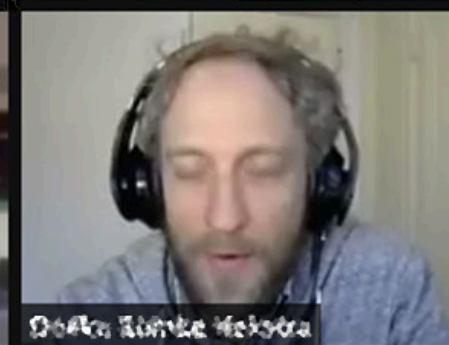
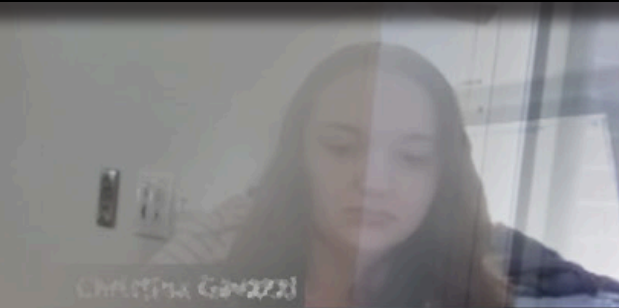


Setting Learning Free: Lessons from online teaching



2023 Ohio PKAL Regional Network Spring Conference
Kenyon College
Gambier, OH, 13 May 2023



Setting Learning Free: Lessons from online teaching



@eric_mazur

2023 Ohio PKAL Regional Network Spring Conference
Kenyon College
Gambier, OH, 13 May 2023







Weekend long reads



© Graziano Panfili

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

-
-
-
-

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.



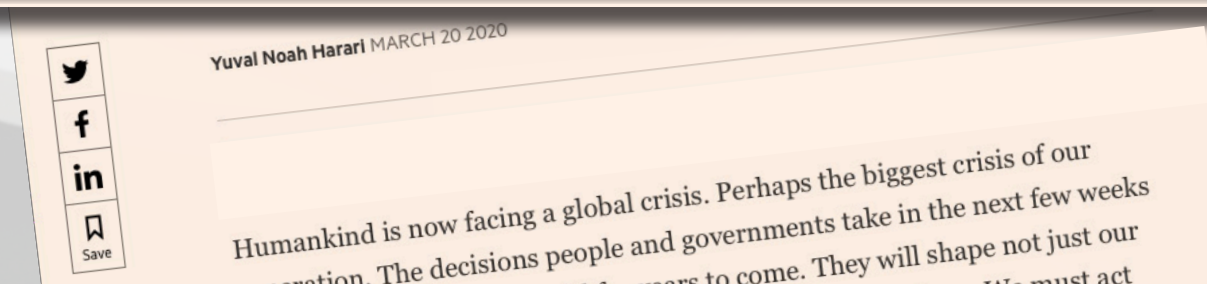


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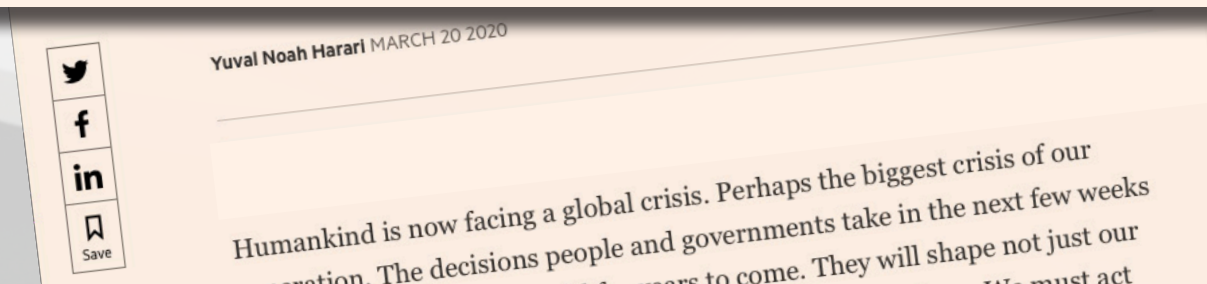




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Will online teaching become a fixture of life?

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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THE WALL STREET JOURNAL.



Popular

Latest

The Atlantic

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

class

information
transfer

instructor-paced
synchronous
lecture

home

information
transfer

instructor-paced
synchronous
online lecture

home

sense-making

self-paced
asynchronous
homework/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

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 a busy, collaborative learning environment.

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**

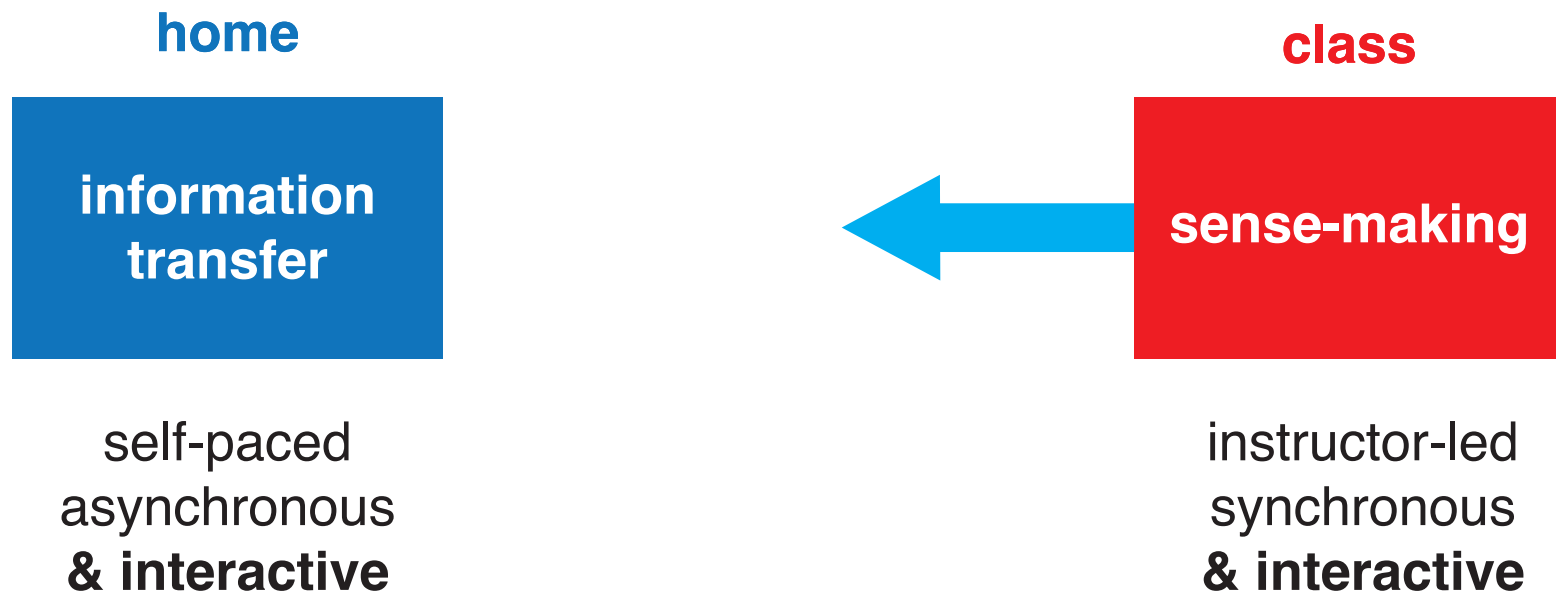
self-paced
asynchronous
& **interactive**

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 pointing at a laptop screen, while others look on attentively. The background shows more students working at desks, creating a busy, collaborative learning environment.

Optimize instructional face-to-face time

home

information
transfer

self-paced
asynchronous
& interactive

home

sense-making

instructor-led
synchronous
& interactive

class

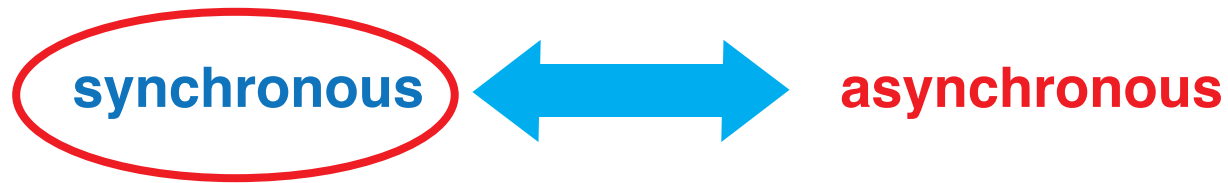
sense-making

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



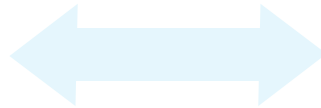
self-paced

everybody together
at the same *pace*

Optimize instructional face-to-face time

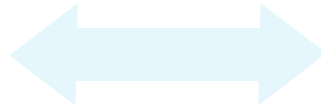
lecture

synchronous



asynchronous

instructor-paced

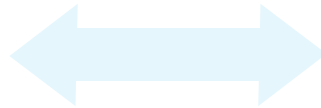


self-paced

Optimize instructional face-to-face time

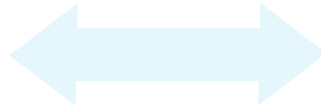
recorded lecture

synchronous



asynchronous

instructor-paced

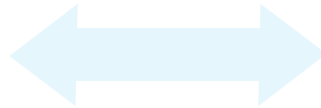


self-paced

Optimize instructional face-to-face time

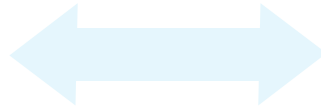
recorded lecture

synchronous



asynchronous

instructor-paced



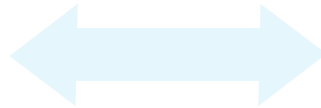
self-paced

1.5x!

Optimize instructional face-to-face time

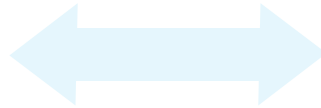
lab

synchronous



asynchronous

instructor-paced

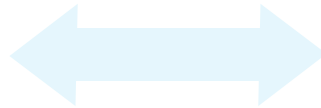


self-paced

Optimize instructional face-to-face time

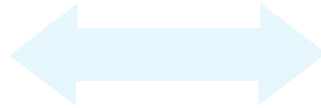
homework/study

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!**

A group of people are gathered around a table in a meeting room, working on laptops and looking at documents. The scene is brightly lit with large windows in the background. The text "Try this exercise!" is overlaid in the center of the image.

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

synchronous



**team
check**

quality control

Establish continuous accountability

A group of people in a meeting room, some sitting at a table with laptops, others standing, engaged in a discussion. The scene is brightly lit, suggesting a modern office or classroom environment. The people are dressed in business casual attire. One woman in the foreground is gesturing with her hand while speaking to others. Several laptops are open on the table, and papers are scattered around. The overall atmosphere is one of collaborative work and learning.

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

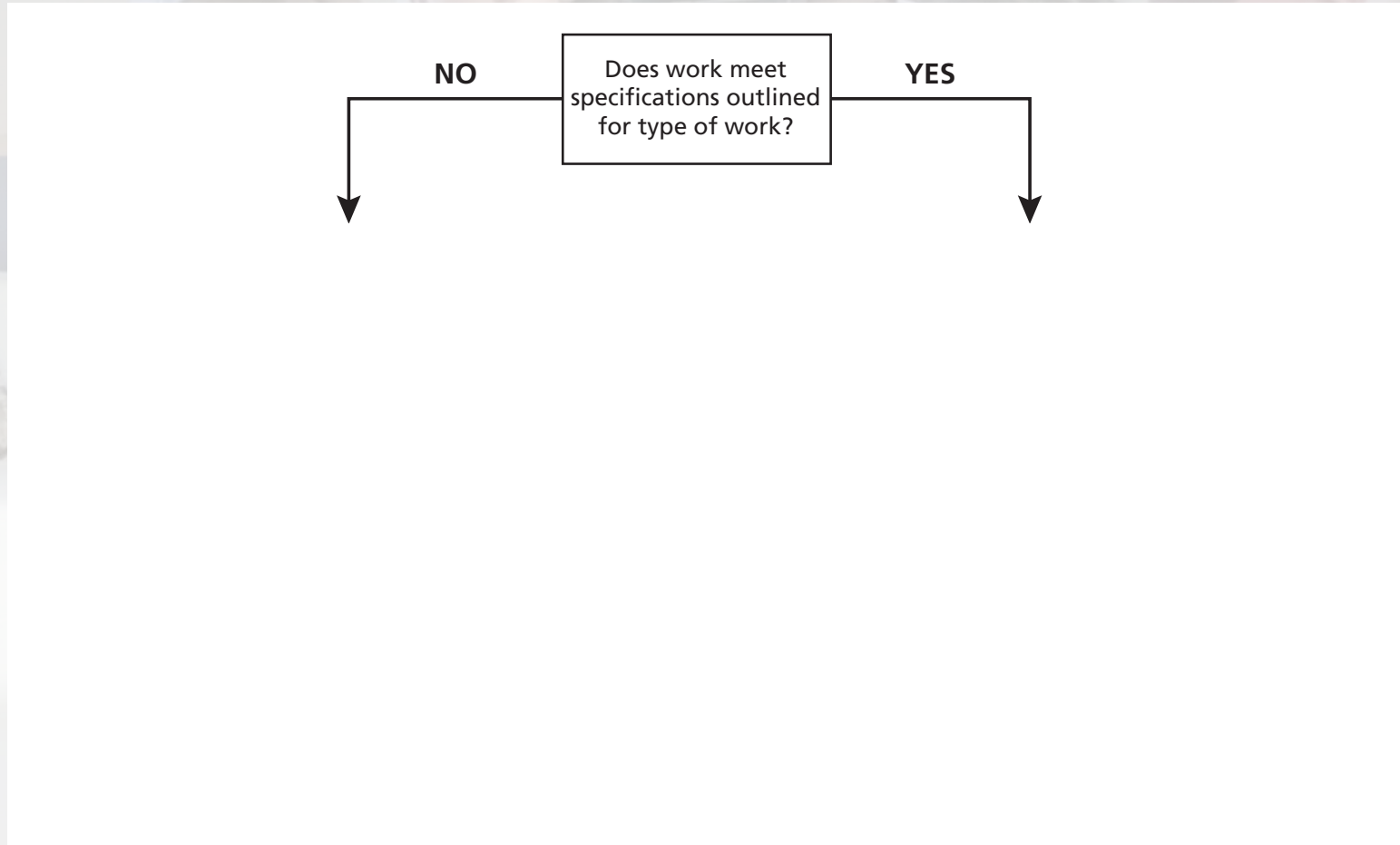


Establish continuous accountability

Specifications grading

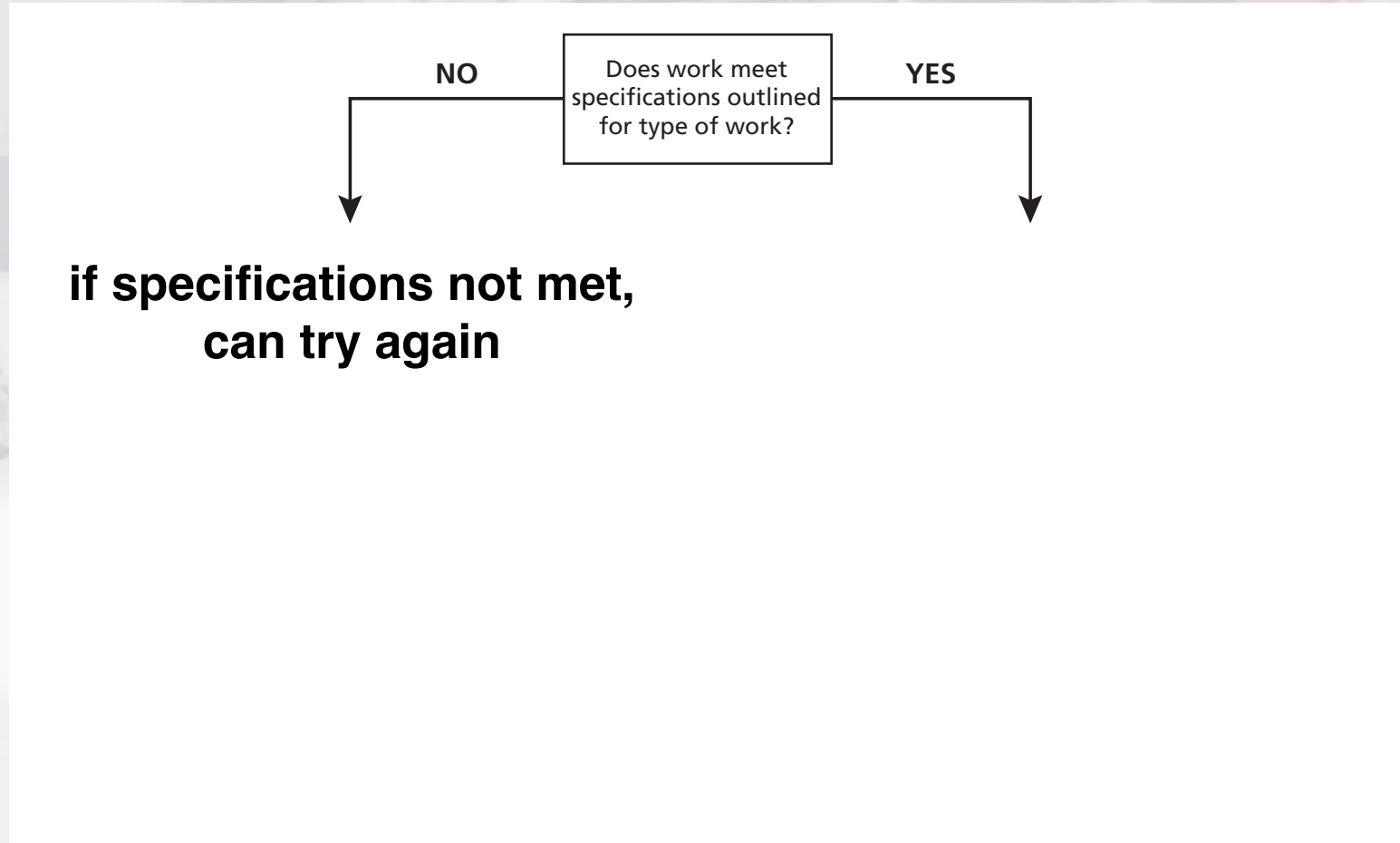
Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

Establish continuous accountability



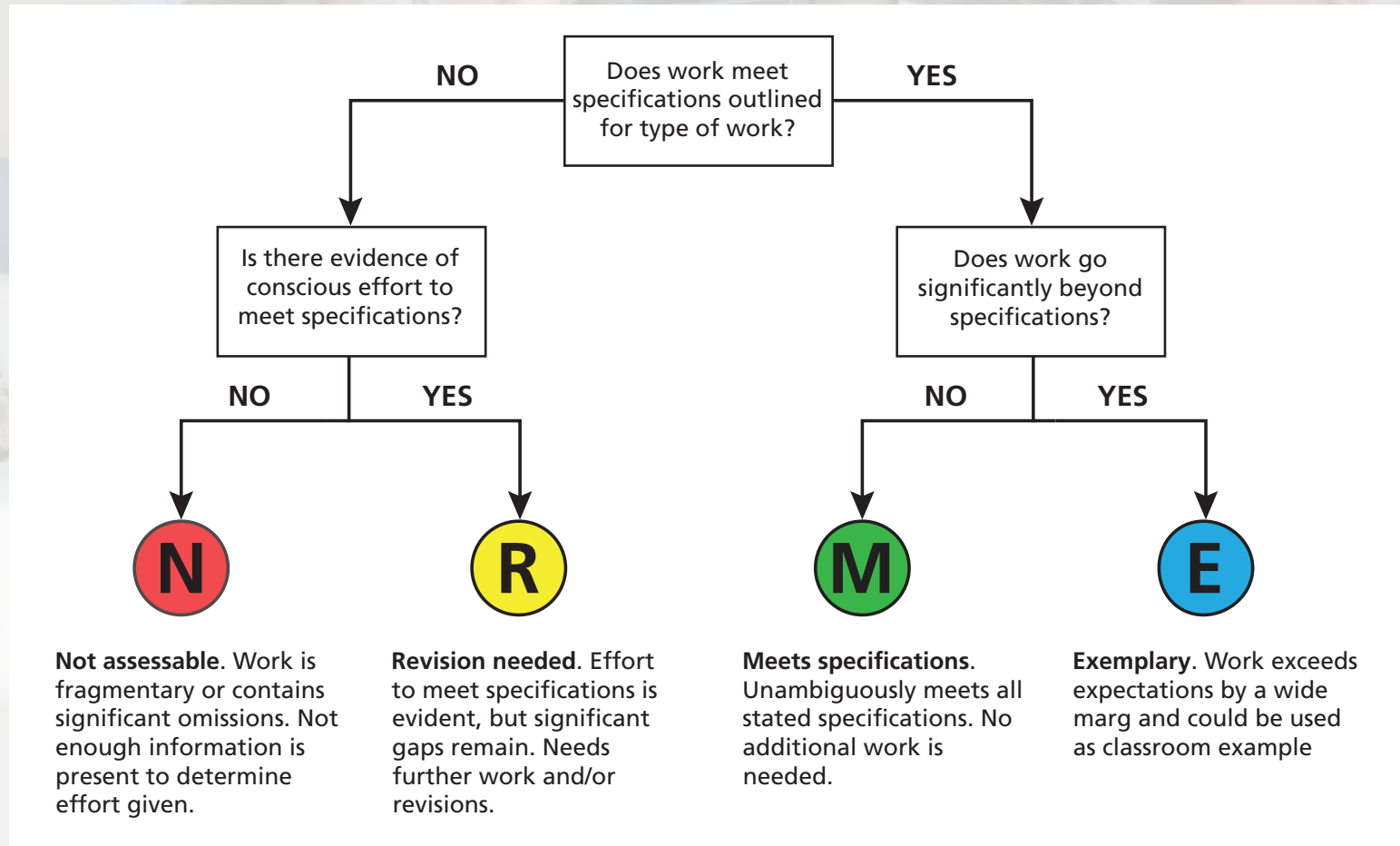
Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

Establish continuous accountability



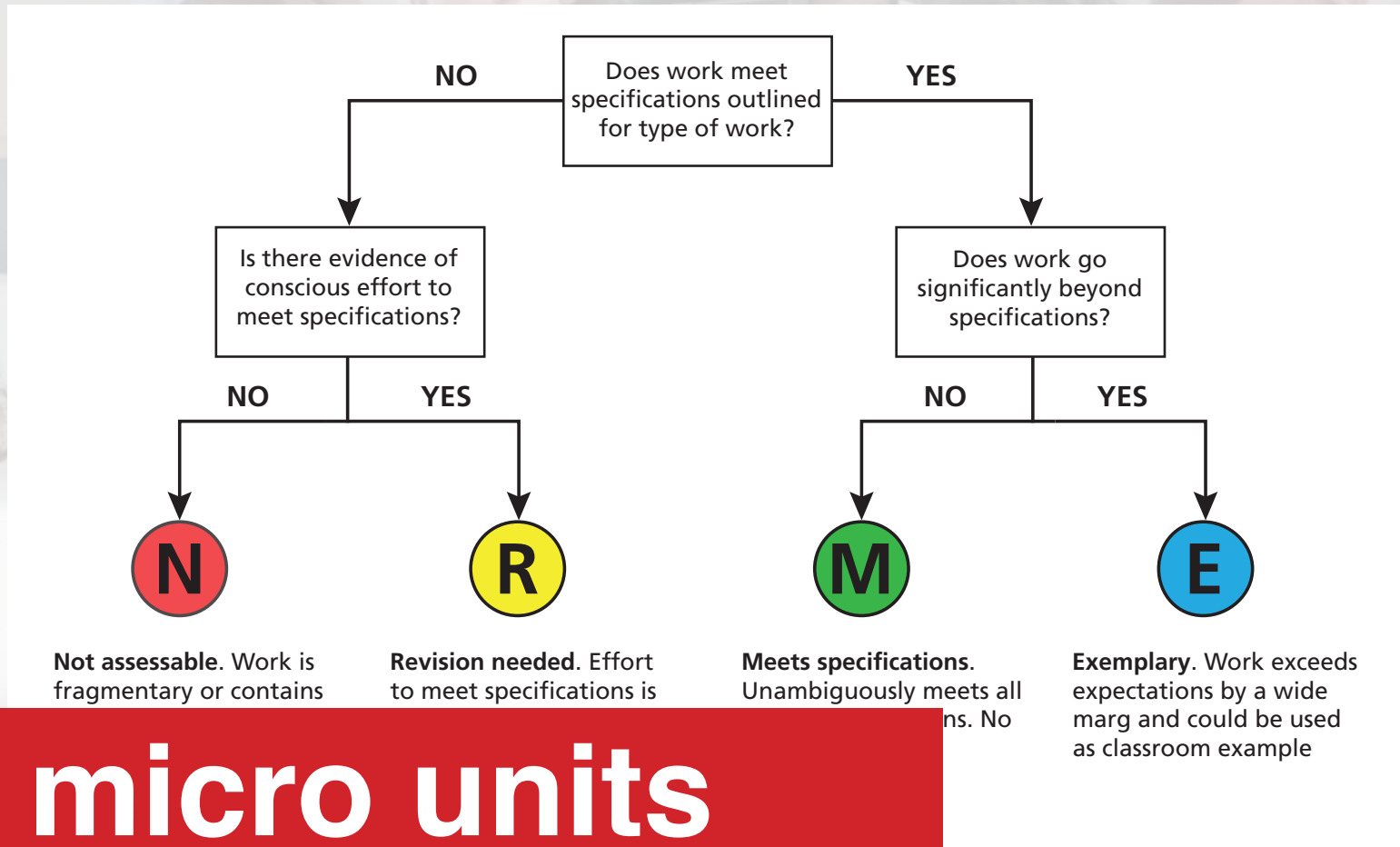
Inside Higher Ed, *Yes, Virginia, there is a better way to grade*

Establish continuous accountability



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

Establish continuous accountability

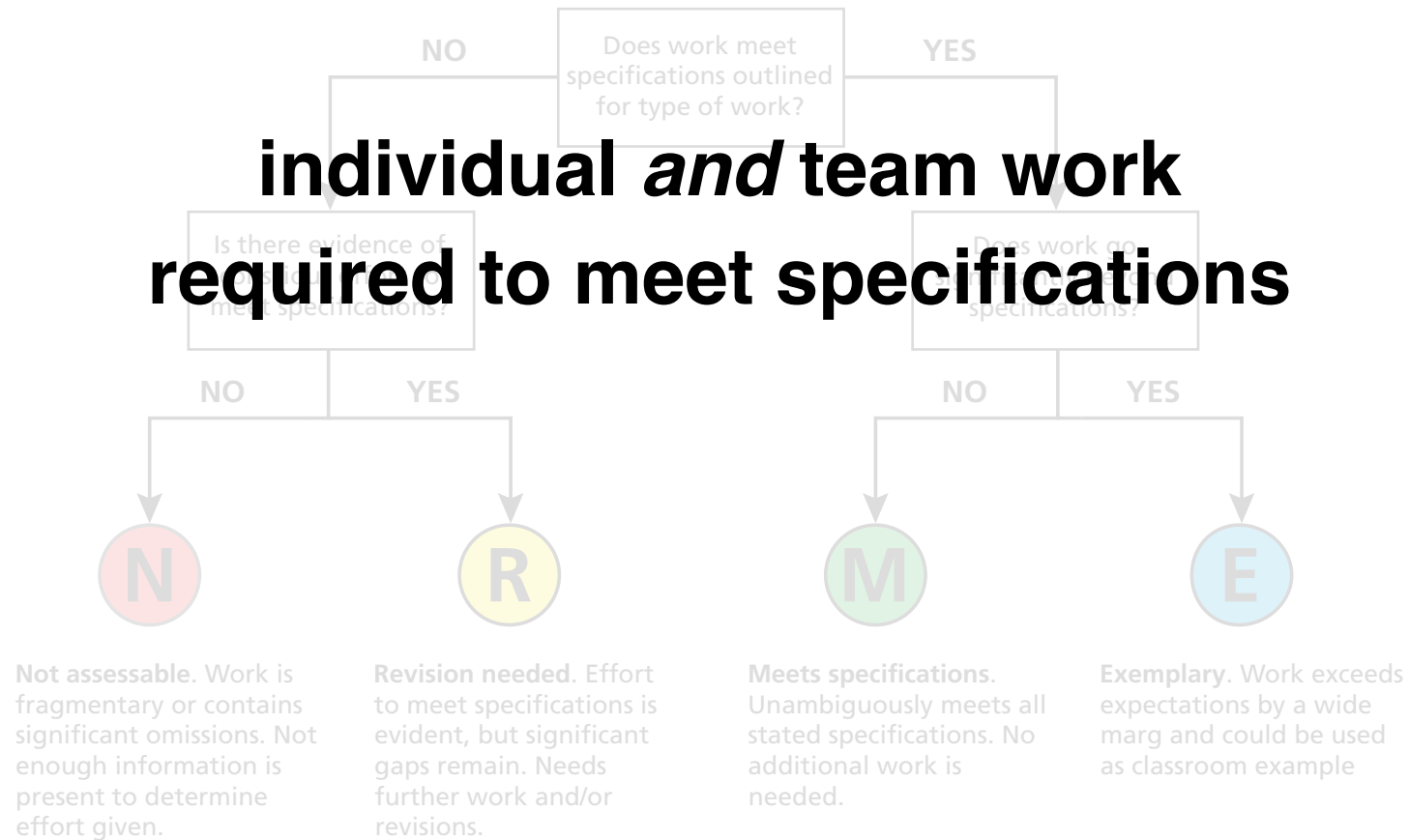


70 micro units

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...

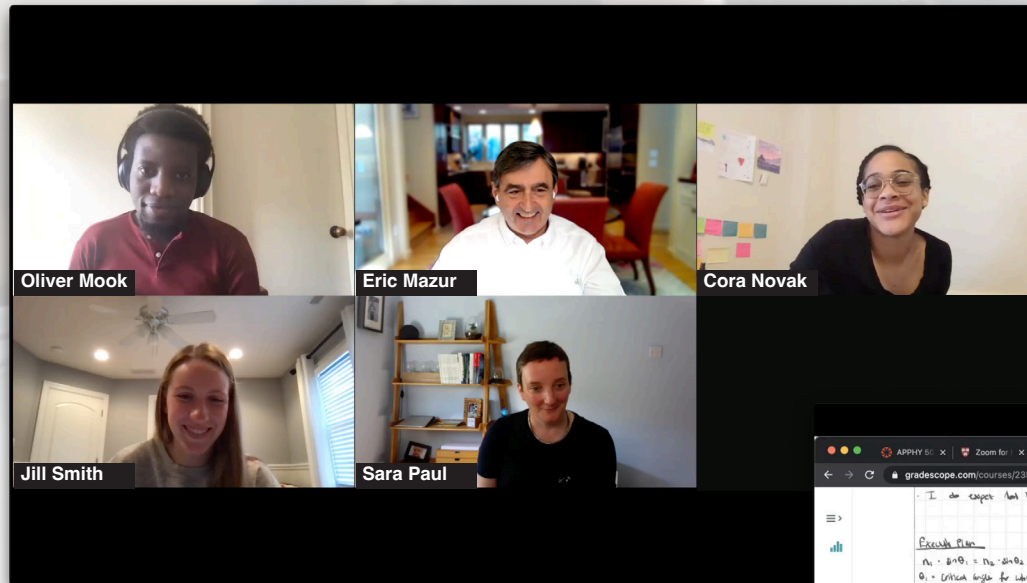
Shift ownership of learning space

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



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 on a grid background:

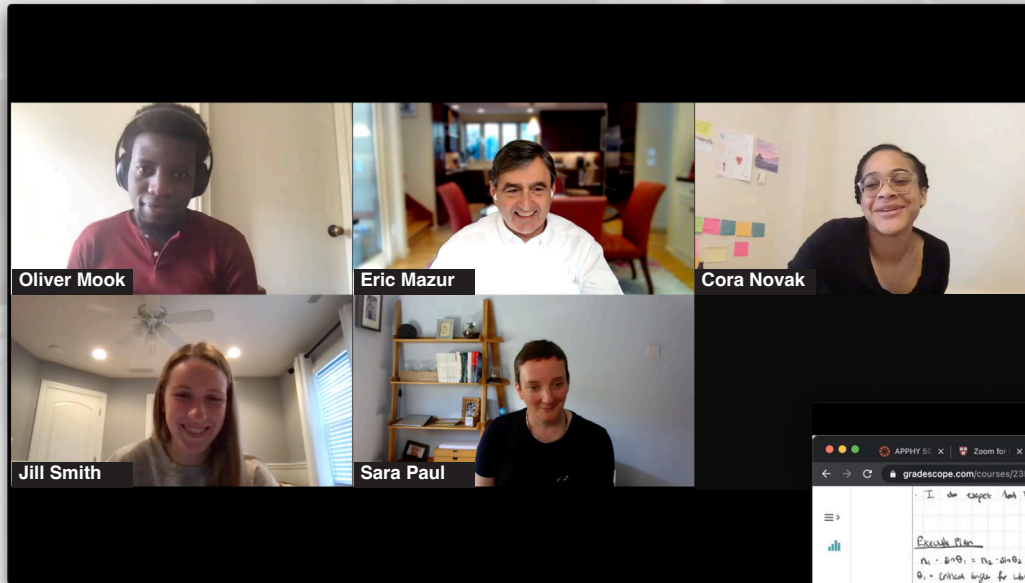
Example 1
 $n_1 = n_2 = n$
 $\theta_1 = \theta_2 = \theta$
 $n_1 \sin \theta_1 = n_2 \sin \theta_2$
 $n \sin \theta = n \sin \theta$
 $\theta_1 = \theta_2 = \theta$
 $n_1 \neq n_2$
 $n_1 \sin \theta_1 = n_2 \sin \theta_2$
 $n_1 \sin \theta_1 = n_2 \sin \theta_2$
 $\sin \theta_1 = \frac{n_2}{n_1} \sin \theta_2$
 $\theta_1 = \sin^{-1} \left(\frac{n_2}{n_1} \sin \theta_2 \right)$

Diagram showing a light ray incident on a boundary between two media with refractive indices n_1 and n_2 . The angle of incidence is θ_1 and the angle of refraction is θ_2 . The critical angle θ_c is also indicated.

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

Shift ownership of learning space

every student on front row

A screenshot of a Gradescope submission page for "Assignment Module 25" (UNGRADED). The page shows handwritten work on a grid background. The work includes a diagram of a right-angled triangle with vertices A, B, and C, and a dashed line representing a normal vector. The student has calculated the critical angle θ_c for total internal reflection. The work includes the following steps:
- Example Plan:
- $n_1 \sin \theta_c = n_2 \sin 90^\circ$
- $\theta_c = \text{critical angle for which total internal reflection occurs}$
- $n_1 \sin \theta_c = n_2 \sin 90^\circ$
- $n_1 \sin \theta_c = n_2$
- $\sin \theta_c = \frac{n_2}{n_1}$
- $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$
- Calculate the θ_c for an interface between 2 media with indices of refraction n_1 and n_2 ($n_1 > n_2$)
- $n_1 \sin \theta_c = n_2 \sin 90^\circ$
- $n_1 \sin \theta_c = n_2$
- $\sin \theta_c = \frac{n_2}{n_1}$
- $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$
The student has also calculated the critical angle for a specific case where $n_1 = 1.5$ and $n_2 = 1.0$, resulting in $\theta_c = 41.8^\circ$.
The page also shows a sidebar with the assignment details and a list of questions.

Shift ownership of learning space

every student on front row & address each by their name

The image displays a virtual learning environment. On the left, a Zoom meeting grid shows five participants: Oliver Mook, Eric Mazur, Cora Novak, Jill Smith, and Sara Paul, each with their name in a yellow oval. On the right, a screenshot of a Gradescope submission interface shows a student's handwritten work on a physics problem involving Snell's Law and critical angles. The interface includes a sidebar with 'Assignment Module 25' and a list of questions.

