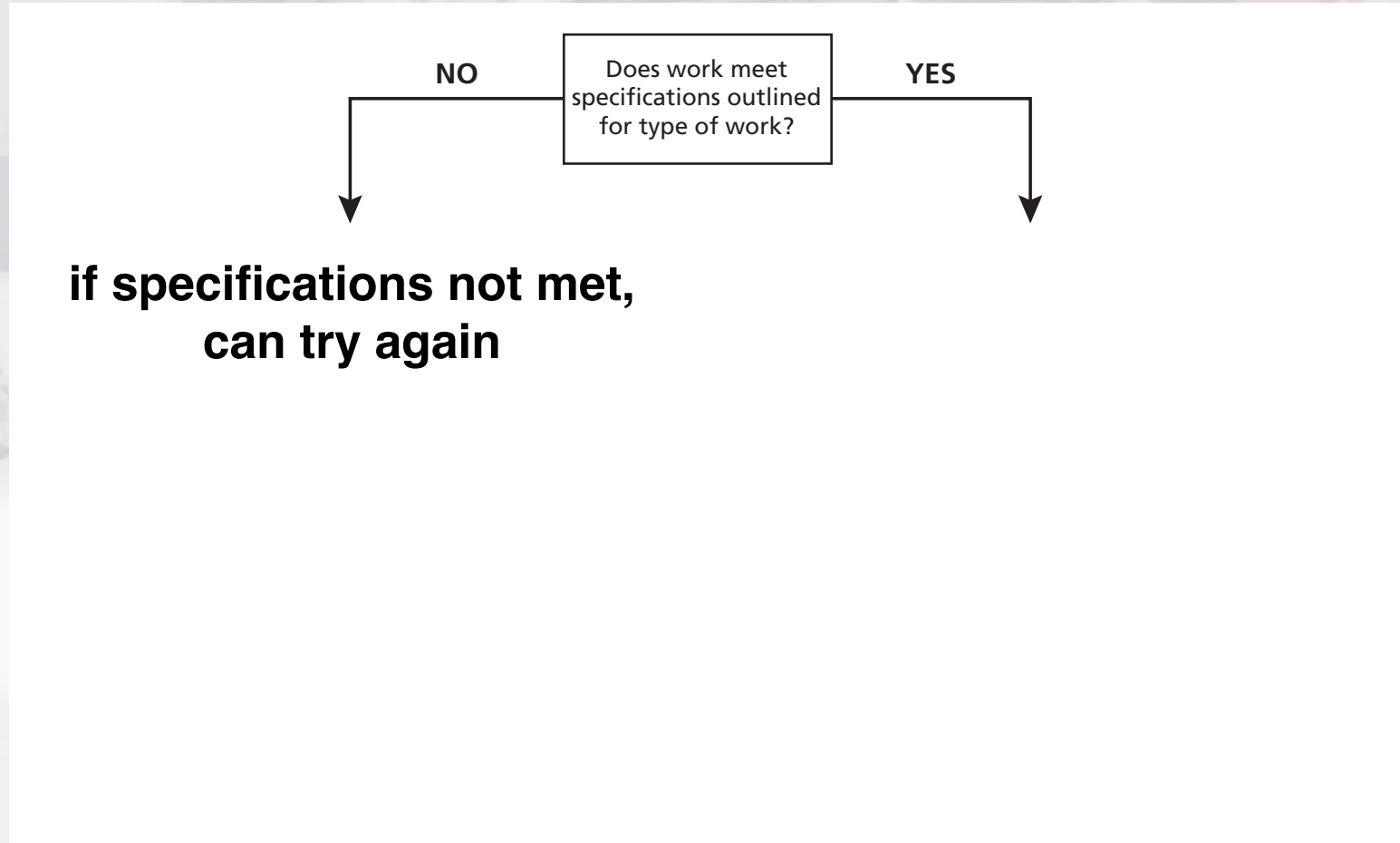
# Establish continuous accountability



Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

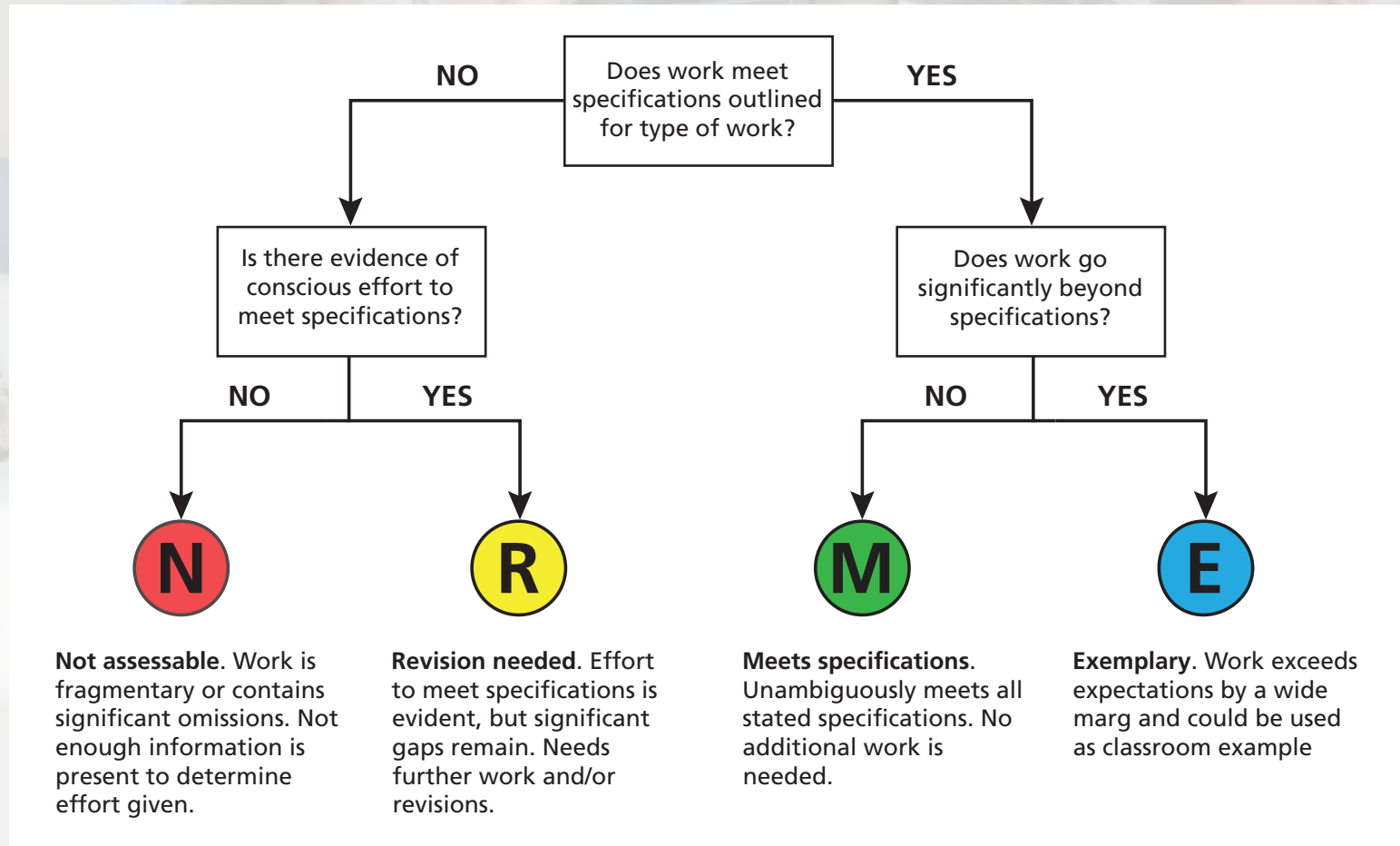


# Establish continuous accountability



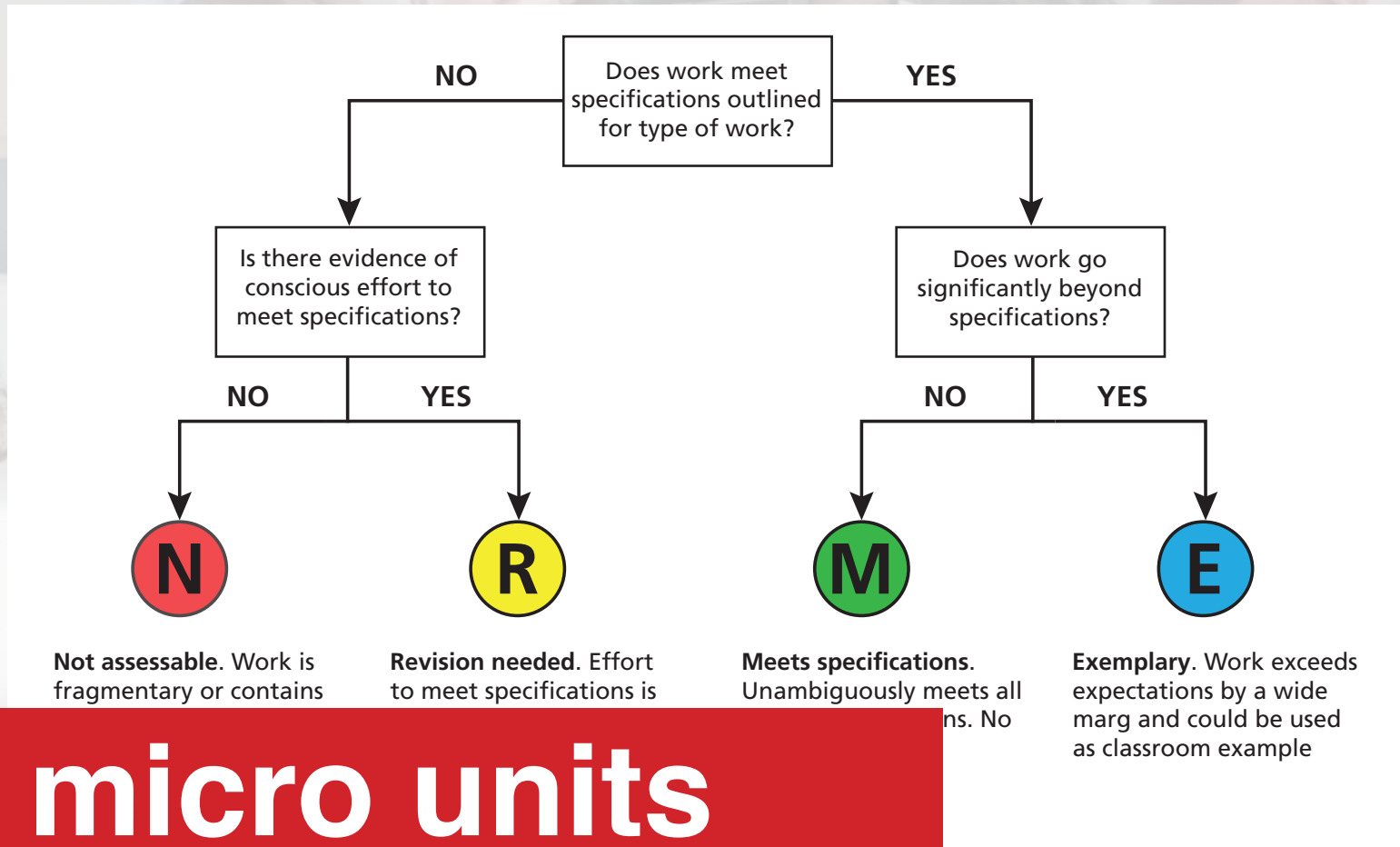
Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

# Establish continuous accountability



Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

# Establish continuous accountability

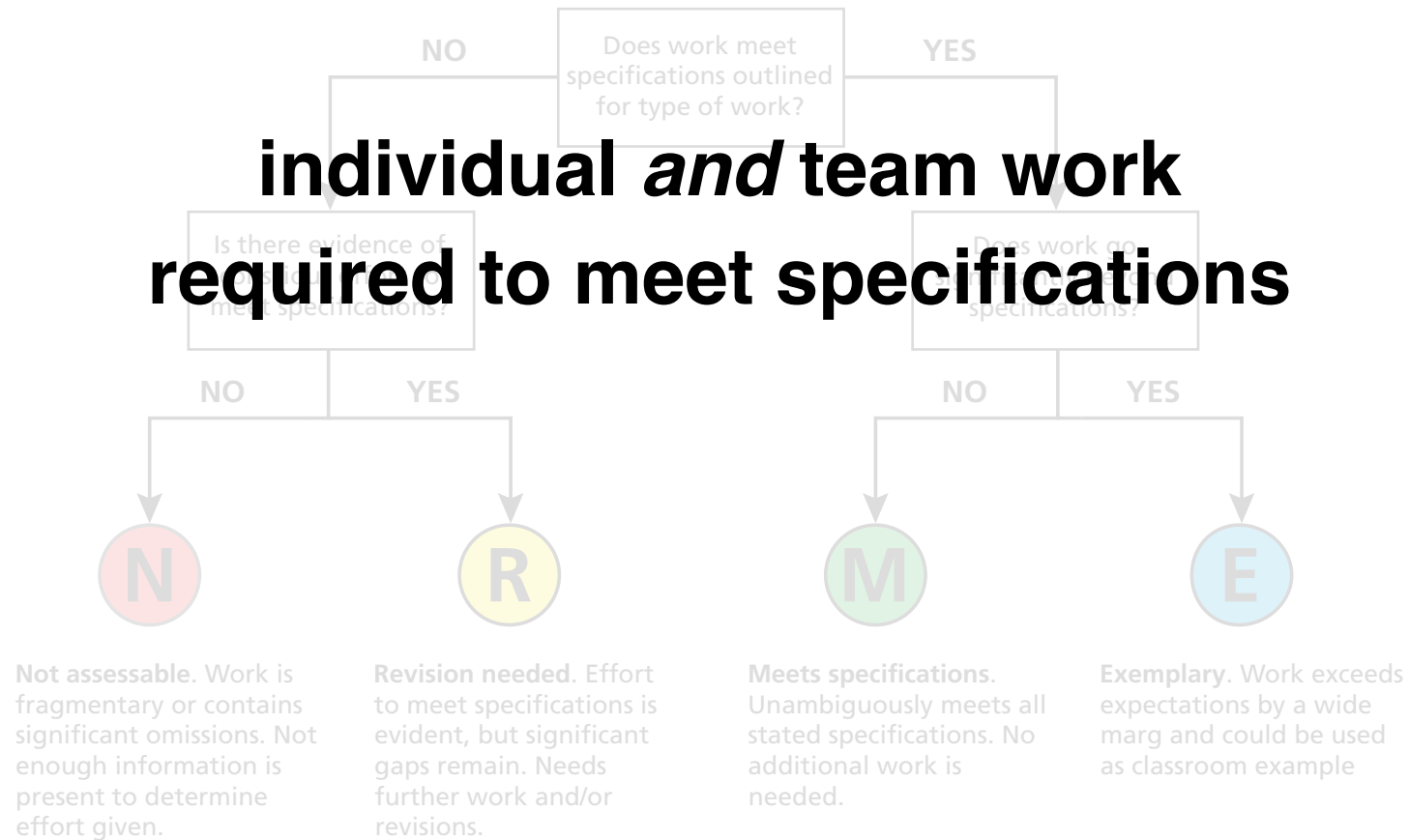


## 70 micro units

Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

# Establish continuous accountability

## individual *and* team work required to meet specifications



Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

# Establish continuous accountability

**individual *and* team work  
required to meet specifications**

**course grade determined by number of units  
for which specifications were met**

**N**  
Not assessable. Work is fragmented, incomplete, or contains significant omissions. Not enough information is present to determine effort given.

**R**  
Revision needed. Effort evident, but significant gaps remain. Needs further work and/or revisions.

**M**  
Meets specifications. Work meets stated specifications. No additional work is needed.

**E**  
Exemplary. Work exceeds specifications. Work is exemplary and could be used as classroom example.

**Inside Higher Ed, *Yes, Virginia, there is a better way to grade***

# Shift ownership of learning space

instead of all students coming to instructor's room...

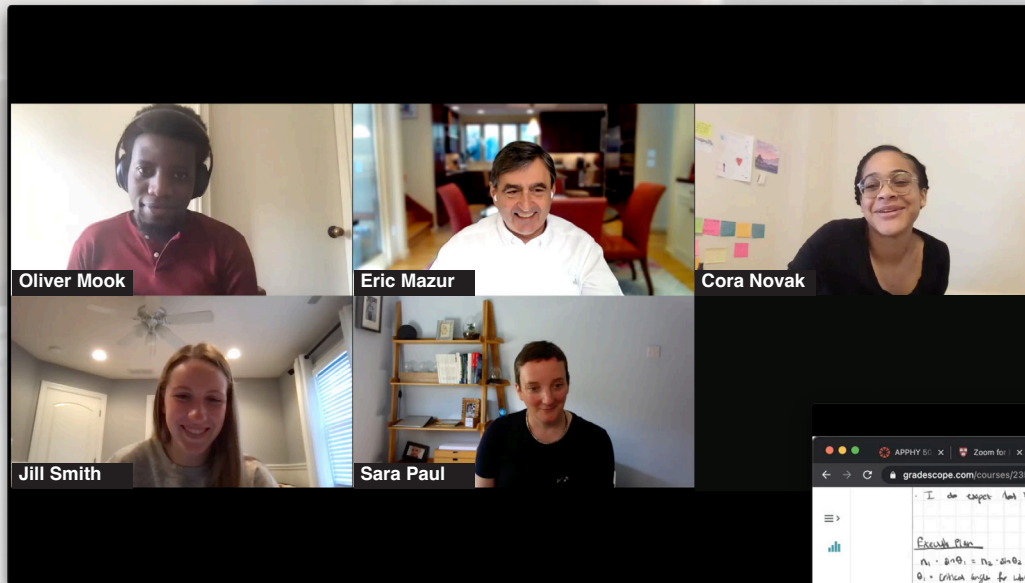
# **Shift ownership of learning space**

**instead of all students coming to instructor's room...**

**...instructional staff visits each team's own room**

# Shift ownership of learning space

80 students in one room → 20 rooms with 4 students

A screenshot of a Gradescope assignment page for "Assignment Module 25" (UNGRADED). The page displays handwritten mathematical work on a grid background. The work includes:

- Problem Plan
- Equations:  $n_1 \sin \theta_1 = n_2 \sin \theta_2$ ,  $\theta_1 = \text{critical angle for which total internal reflection occurs}$ ,  $\theta_1 = 90^\circ$ ,  $n_2 \sin \theta_2 = n_1$ ,  $n_2 \sin \theta_2 = n_1$  (repeated)
- Calculation for  $\theta_2$  for an interface between 2 media with indices  $n_1$  and  $n_2$ :
  - $n_1 \sin \theta_1 = n_2 \sin \theta_2$
  - $n_1 \sin 90^\circ = n_2 \sin \theta_2$
  - $\sin \theta_2 = \frac{n_1}{n_2}$
  - $\theta_2 = \sin^{-1}(\frac{n_1}{n_2})$
- Diagram showing a light ray incident at point A on a boundary, reflecting at point B, and refracting at point C. Angles  $\theta_1$  and  $\theta_2$  are indicated.
- Further calculations:
  - $\cos^2 \theta_2 = 1 - \sin^2 \theta_2 = 1 - \frac{n_1^2}{n_2^2}$
  - $\cos \theta_2 = \sqrt{1 - \frac{n_1^2}{n_2^2}}$
  - $n_1 \sin \theta_1 = n_2 \sin \theta_2$
  - $1 \cdot \sin 90^\circ = n_2 \sin \theta_2$
  - $\sin \theta_2 = \frac{1}{n_2}$
  - $\theta_2 = \sin^{-1}(\frac{1}{n_2})$
  - $\theta_2 = \sin^{-1}(\frac{1}{1.441})$
  - $\theta_2 = 43.6^\circ$

The interface also shows a sidebar with "Assignment Module 25" and a list of questions with scores.



# Shift ownership of learning space

every student on front row

The Zoom meeting grid shows five participants:

- Oliver Mook
- Eric Mazur
- Cora Novak
- Jill Smith
- Sara Paul

The browser window displays a physics assignment page titled "Assignment Module 25" with handwritten student work and a diagram of a prism. The student work includes calculations for critical angles and refractive indices.

Assignment Module 25 • UNGRADED

STUDENT: Codi-Ann Reid  
TOTAL POINTS: - / 0 pts

QUESTION 1: Cover Page (0 pts)  
QUESTION 2: Question 1 (0 pts)  
QUESTION 3: Question 2 (0 pts)  
QUESTION 4: Question 3 (0 pts)  
QUESTION 5: Reflection (0 pts)

Handwritten work includes:

Example Problem  
 $n_1 \sin \theta_1 = n_2 \sin \theta_2$   
 $\theta_1 = \text{critical angle for which total internal reflection occurs}$   
 $\theta_1 = 90^\circ, \theta_2 = 90^\circ - 1$   
 $n_2 \sin \theta_2 = n_1 \sin \theta_1$   
 $n_2 \sin 90^\circ = n_1 \sin 90^\circ$   
 $n_2 = n_1$

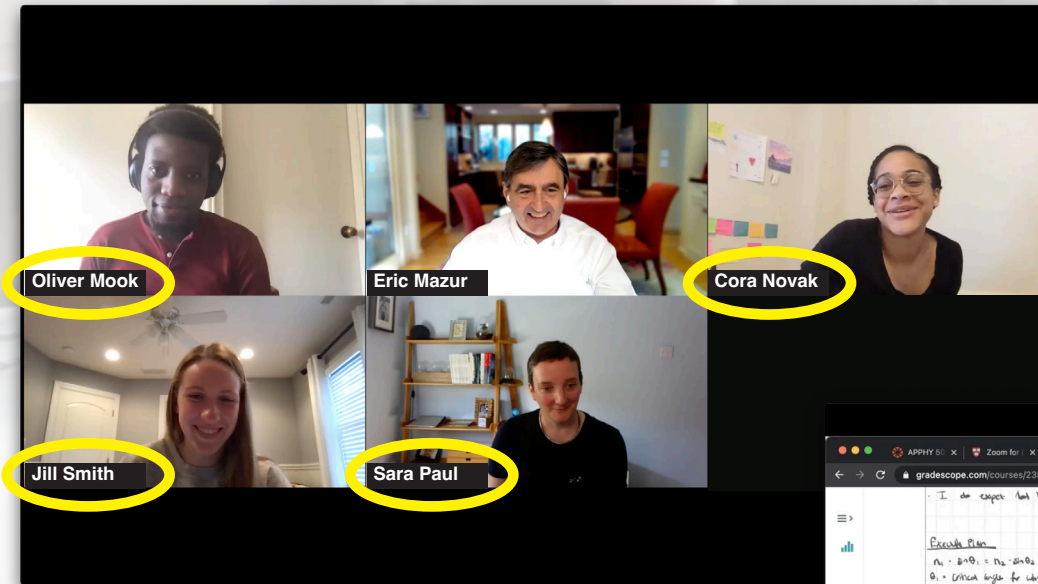
Calculate the  $\theta_c$  for an interface between 2 media with indices of refraction  
 $n_1 \sin \theta_c = n_2 \sin 90^\circ$   
 $\sin \theta_c = \frac{n_2}{n_1}$   
 $\theta_c = \sin^{-1}(\frac{n_2}{n_1})$

Diagram shows a light ray incident at point A on a horizontal interface, refracting at point B. The angle of incidence is  $\theta_1$  and the angle of refraction is  $\theta_2$ .

