Getting every student prepared for every class

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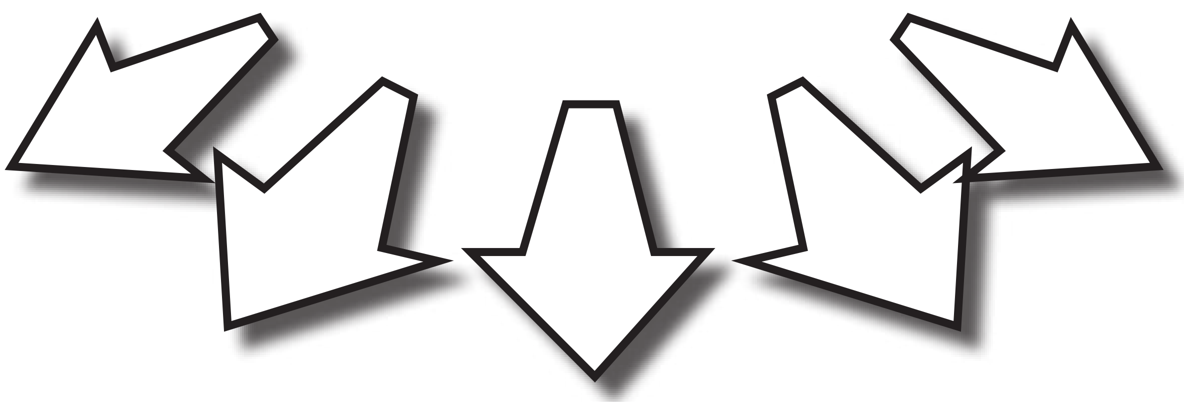
Webinar
3 December 2015

Getting every student prepared for every class

Webinar
12 April 2016




CLASS
ROOM
1st exposure
deeper understanding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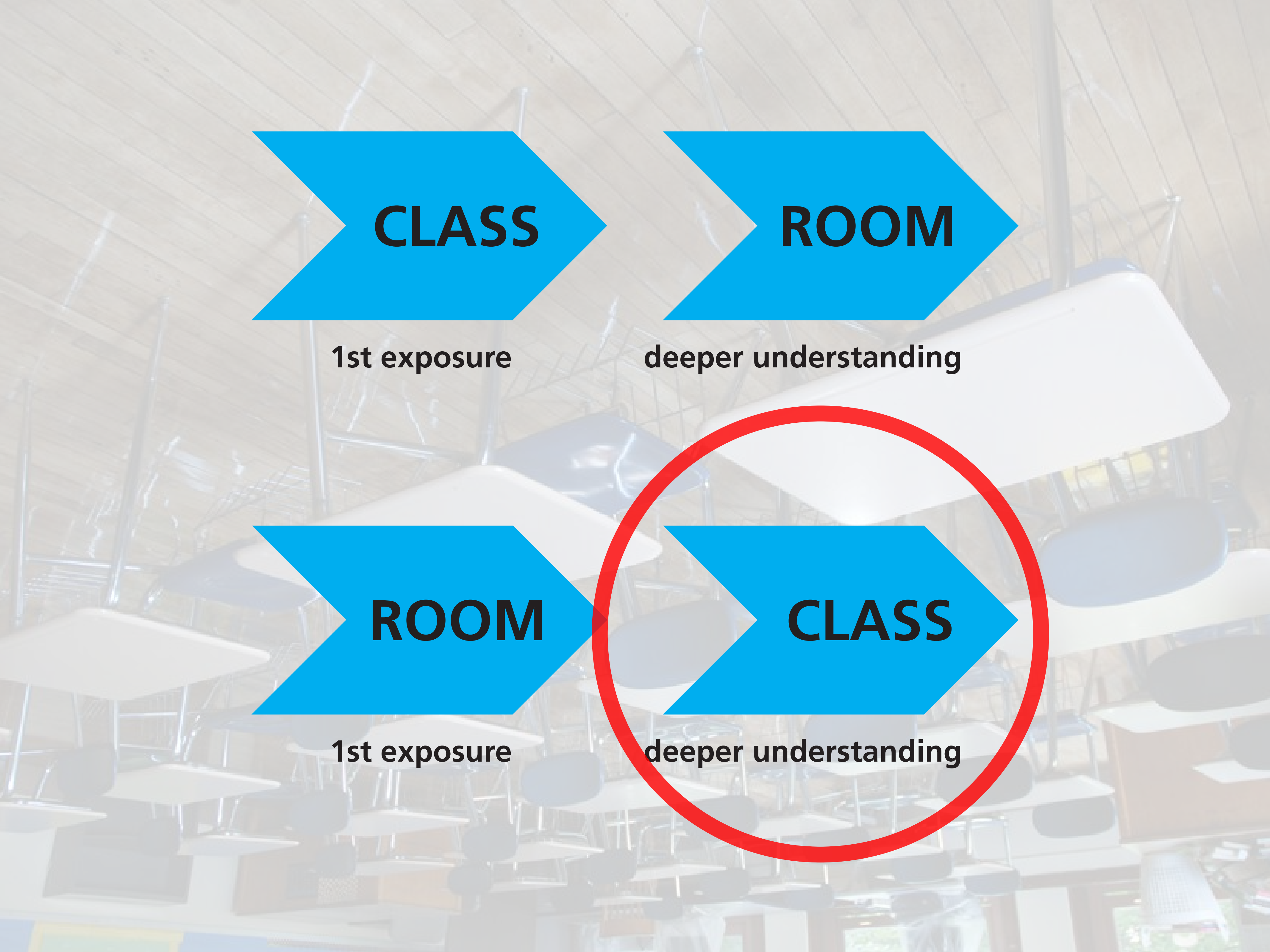
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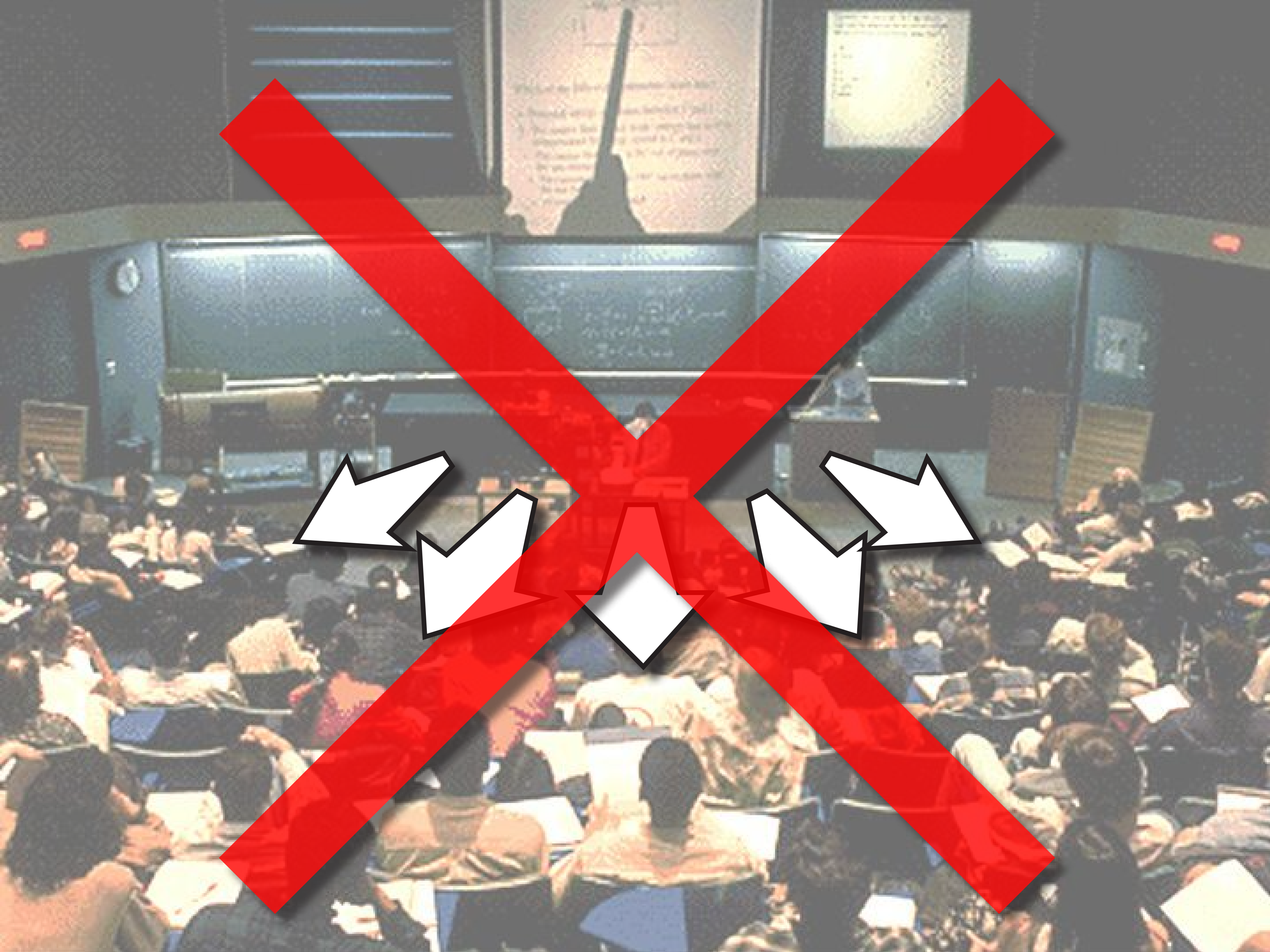
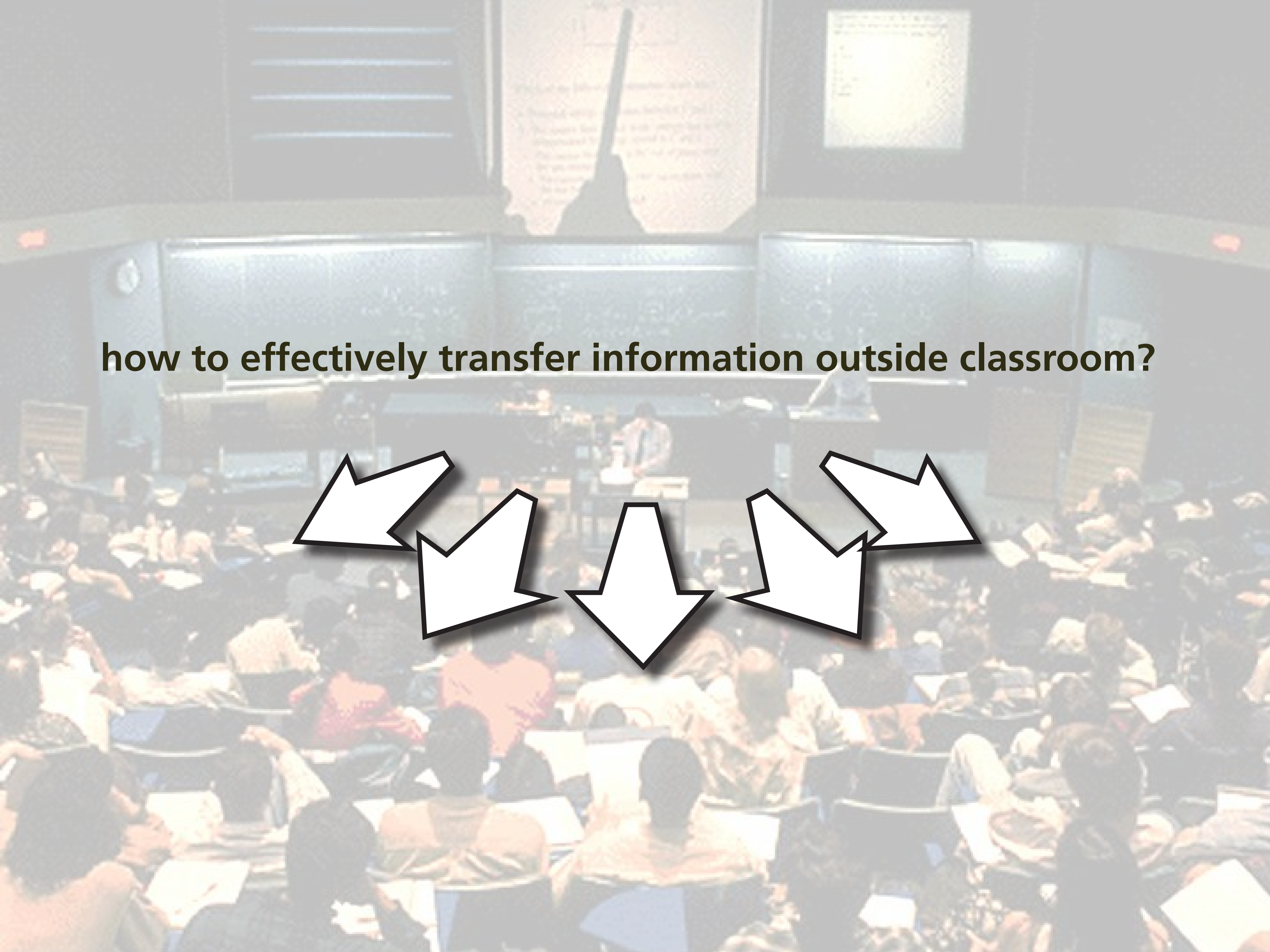
CLASS → ROOM

1st exposure → deeper understanding

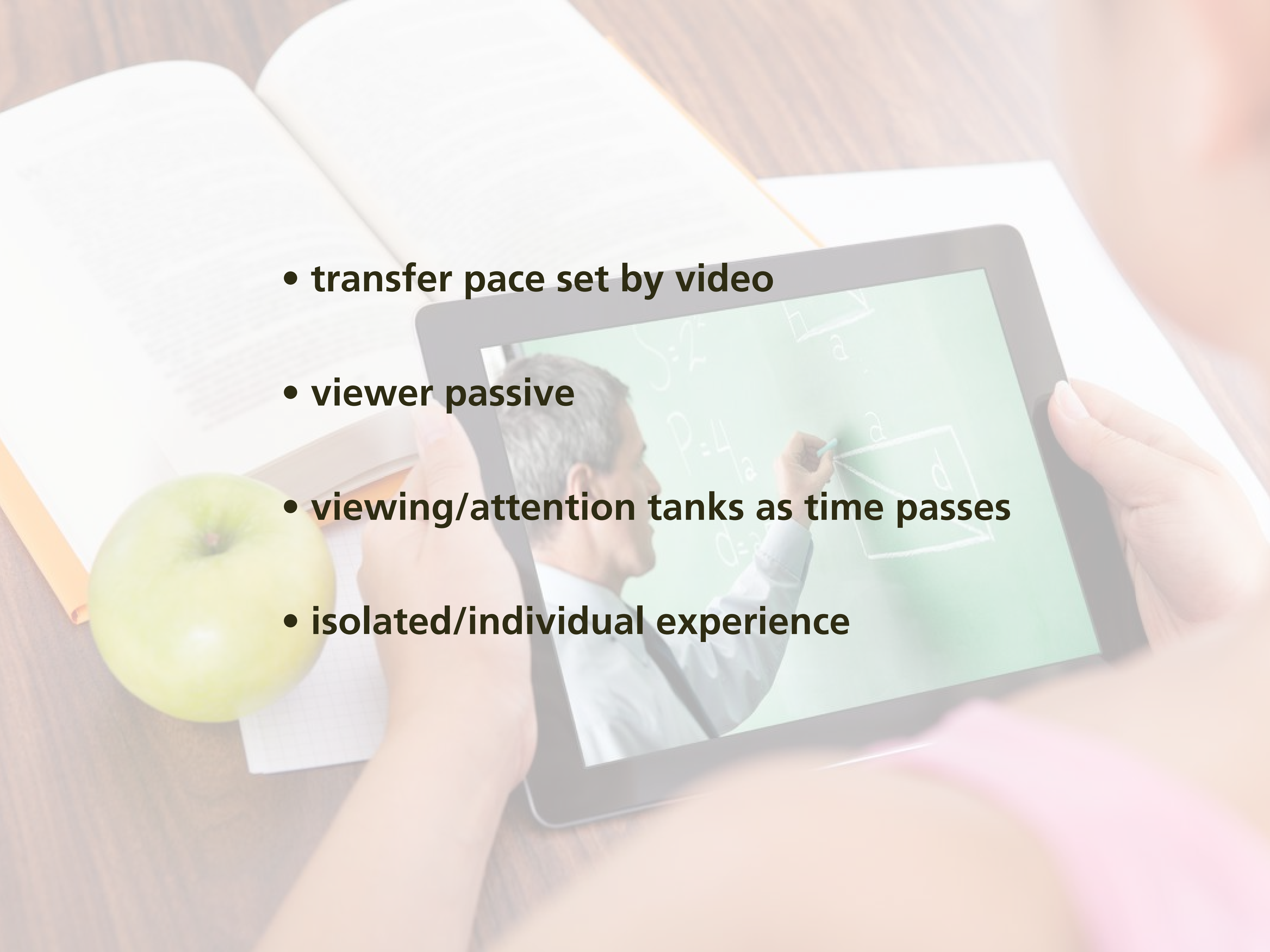
ROOM → CLASS

1st exposure → deeper understanding




how to effectively transfer information outside classroom?


but…



- transfer pace set by video
- viewer passive
- viewing/attention tanks as time passes
- isolated/individual experience

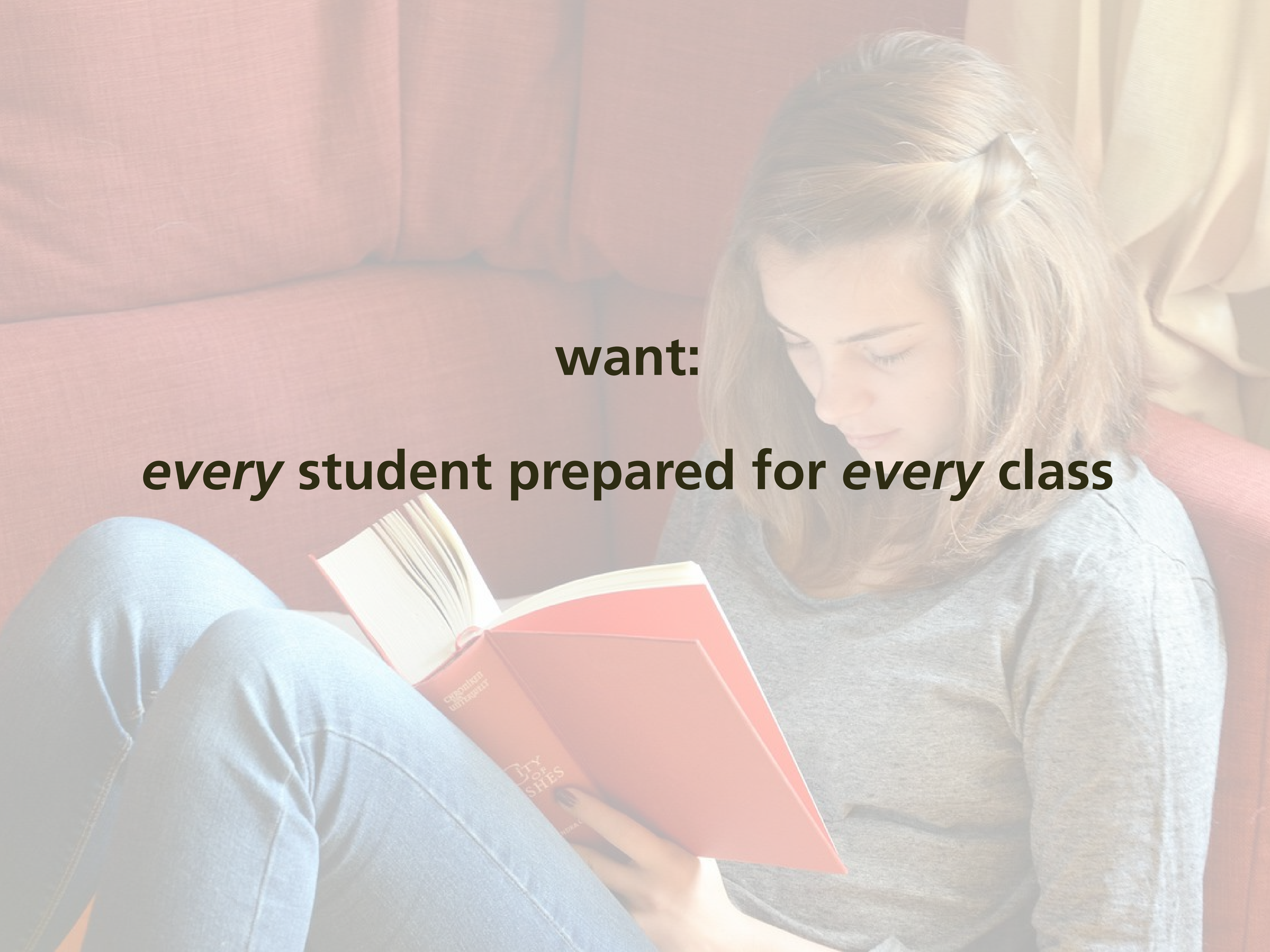

we’re simply moving this outside classroom!

- **transfer pace set by reader**
- **viewer active**


but…

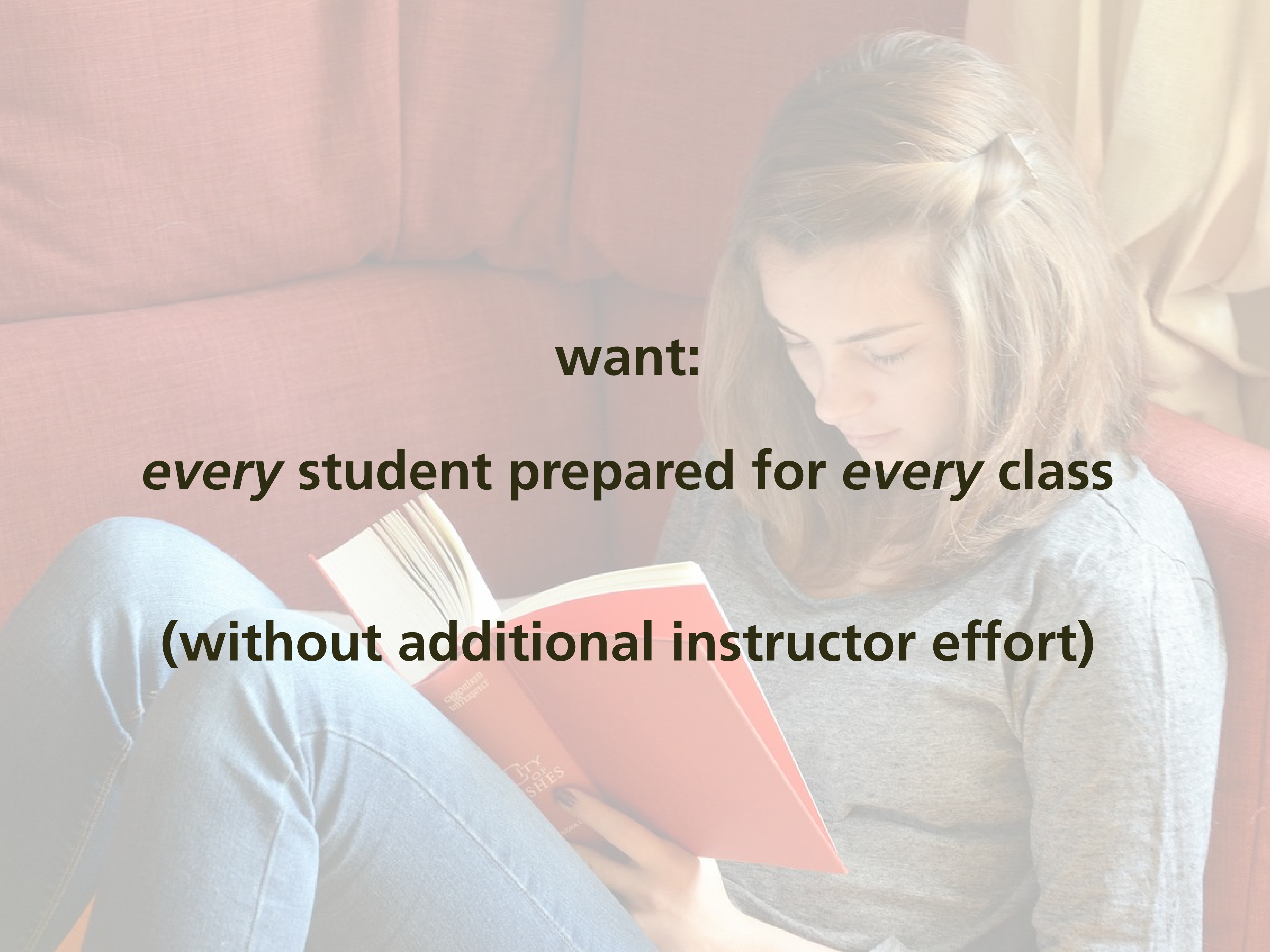
isolated/individual experience &

no real accountability



want:

***every* student prepared for *every* class**



want:

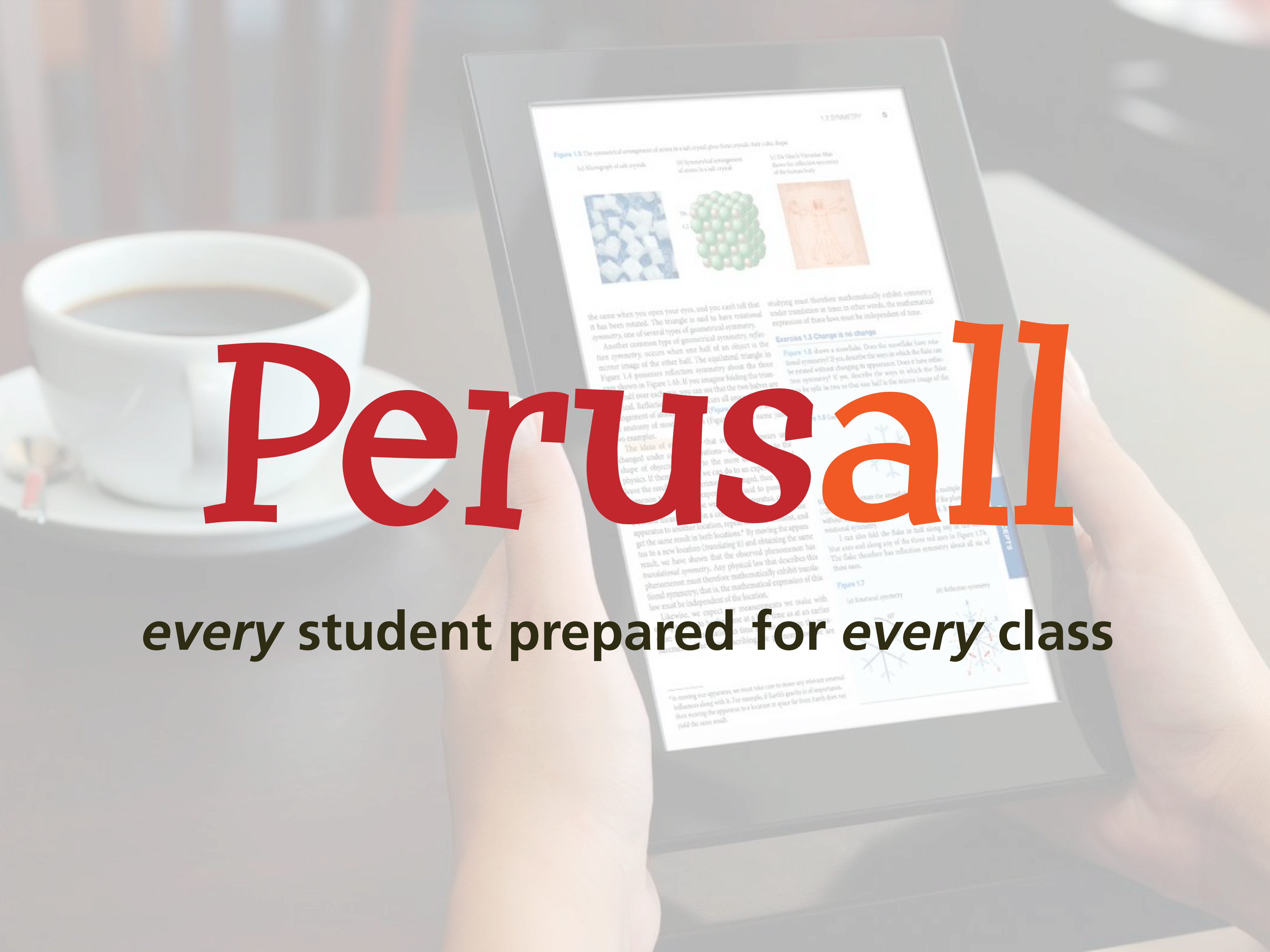
***every* student prepared for *every* class**

(without additional instructor effort)

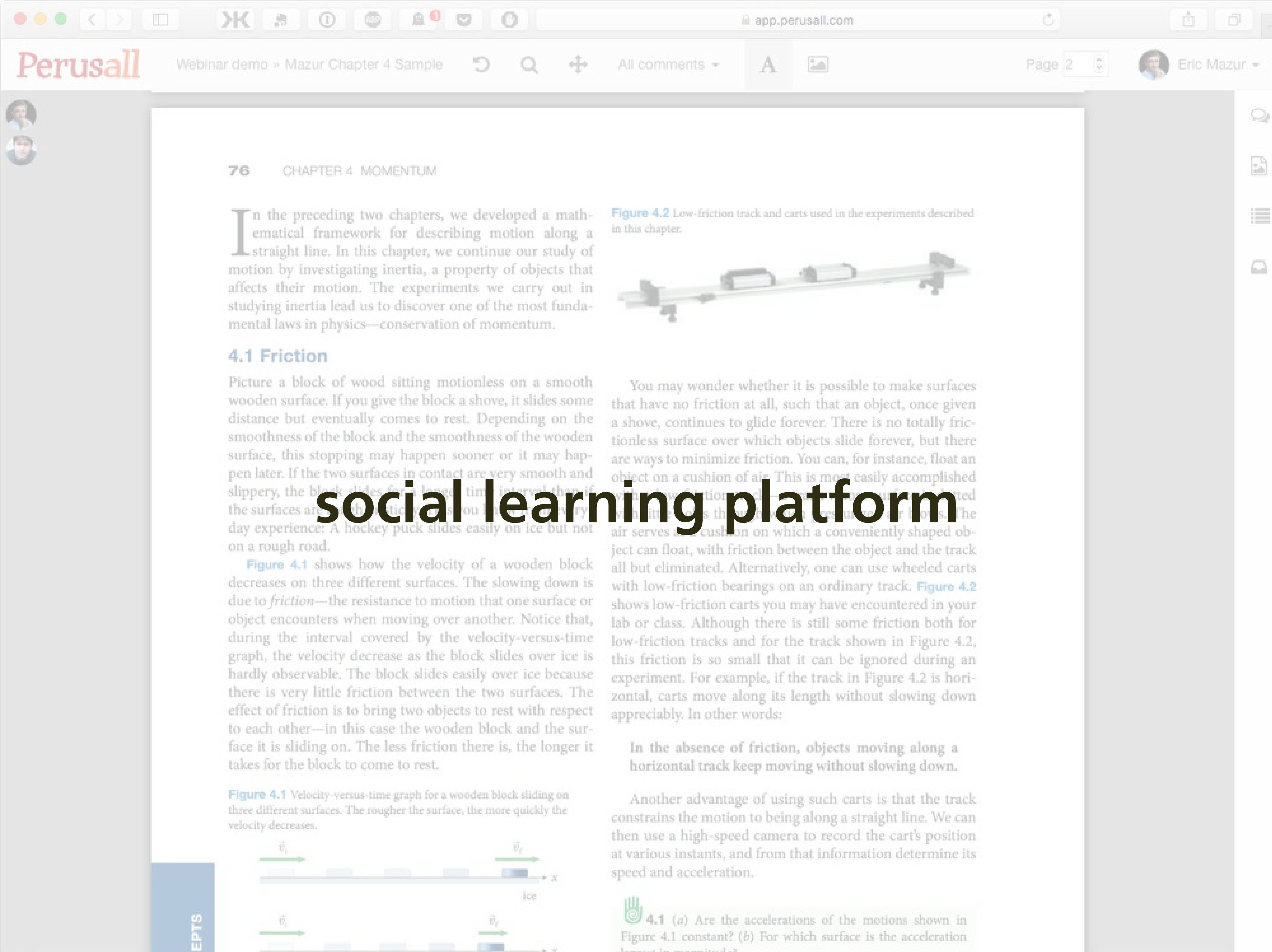
Solution

turn out-of-class component

also into a social interaction!


