Online Pedagogy and Assessment in STEM

Robin Rehagen, Eric Harpell, and Michal Shuldman

Welcome to

Online Pedagogy and Assessment in STEM

Topics for today:

- Asynchronous or Synchronous classes?
- Improving online exams and avoiding cheating
- Hybrid instruction
- Your ideas—what is working and what is not!

Synchronous or Asynchronous Lectures?

Synchronous

- Immediate Answers to Questions
- Active Learning
- Accountability (Attendance)
- Recordings made in case of Emergencies

Asynchronous

- Flexibility
- Active learning (e.g. polls, google doc, discussions)
- Accountability (e.g. embed quiz questions or comments in video)
- Can pause and replay

Active Learning and Student Participation in Lecture

Synchronous

- Pause for students to solve problems individually
- Breakout rooms for students to solve problems in groups
- Interactive demonstrations where students discuss and predict the outcome of the demonstration
- Polls (formative assessment or just-in-time teaching)

Asynchronous

- Google Docs/Padlet/Jam Board
- EdPuzzle/Canvas Studio/Camtasia videos with embedded quizzes or comments
- Flipgrid/Canvas Studio for peer responses
- Hypothes.is for annotation
- Whiteboard.fi for shared whiteboards

Improving Online Examinations

Are students cheating on your exams?

The answer is: YES

Improving Online Examinations

- When do they cheat?
- Why do they cheat?
- How can we stop the cheating?

A bit more Traditional Approach (Harpell)

- Instead of a few midterms and homework quizzes, there are 8 online quizzes in my Physics 1A class, as well as two lab exams and a final exam.
- The Quizzes have two or three problems each (multiple choice and problem solving).
- The Canvas Quizzes tool is used to deliver the quiz. Typically 20 minutes are given per problem (or set of multiple choice problems).
- Five minutes “scan and download” time is given to get the images scanned (via Genius or Adobe scan). Students need practice with this!

A more traditional approach..continued

●Students are monitored via zoom—with web cam and cell phone (not yet with Proctorio).

●An Honor Code is included with every Quiz.

●Incentive points are added to the score to help with stress and prevent cheating (no extra points are given if cheating is an issue).

●No direct evidence of cheating so far--scores are well distributed.

●8 quizzes (with solutions) gives students plenty of feedback prior to the final.

Lecture for every class

Physics classes: One day/week is lecture and the other is problem solving, Help with labs, or a quiz! Catch up lectures are recorded (but *not* during flex day!)
Non Physics classes (Environmental Science and Astronomy)…lecture one day a week, the other day is project (or quiz) day to watch and answer questions about a Video, an article, work or a worksheet, or watch a lecture that I recorded and answer a few questions about it.

Asychronous days?

Questions must be directed: Don’t say: “Summarize the video” Try something like this instead:

For this week, please watch the Video "Ice on Fire”

Questions to Answer in approximately three paragraphs:

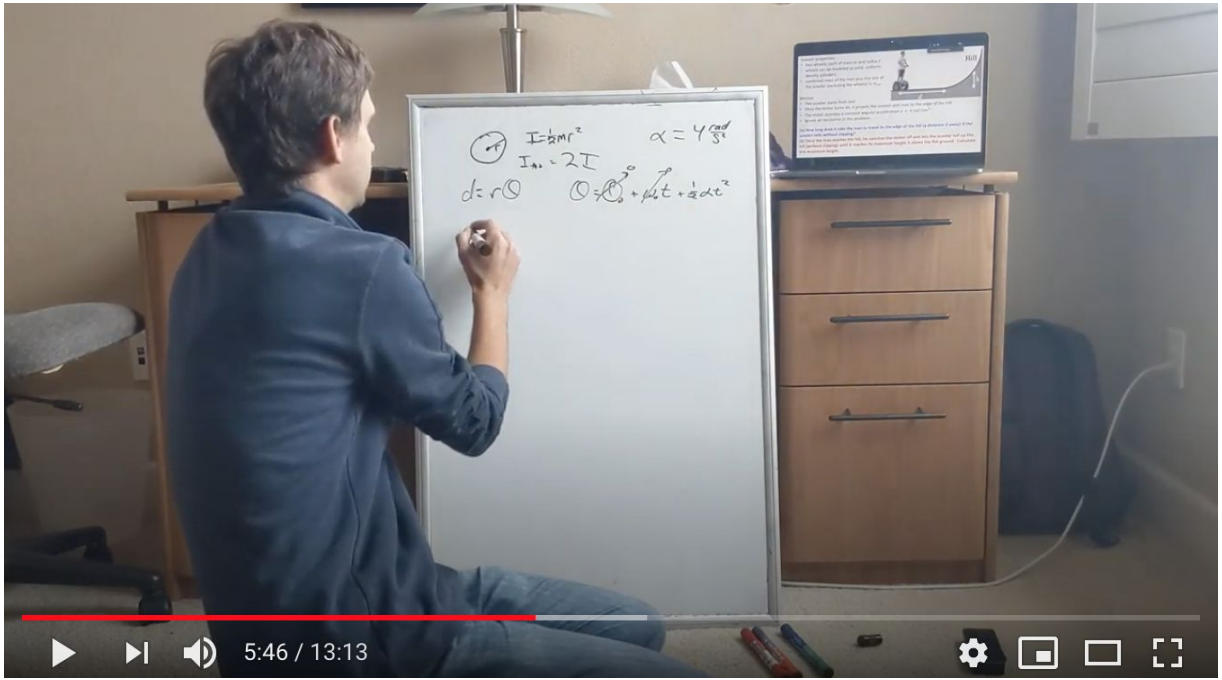
1) What did you find particularly interesting about the Video? In other words, what parts stand out after watching--what would you want to share with your family, friends, or classmates?

2) What did you learn about in the Video that helped you understand or put in perspective some of the ideas and information we discussed in class lecture on 10/14?

3) What Questions and Thoughts do you have after watching the Video that you would like answered in the next lecture?

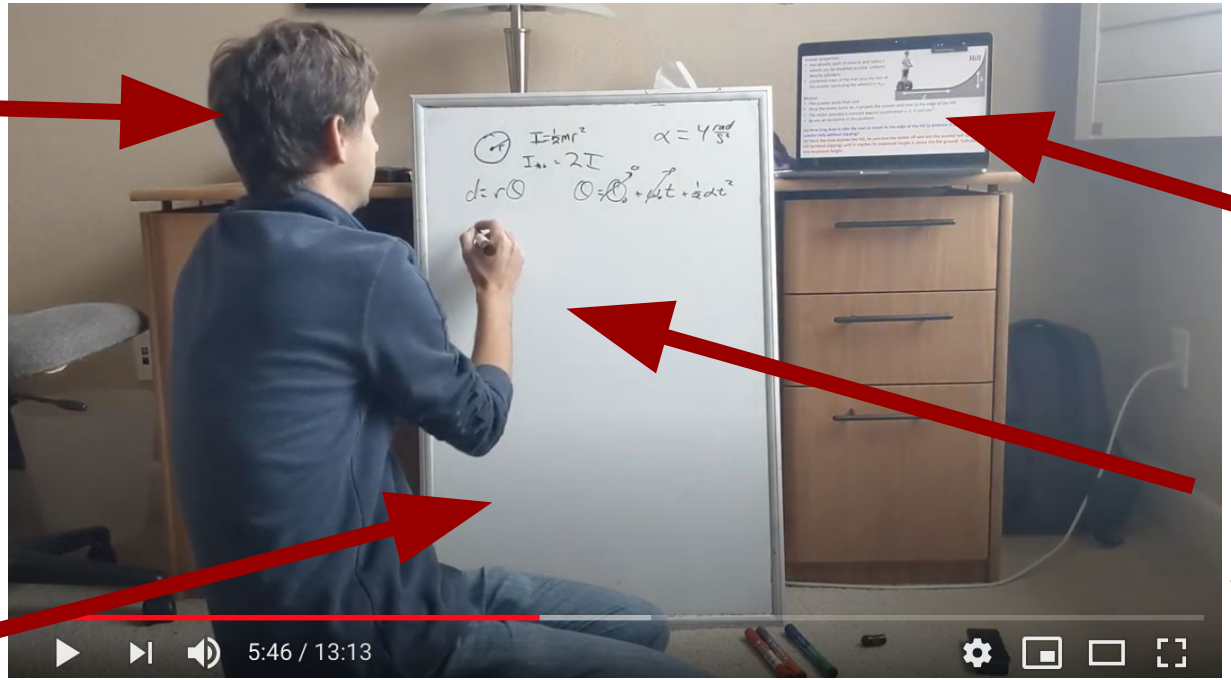
"

