

Electronic Supplemental Information: Student Experiences in a Flipped Physical
Chemistry Course

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Final Exam information

Table S1: The minimum score (min), median score, maximum score (max), mean and standard deviation of scores (Std Dev) from the Final Exams from each of the indicated semesters. The average without the Fall 2020 semester, which was delivered online, is also included at the bottom of the table.

| | Min | Median | Max | Mean | Std Dev |
|-----------------|------|--------|-------|------|---------|
| Fall 2017 | 16.0 | 59.8 | 91.0 | 59.3 | 16.7 |
| Fall 2018 | 22.3 | 74.1 | 97.0 | 72.2 | 16.9 |
| Spring 2019 | 22.3 | 74.1 | 97.0 | 72.2 | 16.9 |
| Fall 2019 | 29.3 | 77.0 | 100.0 | 76.2 | 18.1 |
| Fall 2020 | 20.0 | 72.6 | 100.0 | 71.1 | 20.4 |
| Fall 2021 | 22.8 | 69.0 | 100.0 | 68.2 | 16.6 |
| Spring 2022 | 29.0 | 74.3 | 97.0 | 71.0 | 16.5 |
| | | | | | |
| Average without | | | | | |
| FA2020 | 23.6 | 71.4 | 97.0 | 69.8 | 16.9 |

Table S2: Average percent of points awarded to each of the reoccurring types of questions that frequently appeared on the final exam. The frequently assigned questions included a statistical mechanics question (Stat Mech), a kinetics question, a heat cycle question, an electrochemistry question that includes using the Nernst equation (Electrochem), and an equilibrium question where students are required to include the effect of ions (Ion and Equilib). The average without the Fall 2020 semester, which was delivered online, is also included at the bottom of the table.

| | Stat Mech | Kinetics | Heat Cycle | Electrochem | Ion and Equilib |
|-----------------|-----------|----------|------------|-------------|-----------------|
| Fall 2017 | - | 18 | 68 | 65 | 80 |
| Fall 2018 | 78 | 60 | 71 | 92 | 80 |
| Spring 2019 | - | 55 | 72 | 80 | 84 |
| Fall 2019 | 86 | 59 | 74 | 91 | 81 |
| Fall 2020 | 83 | 34 | 75 | 86 | 80 |
| Fall 2021 | 93 | 30 | 71 | - | 86 |
| Spring 2022 | 94 | 72 | 66 | 85 | 68 |
| | | | | | |
| Average without | | | | | |
| FA2020 | 87 | 46 | 71 | 84 | 79 |