Equations:  
 $\cos^2 \theta_c + \sin^2 \theta_c = 1$   
 $\cos^2 \theta_c = 1 - \sin^2 \theta_c = 1 - (\frac{n_2}{n_1})^2$   
 $\cos \theta_c = \sqrt{1 - (\frac{n_2}{n_1})^2}$   
 $\theta_c = \cos^{-1}(\sqrt{1 - (\frac{n_2}{n_1})^2})$

# Shift ownership of learning space

every student on front row & address each by their name



A screenshot of a Gradescope submission page. The page displays handwritten mathematical work on a grid background. The work includes a diagram of a trapezoid with vertices A, B, and C, and various mathematical equations and calculations. On the right side, there is a sidebar with the title 'Assignment Module 25' and a list of questions with their respective points.

QUESTION	POINTS
QUESTION 1	0 pts
QUESTION 2	0 pts
QUESTION 3	0 pts
QUESTION 4	0 pts
QUESTION 5	0 pts



# Does it work?

**1** pandemic lessons

## Doubling of...

- content learning gains
- physics self-efficacy gains

*Research Shows Students Falling Months Behind During Virus Disruptions*

The abrupt switch to remote learning wiped out academic gains for many students in America, and widened racial and economic



# What do students say?

## *Research Shows Students Falling Months Behind During Virus Disruptions*

The abrupt switch to remote learning wiped out academic gains for many students in America, and widened racial and economic

# Agile Feedback Survey (Talbert)

- 1. I was challenged intellectually**
- 2. I had plenty of support**
- 3. I am closer to mastering the ideas of the course now**
- 4. I made progress because of my own efforts and choices**
- 5. I felt I was part of a community of learners**

# challenge vs. support

**1. I was challenged intellectually**

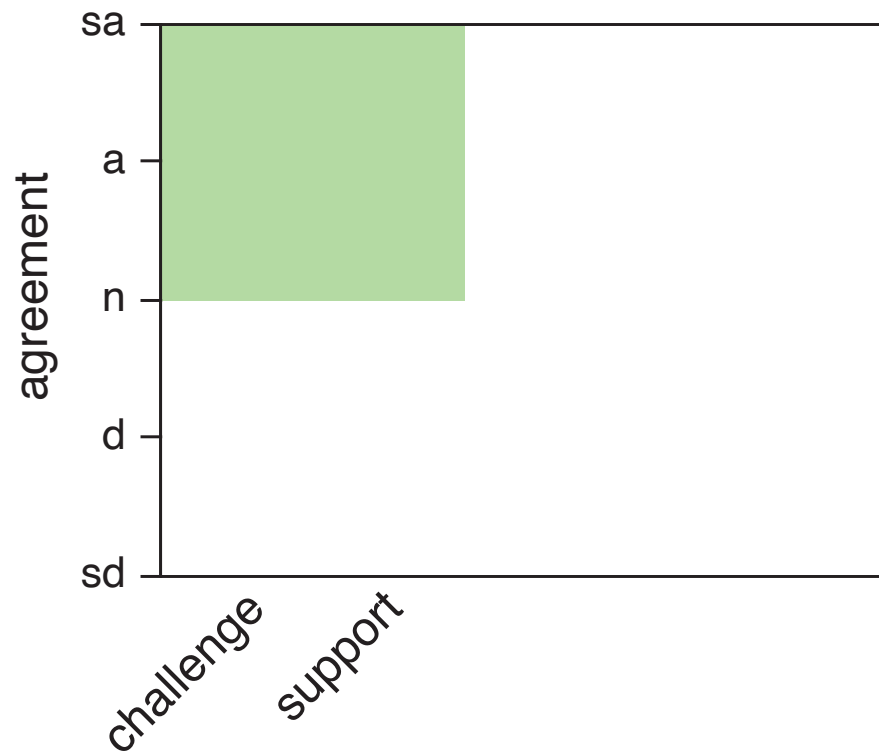
**2. I had plenty of support**

**3. I am closer to mastering the ideas of the course now**

**4. I made progress because of my own efforts and choices**

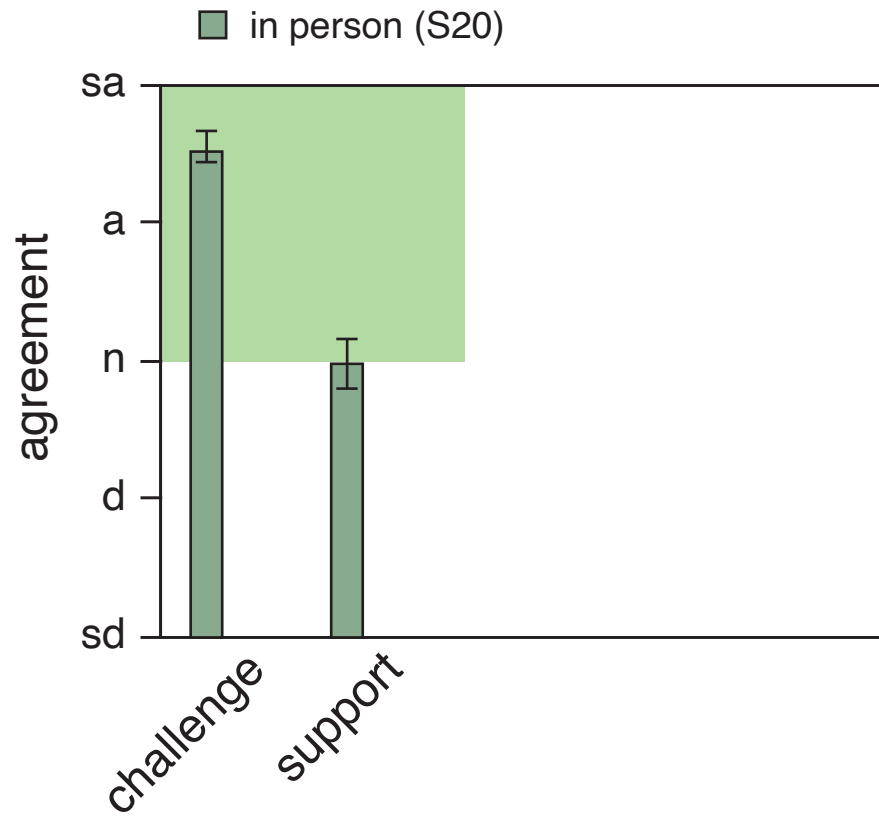
**5. I felt I was part of a community of learners**

# challenge vs. support

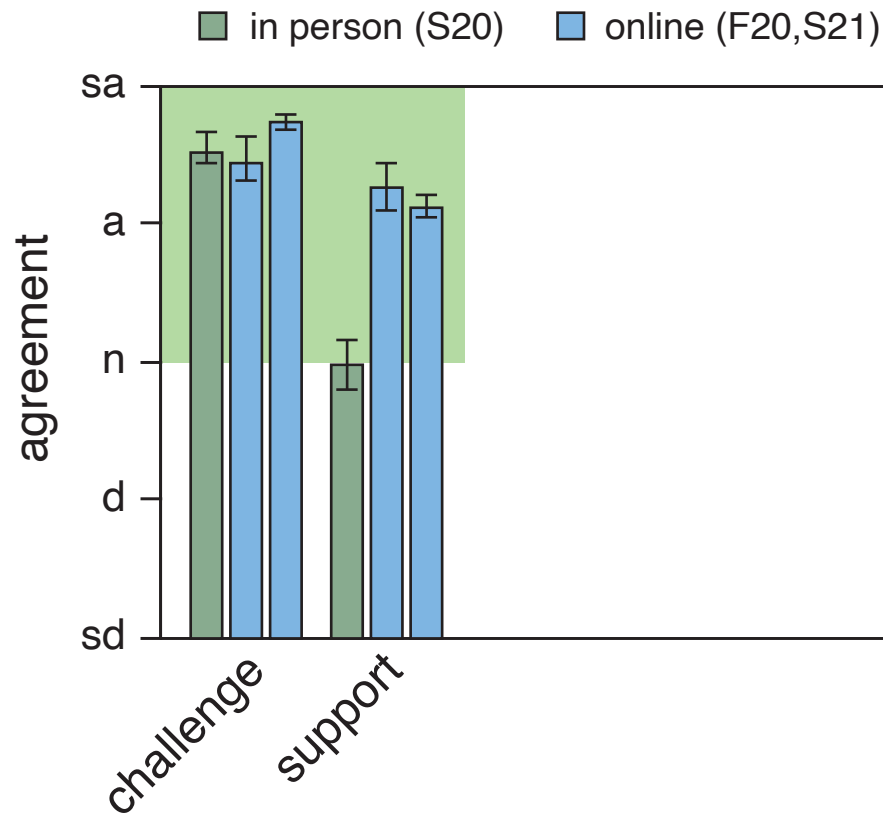




# challenge vs. support



# challenge vs. support





## self-determination

1. I was challenged intellectually (challenge)

2. I had plenty of support (support)

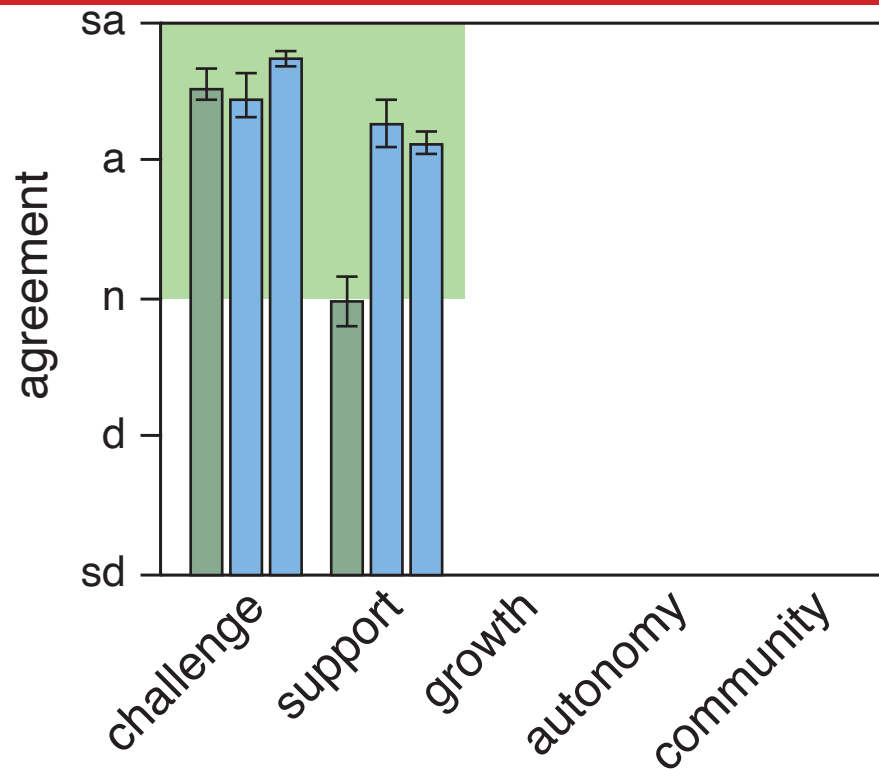
3. I am closer to mastering the ideas of the course now (growth)

4. I made progress because of my own efforts and choices (auton.)

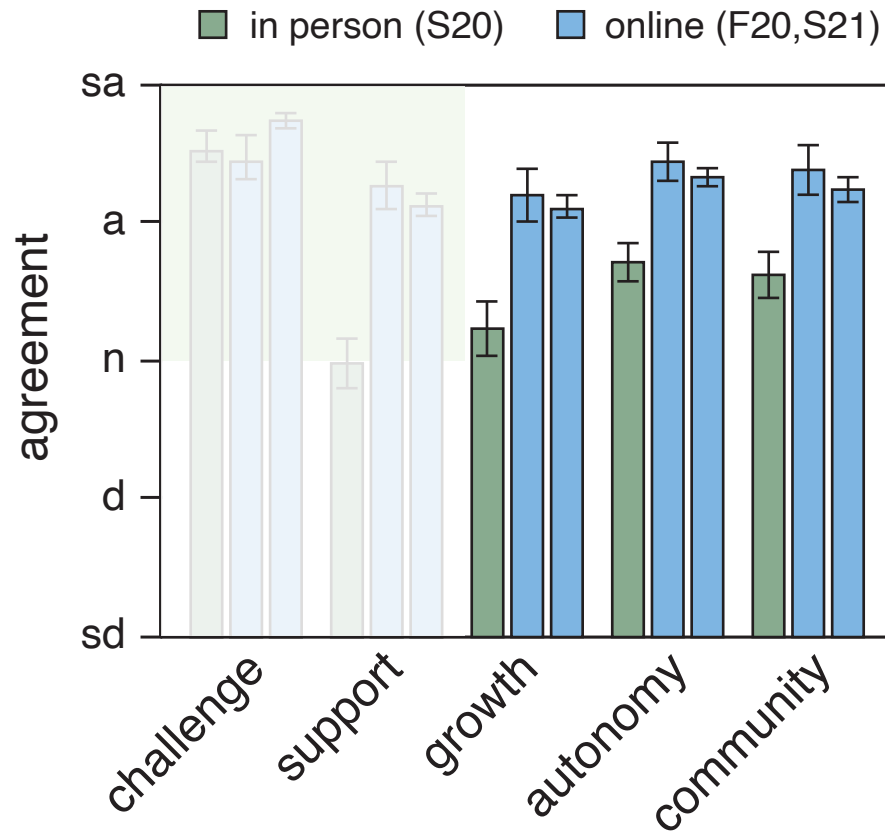
5. I felt I was part of a community of learners (relatedness)

## self-determination

# What do you predict?



# self-determination





**I did my best teaching *ever* online!**

*Research Shows Students Falling Months Behind During Virus Disruptions*

The abrupt switch to remote learning wiped out academic gains for many students in America, and widened racial and economic



**1** pandemic lessons

**2** new normal

# weekly workflow

A group of people in a meeting room, some sitting at a table with laptops, others standing, engaged in a discussion. The scene is dimly lit, with a focus on the people and their interaction. The text 'weekly workflow' is overlaid in the center.

**1** pandemic lessons

**2** new normal



# weekly workflow

content module

practical work

**1** pandemic lessons

**2** new normal

# weekly workflow

content module

practical work

reading

**1** pandemic lessons

**2** new normal

# weekly workflow

**content module**

reading

readiness assurance

**practical work**

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

## practical work

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal



# weekly workflow

## content module

reading

readiness assurance

tutorial

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## practical work

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**replaces lectures**

**1** pandemic lessons

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# Perusall

**1** pandemic lessons

**2** new normal

## 76 CHAPTER 4 MOMENTUM

In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study of motion by investigating inertia, a property of objects that affects their motion. The experiments we carry out in studying inertia lead us to discover one of the most fundamental laws in physics—conservation of momentum.

## 4.1 Friction

Picture a block of wood sitting motionless on a smooth wooden surface. If you give the block a shove, it slides some distance but eventually comes to rest. Depending on the smoothness of the block and the smoothness of the wooden surface, this stopping may happen sooner or it may happen later. If the two surfaces in contact are very smooth and slippery, the block slides for a longer time interval than if the surfaces are rough or sticky. This you know from everyday experience: A hockey puck slides easily on ice but not on a rough road.

Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to *friction*—the resistance to motion that one surface or object encounters when moving over another. Notice that, during the interval covered by the velocity-versus-time graph, the velocity decrease as the block slides over ice is hardly observable. The block slides easily over ice because there is very little friction between the two surfaces. The effect of friction is to bring two objects to rest with respect to each other—in this case the wooden block and the surface it is sliding on. The less friction there is, the longer it takes for the block to come to rest.

Figure 4.1 Velocity-versus-time graph for a wooden block sliding on three different surfaces. The rougher the surface, the more quickly the velocity decreases.



Figure 4.2 Low-friction track and carts used in the experiments described in this chapter.



You may wonder whether it is possible to make surfaces that have no friction at all, such that an object, once given a shove, continues to glide forever. There is no totally frictionless surface over which objects slide forever, but there are ways to minimize friction. You can, for instance, float an object on a cushion of air. This is most easily accomplished with a low-friction track—a track whose surface is dotted with little holes through which pressurized air blows. The air serves as a cushion on which a conveniently shaped object can float, with friction between the object and the track all but eliminated. Alternatively, one can use wheeled carts with low-friction bearings on an ordinary track. Figure 4.2 shows low-friction carts you may have encountered in your lab or class. Although there is still some friction both for low-friction tracks and for the track shown in Figure 4.2, this friction is so small that it can be ignored during an experiment. For example, if the track in Figure 4.2 is horizontal, carts move along its length without slowing down appreciably. In other words:

**In the absence of friction, objects moving along a horizontal track keep moving without slowing down.**

Another advantage of using such carts is that the track constrains the motion to being along a straight line. We can then use a high-speed camera to record the cart's position at various instants, and from that information determine its speed and acceleration.

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Figure 4.1 Velocity-versus-time graph for a wooden block sliding on three different surfaces. The rougher the surface, the more quickly the velocity decreases.



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see who is online

76 CHAPTER 4 MOMENTUM

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Figure 4.1 shows how the velocity of a wooden block decreases on three different surfaces. The slowing down is due to friction. The rougher the surface, the more quickly the velocity decreases. In your graph, the velocity decreases as the block slides over ice. This friction is so small that it can be ignored during an experiment. For example, if the track in Figure 4.2 is horizontal, carts move along its length without slowing down appreciably. In other words: In the absence of friction, objects moving along a horizontal track keep moving without slowing down.

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highlighting text...

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76 CHAPTER 4 MOMENTUM

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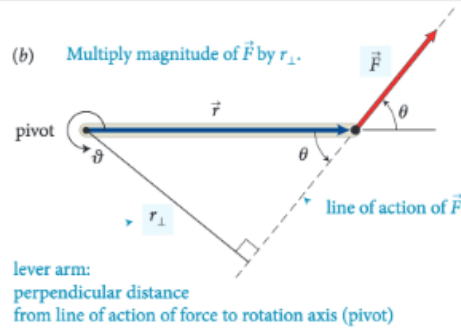
...opens chat window

? No friction at all seems impossible. Isn't there always some friction in any real case. Nov 1 4:41 pm

Enter your comment or question and press Enter

1 pandemic lessons

2 new normal



action of the force and the axis of rotation. So, the torque caused by a force exerted on an object is the product of the magnitude of the force and its lever arm distance. It can be written equivalently as  $rF_1$  and as  $r_1 F$ .

Like other rotational quantities, torque carries a sign that depends on the choice of direction for increasing  $\vartheta$ . In Figure 12.4, for example, the torque caused by  $\vec{F}_1$  about the pivot tends to rotate the rod in the direction of increasing  $\vartheta$  and so is positive; the torque caused by  $\vec{F}_2$  is negative. The sum of the two torques about the pivot is then  $r_1 F_1 + (-r_2 F_2)$ . As we've seen, the two torques are equal in magnitude when the rod is balanced, and so the sum of the torques is zero. When the sum of the torques is not zero, the rod's rotational acceleration is nonzero, and so its rotational velocity and angular momentum change.

In the situations depicted in Figures 12.4 and 12.5 we used the pivot to calculate the lever arm distances. This is a natural choice because that is the point about which the object under consideration is free to rotate. However, torques also play a role for stationary objects that are suspended or supported at several different points and that are not free to rotate—for example, a plank or bridge supported at either end. To determine what reference point to use in such cases, complete the following exercise.

**Exercise 12.1 Reference point**

Consider again the rod in Figure 12.4. Calculate the sum of the torques about the left end of the rod.

**SOLUTION:** I begin by making a sketch of the rod and the three

reference point

The lever arm distances must now be determined relative to the left end of the rod. The lever arm distance of force  $\vec{F}_1$  to this point is zero, and so the torque caused by that force about the left end of the rod is zero. If I choose counterclockwise as the positive direction of rotation,  $\vec{F}_2$  causes a negative torque about the left end of the rod; the force  $\vec{F}_{pr}^c$  exerted by the pivot causes a positive torque about the left end of the rod. The lever arm distance of  $\vec{F}_2$  about the left end of the rod is  $r_1 + r_2$ ; that of  $\vec{F}_{pr}^c$  is  $r_1$ . Because the rod is at rest, the magnitude of the force exerted by the pivot is equal to the sum of the forces  $\vec{F}_1$  and  $\vec{F}_2$ . Taking into account the signs of the torques, we find that the sum of the torques about the left end of the rod is  $r_1(F_1 + F_2) - (r_1 + r_2)F_2 = r_1 F_1 - r_2 F_2$ . This is the same result we obtained for the torques about the pivot, and so the sum of the torques about the left end is zero. ✓

Exercise 12.1 shows that the sum of the torques about the left end of the rod is zero, just like the sum of the torques about the pivot. You can repeat the calculation for the torques about the right end of the rod or any other point, and each time you will find that the sum of the torques is zero. The reason is that the rod is not rotating about any point, and so the sum of the torques must be zero about any point. In general we can say:

**For a stationary object, the sum of the torques is zero.**

For a stationary object we can choose any reference point we like to calculate torques. It pays to choose a reference point that simplifies the calculation. As you have seen, we do not need to consider any force that is exerted at the reference point. So, by putting the reference point at the point of application of a force, we can eliminate that force from the calculation.

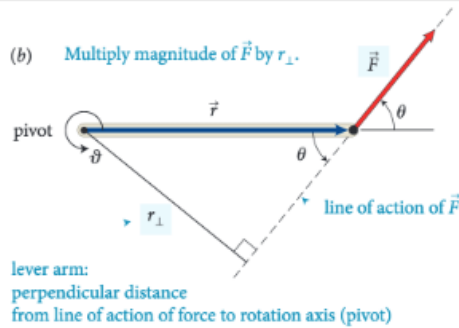
**12.2** In the situation depicted in Figure 12.2a, you must continue to exert a force on the seesaw to keep the child off the ground. The force you exert causes a torque on the seesaw, and yet the seesaw's rotational acceleration is zero. How can this be if torques cause objects to accelerate rotationally?