Method 1: Proctored Oral Exams



Method 1: Proctored Oral Exams

Student visible in recording to verify identity



Exam problem shown on computer (Zoom Session)

Problem solved on whiteboard to be easily seen in video

Student may explain their work aloud as they solve the problem

Method 1: Proctored Oral Exams

How does the exam work?

1. Student records oral examination (with phone). The recording shows the student, whiteboard, and a computer with the Zoom session visible.
2. The instructor shares (on Zoom) a Powerpoint Slide showing the exam question(s).
3. The student solves the exam problem in the allotted time.
4. The student uploads their video as an unlisted Youtube Video (easiest) or sends the video file to instructor through other means (Dropbox, OneDrive, Google Photos, etc.)
5. The student scans their whiteboard as a PDF, and uploads it to Canvas. The student posts a link to the video in the Canvas comments.

Method 1: Proctored Oral Exams

Cheating is not possible!

1. The live Zoom session in the video ensures that the recording was made during the test-taking period.

2. All students take the exam at the same time so there is no communication between students.

3. The student's full body (and computer screen) are visible on the screen at all times while the exam question is displayed. Thus, the exam is proctored: there is no way for the student to access help from outside sources (whether live or online)

Method 1: Proctored Oral Exams

Pedagogy

1. Students may communicate their understanding in multiple ways: written only, or a combination of written and oral.
2. Two problems are given to vary the topics tested: students pick the problem they feel most confident in.
3. Time is short, but problems are shorter and simpler than on a written test.
4. Equity: Ungraded reading period is given before the exam starts (to even the playing field between slow and fast readers).
5. Students may type questions into the Zoom chat during the reading period. They may also write things down to help them process the question, but nothing during this period is graded.
6. More frequent exams given, with fewer topics per exam.

Method 1: Proctored Oral Exams

Drawbacks

1. Unfamiliar format (oral exam) may increase test anxiety
2. Short time period leaves no room for “freak out” or “blanking”
3. Pushback from whiny students

Advantages

1. Multiple ways for students to demonstrate learning (equity)
    a. students who are verbal communicators thrive
    b. students who are written communicators may write (as usual)
2. Higher overall exam grades
3. Grading is easier than written exams

Method 1: Proctored Oral Exams

Sample Exam Questions

(Displayed on Zoom via screenshare)

Information relevant to both problems:

Atom	Atomic Weight
Hydrogen (H)	1 amu
Oxygen (O)	16 amu

Problem 1

A closed, thermally insulated cubic container (10 cm to a side) contains 100 g of liquid water (H_2O) initially at 100°C. Over the course of 10 minutes, 250,000 J of energy are imparted to the liquid water. Assume no energy escapes from the system.

After the 10 minutes has elapsed:

(a) What is the final temperature of the system (in Kelvin)?

(b) What is the mean-free path of an H_2O molecule if the typical collision cross-section is $1.4\times10^{-18}\ \mathrm{m}^2$?

Problem 2

The star G29-38 has a radius of 7×10^8 km and radiates energy at a rate of 6.8×10^{33}W. Assume that the star is a highly efficient absorber and emitter of light. In 2013, molecular hydrogen (H_2) was discovered on the surface of this star. The star's surface temperature is hot enough that molecular hydrogen undergoes all available types of motion (translational, rotational, and vibrational).