Student Reported YouTube Video Lecture Topics they Watched

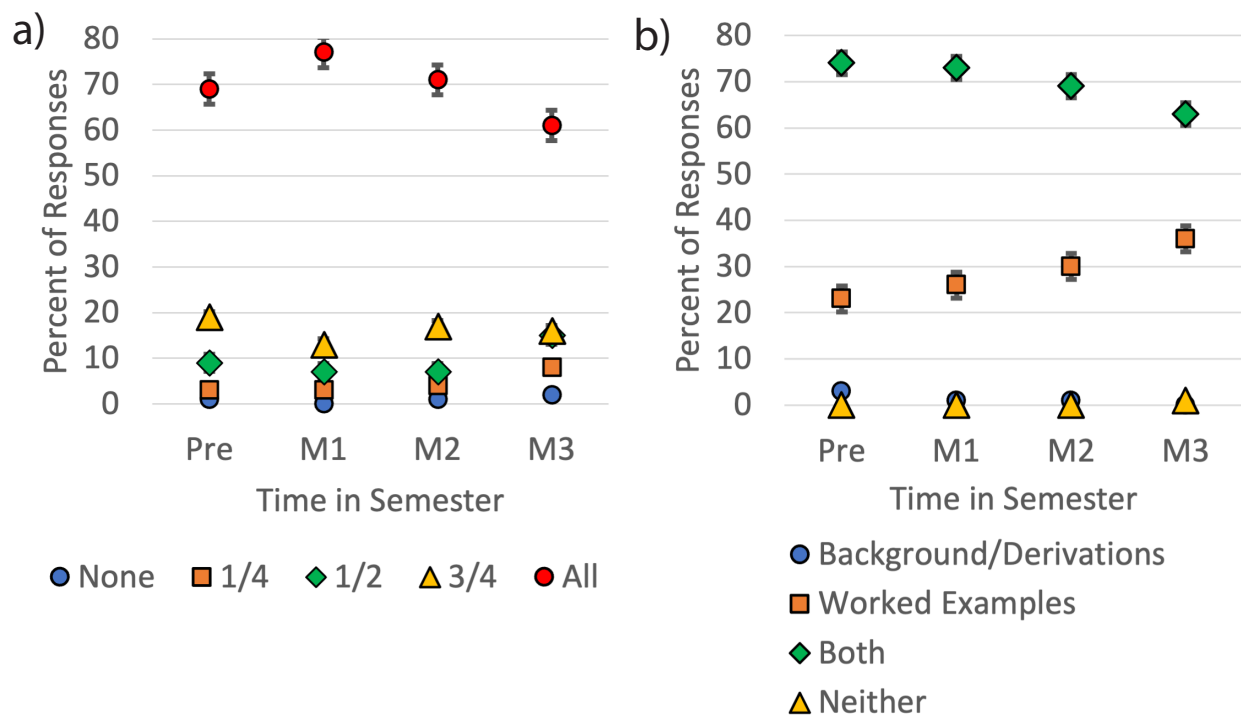


Figure S1: In (a) the percent of student respondents who reported that they watched none, 1/4, 1/2, 3/4, or all the lecture videos is illustrated. In (b) the percent of student respondents who only watched the background/derivation parts of the video lectures, only the worked examples, both the background and worked examples, or neither of these topics. These results are averaged over all 7 of the flipped classroom semesters.

Example of Scaffolded Preparation Questions

The following is the preparation questions used as a part of the pre-class activities for the 7th lecture in the course on entropy. The scaffolding here is meant to lead students through calculating the change in entropy for a process where both the volume and temperature changes, the total change in entropy for a reversible process, the total change in entropy for an irreversible process and the residual entropy. Examples on how to do these calculations are in the lecture videos.

| Question 1 | 1 pts |
|---|-------|
| <p>A sample of monatomic gas is initially at 303 K and 1.0 atm is expanded from 1.75 L to 4.18 L and simultaneously heated to 357 K. Assume the gas is ideal and use the initial parameters to determine any necessary state variables. Calculate the change in entropy for the process. Express your answer in J K^{-1} to three decimal places (X.XXX).</p> | |
| <input type="text"/> | |

Question 2**1 pts**

The heat capacity of hydrogen may be represented by

$$C_{p,m} = (1.554 + 0.0022T) \text{ J K}^{-1} \text{ mol}^{-1}$$

Calculate the change entropy of the system for the reversible heating of 2.2 moles of hydrogen from 230 K to 509 K. Express your answer in J K^{-1} to 2 decimal places (X.XX).

Question 3**1 pts**

The heat capacity of hydrogen may be represented by

$$C_{p,m} = (1.554 + 0.0022T) \text{ J K}^{-1} \text{ mol}^{-1}$$

Calculate the change in entropy of the surroundings for the reversible heating of 2.5 moles of hydrogen from 339 K to 591 K. Express your answer in J K^{-1} to 2 decimal places (X.XX).

Question 4**1.5 pts**

The heat capacity of hydrogen may be represented by

$$C_{p,m} = (1.554 + 0.0022T) \text{ J K}^{-1} \text{ mol}^{-1}$$

Calculate the total change in entropy for the reversible heating of 2.5 moles of hydrogen from 291 K to 505 K. Express your answer in J K^{-1} to 2 decimal places (X.XX).

Question 5**1 pts**

The heat capacity of hydrogen may be represented by

$$C_{p,m} = (1.554 + 0.0022T) \text{ J K}^{-1} \text{ mol}^{-1}$$

Calculate the change entropy of the system for the irreversible heating of 1.5 moles of hydrogen from 308 K to 695 K. Express your answer in J K^{-1} to 2 decimal places (X.XX).

Question 6

1 pts

The heat capacity of hydrogen may be represented by

$$C_{p,m} = (1.554 + 0.0022T) \text{ J K}^{-1} \text{ mol}^{-1}$$

Calculate the change in entropy of the surroundings for the irreversible heating of 3.4 moles of hydrogen from 244 K to 609 K. Assume that the surroundings are at 609 K. Express your answer in J K^{-1} to 2 decimal places (X.XX).