**Example 12.2 Torques on lever**

Three forces are exerted on the lever of Figure 12.7. Forces  $\vec{F}_1$  and  $\vec{F}_3$  are equal in magnitude, and the magnitude of  $\vec{F}_2$  is half as great. Force  $\vec{F}_1$  is horizontal,  $\vec{F}_2$  and  $\vec{F}_3$  are vertical, and the lever

CONCEPTS





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reference point  
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- Oct 20 12:09 am

I don't understand how this combination of factors tells you anything about direction? Aren't magnitude and lever arm distance both scalar quantities? It seems like we would need to know some sort of direction to calculate torque.
- Oct 20 12:38 am

I think you may be able to think about the direction separately. So, after multiplying this magnitude and distance, you can attach a sign to the torque based on the defined parameters of the system. In the following paragraph, they start to explain how to choose this direction.
- Oct 22 8:48 pm

This is a great question. To further elaborate on this, we can think of this in terms of the Torque equation. The equation for torque is  $\tau = r \times F$ , with  $r$  being the level arm distance and  $F$  being force. We know that force is a vector vector from previous chapters, and in regards to "r" it can also be thought of as the radial vector. What this means is that this distance from the pivot points from the axis of rotation to the point where the force acts. In as previously mentioned, there is a general convention (the right-hand rule) that is used to determine the direction which happens to be perpendicular to both the radius from the axis and to the force.

Perusall AP50 Fall 2015 » Chapter 12 Group 1's comments Page 284 Eric Mazur

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1 pandemic lessons

2 new normal

# weekly workflow

## content module

reading

**readiness assurance**

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**strengthen basic knowledge**

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

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challenge

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skills session

project work

**strengthen basic knowledge  
through self-paced Peer Instruction**

**1** pandemic lessons

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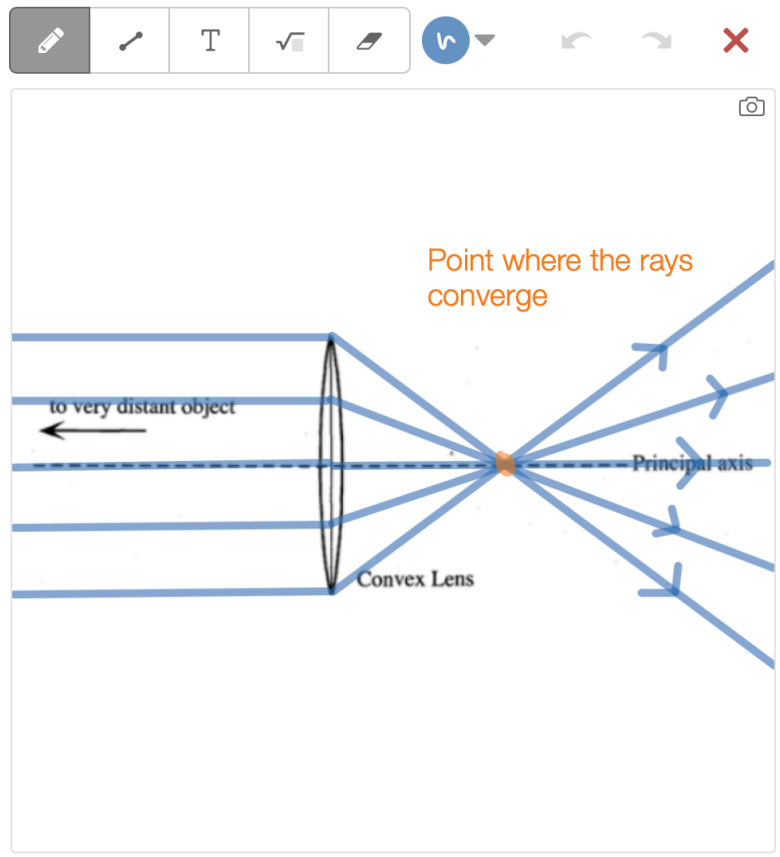
project work

**resolve common misconceptions**

**1** pandemic lessons

**2** new normal

### Part 2. Ray tracing and convex lenses



B. Consider a point on the distant object that is also on the principal axis of the lens. On the diagram, sketch several rays from this distant point that reach the lens.

How are these rays oriented with respect to one another and to the principal axis? Explain.

they are parallel

Submit

In the diagram below x represents the x location of the orange point below. The dashed lines represent a few of the rays that emanate from the orange point and hit the red vertical plane.

Try entering a large negative number below to test your answer

On the basis of your observations from part A, show the continuation of each of these rays through the lens and out the other side. On the diagram, indicate where the rays converge.

*Note:* Refraction takes place at the two surface of the lens. However, in drawing a diagram for a thin lens, it is customary to draw rays as if all refraction takes place at the center of the lens.

desmos.com



### Part 2. Ray tracing and convex lenses

Point where the rays converge

Convex Lens

Principal axis

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**complete individually before class**

**review with team & present to staff in class**

# weekly workflow

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reading

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tutorial

challenge

## practical work

skills session

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**1** pandemic lessons

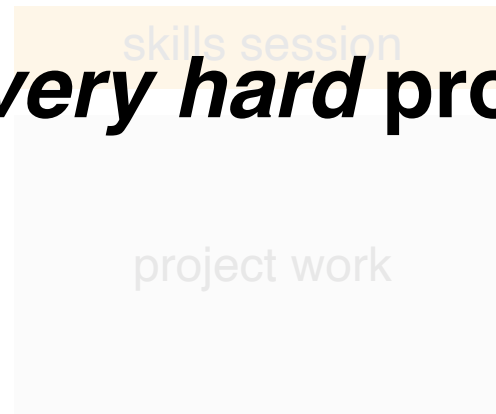
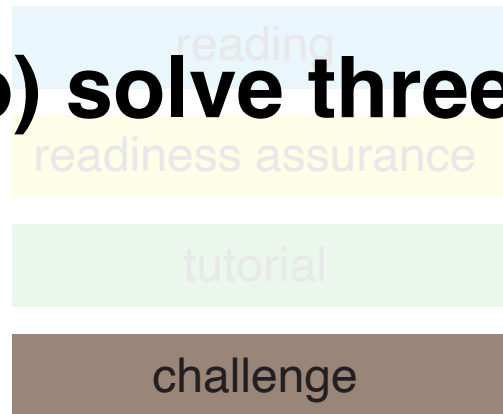
**2** new normal

# weekly workflow

**(try to) solve three *very hard* problems**

content module

practical work



**1** pandemic lessons

**2** new normal

# weekly workflow

content module

practical work

(try to) solve three *very hard* problems  
(and reflect on your work)

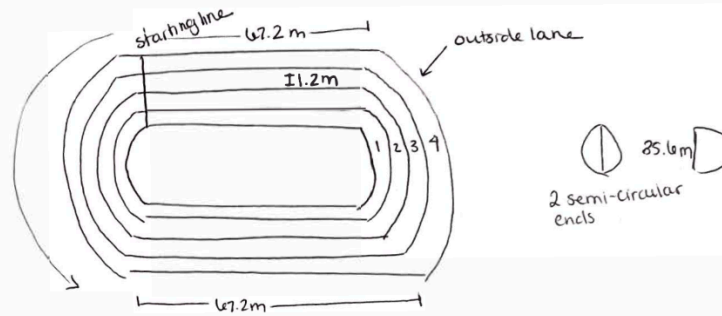
challenge

1 pandemic lessons

2 new normal

Question 2

1. Getting started: The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.



# upload individual work before class


2. Devise a Plan

- ① calculate how much the runner in lane 1 runs
  - ② calculate how much runner in lane 2 runs
  - ③ calculate how much runner in lane 3 runs
  - ④ calculate how much runner in lane 4 runs
  - ⑤ double check by subtracting lane 1 from lane 4 distance
- each time, add the lane thickness allotted,  
2 straightaways + appropriate diameter

4. Evaluate the Plan

This seems reasonable, both in expectation as well as considering why a track stagger starts to offset the difference (runner in lane 4 would start 20m ahead or so here so as to not run extra).  
Another way to check is to do  $35.6\pi - (35.6 - 6(1-2))\pi$ , which is the difference of diameters. This checks out!

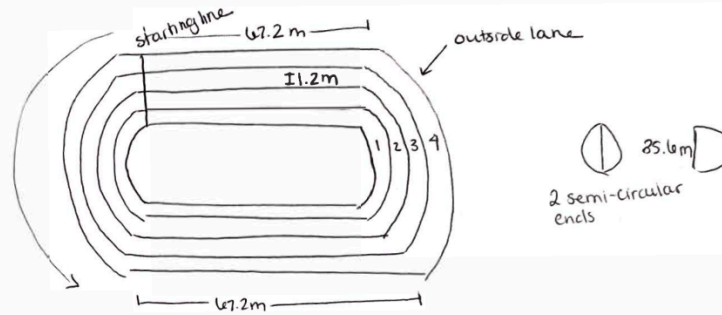
3. Execute the Plan

- ① straightaways for runner 4:  $67.2m + 67.2m = 134.4m$   
curves:  $35.6$  diameter -  $0m$  (no lane adjustment)  
 $35.6\pi = 111.84$   distance around curve is circumference,  $2\pi r$  (whole circle, since 2 curves)  
curves for runner in lane 4:  $246.2m$  + straightaways
- ② Runner 3:  $67.2m + 67.2m = 134.4m$  straightaways  
curves:  $35.6 - 1.2 - 1.2 = 33.2$   
distance around both curves is  $2\pi r = 33.2\pi = 104.3$   
altogether runner in lane 3:  $238.7$
- ③ Runner in lane 2:  $67.2m + 67.2m = 134.4m$  straightaways  
curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 =$  diameter of  $30.8$   
distance around both curves =  $2\pi r = 30.8\pi = 96.8$   
altogether runner in lane 2:  $231.2m$
- ④ Runner in lane 1:  $67.2m + 67.2m = 134.4m$  straightaways  
curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$   
distance around both curves is  $2\pi r = 28.4\pi = 89.2$   
altogether runner in lane 1 =  $223.6m$   
AP50 F2021
- ⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2m - 223.6m = 22.6m$  extra

gradescope.com

Question 2

1. Getting Started: The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.



# upload individual work before class


2. Devise a Plan

- ① Calculate how much the runner in lane 4 runs
  - ② calculate how much runner in lane 3 runs
  - ③ calculate how much runner in lane 2 runs
  - ④ calculate how much runner in lane 1 runs
  - ⑤ double check by subtracting lane 1 from lane 4 distance
- (evaluated on effort)**
- each time, add the lane thickness*  
*straightaways is applicable*

4. Evaluate the Plan

This seems reasonable, both in expectation as well as considering why a track stagger starts to offset the difference (runner in lane 4 would start 20 m ahead or so here so as to not run extra).  
 Another way to check is to do  $35.6\pi - (35.6 - 6(1-2))\pi$ , which is the difference of diameters. This checks out!

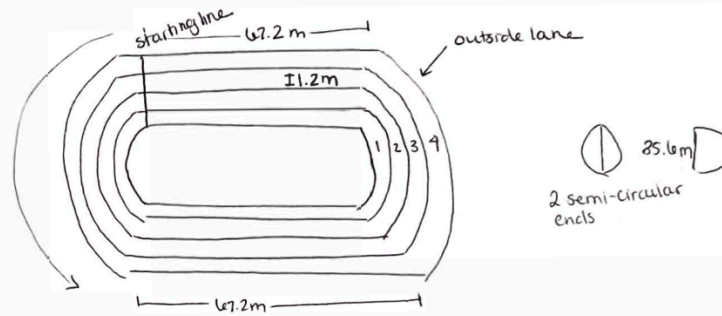
3. Execute the Plan

- ① straightaways for runner 4:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$   
 curves:  $35.6\text{ diameter} - 0\text{ m (no lane adjustment)}$   
 $35.6\pi = 111.84$   distance around curve is circumference,  $2\pi r$  (whole circle, since 2 curves)  
 curves for runner in lane 4:  $246.2\text{ m}$   
 + straightaways
- ② Runner 3:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 = 33.2$   
 distance around both curves is  $2\pi r = 33.2\pi = 104.3$   
 altogether runner in lane 3:  $238.7$
- ③ Runner in lane 2:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 = \text{diameter of } 30.8$   
 distance around both curves =  $2\pi r = 30.8\pi = 96.8$   
 altogether runner in lane 2:  $231.2\text{ m}$
- ④ Runner in lane 1:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$   
 distance around both curves is  $2\pi r = 28.4\pi = 89.2$   
 altogether runner in lane 1 =  $223.6\text{ m}$   
 AP50 F2021
- ⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{ m} - 223.6\text{ m} = 22.6\text{ m extra}$

gradescope.com

Question 2

1. Getting started: The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.




2. Devise a Plan

- ① calculate how much the runner in lane 1 runs
  - ② calculate how much runner in lane 2 runs
  - ③ calculate how much runner in lane 3 runs
  - ④ calculate how much runner in lane 4 runs
  - ⑤ double check by subtracting lane 1 from lane 4 distance
- each time, add the lanethickness allotted,  
2 straightaways + appropriate diameter

4. Evaluate the Plan

This seems reasonable, both in expectation as well as considering why a track staggers starts to offset the difference (runner in lane 4 would start 20 m ahead or so here so as to not run extra).  
Another way to check is to do  $35.6\pi - (35.6 - 6(1-2))\pi$ , which is the difference of diameters. This checks out!

3. Execute the Plan

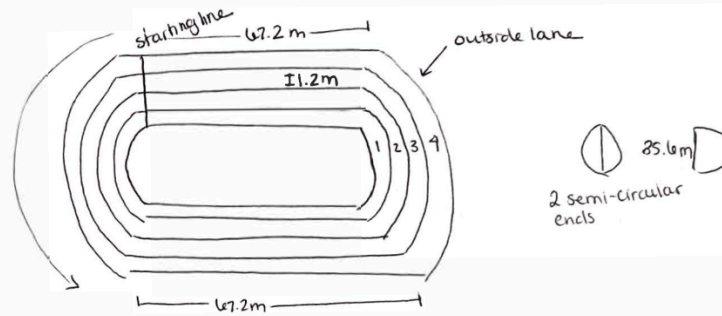
- ① straightaways for runner 4:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$   
 curves:  $35.6\text{ diameter} - 0\text{ m}$  (no lane adjustment)  
 $35.6\pi = 111.84$   distance around curve is circumference,  $2\pi r$  (whole circle, since 2 curves)  
 curves for runner in lane 4:  $246.2\text{ m}$  + straightaways
- ② Runner 3:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 = 33.2$   
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 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 =$  diameter of  $30.8$   
 distance around both curves =  $2\pi r = 30.8\pi = 96.8$   
 altogether runner in lane 2:  $231.2\text{ m}$
- ④ Runner in lane 1:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$   
 distance around both curves is  $2\pi r = 28.4\pi = 89.2$   
 altogether runner in lane 1 =  $223.6\text{ m}$   
 AP50 F2021

⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{ m} - 223.6\text{ m} = 22.6\text{ m extra}$

gradescope.com

Question 2

1. Getting started: The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.




2. Devise a Plan

- ① calculate how much the runner in lane 1 runs
  - ② calculate how much runner in lane 2 runs
  - ③ calculate how much runner in lane 3 runs
  - ④ calculate how much runner in lane 4 runs
  - ⑤ double check by subtracting lane 1 from lane 4 distance
- each time, add the lanethickness allotted,  
2 straightaways + appropriate diameter

4. Evaluate the Plan

This seems reasonable, both in expectation as well as considering why a track stagger starts to offset the difference (runner in lane 4 would start 20 m ahead or so here so as to not run extra).  
Another way to check is to do  $35.6\pi - (35.6 - 6(1-2))\pi$ , which is the difference of diameters. This checks out!

3. Execute the Plan

① straightaways for runner 4:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$   
 (inside)  
 curves:  $35.6\text{ diameter} - 0\text{ m}$  (no lane adjustment)  
 $35.6\pi = 111.84$   distance around curve is circumference,  $2\pi r$  (whole circle, since 2 curves)  
 curves for runner in lane 4:  $246.2\text{ m}$   
 + straightaways

② Runner 3:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 = 33.2$   
 distance around both curves is  $2\pi r = 33.2\pi = 104.3$   
 altogether runner in lane 3:  $238.7$

③ Runner in lane 2:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 =$  diameter of  $30.8$   
 distance around both curves =  $2\pi r = 30.8\pi = 96.8$   
 altogether runner in lane 2:  $231.2\text{ m}$

④ Runner in lane 1:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$  straightaways  
 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$   
 distance around both curves is  $2\pi r = 28.4\pi = 89.2$   
 altogether runner in lane 1 =  $223.6\text{ m}$   
 AP50 F2021

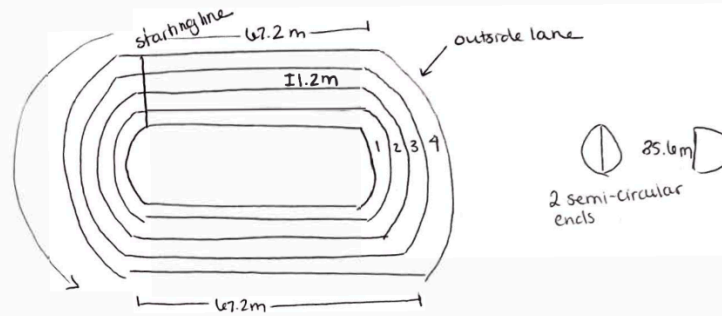
⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{ m} - 223.6\text{ m} = 22.6\text{ m extra}$

gradescope.com



Question 2

1. Getting started: The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.




2. Devise a Plan

- ① calculate how much the runner in lane 1 runs
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  - ④ calculate how much runner in lane 4 runs
  - ⑤ double check by subtracting lane 1 from lane 4 distance
- each time, add the lanethickness allotted,  
2 straightaways + appropriate diameter

4. Evaluate the Plan

This seems reasonable, both in expectation as well as considering why a track staggers starts to offset the difference (runner in lane 4 would start 20m ahead or so here so as to not run extra).  
Another way to check is to do  $35.6\pi - (35.6 - 6(1-4))\pi$ , which is the difference of diameters. This checks out!

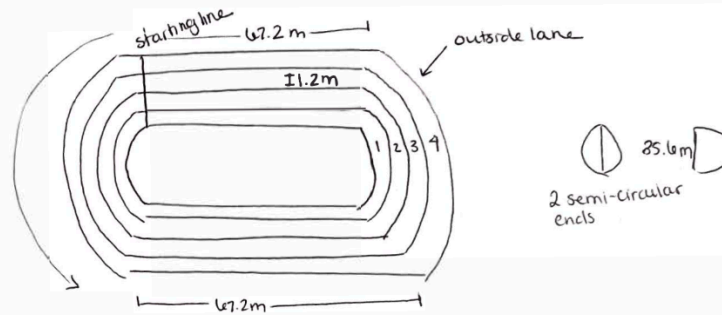
3. Execute the Plan

- ① straightaways for runner 4:  $67.2\text{m} + 67.2\text{m} = 134.4\text{m}$   
 curves:  $35.6\text{ diameter} - 0\text{m}$  (no lane adjustment)  
 $35.6\pi = 111.84$   distance around curve is circumference,  $2\pi r$  (whole circle, since 2 curves)  
 curves for runner in lane 4:  $246.2\text{m}$  + straightaways
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 altogether runner in lane 3:  $238.7$
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 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 = \text{diameter of } 30.8$   
 distance around both curves =  $2\pi r = 30.8\pi = 96.8$   
 altogether runner in lane 2:  $231.2\text{m}$
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 curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$   
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 AP50 F2021
- ⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{m} - 223.6\text{m} = 22.6\text{m extra}$

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Question 2


**1. Getting started:** The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.



**2. Devise a Plan**

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2 straightaways + appropriate diameter

**3. Execute the Plan**

- ① straightaways for runner 4:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$   
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 altogether runner in lane 1 =  $223.6\text{ m}$   
 AP50 F2021

**4. Evaluate the Plan**

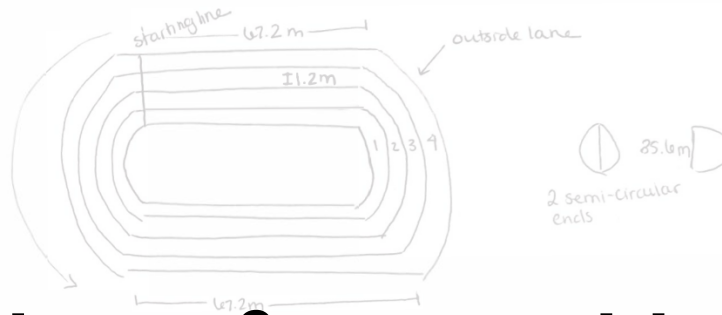
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 Another way to check is to do  $35.6\pi - (35.6 - 6(1.2))\pi$ , which is the difference of diameters. This checks out!

⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{ m} - 223.6\text{ m} = 22.6\text{ m extra}$

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Question 2

1. Getting started: The goal here is to look at a 4-lane track with given measurements for straightaways and curves and to calculate how much more distance the runner on the outside lane would run given a specified starting point.



# review with team & present to staff in class


2. Devise a Plan

- ① calculate how much the runner in lane 1 runs
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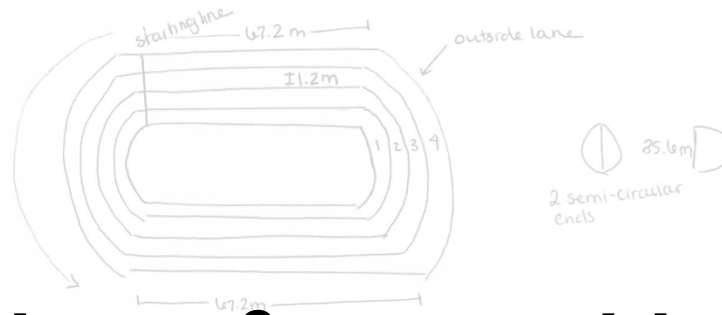
3. Execute the Plan

- ① straightaways for runner 4:  $67.2\text{m} + 67.2\text{m} = 134.4\text{m}$   
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curves for runner in lane 4:  $246.2\text{m}$  + straightaways
- ② Runner 3:  $67.2\text{m} + 67.2\text{m} = 134.4\text{m}$  straightaways  
curves:  $35.6 - 1.2 - 1.2 = 33.2$   
distance around both curves is  $2\pi r = 83.2\pi = 104.3$   
altogether runner in lane 3:  $238.7$
- ③ Runner in lane 2:  $67.2\text{m} + 67.2\text{m} = 134.4\text{m}$  straightaways  
curves:  $35.6 - 1.2 - 1.2 - 1.2 - 1.2 = \text{diameter of } 30.8$   
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altogether runner in lane 2:  $231.2\text{m}$
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AP50 F2021
- ⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{m} - 223.6\text{m} = 22.6\text{m extra}$

gradescope.com

Question 2

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**review with team & present to staff in class**

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- each time, add the lane thickness allotted,  
2 straightaways + appropriate diameter

**mark up, write reflection, & reupload after class**

3. Execute the Plan

- ① straightaways for runner 4:  $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$   
 curves:  $35.6\text{ diameter} - 0\text{ m}$  (no lane adjustment)  
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 AP50 F2021
  - ⑤ lane 4 distance - lane 1 distance  $\rightarrow 246.2\text{ m} - 223.6\text{ m} = 22.6\text{ m extra}$
- Another way to check is to do  $35.6\pi - (35.6 - 6(1.2))\pi$ , which is the difference of diameters. This checks out!