Perusall
every student prepared for *every* class

social learning platform



76 CHAPTER 4 MOMENTUM

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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 bl[illegible] interval than if the surfaces ar[illegible] day experience: A hockey puck slides easily on ice but not on a rough road.

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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.

ice

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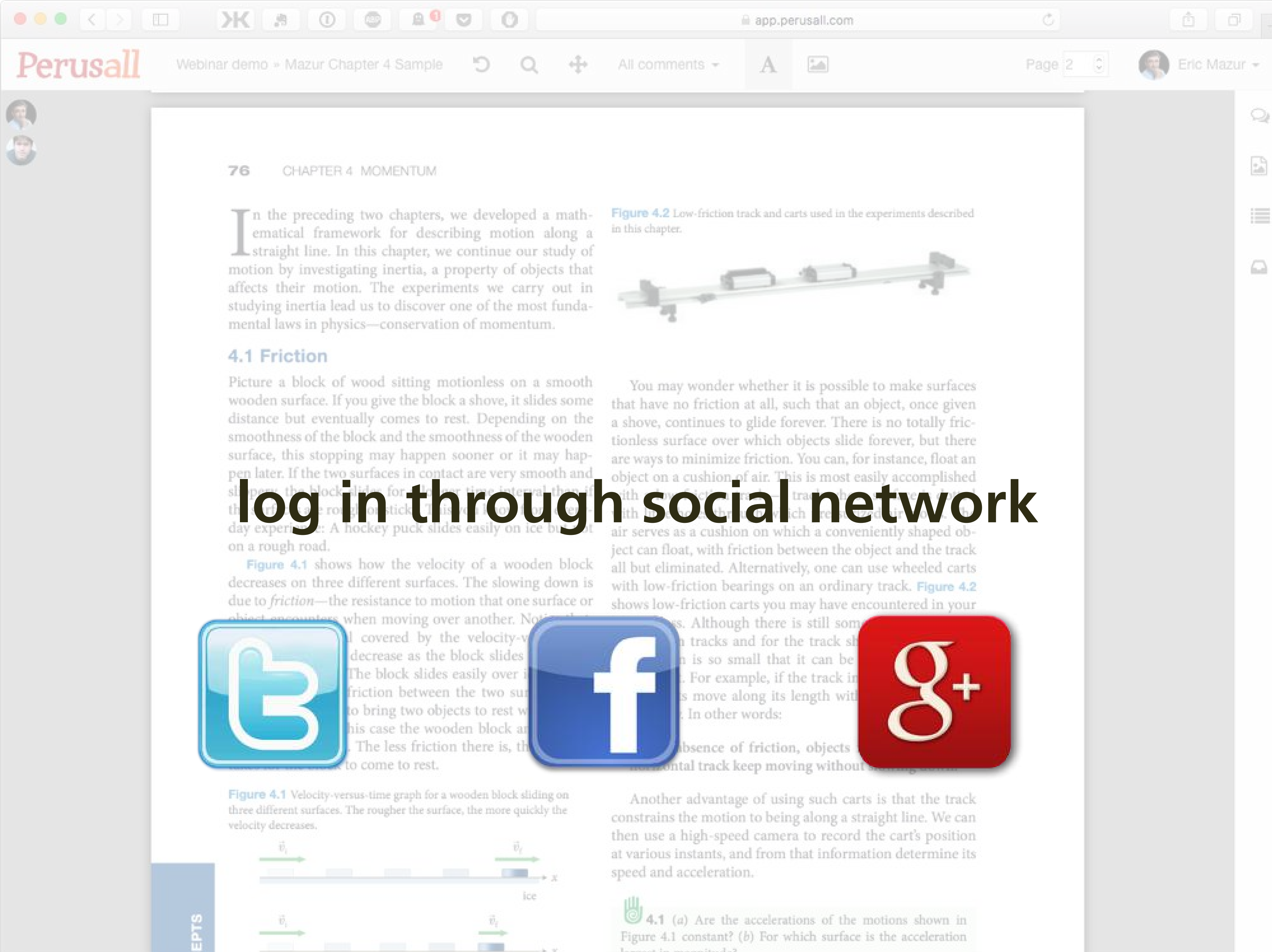
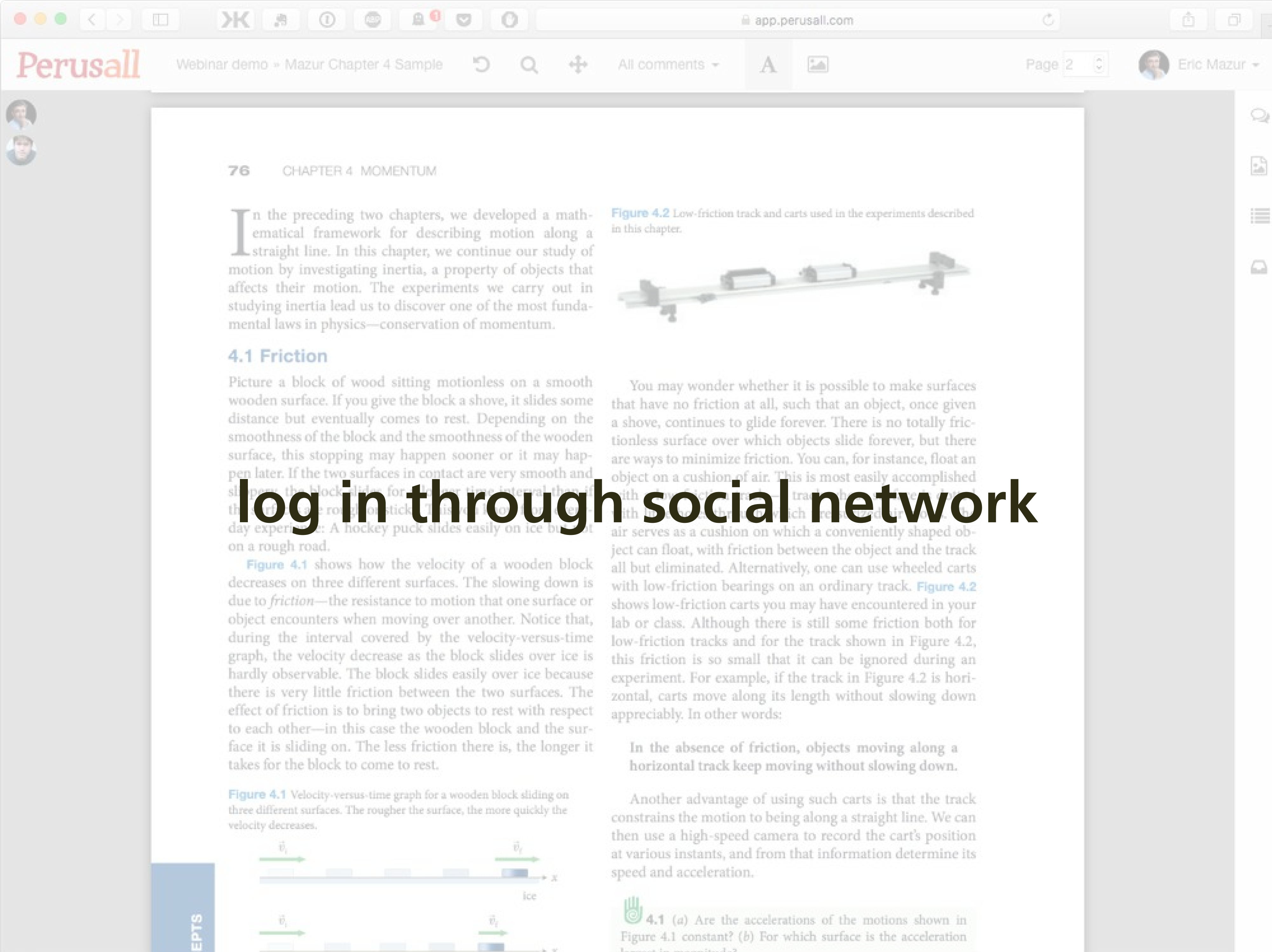
CEPTS

log in through social network

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All comments
Page 2
Eric Mazur
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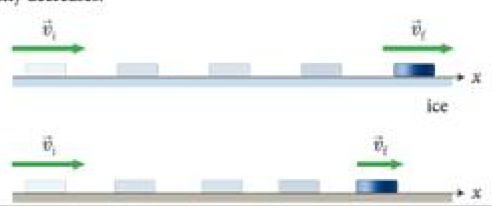

CEPTS

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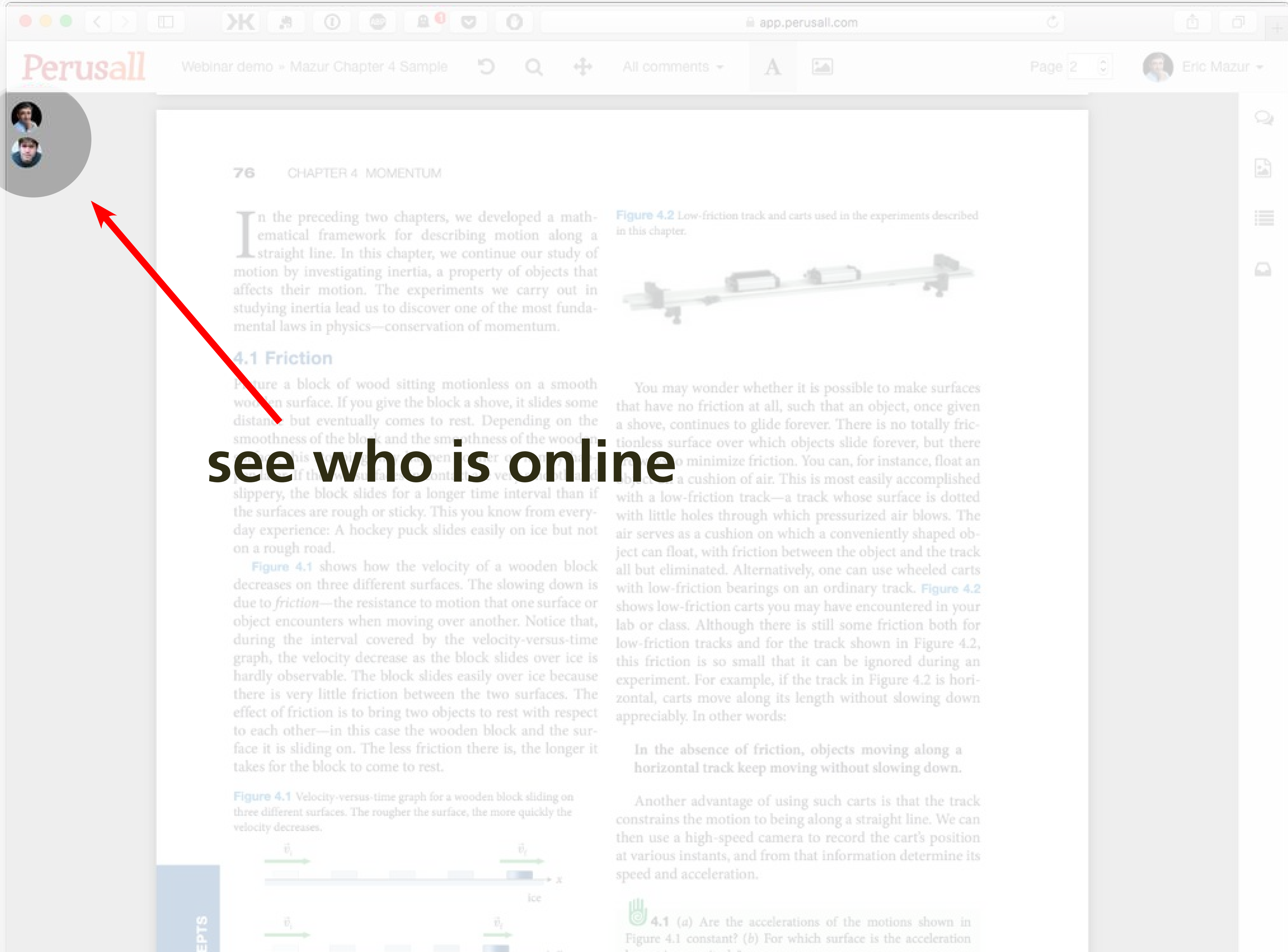

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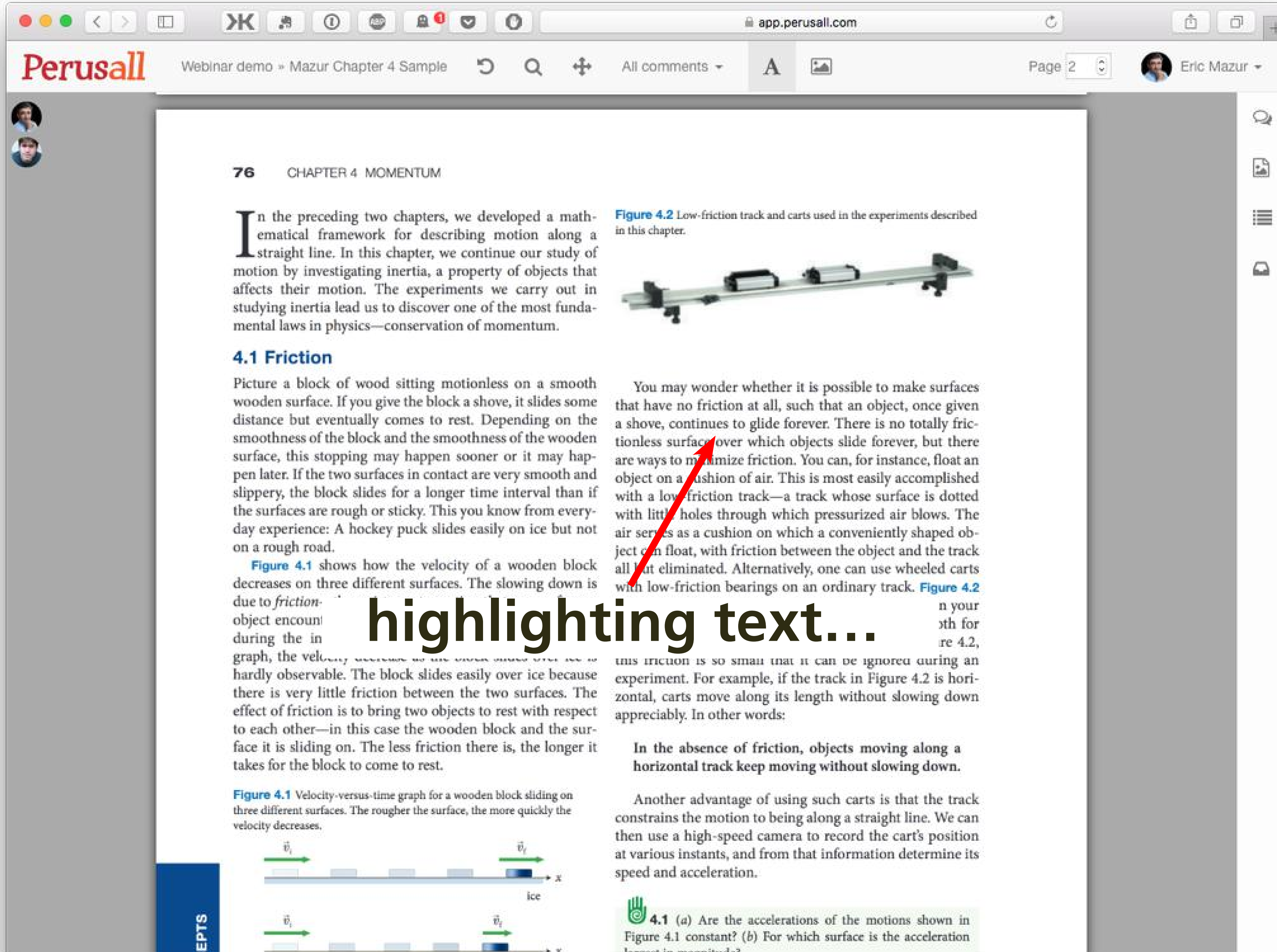

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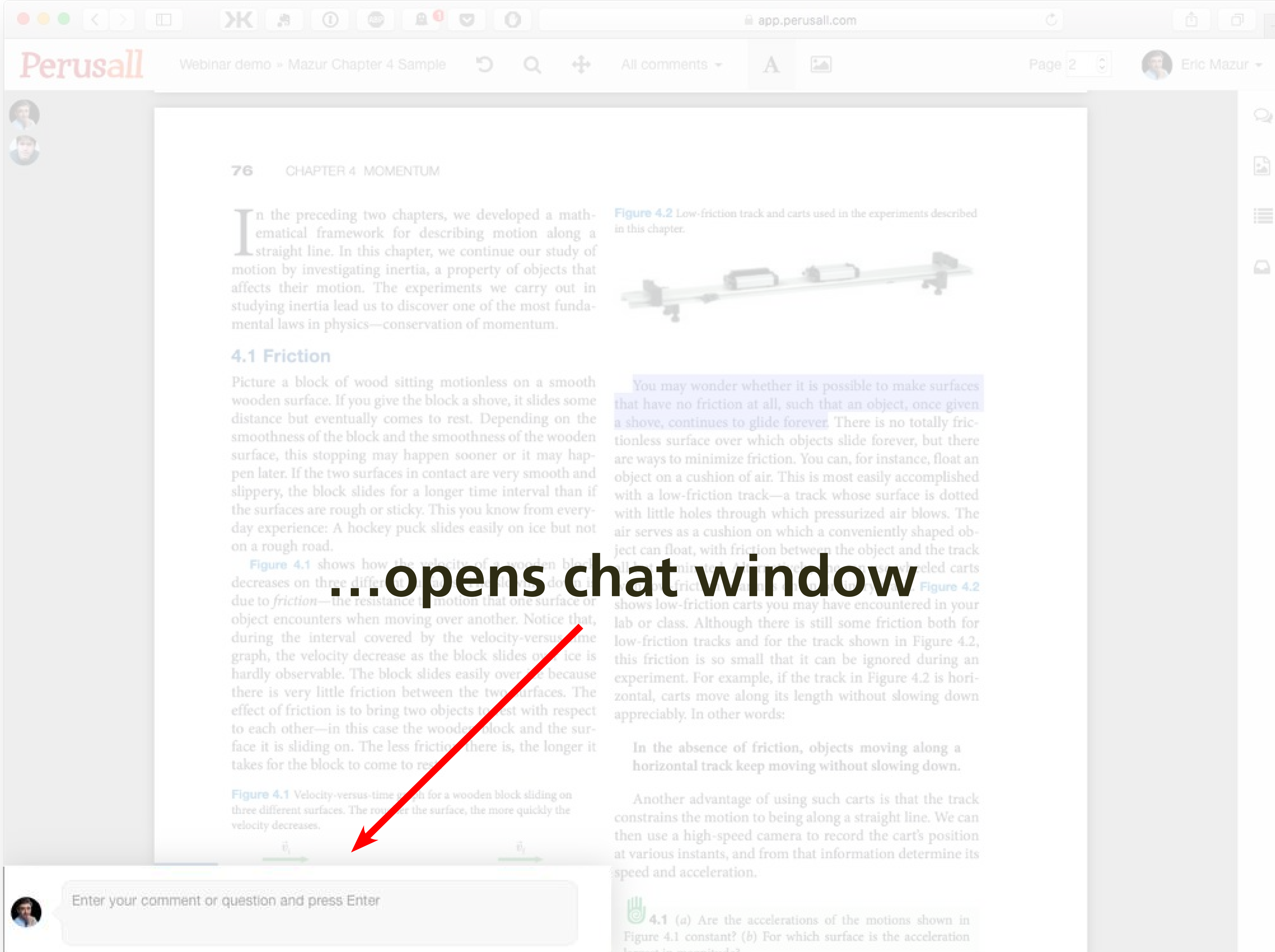

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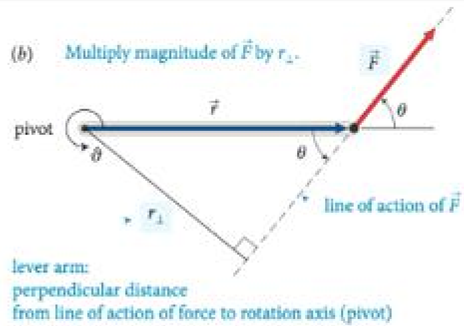
Enter your comment or question and press Enter



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 $rF_\perp$ 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.

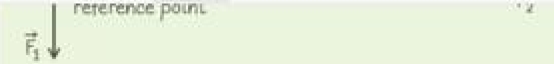
In the situations depicted in Figures 12.4 and 12.5 we used the pivot to calculate the lever arm distances. This is a natural choice because that is the point about which the object under consideration is free to rotate. However, torques also play a role for stationary objects that are suspended or supported 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.

CONCEPTS

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 forces exerted on it, showing their points of application on the rod (Figure 12.6).



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 $\vec{F}^c_{pr}$ 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 $\vec{F}^c_{pr}$ 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. ✔

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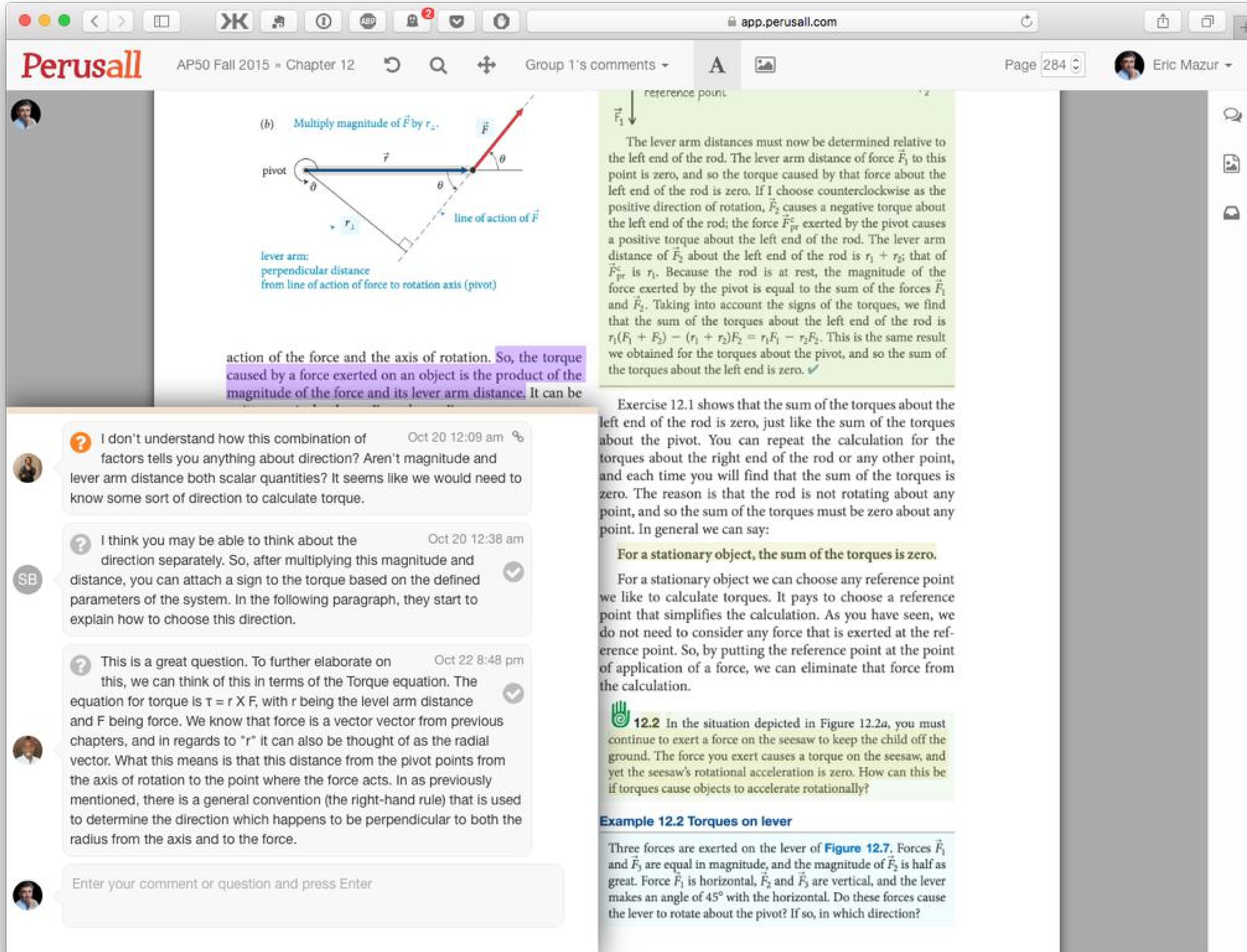

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Eric Mazur
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pivot
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$\vec{F}$
θ
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Oct 20 12:09 am
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Oct 22 8:48 pm
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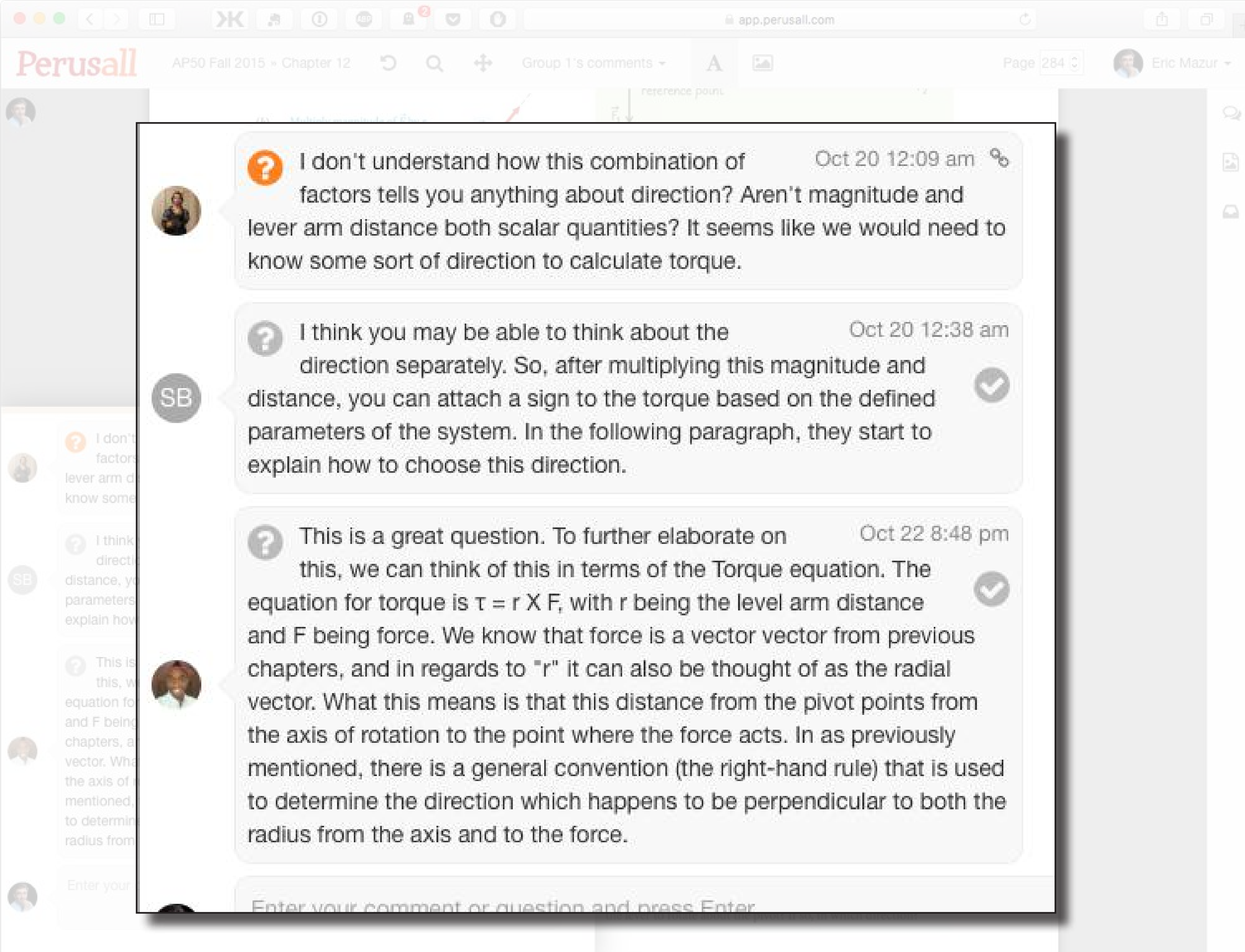
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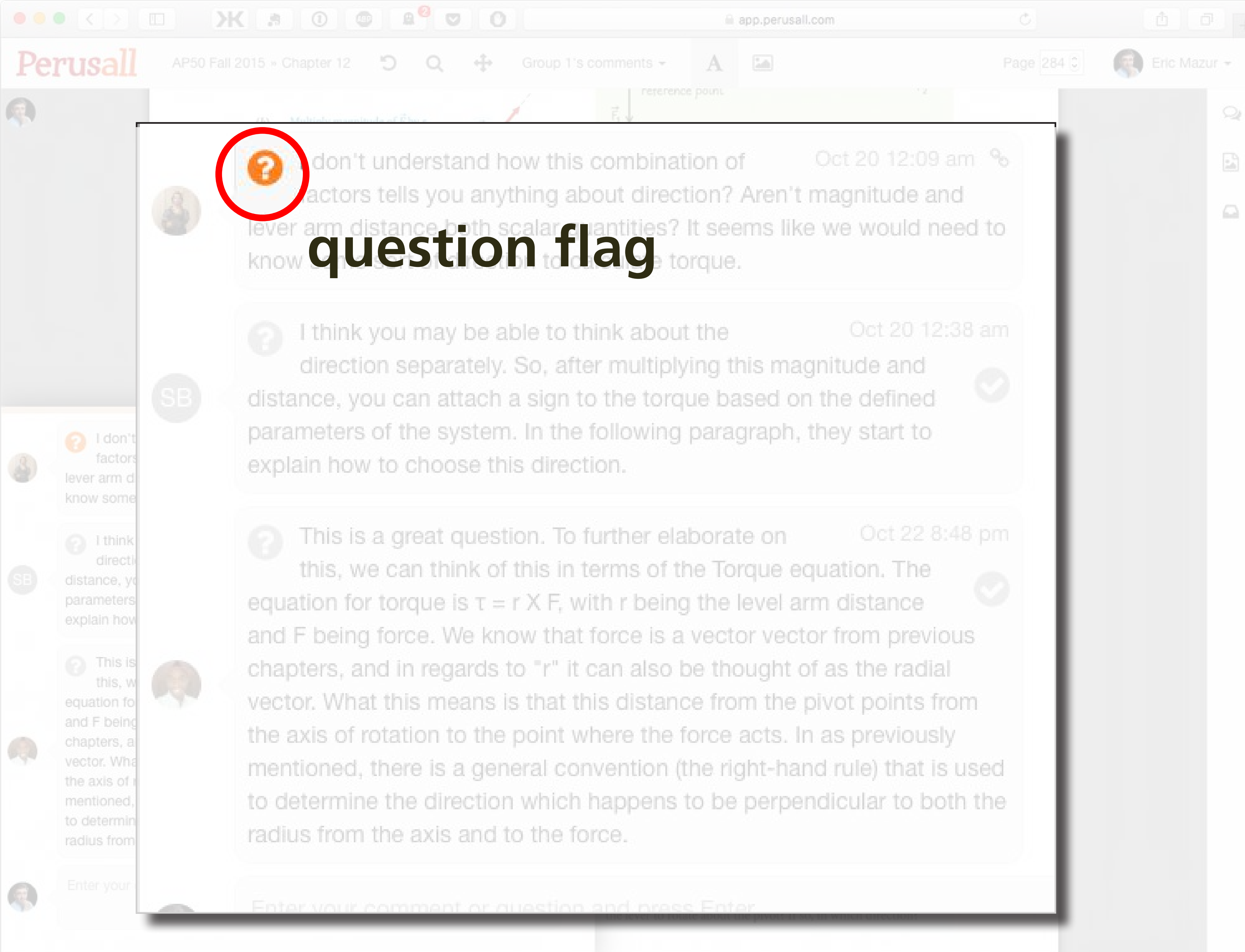
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question flag
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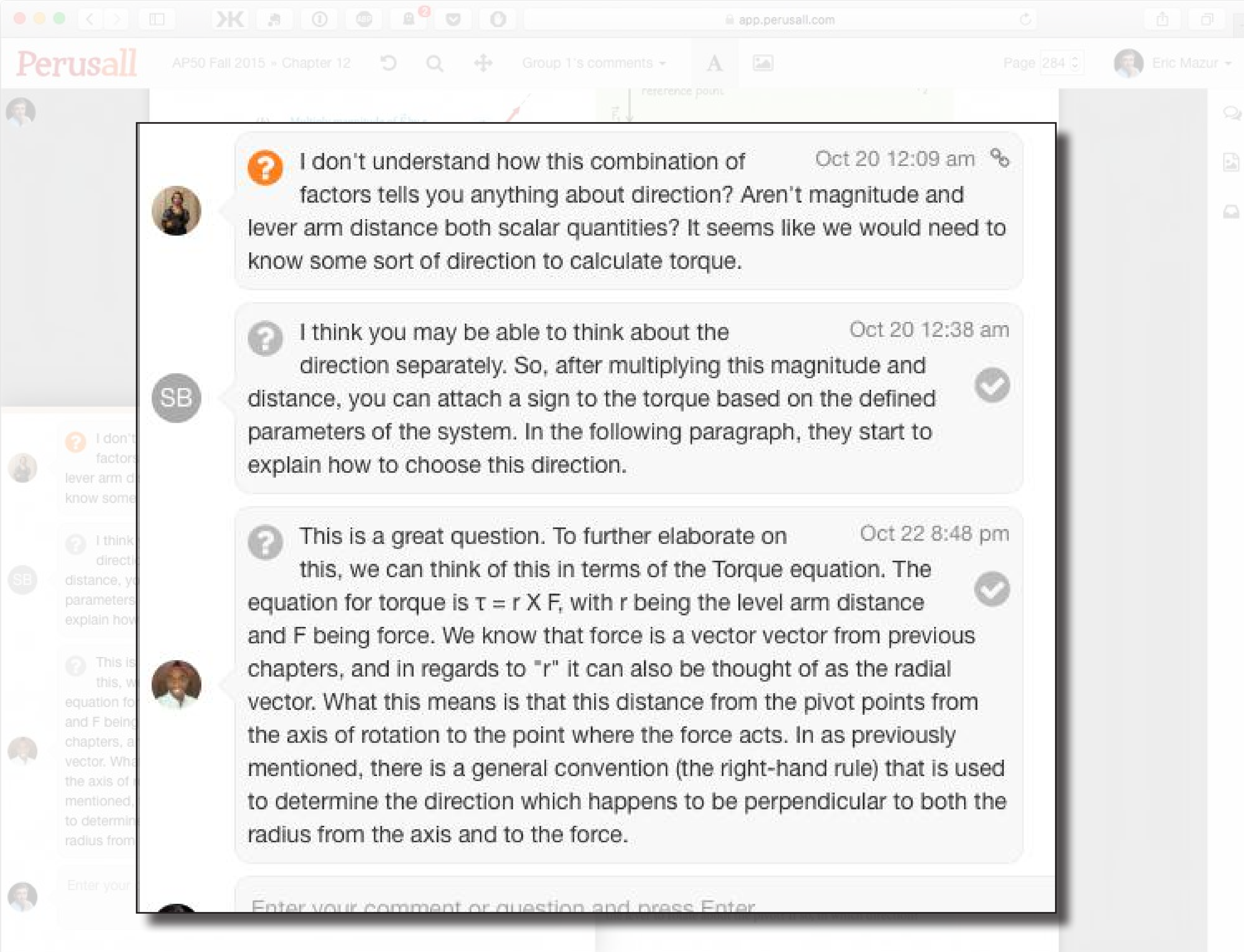