Question 7

1.5 pts

The heat capacity of hydrogen may be represented by

$$C_{p,m} = (1.554 + 0.0022T) \text{ J K}^{-1} \text{ mol}^{-1}$$

Calculate the total change in entropy for the irreversible heating of 3 moles of hydrogen from 336 K to 576 K. Express your answer in J K^{-1} to 3 decimal places (X.XXX).

Question 8

1 pts

Calculate the molar residual entropy of a solid in which the molecules can adopt 63 orientations of equal energy at absolute zero. Express your answer $\text{J K}^{-1} \text{ mol}^{-1}$ to three decimal places (X.XXX).

Question 9

1 pts

What topics did you find unclear in the preparation material? You must write something in the field below to get credit for the question.

Edit View Insert Format Tools Table

12pt Paragraph | **B** *I* U **A** |  T^2 |    |  **H-P**   | :

p

  | 0 words |   

CHEM 361A - Lecture 7 Activity
Entropy

In Class

1. Make the following table and fill in everything:

Table 1: Calculating entropy.

| | Reversible | Irreversible |
|-------------------|------------|--------------|
| ΔS_{sys} | | |
| ΔS_{surr} | | |

2. According to the second law of thermodynamics, the entropy of an irreversible process in an isolated system must always increase. On the other hand, it is well known that the entropy of living systems remains small. For example, the synthesis of highly complex protein molecules from individual amino acids is a process that leads to a decrease in entropy. Is the second law invalid for living systems? Explain.
3. Examining the hydrophobic effect is another way to look at the importance of quantifying the entropy of the system and the surroundings. Pretend that you have a well mixed system of water and a protein with both hydrophobic and hydrophilic groups in an isolated container.
 - (a) Does the entropy of the protein go up or down if it were to aggregate? Why?
 - (b) Does the entropy of the water go up or down if the protein aggregates? Why?
 - (c) How is this generalisable to other non-polar/water interactions (say oil and water)?
4. The second law of thermodynamics asserts that

It is impossible for a system to undergo a cyclic process whose sole effects are the flow of heat into the system from a heat reservoir and the performance of an equal amount of work by the system on the surroundings.

This is because the entropy decrease in the hot reservoir must be offset by an increase in entropy in a cold reservoir. What this means is that there is a thermodynamic limit to the efficiency of a heat engine as some heat must be deposited into a cold reservoir.

- (a) To demonstrate why there must be a cold reservoir, determine the work that is performed by the Carnot Cycle when the cold reservoir is at the same temperature as the hot reservoir.

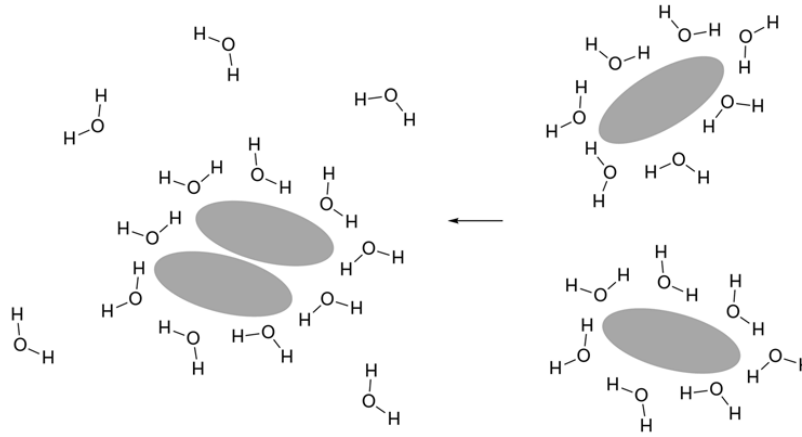


Figure 1: Illustration of protein aggregation.

- (b) Using the labels in Figure 2, determine the ΔS_{hot} , ΔS_{cold} and ΔS_{Total} .
- (c) The maximum efficiency for an ideal Carnot Engine occurs when $\Delta S_{Total} = 0$. Using this condition, write an expression for $|q'|/|q|$.
- (d) If the efficiency of a process is the work done over the heat supplied, show that the efficiency of an ideal Carnot Engine is

$$\eta = 1 - \frac{T_{cold}}{T_{hot}}$$

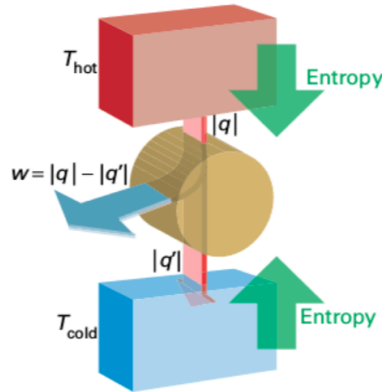
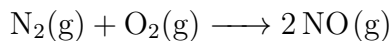


Figure 2: A Carnot Engine connected to a hot and cold reservoir showing the decrease in entropy in the hot reservoir and the increase in entropy in the cold reservoir.