Participant Names: Oliver Mook, Eric Mazur, Cora Novak, Jill Smith, Sara Paul

Gradescope Submission: Assignment Module 25 • UNGRADED

Handwritten Work:

Example Problem

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

Calculate the θ_c for an interface between 2 media with indices of refraction

$n_1 = 1.5, n_2 = 1.2$
 $\sin \theta_c = \frac{n_2}{n_1} = \frac{1.2}{1.5} = \frac{4}{5}$
 $\theta_c = \sin^{-1}(\frac{4}{5})$

$\cos^2 \theta_c + \sin^2 \theta_c = 1$
 $\cos^2 \theta_c = 1 - \sin^2 \theta_c = 1 - (\frac{4}{5})^2 = 1 - \frac{16}{25} = \frac{9}{25}$
 $\cos \theta_c = \frac{3}{5}$

$n_1 \sin \theta = n_2 \sin \theta$
 $1.5 \sin \theta = 1.2 \sin(\theta + 90^\circ)$
 $\sin \theta = \frac{4}{5} \cos \theta$
 $\theta = \tan^{-1}(\frac{4}{3})$
 $\theta = \sin^{-1}(\frac{4}{5})$

$\theta = \sin^{-1}(\frac{4}{5}) = 53.13^\circ$

$\theta = 53.13^\circ$

Gradescope Interface:

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)



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

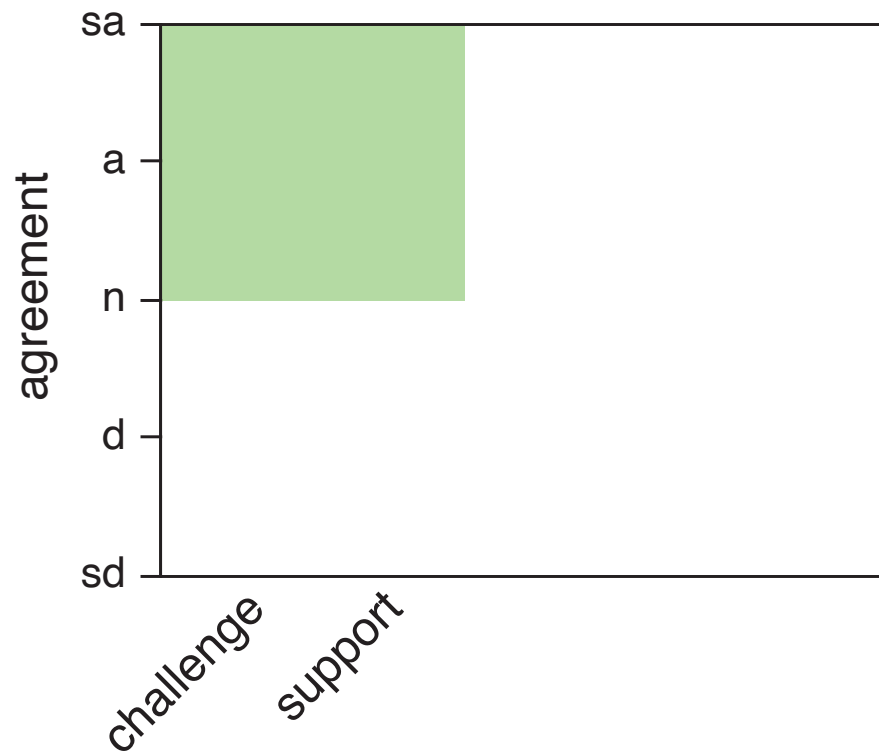
2. I had plenty of support

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

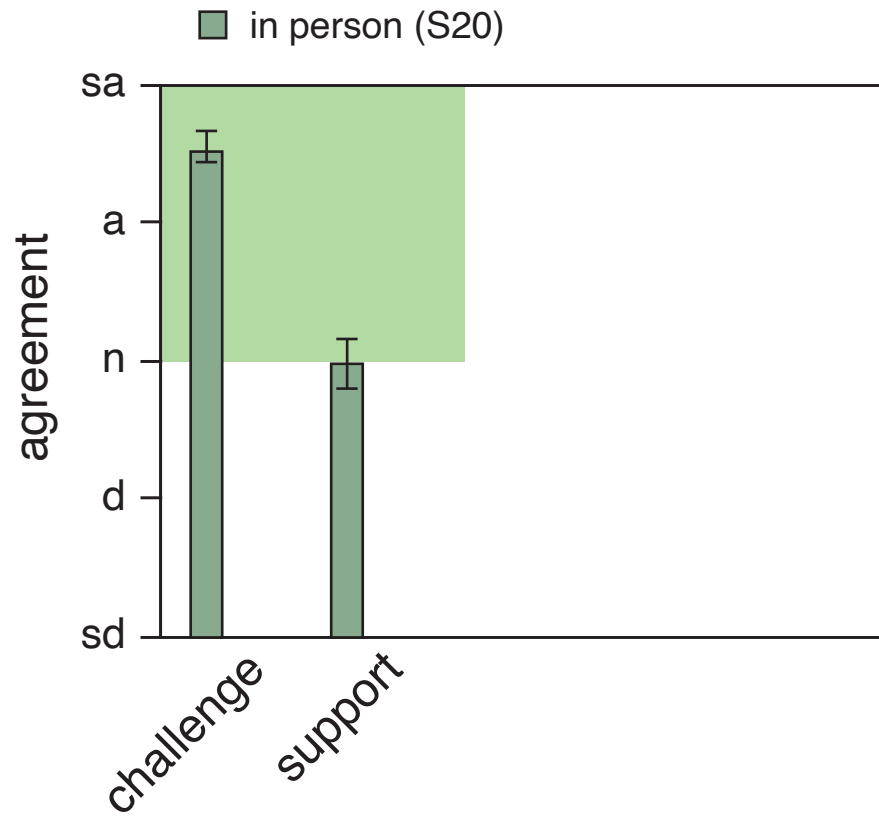
4. I made progress because of my own efforts and choices

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

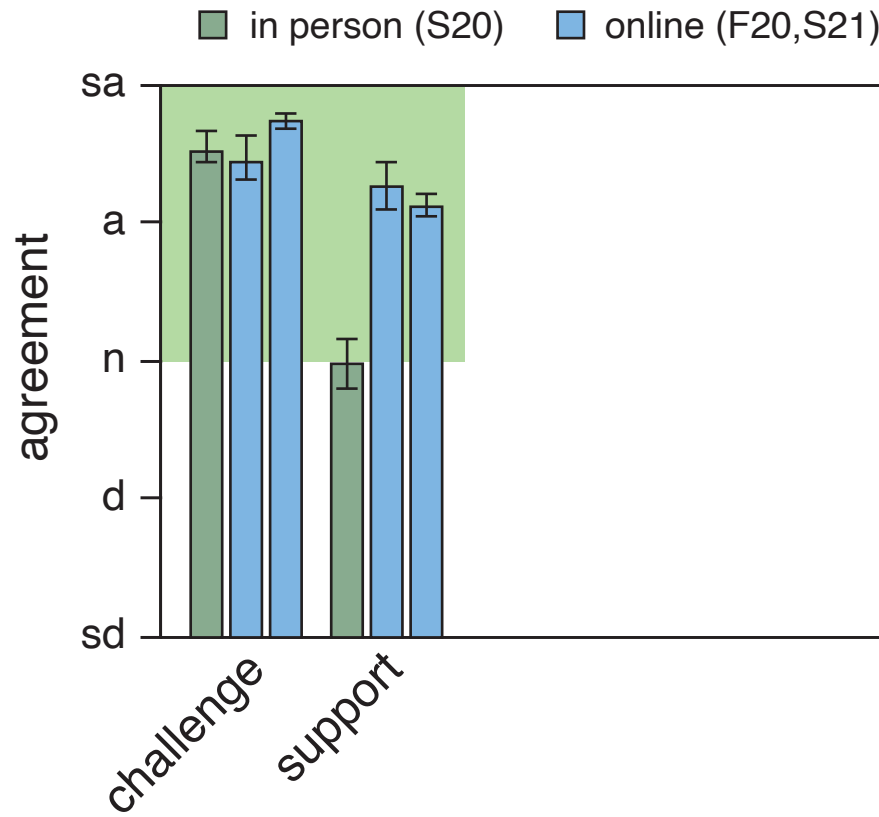
challenge vs. support



challenge vs. support



challenge vs. support





self-determination

1. I was challenged intellectually (challenge)

2. I had plenty of support (support)

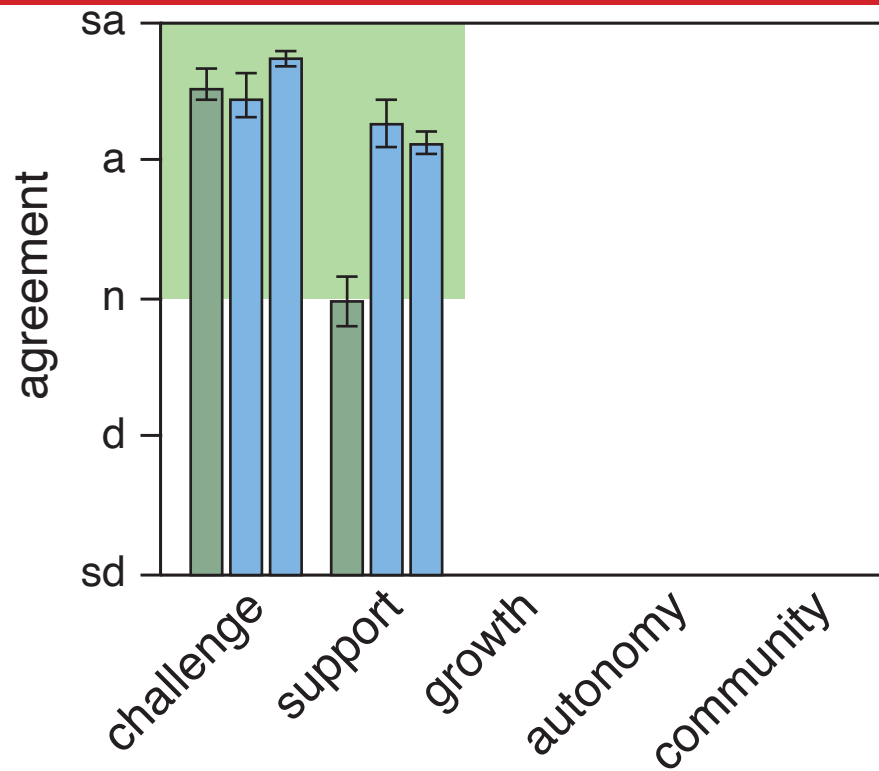
3. I am closer to mastering the ideas of the course now (growth)

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

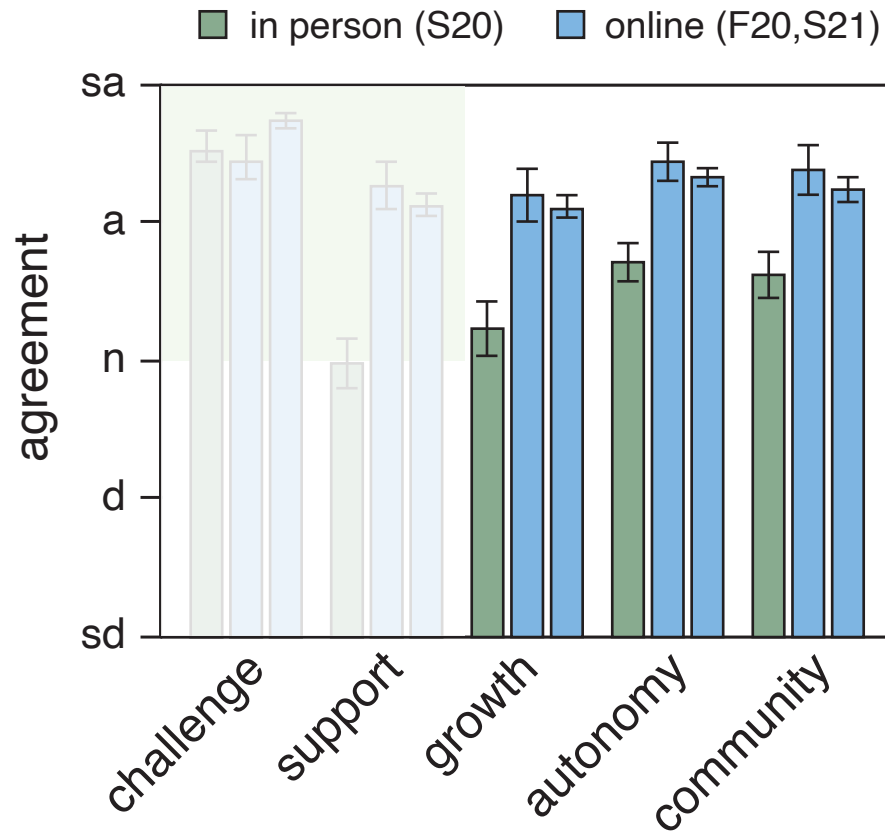
5. I felt I was part of a community of learners (relatedness)

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 interactions. 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

challenge

practical work

skills session

project work

replaces lectures

1 pandemic lessons

2 new normal

weekly workflow

content module

reading

readiness assurance

replaces lectures

tutorial

using a social learning platform

practical work

skillsession

project work

1 pandemic lessons

2 new normal

weekly workflow

content module

reading

readiness assurance

replaces lectures

tutorial

challenge

practical work

skillsession

project work

using a social learning platform

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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see who is online

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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:

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highlighting text...

76 CHAPTER 4 MOMENTUM

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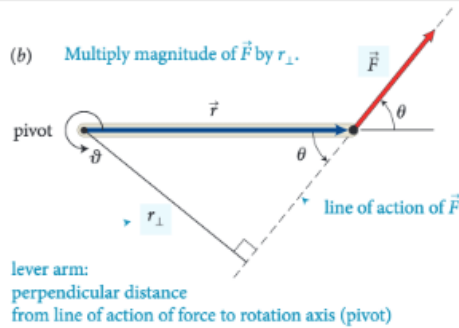
...opens chat window

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 $r_{\perp}F$.

Like other rotational quantities, torque carries a sign that depends on the choice of direction for increasing ϑ . 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 ϑ and so is positive; the torque caused by \vec{F}_2 is negative. The sum of the two torques about the pivot is then $r_1F_1 + (-r_2F_2)$. 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 $r_1(F_1 + F_2) - (r_1 + r_2)F_2 = r_1F_1 - r_2F_2$. 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.

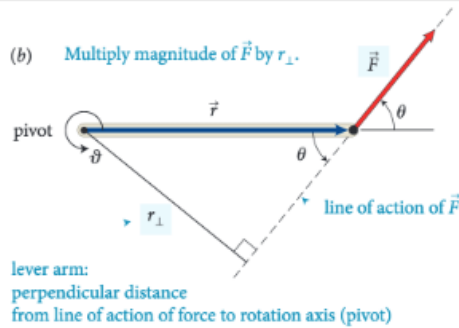
For a stationary object we can choose any reference point we like to calculate torques. It pays to choose a reference point that simplifies the calculation. As you have seen, we do not need to consider any force that is exerted at the reference point. So, by putting the reference point at the point of 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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? 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 20 12:38 am

? 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. Oct 22 8:48 pm

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

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tutorial

challenge

practical work

skills session

project work

strengthen basic knowledge

1 pandemic lessons

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weekly workflow

content module

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project work

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

1 pandemic lessons

2 new normal

weekly workflow

content module

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challenge

practical work

skills session

project work

1 pandemic lessons

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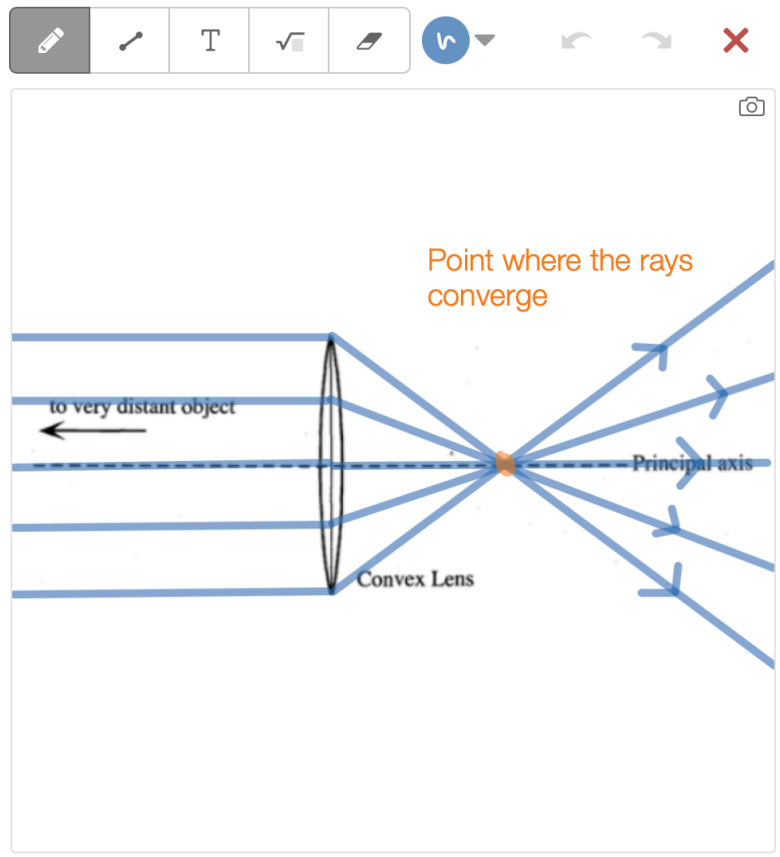
project work

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.

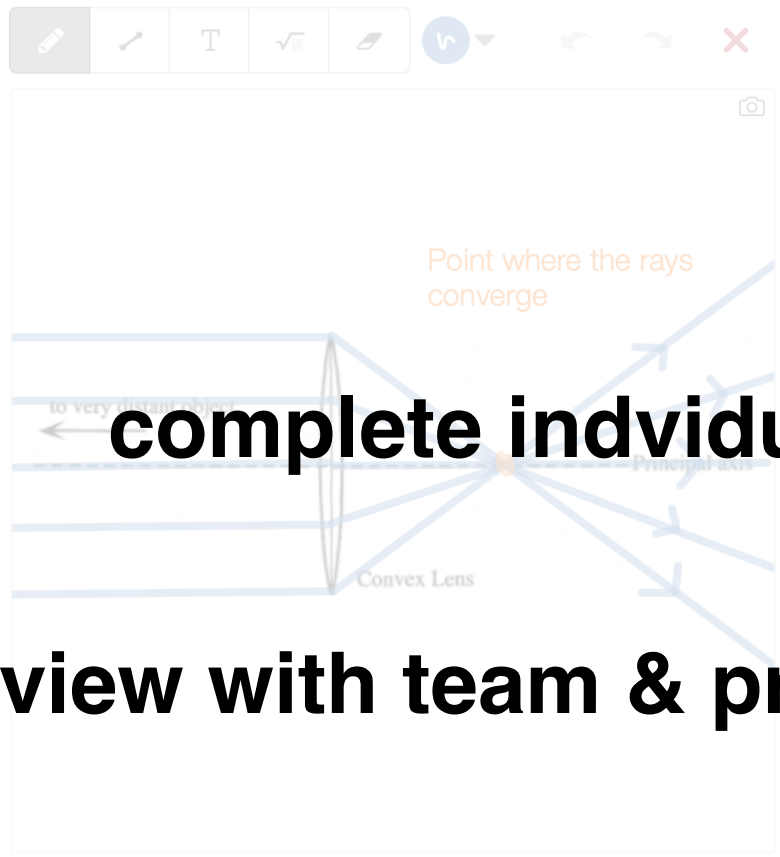
Try entering a large negative number below to test your answer

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



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the rays parallel

to very distant object

Submit

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Try entering a large negative number below to test your answer

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complete individually before class

review with team & present to staff in class

weekly workflow

content module

reading

readiness assurance

tutorial

challenge

practical work

skills session

project work

1 pandemic lessons

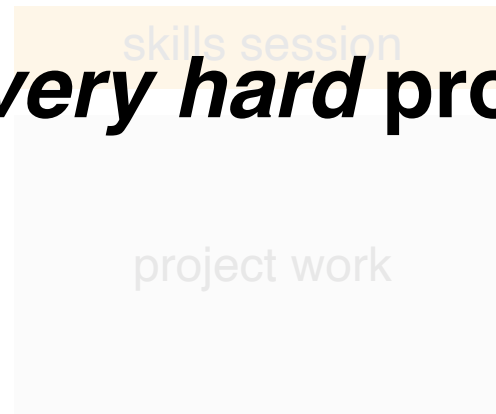
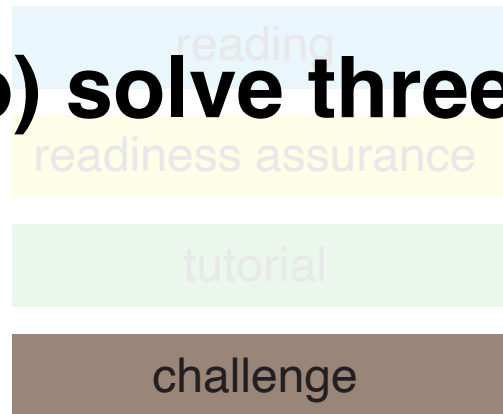
2 new normal

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)

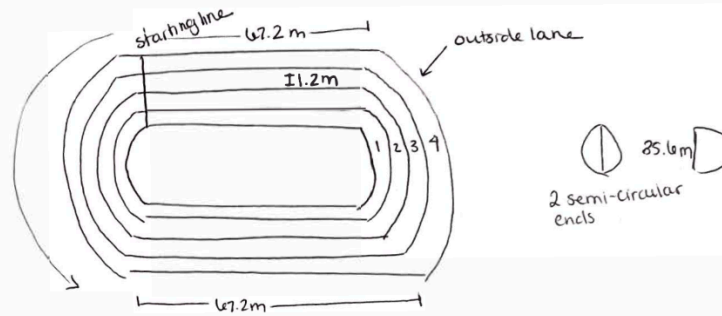
challenge

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 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 $35.6\pi - (35.6 - 6(1-4))\pi$, which is the difference of diameters. This checks out!

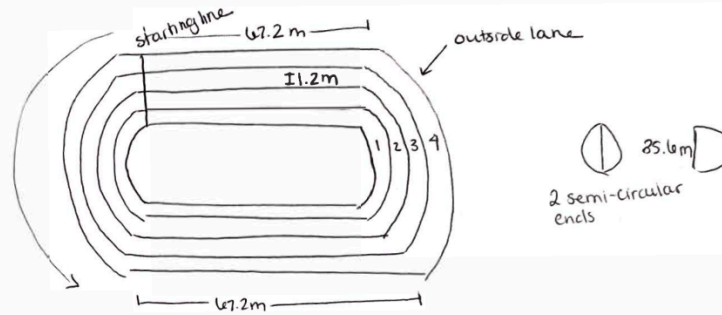
3. Execute the Plan

- 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 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 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 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

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upload individual work before class

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 - 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!

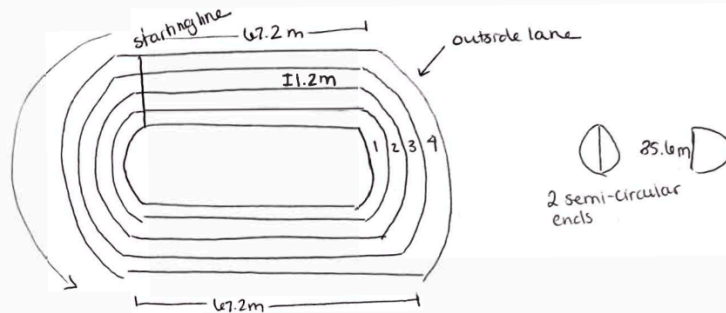
3. Execute the Plan

- 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 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 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 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 $35.6\pi - (35.6 - 6(1-4))\pi$, which is the difference of diameters. This checks out!

3. Execute the Plan

① straightaways for runner 4: $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$
 (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 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 m

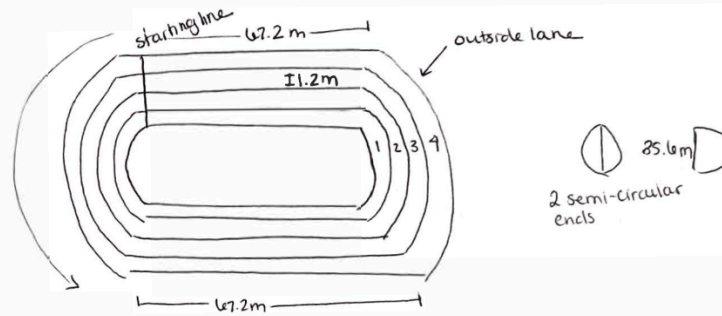
④ Runner in lane 1: $67.2\text{ m} + 67.2\text{ m} = 134.4\text{ m}$ straightaways
 curves: $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$
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 altogether runner in lane 1 = 223.6 m
 AP50 F2021

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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 - 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

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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: $67.2m + 67.2m = 134.4m$
 (inside)
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 $35.6\pi = 111.84$ distance around curve is circumference, $2\pi r$ (whole circle, since 2 curves)
 curves for runner in lane 4: $246.2m$ + straightaways

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 distance around both curves = $2\pi r = 30.8\pi = 96.8$
 altogether runner in lane 2: $231.2m$

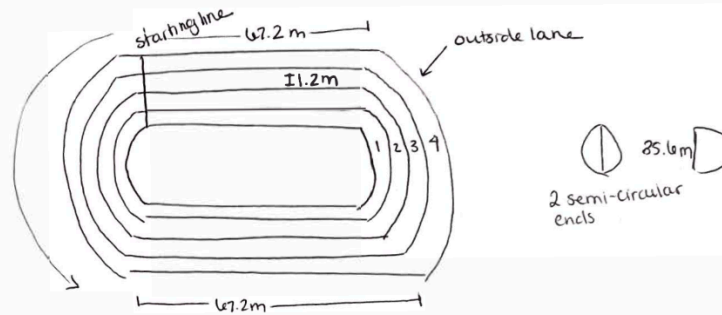
④ Runner in lane 1: $67.2m + 67.2m = 134.4m$ straightaways
 curves: $35.6 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 - 1.2 = 28.4$
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 altogether runner in lane 1 = $223.6m$
 AP50 F2021

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

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Question 2

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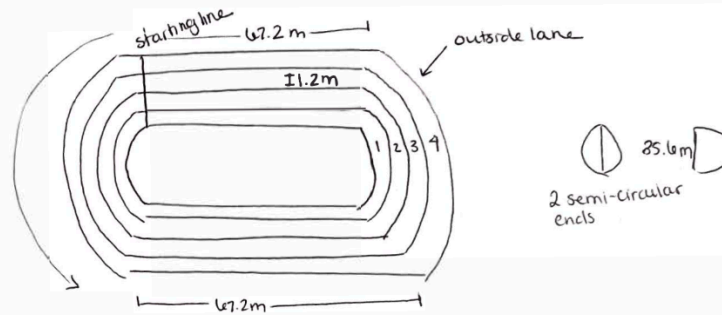
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 AP50 F2021
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Question 2


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2. Devise a Plan

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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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 $35.6\pi = 111.84$  distance around curve is circumference,
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 curves for runner in lane 4: 246.2 m
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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 m
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 altogether runner in lane 1 = 223.6 m
 AP50 F2021

4. Evaluate the Plan

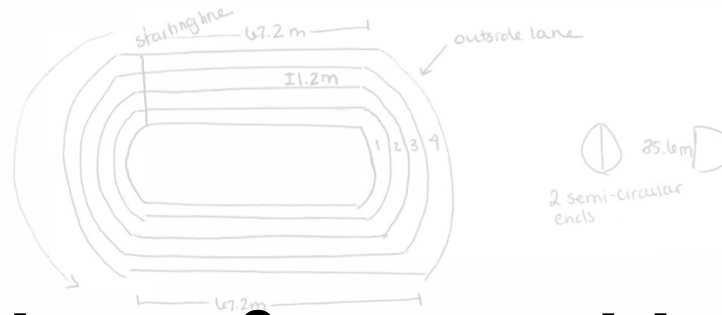
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⑤ lane 4 distance - lane 1 distance $\rightarrow 246.2\text{ m} - 223.6\text{ m} = 22.6\text{ m extra}$

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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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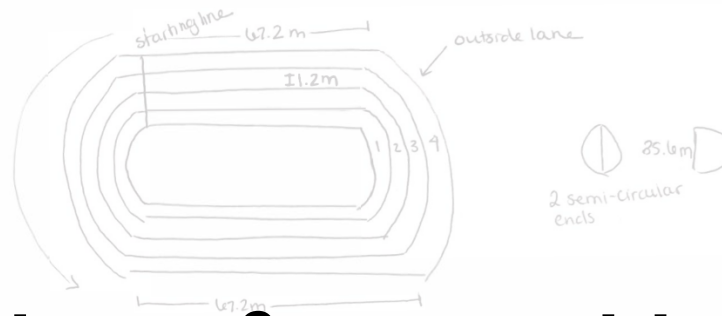
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curves: $35.6 - 1.2 - 1.2 = 33.2$
distance around both curves is $2\pi r = 83.2\pi = 104.3$
altogether runner in lane 3: 238.7
- ③ Runner in lane 2: $67.2\text{m} + 67.2\text{m} = 134.4\text{m}$ straightaways
curves: $35.6 - 1.2 - 1.2 - 1.2 - 1.2 =$ diameter of 30.8
distance around both curves = $2\pi r = 30.8\pi = 96.8$
altogether runner in lane 2: 231.2m
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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
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Question 2

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review with team & present to staff in 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
- 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!

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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

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InnoBreakCafe

learning space

content module

practical work

reading

ONLINE

readiness assurance

tutorial

challenge

FLEX SPACE

skills session

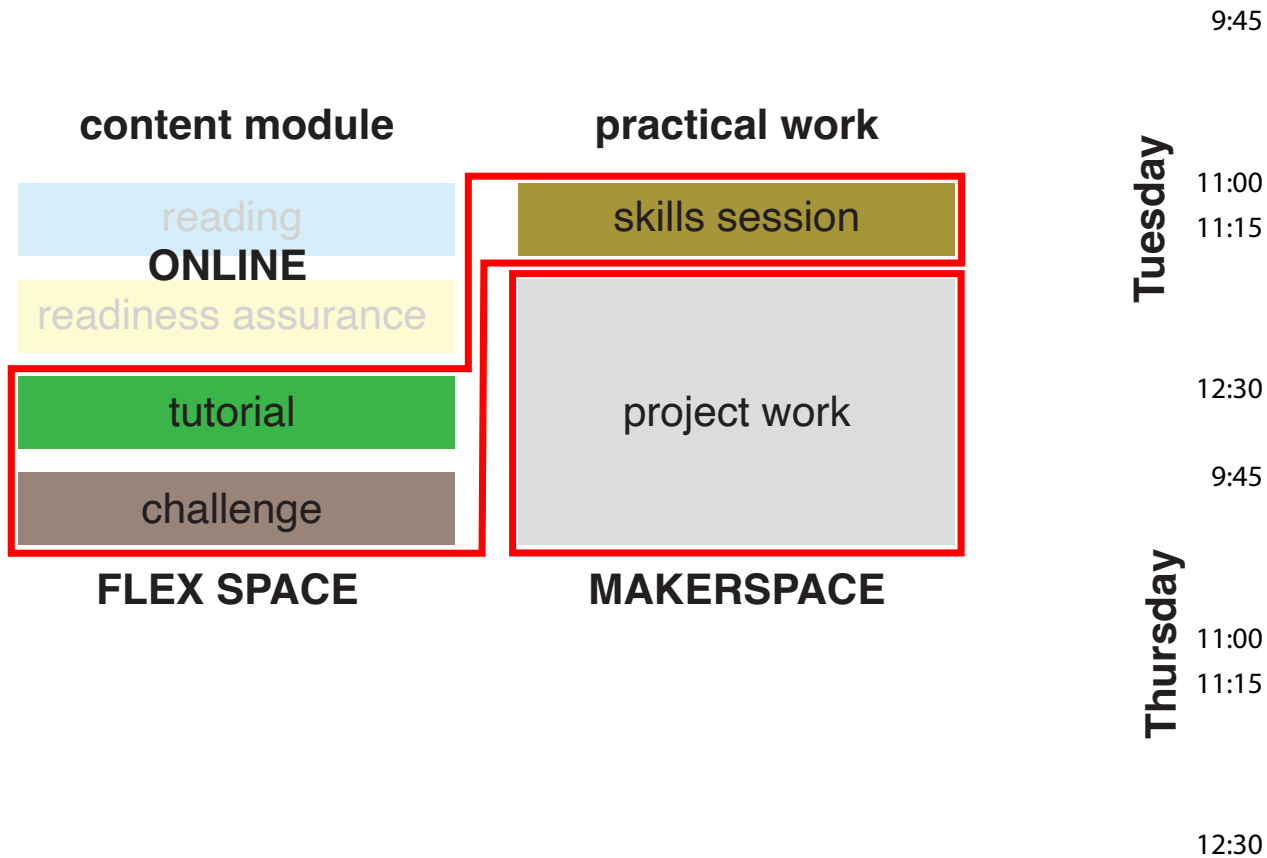
project work

MAKERSPACE

1 pandemic lessons

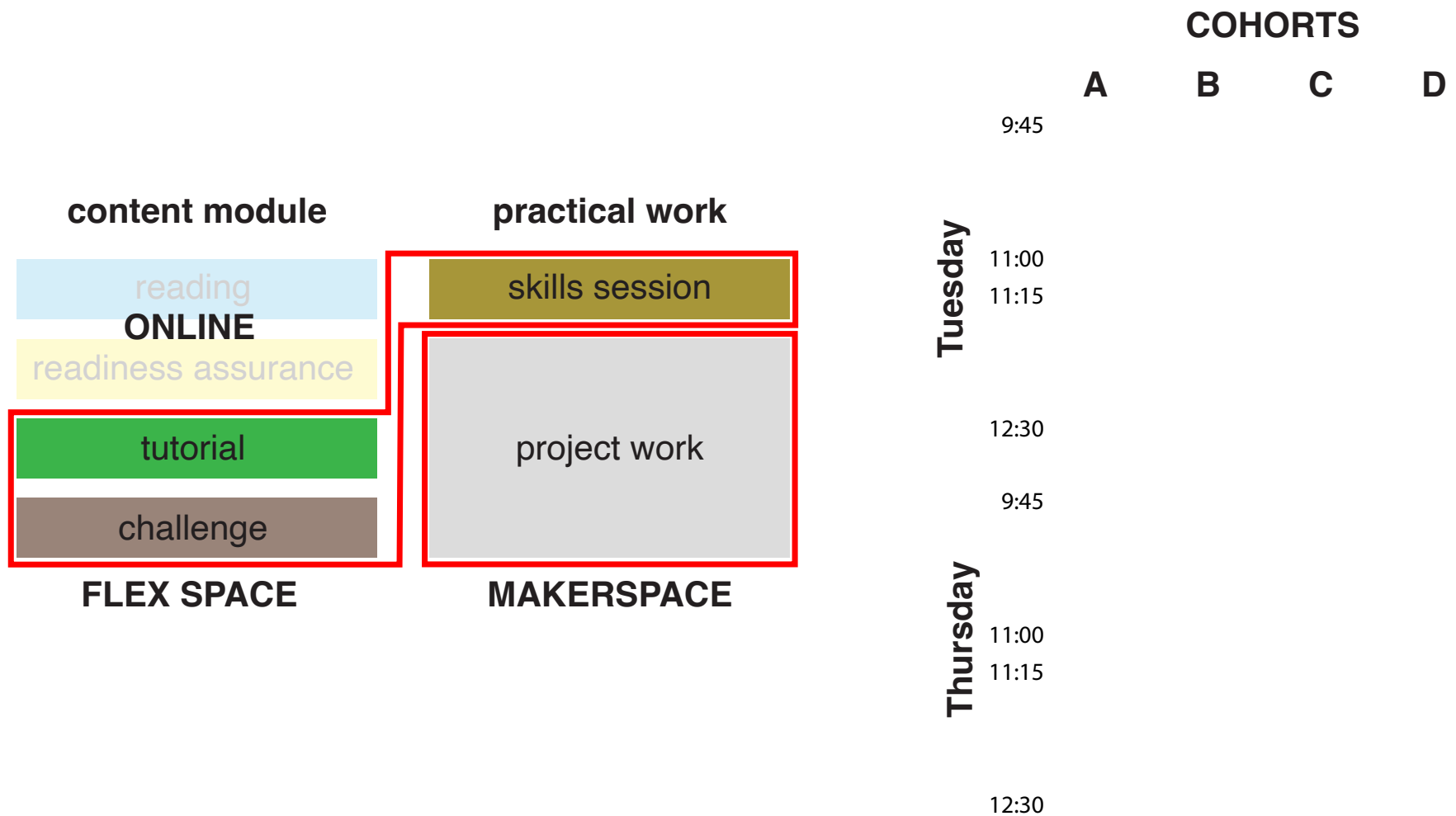
2 new normal

learning space



InnoBreakCafe

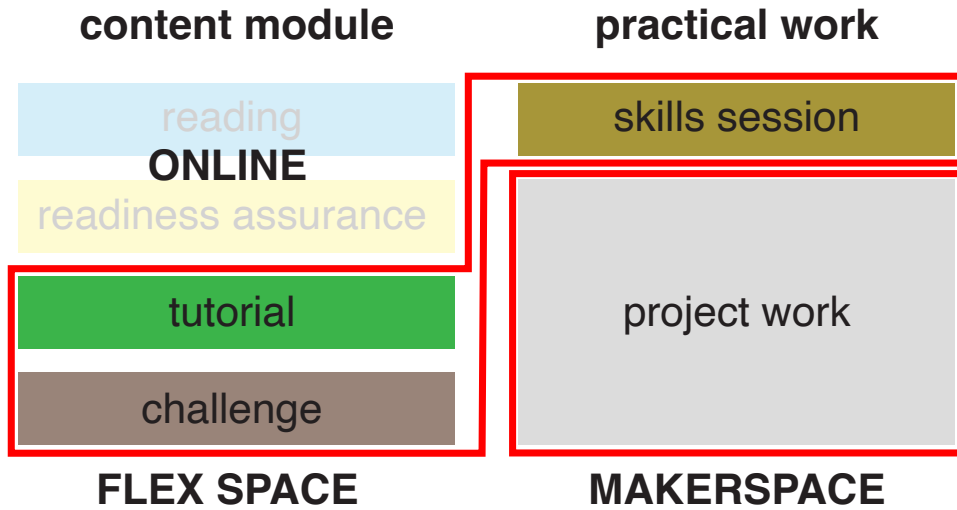
learning space



1 pandemic lessons

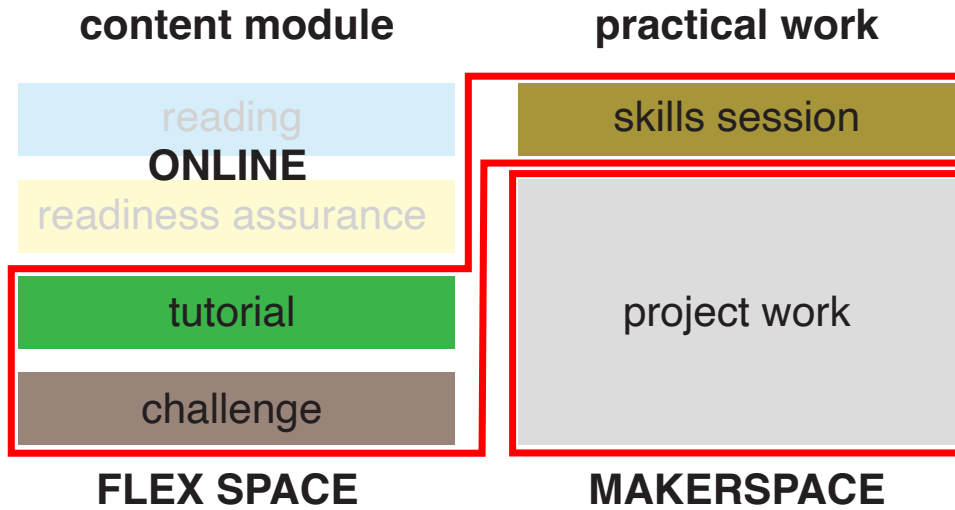
2 new normal

learning space



		COHORTS			
		A	B	C	D
Tuesday	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					
Thursday	9:45				
	11:00				
	11:15				
	12:30				

learning space



COHORTS

	A	B	C	D
Tuesday	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			
Thursday	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