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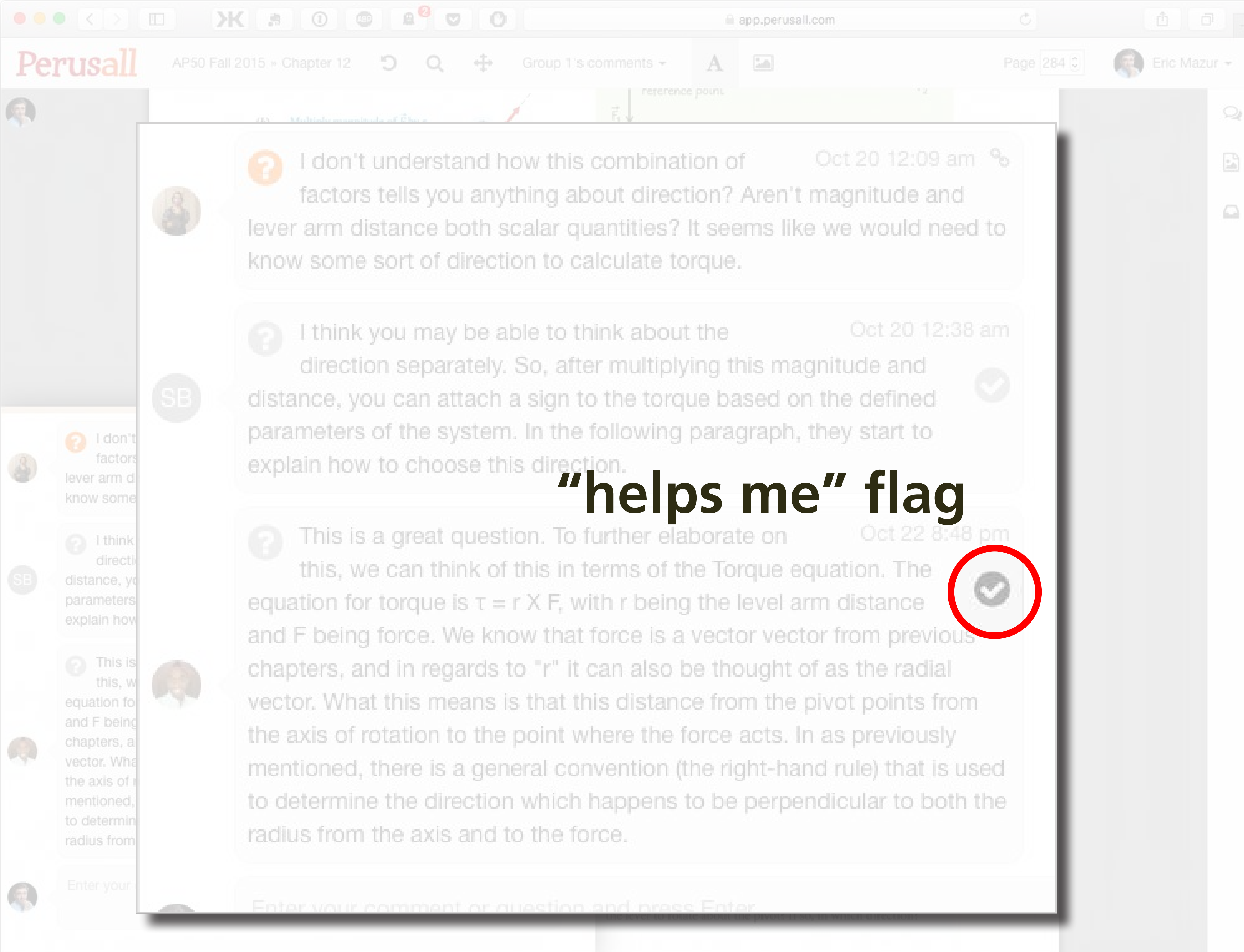
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“helps me” flag
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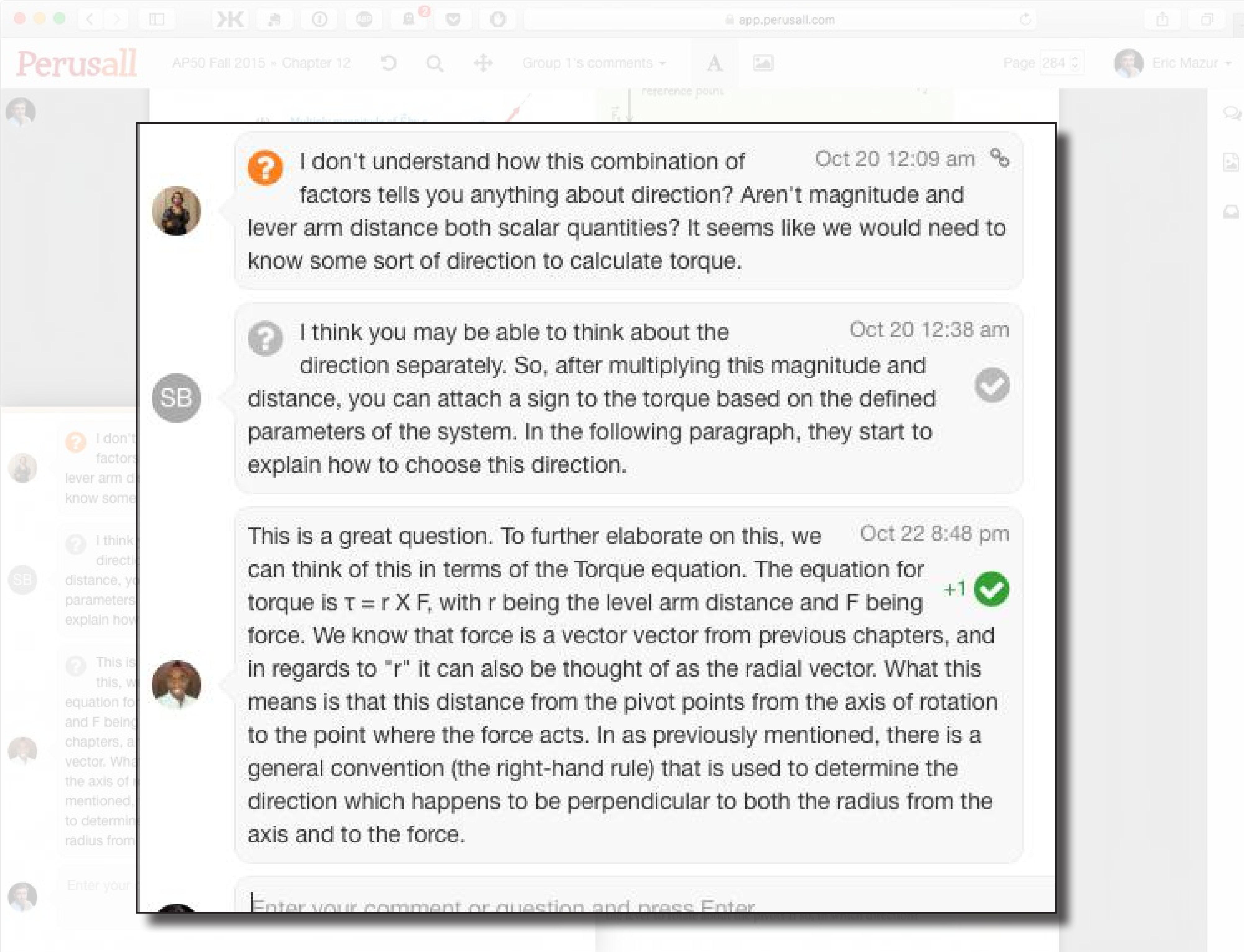
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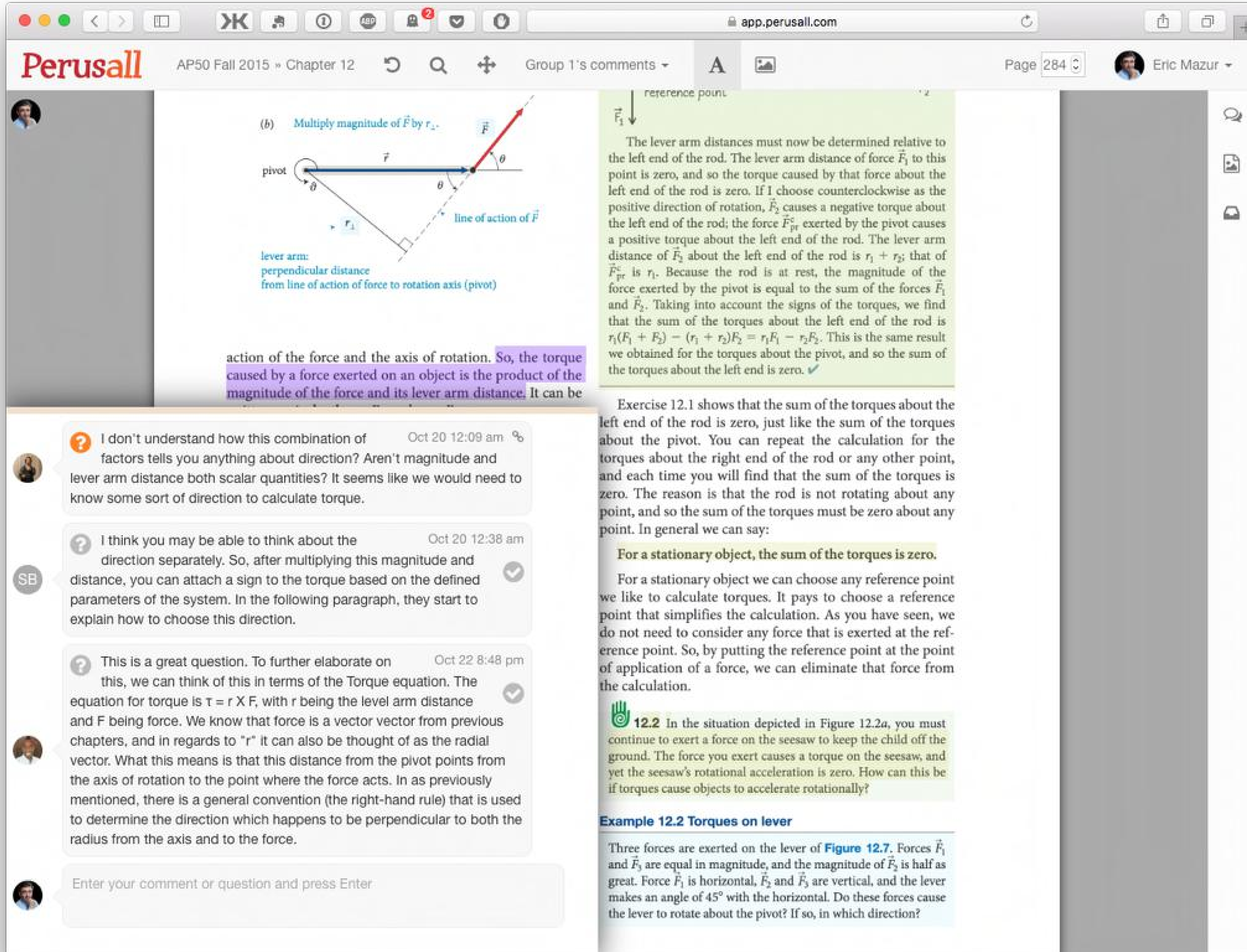
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Eric Mazur
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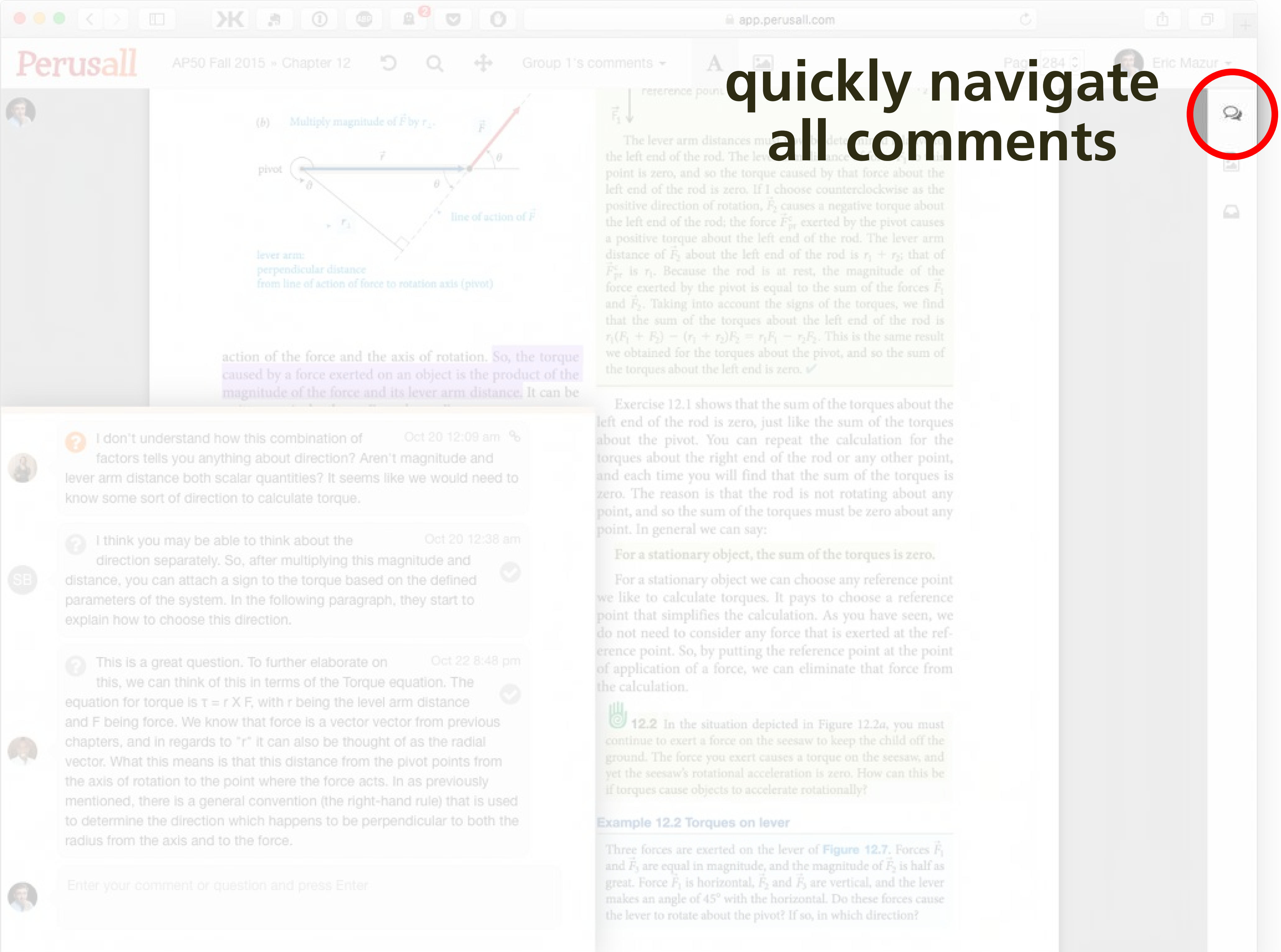

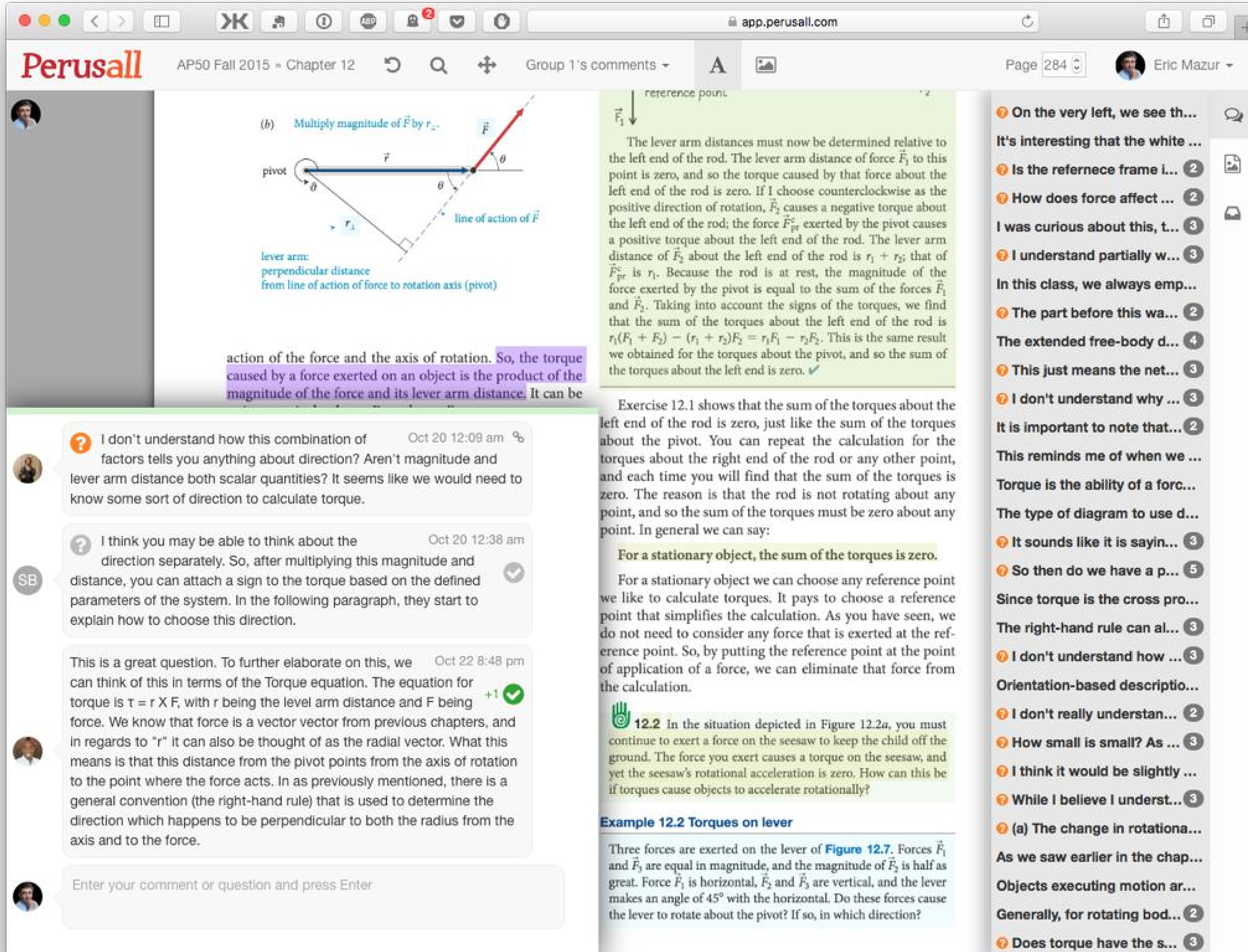

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Eric Mazur
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Oct 22 8:48 pm
+1
Enter your comment or question and press Enter
On the very left, we see th...
It's interesting that the white ...
Is the refernece frame i... 2
How does force affect ... 2
I was curious about this, t... 3
I understand partially w... 3
In this class, we always emp...
The part before this wa... 2
The extended free-body d... 4
This just means the net... 3
I don't understand why ... 3
It is important to note that... 2
This reminds me of when we ...
Torque is the ability of a forc...
The type of diagram to use d...
It sounds like it is sayin... 3
So then do we have a p... 5
Since torque is the cross pro...
The right-hand rule can al... 3
I don't understand how ... 3
Orientation-based descriptio...
I don't really understan... 2
How small is small? As ... 3
I think it would be slightly ...
While I believe I underst... 3
(a) The change in rotationa...
As we saw earlier in the chap...
Objects executing motion ar...
Generally, for rotating bod... 2
Does torque have the s... 3

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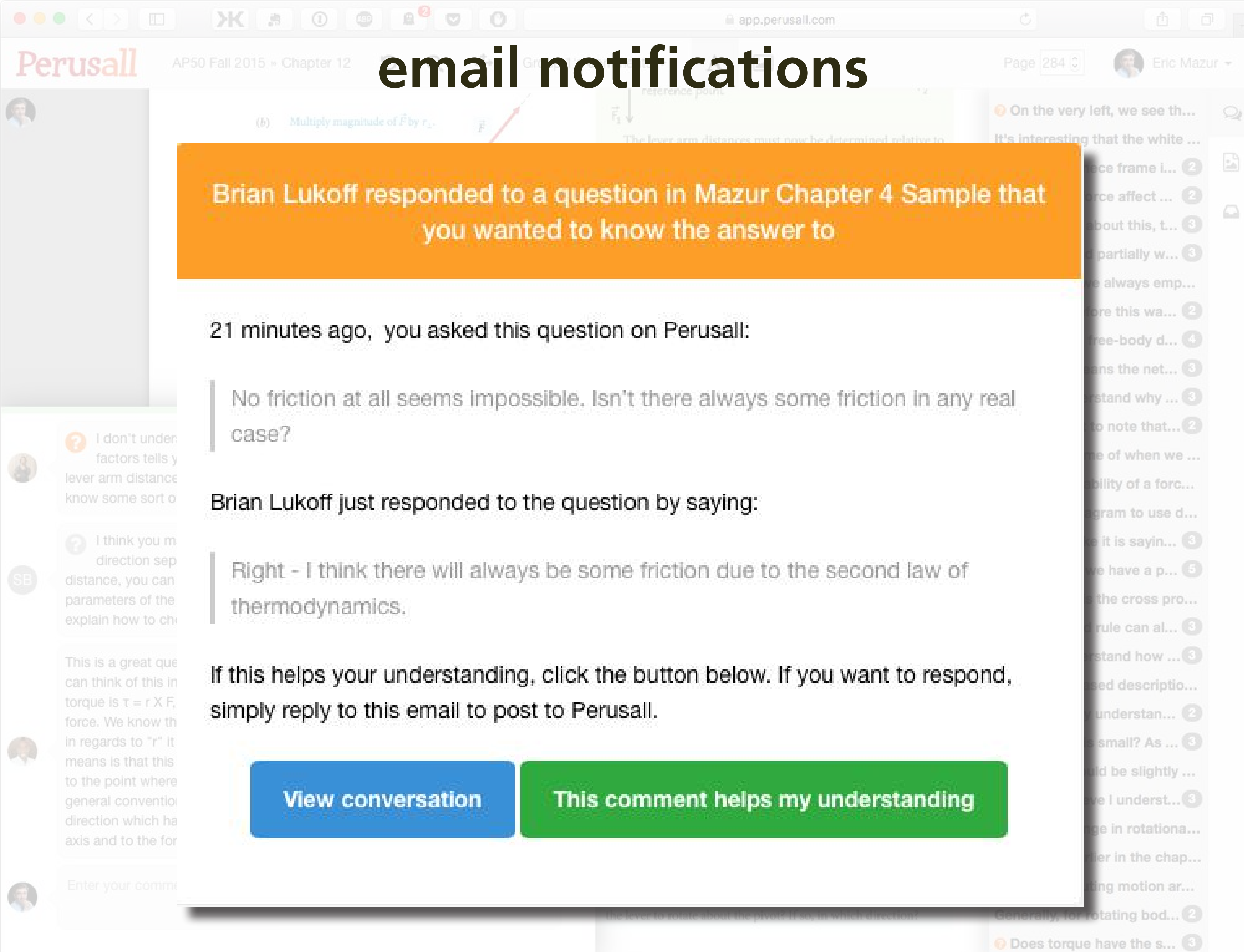
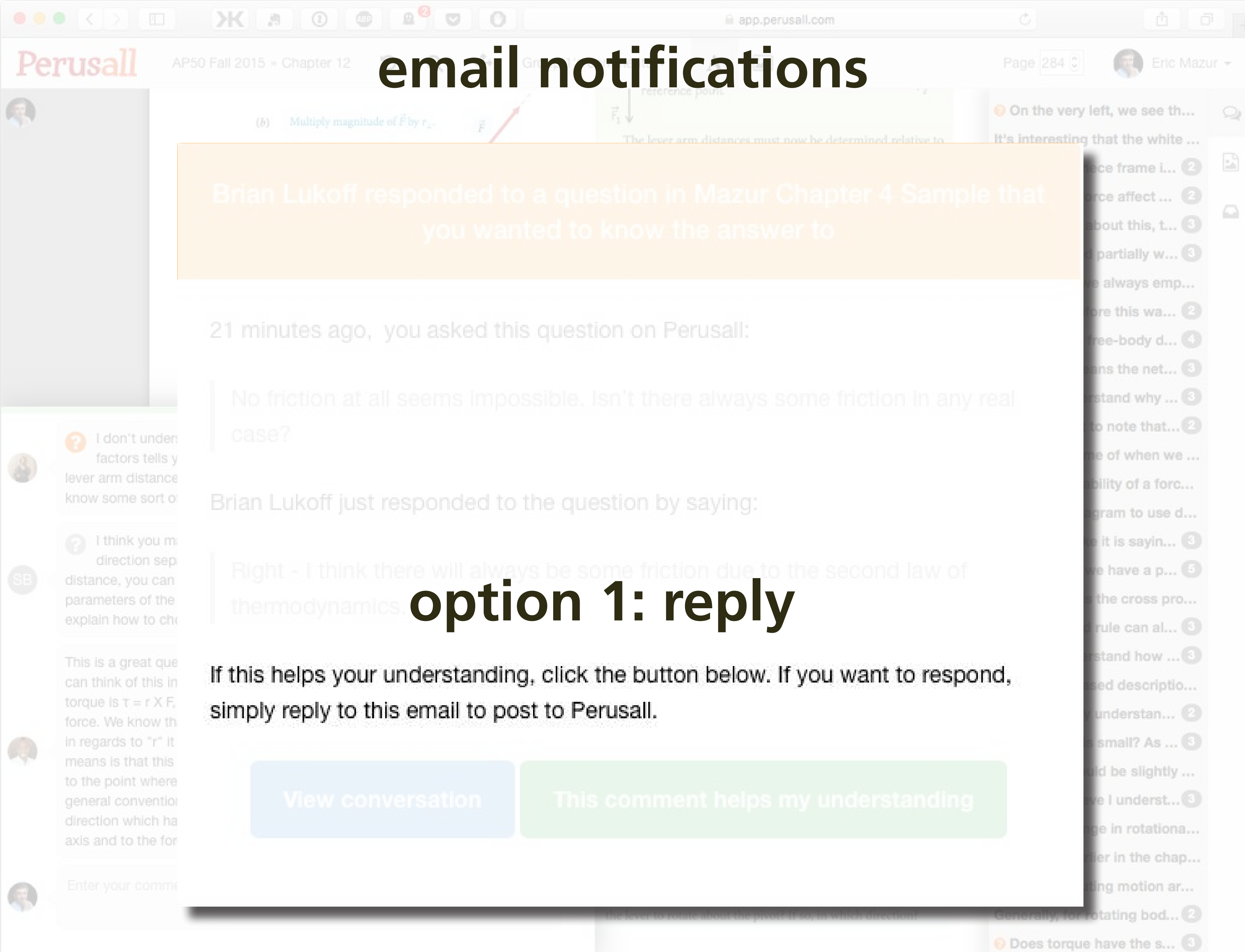
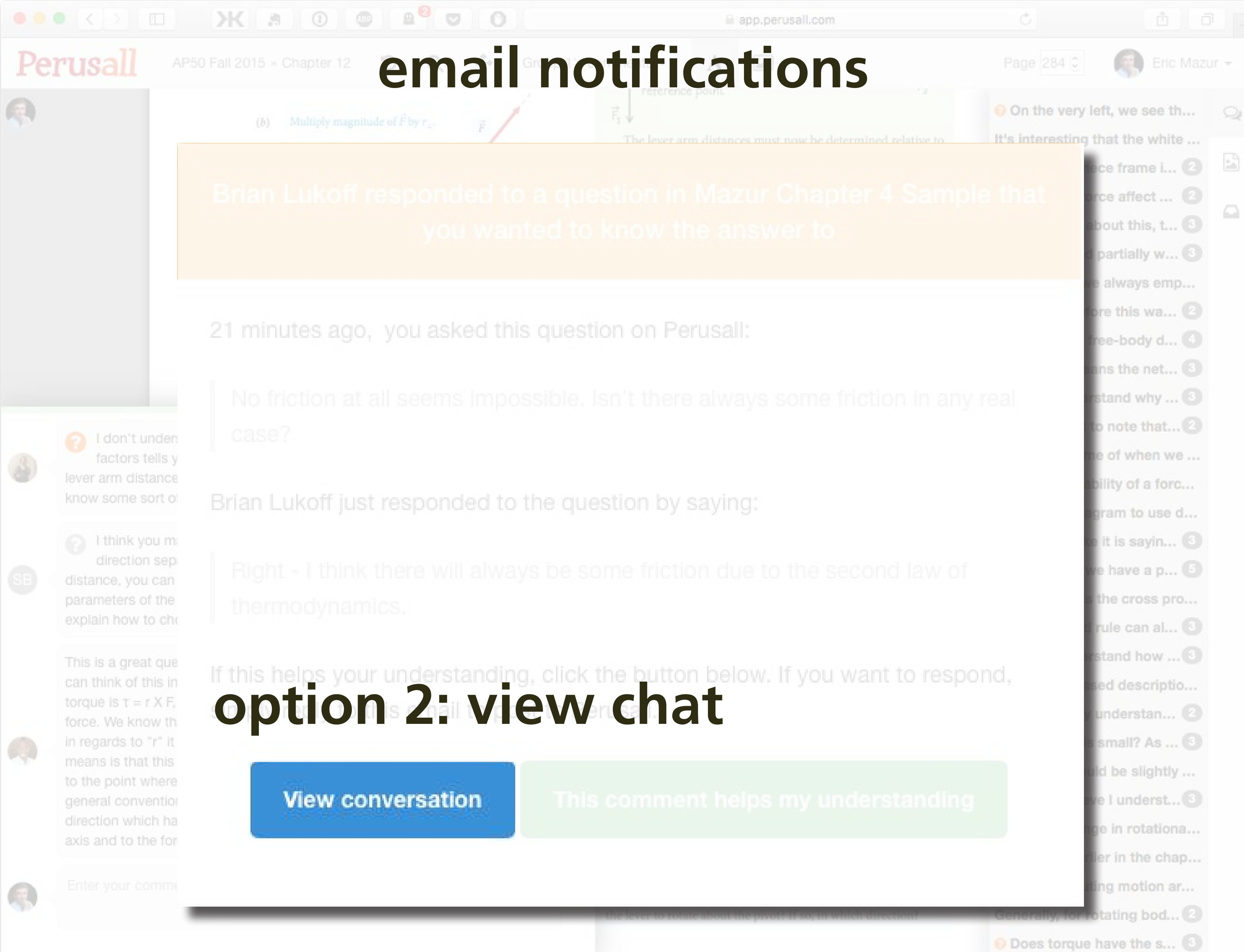