Homework

5. Consider the reaction



Calculate the values of $\Delta_r S^\ominus$ for the reaction mixture, the surroundings, and the universe (total ΔS) at 298 K. Why is your result reassuring to Earth's inhabitants? ($\Delta S_{univ} = -582 \text{ J K}^{-1}$).

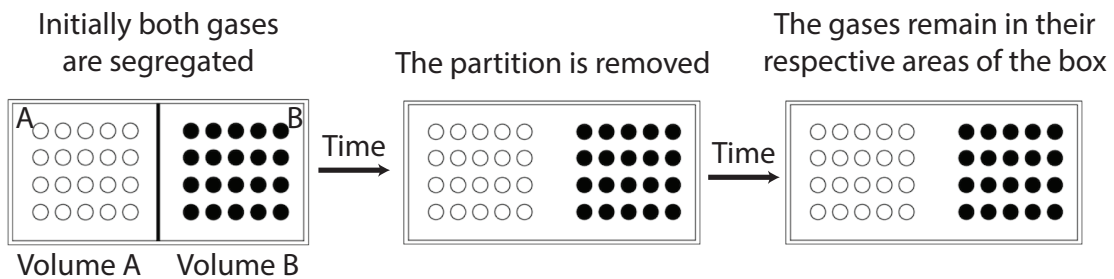
6. Calculate the entropy change when neon at 298 K and 1 atm in a container of volume 0.780 L is allowed to expand to 1.25 L and simultaneously heated to 358 K. Assume ideal behaviour. Hint: Because S is a state function, you can first calculate the value of ΔS for the expansion at constant temperature, and then the value of ΔS due to heating at constant volume. ($\Delta S_{Tot} = 0.20 \text{ J K}^{-1}$)
7. The second law of thermodynamics requires a particular direction of time since the entropy of an isolated system can never decrease. For this reason, we can use entropy to distinguish the past from the future. For example, we expect in most cases that two substances will mix as time moves forward. We will use the second law of thermodynamics to show this to be true. Suppose we have an isolated container separated in half by a wall. In one half is one mole of gas A, and in the other is one mole of gas B. We can use the fraction of the volume of the box that each gas occupies as a proxy for the number of microstates.

- (a) Using

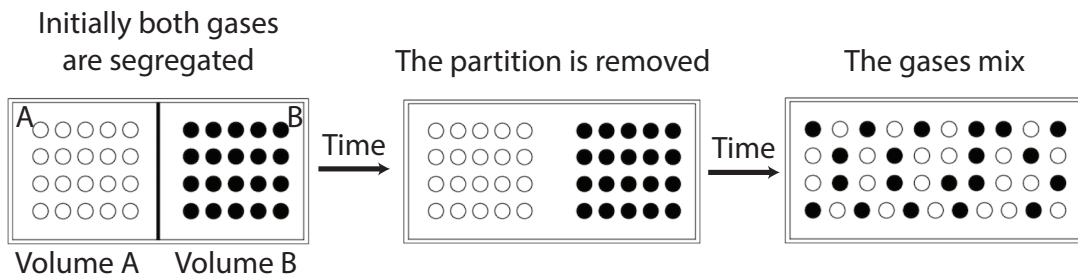
$$\Delta S = nR \ln \frac{V_f}{V_i}$$

calculate the change in entropy between the case where the partition is first removed and at some later time where all of gas A is found in the same half as it was initially, and all of gas B is found in the same half as it was initially. This is illustrated in Figure 3a. ($\Delta S = 0$)

- (b) Now calculate the total change in entropy between when the wall is first removed and at some later time where both gases mixed and filled the total container. This is illustrated in Figure 3b. ($\Delta S = nR \ln \frac{(V_A + V_B)^2}{V_A V_B}$)
- (c) Which scenario (gases stay in the same half of the box or mix and fill the complete volume) will spontaneously occur according to the ΔS results? Does this fit with your perception of the evolution of time for this system? What about the other scenario: does it fit with time moving forward or time standing still?