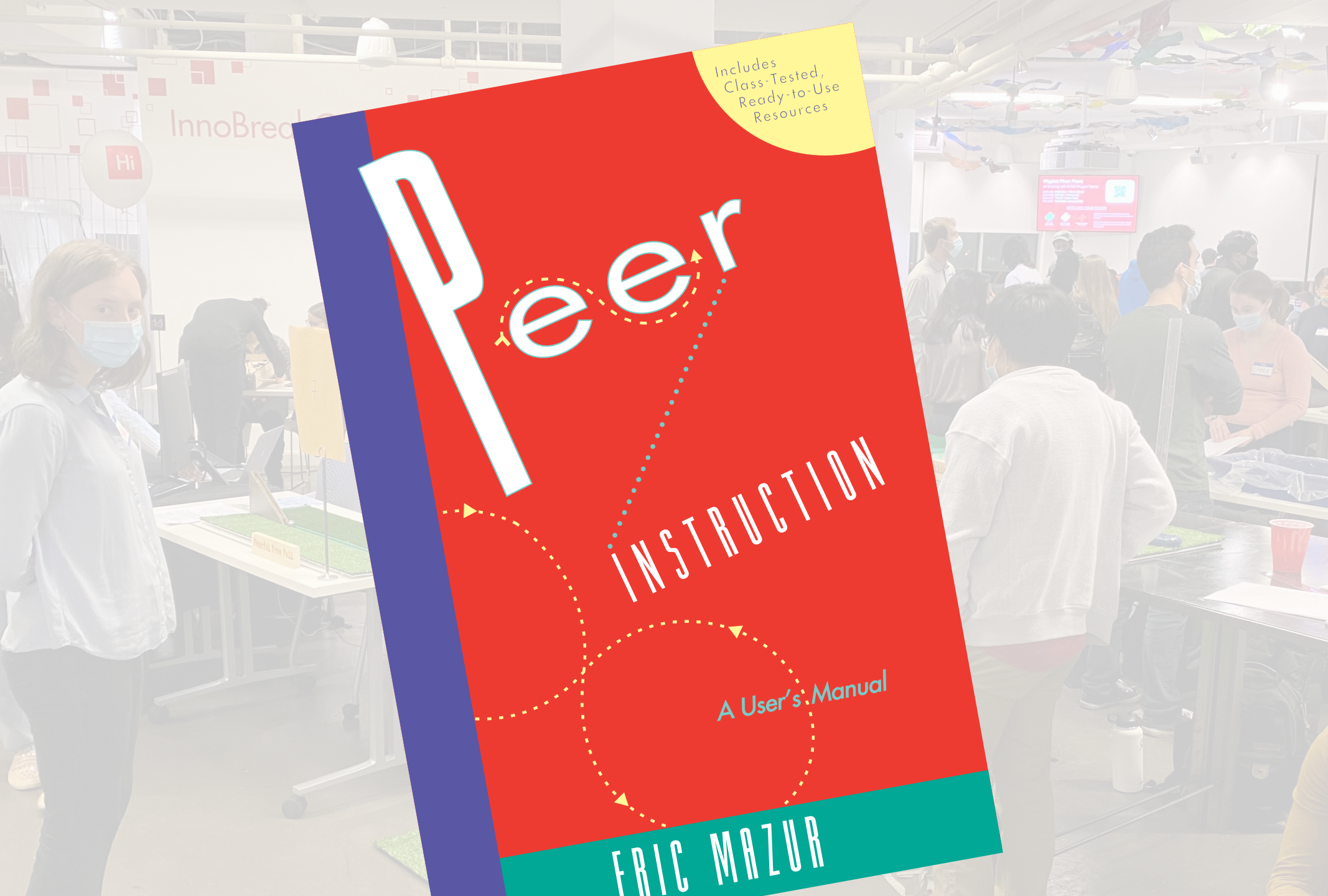
2 new normal

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

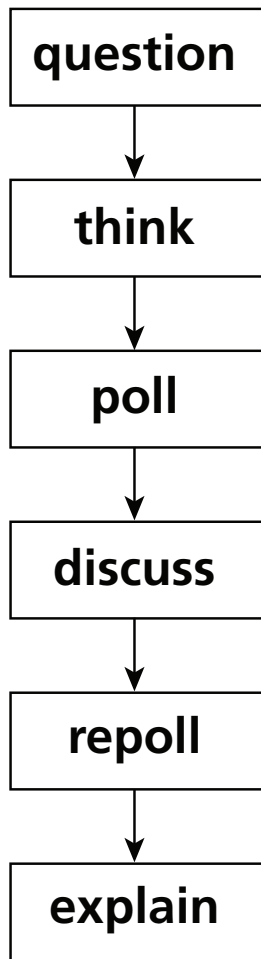
A User's Manual

ERIC MAZUR

1 pandemic lessons

2 new normal

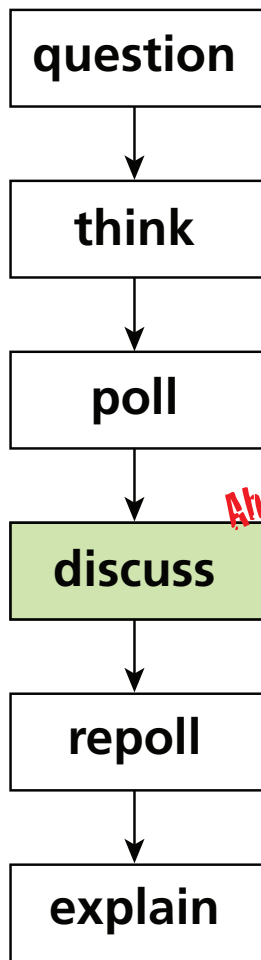
3 self-paced PI



1 pandemic lessons

2 new normal

3 self-paced PI



1 pandemic lessons

2 new normal

3 self-paced PI

Peer Instruction

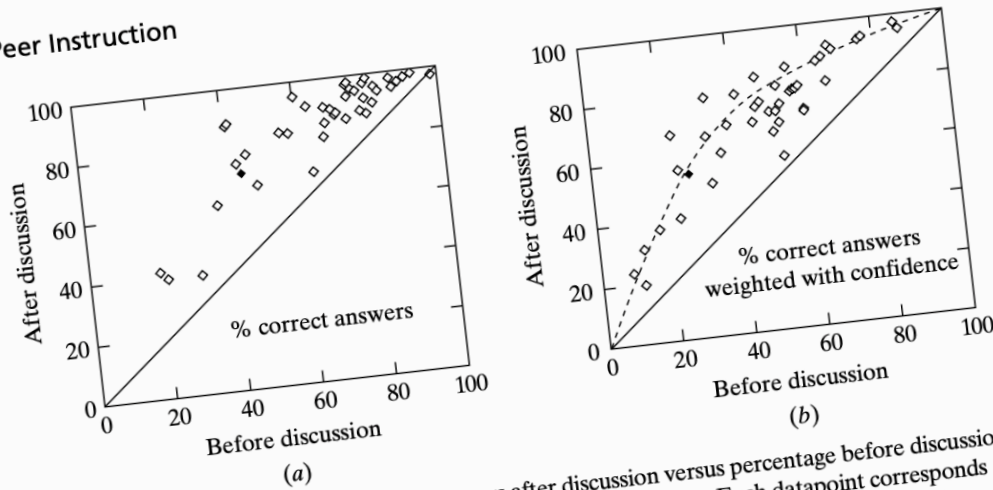
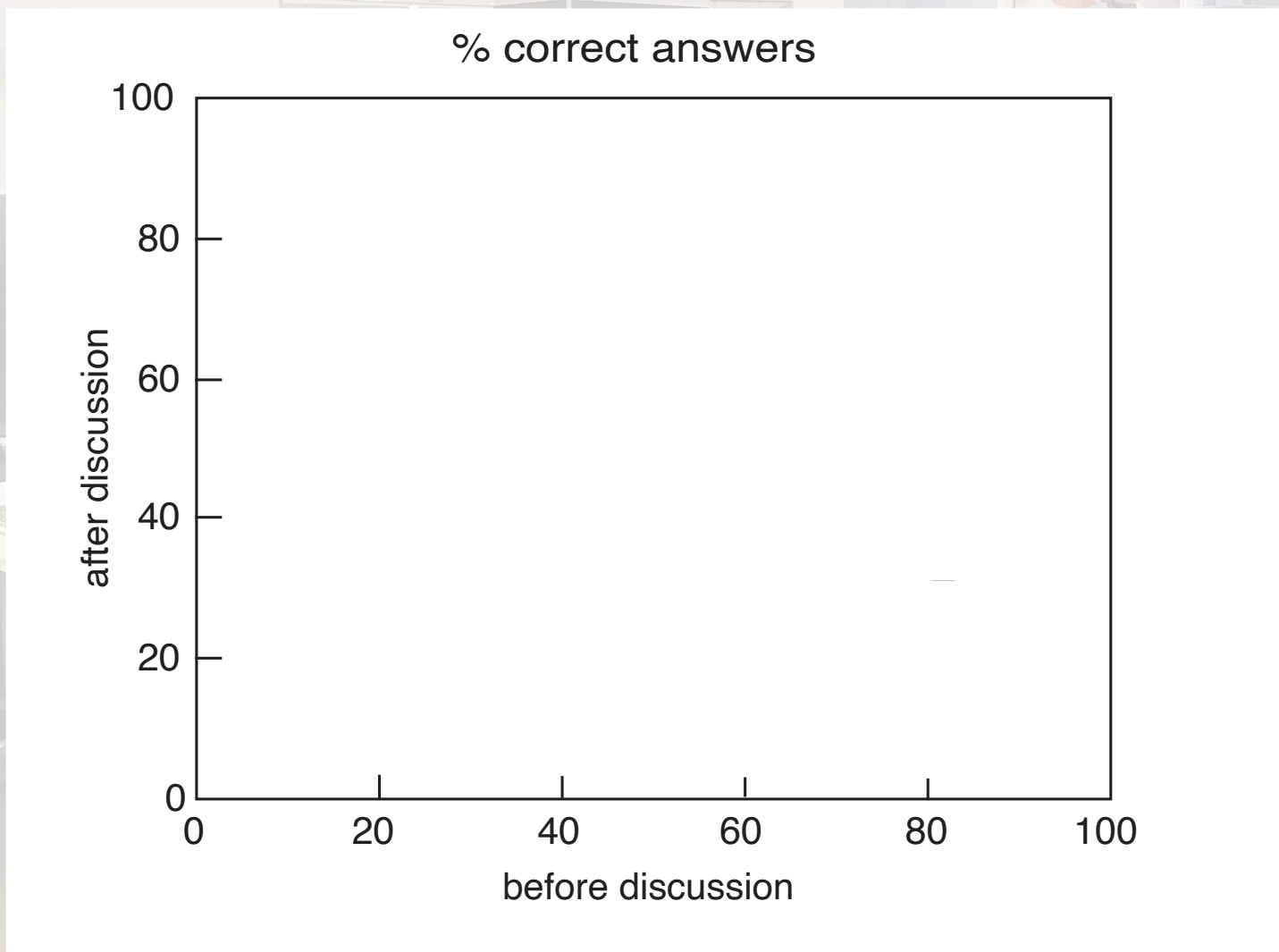


Figure 2.3 (a) Percentage of correct answers after discussion versus percentage before discussion and (b) the same information weighted with the students' confidence. Each datapoint corresponds to a single *ConcepTest* question. The filled datapoint is for the buoyancy question in Figure 2.1.