**gradescope.com**

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

**develop relevant skills**

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

# weekly workflow

content module

reading

readiness assurance

**develop relevant skills**

challenge

practical work

skills session

project work

**(team work, taking data, building circuits, etc.)**

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal



# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**3 month-long projects per semester (six total)**

**1** pandemic lessons

**2** new normal

# weekly workflow

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**3 month-long projects per semester (six total)**  
**new team for each project**

**1** pandemic lessons

**2** new normal



**classrooms are a constraint**

**1** pandemic lessons

**2** new normal

InnoBreakCafe

# learning space

## content module

reading

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

InnoBreakCafe

# learning space

## content module

reading

**ONLINE**

readiness assurance

tutorial

challenge

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

InnoBreakCafe

# learning space

## content module

reading

**ONLINE**

readiness assurance

tutorial

challenge

**FLEX SPACE**

## practical work

skills session

project work

**1** pandemic lessons

**2** new normal

InnoBreakCafe

# learning space

content module

practical work

reading

**ONLINE**

readiness assurance

tutorial

challenge

**FLEX SPACE**

skills session

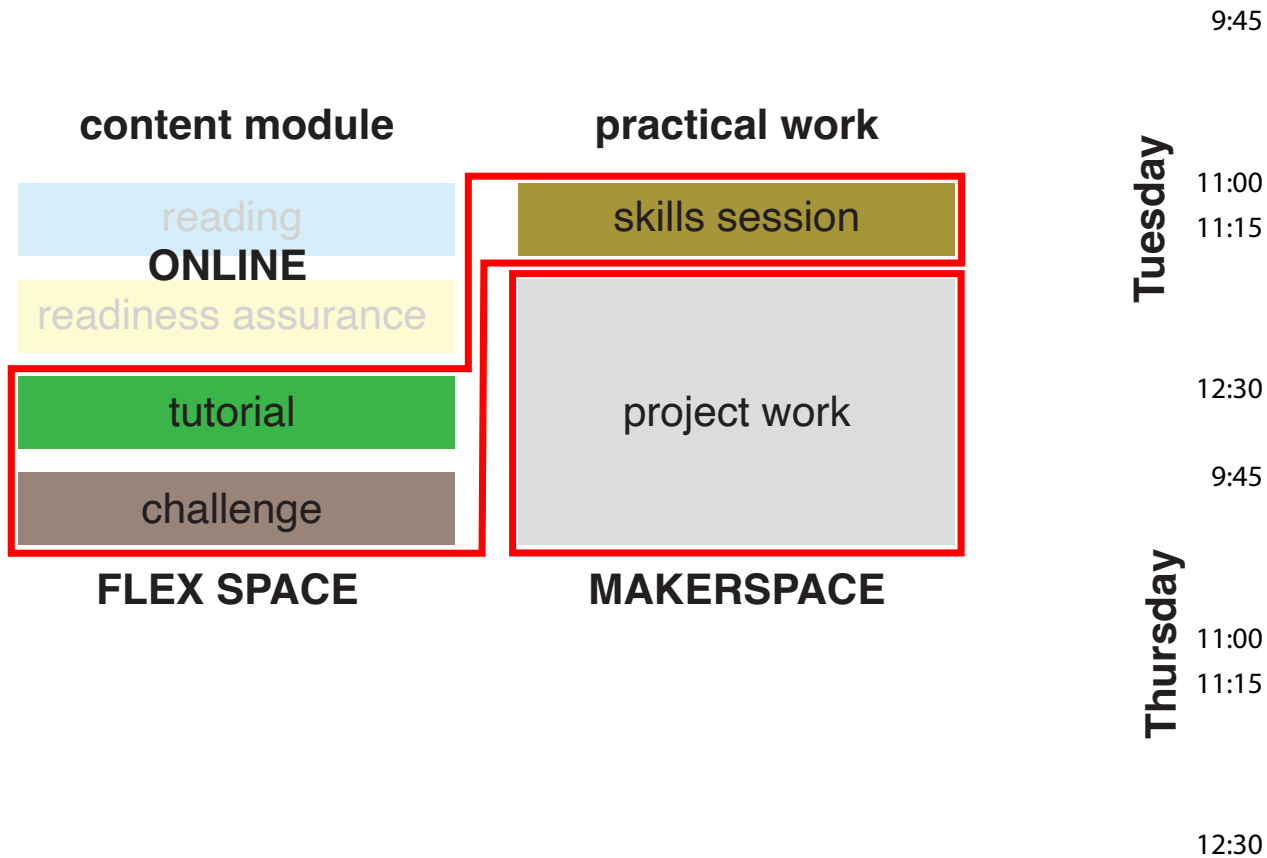
project work

**MAKERSPACE**

**1** pandemic lessons

**2** new normal

# learning space





InnoBreakCafe

# learning space

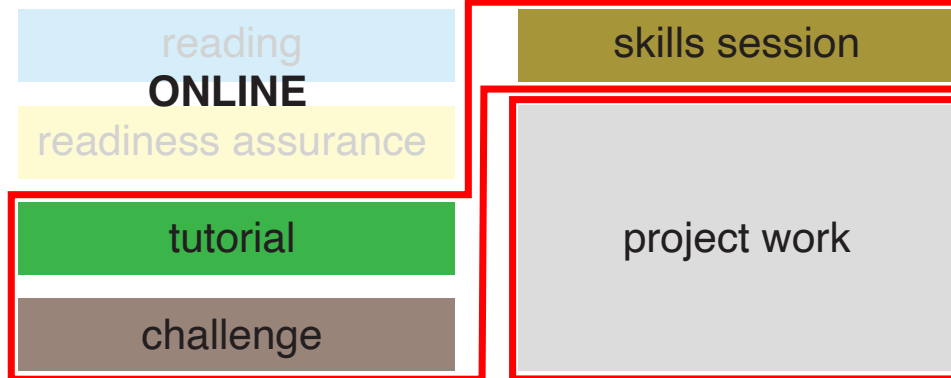
## COHORTS

A B C D

9:45

### content module

### practical work



FLEX SPACE

MAKERSPACE

Tuesday

11:00

11:15

12:30

9:45

Thursday

11:00

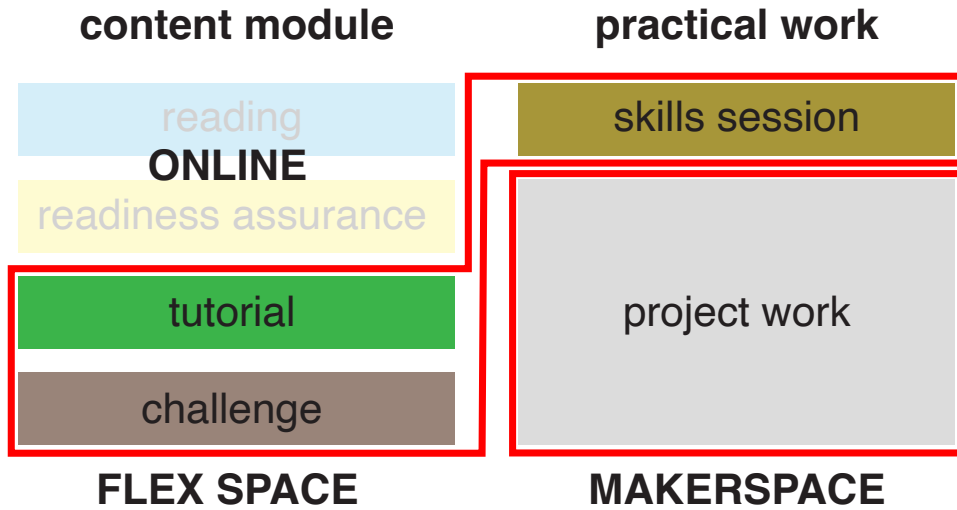
11:15

12:30

1 pandemic lessons

2 new normal

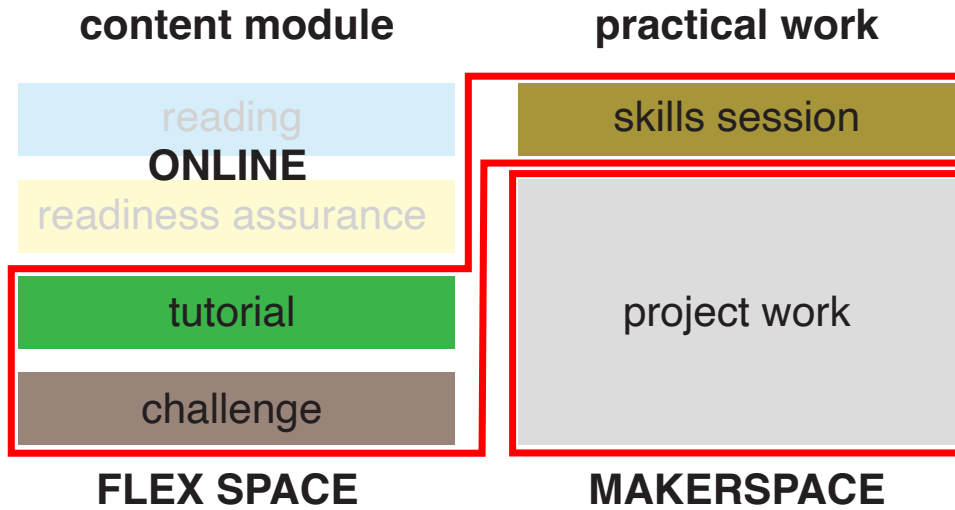
# learning space



**COHORTS**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
<b>Tuesday</b>	9:45	Team Review of Tutorial LL2.229	Project A.L.L	Skills LL2.223
	11:00			
	11:15	Project A.L.L	Skills LL2.223	Team Review of Tutorial LL2.229
<b>Thursday</b>	12:30			
	9:45			
	11:00			
	11:15			
12:30				

# learning space



**COHORTS**

	A	B	C	D
<b>Tuesday</b>	9:45	Team Review of Tutorial LL2.229	Project A.L.L	Skills LL2.223
	11:00			
	11:15	Project A.L.L	Skills LL2.223	Team Review of Tutorial LL2.229
	12:30			
<b>Thursday</b>	9:45	Team Review of Challenge LL2.229	Skills LL2.223	Project A.L.L
	11:00			
	11:15	Skills LL2.223	Project A.L.L	Team Review of Challenge LL2.229
	12:30			



**1** pandemic lessons

**2** new normal



**“breaking down classroom walls”**

**1 pandemic lessons**

**2 new normal**

# the new (not so) normal



**1** pandemic lessons

**2** new normal

# the new (not so) normal

- no lectures

**1** pandemic lessons

**2** new normal

# the new (not so) normal

- no lectures
- no exams

**1** pandemic lessons

**2** new normal



# the new (not so) normal

- no lectures
- no exams
- no (fixed) classroom

**1** pandemic lessons

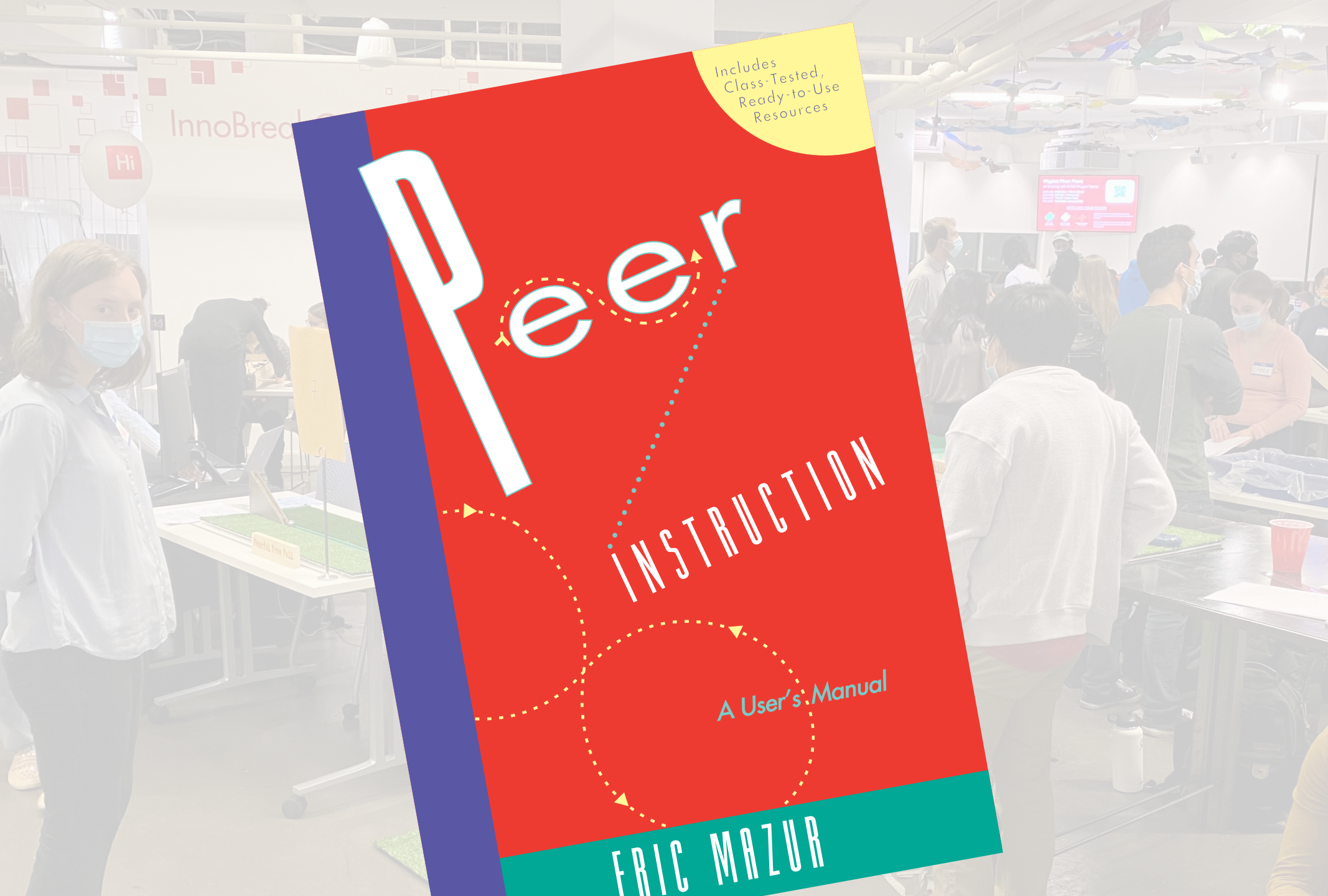
**2** new normal

# the new (not so) normal

- no lectures
- no exams
- no (fixed) classroom
- no (fixed) start or end time

**1** pandemic lessons

**2** new normal



Includes  
Class-Tested,  
Ready-to-Use  
Resources

# Peer

## INSTRUCTION

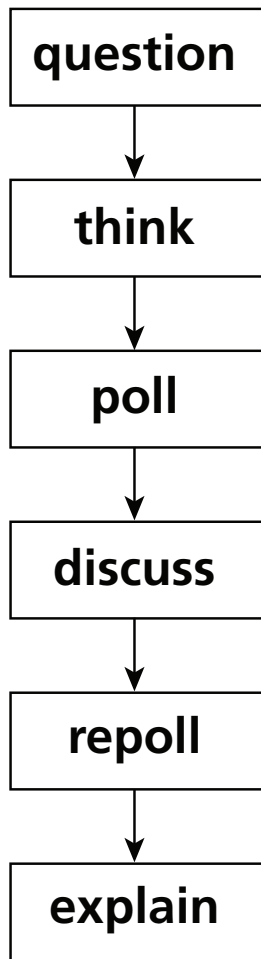
A User's Manual

### ERIC MAZUR

1 pandemic lessons

2 new normal

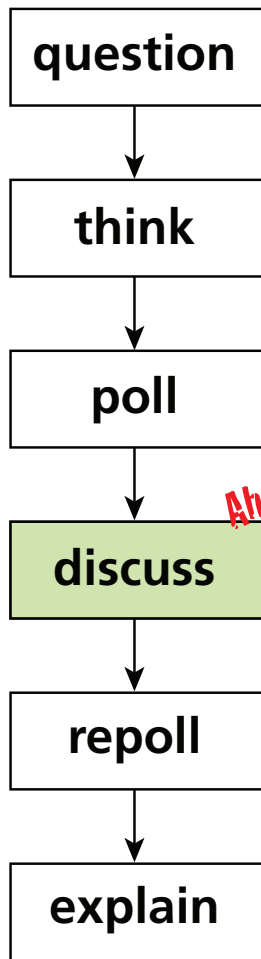
3 self-paced PI



**1** pandemic lessons

**2** new normal

**3** self-paced PI

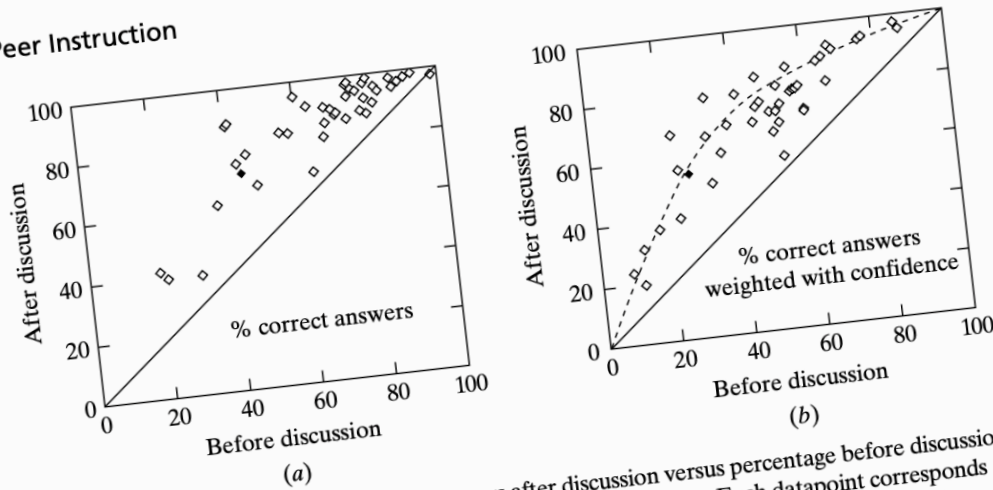


**1** pandemic lessons

**2** new normal

**3** self-paced PI

Peer Instruction

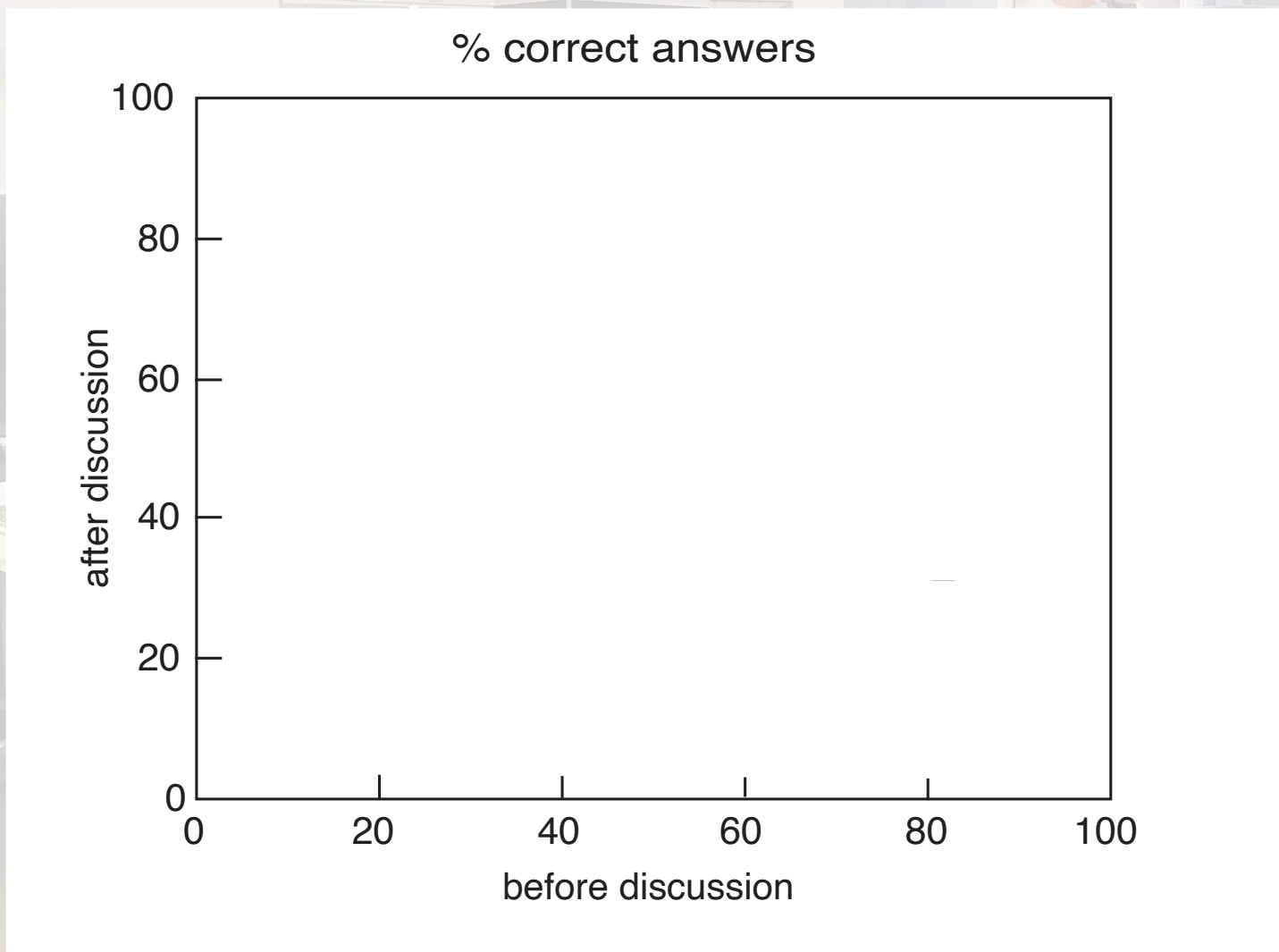


**Figure 2.3** (a) Percentage of correct answers after discussion versus percentage before discussion and (b) the same information weighted with the students' confidence. Each datapoint corresponds to a single *ConcepTest* question. The filled datapoint is for the buoyancy question in Figure 2.1.