(a) No gas mixing scenario. We would perceive that very little or no time has passed between the middle and right panel.



(b) Gas mixing scenario. We would expect some measurable amount of time to have passed between the middle and right panel.

Figure 3: Two gas mixing scenarios where the difference in entropy from the middle panel to the right panel can be calculated to demonstrate how entropy is time's arrow.

Fall 2019 Start of Course Survey

Q1 In this course, what aspect do you think you will enjoy the most?

Q2 In this course, what aspect do you think you will enjoy the least?

Q3 In this course, what do you think you will find to be the most useful thing we do?

Q4 Have you ever been in a flipped class before this one?

Yes

No

Q5 How satisfied do you think you will be with a flipped delivery of the course?

| | Extremel y satisfied (1) | Moderatel y satisfied (2) | Slightly satisfie d (3) | Neither satisfied nor dissatisfie d (4) | Slightly dissatisfie d (5) | Moderatel y dissatisfied (6) | Extremely dissatisfie d (7) |
|---------------------------------|-----------------------------------|---------------------------------|-------------------------------|---|----------------------------------|---------------------------------------|-----------------------------------|
| Current satisfactio n (2) | | | | | | | |

Q6 Please respond on if you agree with the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|--|------------------------------|-------------------------------|-----------------------------|---|-----------------------|-------------------------|------------------------|
| Watching lectures at home and problem- solving in class is more effective than if I had listened to a lecture during class and did | | | | | | | |

problems
on my
own at
home (6)

Q7 How much of each pre-recorded lecture do you think you will typically watch?

- None (1)
- About a quarter of each (2)
- About half of each (3)
- About three quarters of each (4)
- All of each (6)

Q8 Which part of each lecture video (if any) do you think you will typically watch?

- Background/Derivations (1)
- Worked Examples (2)
- Both the background and the worked examples (3)
- Neither the background nor the worked examples (4)

Q9 Rank the following statements. I think I will use the pre-recorded lectures to help me

- _____ Prepare for class (1)
- _____ Complete preparation assignments (2)
- _____ Complete class activities (3)
- _____ Prepare for quizzes and exams (4)
- _____ Reinforce course concepts (5)

Q10 I identify as

- Female (1)
- Male (2)
- Neither (4)

Q11 I identify as

- American Indian or Alaska Native (3)
- Asian (4)
- Black (7)
- Hispanic (2)
- Native Hawaiian or Pacific Islander (5)
- White (1)
- Other (6)

Q12 My parents' level of education is

- Both parents graduated from college (1)
- One parent graduated from college (2)
- Neither parent graduated from college (3)

Q13 Use this space to add any observations about the course that you wish to share.

Fall 2019 Post Midterm 1 Survey

Q1 In this course, what aspect do you enjoy the most?

Q2 In this course, what aspect do you enjoy the least?

Q3 In this course, what do you find to be the most useful thing we do?

Q4 Have you ever been in a flipped class before?

Yes (4)

No (5)

Q5 How satisfied are you with the delivery of the course?

| | Extremel y satisfied (1) | Moderatel y satisfied (2) | Slightly satisfie d (3) | Neither satisfied nor dissatisfie d (4) | Slightly dissatisfie d (5) | Moderatel y dissatisfied (6) | Extremely dissatisfie d (7) |
|---------------------------------|-----------------------------------|---------------------------------|-------------------------------|---|----------------------------------|---------------------------------------|-----------------------------------|
| Current satisfactio n (2) | | | | | | | |

Q6 Please respond on if you agree with the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|--|------------------------------|----------------------------|-----------------------------|--|--------------------------|-------------------------|------------------------|
| Watching lectures at home and problem- solving in class is more effective than if I had listened to a lecture | | | | | | | |

during
class and
did
problems
on my
own at
home (6)

Q7 How much of each pre-recorded lecture do you typically watch?

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- About half of each (3)
- About three quarters of each (4)
- All of each (6)

Q8 Which part of each lecture video (if any) do you typically watch?