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

InnoBreakCafe

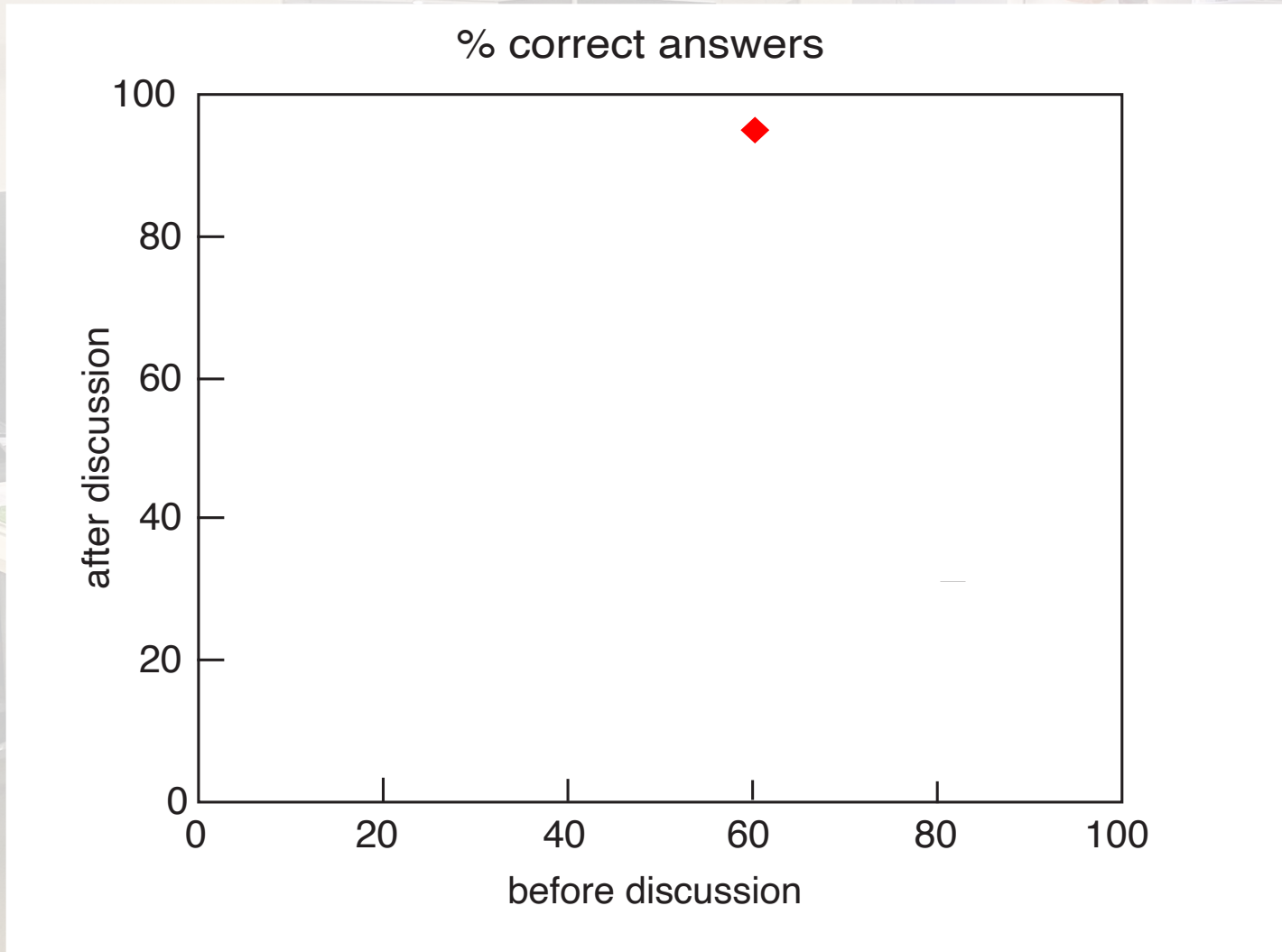


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

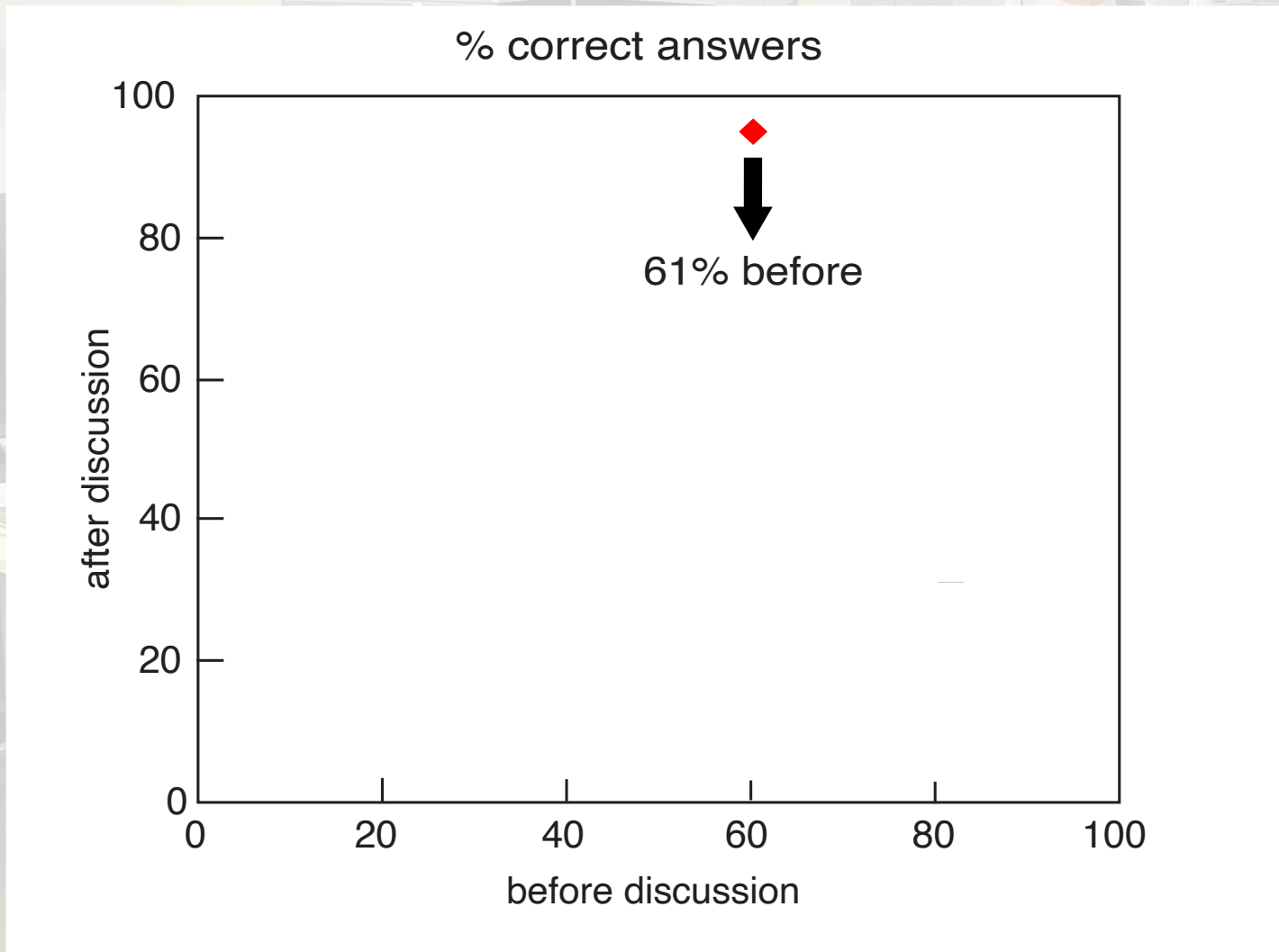


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

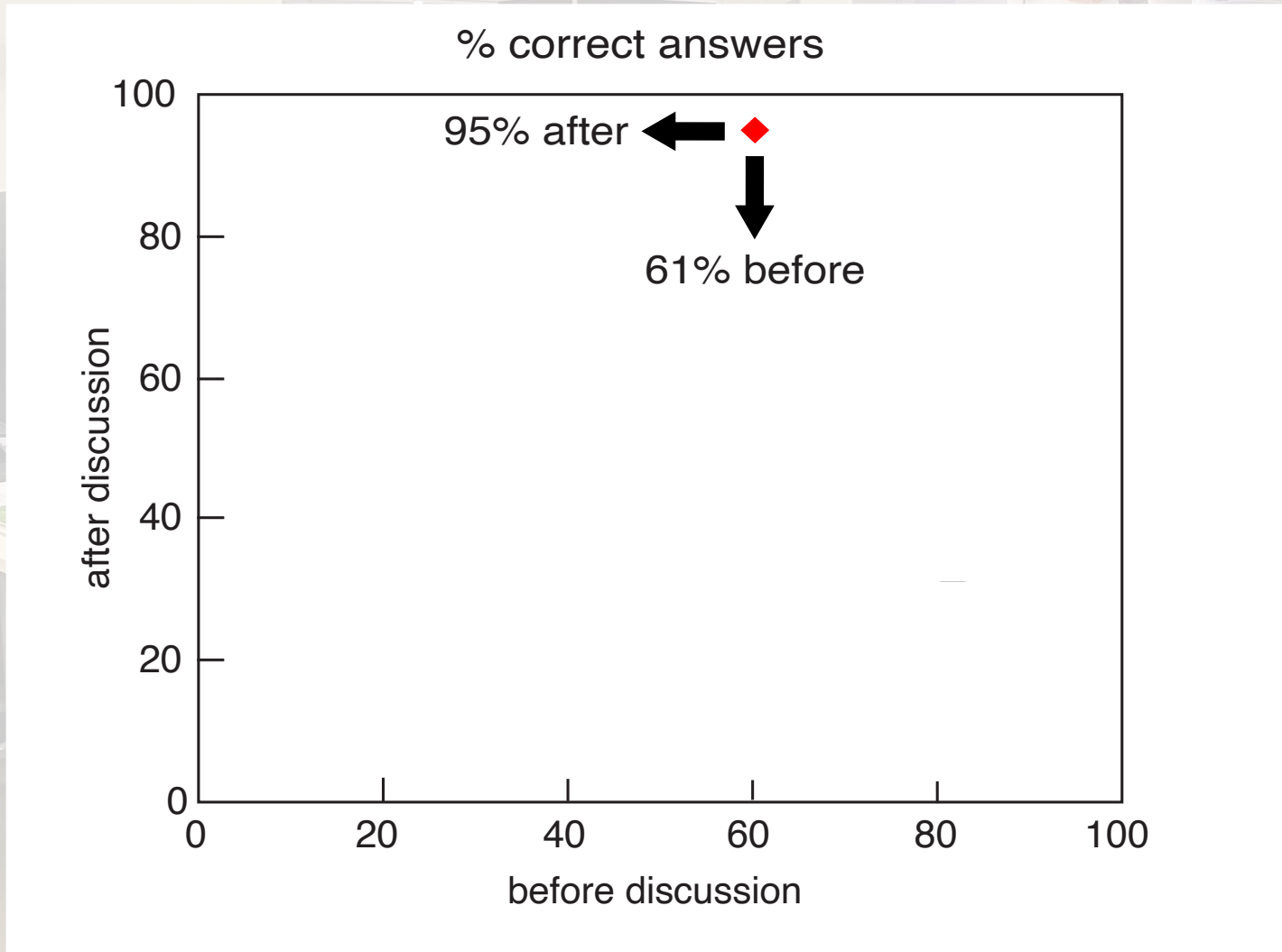


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3 self-paced PI

in-class PI

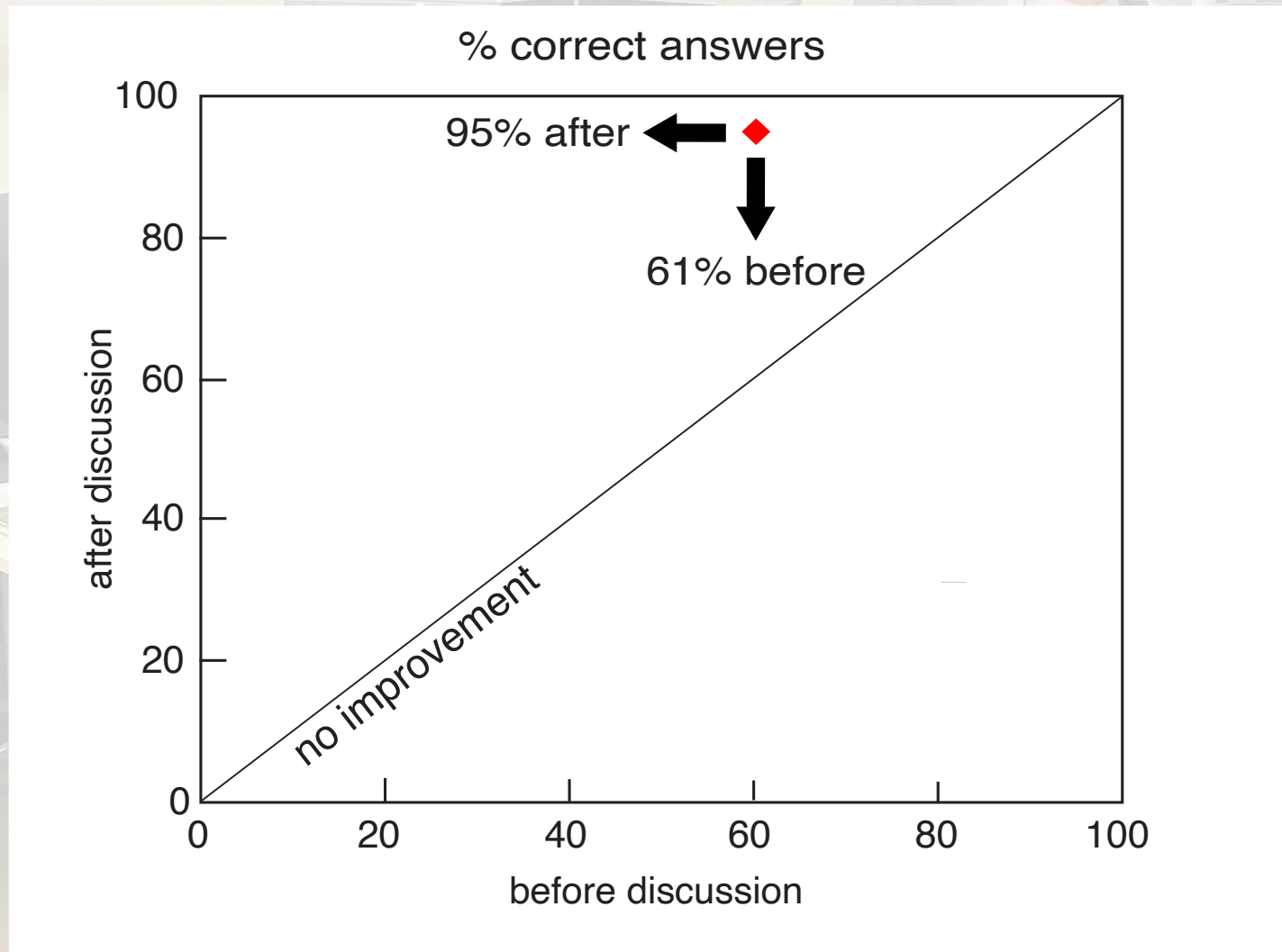


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

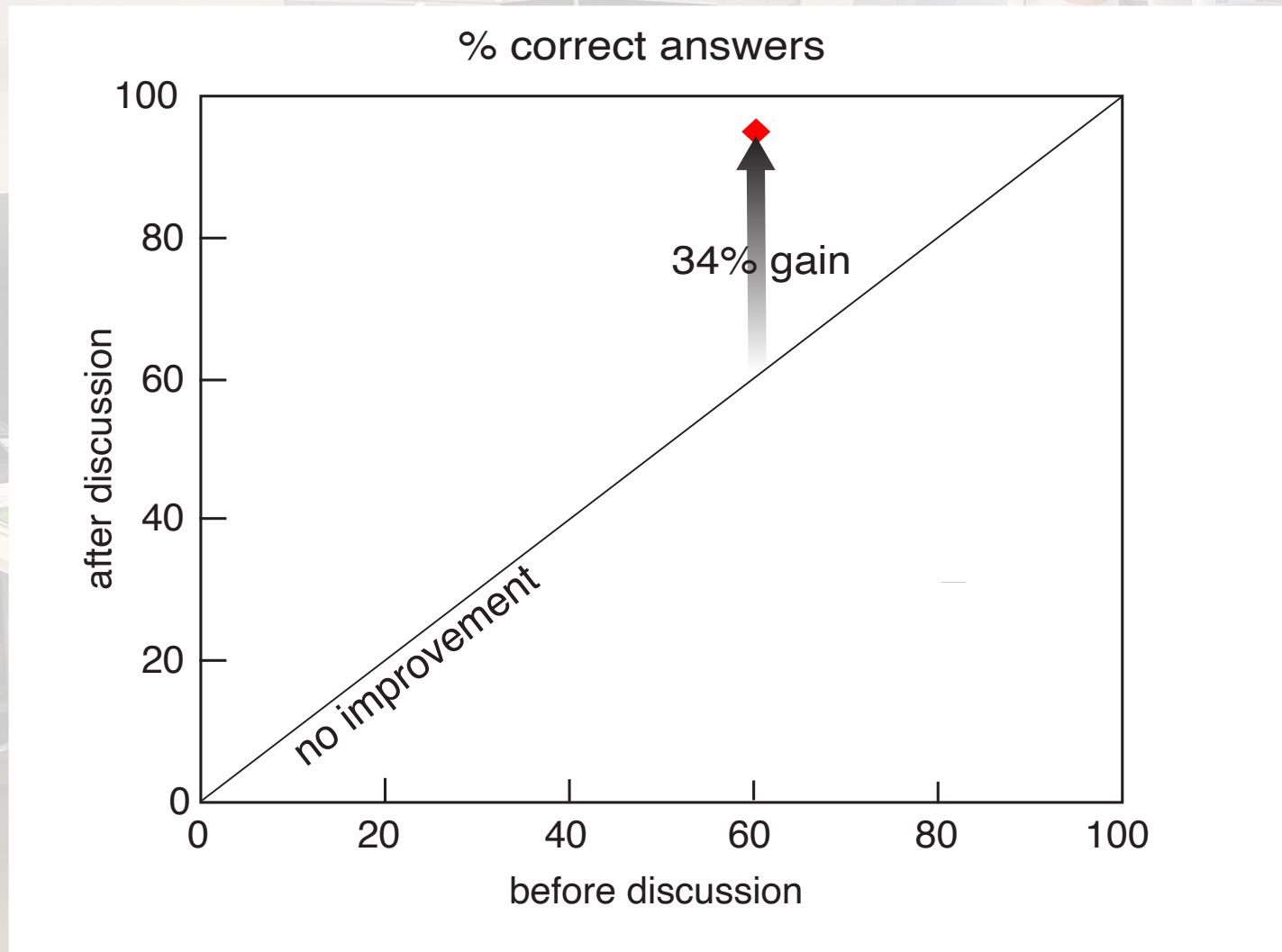


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

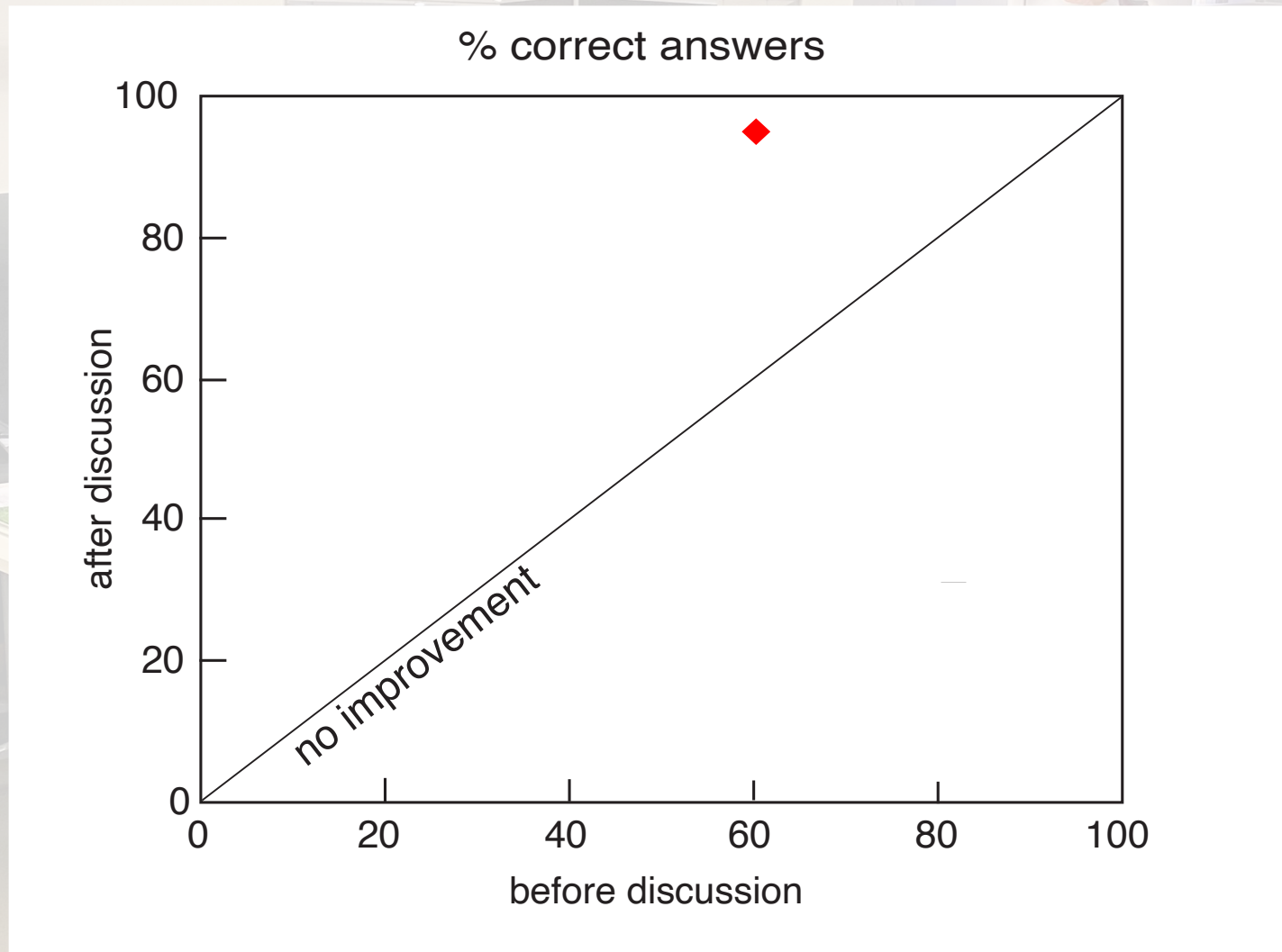


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

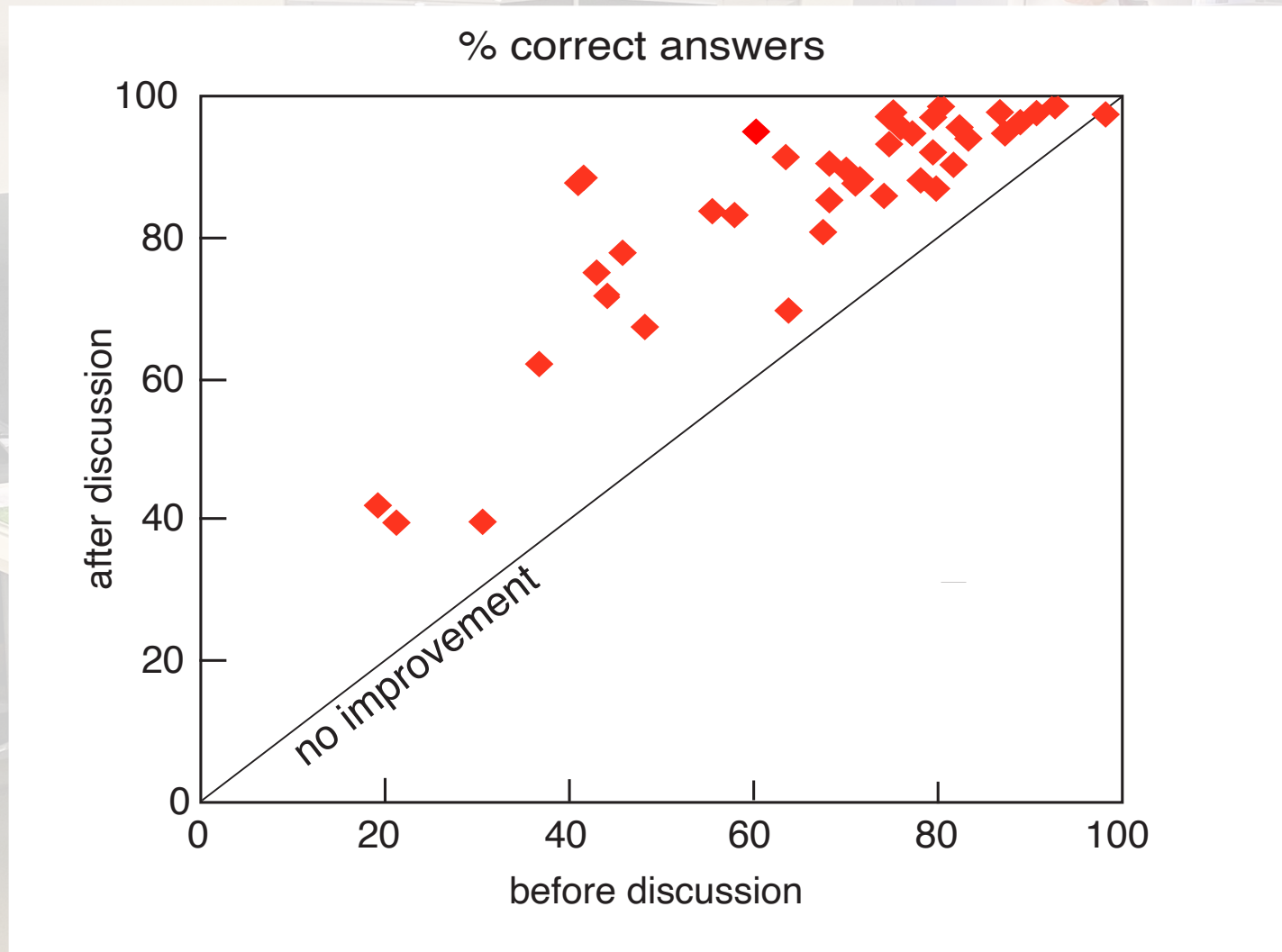


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

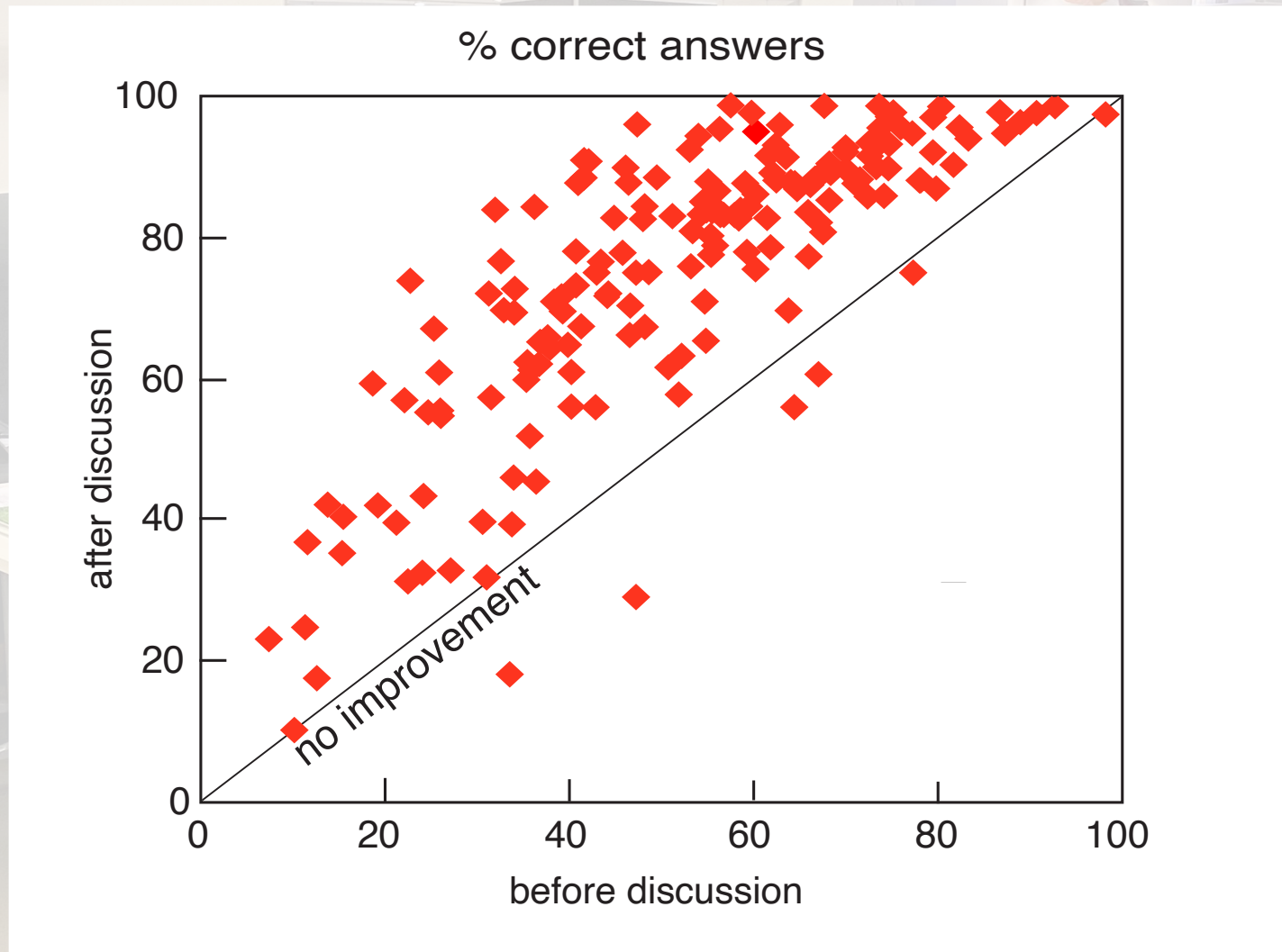


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI

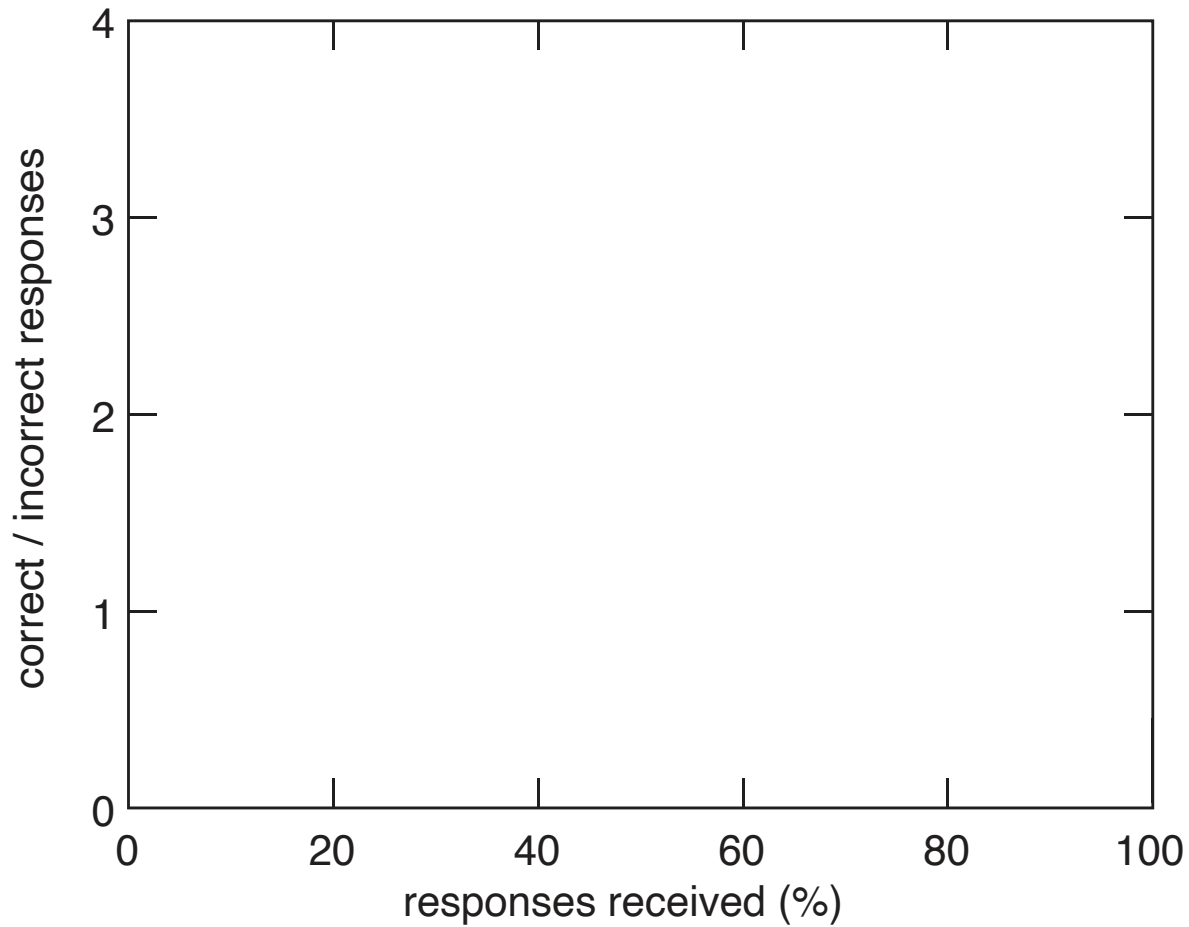


① pandemic lessons

② new normal

③ self-paced PI

in-class PI: response time analysis

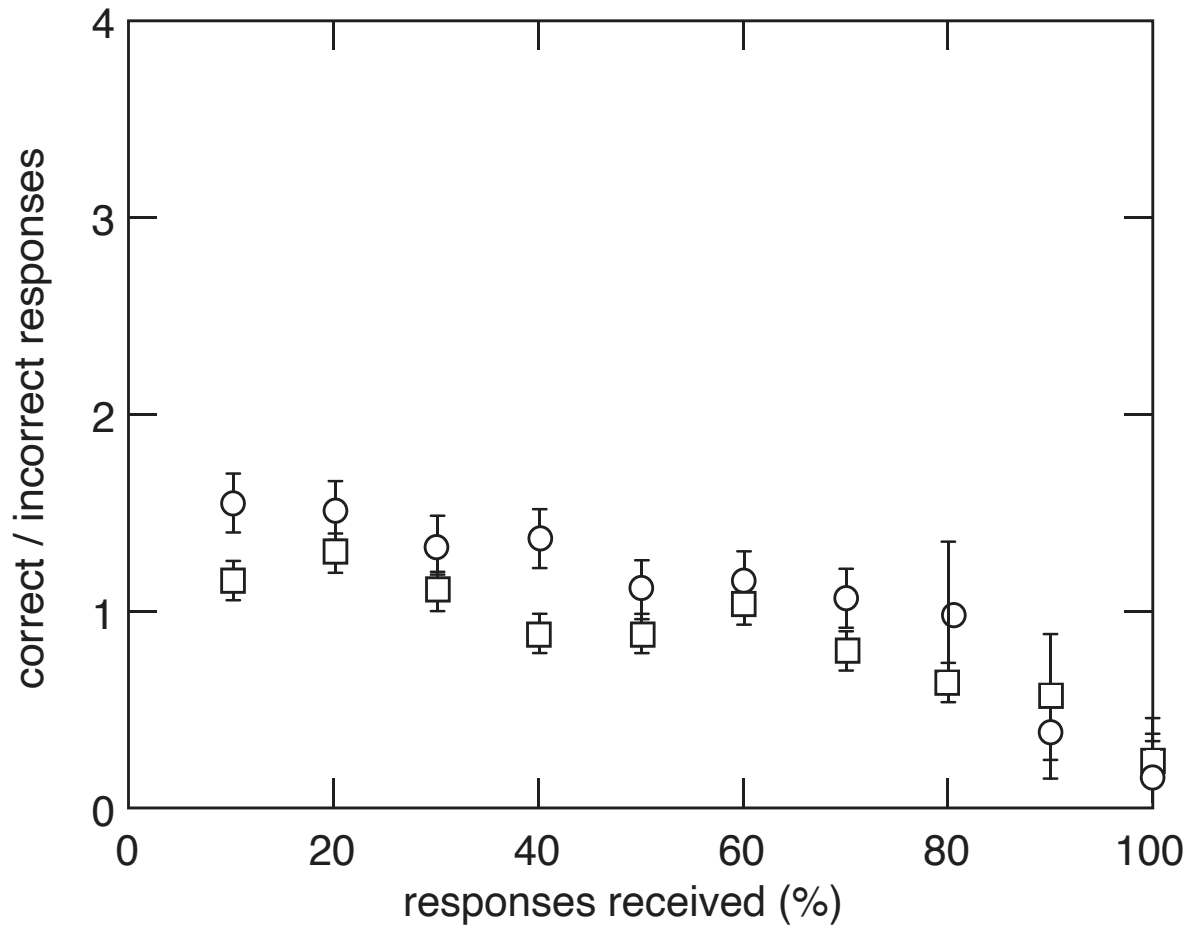


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: response time analysis



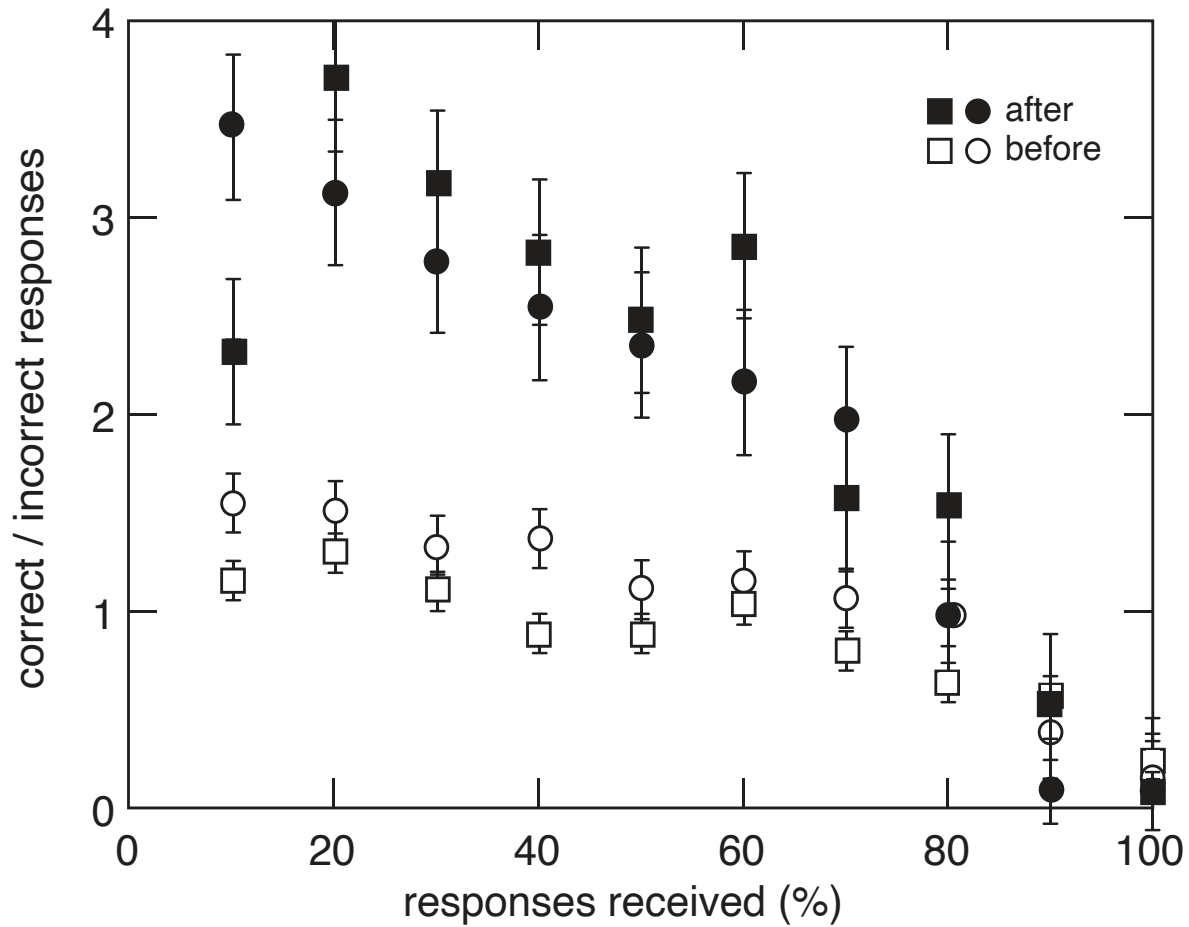
1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: response time analysis

InnoBreakCafe

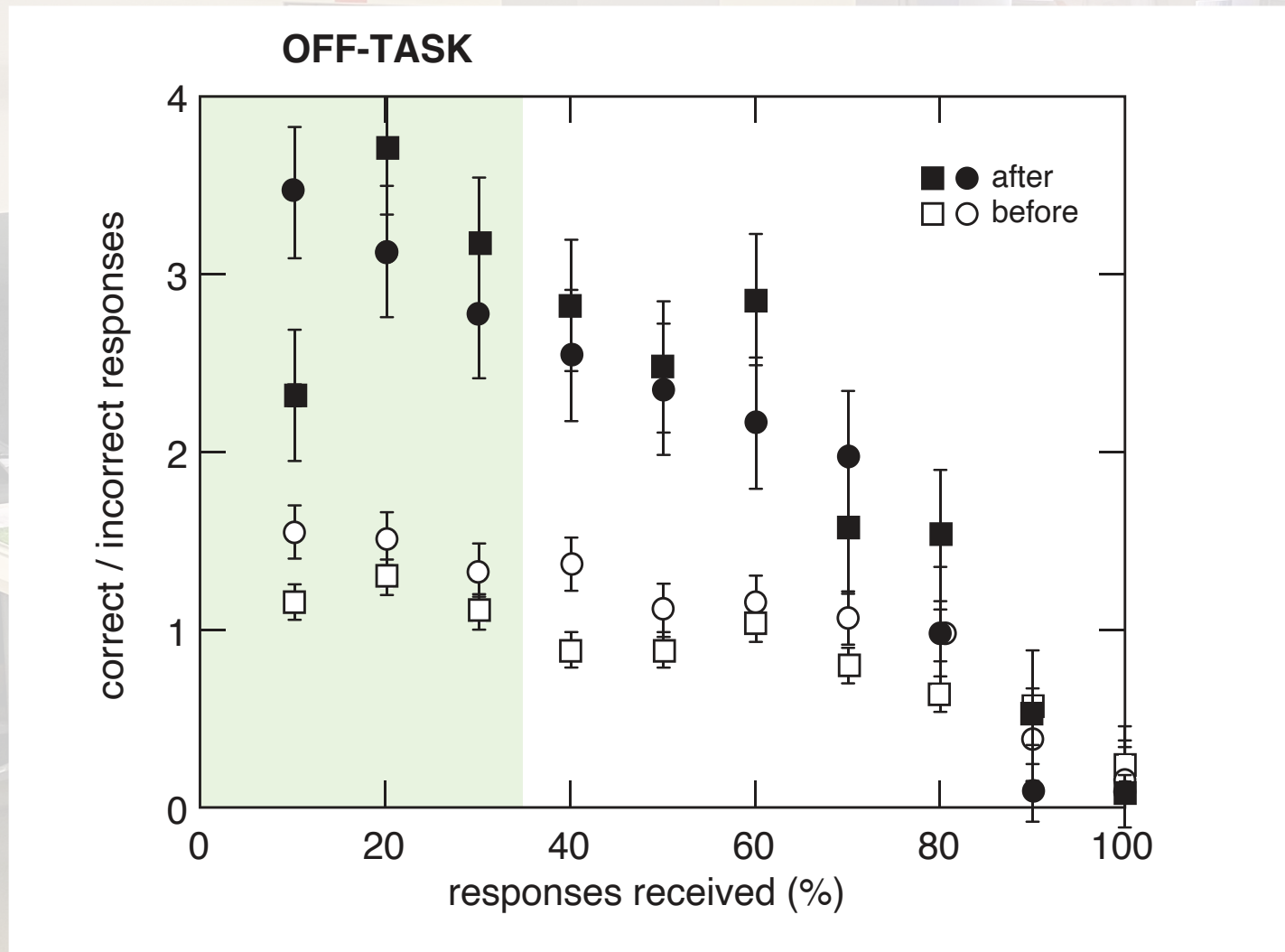


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: response time analysis

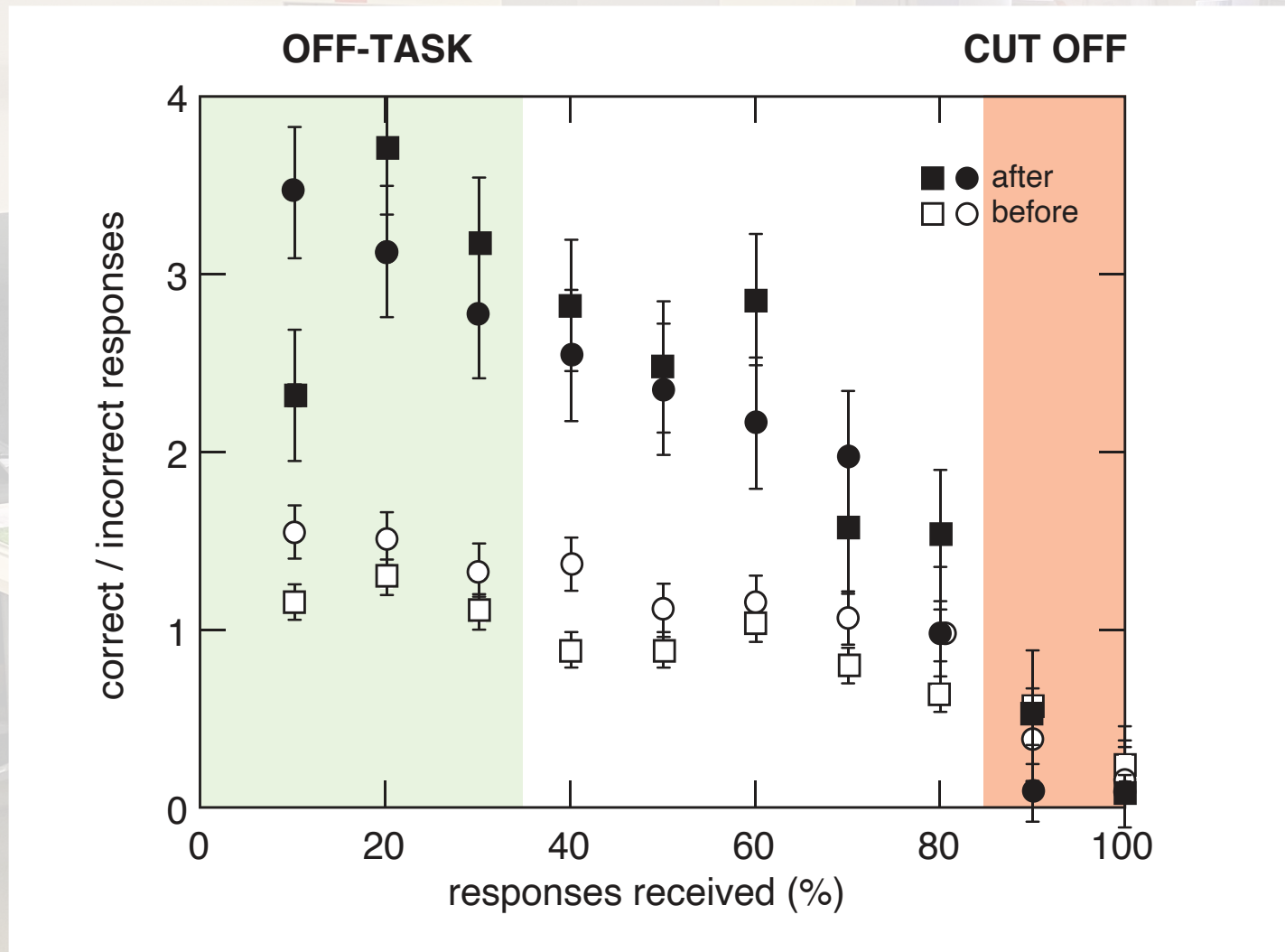


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: response time analysis

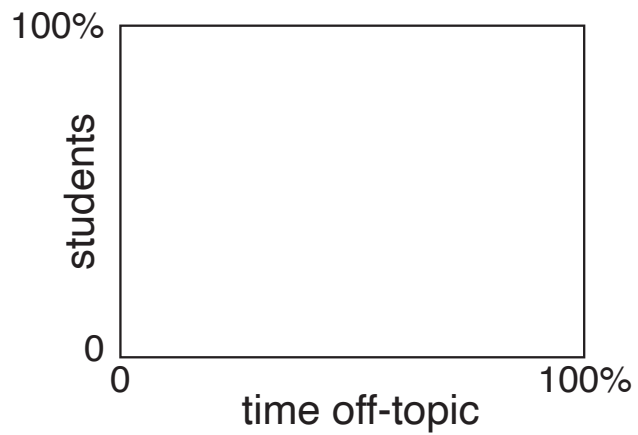


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: time off-task

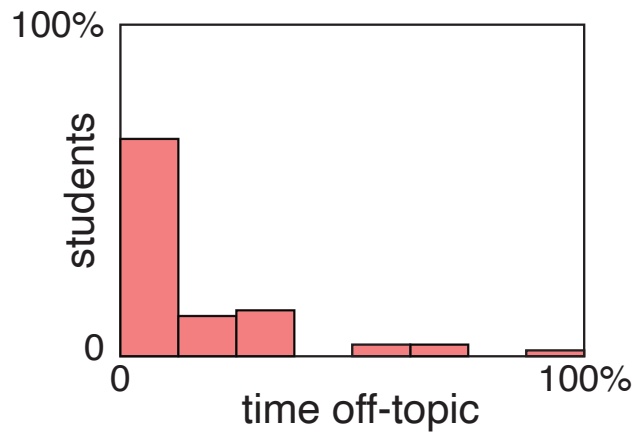


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: time off-task

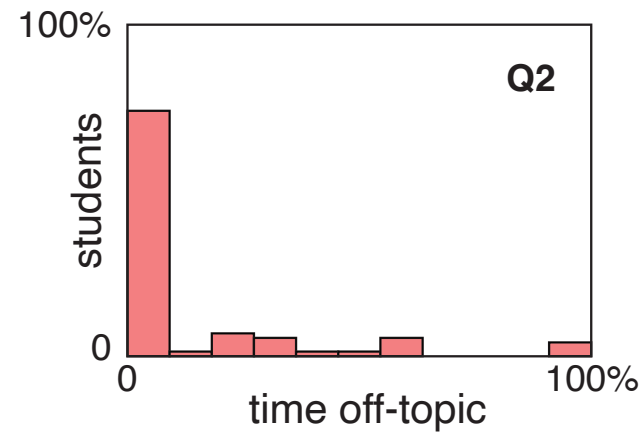
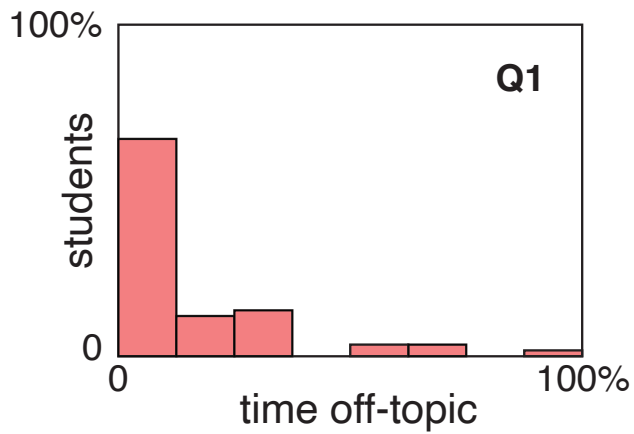


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: time off-task

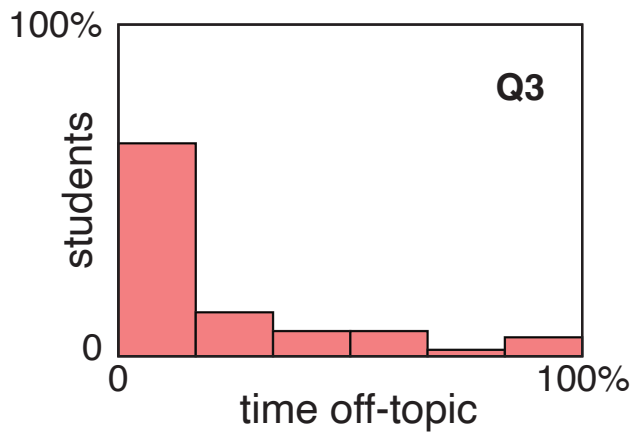
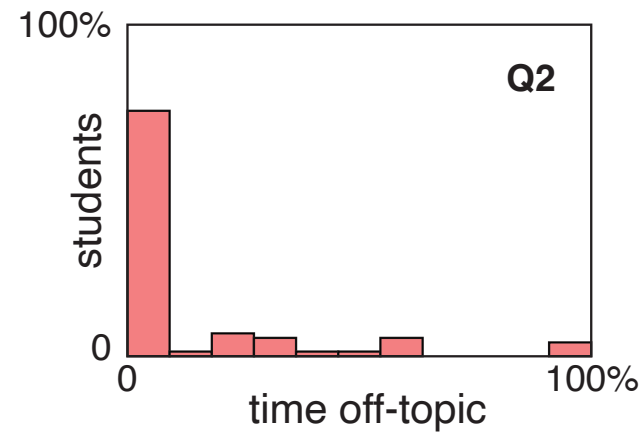
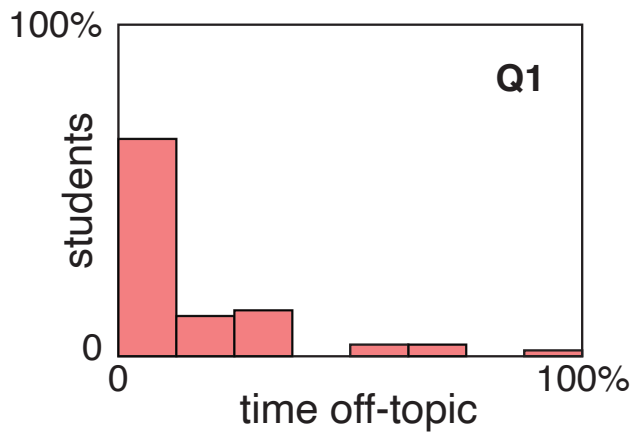


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: time off-task

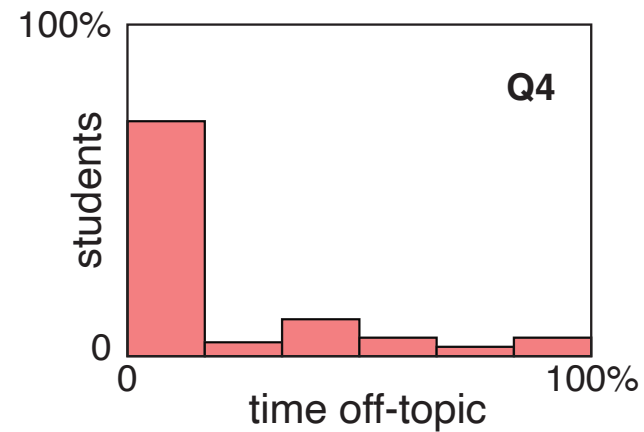
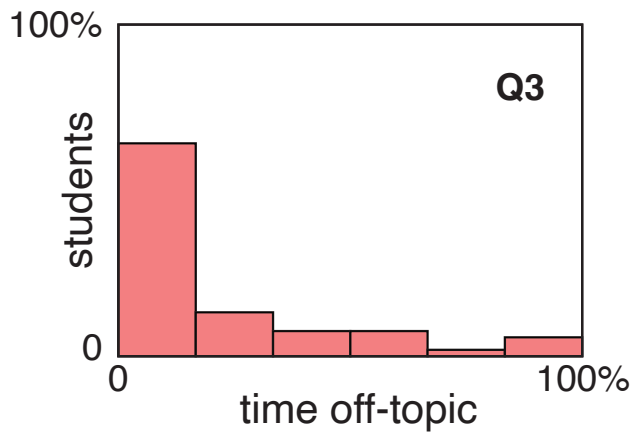
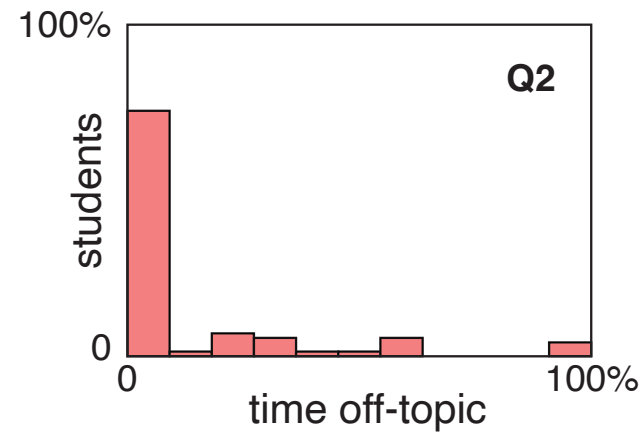
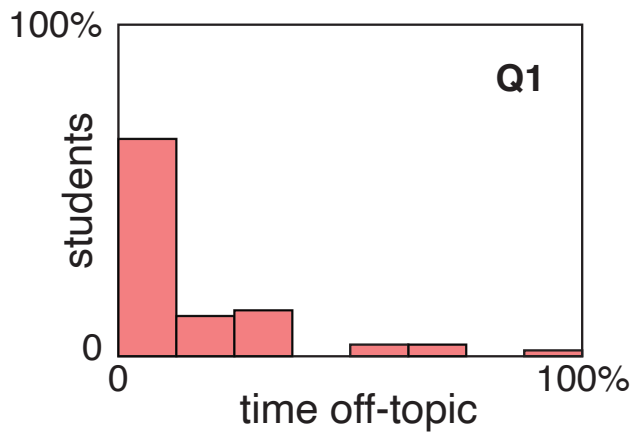