email notifications
Brian Lukoff responded to a question in Mazur Chapter 4 Sample that you wanted to know the answer to
21 minutes ago, you asked this question on Perusall:
No friction at all seems impossible. Isn't there always some friction in any real case?
Brian Lukoff just responded to the question by saying:
Right - I think there will always be some friction due to the second law of thermodynamics.
option 1: reply
If this helps your understanding, click the button below. If you want to respond, simply reply to this email to post to Perusall.
View conversation
This comment helps my understanding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Eric Mazur
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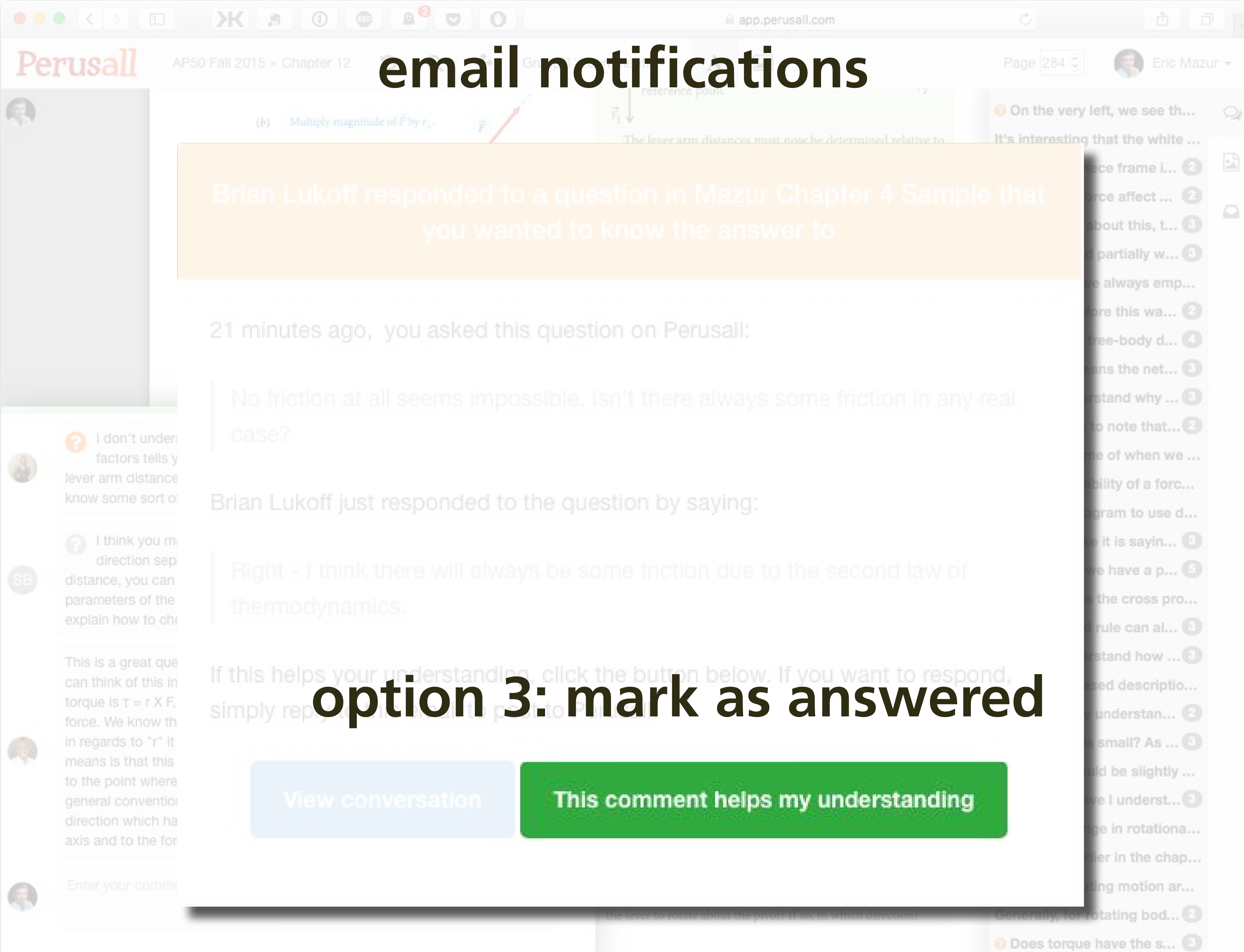
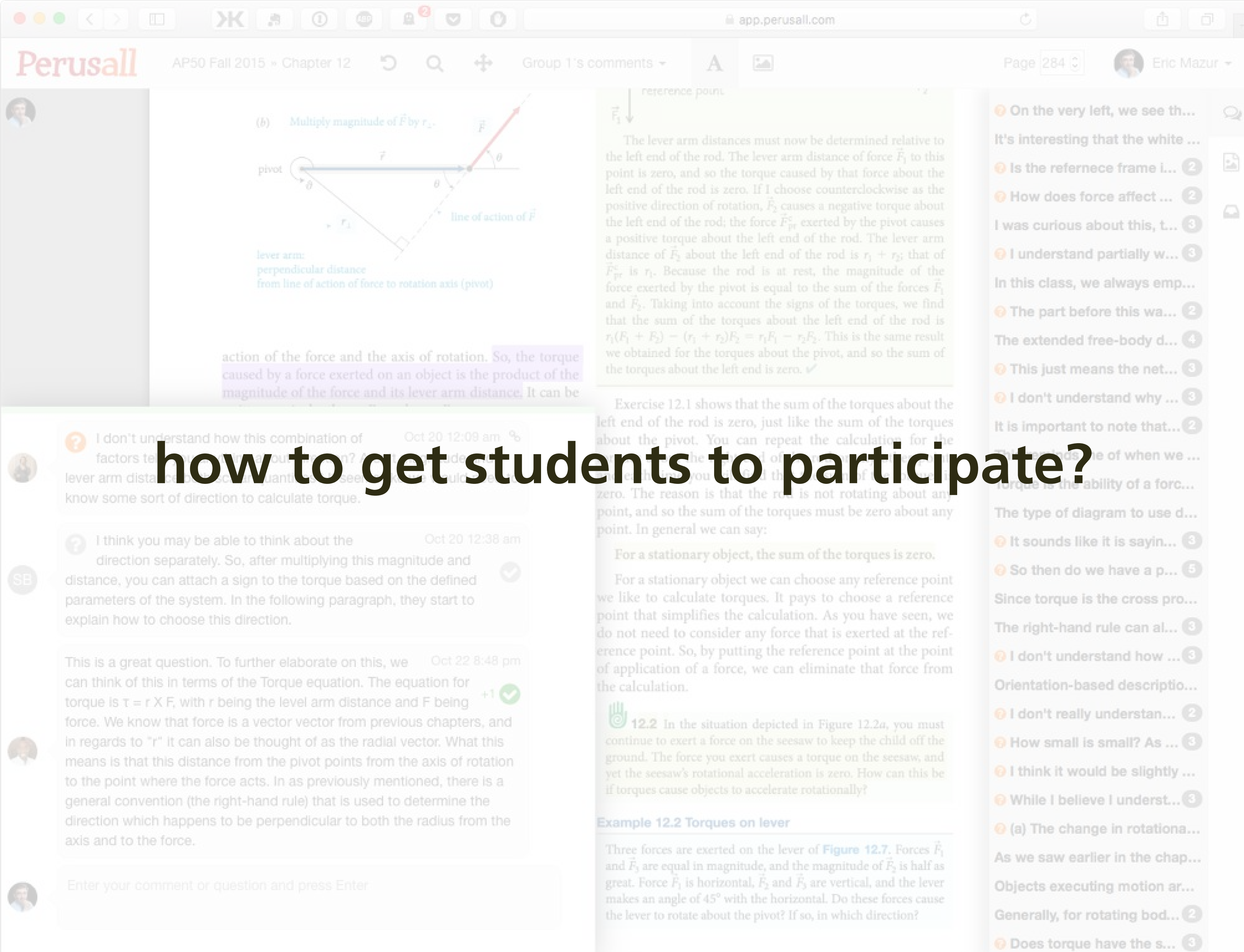
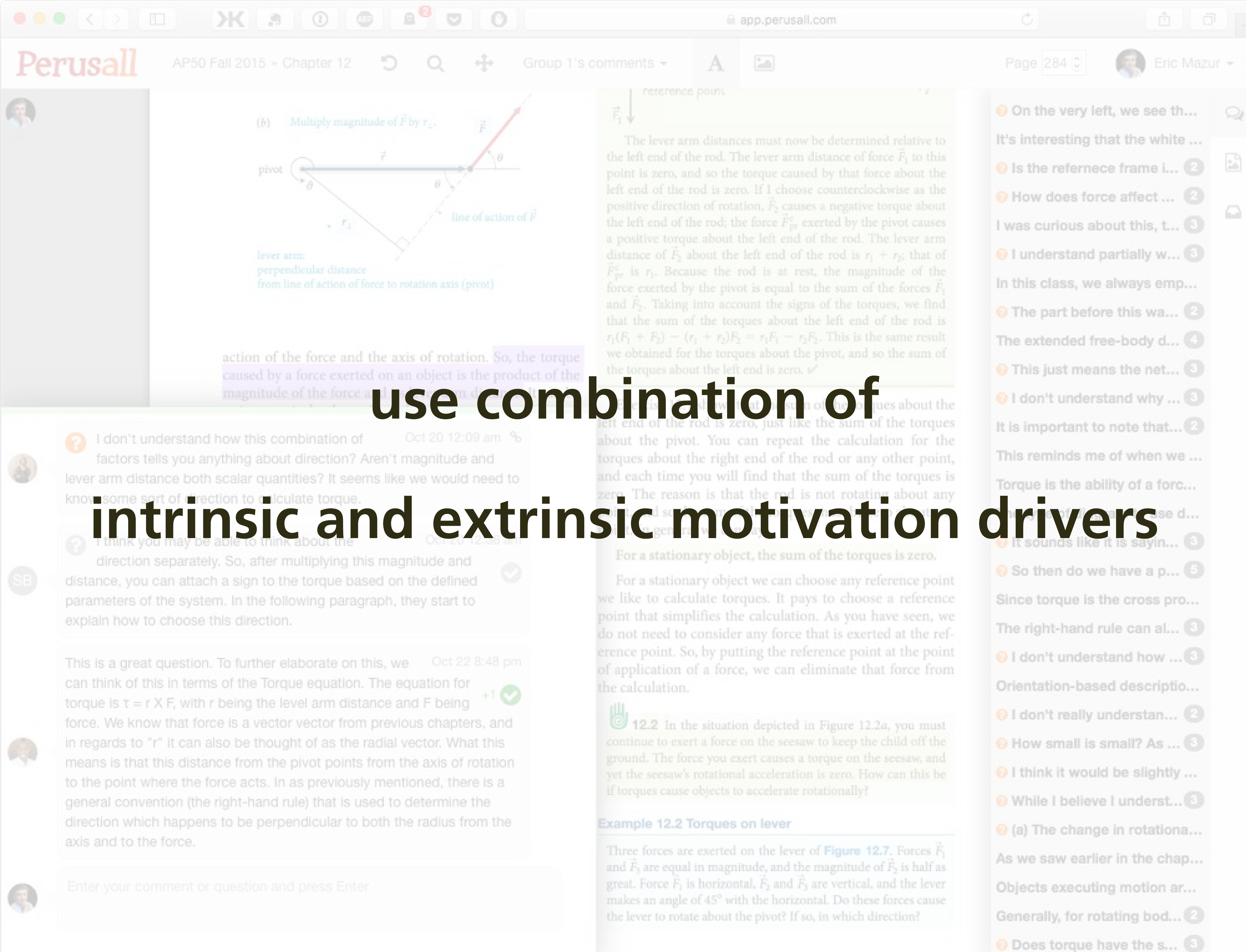


option 3: mark as answered

how to get students to participate?



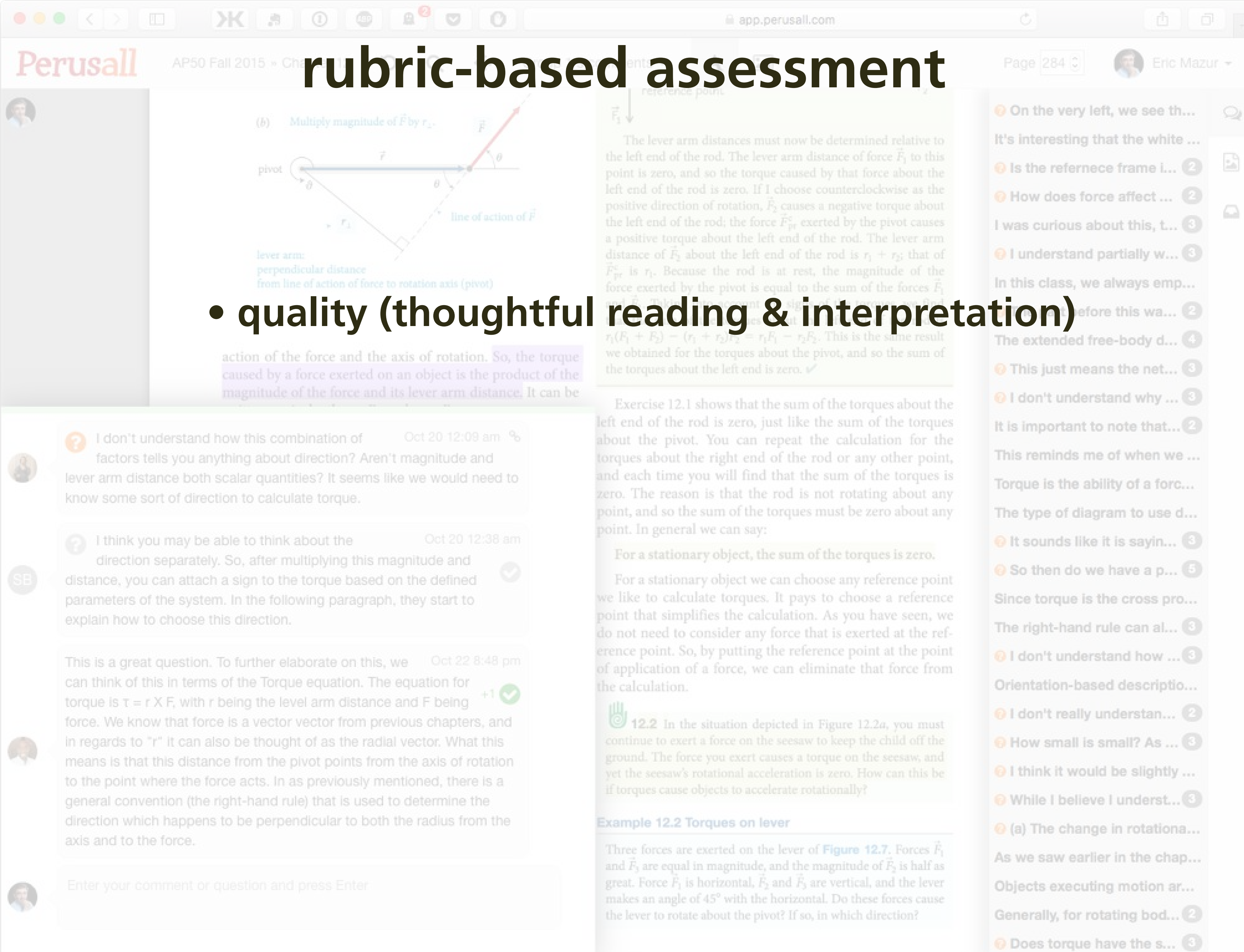


use combination of

intrinsic and extrinsic motivation drivers

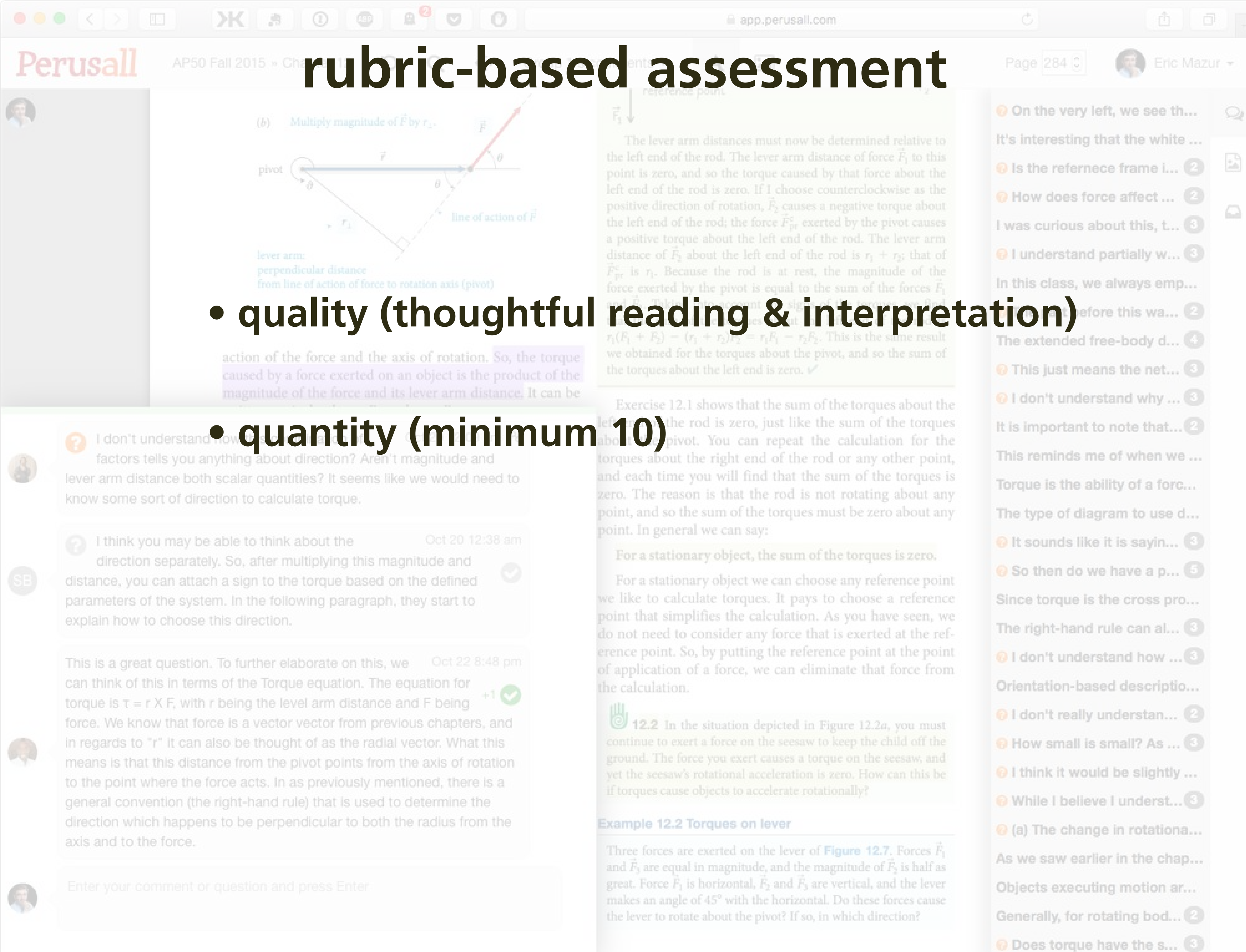
rubric-based assessment

- quality (thoughtful reading & interpretation)

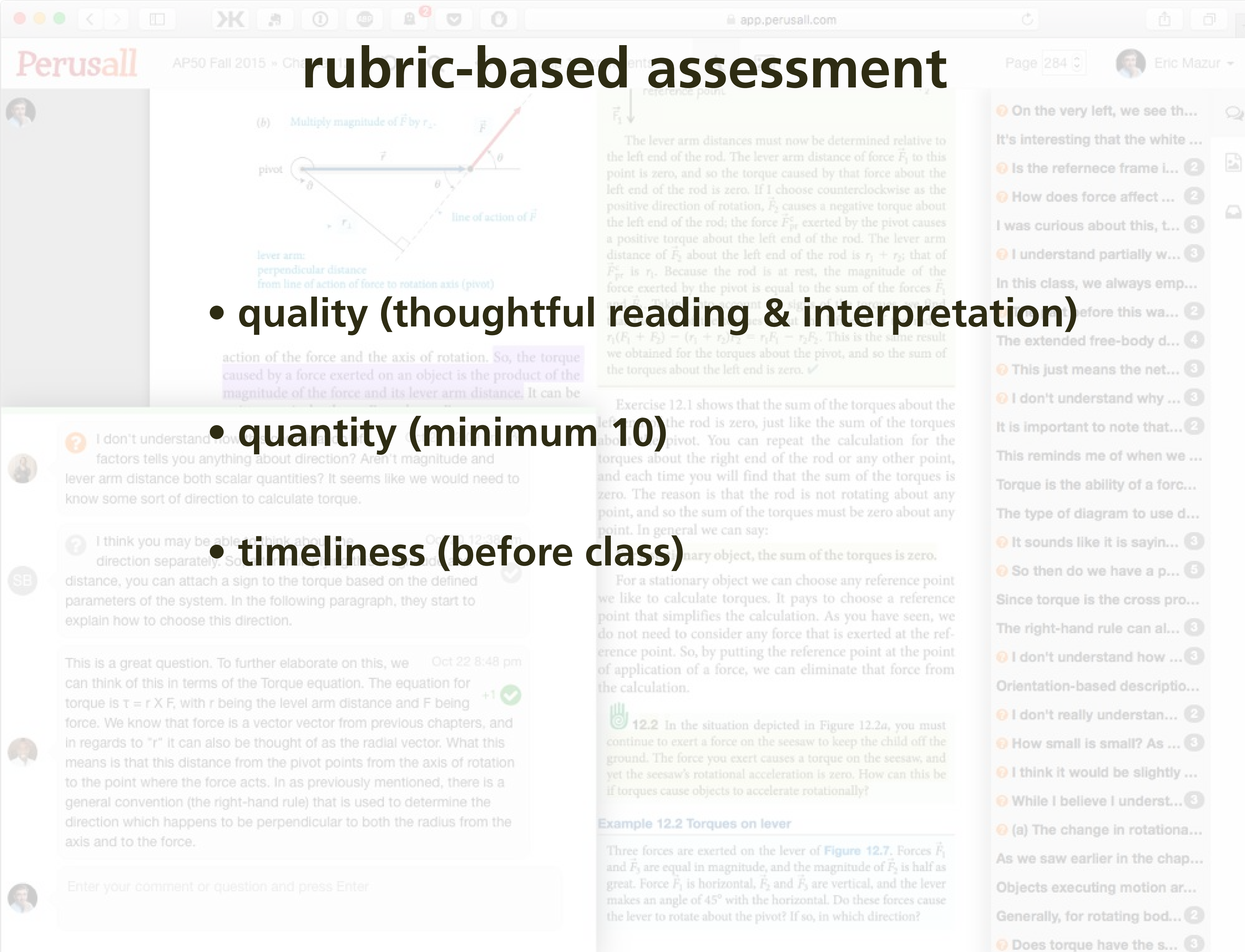


rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)



rubric-based assessment



- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)

rubric-based assessment

- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

rubric-based assessment

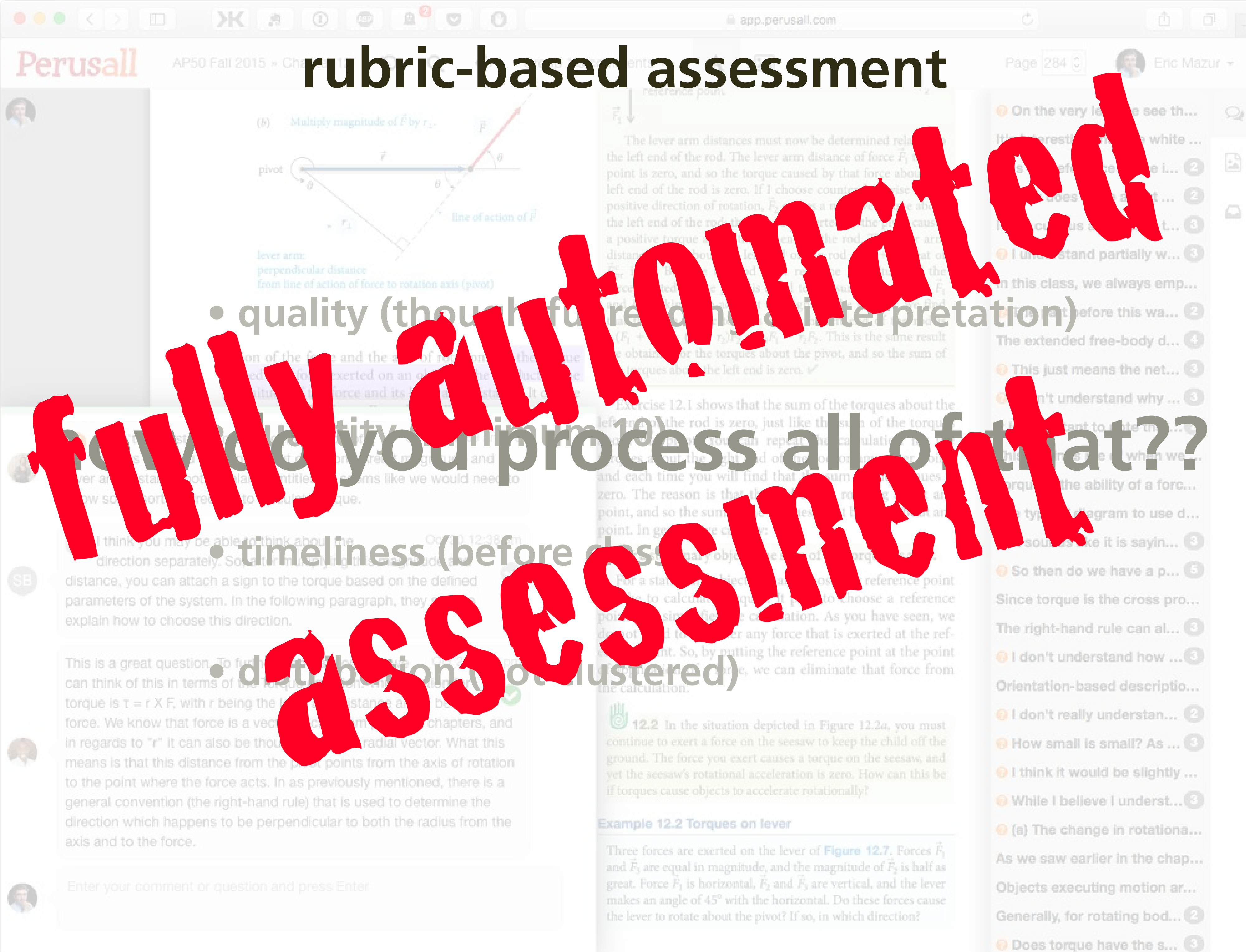
- quality (thoughtful reading & interpretation)
- quantity (minimum 7)
- timeliness (before class)
- distribution (not clustered)

over 20,000 annotations!

rubric-based assessment

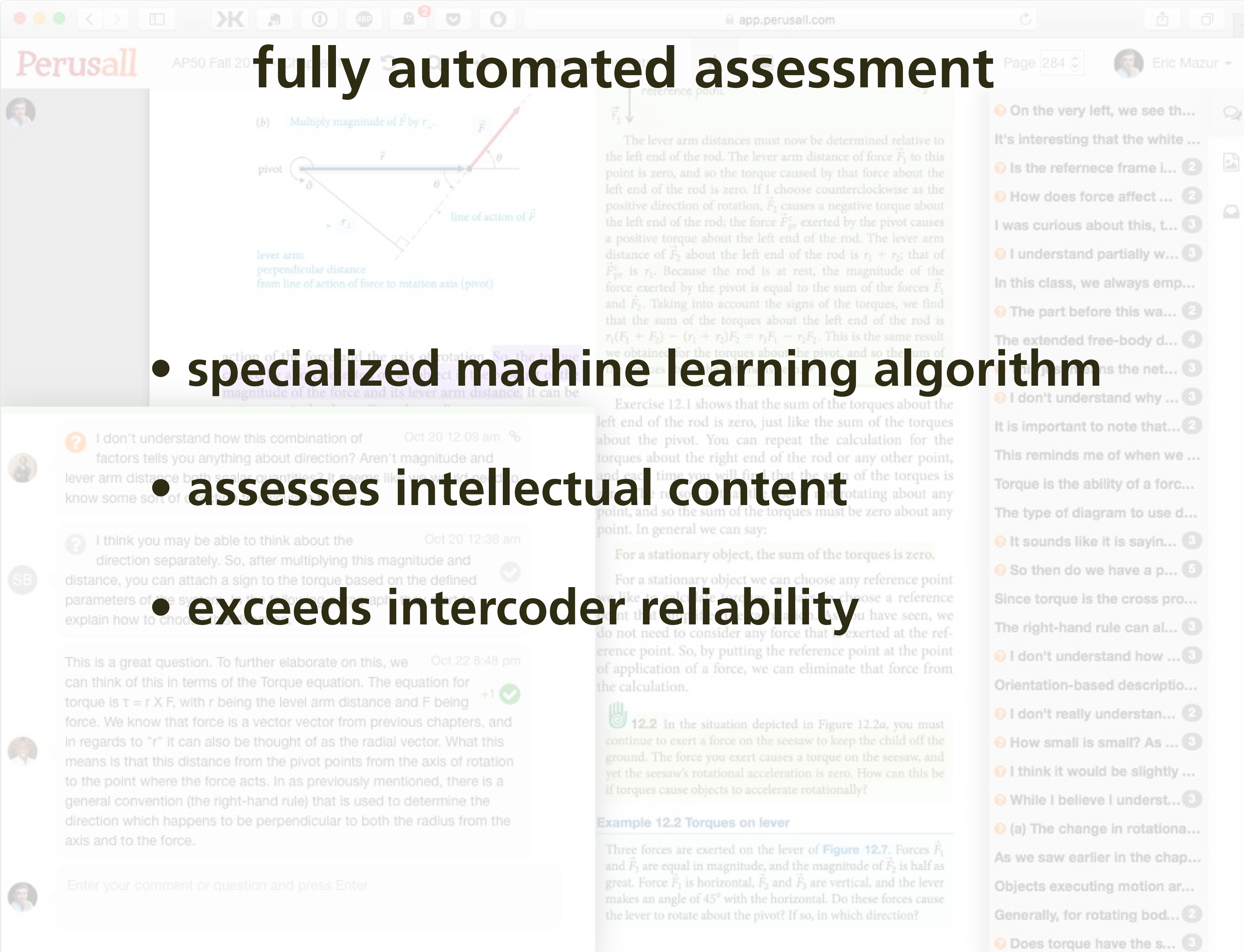
- quality (thoughtful reading & interpretation)
- quantity (minimum 10)
- timeliness (before class)
- distribution (not clustered)

how do you process all of that??