- Background/Derivations (1)
- Worked Examples (2)
- Both the background and the worked examples (3)
- Neither the background nor the worked examples (4)

Q9 Rank the following statements. I use the pre-recorded lectures to help me

- _____ Prepare for class (1)
- _____ Complete preparation assignments (2)
- _____ Complete class activities (3)
- _____ Prepare for quizzes and exams (4)
- _____ Reinforce course concepts (5)

Q10 Please respond on how useful you find the following aspects to the course:

| | Extremel y Useless (1) | Moderatel y useless (2) | Slightl y useles s (3) | Neithe r useful nor useless (4) | Slightl y useful (5) | Moderatel y useful (6) | Extremel y useful (7) |
|---|------------------------------|-------------------------------|---------------------------------|--|-------------------------------|---------------------------|-----------------------------|
| Having the pre-recorded lectures assigned as outside work before class in order to make time for other activities during lectures makes class time more | | | | | | | |

useful/enlightening
. (1)

I found the
preparation
assignments useful
in reinforcing
concepts in the
lecture videos (2)

I found the
preparation
assignment useful
because it covered
the material
presented in the
lecture videos (3)

I found the time
spent in class
answering the
'What topics did
you find unclear in
the preparation
material?' question
useful to
understand the
lecture material.
(4)

I found the time
spent in class
answering the
'What topics did
you find unclear in
the preparation
material?' question
useful to prepare
for the in-class
activity (5)

Q11 Please respond on if you agree with the following statements about the course:

| | | | | | | |
|------------------------------|-------------------------------|-----------------------------|--|--------------------------|-------------------------|------------------------|
| Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|------------------------------|-------------------------------|-----------------------------|--|--------------------------|-------------------------|------------------------|

I found the
time spent
in class on
the
activities
helps me
understand
the lecture
material
more
clearly (1)

I found the
time spent
in class on
the
activities
helps me
prepare for
quizzes
and exams
(2)

I found the
time spent
in class on
the
activities is
helping me
to become
a more
critical
thinker. (4)

Please
select
extremely
disagree as
the answer
to this
prompt (3)

I found the
time spent
in class on
the
activities is
helping me
to become

better at
working in
a team. (8)

Being able
to interact
personally
with the
instructor
during in-
class
activities is
helpful to
complete
the group
activity (5)

Being able
to interact
personally
with the
instructor
during in-
class
activities
helps me
better
understand
the course
material
(9)

- Q12 Which of the following would you remove from the live lecture
Spending time answering the 'What topics did you find unclear in the preparation material?'
questions (1)
The group activities (2)
Both (3)
Neither (4)

Q13 Explain why you would remove, if any, the indicated part(s) of the live lecture.

Q14 What would you add to the live lecture that would make it more useful/engaging?

Q15 Please respond to the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|--|------------------------|-------------------------|-----------------------|--------------------------------|--------------------|----------------------|---------------------|
| Taking in-class assessments as a group help to reinforce course concepts (9) | | | | | | | |
| Immediate peer-evaluation of in-class assessments helps to reinforce course concepts (8) | | | | | | | |
| Creating questions on PeerWise helps me prepare for in-class assessments (11) | | | | | | | |
| Engaging with questions posted to PeerWise helps me prepare for in-class assessments (3) | | | | | | | |

Q16 I identify as

Female (1)
Male (2)
Neither (4)

Q17 I identify as

American Indian or Alaska Native (3)
Asian (4)
Black (7)
Hispanic (2)
Native Hawaiian or Pacific Islander (5)
White (1)
Other (6)

Q18 My parents' level of education is

Both parents graduated from college (1)
One parent graduated from college (2)
Neither parent graduated from college (3)

Q19 Use this space to add any observations about the course that you wish to share.

Fall 2021 Post Midterm 2 Survey

Q1 In this course, what aspect do you enjoy the most?

Q2 In this course, what aspect do you enjoy the least?

Q3 In this course, what do you find to be the most useful thing we do?

Q4 Have you ever been in a flipped class before?

Yes (4)

No (5)

Q5 How satisfied are you with the delivery of the course?

| | Extremel y satisfied (1) | Moderatel y satisfied (2) | Slightly satisfie d (3) | Neither satisfied nor dissatisfie d (4) | Slightly dissatisfie d (5) | Moderatel y dissatisfied (6) | Extremely dissatisfie d (7) |
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| Watching lectures at home and problem- solving in class is more effective than if I had listened to a lecture during class and did | | | | | | | |

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Q7 How much of each pre-recorded lecture do you typically watch?

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Q8 Which part of each lecture video (if any) do you typically watch?