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: time off-task

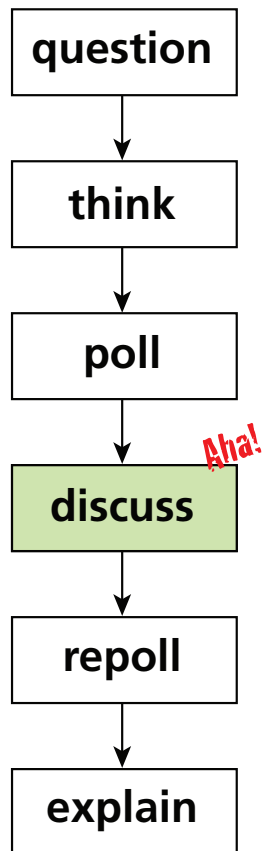


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: class sequence

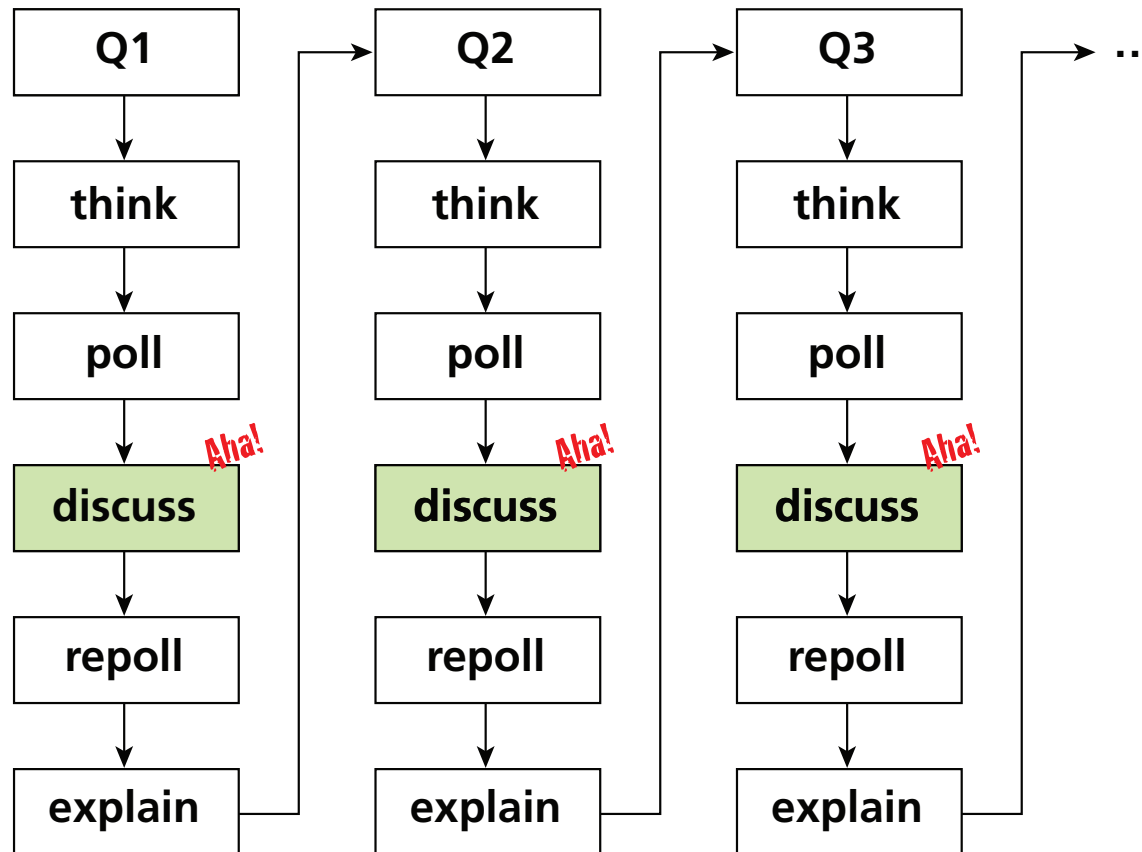


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: class sequence

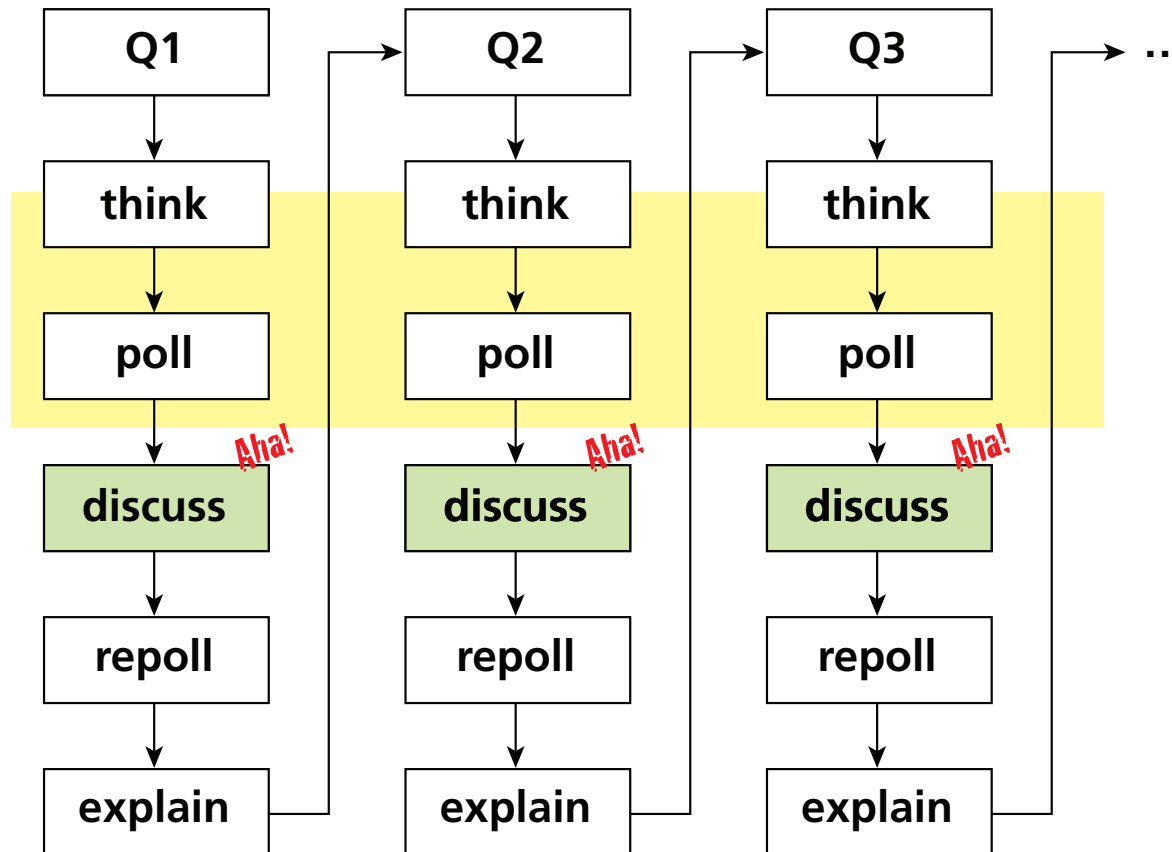


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: class sequence

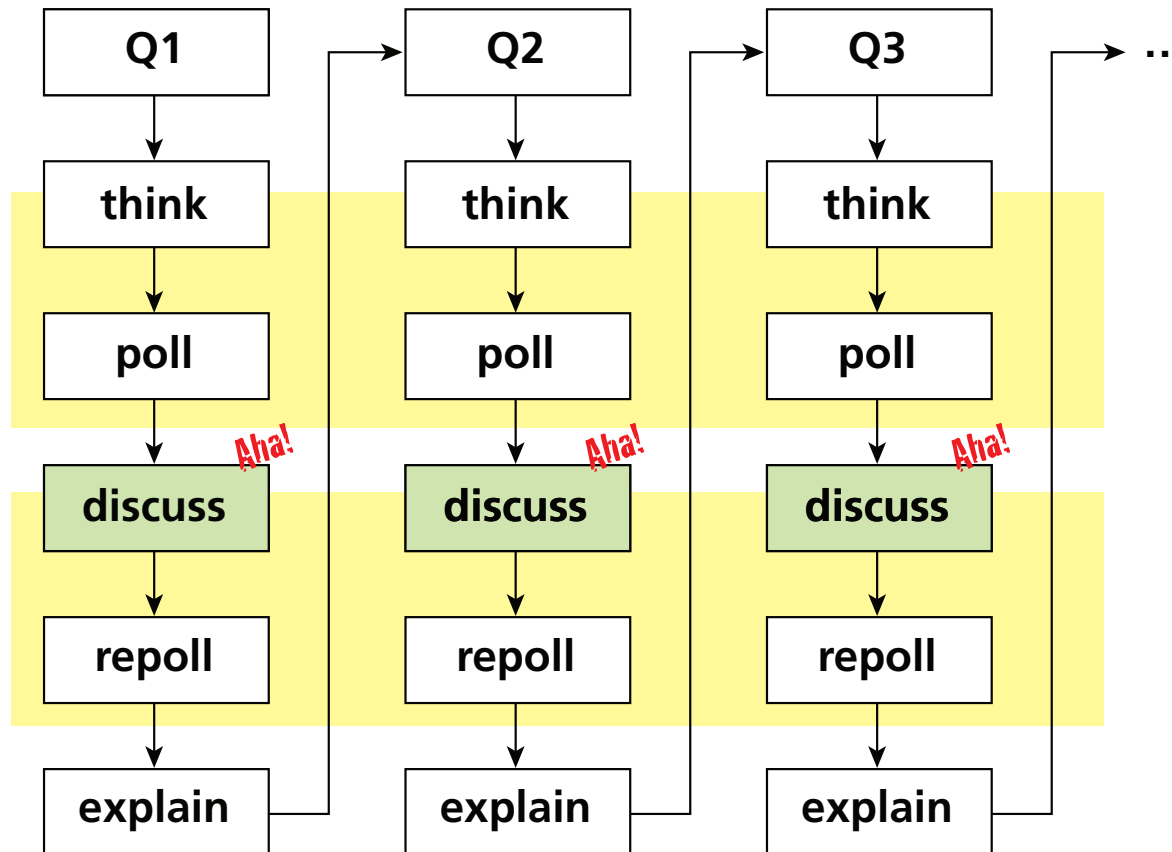


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: class sequence

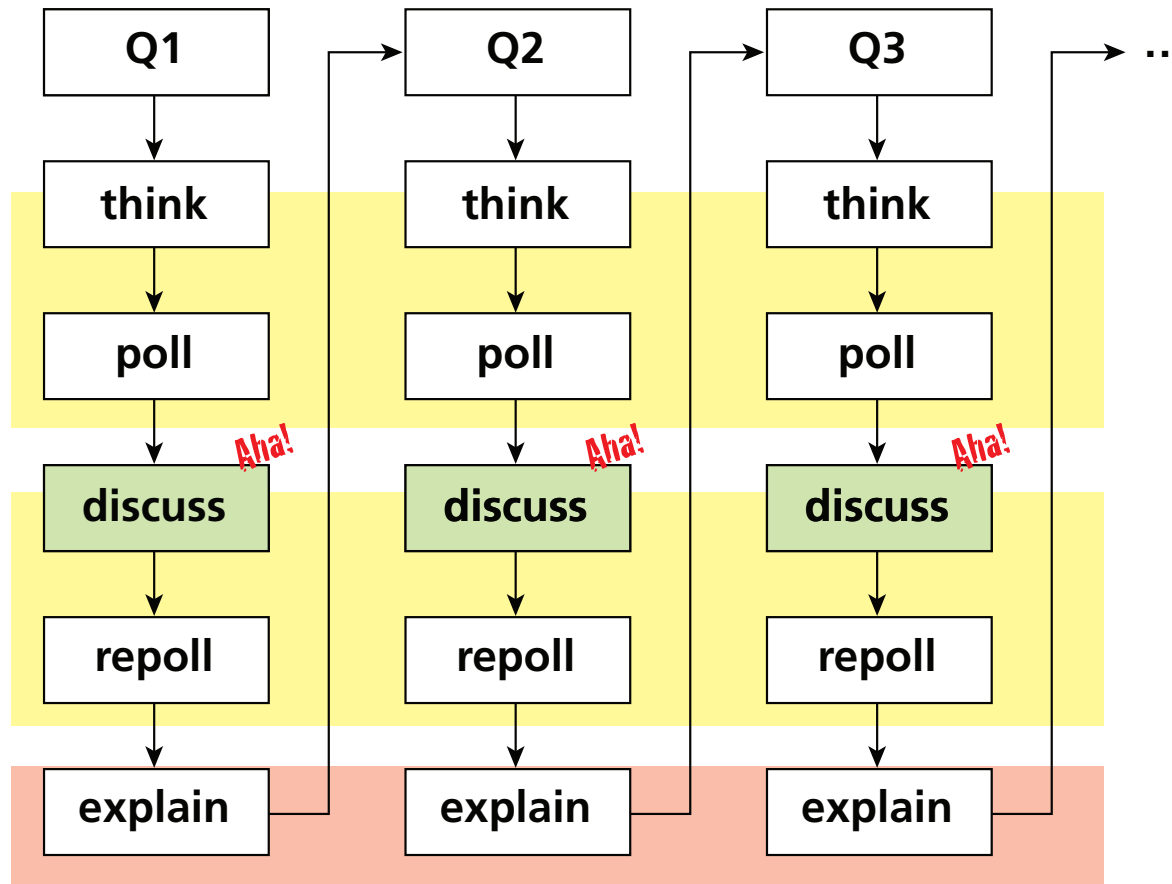


1 pandemic lessons

2 new normal

3 self-paced PI

in-class PI: class sequence

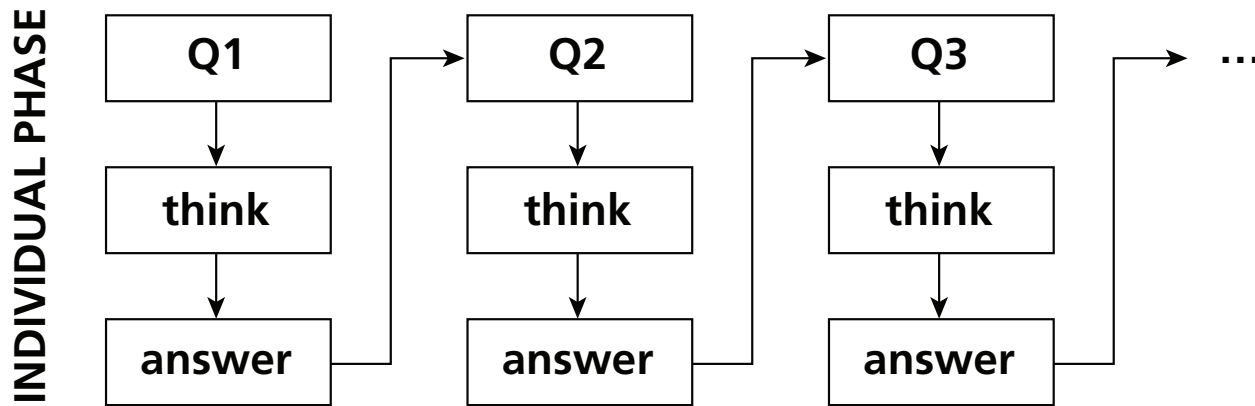


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI

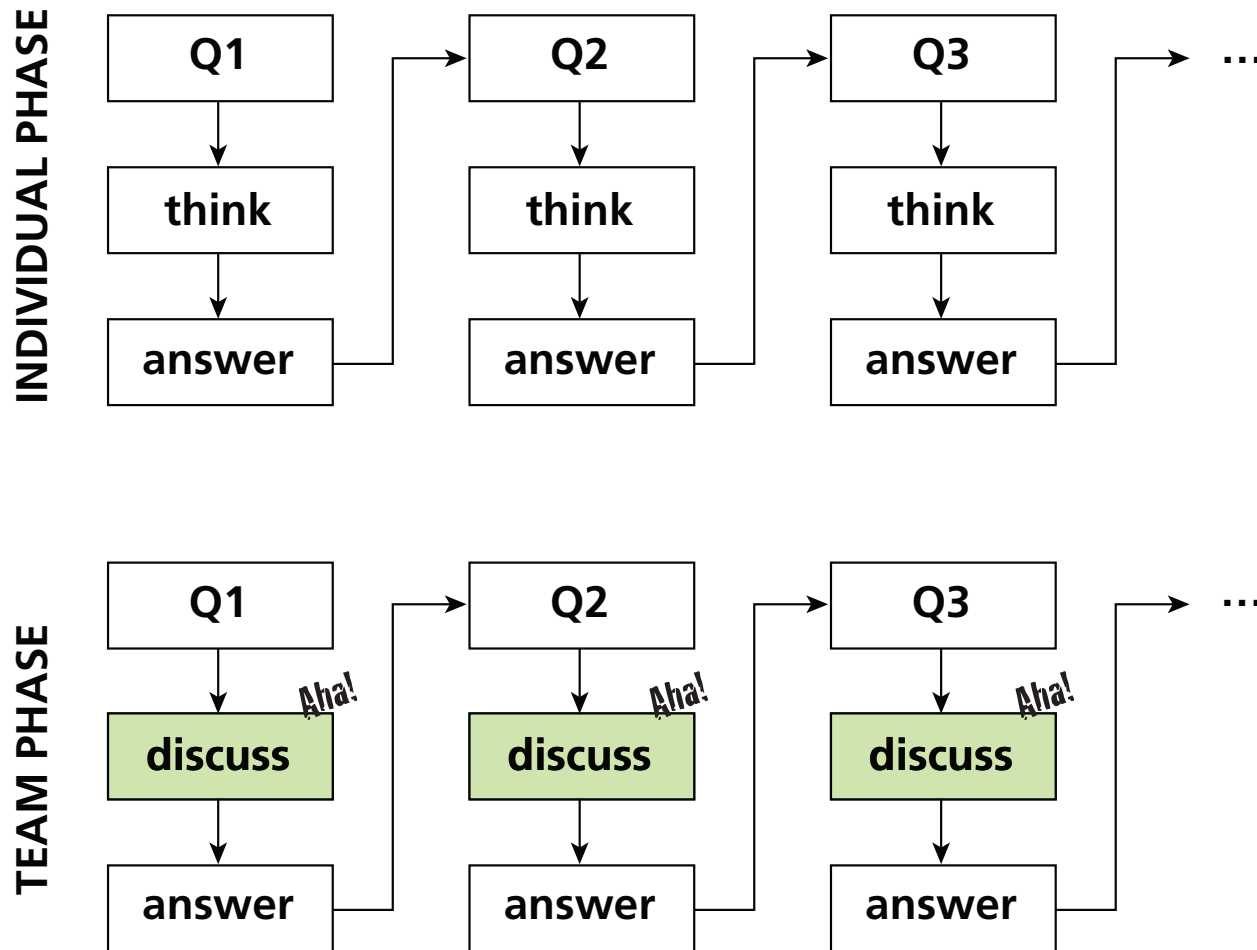


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI



1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: attempts & points

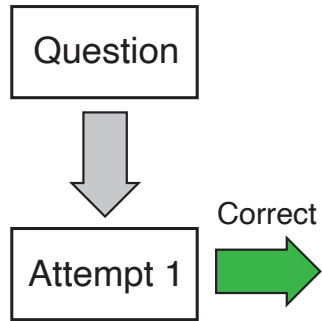
Question

1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: attempts & points

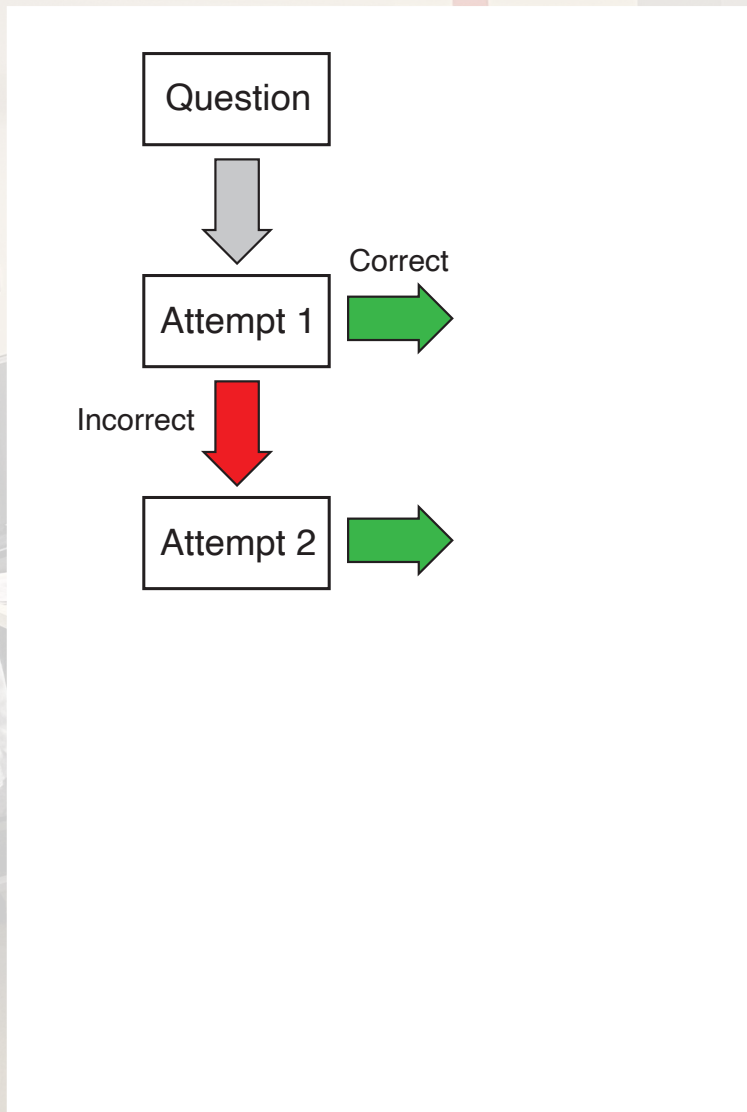


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: attempts & points

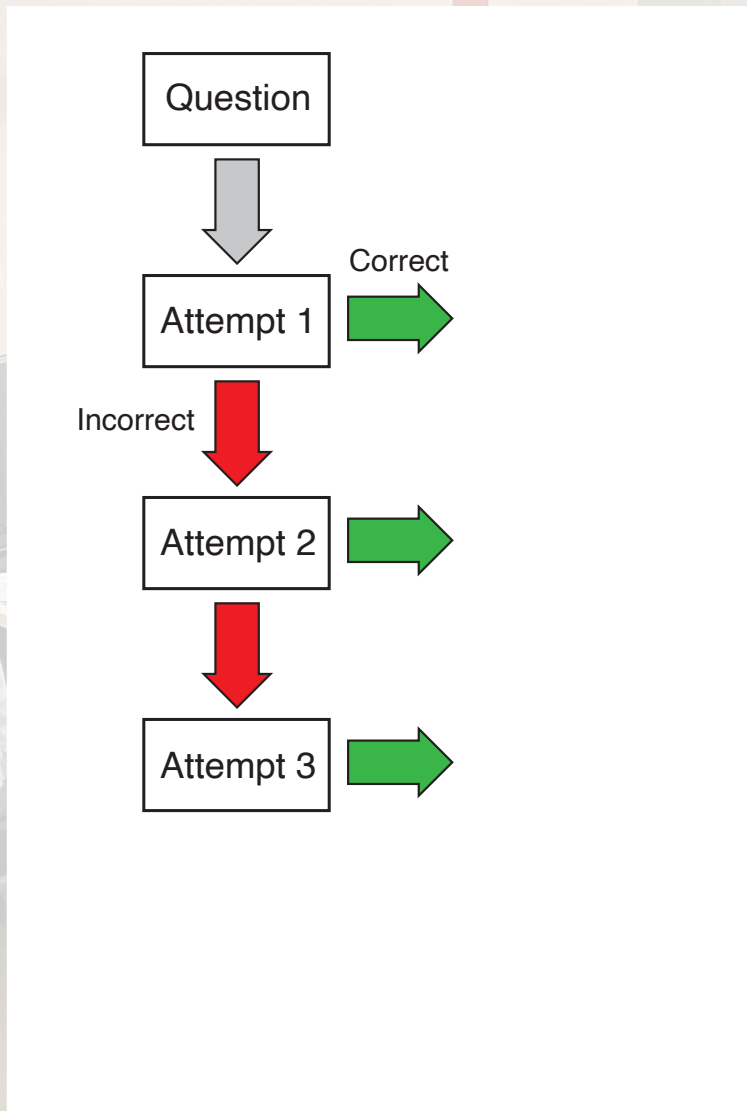


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: attempts & points

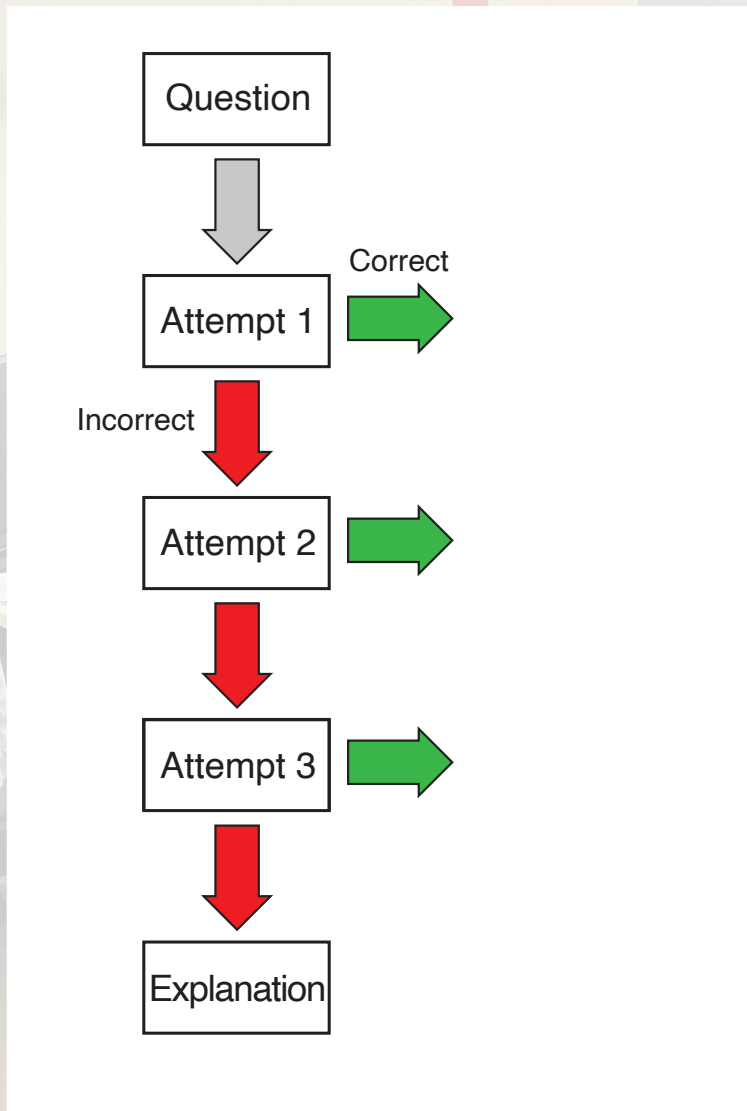


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: attempts & points

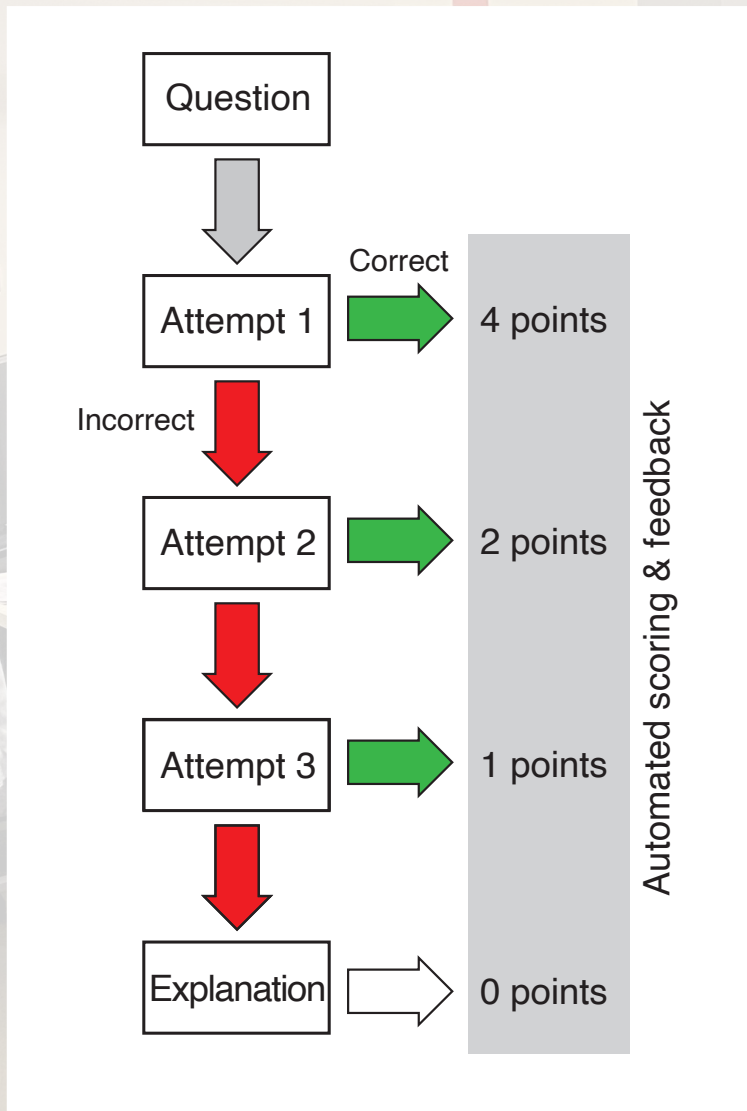


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: attempts & points

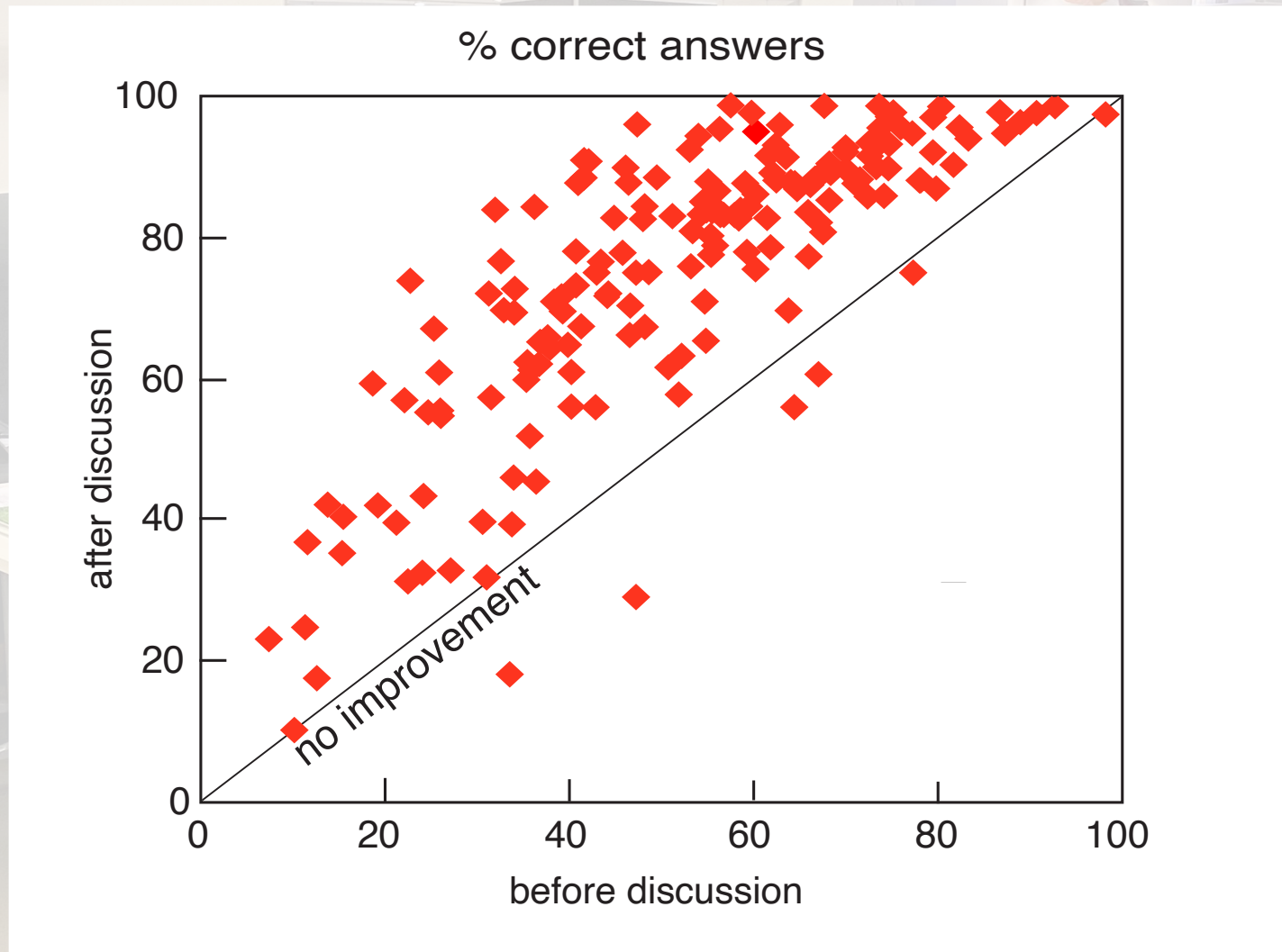


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

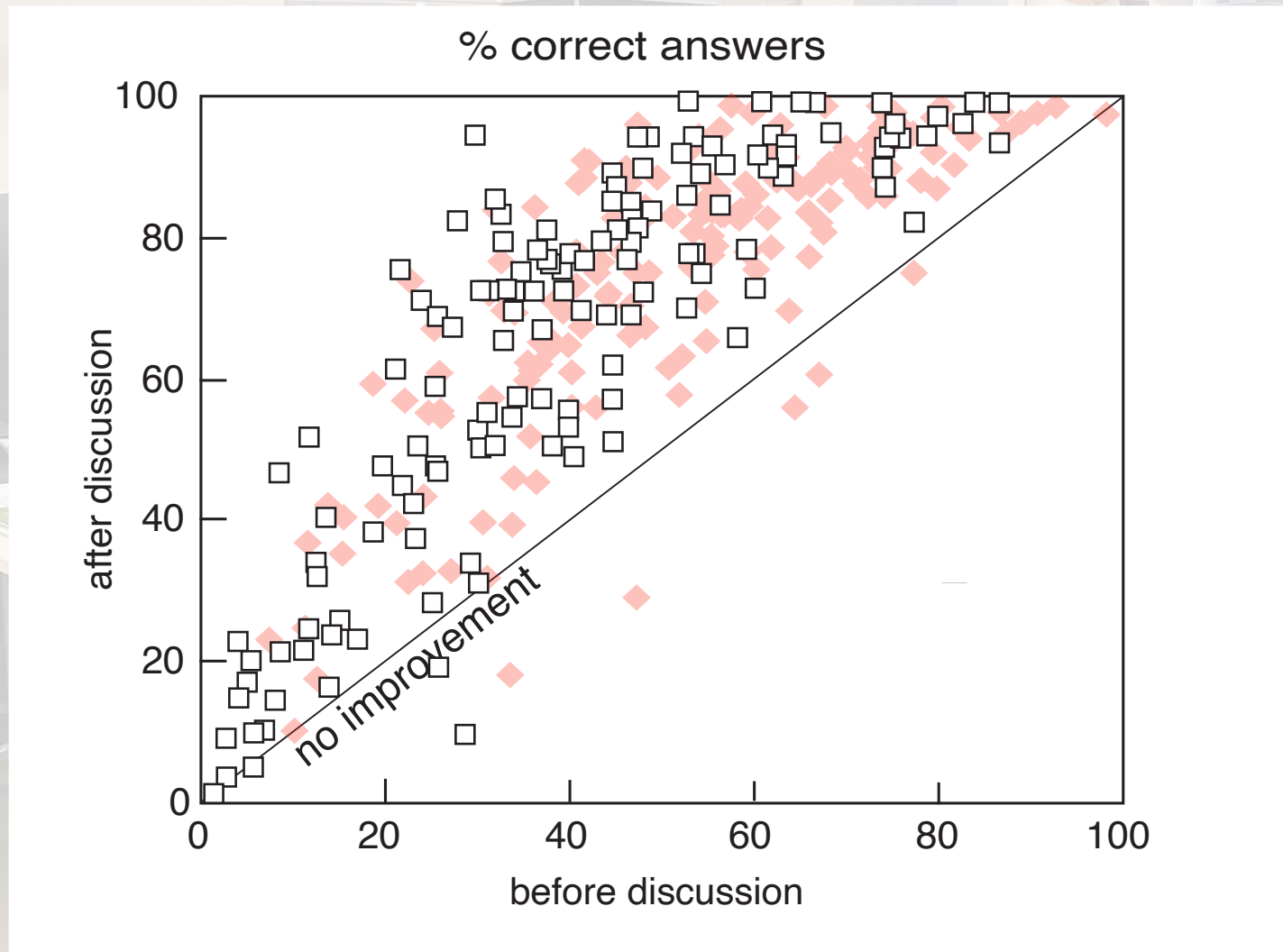


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

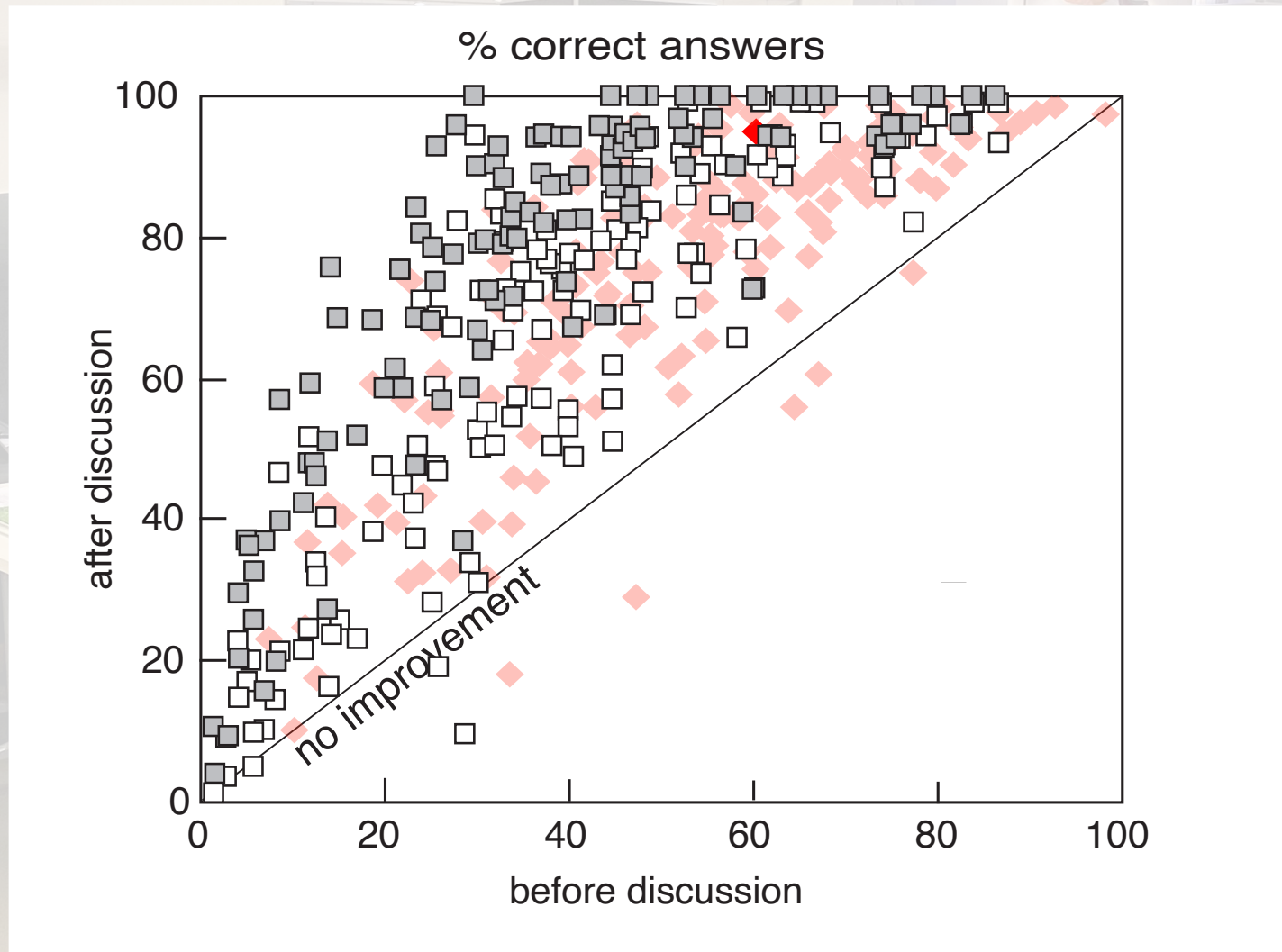


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

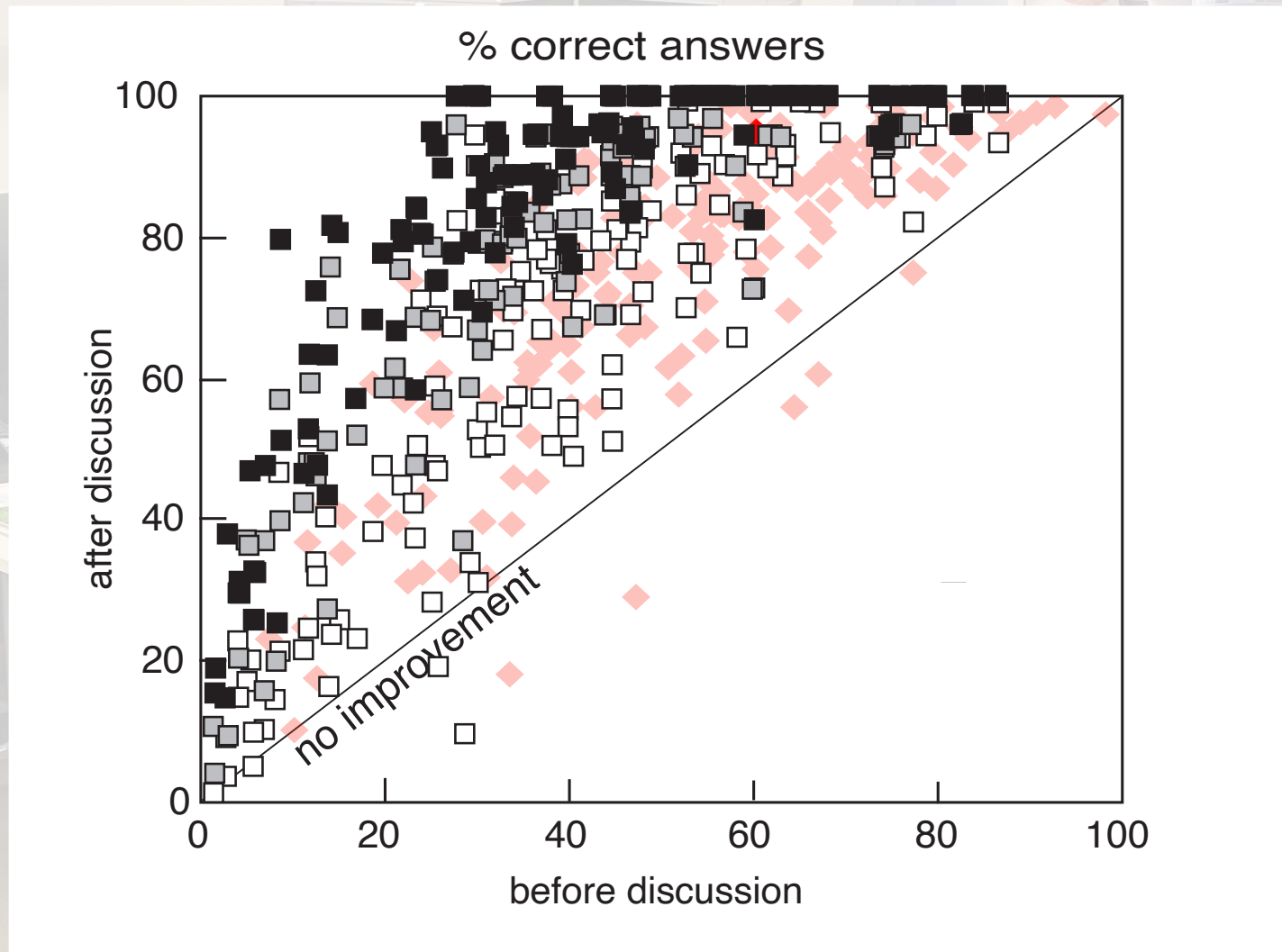


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