Figure 2.4 shows how students revised their answers in the discussion of the buoyancy question posed in Figure 2.1. In fact, 29% correctly revised their initially incorrect answer, while only 3% changed from correct to incorrect. Figure 2.3 demonstrates that there is always an increase and never a decrease in the percentage of correct answers. The reason is that it is much easier to change the mind of someone who is wrong than it is to change the mind of someone who has selected the right answer for the right reasons. The observed improvement in confidence is also no surprise. Students who are initially right but not very confident become more confident when it appears that neighbors have chosen the same answer or when their confidence is reinforced by reasoning that leads to the right answer. At times, it seems that students are able to explain concepts to one another more effectively than are their teachers (see Figure 2.5). A likely explanation is that students who understand the concept when the question is posed have only recently mastered the idea and are still aware of the difficulties involved in grasping that concept. Consequently, they know precisely what to emphasize in

# in-class PI

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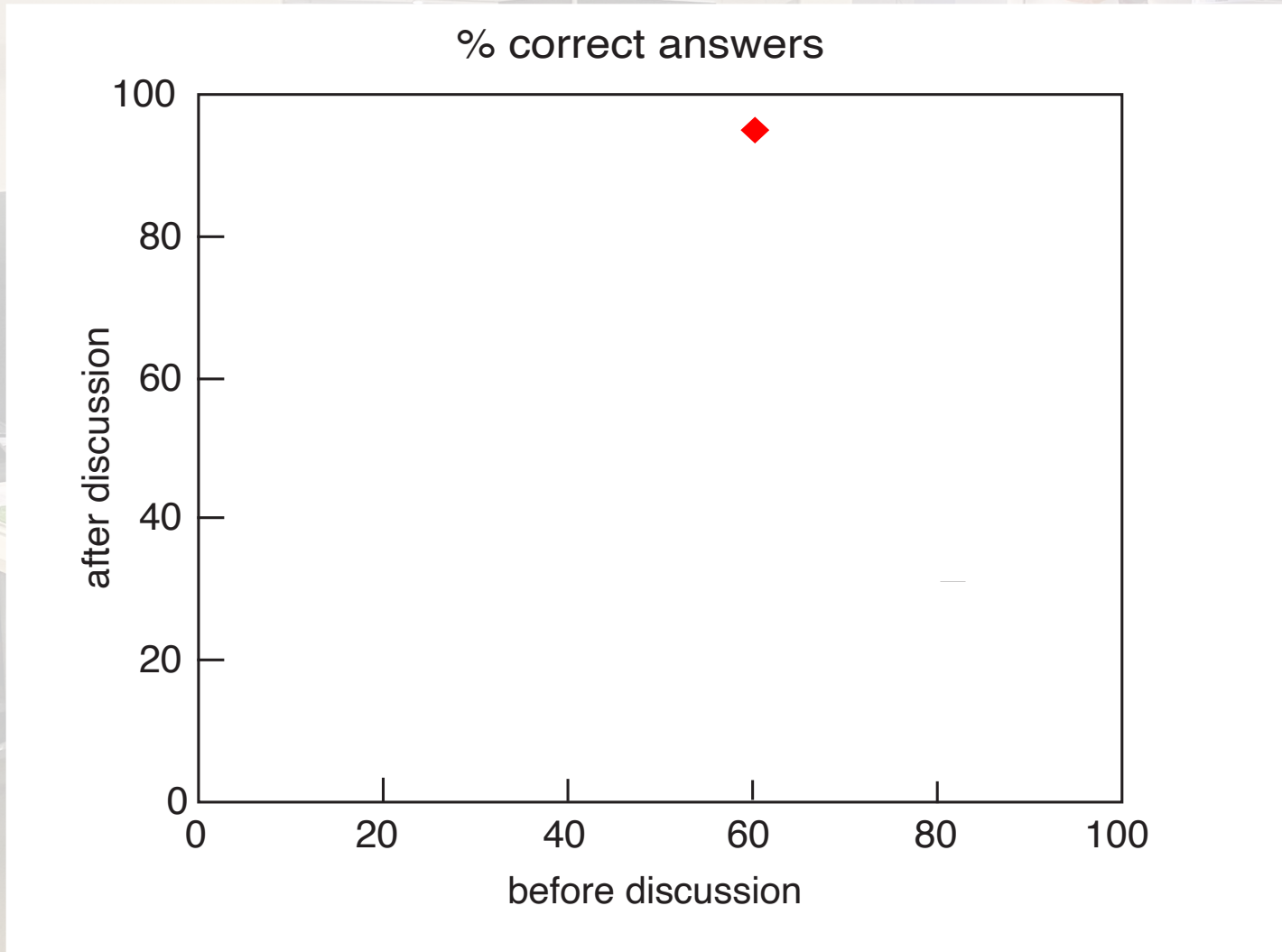