- Background/Derivations (1)
- Worked Examples (2)
- Both the background and the worked examples (3)
- Neither the background nor the worked examples (4)

Q9 Rank the following statements. I use the pre-recorded lectures to help me

- _____ Prepare for class (1)
- _____ Complete preparation assignments (2)
- _____ Complete class activities (3)
- _____ Prepare for quizzes and exams (4)
- _____ Reinforce course concepts (5)

Q10 Please respond on how useful you find the following aspects to the course:

| | Extremel y Useless (1) | Moderatel y useless (2) | Slightl y useles s (3) | Neithe r useful nor useless (4) | Slightl y useful (5) | Moderatel y useful (6) | Extremel y useful (7) |
|---|------------------------------|-------------------------------|------------------------------|--|-------------------------------|---------------------------|-----------------------------|
| Having the pre-recorded lectures assigned as outside work before class in order to make time for other activities during lectures makes class time more useful/enlightening . (1) | | | | | | | |

I found the preparation assignments useful in reinforcing concepts in the lecture videos (2)

I found the preparation assignment useful because it covered the material presented in the lecture videos (3)

I found the time spent in class answering the 'What topics did you find unclear in the preparation material?' question useful to understand the lecture material. (4)

I found the time spent in class answering the 'What topics did you find unclear in the preparation material?' question useful to prepare for the in-class activity (5)

Q11 Please respond on if you agree with the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|------------------------------------|------------------------|-------------------------|-----------------------|--------------------------------|--------------------|----------------------|---------------------|
| I found the time spent in class on | | | | | | | |

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I found the
time spent
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quizzes
and exams
(2)

I found the
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the
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Please
select
extremely
disagree as
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I found the
time spent
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to become
better at
working in
a team. (8)

Being able to interact personally with the instructor during in-class activities is helpful to complete the group activity (5)

Being able to interact personally with the instructor during in-class activities helps me better understand the course material (9)

- Q12 Which of the following would you remove from the live lecture
 Spending time answering the 'What topics did you find unclear in the preparation material?' questions (1)
 The group activities (2)
 Both (3)
 Neither (4)

Q13 Explain why you would remove, if any, the indicated part(s) of the live lecture.

Q14 What would you add to the live lecture that would make it more useful/engaging?

Q15 Please respond to the following statements about the course:

| Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|------------------------|-------------------------|-----------------------|--------------------------------|--------------------|----------------------|---------------------|
|------------------------|-------------------------|-----------------------|--------------------------------|--------------------|----------------------|---------------------|

Taking in-class assessments as a group help to reinforce course concepts (9)

Immediate peer-evaluation of in-class assessments helps to reinforce course concepts (8)

Creating questions on PeerWise helps me prepare for in-class assessments (11)

Engaging with questions posted to PeerWise helps me prepare for in-class assessments (3)

Q16 How are you coping with returning to in person classes? Is there anything that the instructor can do to help?

Q17 Have you found that your study habits have changed given that classes are transitioning back to in person?

Q18 Have you noticed a change in cheating/academic dishonesty as classes are moving back to being in person? Explain.

Q19 I identify as

Female (1)

Male (2)

Neither (4)

Q20 I identify as

American Indian or Alaska Native (3)

Asian (4)

Black (7)

Hispanic (2)

Native Hawaiian or Pacific Islander (5)

White (1)

Other (6)

Q21 My parents' level of education is

Both parents graduated from college (1)

One parent graduated from college (2)

Neither parent graduated from college (3)

Q22 Use this space to add any observations about the course that you wish to share.

Fall 2020 Post Midterm 3 Survey

Q1 In this course, what aspect do you enjoy the most?

Q2 In this course, what aspect do you enjoy the least?

Q3 In this course, what do you find to be the most useful thing we do?

Q4 How are you coping with the 100% online environment and COVID? Is there anything that the instructor can do to help?

Q5 Have you found that your study habits have changed since classes transitioned online? For example, since exams are open book in this class, are you relying more on being able to search for answers/concepts compared to knowing these concepts like you would for a closed book exam?

Q6 Have you noticed an increase in cheating/academic dishonesty since classes transitioned online. Explain.

Q7 Have you ever been in a flipped class before?