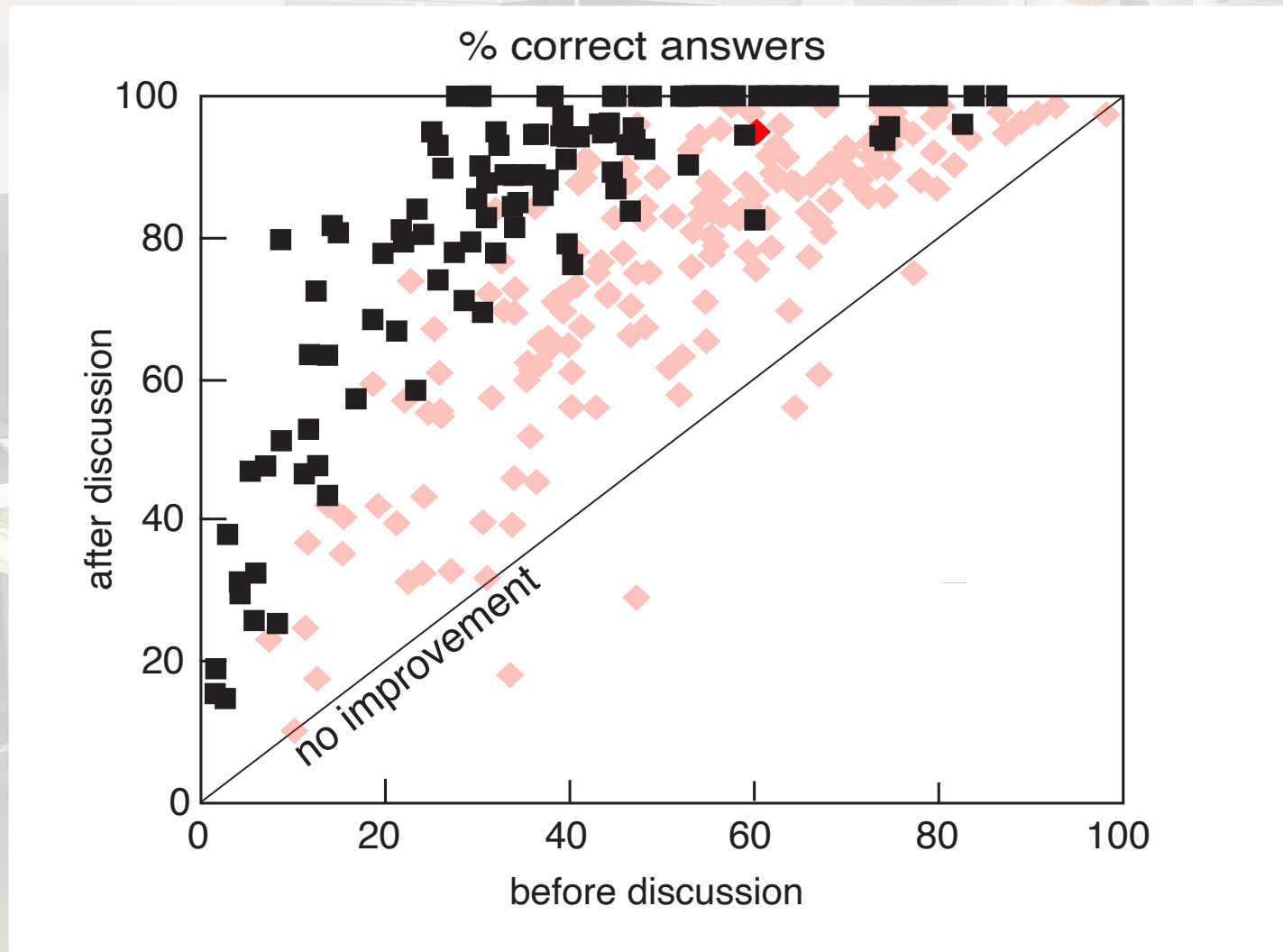


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

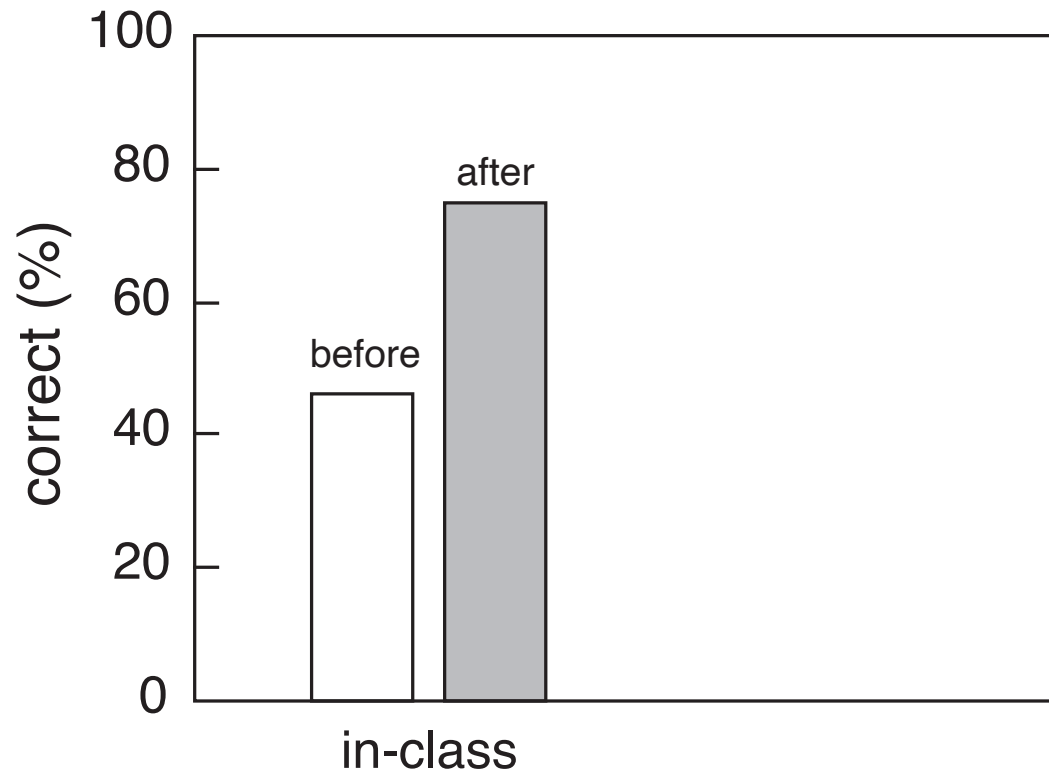


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

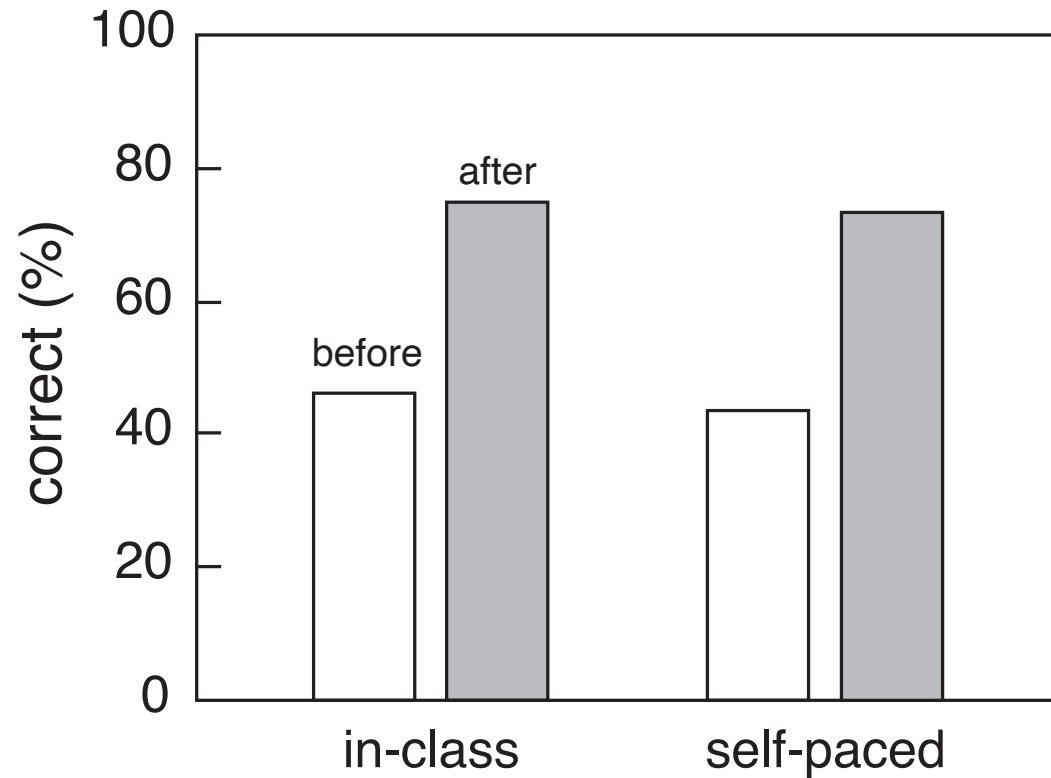


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

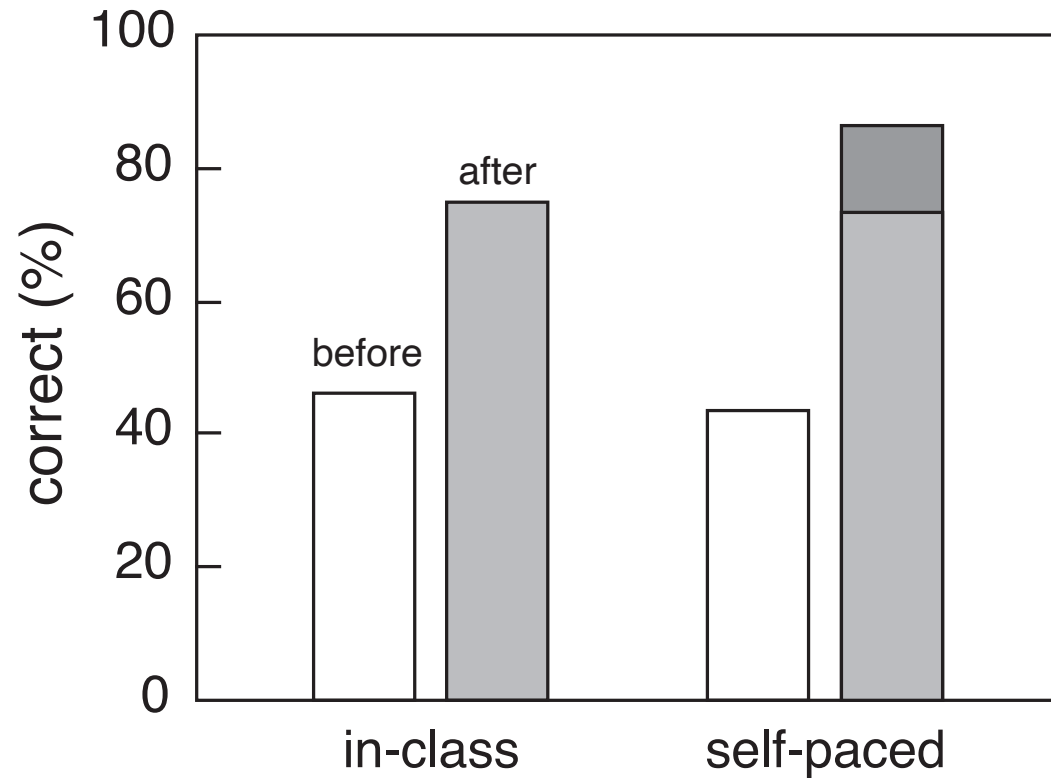


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced vs. in-class PI

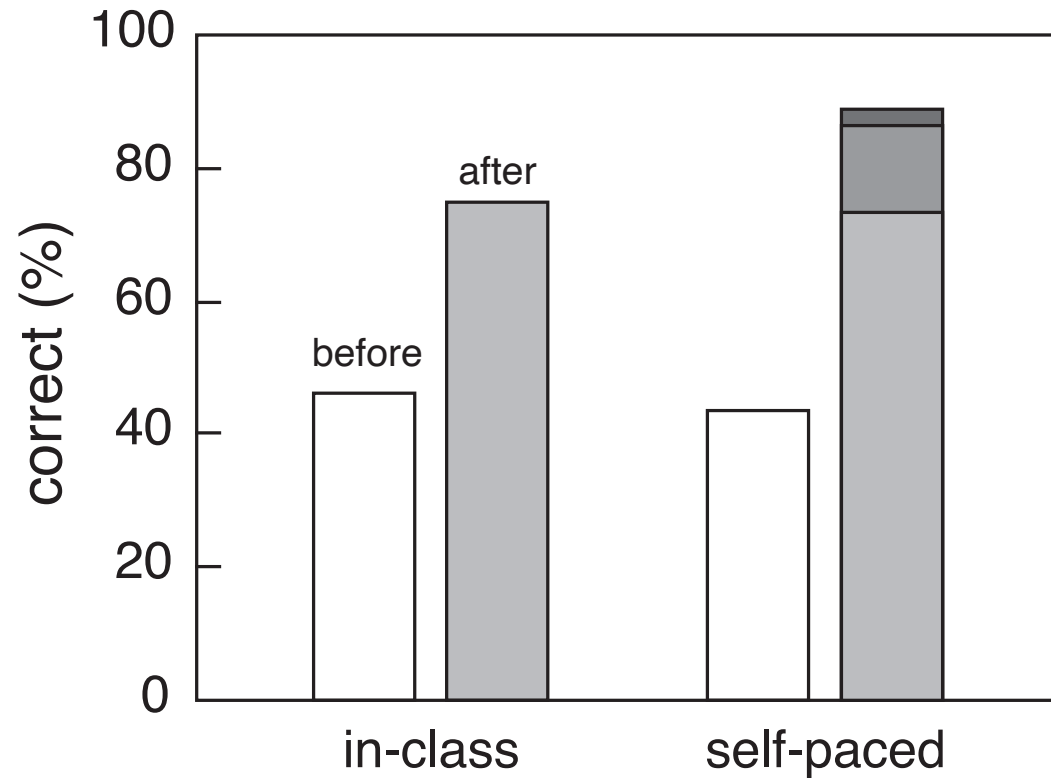


1 pandemic lessons

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

InnoBreakCafe

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

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

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

InnoBreakCafe

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

InnoBreakCafe

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



less time, more learning!

1 pandemic lessons

2 new normal

3 self-paced PI



question, it will count for your entire team (you, Destiny Rochester, Julia Welsh, and Dagmawi Misgano). Only one question (otherwise it will count as multiple attempts).

Jump to ▼ 1 2 **3** 4 5 6 7 8 9 10 ▶

dy is height h , what minimum length must the mirror be in order for you to see your entire body in the mirror?

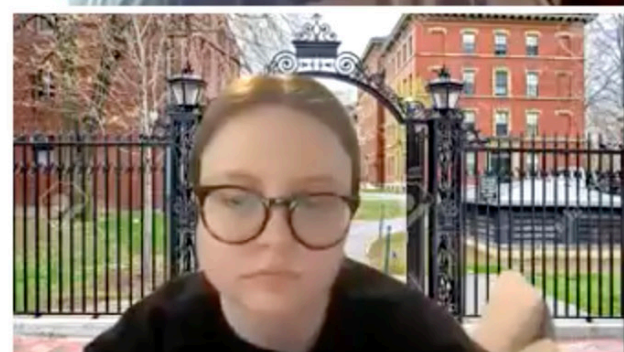
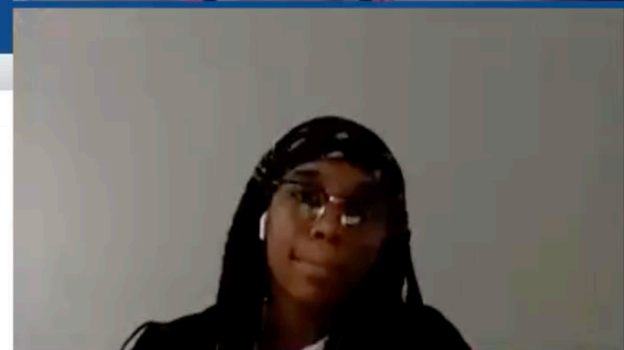
If answers other than expressions are entered (such as equations, inequalities, or number sets), they will be marked

ctions, \log , \ln and \exp , for example, $\sin(x)$, $\ln(y)$, $\exp(2)$. Inverse trigonometric functions are supported only in form of $\exp(1)$ for Euler's number. $\log(z)$ presents the logarithm of z to base 10, while $\ln(z)$ to base $\exp(1)$ and $\log(z,2)$ to base

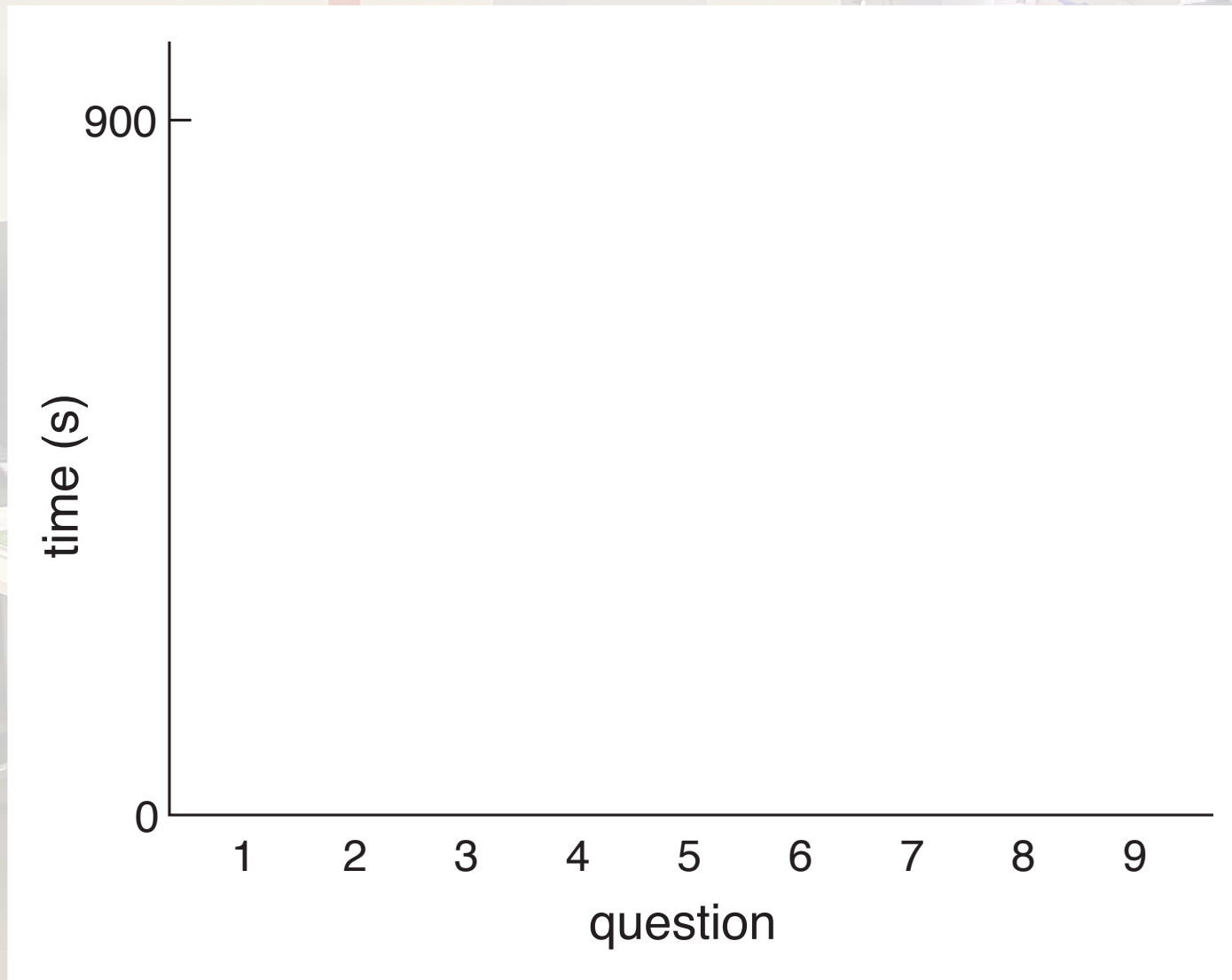
pts so far in team round [Score details](#)

[Send a message to the instructor](#)

[Join another session](#)



self-paced PI: how is time spent?