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI



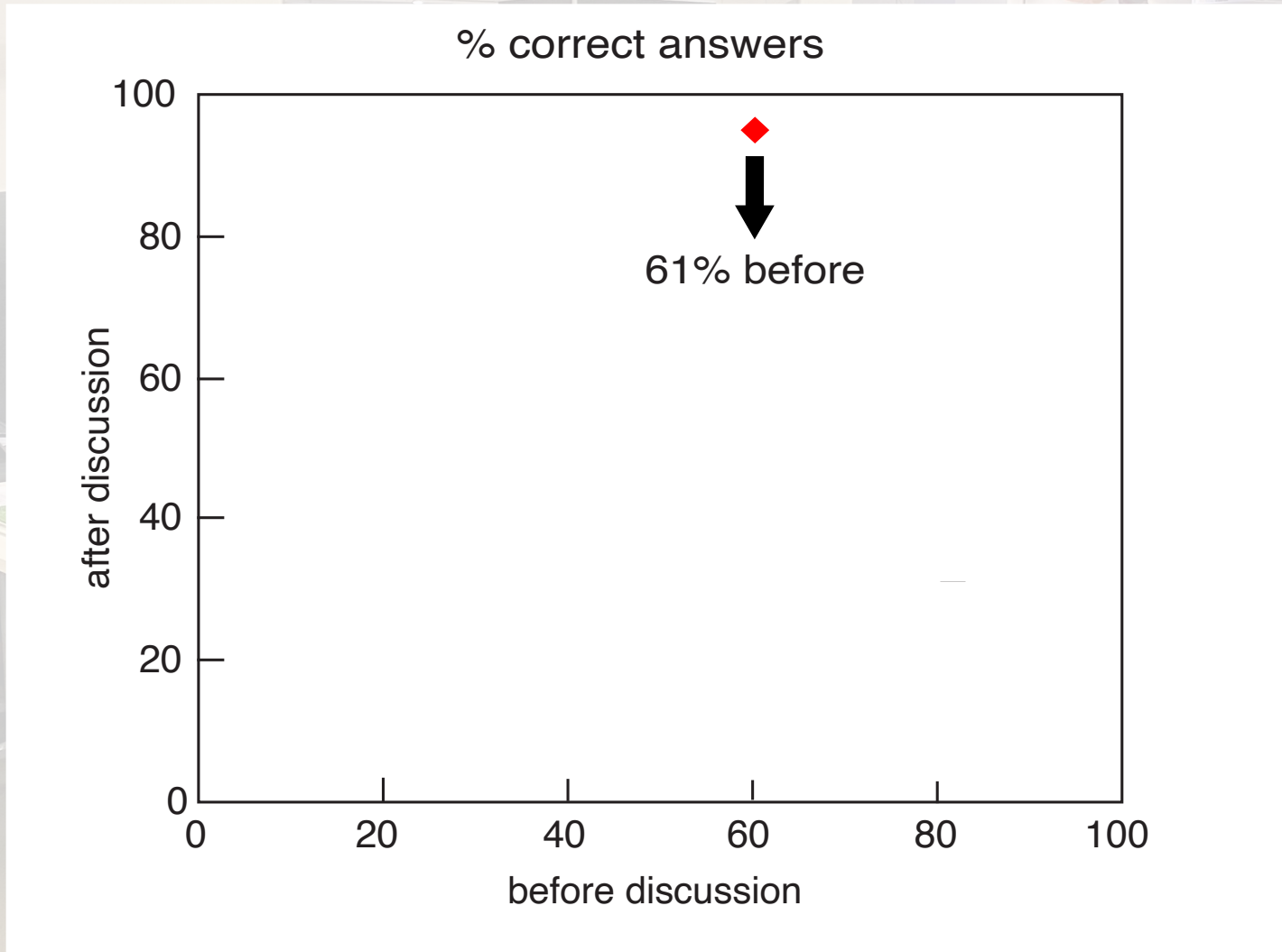
1 pandemic lessons

2 new normal

3 self-paced PI



# in-class PI

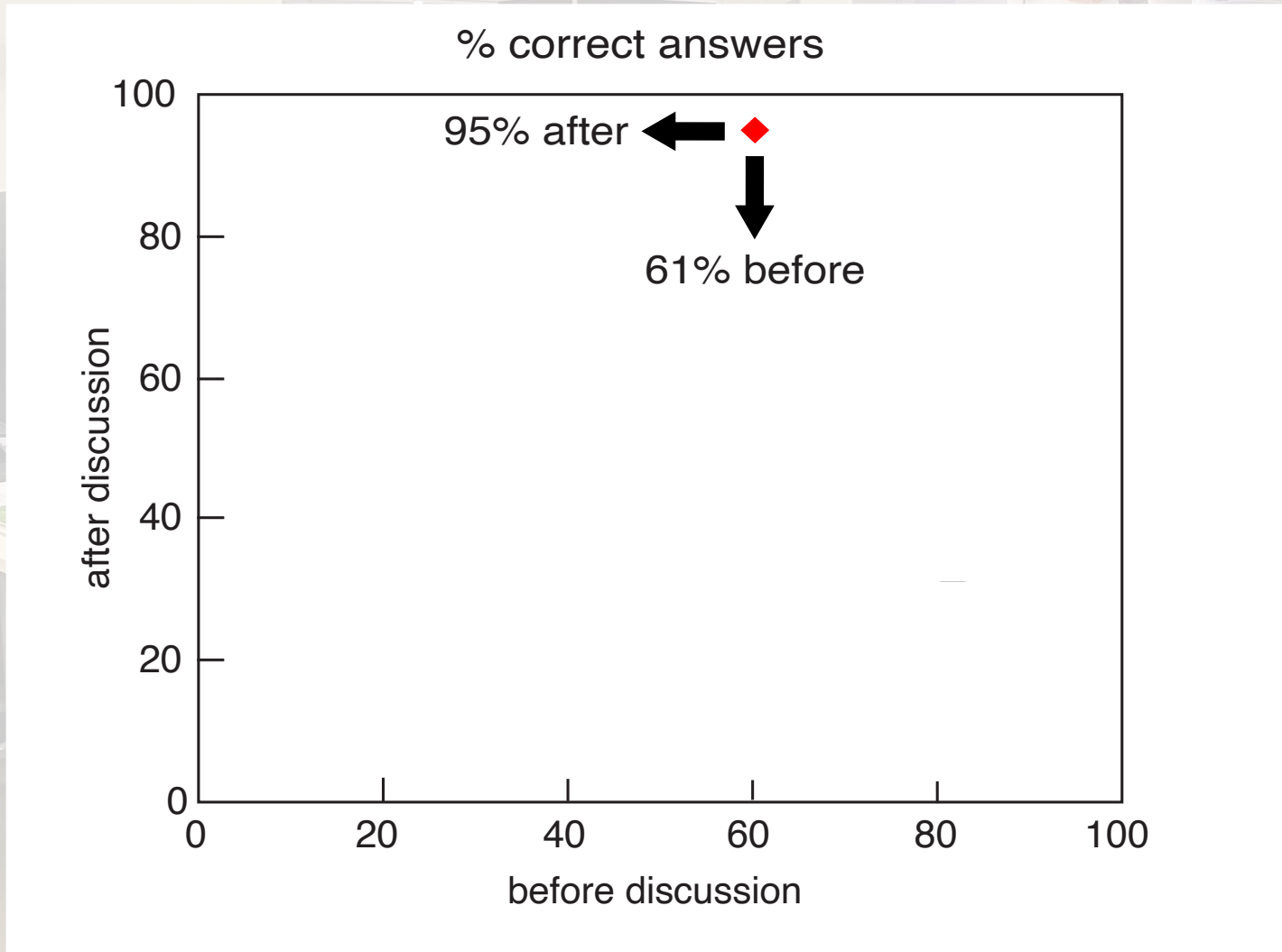


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI

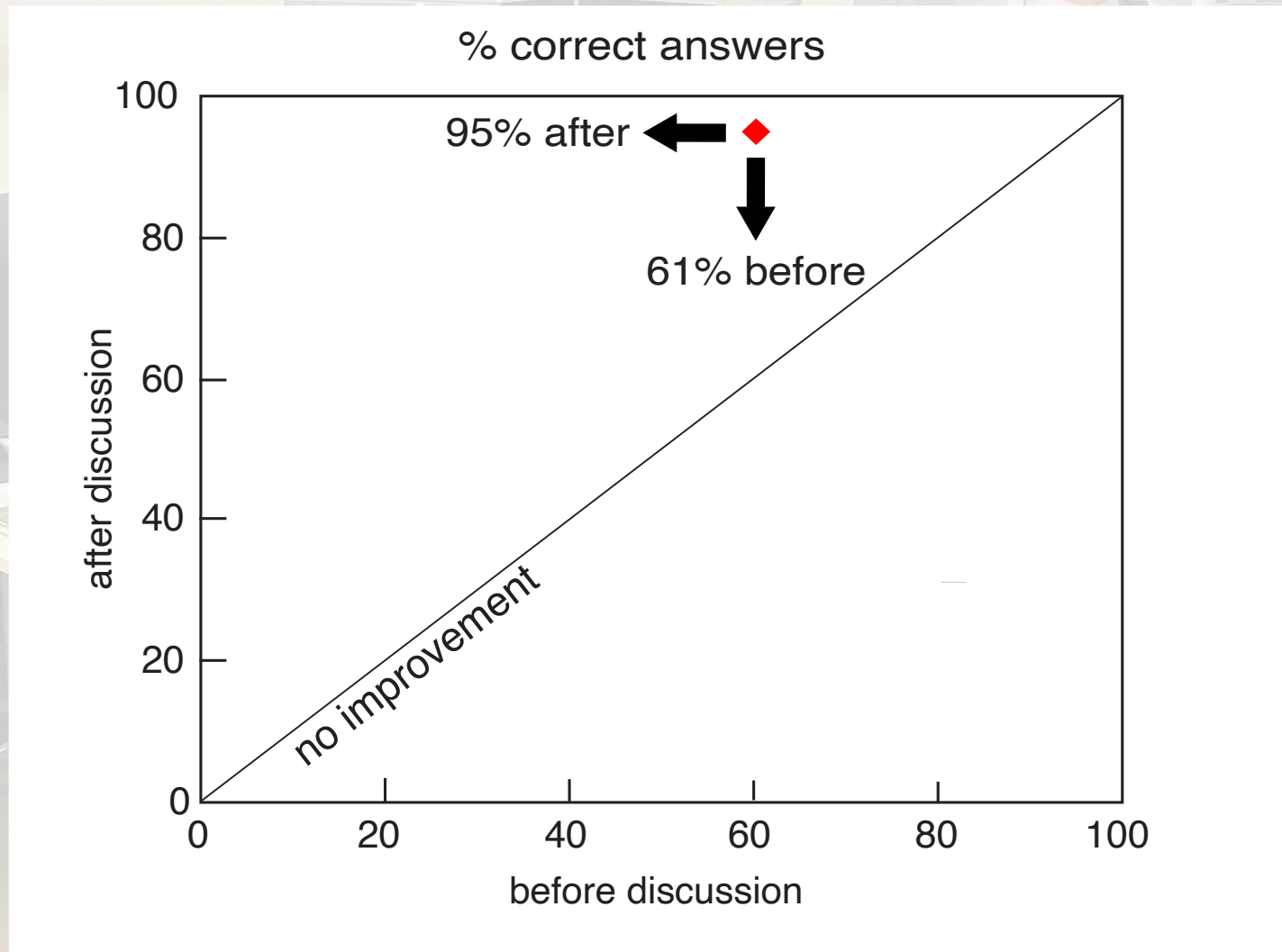


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI

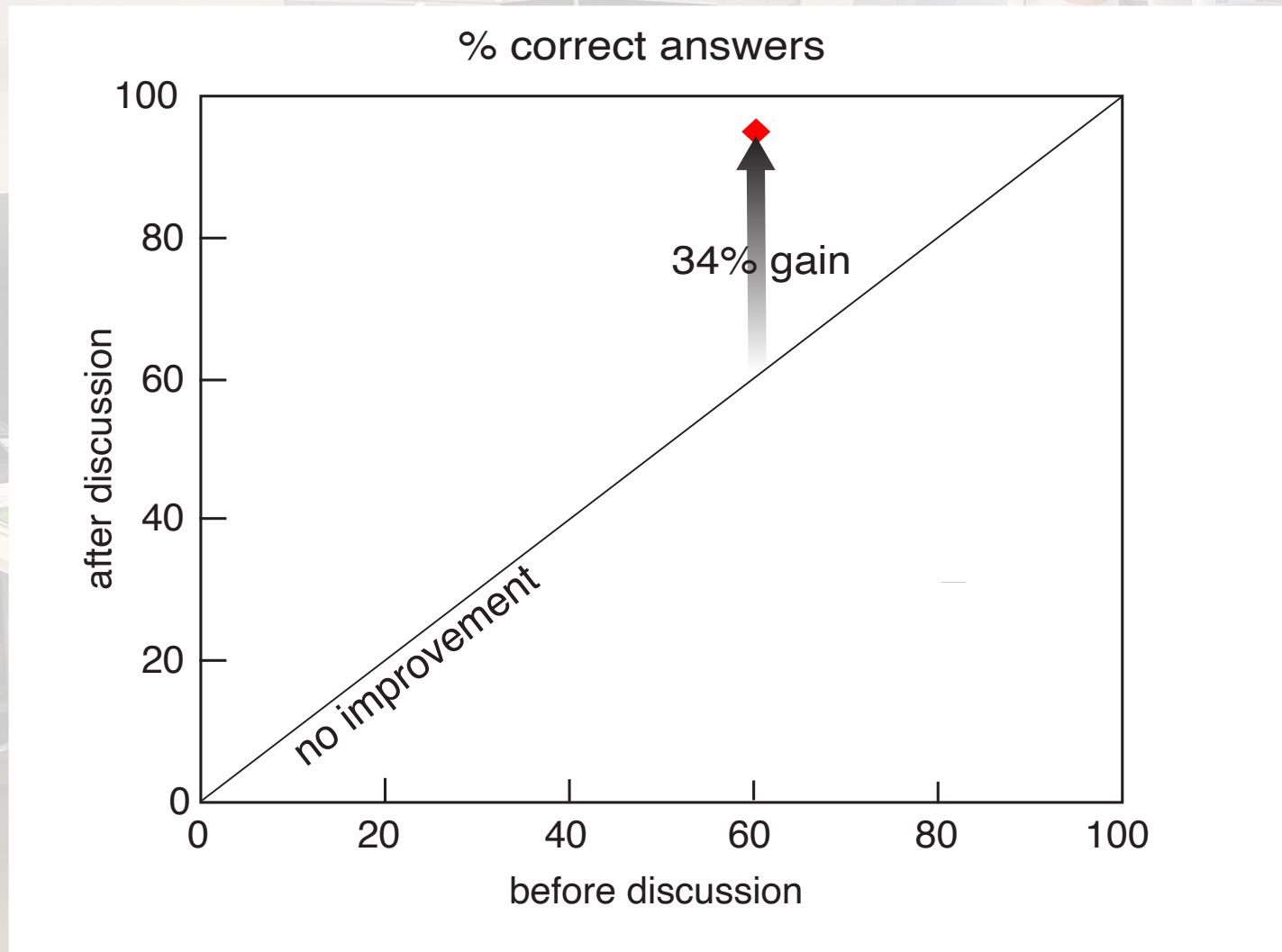


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI

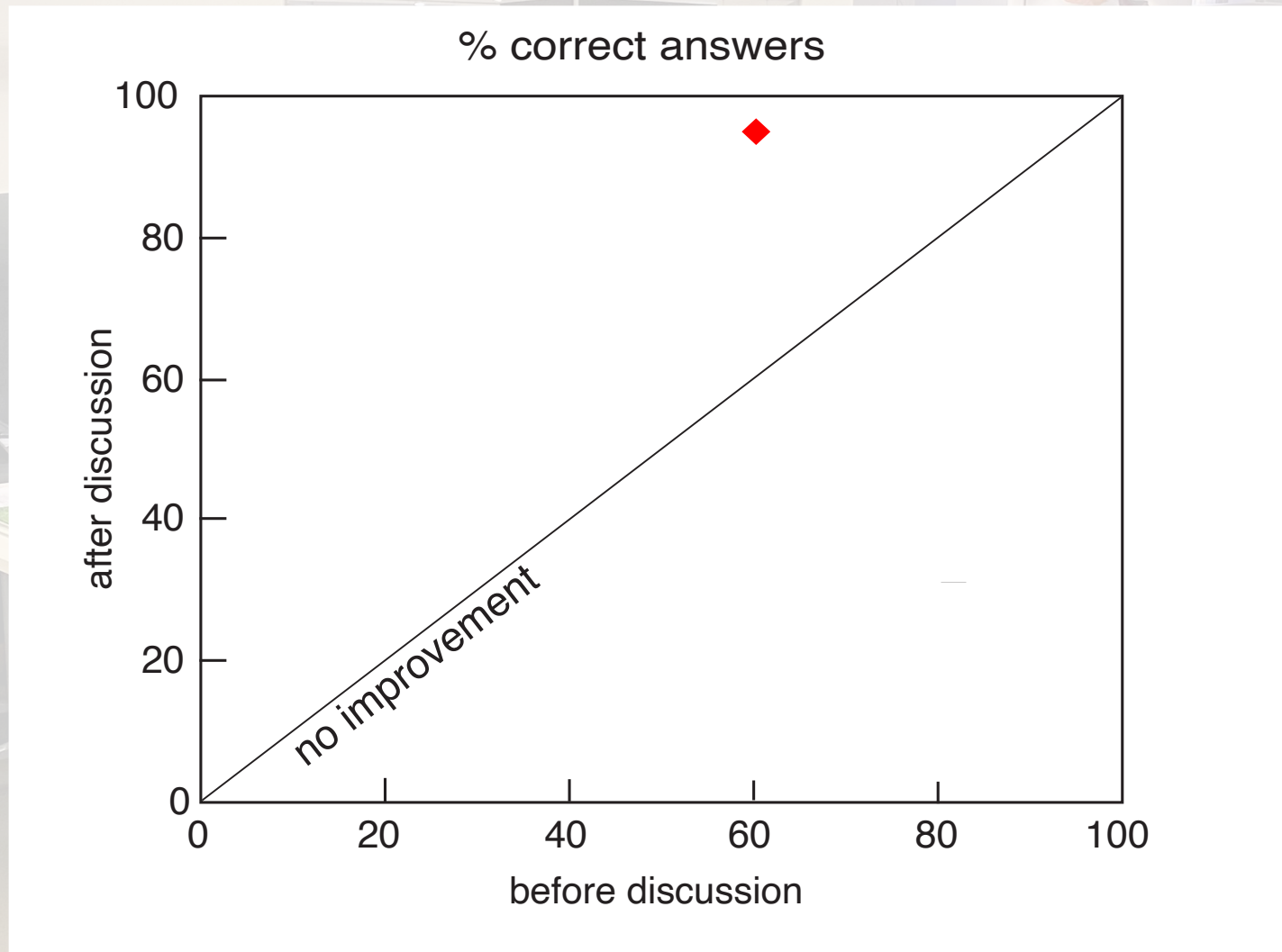


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI

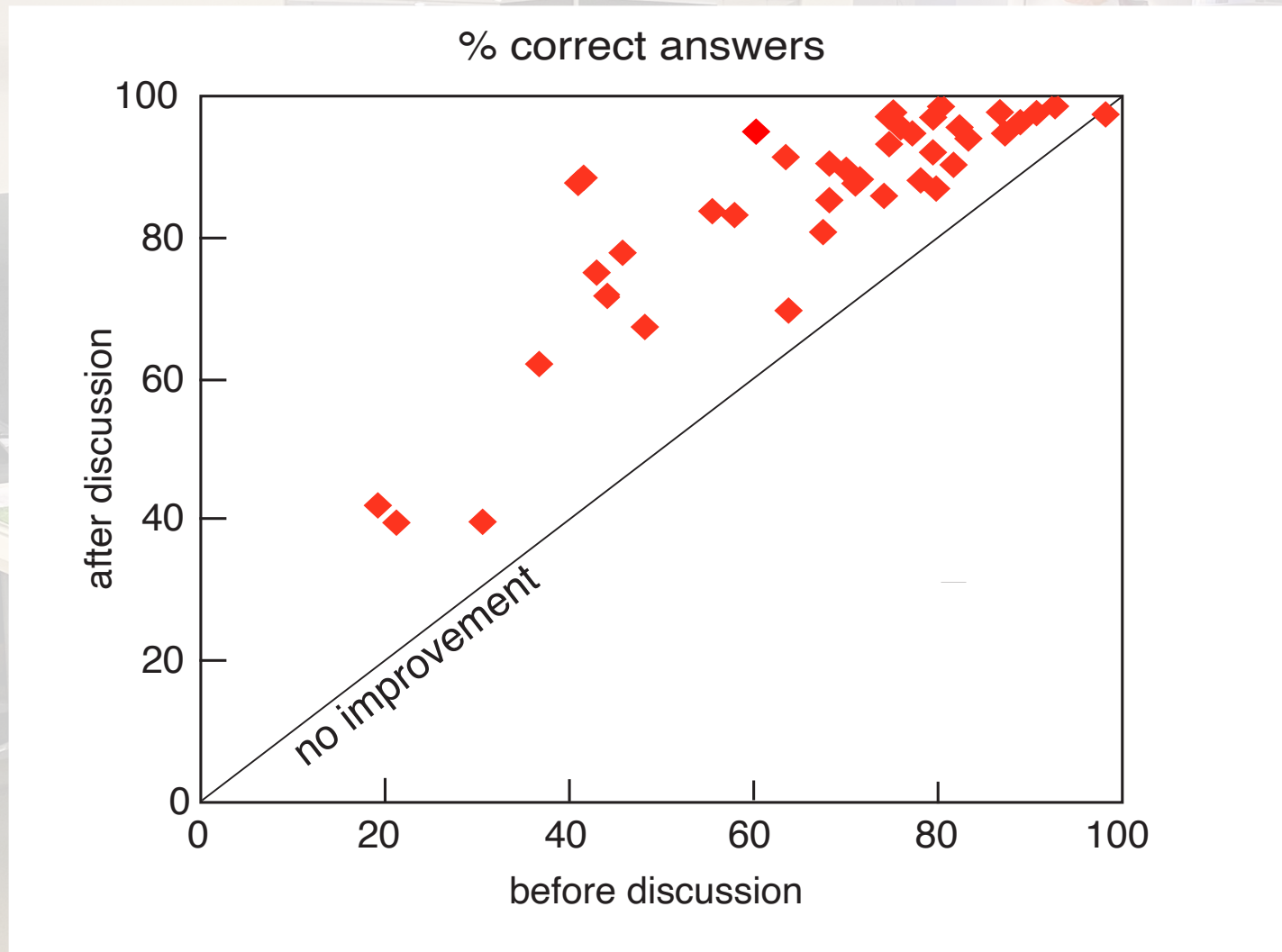


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI

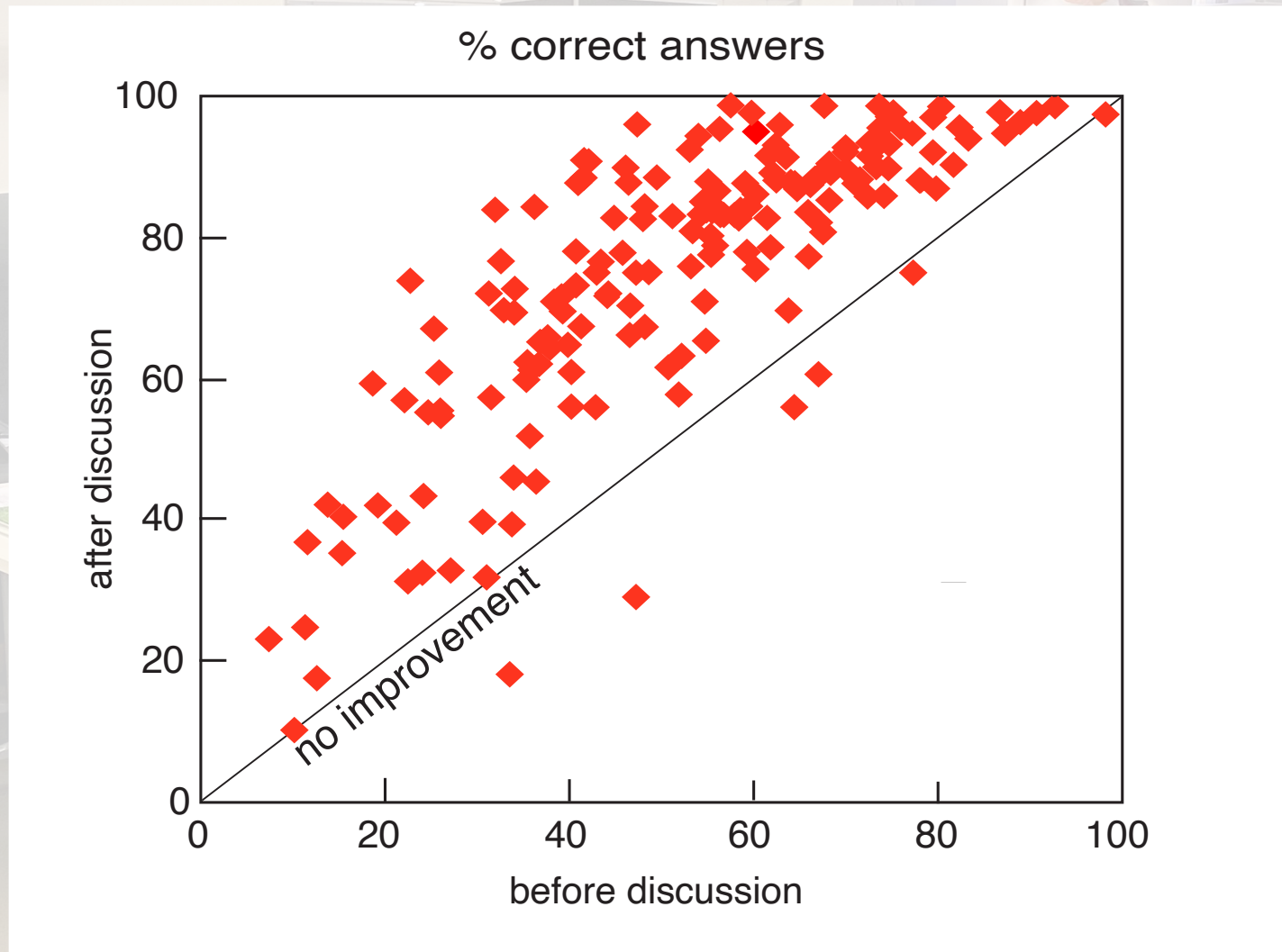


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI

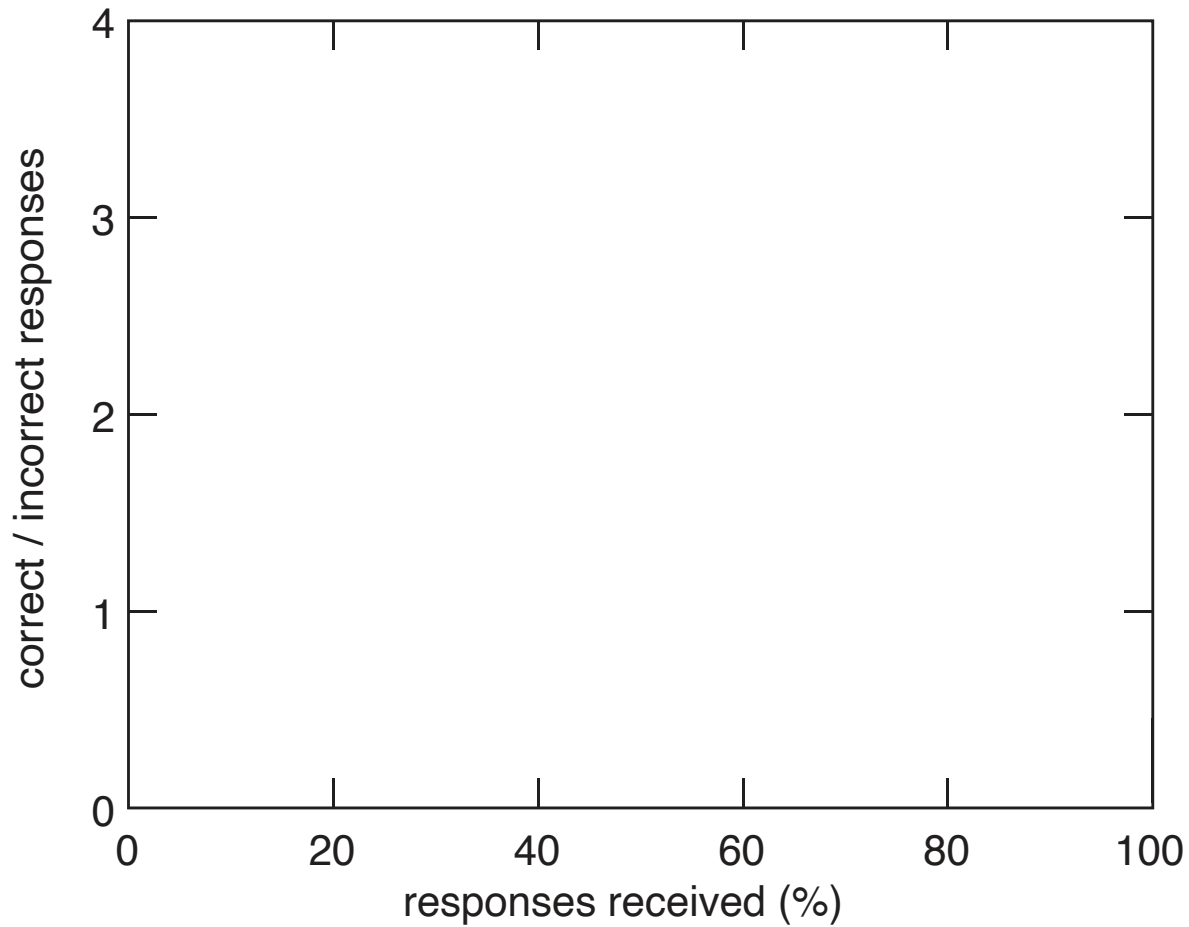


① pandemic lessons

② new normal

③ self-paced PI

# in-class PI: response time analysis



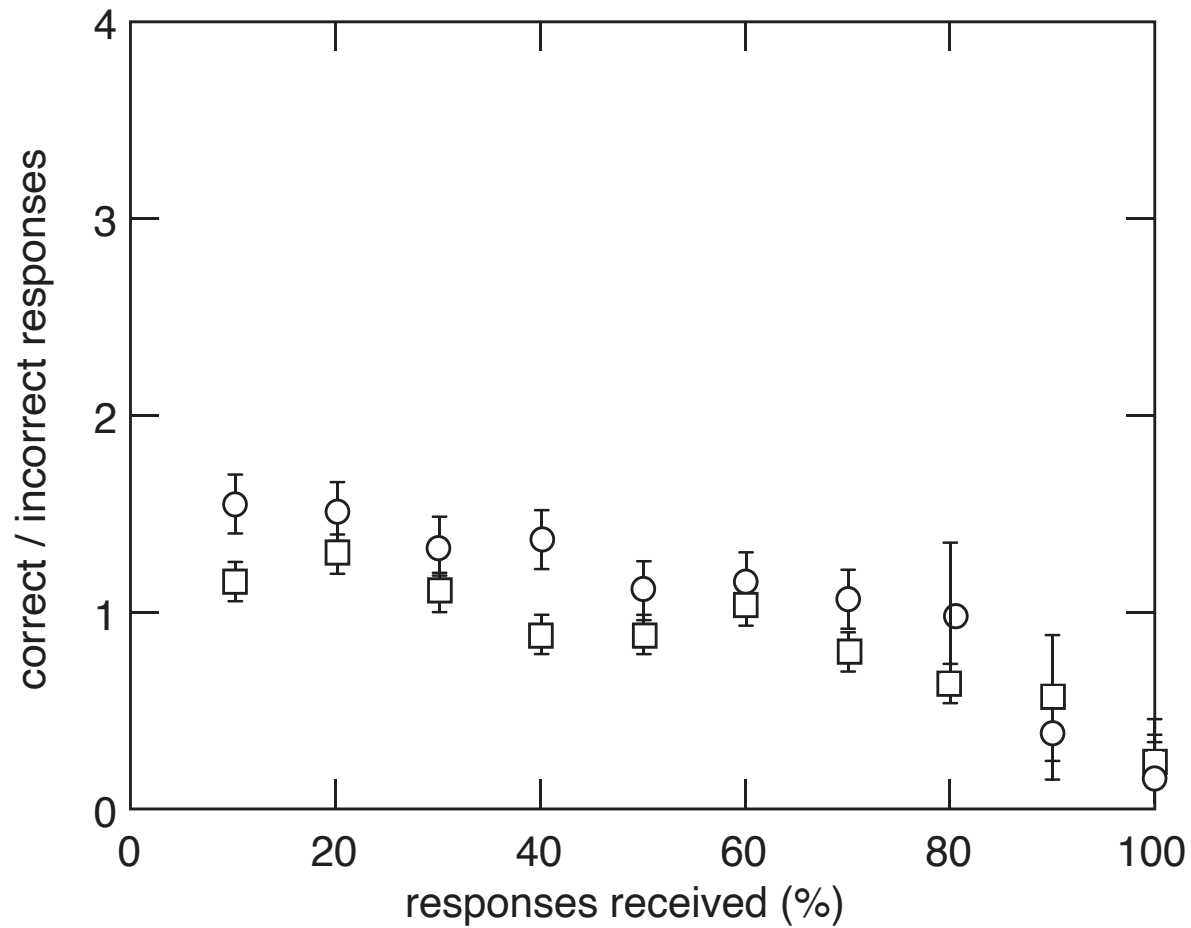
**1** pandemic lessons

**2** new normal

**3** self-paced PI



# in-class PI: response time analysis



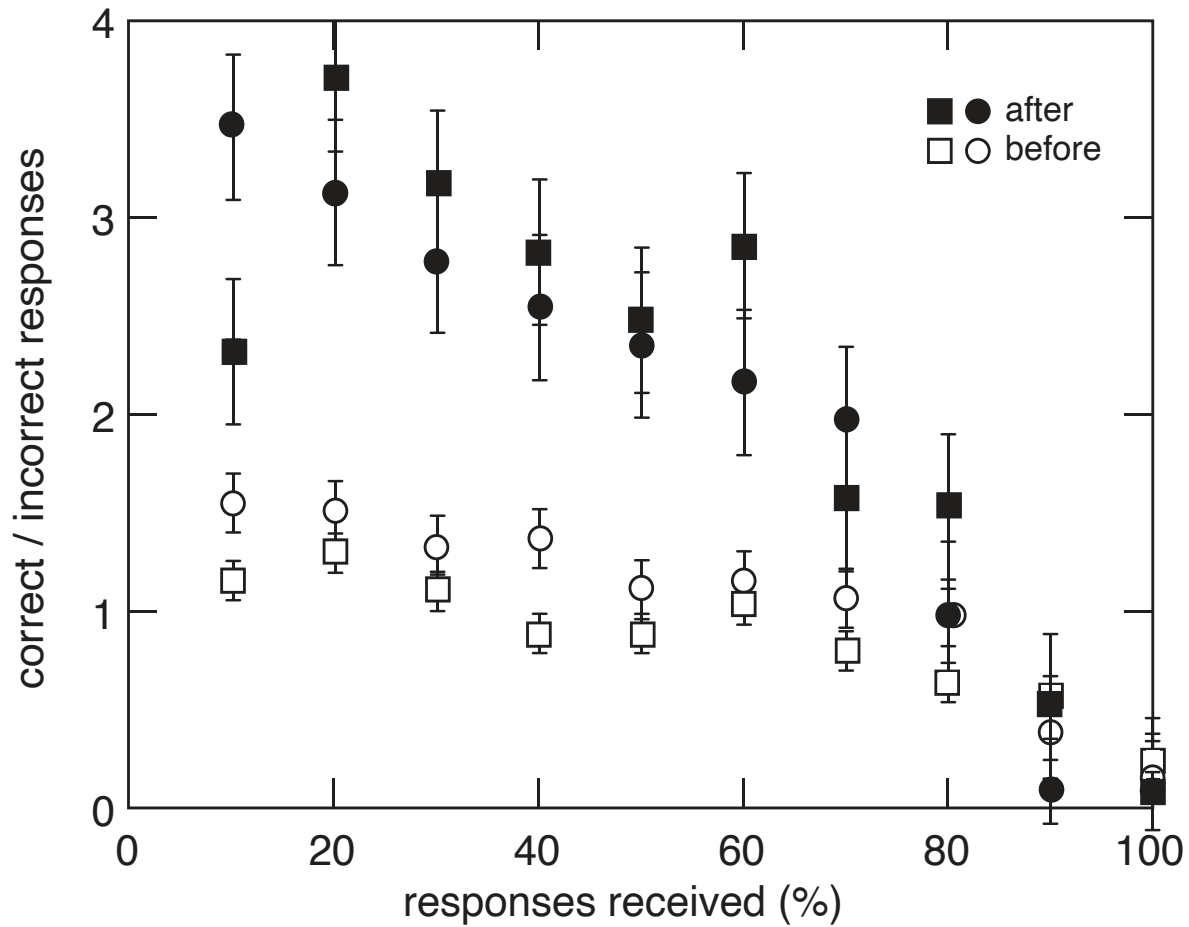
1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI: response time analysis