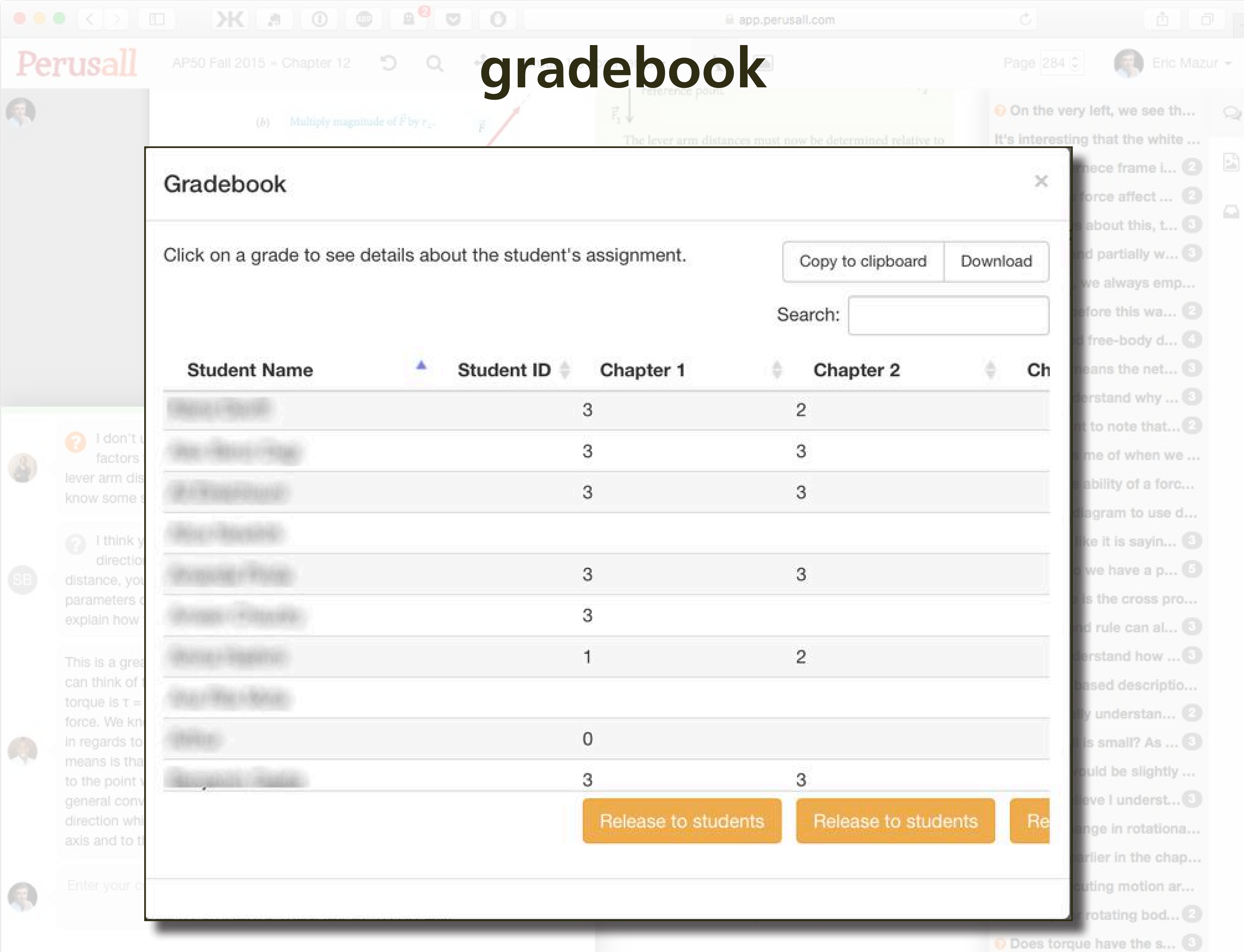
rubric-based assessment
• quality (thoughtful interpretation)
• quantity (minimum 10)
• timeliness (before class)
• distribution (not clustered)
how do you process all of that??
fully automated assessment

fully automated assessment



- specialized machine learning algorithm
- assesses intellectual content
- exceeds intercoder reliability

gradebook



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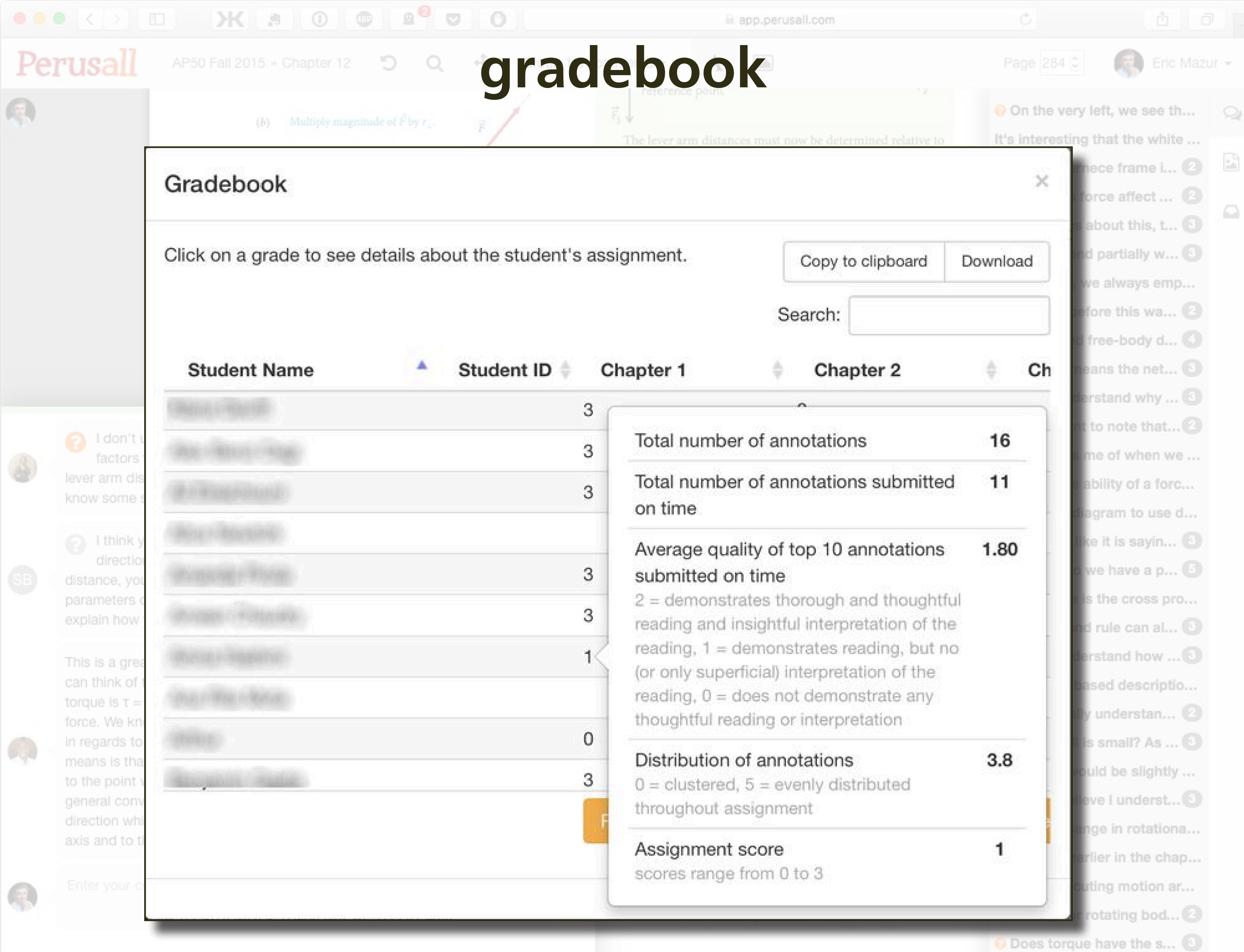

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Gradebook
Click on a grade to see details about the student's assignment.
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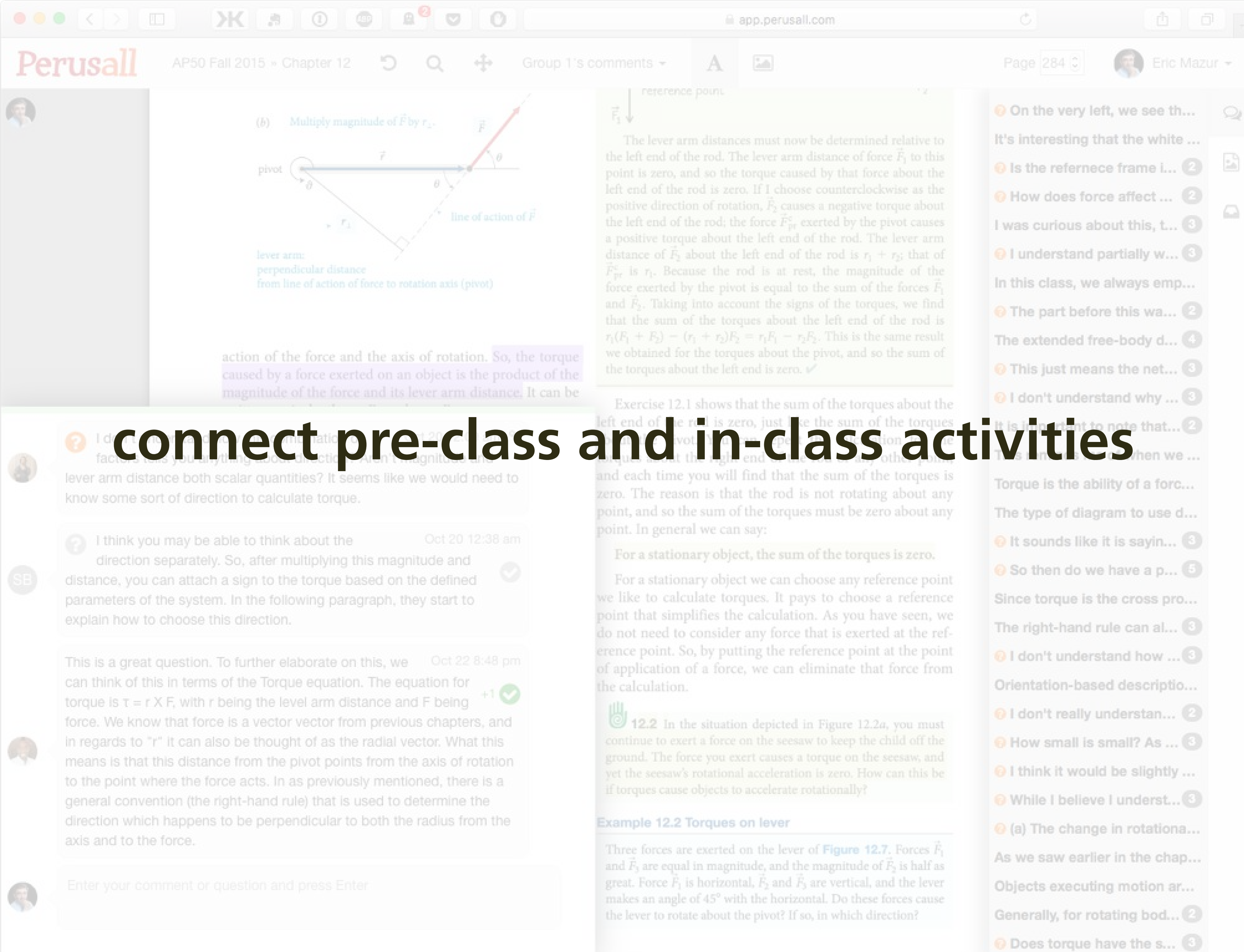
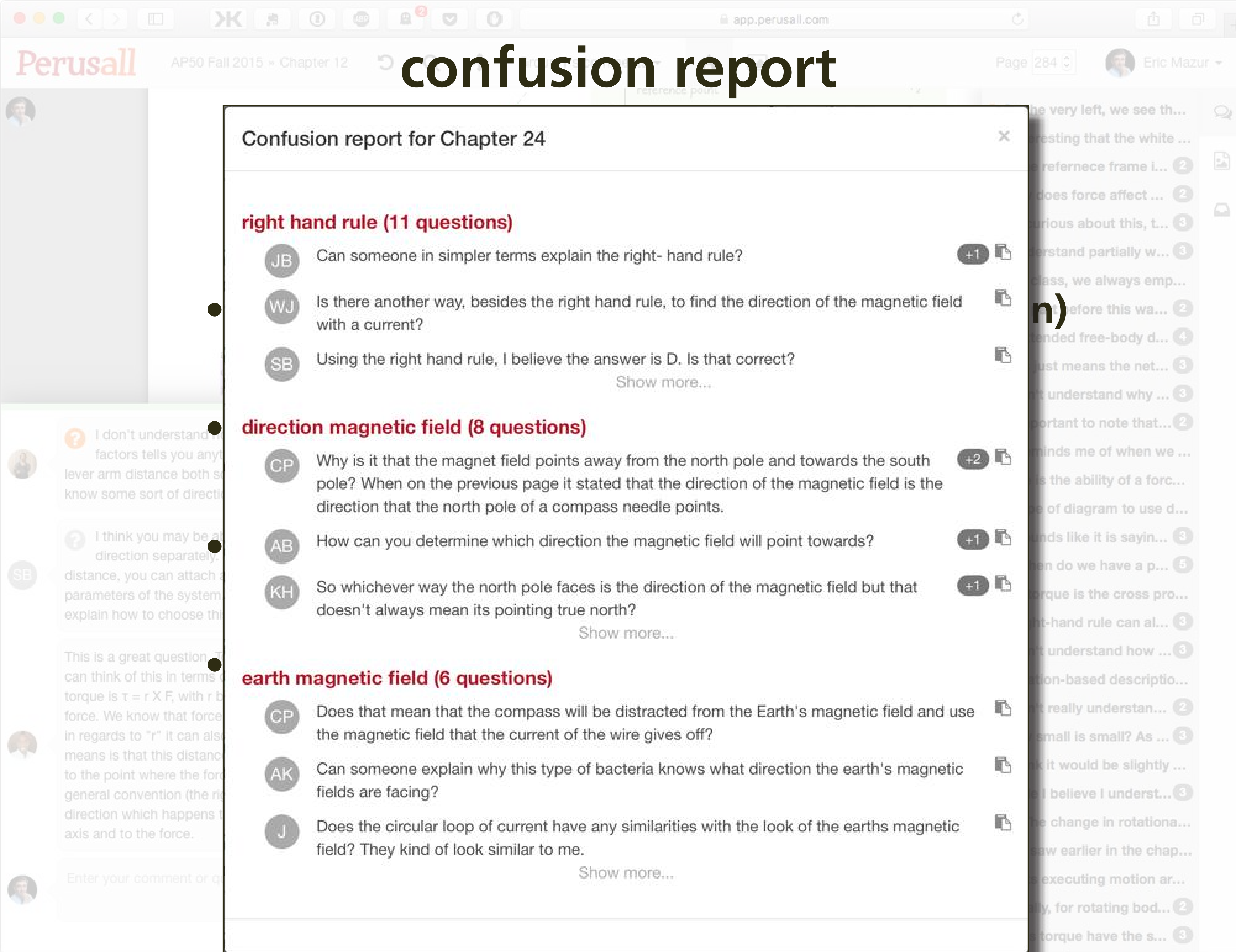
Search:
Student Name
Student ID
Chapter 1
Chapter 2
Ch
Total number of annotations
16
Total number of annotations submitted on time
11
Average quality of top 10 annotations submitted on time
1.80
2 = demonstrates thorough and thoughtful reading and insightful interpretation of the reading, 1 = demonstrates reading, but no (or only superficial) interpretation of the reading, 0 = does not demonstrate any thoughtful reading or interpretation
Distribution of annotations
3.8
0 = clustered, 5 = evenly distributed throughout assignment
Assignment score
1
scores range from 0 to 3



connect pre-class and in-class activities

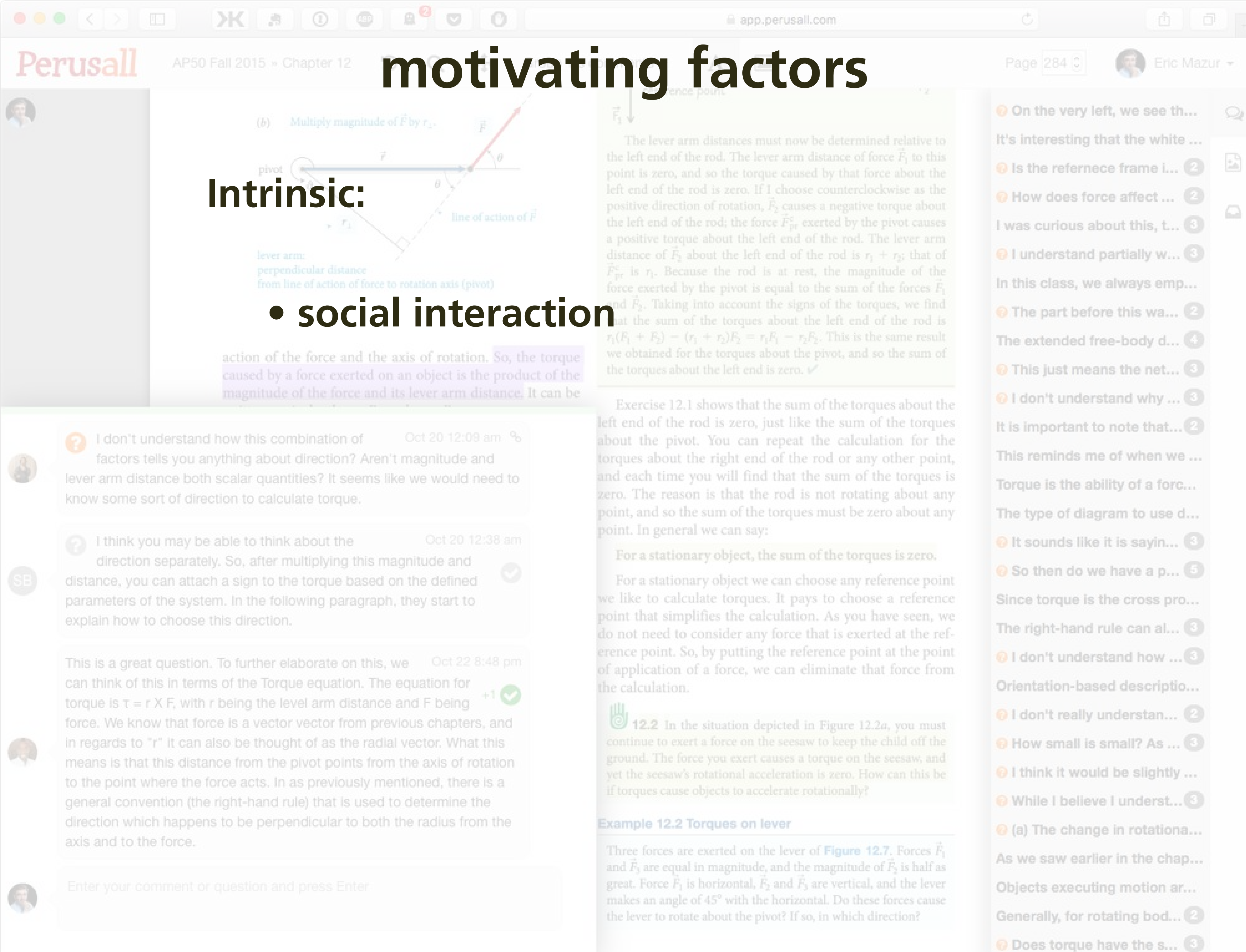
confusion report



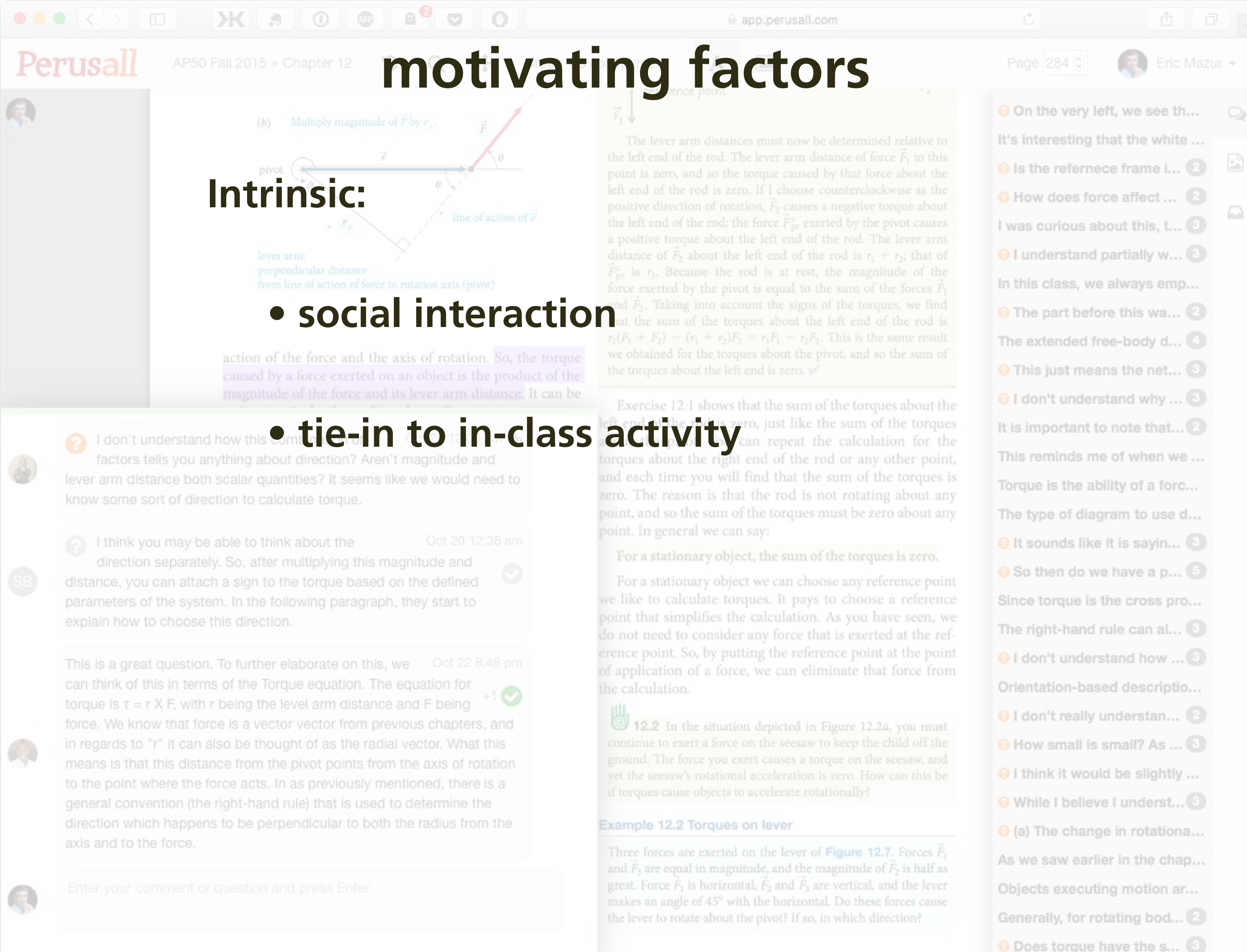
motivating factors

Intrinsic:

- social interaction



motivating factors



Intrinsic:

- social interaction
- tie-in to in-class activity

motivating factors

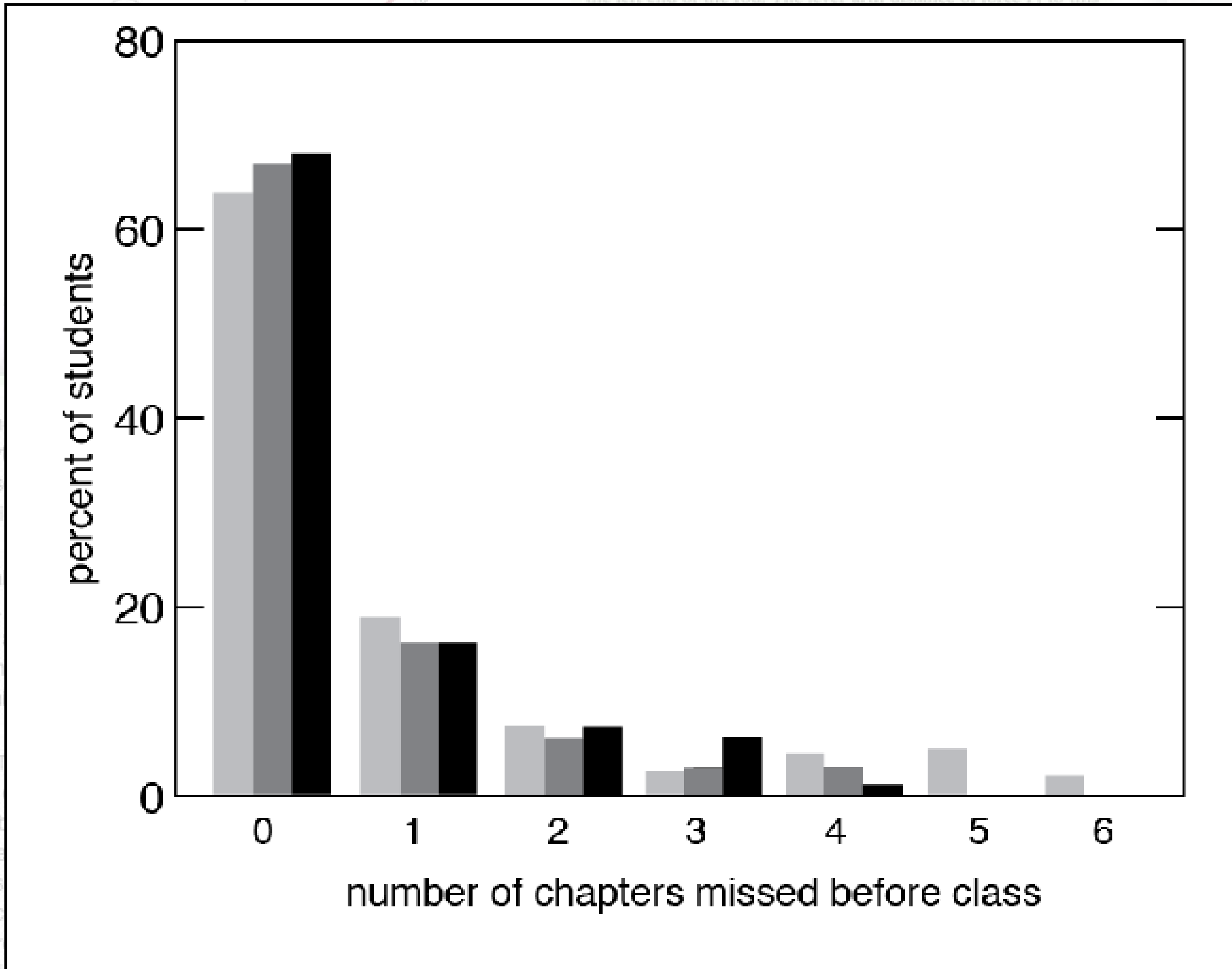
Intrinsic:

- social interaction
- tie-in to in-class activity

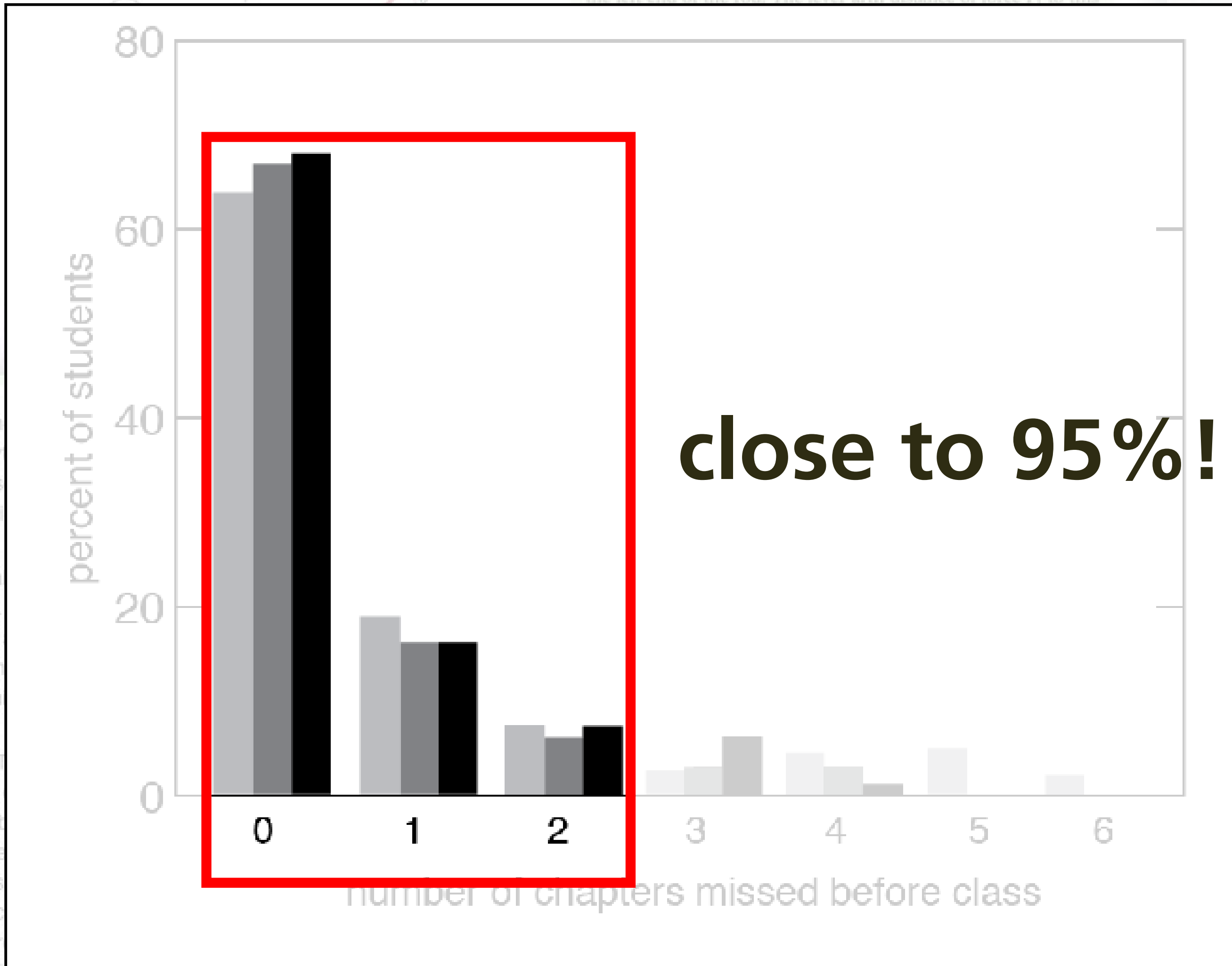
Extrinsic:

- assessment (fully automated)

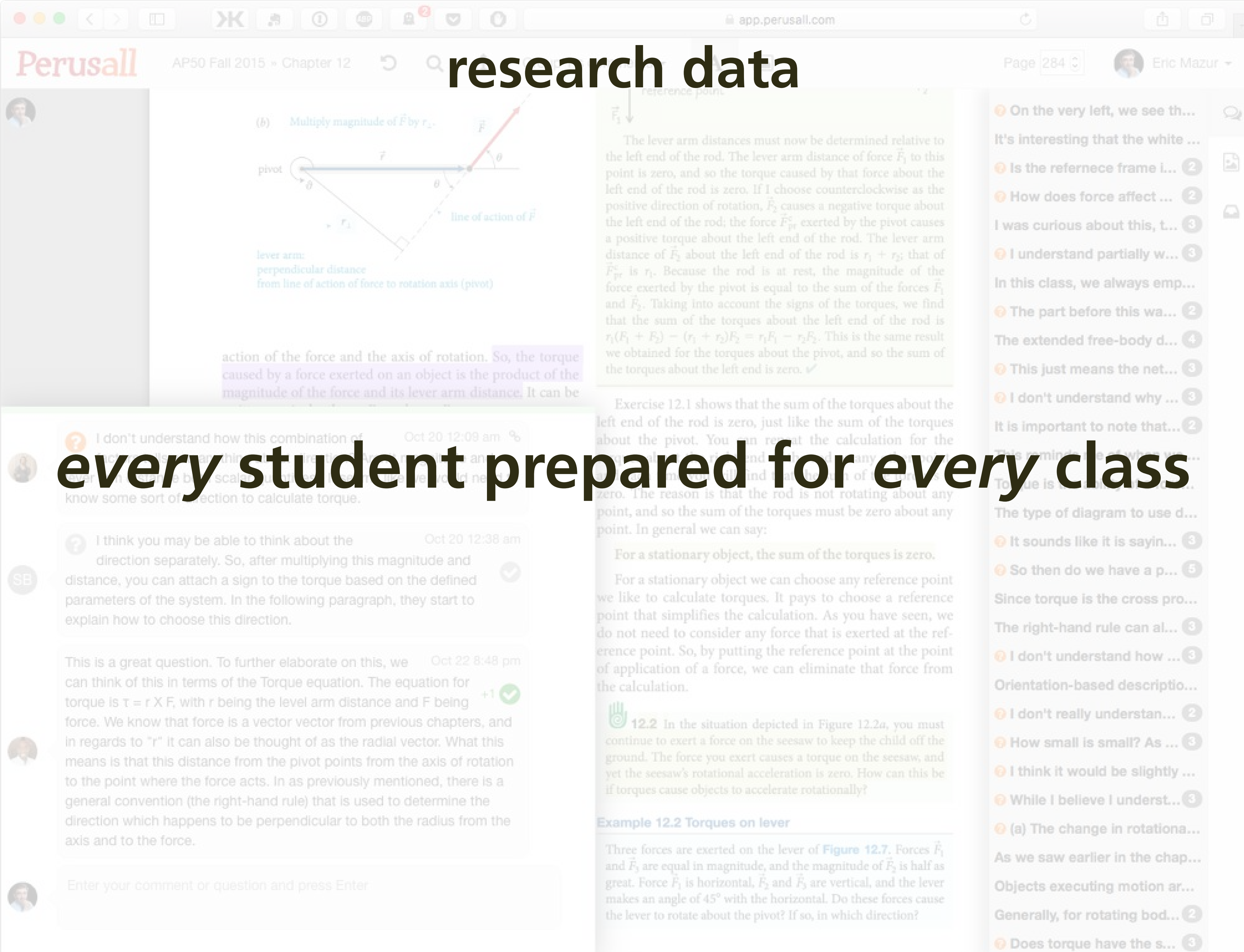
research data



research data



research data



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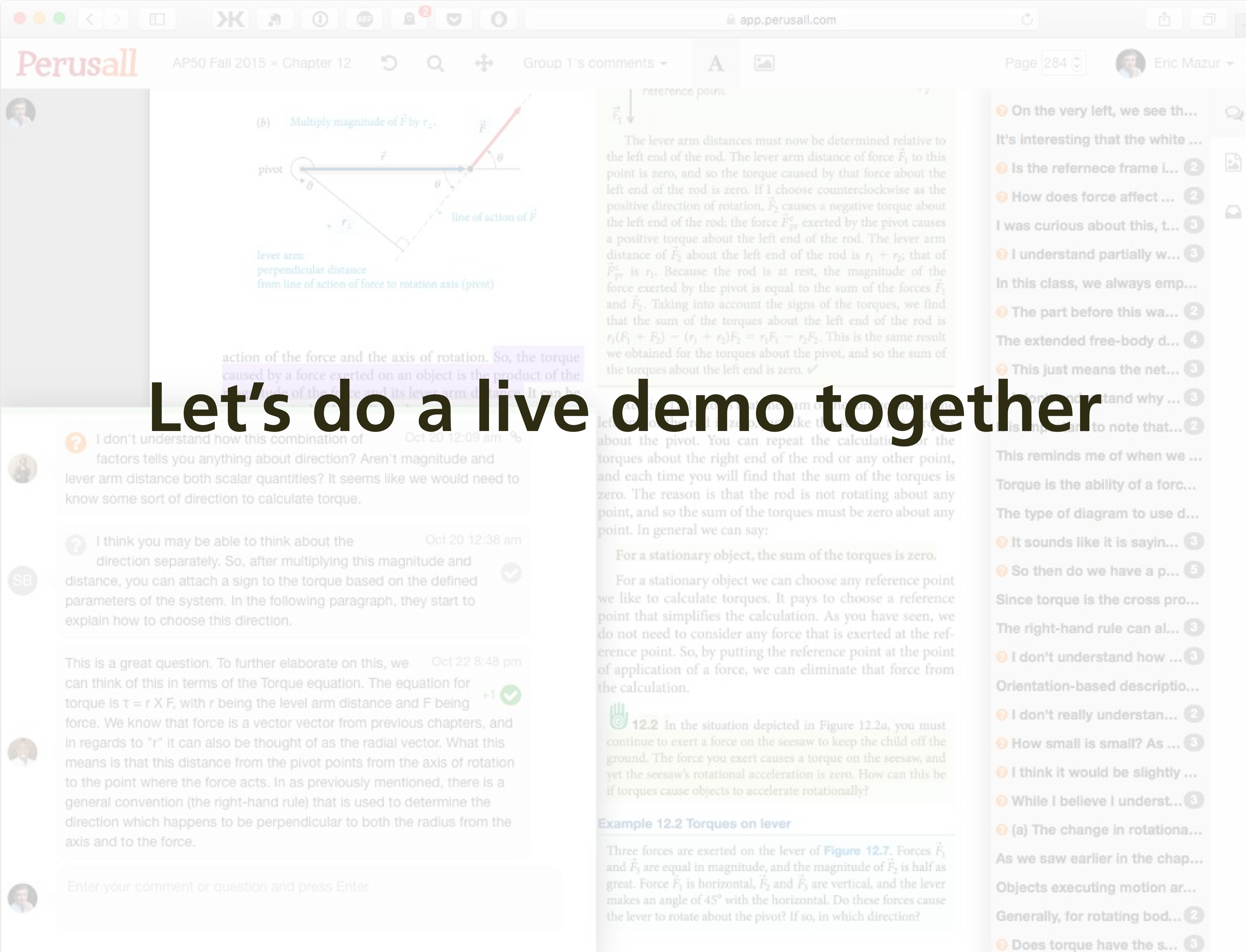
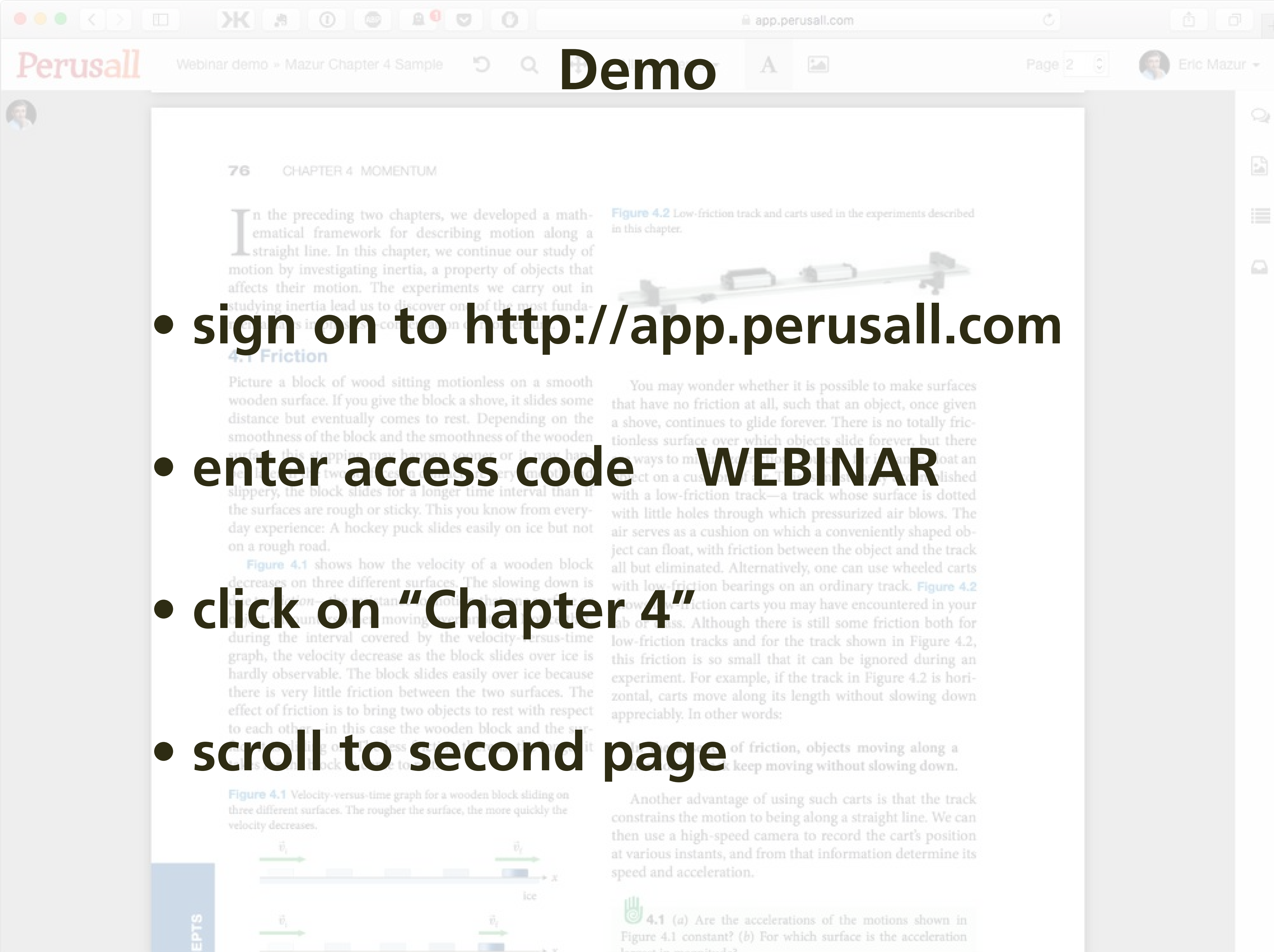


Demo



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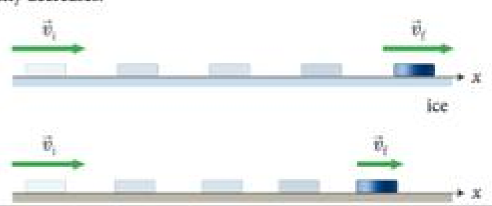
In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study of motion by investigating inertia, a property of objects that affects their motion. The experiments we carry out in studying inertia lead us to discover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



CEPTS

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

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

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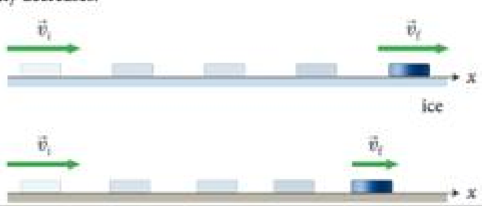

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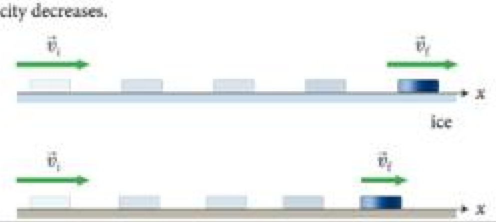

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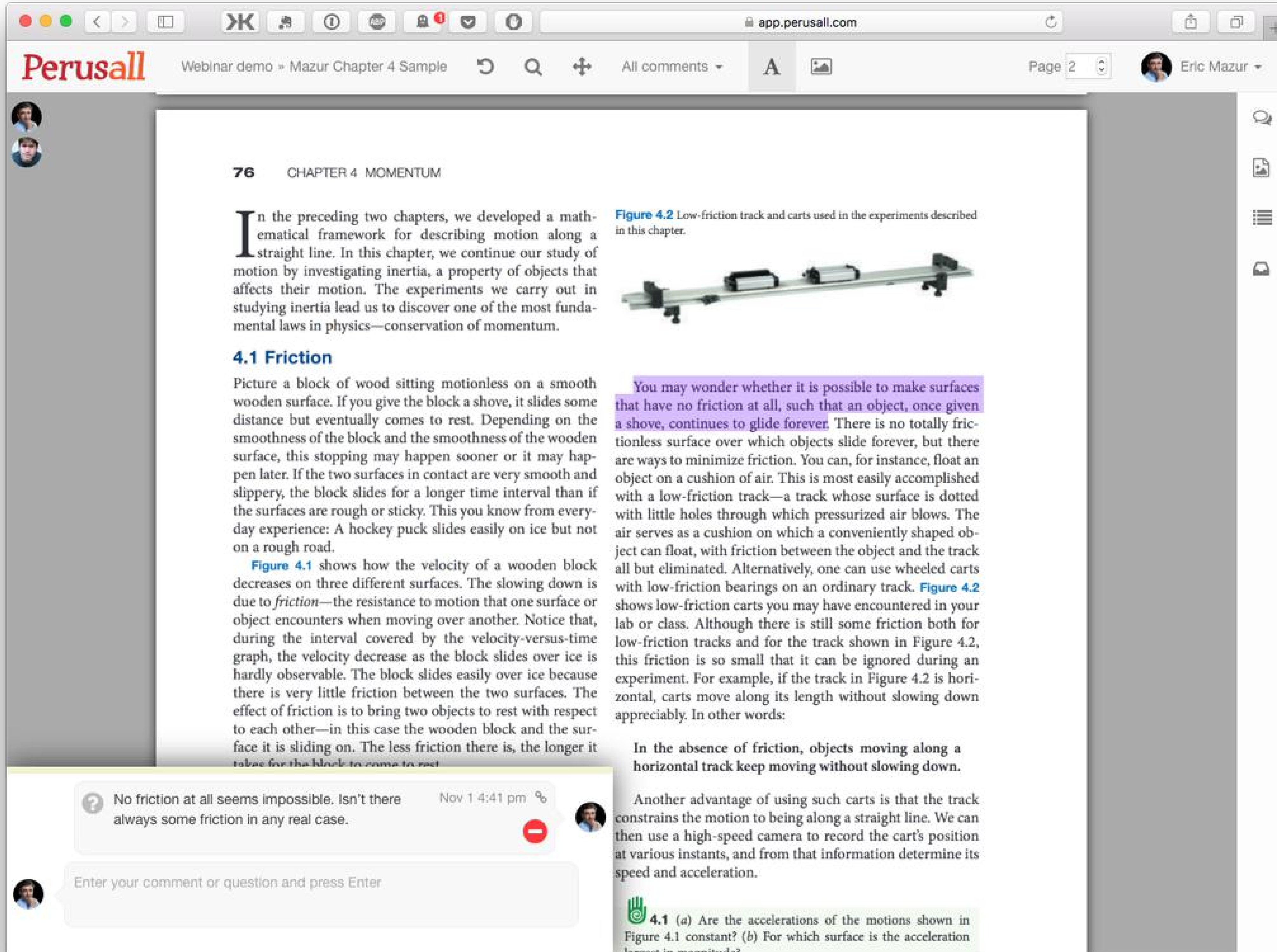
CEPTS



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Click to request an answer

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

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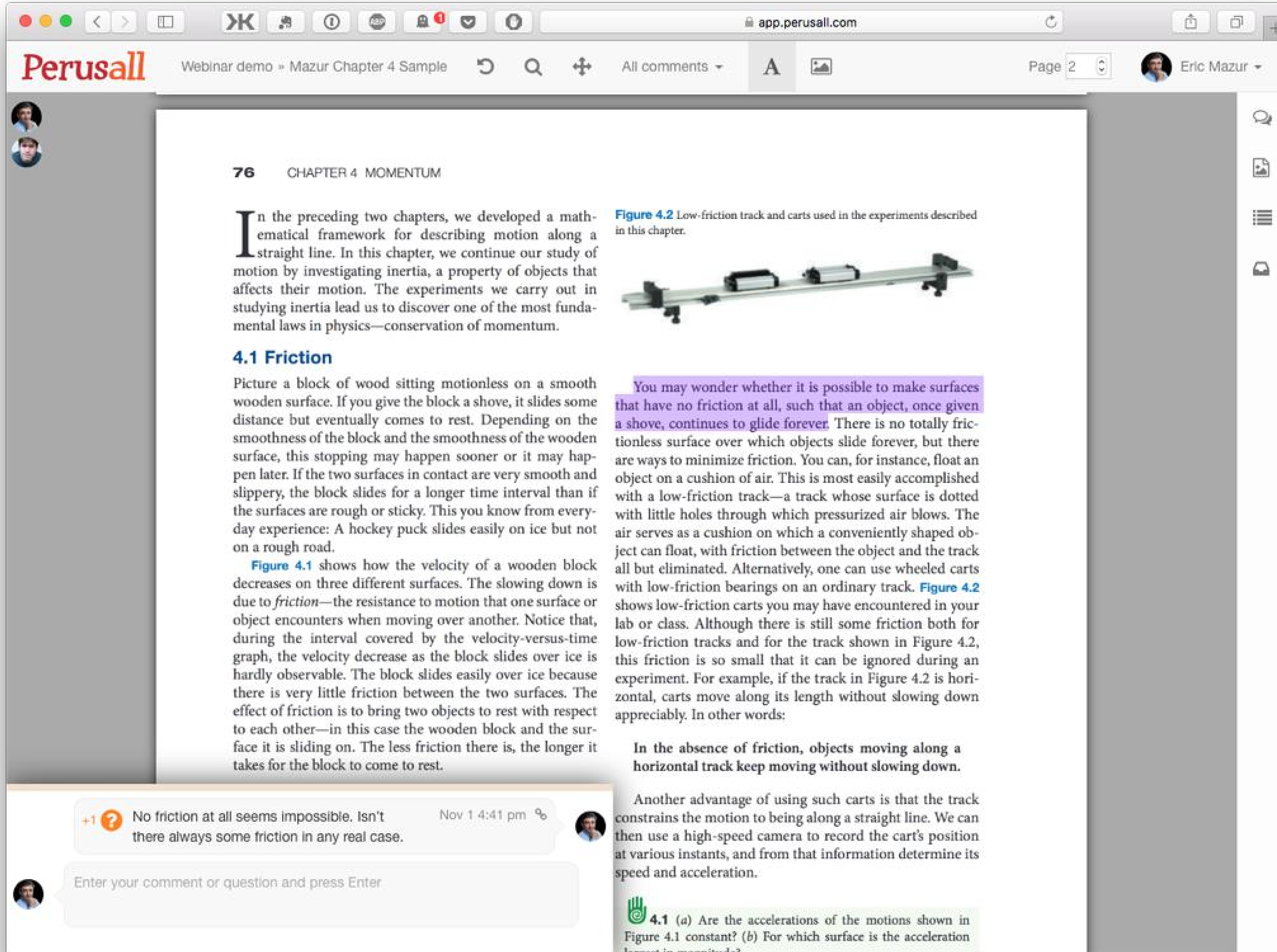
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Eric Mazur
76 CHAPTER 4 MOMENTUM
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+1 No friction at all seems impossible. Isn't there always some friction in any real case.
Nov 1 4:41 pm
Enter your comment or question and press Enter

Example 4.5 Bullet and bowling ball

Compare the magnitude of the momenta of a 0.010-kg bullet fired from a rifle at 1300 m/s and a 6.5-kg bowling ball lumbering across the floor at 4.0 m/s.

❶ GETTING STARTED Momentum is the product of inertia and velocity. I have to calculate this quantity for both the bullet and the bowling ball and then compare the resulting values.

❷ DEVISE PLAN Equation 4.6 gives the momentum of an object. To determine the magnitude of the momentum of an object, I must take the product of the inertia m and the speed v: $p = mv$.

❸ EXECUTE PLAN Substituting the values given in the problem statement, I get

$$p_{\text{bullet}} = (0.010\ \text{kg})(1300\ \text{m/s}) = 13\ \text{kg}\cdot\text{m/s}\ ✔$$

$$p_{\text{bowling}} = (6.5\ \text{kg})(4.0\ \text{m/s}) = 26\ \text{kg}\cdot\text{m/s}.\ ✔$$

❹ EVALUATE RESULT Surprisingly, the magnitudes of the momenta are very close! I have no way of evaluating momenta because I don't have much experience yet with this quantity. However, the bullet has less inertia and a high speed and the bowling ball has greater inertia and a low speed, so it is not unreasonable that the product of these quantities is similar.

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With the definition of momentum, we can rewrite Eq. 4.5 in the form

$$p_{\text{u}x,\text{f}} - p_{\text{u}x,\text{i}} + p_{\text{s}x,\text{f}} - p_{\text{s}x,\text{i}} = 0. \tag{4.8}$$

If we write $\Delta p_{\text{u}x} \equiv p_{\text{u}x,\text{f}} - p_{\text{u}x,\text{i}}$ and $\Delta p_{\text{s}x} \equiv p_{\text{s}x,\text{f}} - p_{\text{s}x,\text{i}}$, Eq. 4.8 takes on the beautifully simple form

$$\Delta p_{\text{u}x} + \Delta p_{\text{s}x} = 0. \tag{4.9}$$

This equation means that, whenever an object of unknown inertia collides with the inertial standard, the changes in the x components of the momenta of the two objects add up to zero. In other words, the change in the x component of the momentum for one object is always the negative of the change for the other.

Example 4.6 Collisions and momentum changes

(*a*) A red cart with an initial speed of 0.35 m/s collides with a stationary standard cart ($m_s = 1.0$ kg). After the collision, the standard cart moves away at a speed of 0.38 m/s. What is the momentum change for each cart? (*b*) The experiment is repeated with a blue cart, and now the final speed of the standard cart is 0.31 m/s. What is the momentum change for each cart in this second collision? (*c*) If in the collisions $v_{r\,x,f} = +0.032$ m/s and $v_{b\,x,f} = -0.039$ m/s, what are the inertias of the red and the blue carts?

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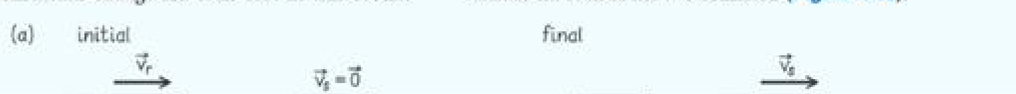
Figure 4.18



Right - I think there will always be some friction due to the second law of thermodynamics.

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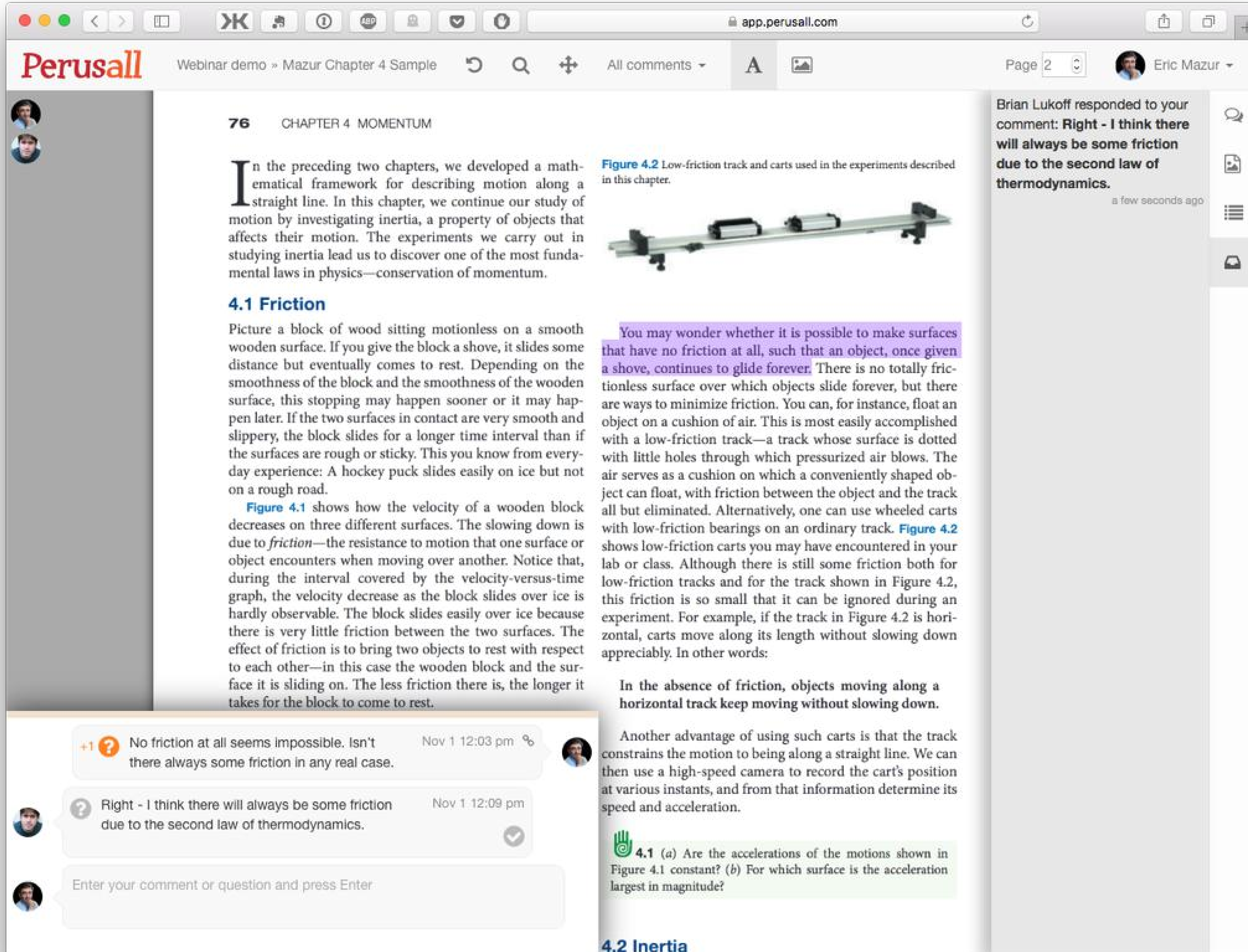

In the preceding two chapters, we developed a mathematical framework for describing motion along a straight line. In this chapter, we continue our study of motion by investigating inertia, a property of objects that affects their motion. The experiments we carry out in studying inertia lead us to discover 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 4.2 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.

4.1 (*a*) Are the accelerations of the motions shown in Figure 4.1 constant? (*b*) For which surface is the acceleration largest in magnitude?

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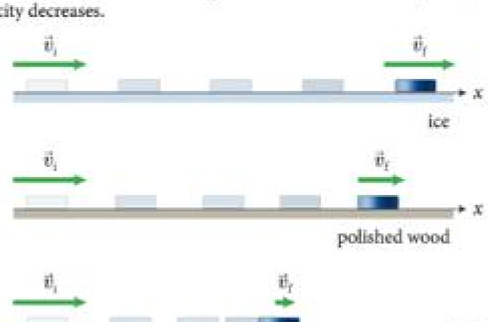

CONCEPTS

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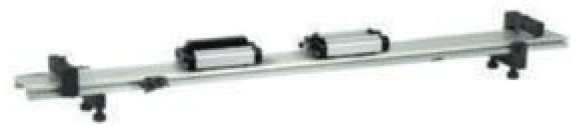

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4.2 Inertia

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Annotate some text

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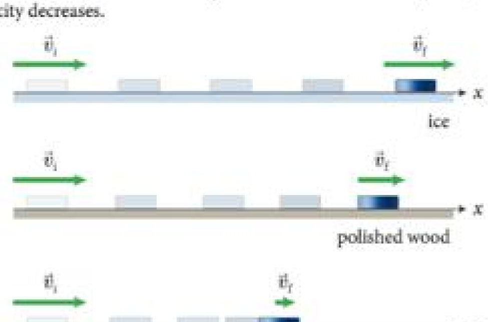

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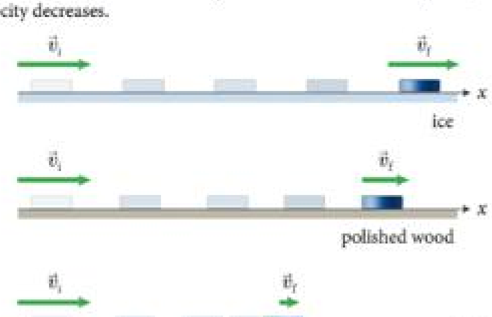

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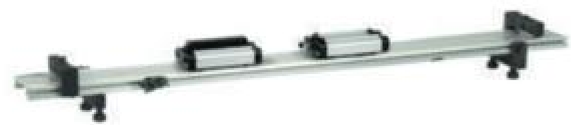

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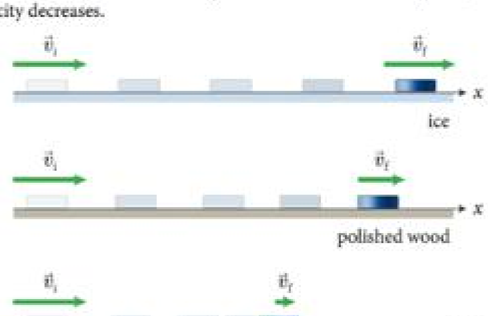
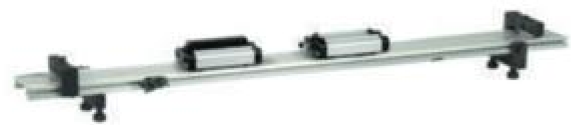


CONCEPTS

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.