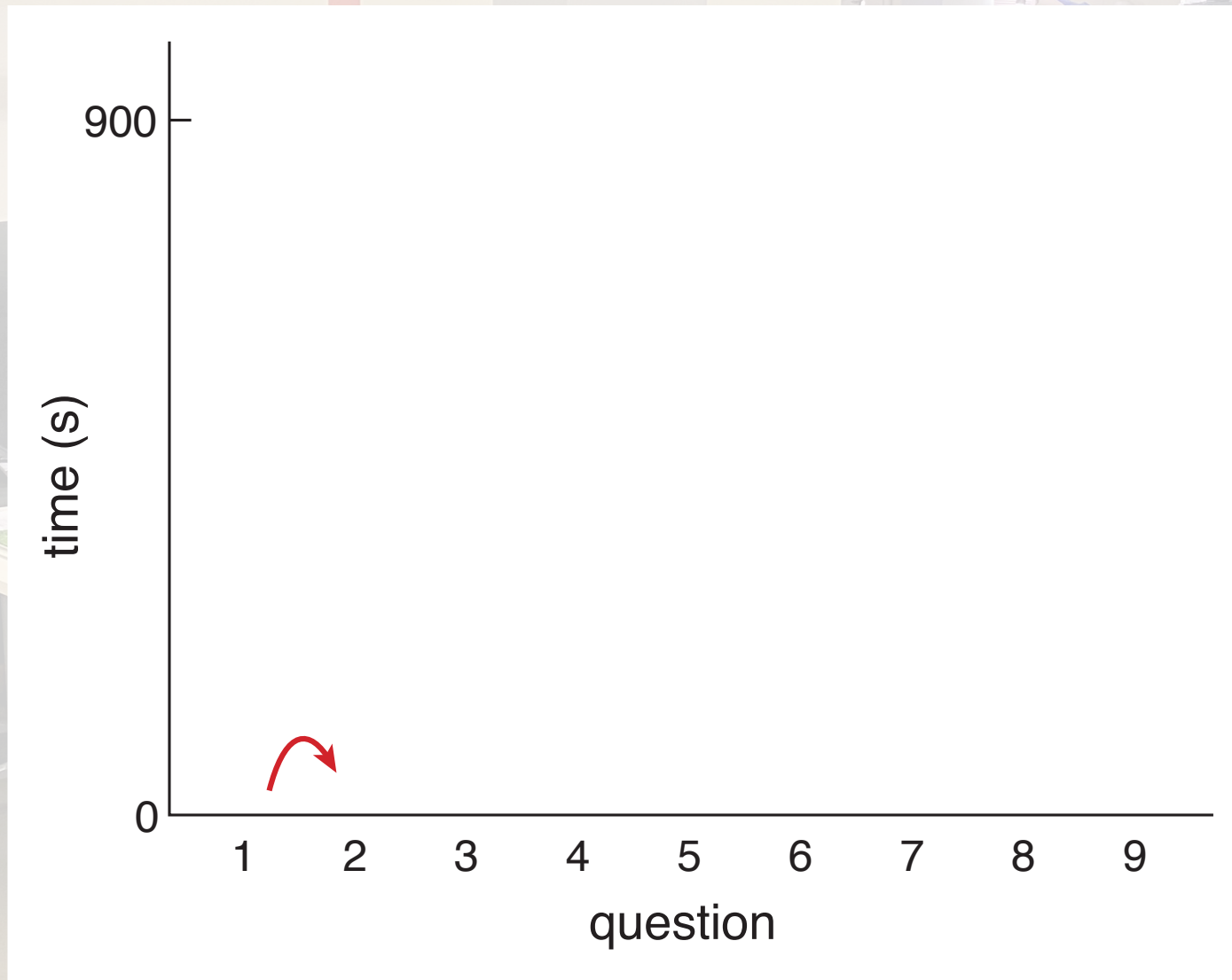


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

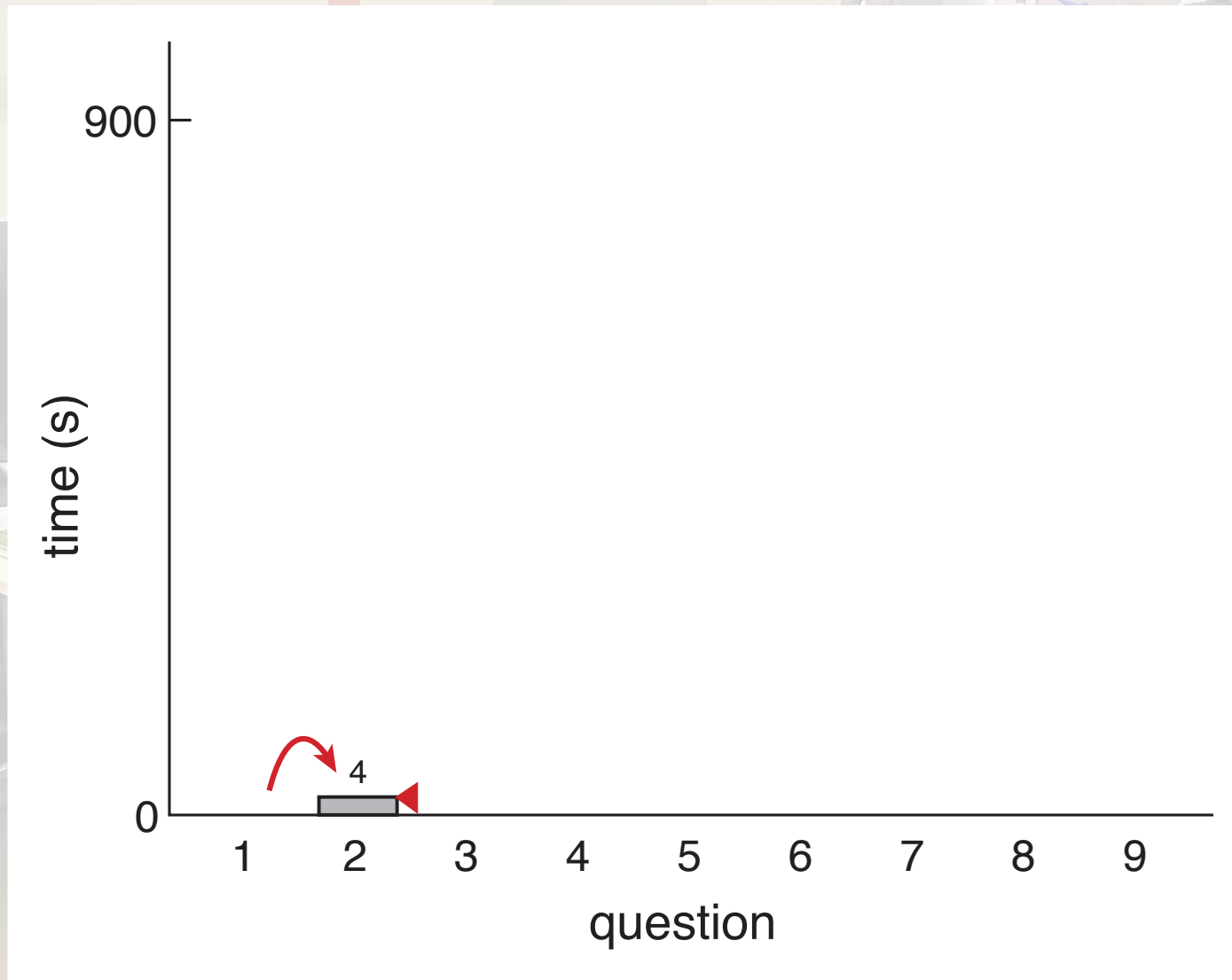


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

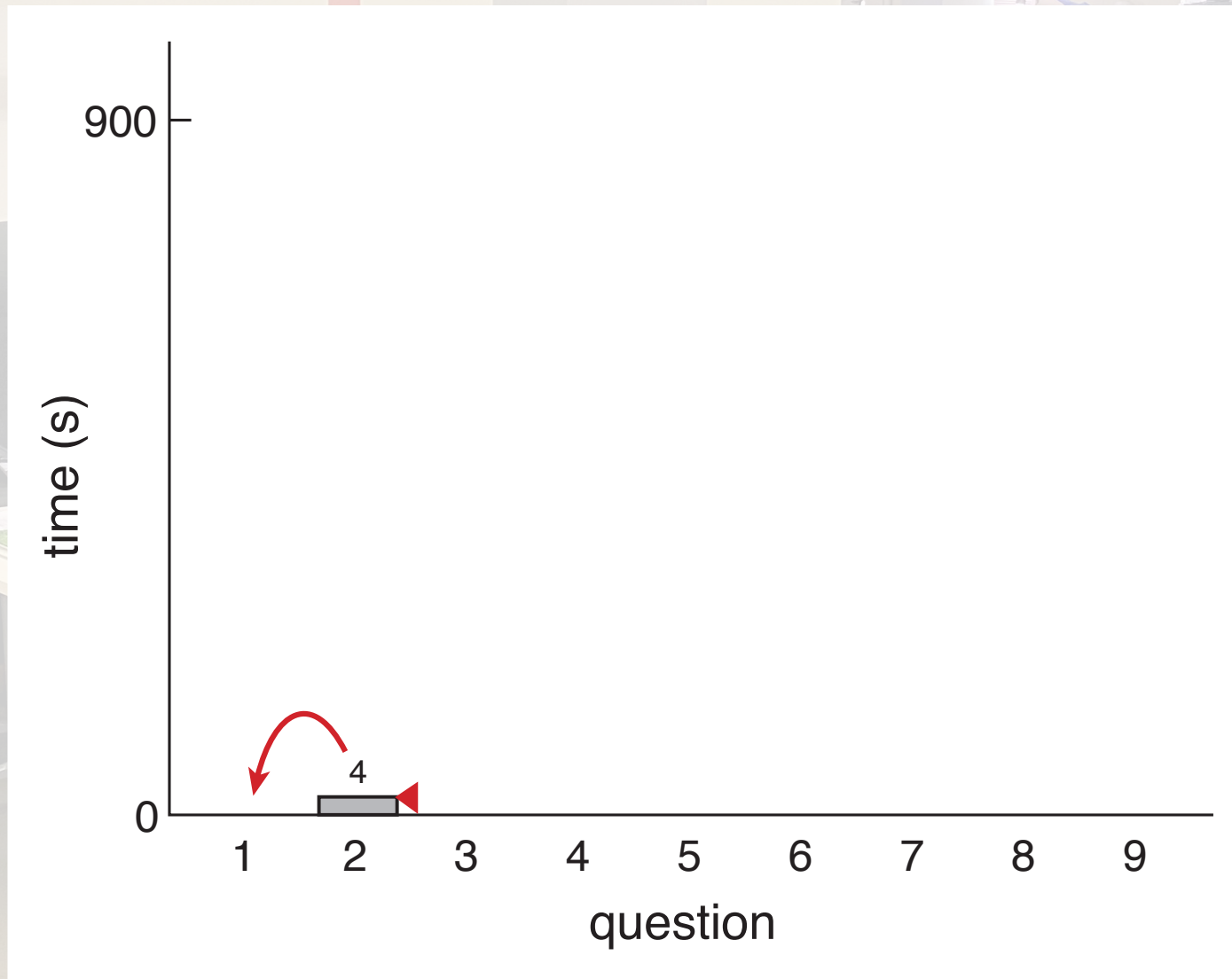


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

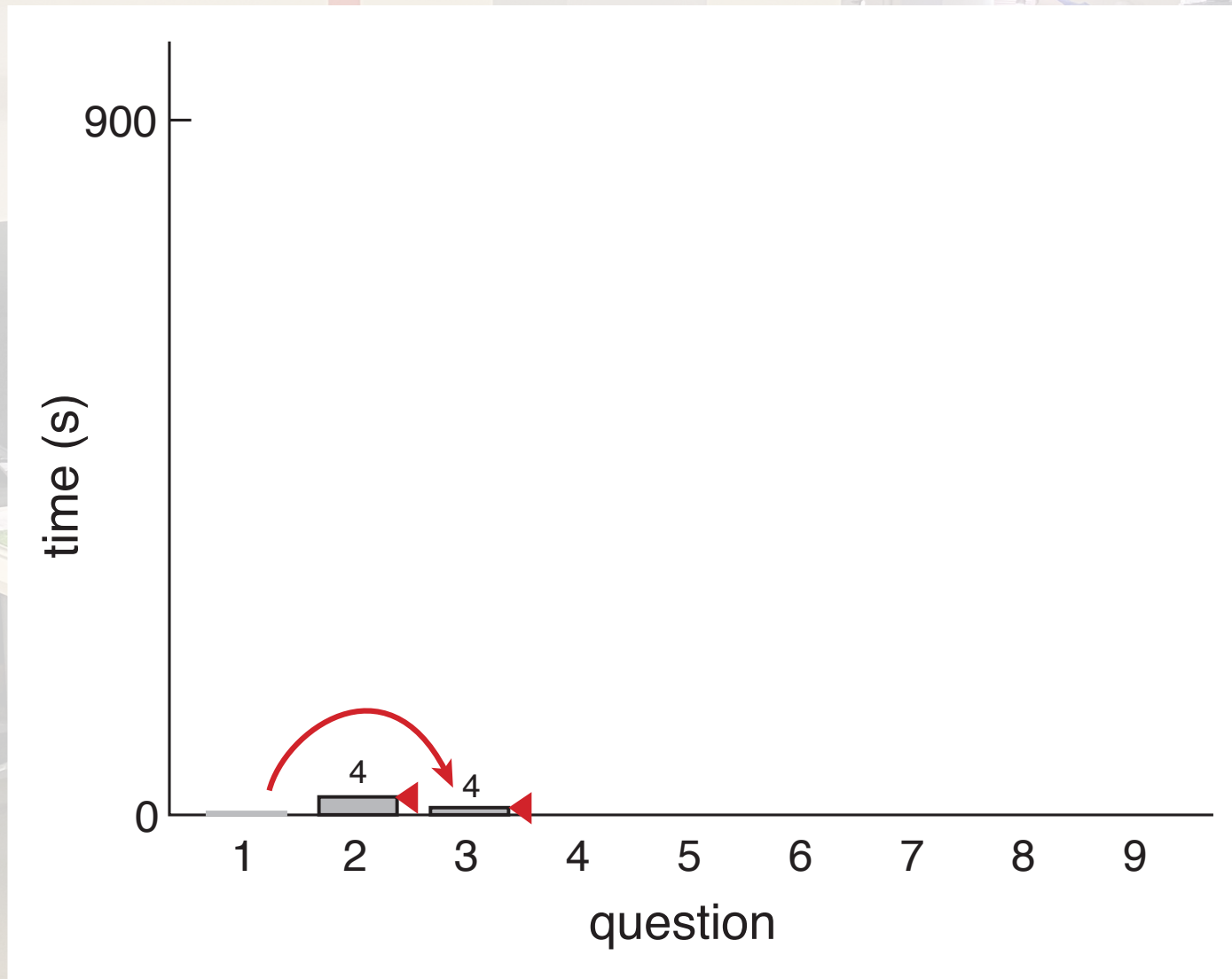


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

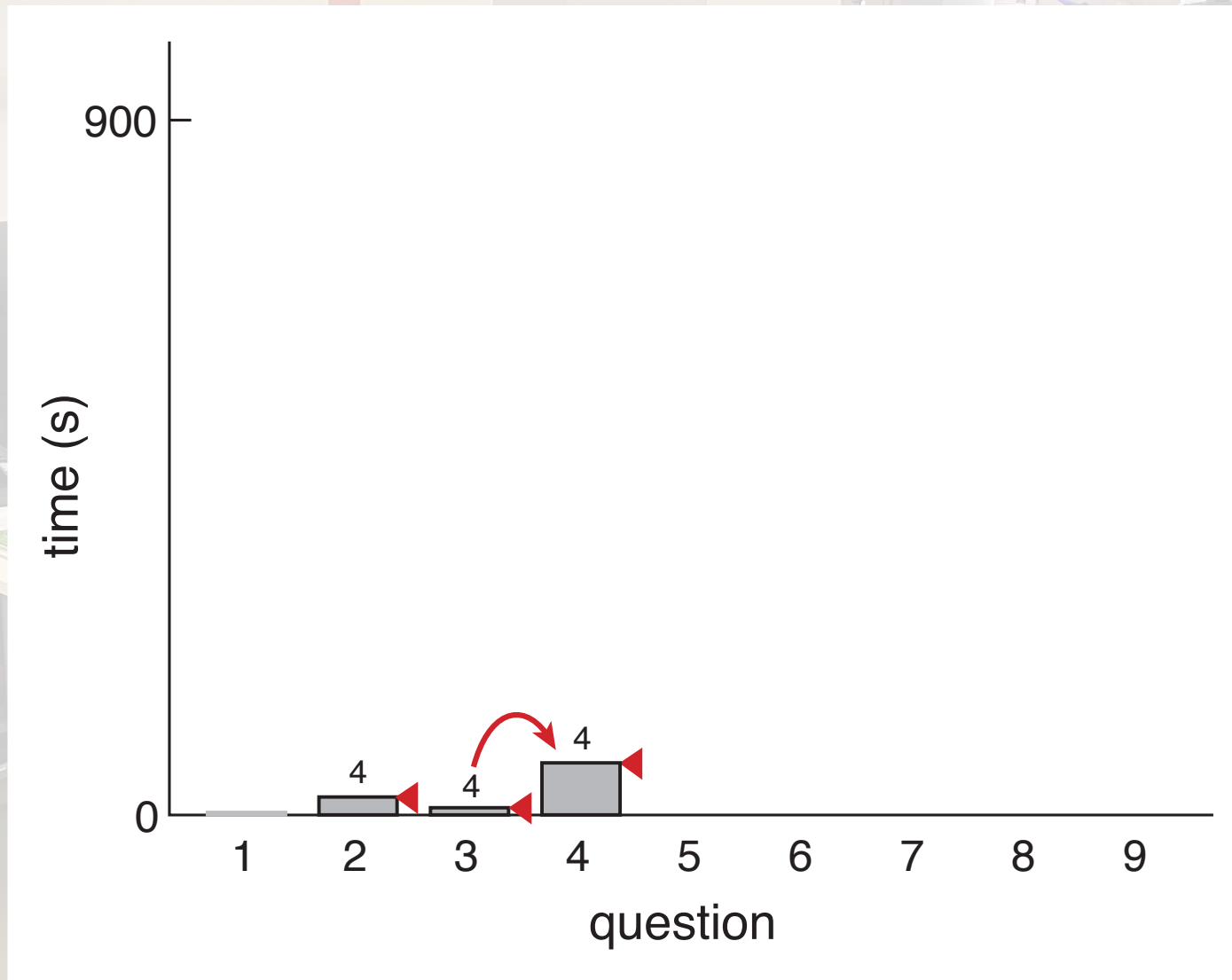


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

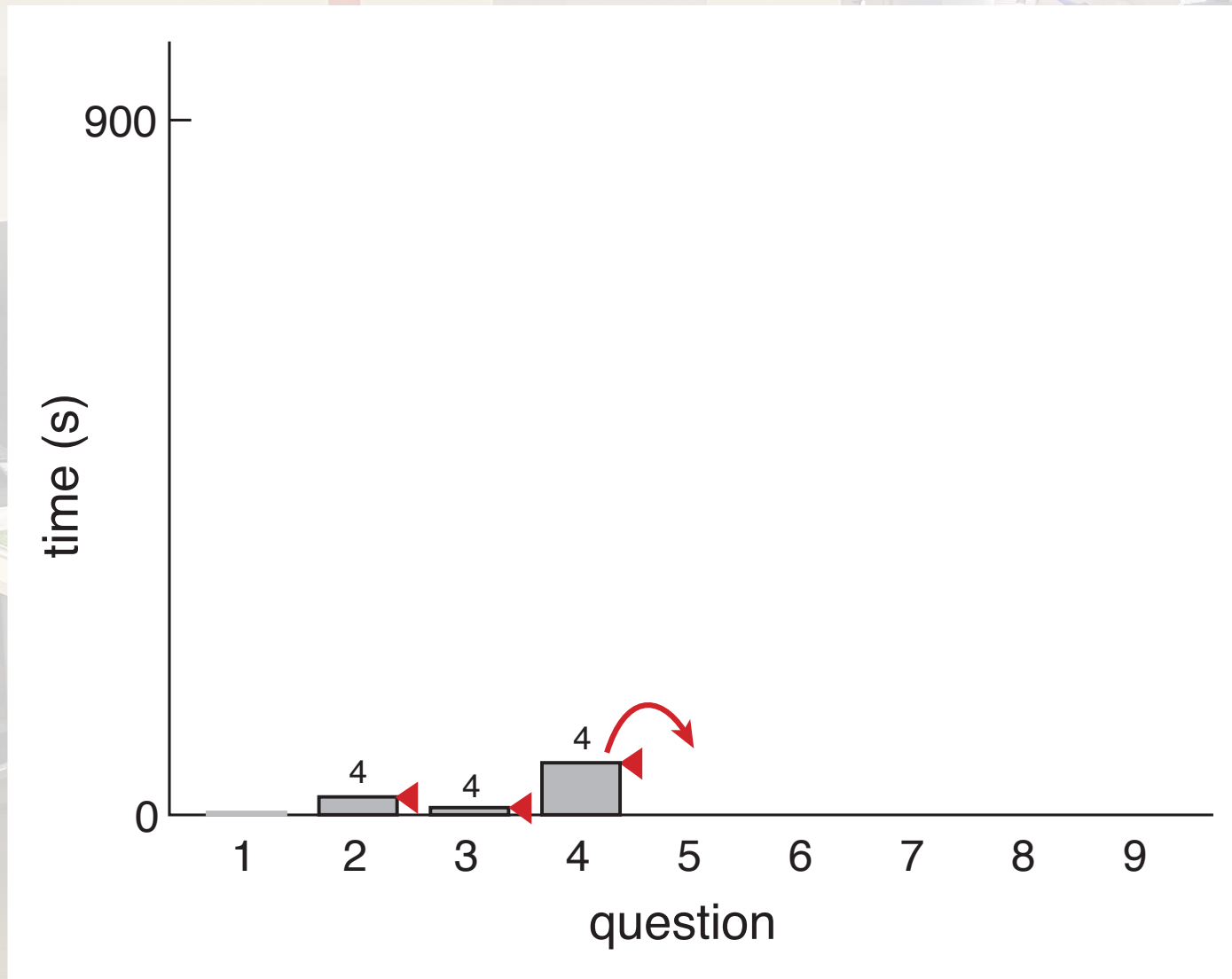


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

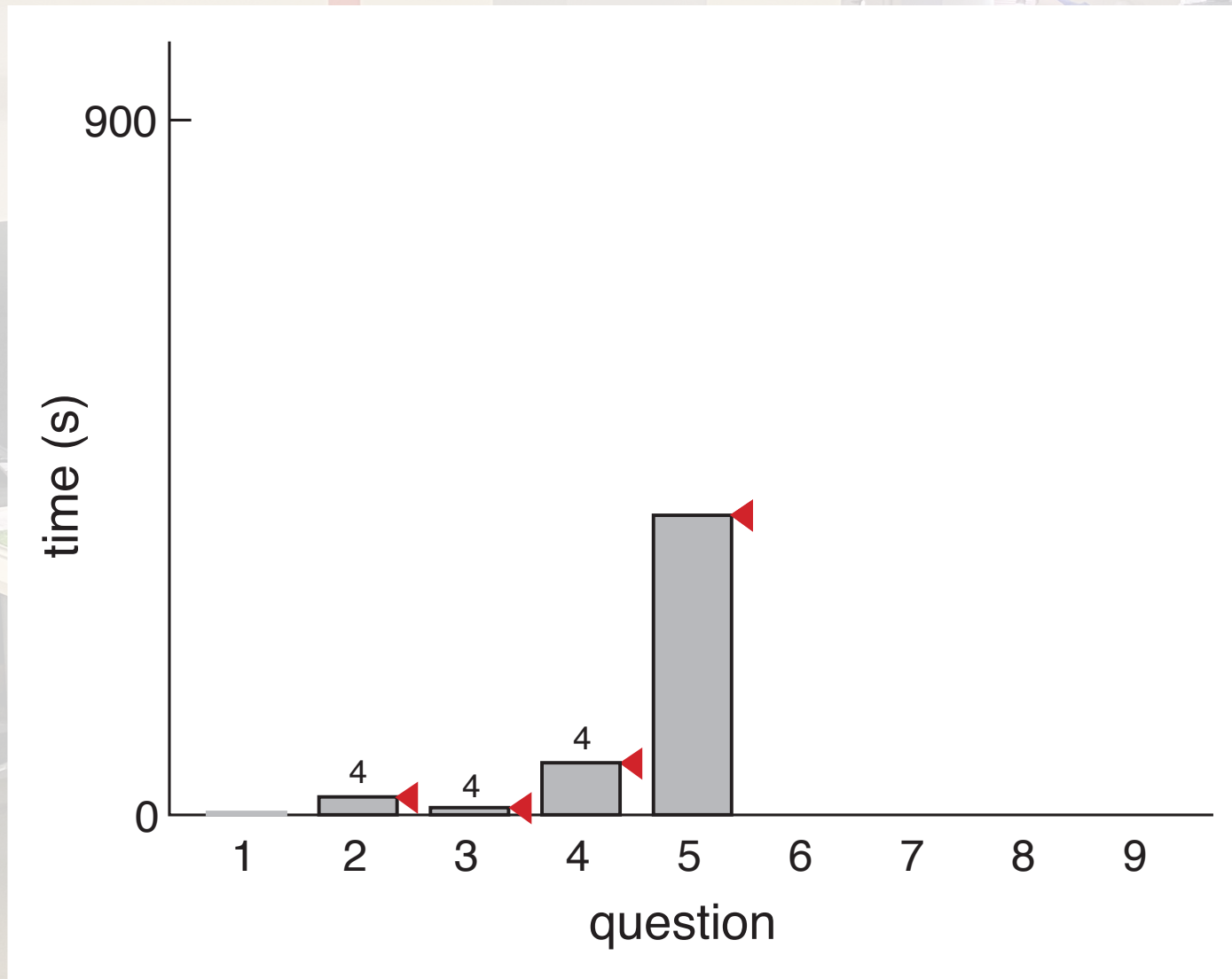


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

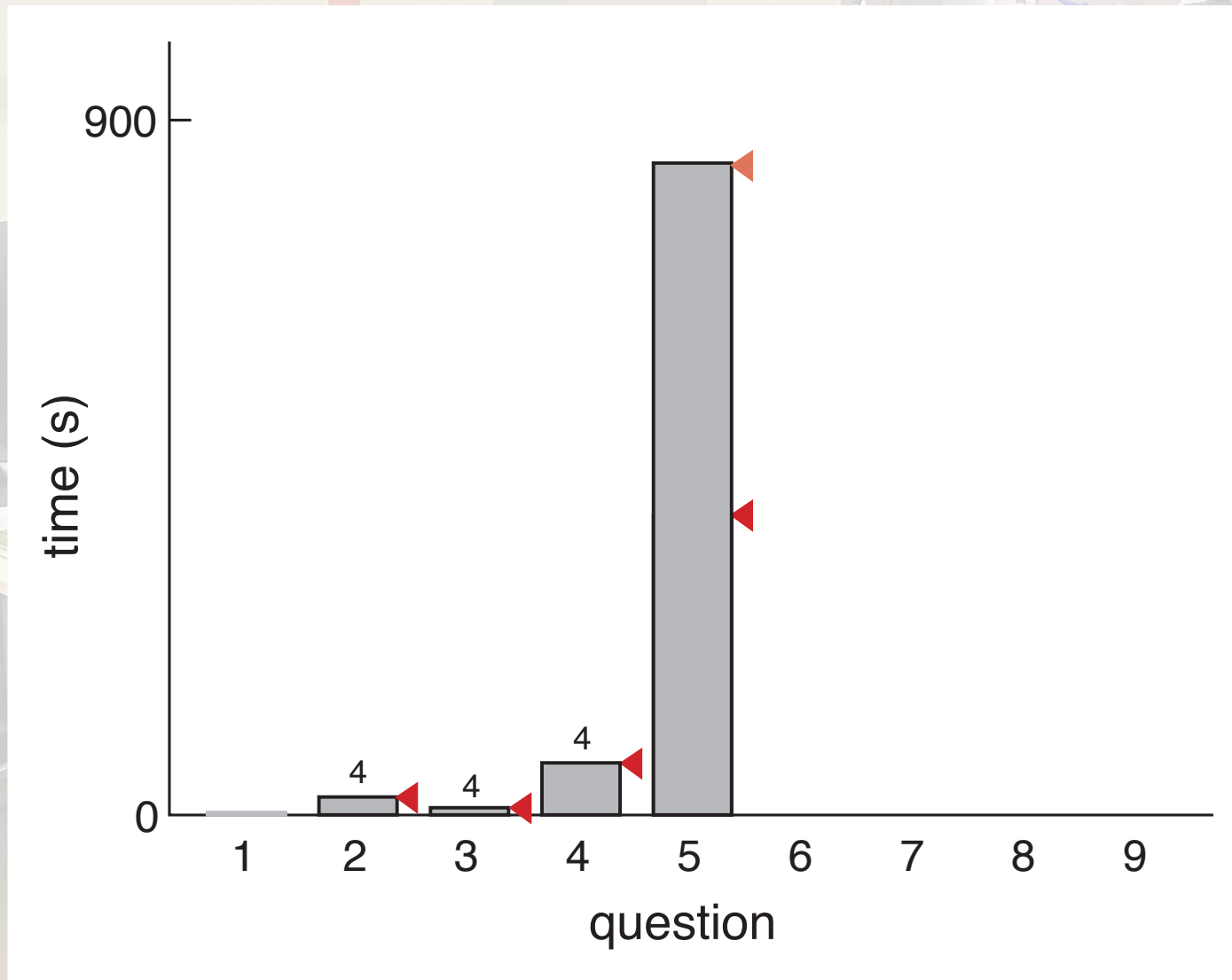


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

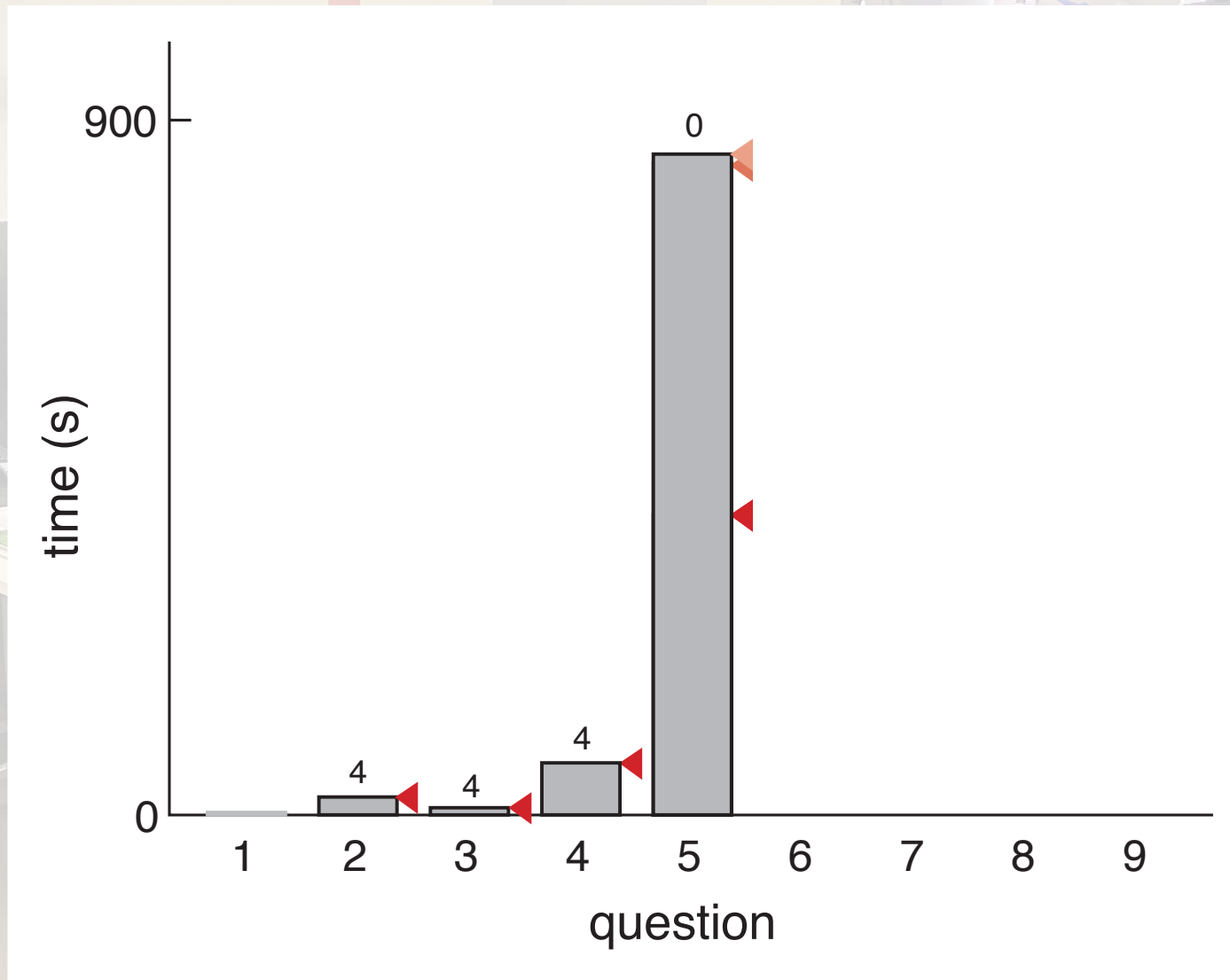


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

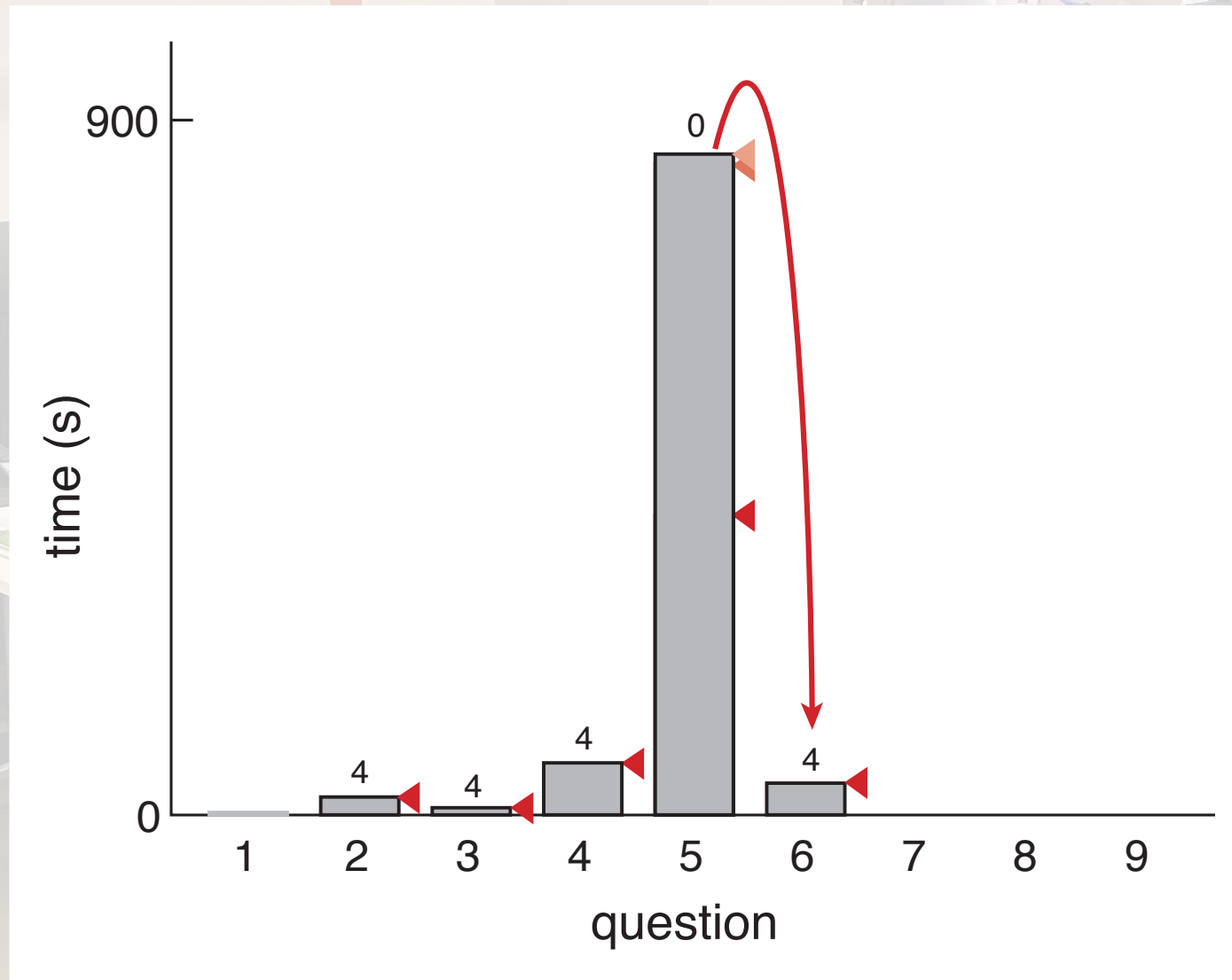


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

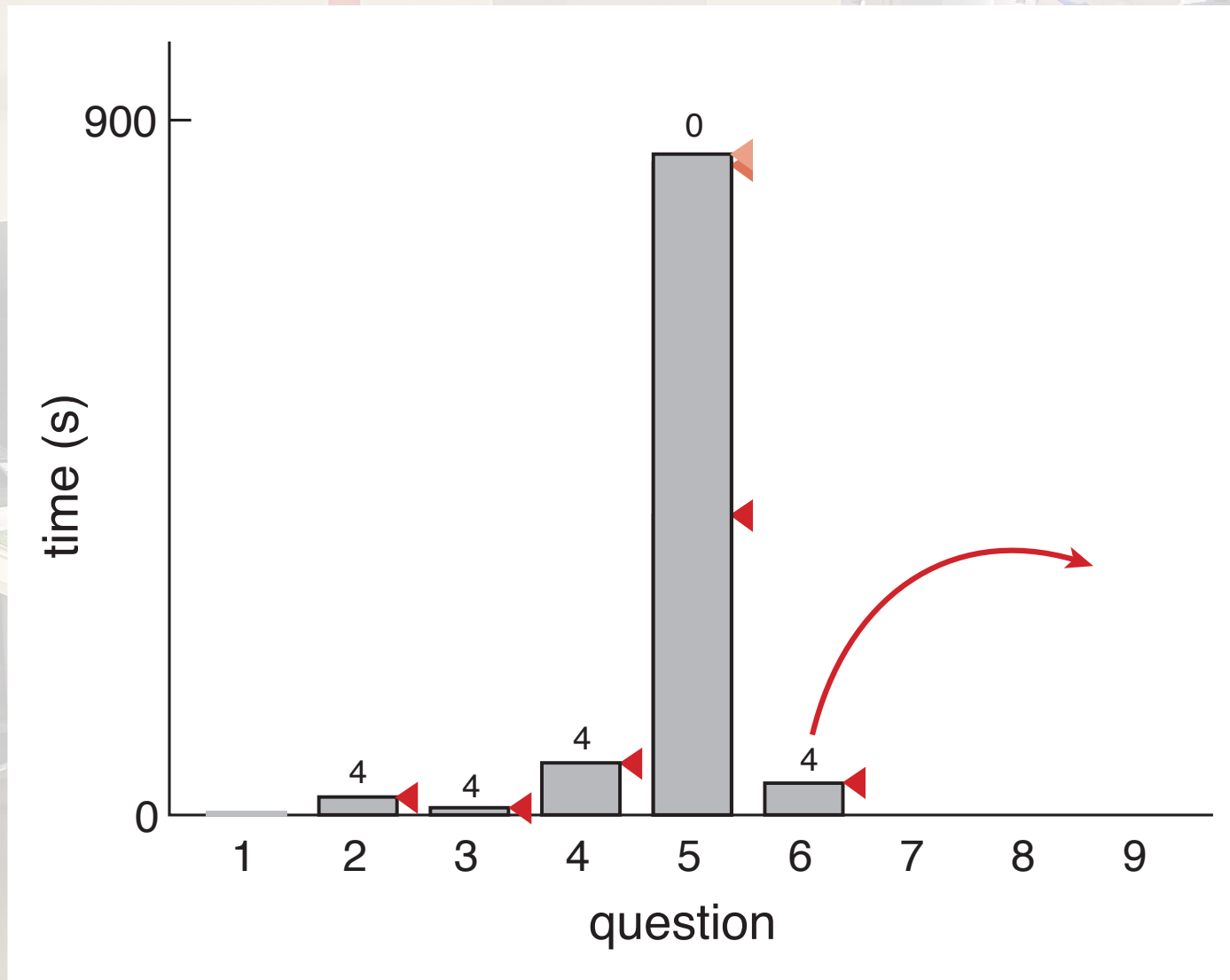


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

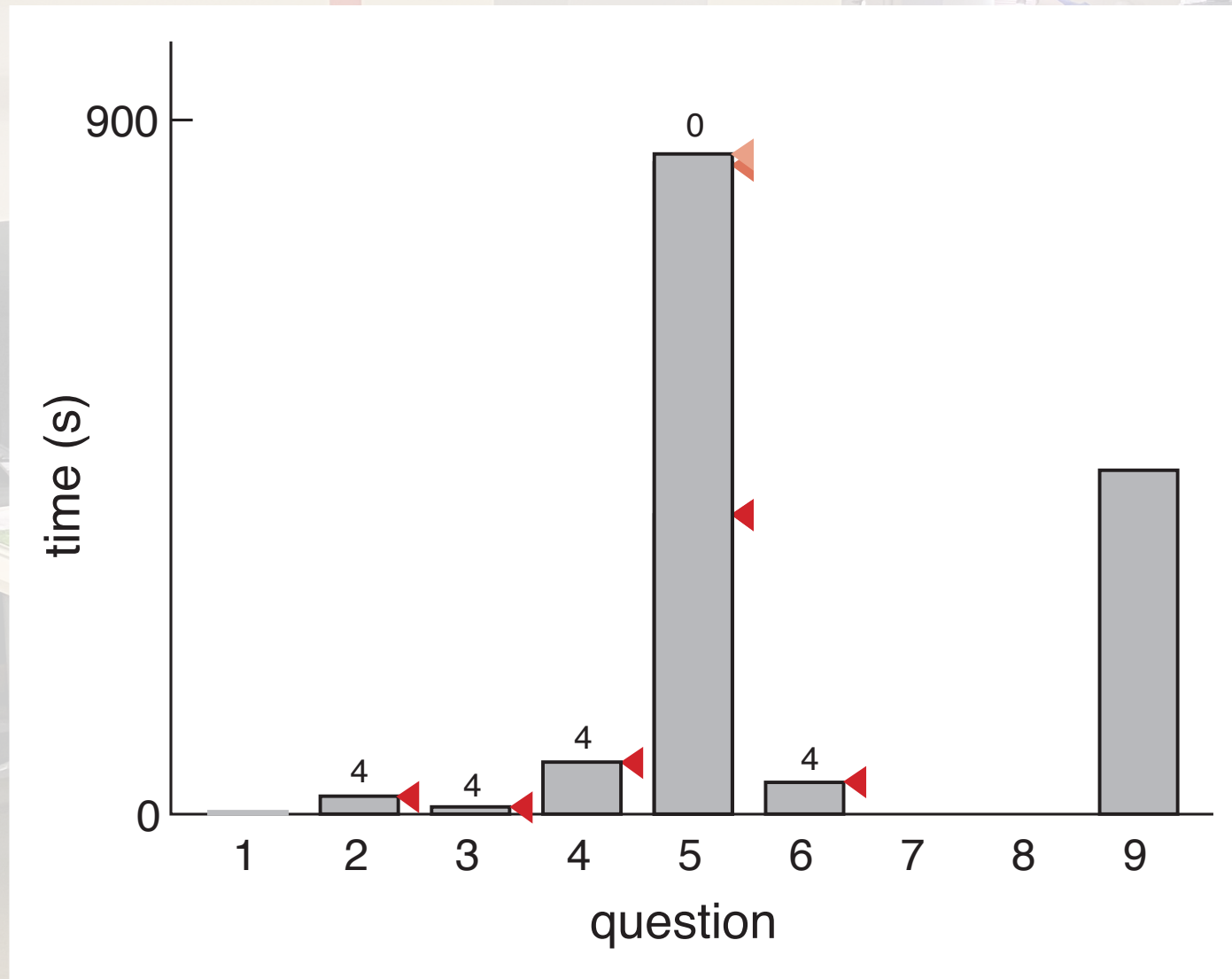


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

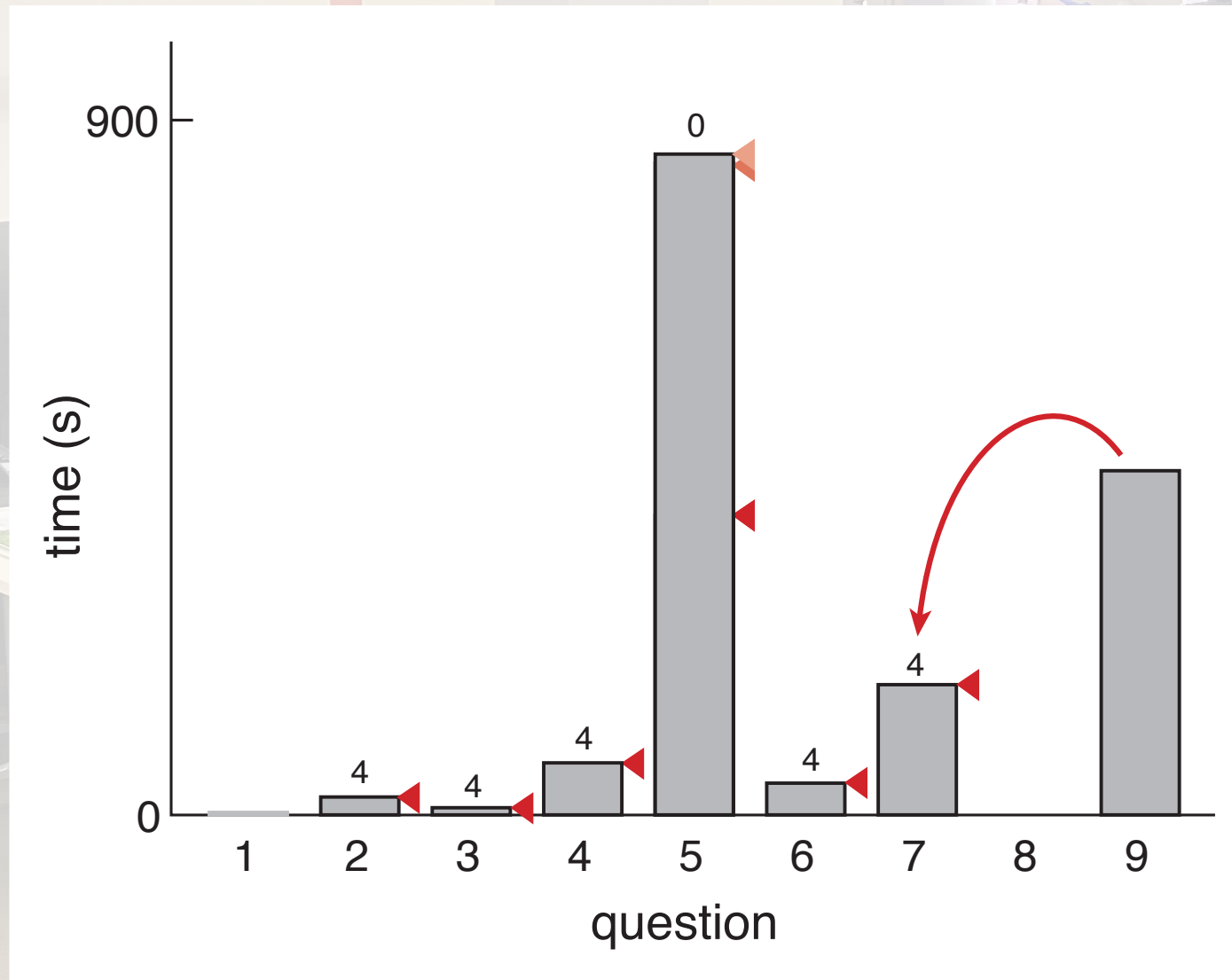


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

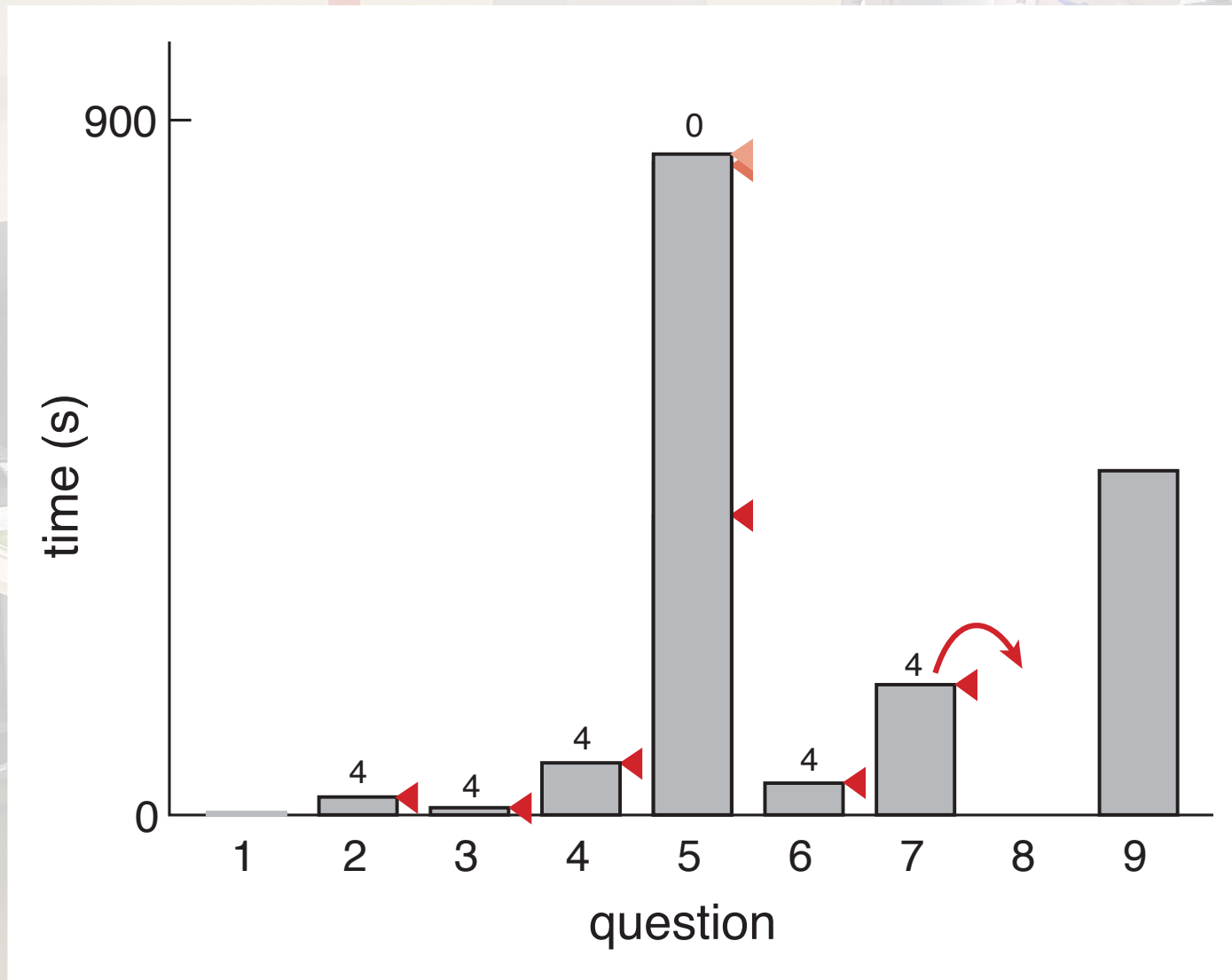


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

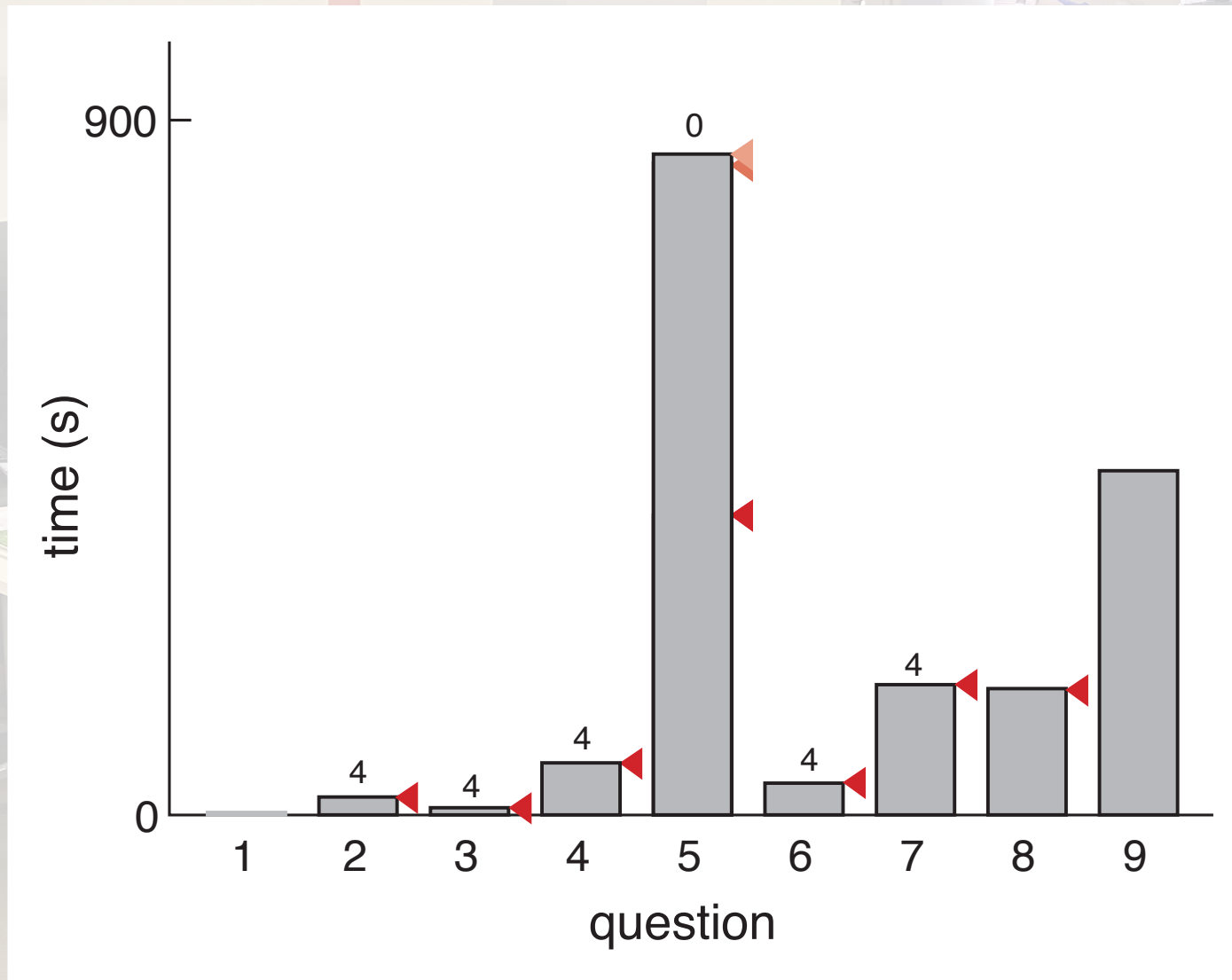