Yes (4)

No (5)

Q8 How satisfied are you with the delivery of the course?

| | Extremely satisfied (1) | Moderately satisfied (2) | Slightly satisfied (3) | Neither satisfied nor dissatisfied (4) | Slightly dissatisfied (5) | Moderately dissatisfied (6) | Extremely dissatisfied (7) |
|--------------------------|-------------------------|--------------------------|------------------------|--|---------------------------|-----------------------------|----------------------------|
| Current satisfaction (2) | | | | | | | |

Q9 Please respond on if you agree with the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|--|------------------------|-------------------------|-----------------------|--------------------------------|--------------------|----------------------|---------------------|
| Watching lectures at home and problem- | | | | | | | |

solving in class is more effective than if I had listened to a lecture during class and did problems on my own at home (6)

Q10 How much of each pre-recorded lecture do you typically watch?

- None (1)
- About a quarter of each (2)
- About half of each (3)
- About three quarters of each (4)
- All of each (6)

Q11 Which part of each lecture video (if any) do you typically watch?

- Background/Derivations (1)
- Worked Examples (2)
- Both the background and the worked examples (3)
- Neither the background nor the worked examples (4)

Q12 Rank the following statements. I use the pre-recorded lectures to help me

- _____ Prepare for class (1)
- _____ Complete preparation assignments (2)
- _____ Complete class activities (3)
- _____ Prepare for quizzes and exams (4)
- _____ Reinforce course concepts (5)

Q13 Please respond on how useful you find the following aspects to the course:

| | | | | | | |
|------------------------------|-------------------------------|------------------------------|--------------------------------------|-------------------------------|---------------------------|-----------------------------|
| | | | Neither | | | |
| Extremel y Useless (1) | Moderatel y useless (2) | Slightl y useles s (3) | r useful nor useless (4) | Slightl y useful (5) | Moderatel y useful (6) | Extremel y useful (7) |

Having the pre-recorded lectures assigned as outside work before class in order to make time for other activities during lectures makes class time more useful/enlightening . (1)

I found the preparation assignments useful in reinforcing concepts in the lecture videos (2)

I found the preparation assignment useful because it covered the material presented in the lecture videos (3)

I found the time spent in class answering the 'What topics did you find unclear in the preparation material?' question useful to understand the lecture material. (4)

I found the time spent in class answering the 'What topics did you find unclear in the preparation material?' question useful to prepare for the in-class activity (5)

Q14 Please respond on if you agree with the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|---|------------------------------|-------------------------------|-----------------------------|--|--------------------------|-------------------------|------------------------|
| I found the time spent in class on the activities helps me understand the lecture material more clearly (1) | | | | | | | |
| I found the time spent in class on the activities helps me prepare for quizzes and exams (2) | | | | | | | |
| I found the time spent in class on the activities is helping me to become a more critical thinker. (4) | | | | | | | |
| Please select extremely disagree as the answer to this prompt (3) | | | | | | | |

I found the time spent in class on the activities is helping me to become better at working in a team. (8)

Being able to interact personally with the instructor during in-class activities is helpful to complete the group activity (5)

Being able to interact personally with the instructor during in-class activities helps me better understand the course material (9)

Q15 Which of the following would you remove from the live lecture
Spending time answering the 'What topics did you find unclear in the preparation material?' questions (1)

The group activities (2)

Both (3)

Neither (4)

Q16 Explain why you would remove, if any, the indicated part(s) of the live lecture.

Q17 What would you add to the live lecture that would make it more useful/engaging?

Q18 Please respond to the following statements about the course:

| | Extremely Disagree (1) | Moderately Disagree (2) | Slightly Disagree (3) | Neither Agree nor Disagree (4) | Slightly Agree (5) | Moderately Agree (6) | Extremely Agree (7) |
|--|------------------------|-------------------------|-----------------------|--------------------------------|--------------------|----------------------|---------------------|
| Taking in-class assessments as a group help to reinforce course concepts (9) | | | | | | | |
| Immediate peer-evaluation of in-class assessments helps to reinforce course concepts (8) | | | | | | | |
| Creating questions on PeerWise helps me prepare for in-class assessments (11) | | | | | | | |
| Engaging with questions posted to PeerWise helps me prepare for in-class | | | | | | | |

assessments
(3)

Q19 I identify as

Female (1)

Male (2)

Neither (4)

Q20 I identify as

American Indian or Alaska Native (3)

Asian (4)

Black (7)

Hispanic (2)

Native Hawaiian or Pacific Islander (5)

White (1)

Other (6)

Q21 My parents' level of education is

Both parents graduated from college (1)

One parent graduated from college (2)

Neither parent graduated from college (3)

Q22 Use this space to add any observations about the course that you wish to share.