4.1 (*a*) Are the accelerations of the motions shown in Figure 4.1 constant? (*b*) For which surface is the acceleration largest in magnitude?

4.2 Inertia

Try this:

1. post a question

2. answer someone else’s question

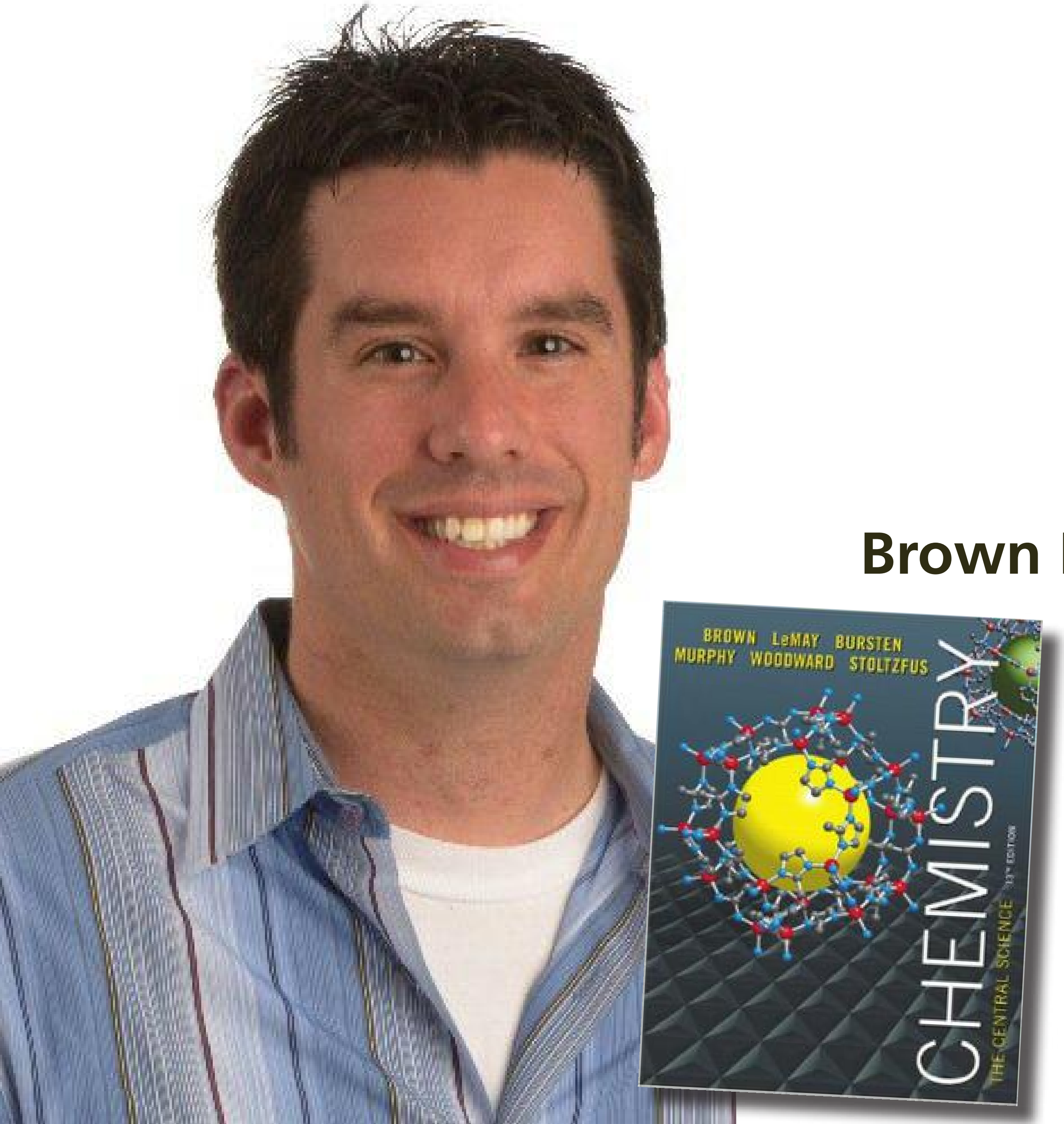
3. check email and try out email interface

CHEM1210: General Chemistry

Matt Stoltzfus
Ohio State University

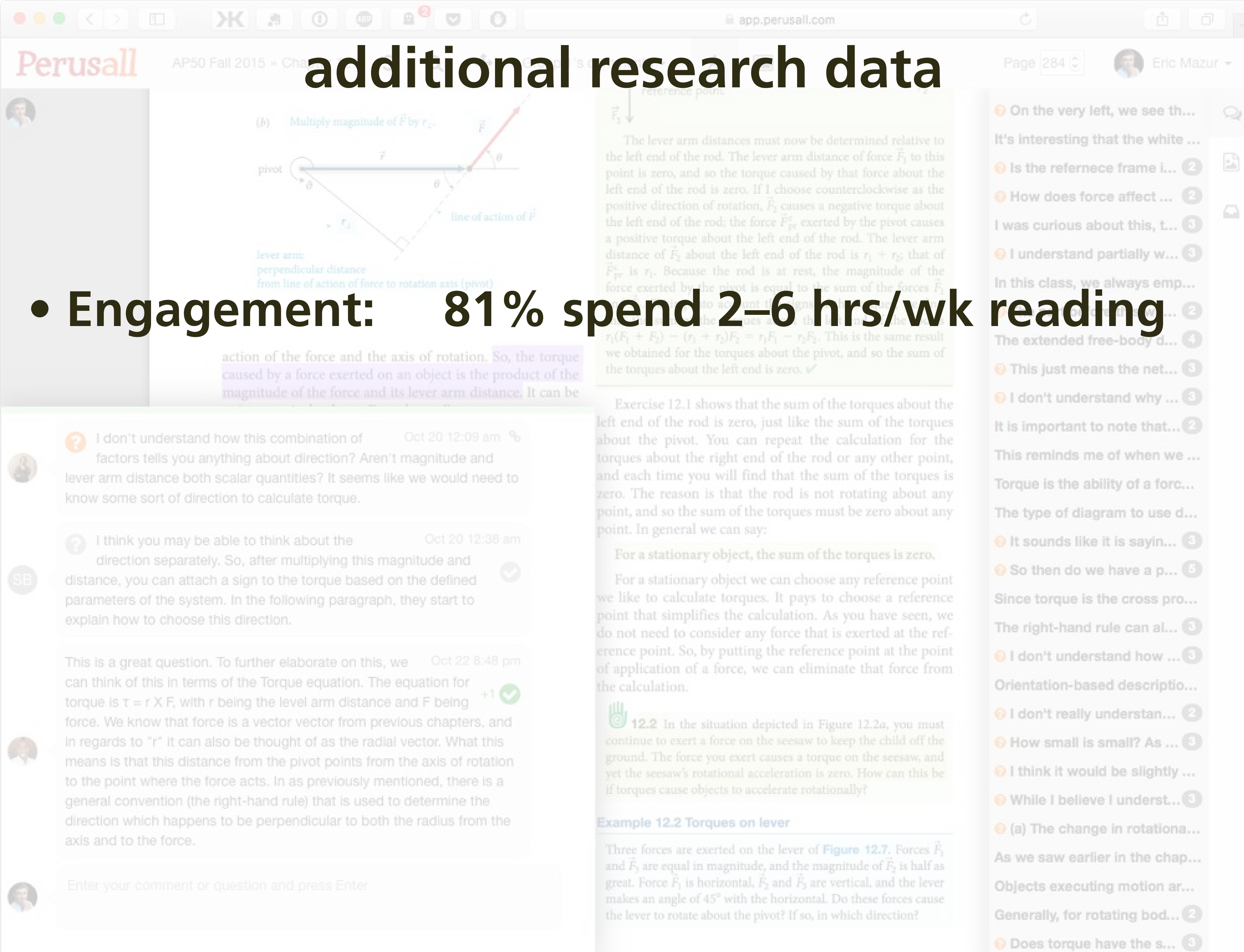
525 students

Brown Lemay 13th ed (Pearson)



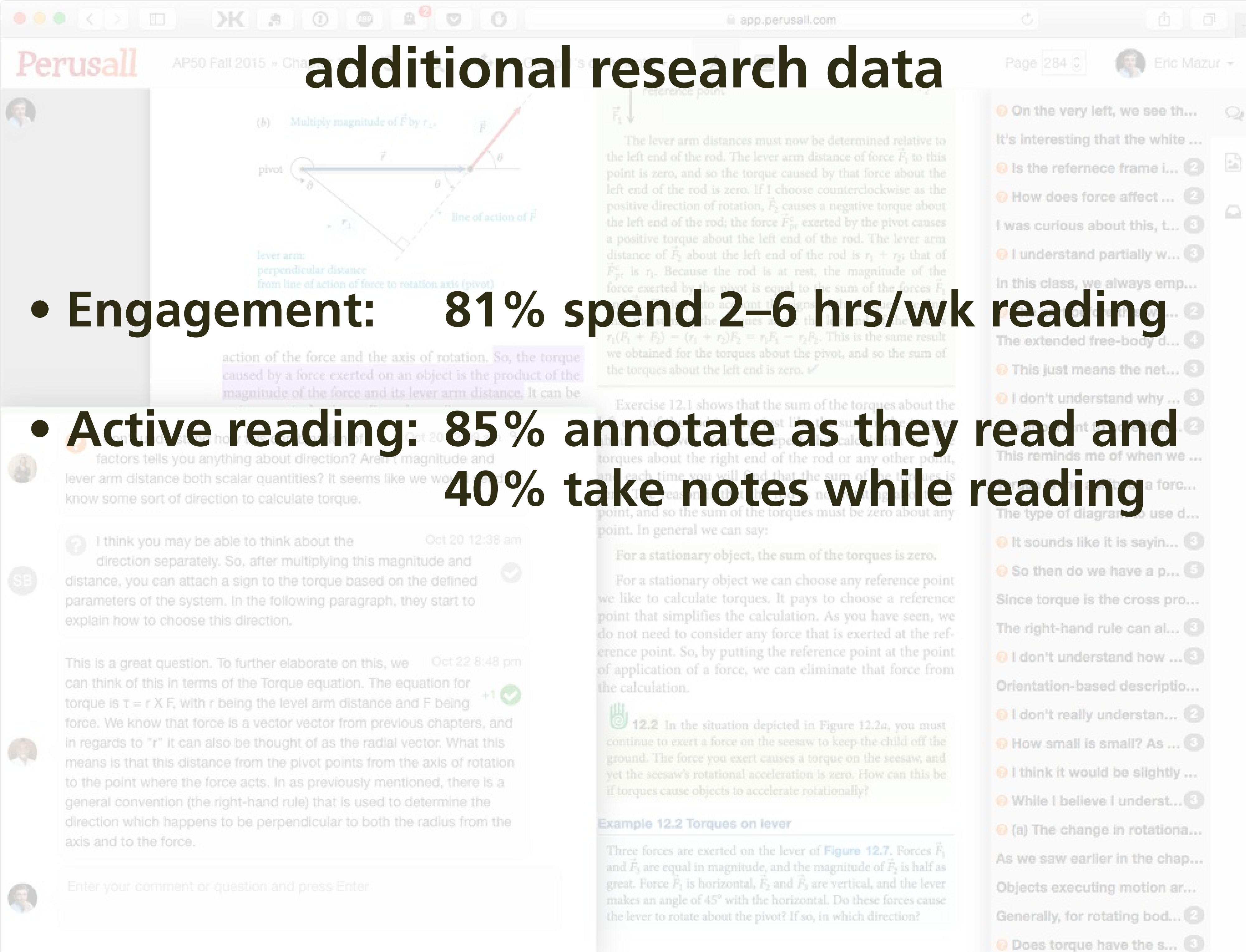
additional research data

- **Engagement: 81% spend 2–6 hrs/wk reading**



additional research data

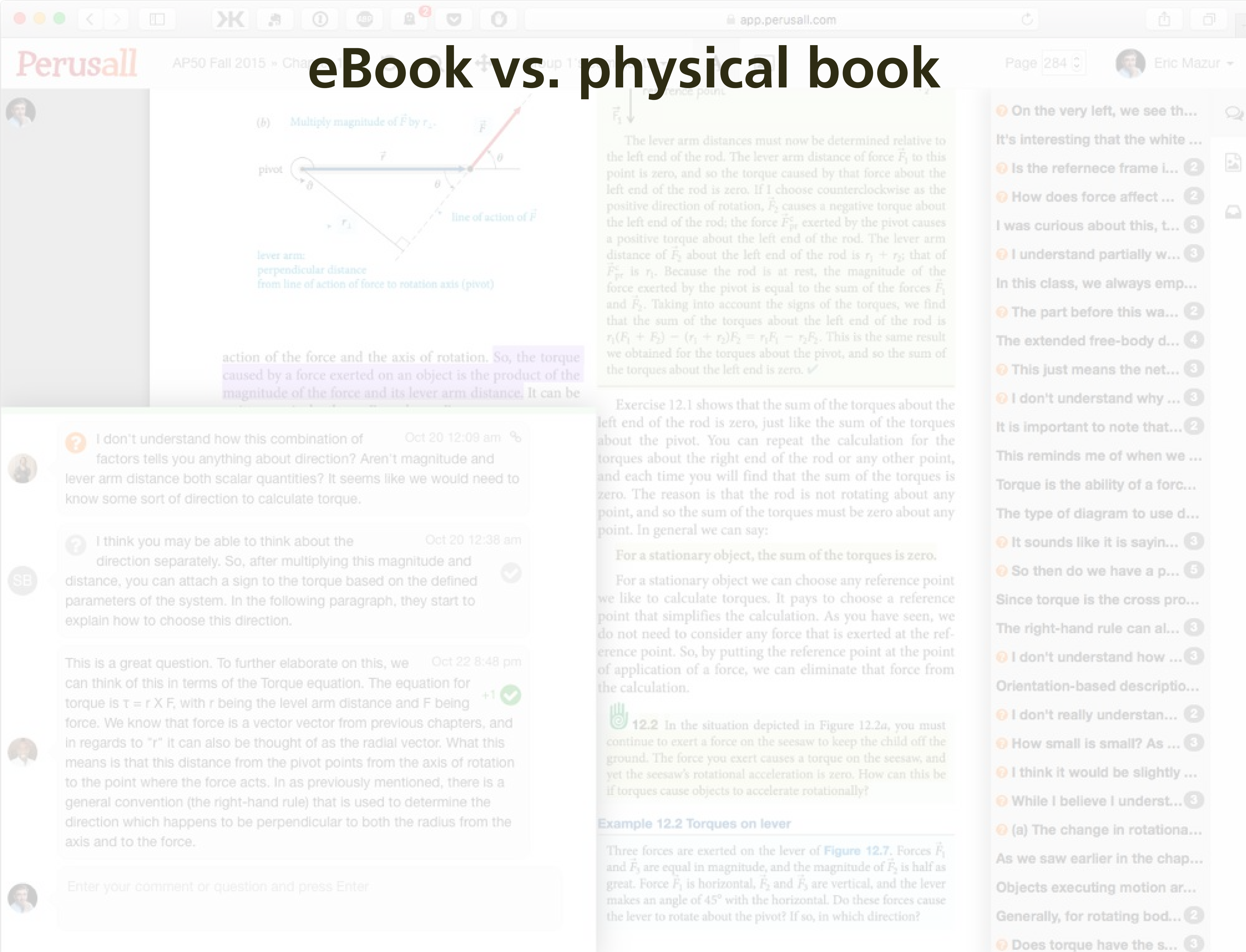
- **Engagement:** 81% spend 2–6 hrs/wk reading
- **Active reading:** 85% annotate as they read and
  40% take notes while reading



additional research data

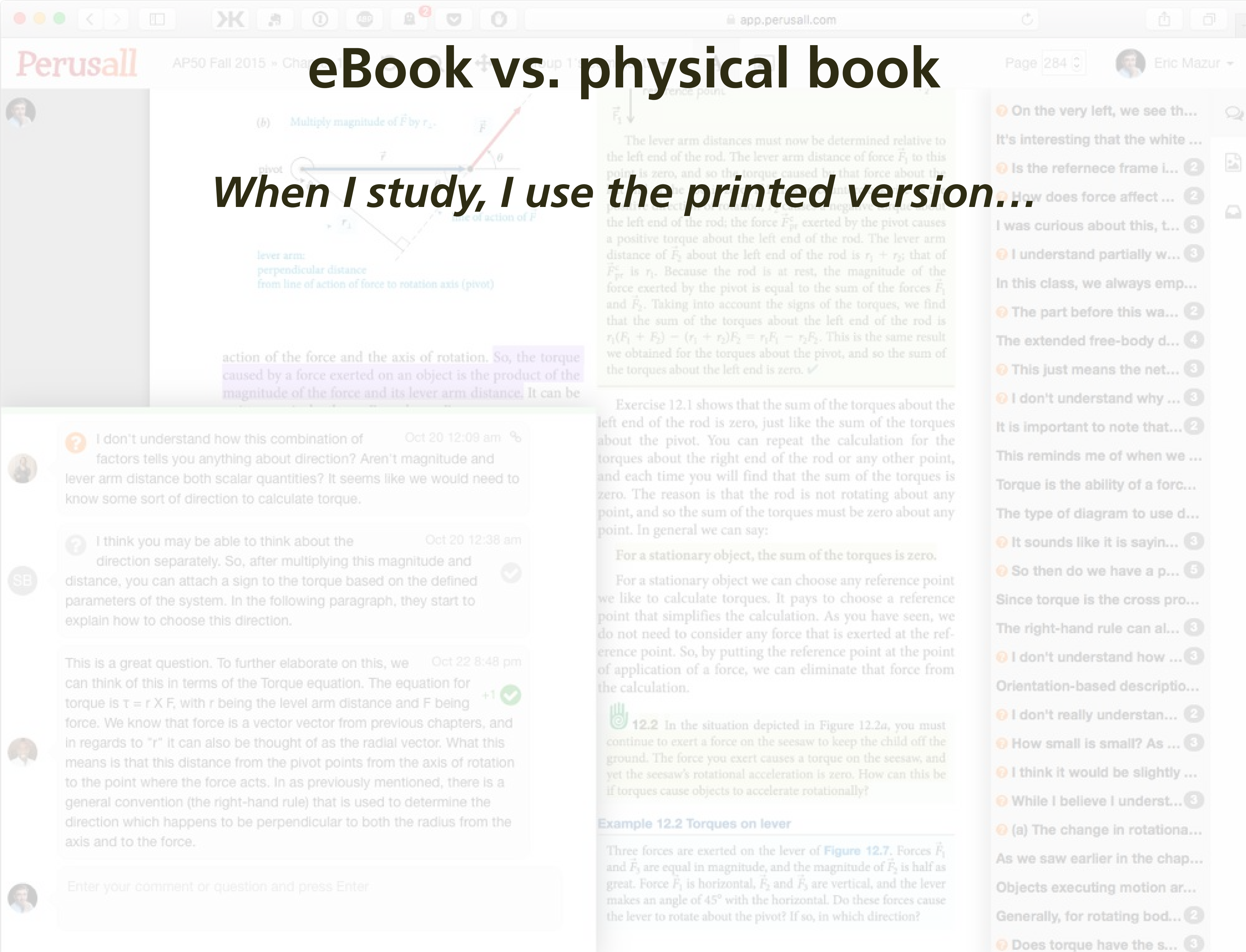
- **Engagement:** 81% spend 2–6 hrs/wk reading
- **Active reading:** 85% annotate as they read and 40% take notes while reading
- **Performance:** significantly higher scores

eBook vs. physical book



eBook vs. physical book

When I study, I use the printed version…



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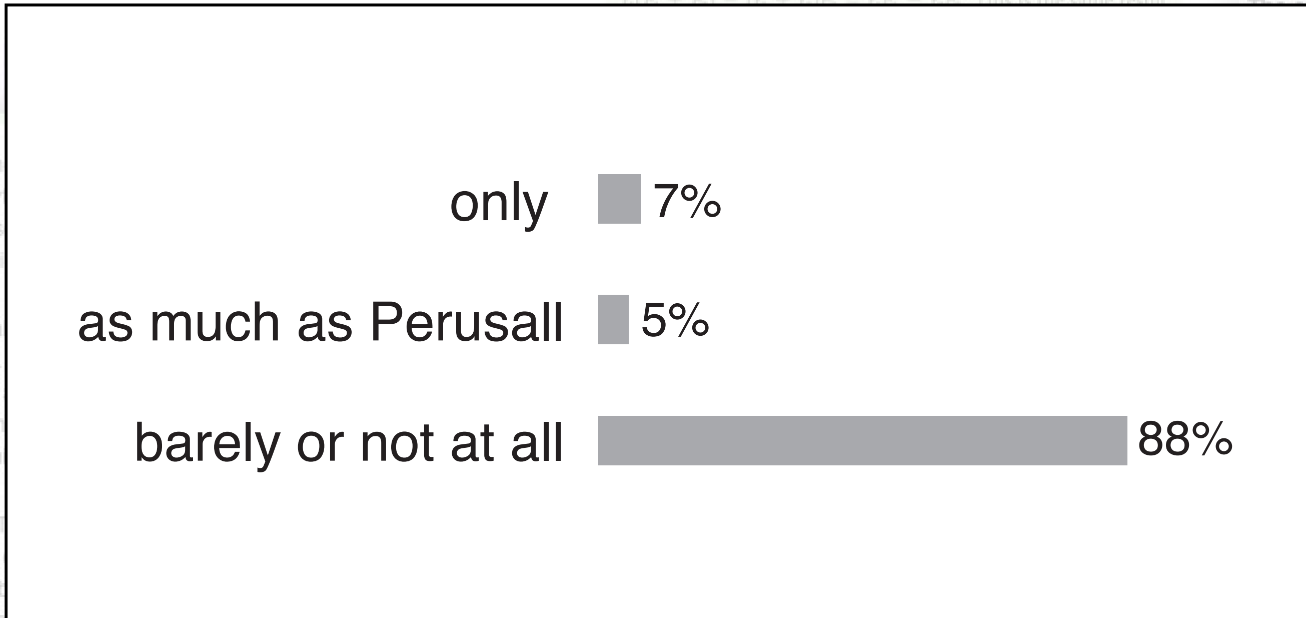
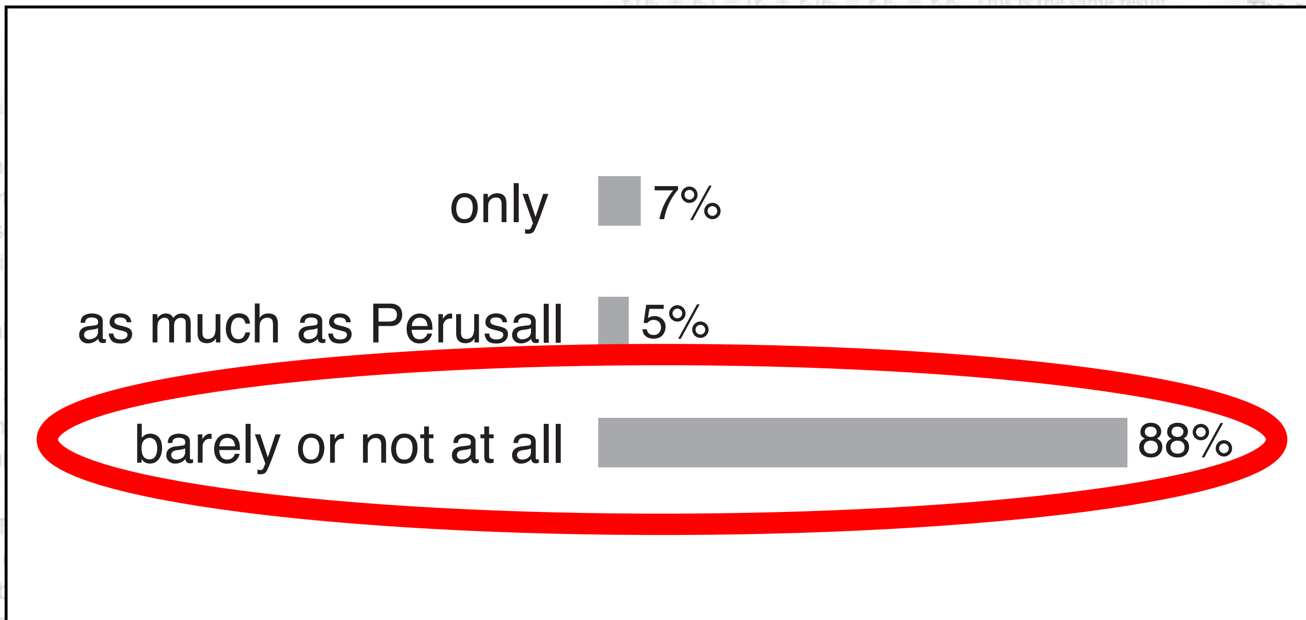


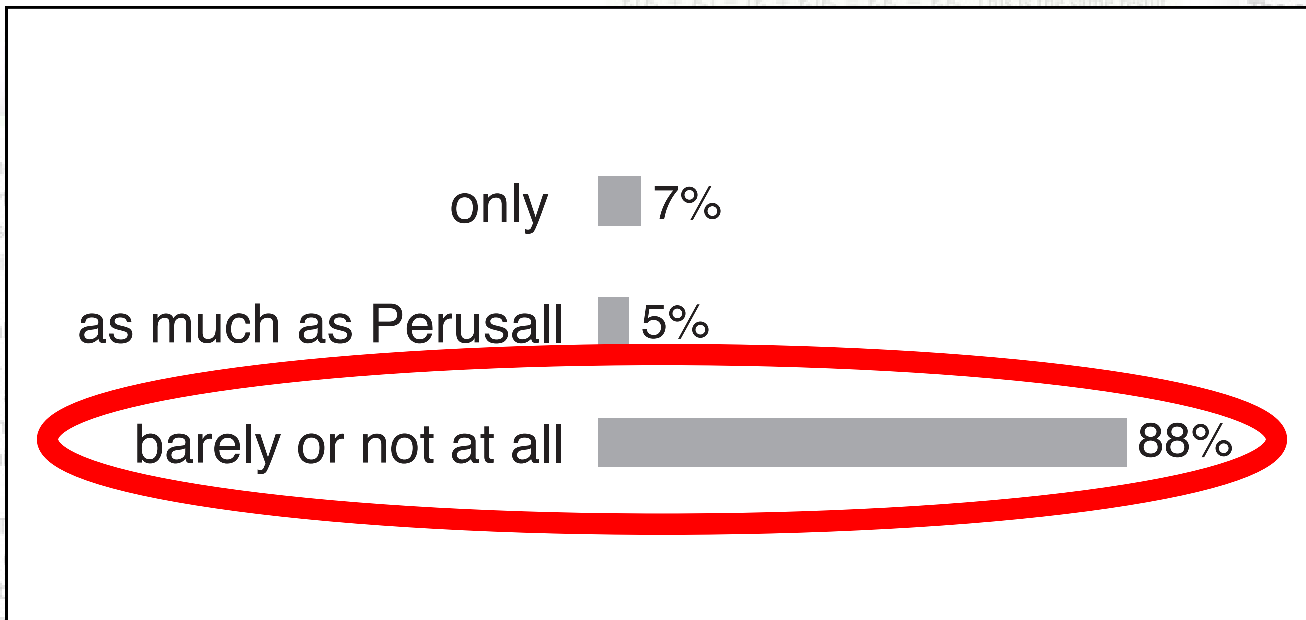
eBook vs. physical book

When I study, I use the printed version…



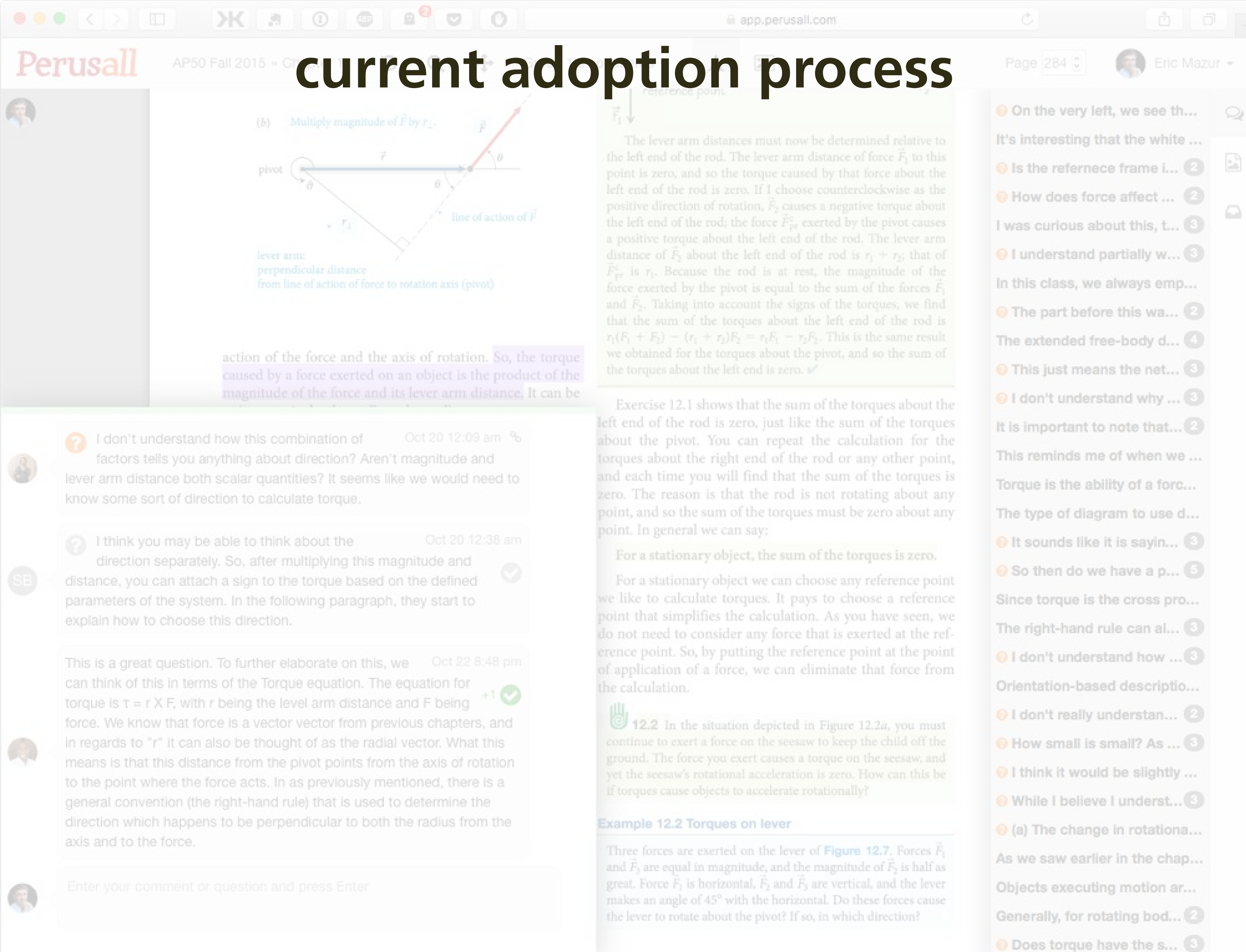
eBook vs. physical book

When I study, I use the printed version…



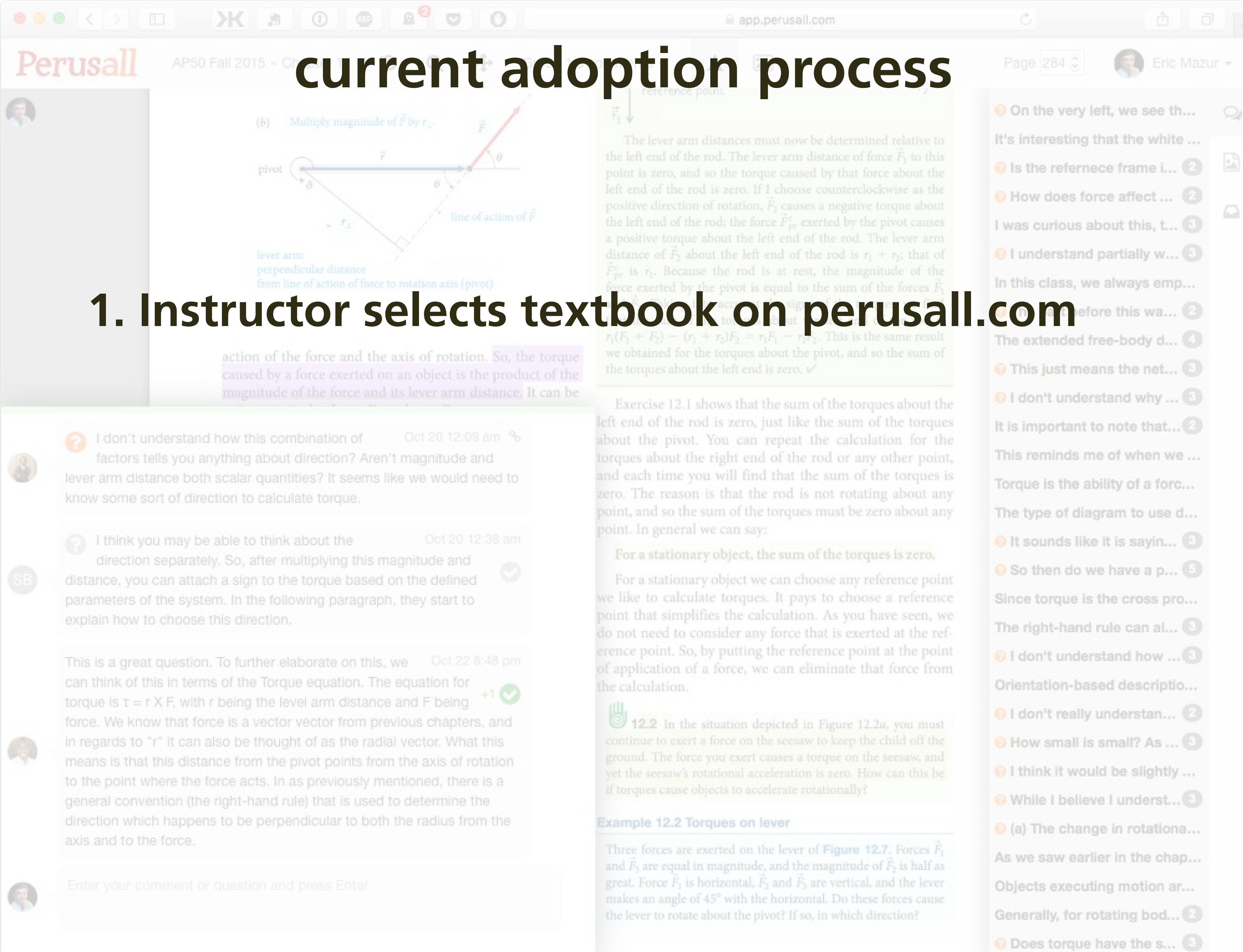
can eliminate printed books!