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

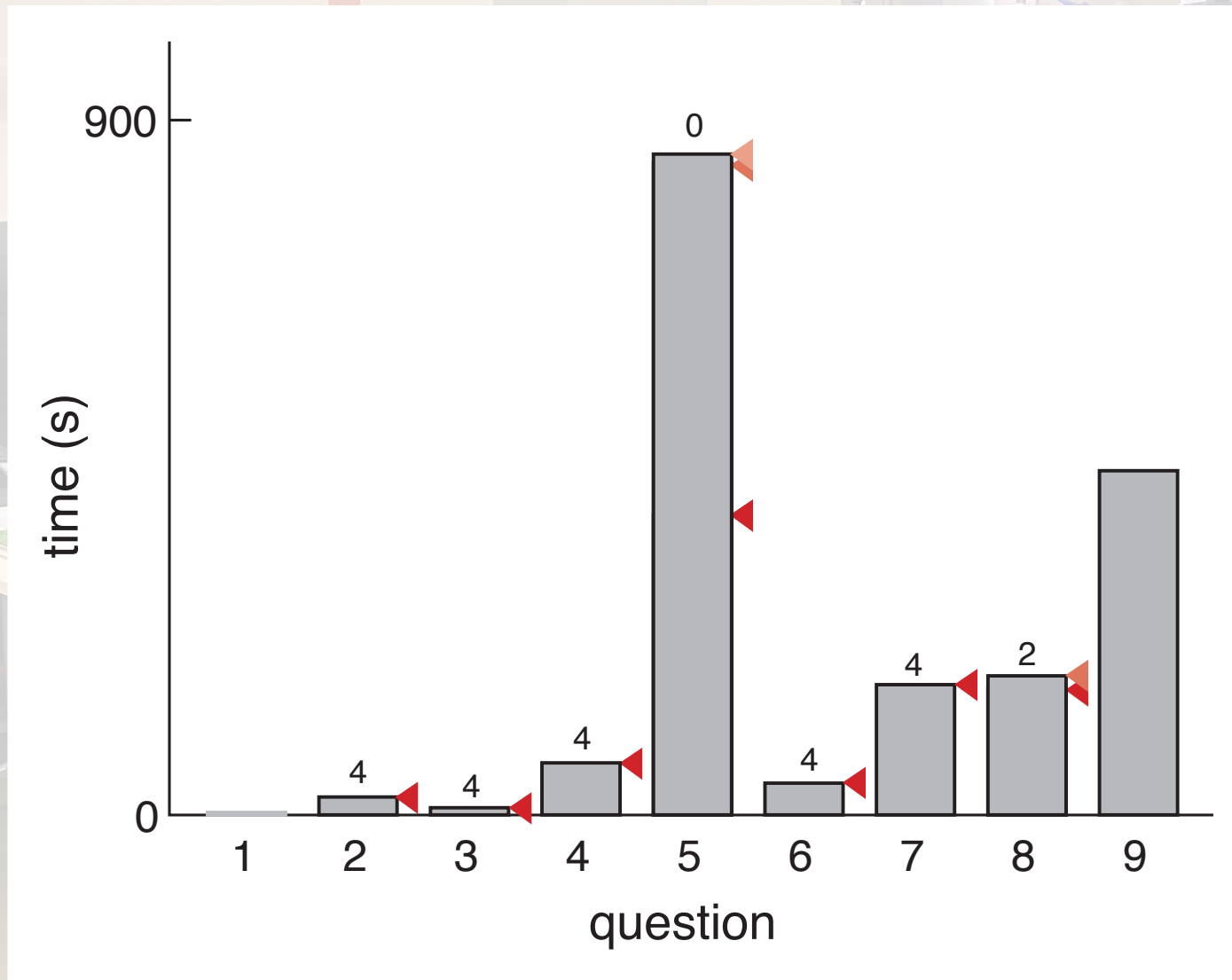


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

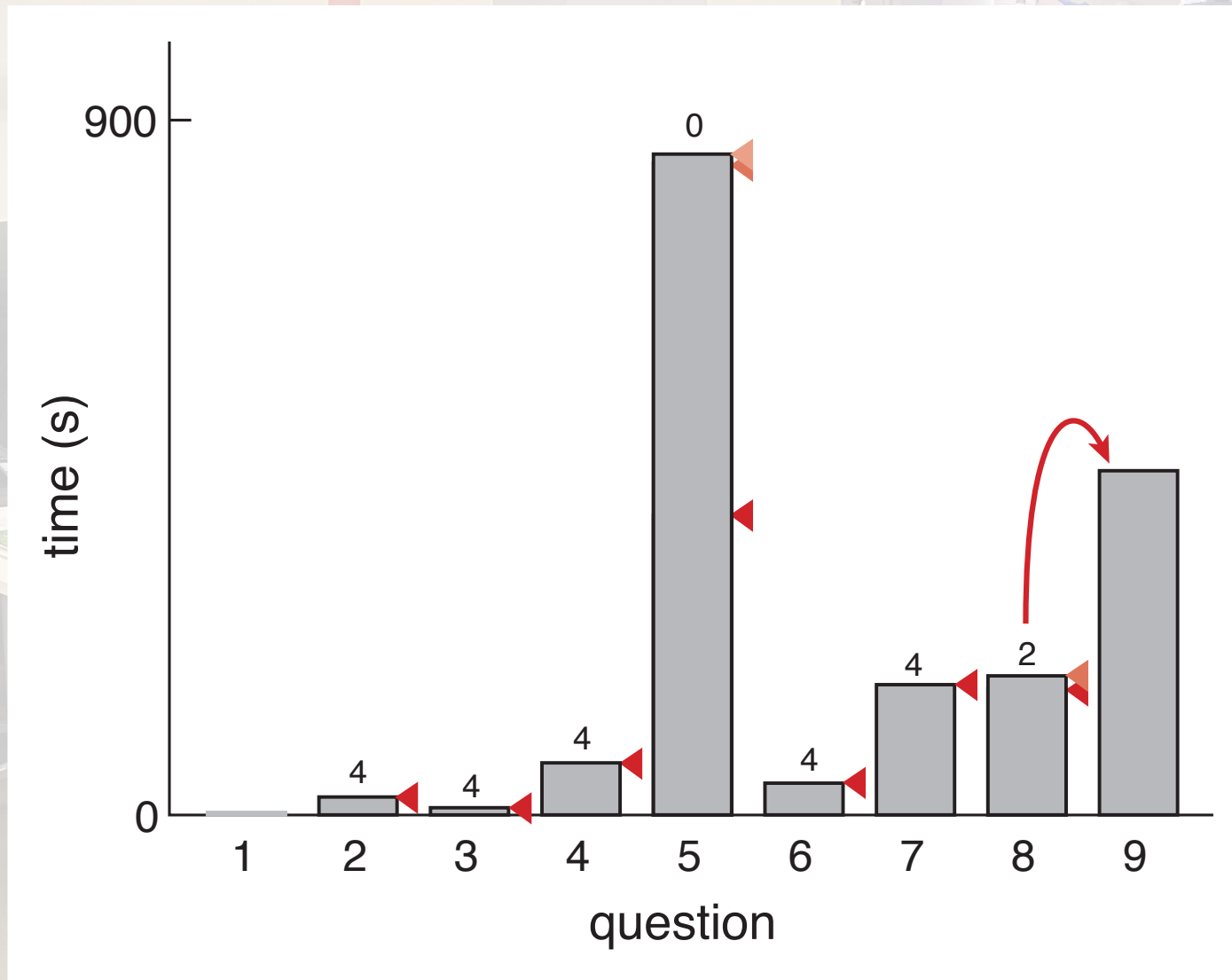


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

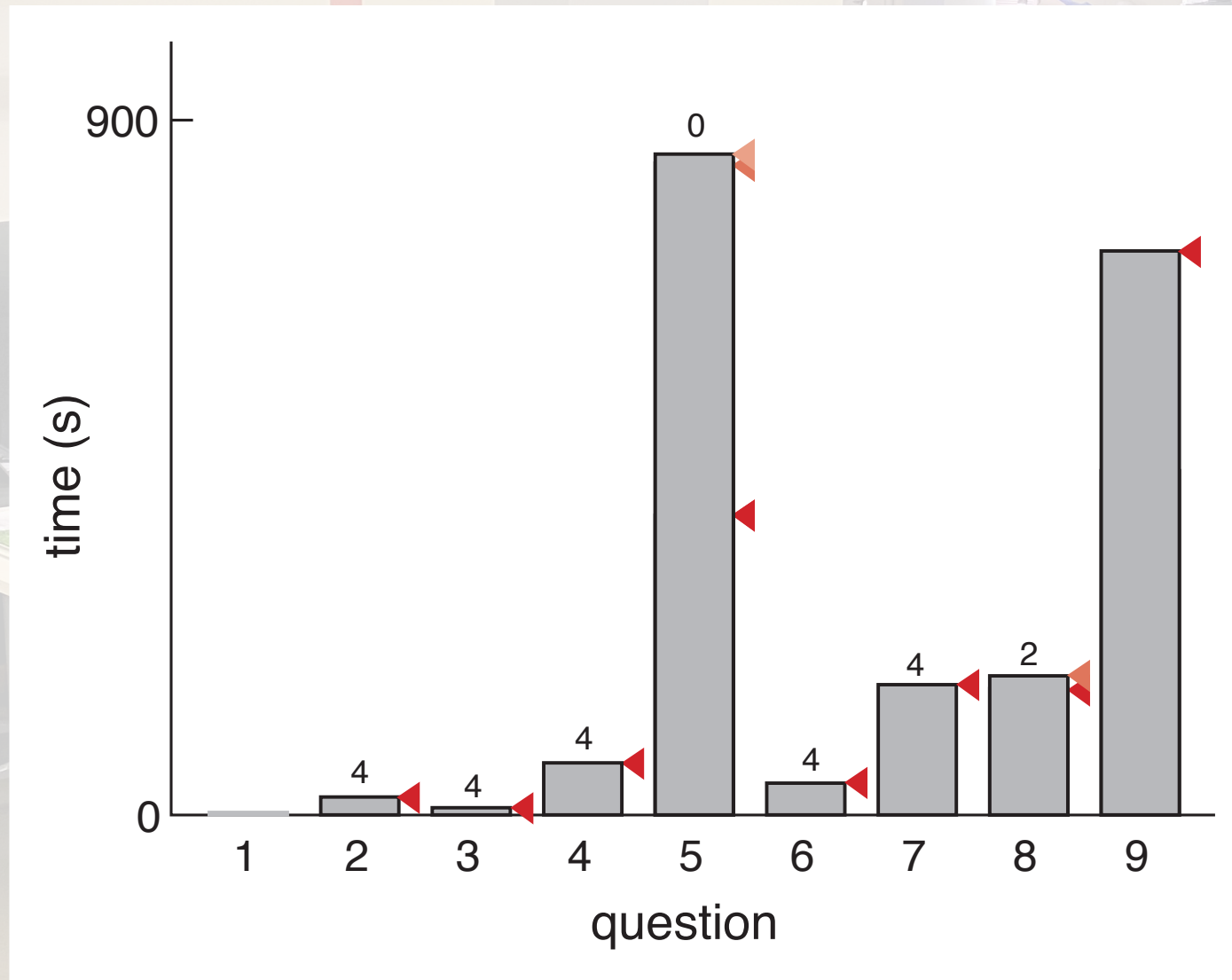


1 pandemic lessons

2 new normal

3 self-paced PI

self-paced PI: how is time spent?

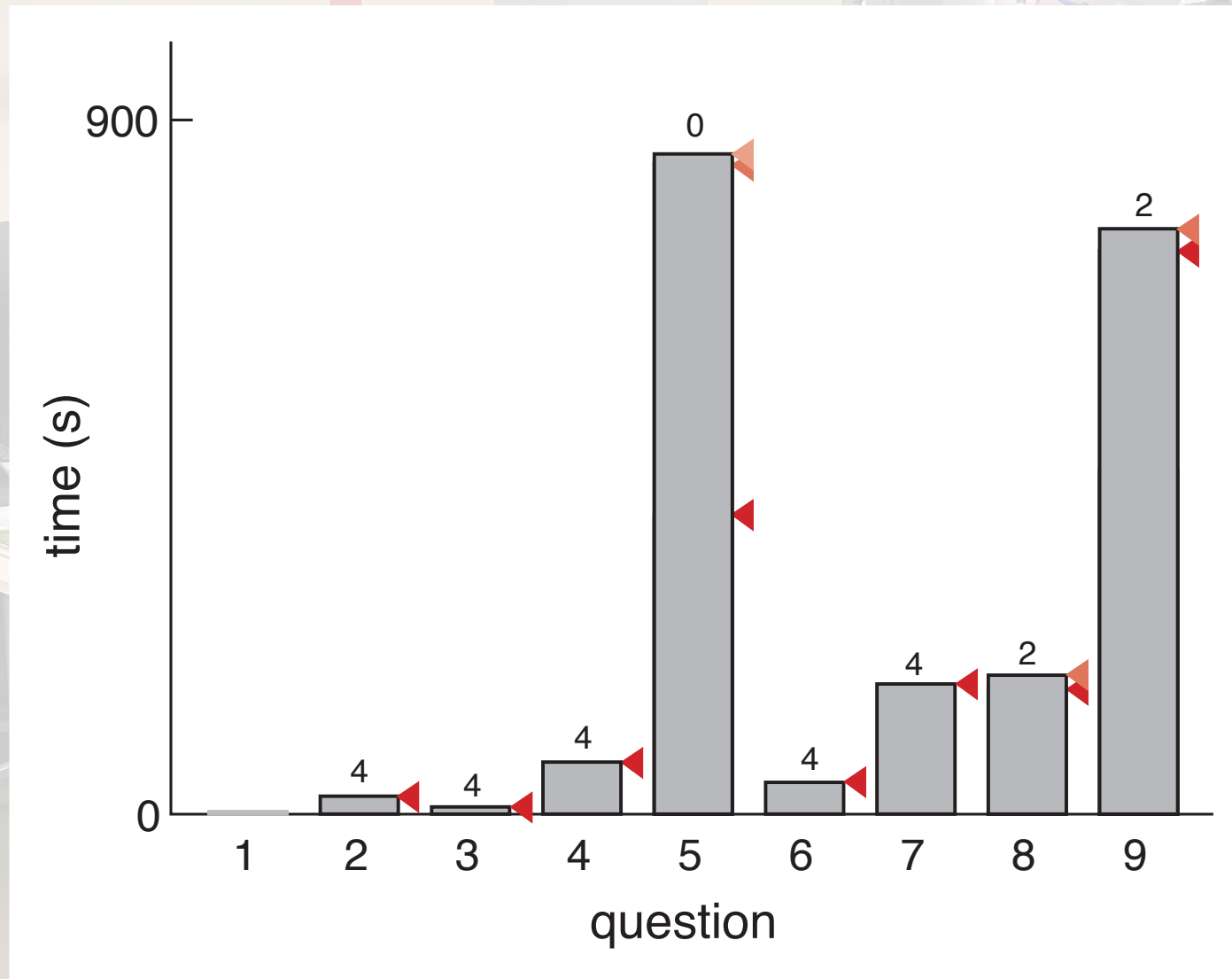


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

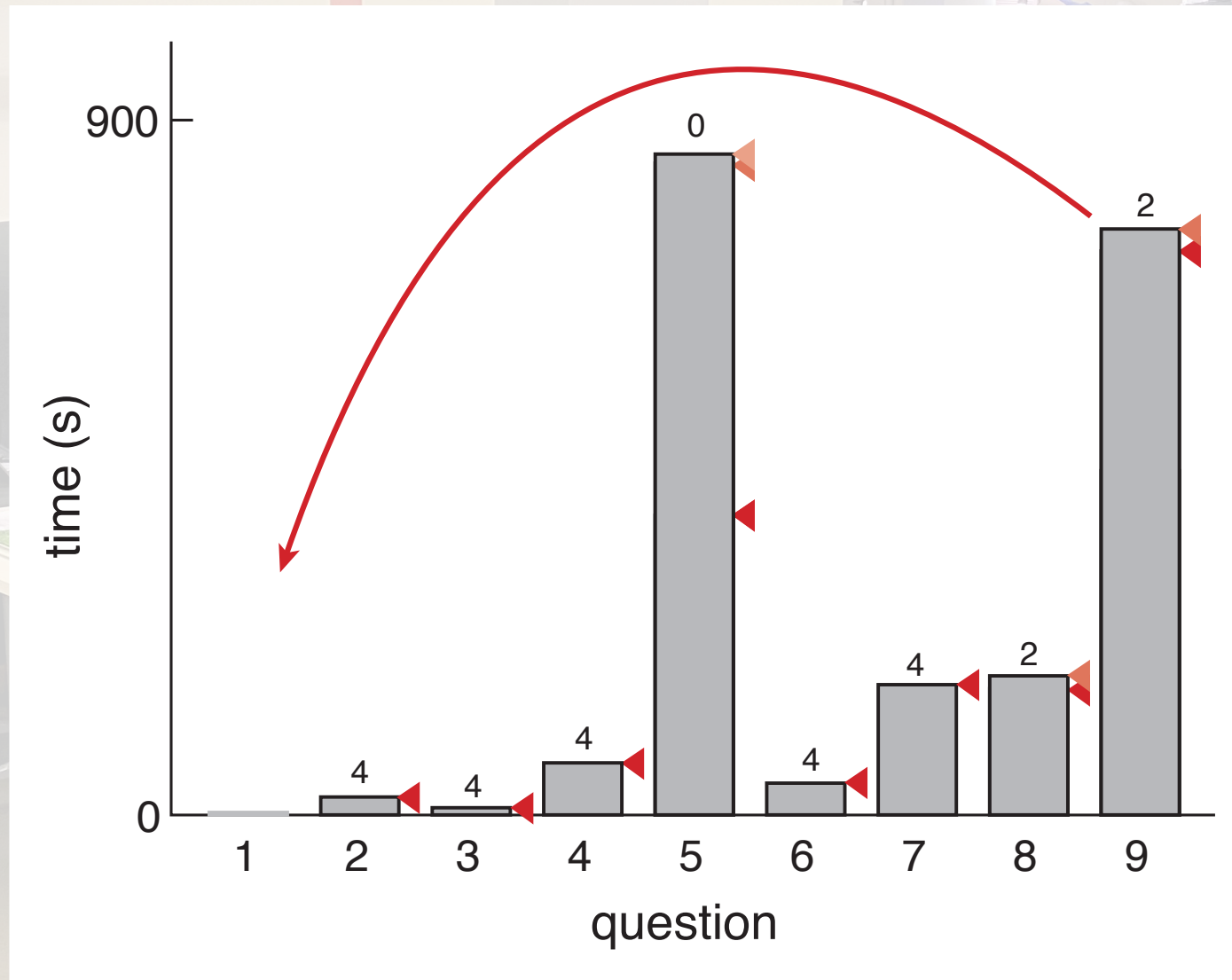


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

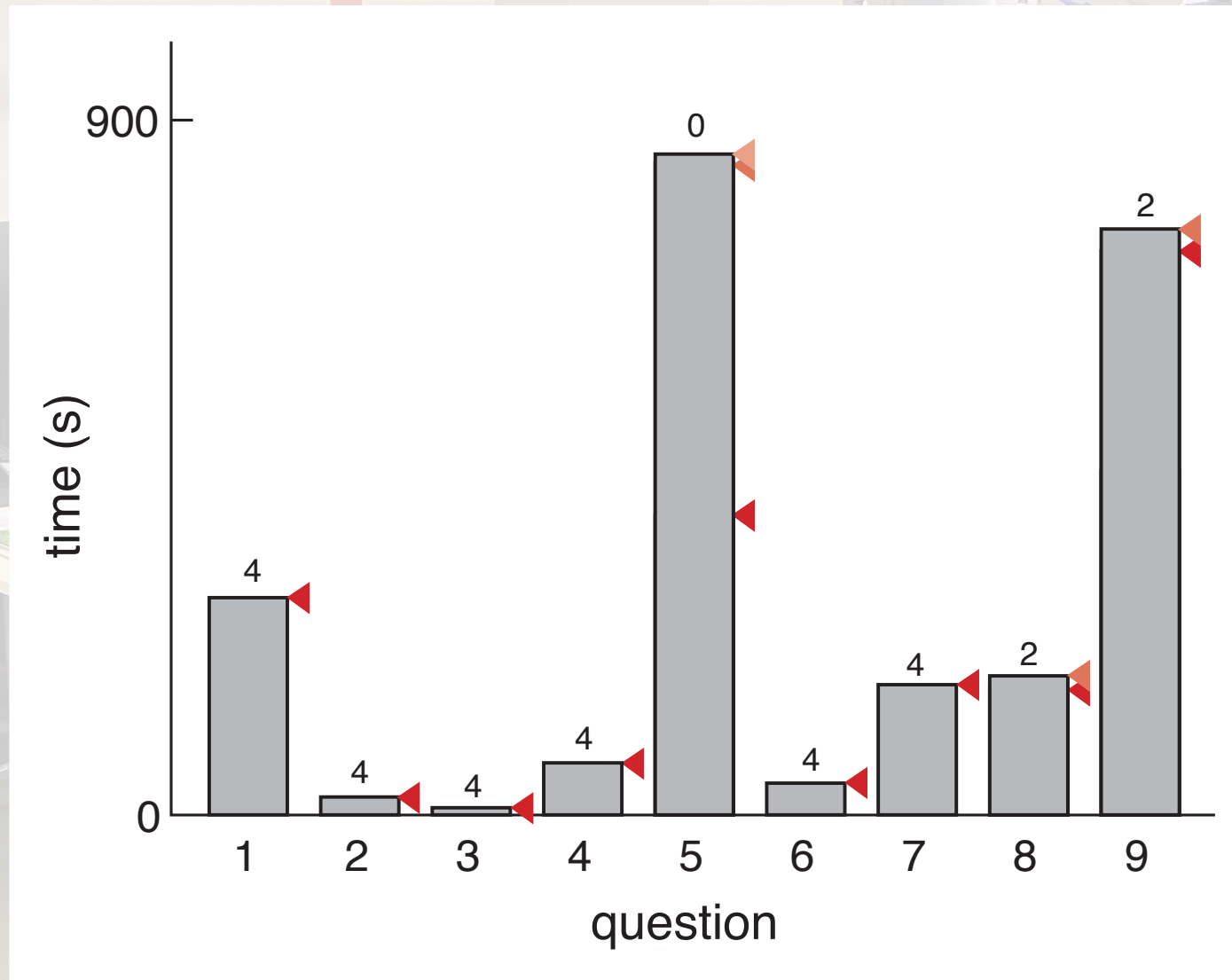


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?

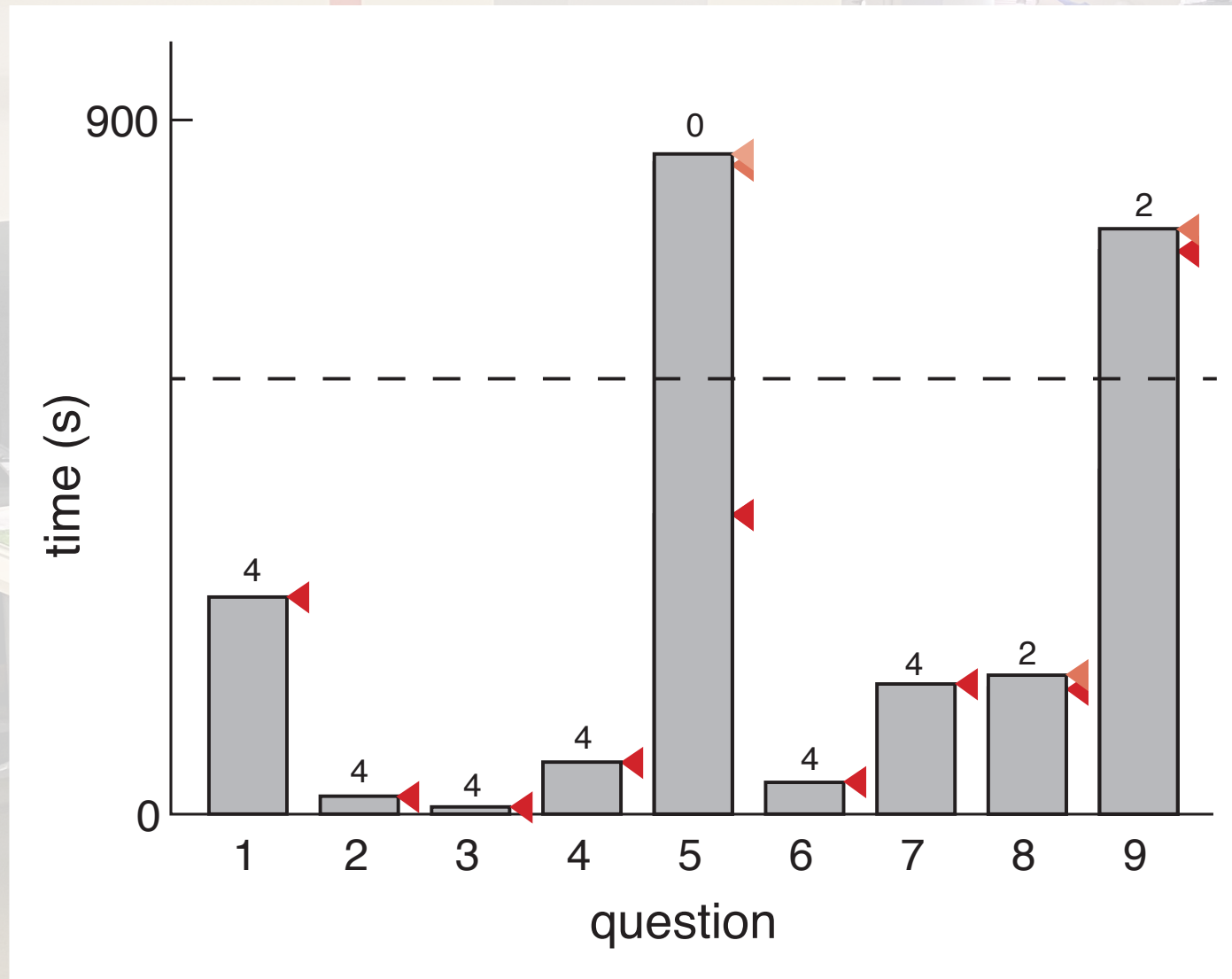


① pandemic lessons

② new normal

③ self-paced PI

self-paced PI: how is time spent?



① pandemic lessons

② new normal

③ self-paced PI

InnoBreakCafe

self-paced PI

- less time, more learning

1 pandemic lessons

2 new normal

3 self-paced PI

InnoBreakCafe

self-paced PI

- less time, more learning
- better integration with reading

1 pandemic lessons

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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

InnoBreakCafe

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

InnoBreakCafe

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

InnoBreakCafe

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