InnoBreakCafe

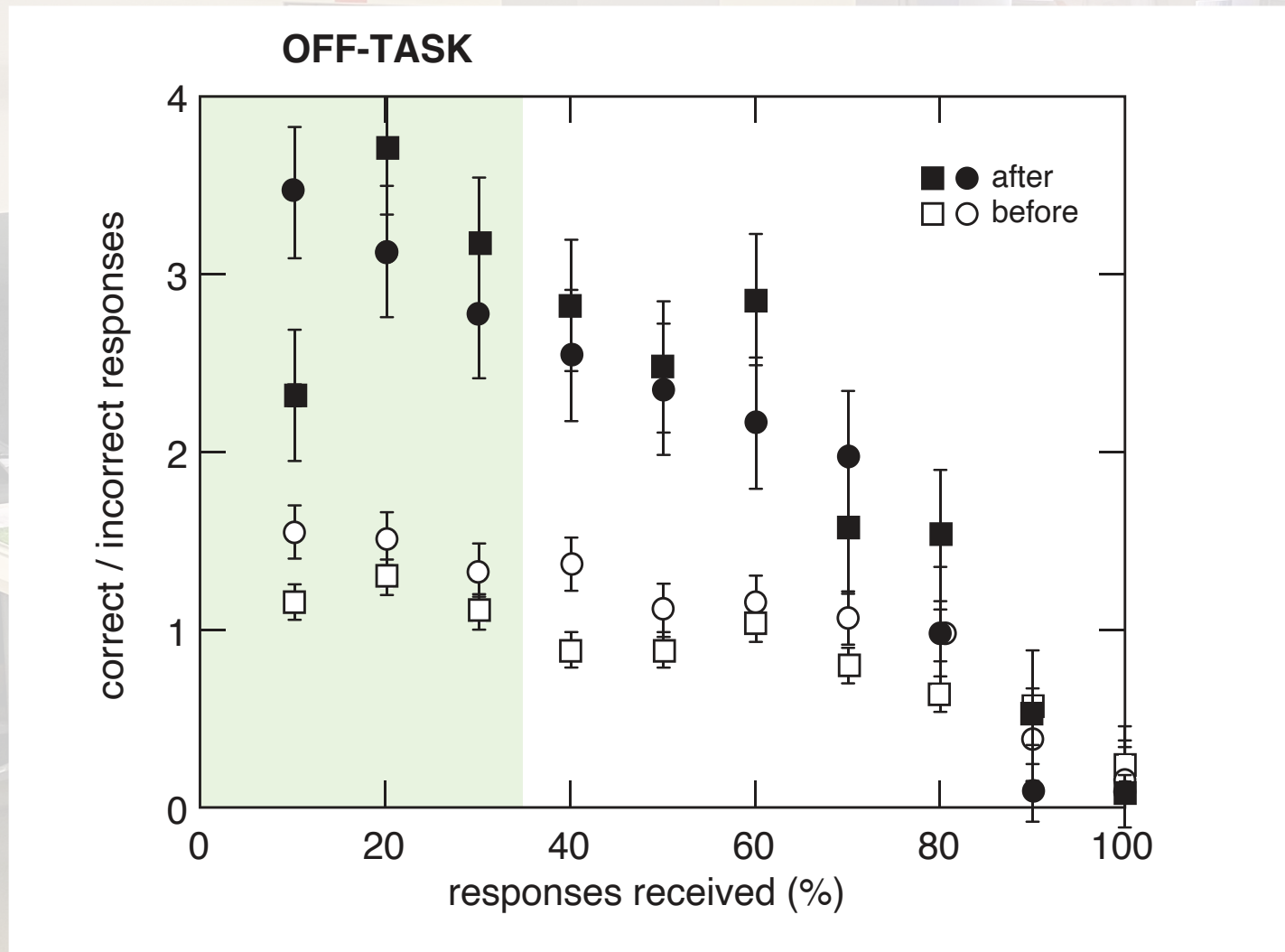


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI: response time analysis

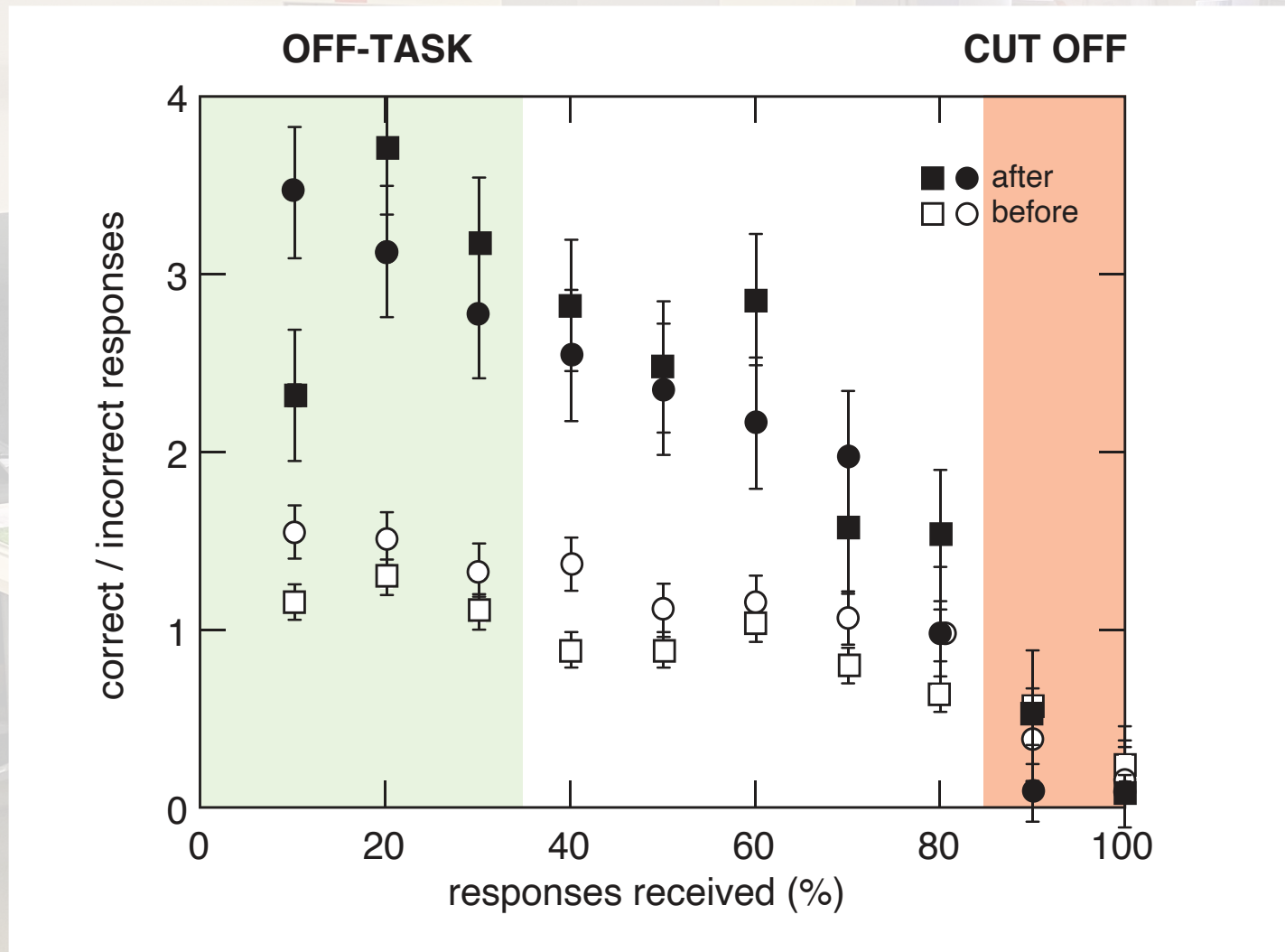


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI: response time analysis

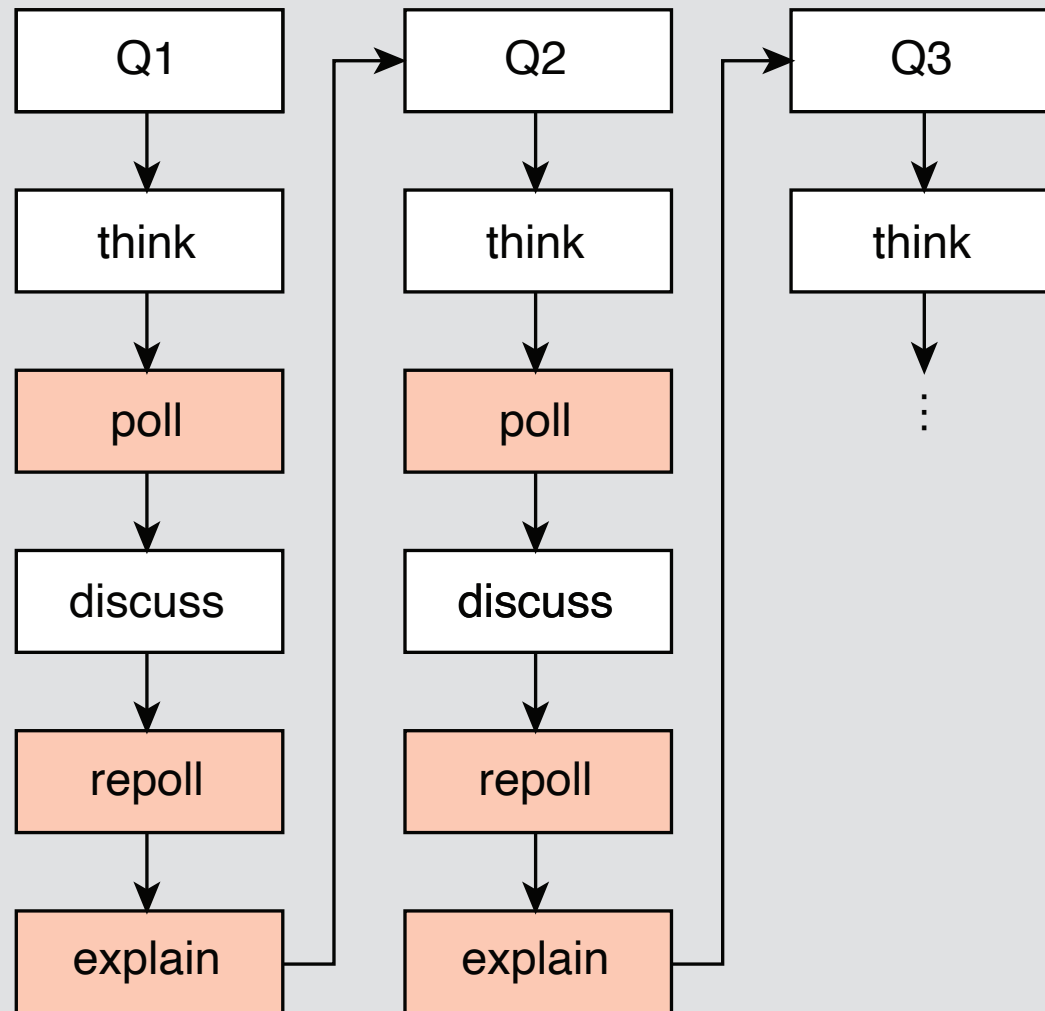


1 pandemic lessons

2 new normal

3 self-paced PI

# in-class PI: class sequence



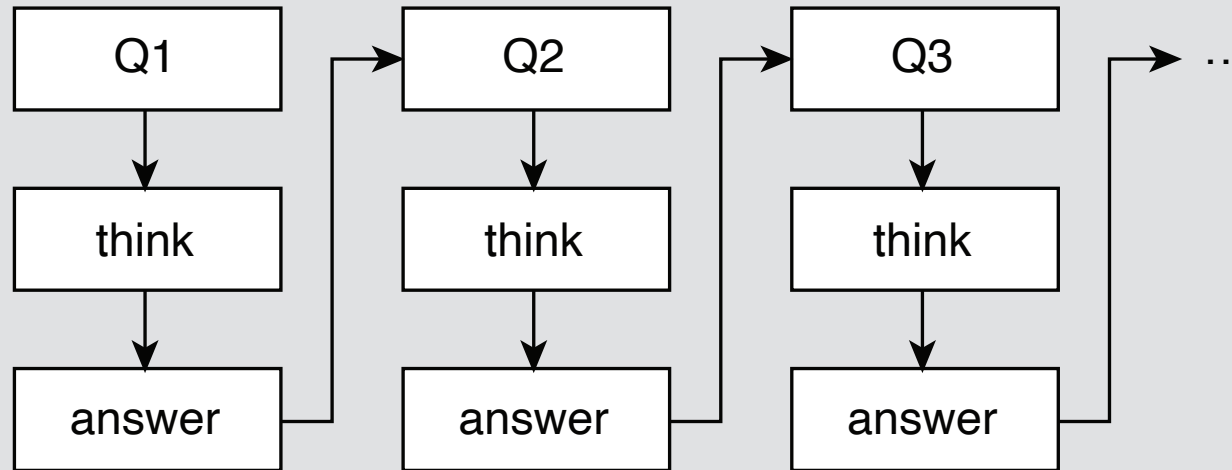
1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced PI: two phases