current adoption process



current adoption process

1. Instructor selects textbook on perusall.com

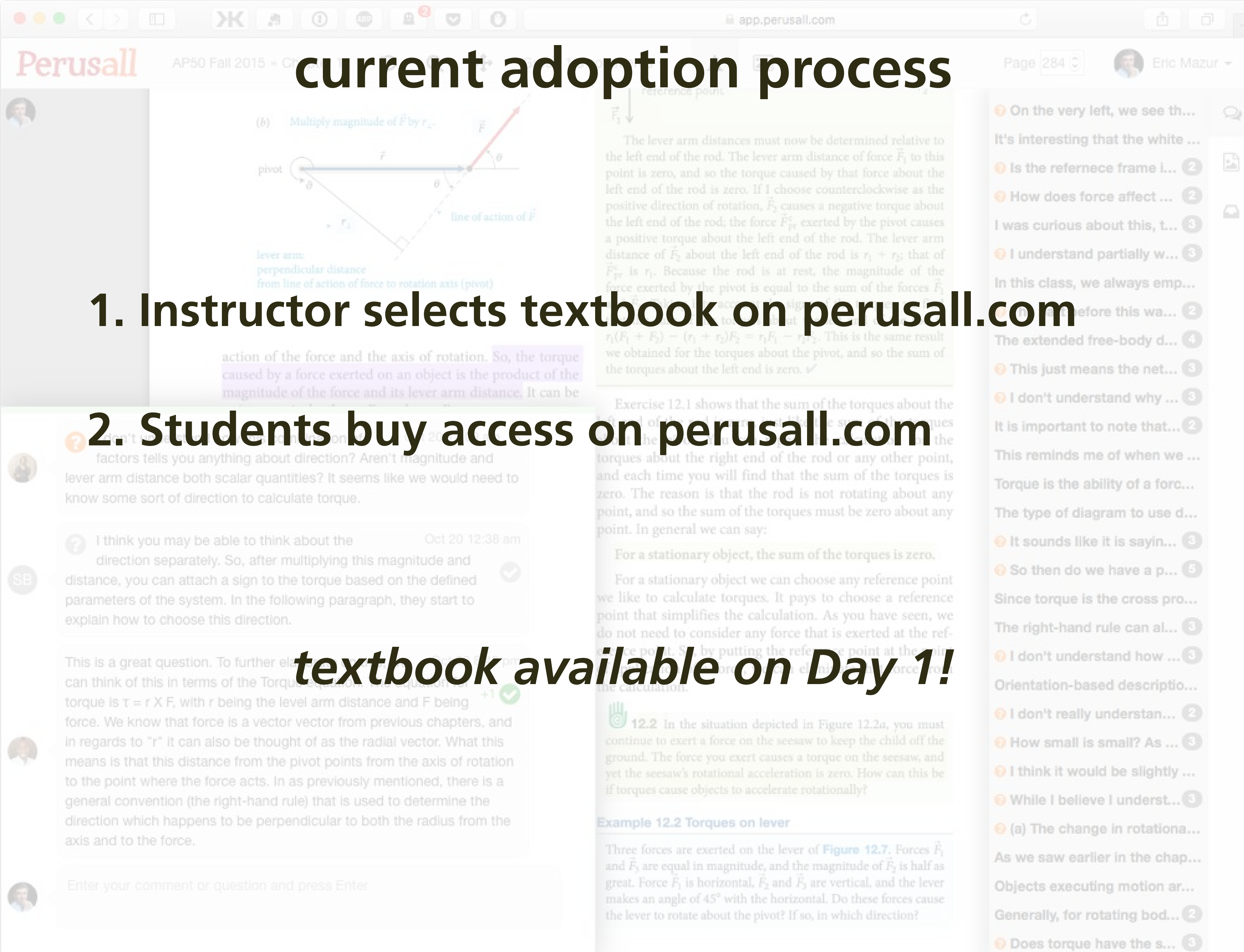


current adoption process

1. Instructor selects textbook on perusall.com

2. Students buy access on perusall.com

current adoption process



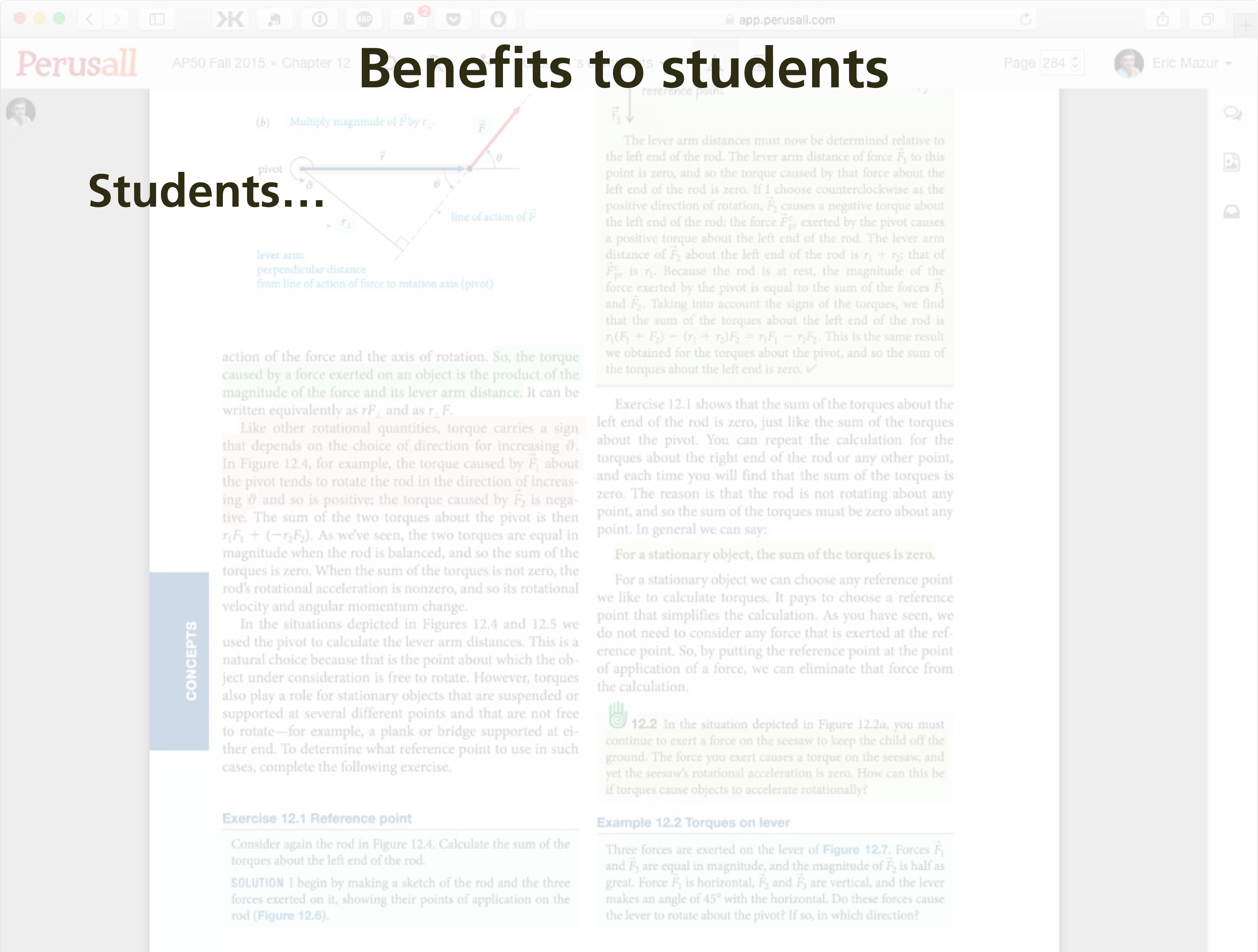
1. **Instructor selects textbook on perusall.com**

2. **Students buy access on perusall.com**

textbook available on Day 1!

Benefits to students

Students…



Benefits to students

Students…

- read the textbook

Benefits to students

Students…

- read the textbook
- learn how to read

Benefits to students

Students…

- read the textbook
- learn how to read
- learn how to read critically

Benefits to students

Students…

- read the textbook
- learn how to read
- learn how to read critically
- participate in a collaborative experience

Benefits to students

Students…

- read the textbook
- learn how to read
- learn how to read critically
- participate in a collaborative experience
- get more out of their classes

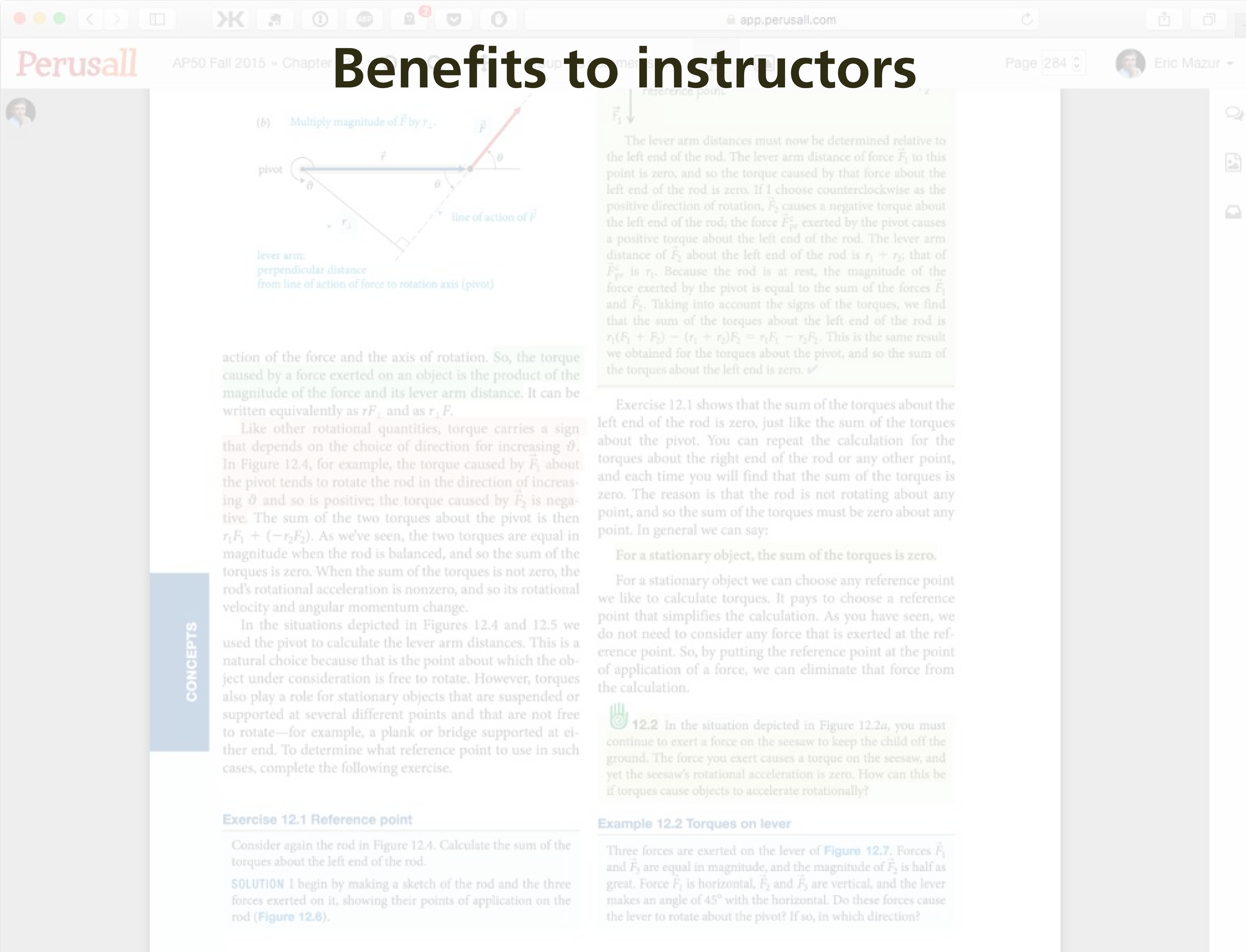
Benefits to students

Students…

- read the textbook
- learn how to read
- learn how to read critically
- learn how to study and work collaboratively
- get more out of their classes

transferable skills

Benefits to instructors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(b) Multiply magnitude of $\vec{F}$ by $r_\perp$.

pivot

line of action of $\vec{F}$

lever arm: perpendicular distance from line of action of force to rotation axis (pivot)

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 $rF_\perp$ 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.

CONCEPTS

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 forces exerted on it, showing their points of application on the rod (Figure 12.6).

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 $\vec{F}^c_{pr}$ 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 $\vec{F}^c_{pr}$ 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.

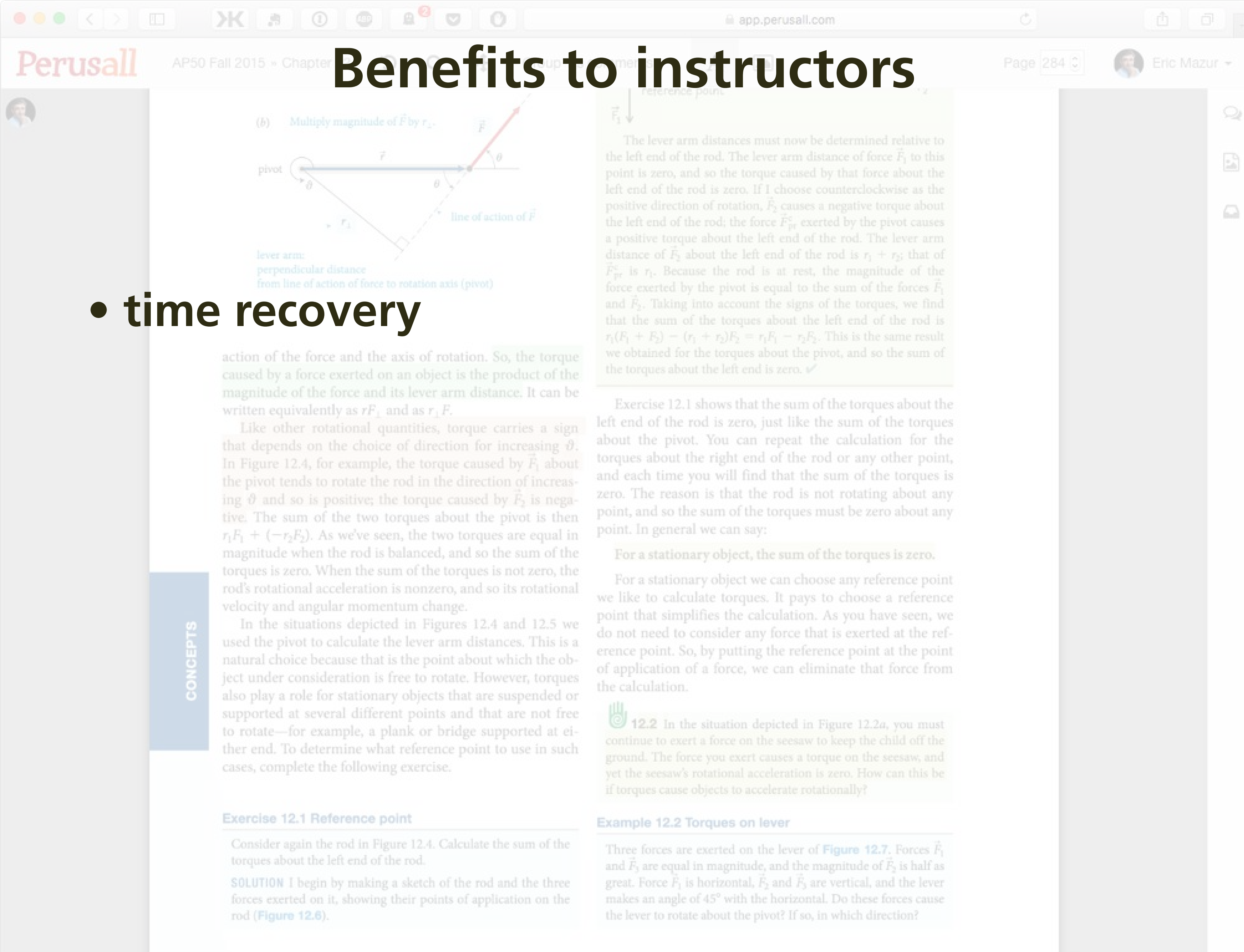
For a stationary object we can choose any reference point we like to calculate torques. It pays to choose a reference point that simplifies the calculation. As you have seen, we do not need to consider any force that is exerted at the reference point. So, by putting the reference point at the point of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

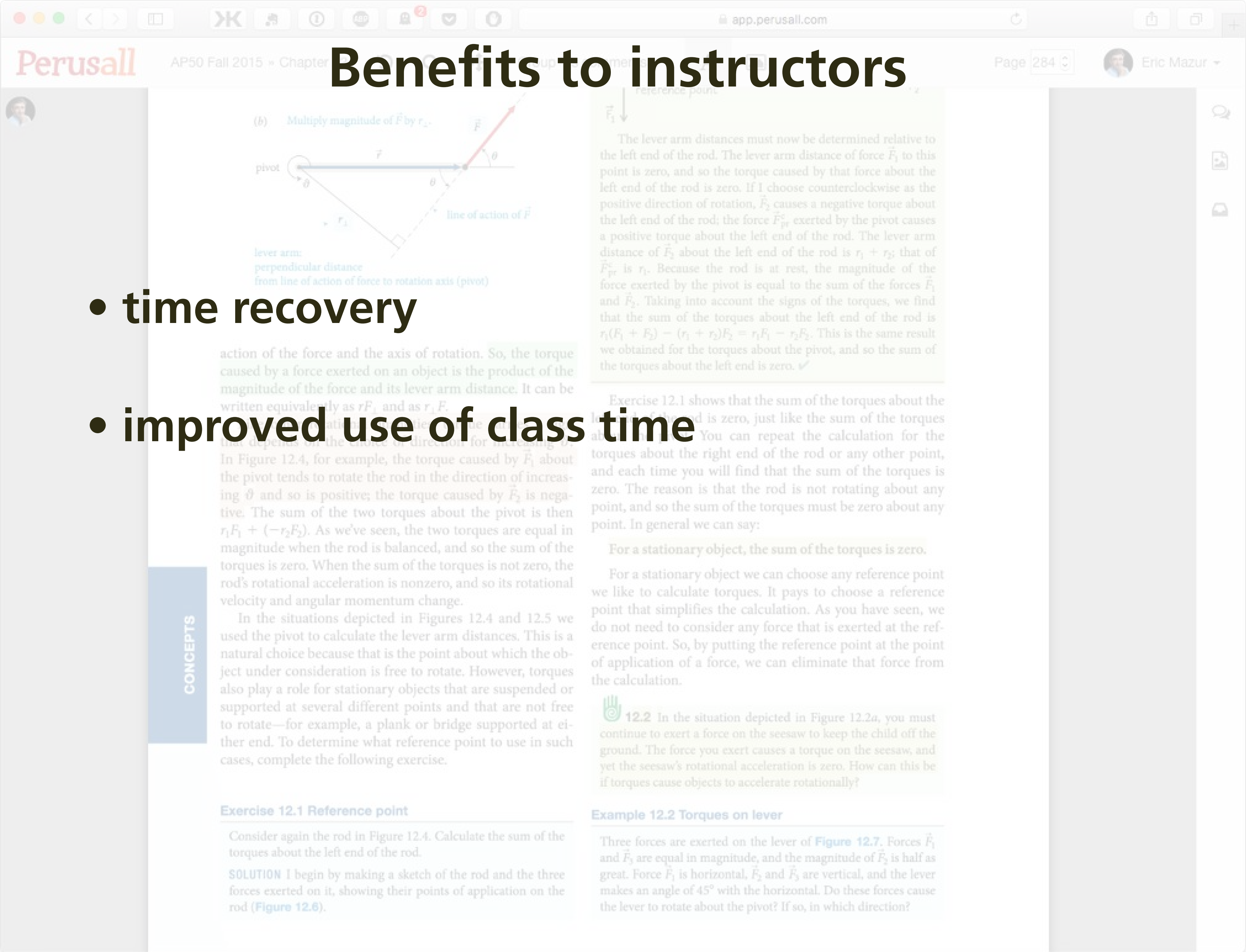
Three forces are exerted on the lever of Figure 12.7. Forces $\vec{F}_1$ and $\vec{F}_3$ are equal in magnitude, and the magnitude of $\vec{F}_2$ is half as great. Force $\vec{F}_1$ is horizontal, $\vec{F}_2$ and $\vec{F}_3$ are vertical, and the lever makes an angle of 45° with the horizontal. Do these forces cause the lever to rotate about the pivot? If so, in which direction?

Benefits to instructors



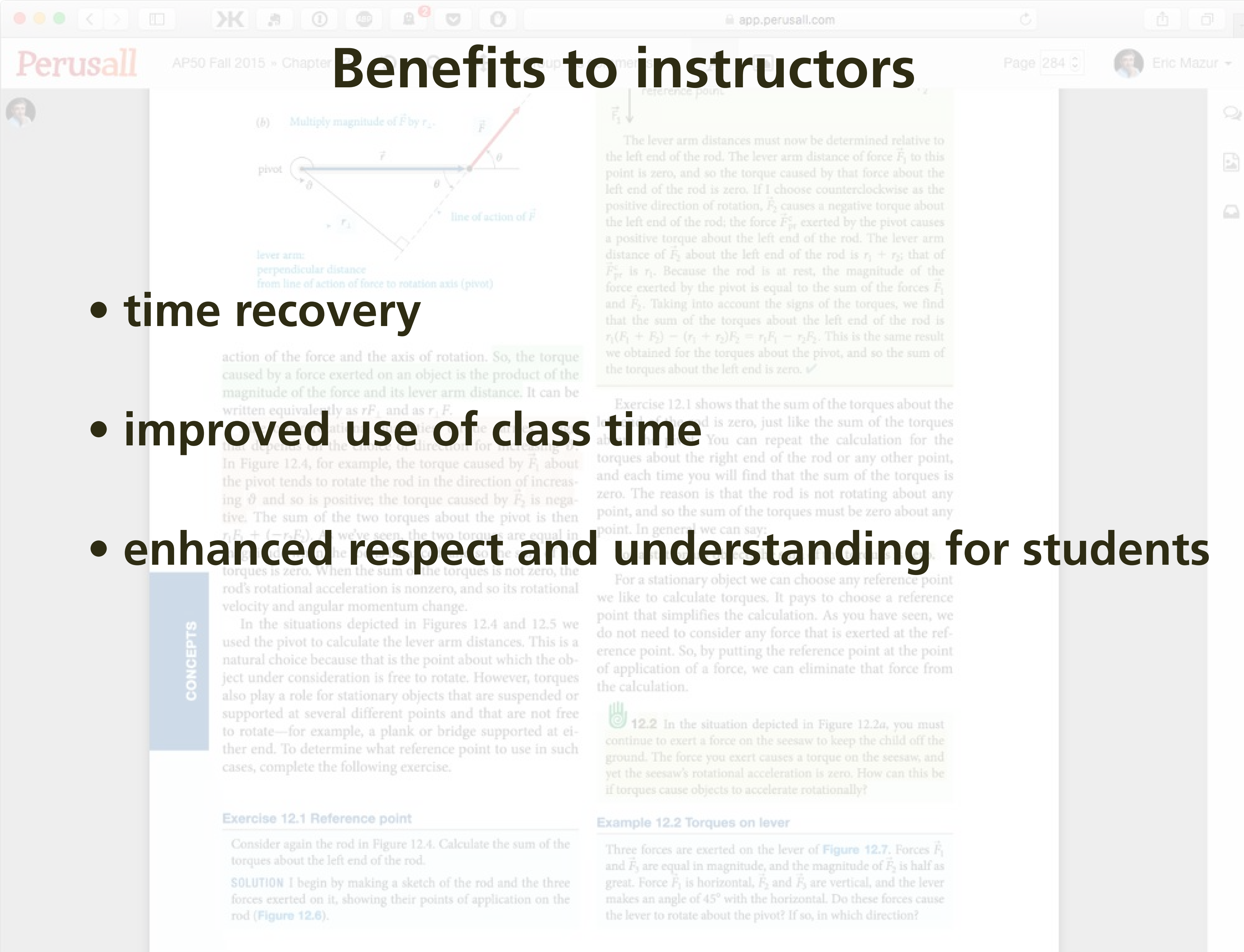
- time recovery

Benefits to instructors



- time recovery
- improved use of class time

Benefits to instructors

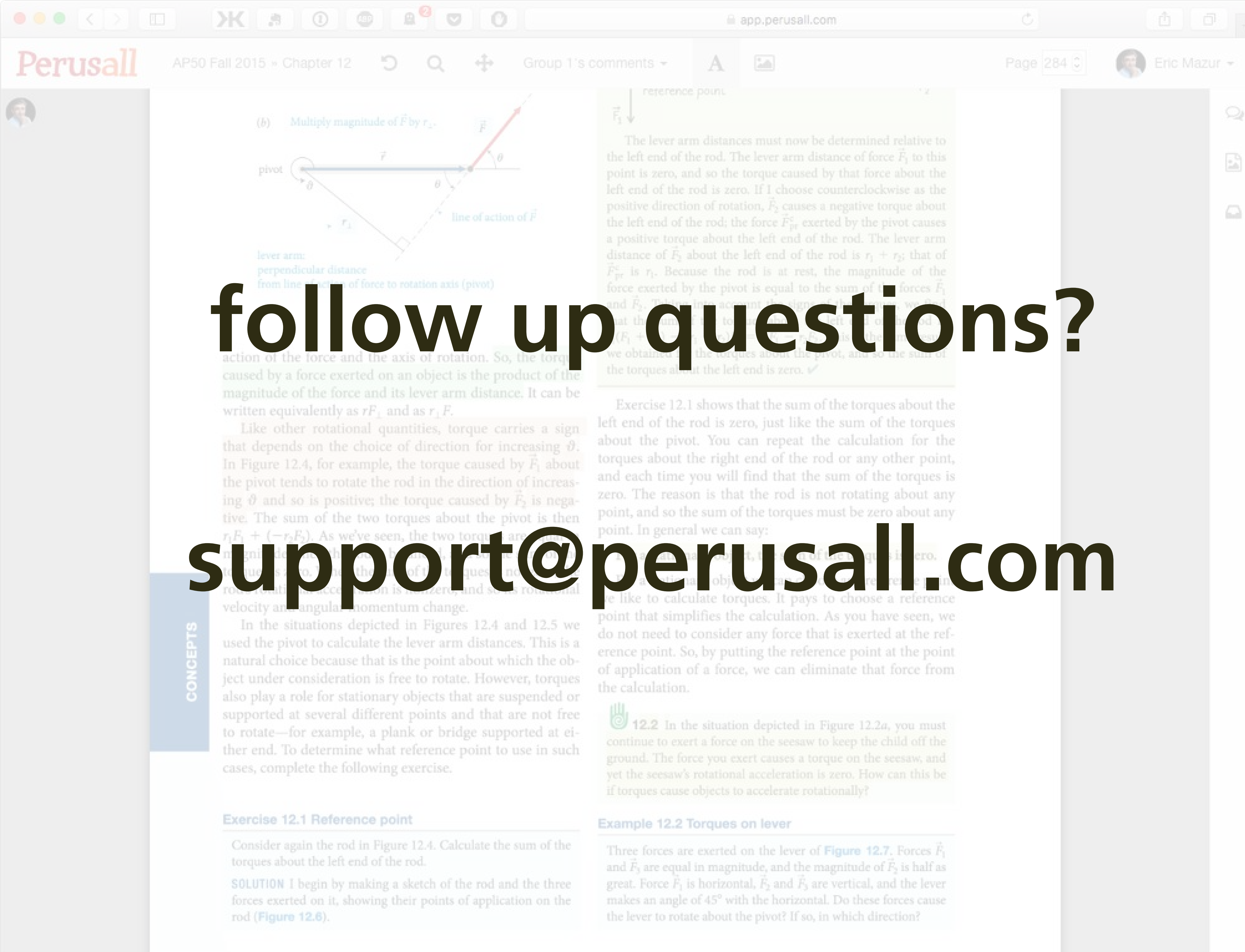


- time recovery
- improved use of class time
- enhanced respect and understanding for students

Benefits to instructors

- time recovery
- improved use of class time
- enhanced respect and understanding for students

all at no cost & no additional effort!



follow up questions?

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