## INDIVIDUAL PHASE



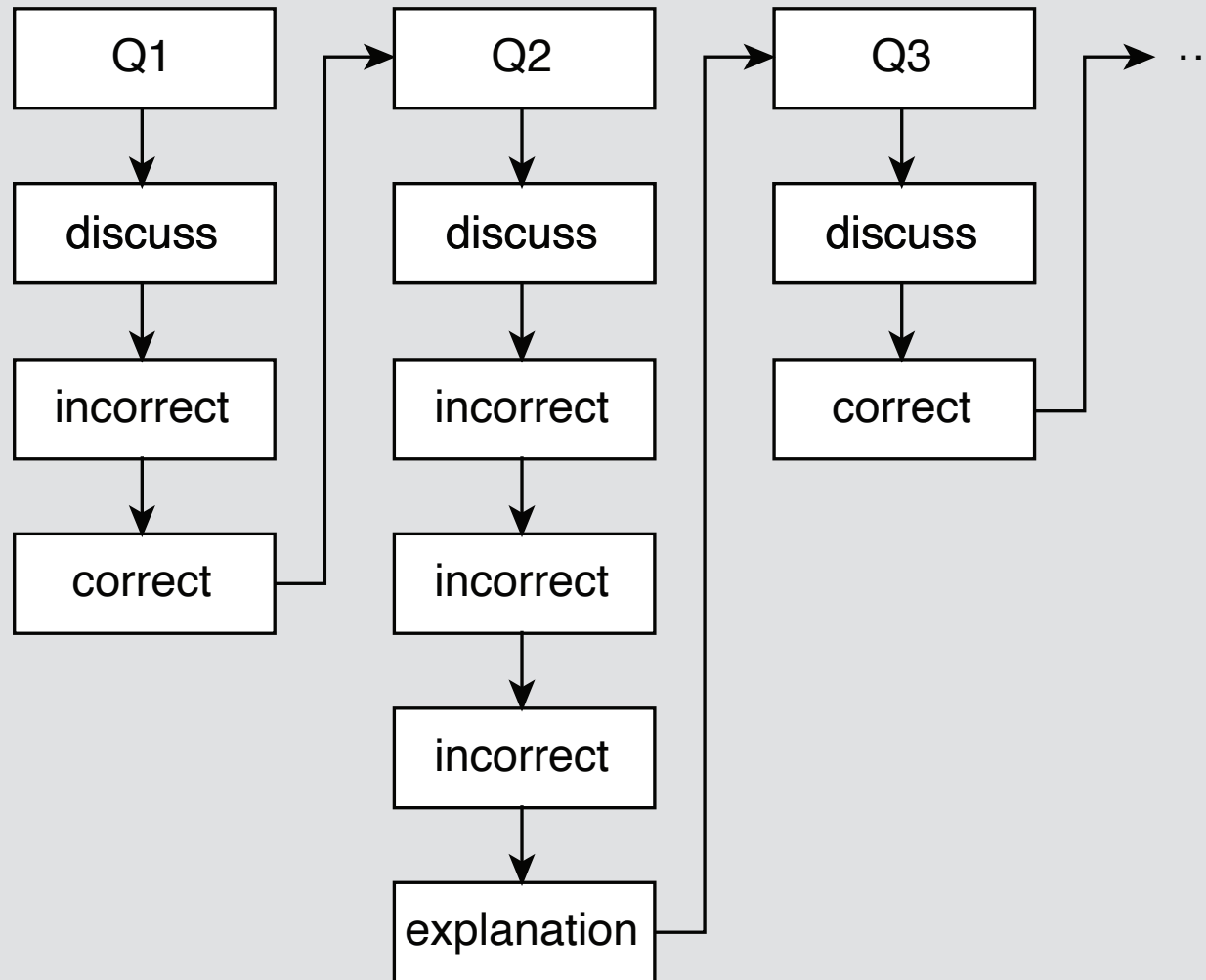
**1** pandemic lessons

**2** new normal

**3** self-paced PI

# self-paced PI: two phases

## TEAM PHASE



1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced PI: attempts & points

Question

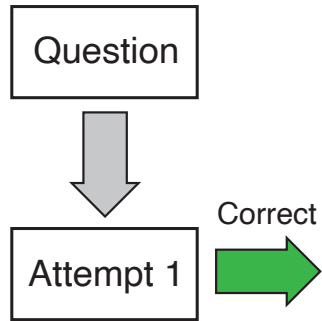
**1** pandemic lessons

**2** new normal

**3** self-paced PI



# self-paced PI: attempts & points

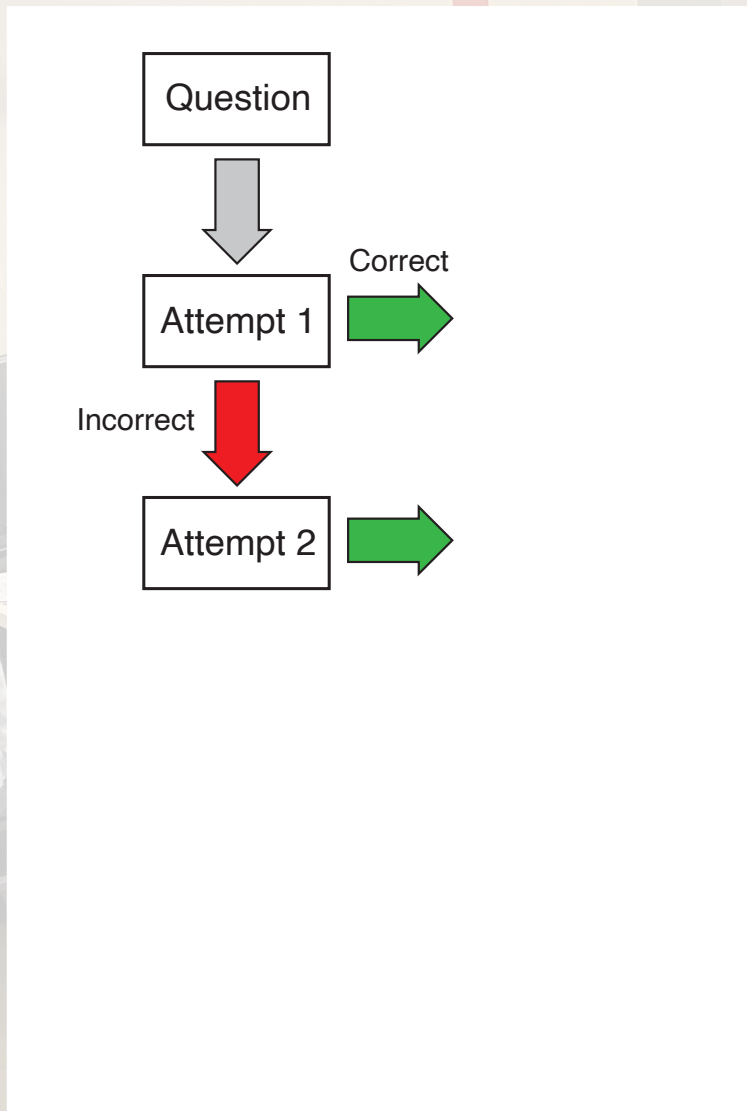


**1** pandemic lessons

**2** new normal

**3** self-paced PI

# self-paced PI: attempts & points

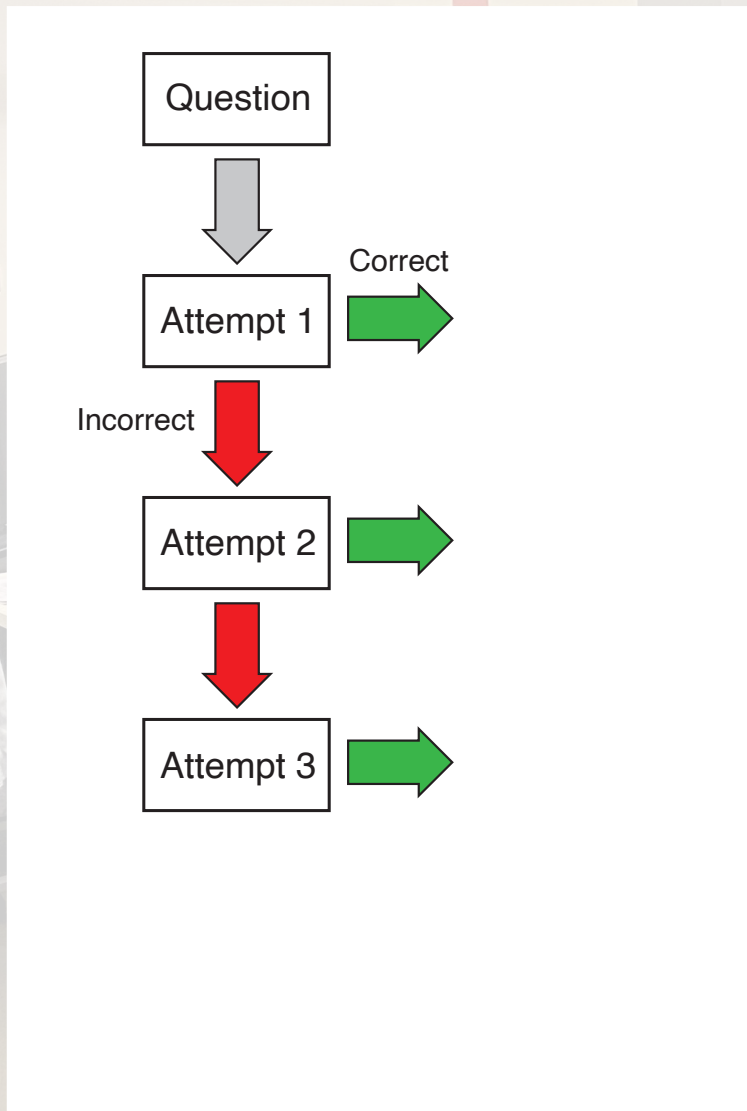


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced PI: attempts & points

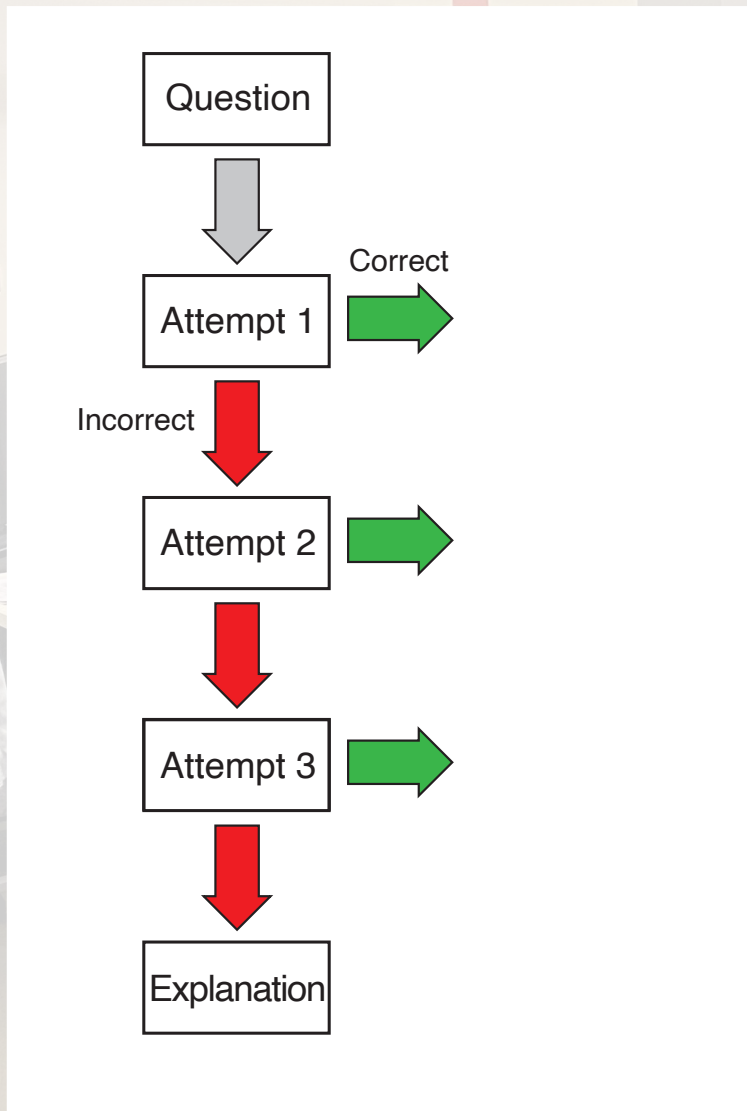


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced PI: attempts & points

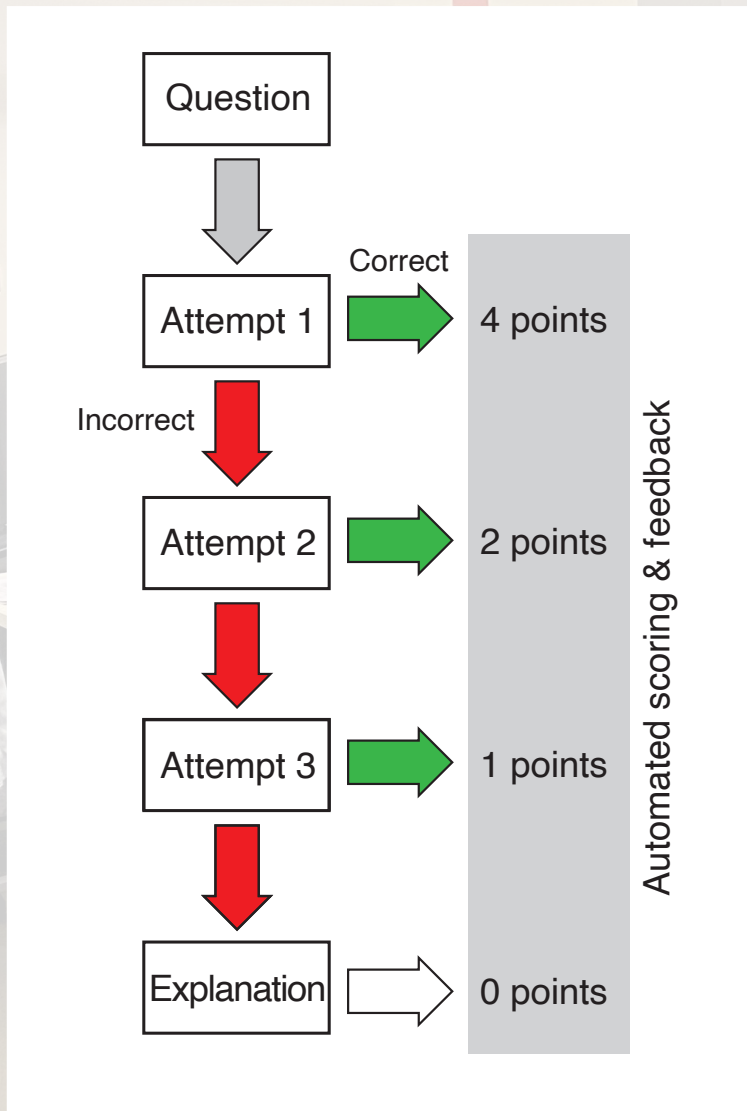


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced PI: attempts & points

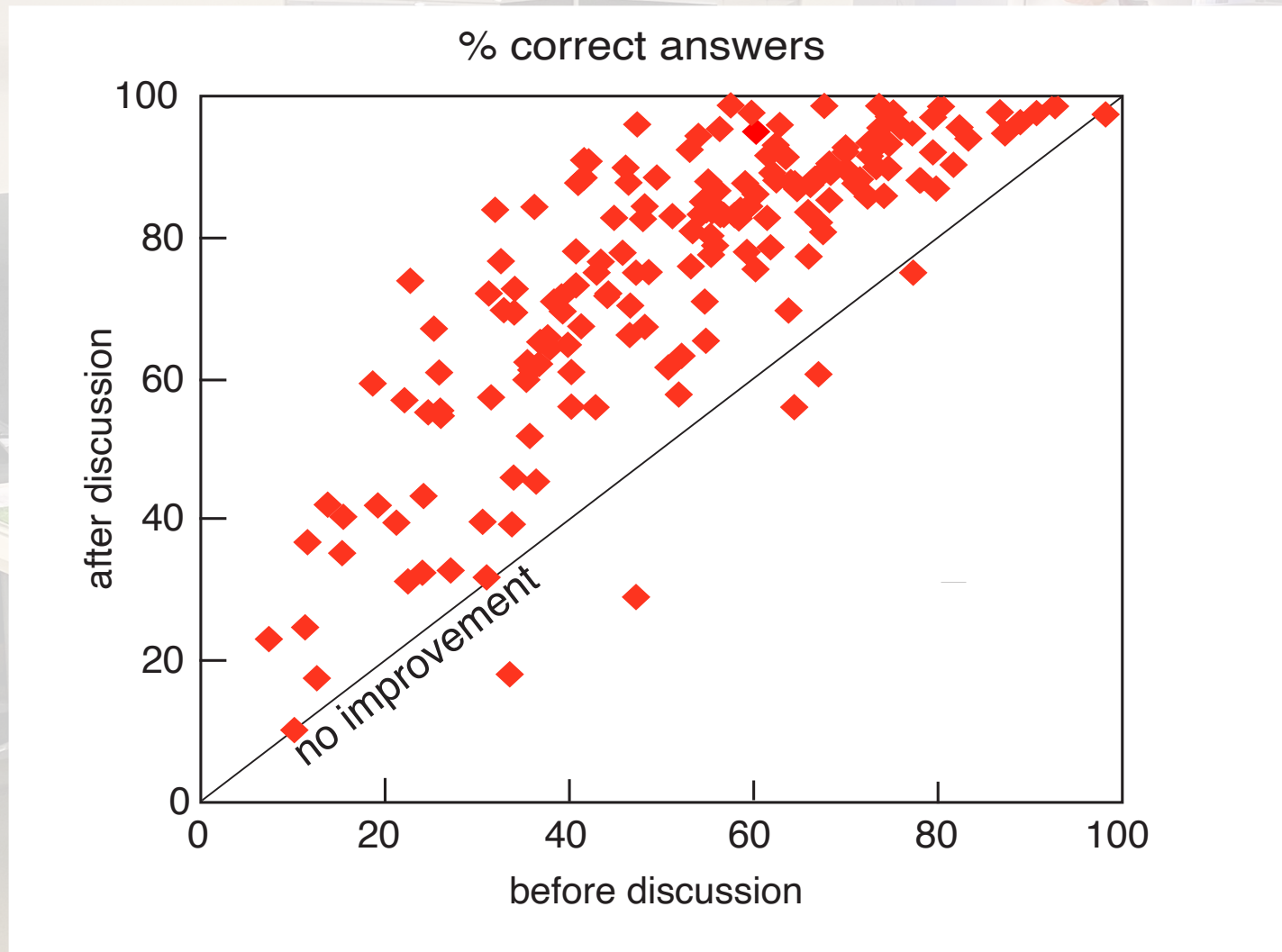


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced vs. in-class PI

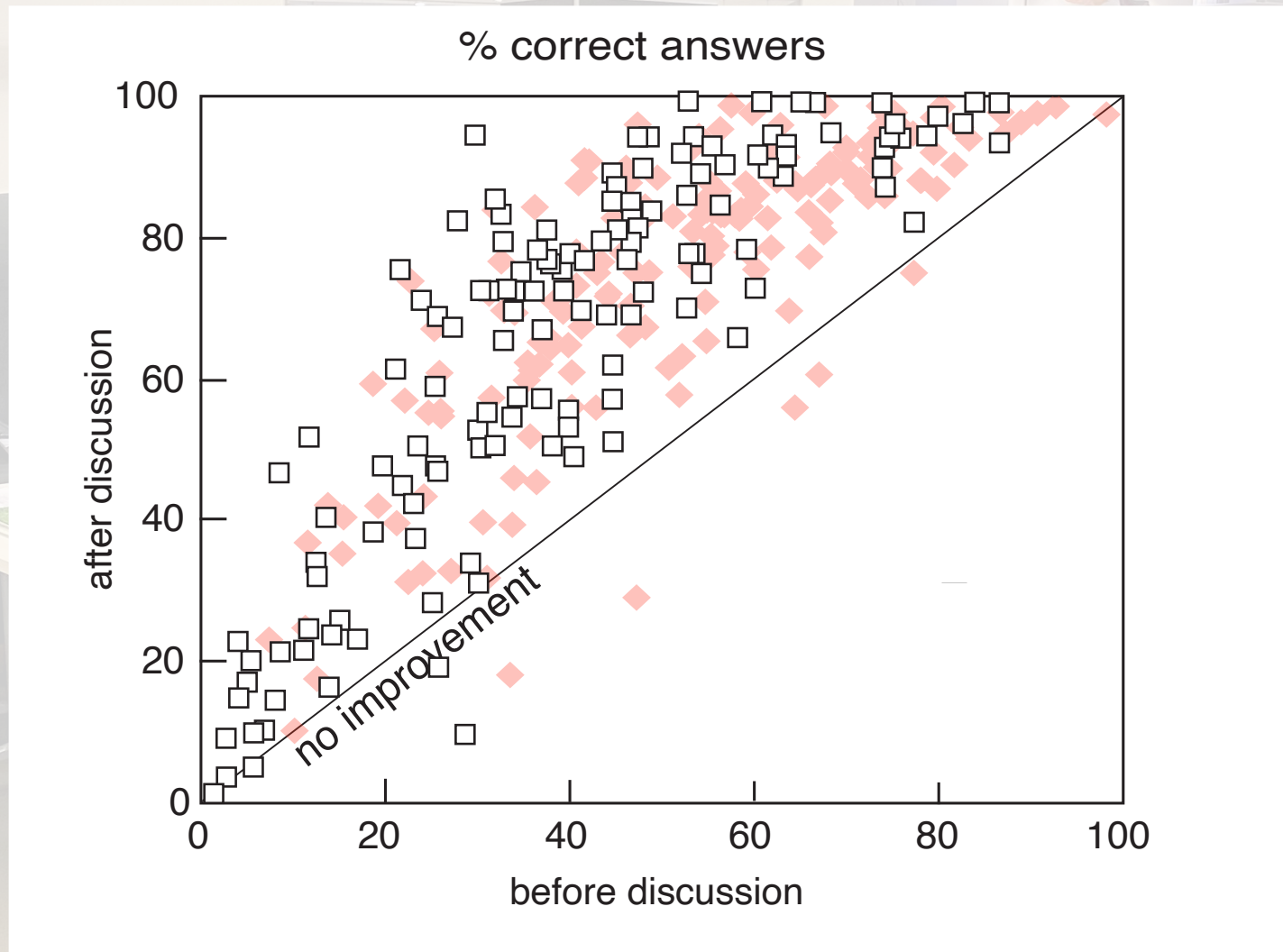


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced vs. in-class PI

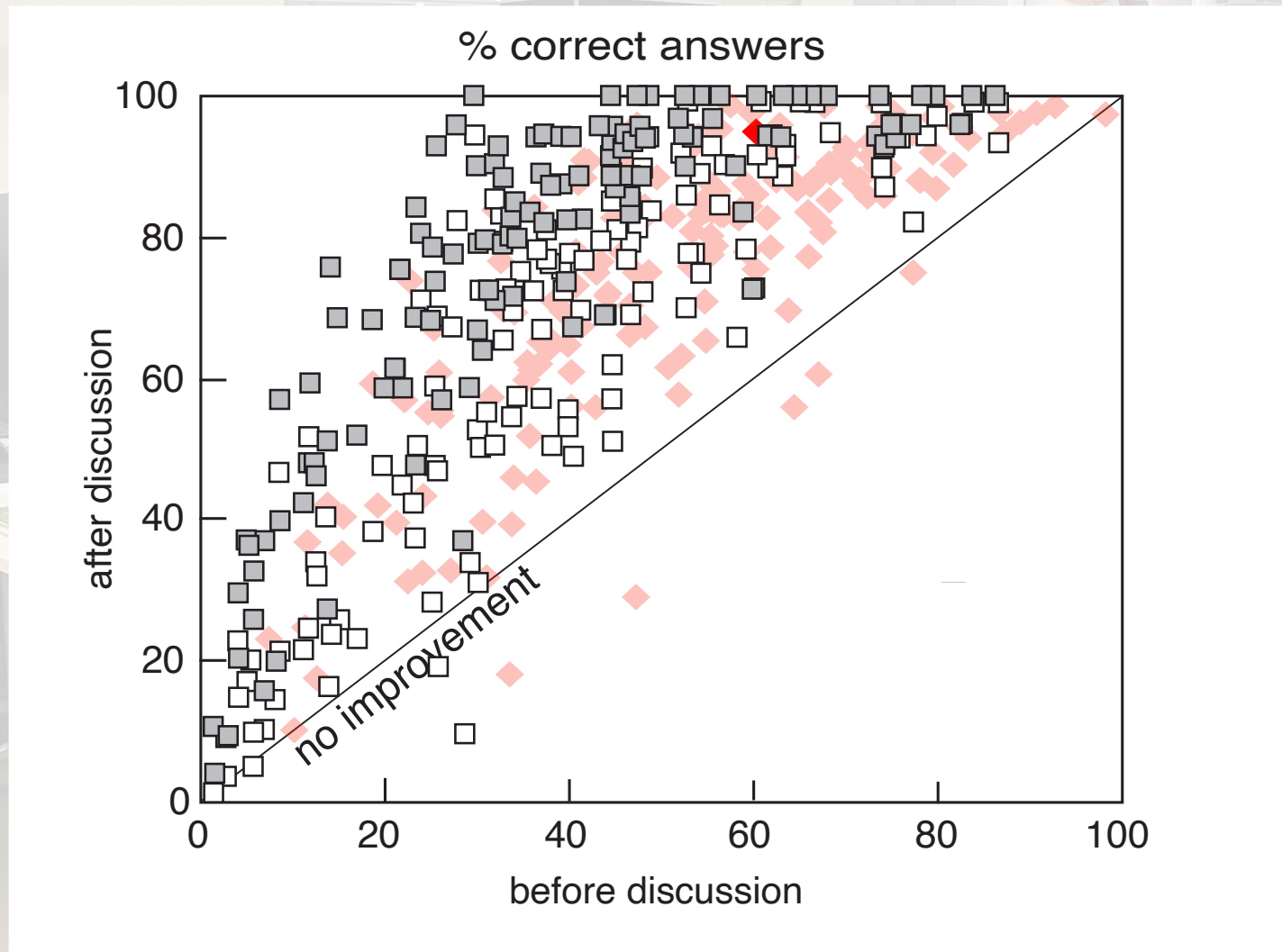


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced vs. in-class PI



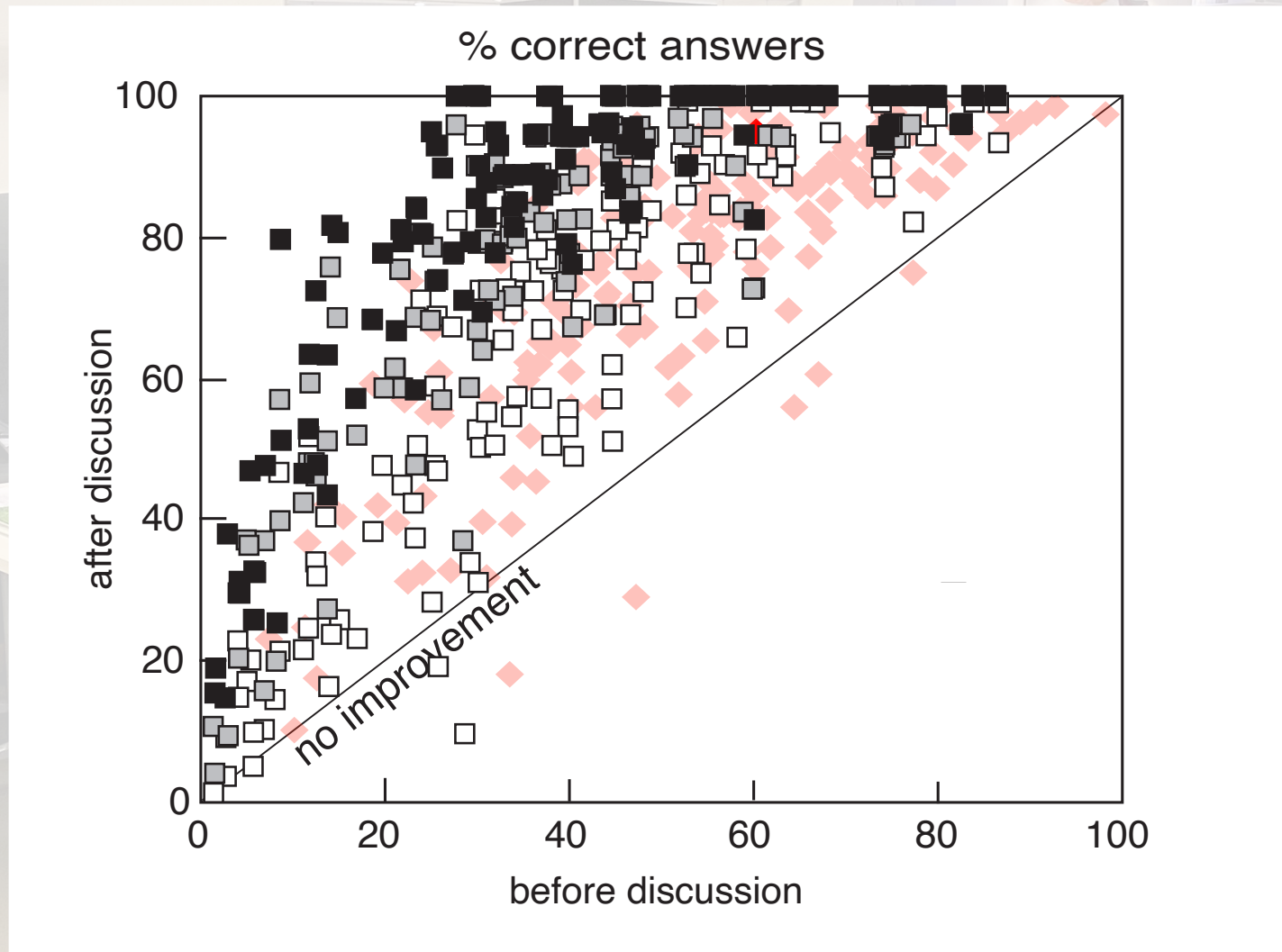
1 pandemic lessons

2 new normal

3 self-paced PI



# self-paced vs. in-class PI

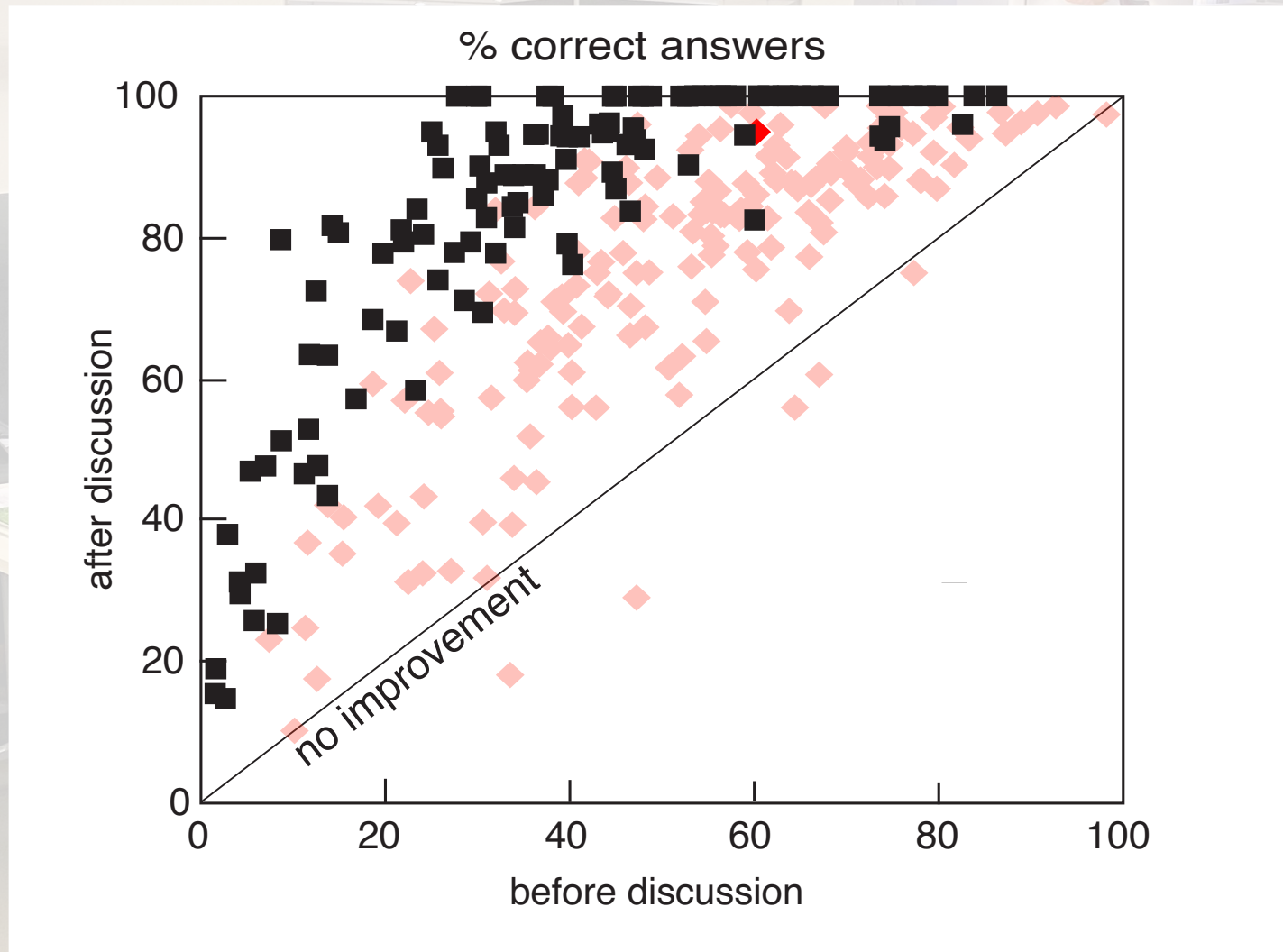


1 pandemic lessons

2 new normal

3 self-paced PI

# self-paced vs. in-class PI



1 pandemic lessons

2 new normal

3 self-paced PI



---

**in-class PI**      **self-paced PI**

---

**1** pandemic lessons

**2** new normal

**3** self-paced PI

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in-class PI

self-paced PI

av. time per session

1 pandemic lessons

2 new normal

3 self-paced PI

InnoBreakCafe

in-class PI

self-paced PI

av. time per session

92 min

1 pandemic lessons

2 new normal

3 self-paced PI

InnoBreakCafe

Hi

**in-class PI**

**self-paced PI**

**av. time per session**

**92 min**

**71 min**

**1 pandemic lessons**

**2 new normal**

**3 self-paced PI**

InnoBreakCafe

**in-class PI**

**self-paced PI**

**av. time per session**

**92 min**

**71 min\***

**\*outside of class!**

**1 pandemic lessons**

**2 new normal**

**3 self-paced PI**

InnoBreakCafe

Hi

**in-class PI**

**self-paced PI**

**av. time per session**

**92 min**

**71 min\***

**av. number of questions**

**9.3**

**\*outside of class!**

**1 pandemic lessons**

**2 new normal**

**3 self-paced PI**



InnoBreakCafe

Hi

**in-class PI**

**self-paced PI**

**av. time per session**

**92 min**

**71 min\***

**av. number of questions**

**9.3 (6.9)**

**\*outside of class!**

**1 pandemic lessons**

**2 new normal**

**3 self-paced PI**

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Hi

**in-class PI**

**self-paced PI**

**av. time per session**

**92 min**

**71 min\***

**av. number of questions**

**9.3 (6.9)**

**11**

**\*outside of class!**

**1 pandemic lessons**

**2 new normal**

**3 self-paced PI**

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**in-class PI**

**self-paced PI**

**av. time per session**

**92 min**

**71 min\***

**av. number of questions**

**9.3 (6.9)**

**11**

**increased gains in content learning & self efficacy!**

**\*outside of class!**

**1 pandemic lessons**

**2 new normal**

**3 self-paced PI**

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## self-paced PI

- less time, more learning

1 pandemic lessons

2 new normal

3 self-paced PI

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## self-paced PI

- less time, more learning
- better integration with reading

1 pandemic lessons

2 new normal

3 self-paced PI

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## self-paced PI

- less time, more learning
- better integration with reading
- free up class time for other learning activities

1 pandemic lessons

2 new normal

3 self-paced PI

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- online can be *better* than in person
- pedagogy is key
- time together is precious

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- online can be *better* than in person
- pedagogy is key
- time together is precious
- physical classroom is a constraint



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