(a) Explain conceptually all types motion (i.e., degrees of freedom) available to the H_2 molecules. Draw diagrams that illustrate these types of motion.

(b) What is the molar heat capacity of the H_2 gas on the surface of G29-38? Explain your reasoning.

(c) What is the total kinetic energy (on average) of an individual gas molecule?

(d) What is the average velocity of an individual gas molecule?

Method 1: Proctored Oral Exams

Concept (Problem 2)	Weight	Score
Explanation of translational, rotational, and vibrational motion	1	
All degrees of freedom are available because the temperature is hot enough	1	
$C_V = \frac{7}{2}R$ ($\frac{1}{2}R$ per degree of freedom)	1	
$K_{tot} = \frac{7}{2}kT$ (this includes translational, rotational, and vibrational)	1	
$v_{rms} = \sqrt{3kT/m}$	1	
Mass found from atomic weight	1	
Temperature found from radiation: $\frac{dQ}{dt} = Ae\sigma T^4$	1	
$A = 4\pi R^2$	1	
$e = 1$	1	
$\frac{dQ}{dt} = 6.8 \times 10^{33}$ W	1	
Total	10	

Sample Grading Rubric

Grade	Problem 1 (out of 12)	Problem 2 (out of 10)	Exam Points (out of 20)
A+	11, 11.5, 12	9.5, 10	20
A	9.5, 10, 10.5	8, 8.5, 9	19
A-/B+	8.5, 9	7, 7.5	18
B	7, 7.5, 8	5.5, 6, 6.5	17
B-/C+	6, 6.5	4.5, 5	16
C	4.5, 5, 5.5	3, 3.5, 4	15
C-/D+	3.5, 4	2, 2.5	14
D	2, 2.5, 3	1, 1.5	13
F	0, 0.5, 1, 1.5	0, 0.5	10

Method 2: Open notes, group test

- Example language: “This examination is open book, open notes, open classmates, open universe. You may consult any text or person that you would like to in order to help you answer these questions. However, *you must write your own, individual answers*.”

- Questions are much more complicated than a typical exam. They should integrate many components of a unit and have students solve authentic problems.

- Choose questions that have more than one correct answer where student need to use data to back up their interpretation.

While visiting the Bignbad Desert in southern Africa, you come across a blind man, Rubin Ace, who lives in a nearby village. He likes to drink tea and sends his great granddaughter, Pep, out to collect leaves each month from three dominant plant species within this region. Resentful of her chore duty, Pep won't tell her grandfather where she collects his plants. But knowing a little about plant physiology, Rubin asks you analyze the three species for their carbon isotope composition ($d^{13}C$), thinking that he may be able to decipher where the plants grow based on their $d^{13}C$. During certain times of the year, the soil salinity may fluctuate considerably. Below is the data set for these three plants.

Month	*I. lukferit* **$d^{13}C$**	*U. goferit* **$d^{13}C$**	*Y. looseit* **$d^{13}C$**
Jan.	-24.4	-14.5	-14.7
Feb.	-24.0	-14.0	-13.8
March	-23.6	-14.6	-13.1
April	-23.2	-13.7	-14.2
May	-24.5	-13.1	-16.4
June	-26.1	-12.5	-18.6
July	-27.9	-12.9	-21.9
Aug.	-26.6	-13.4	-20.3
Sept.	-26.4	-13.7	-19.5
Oct.	-26.1	-14.2	-18.0
Nov.	-24.3	-14.4	-17.8
Dec.	-23.8	-14.7	-16.4

Answer the following sub-questions:

1. Using the data above, provide a description for Rubin of each plant species, including leaf structural characteristics (e.g. thick vs. thin), plant life form (e.g. herb vs. tree) and its general physiological characteristics.

2. For each species, provide your expert opinion as to why the $d^{13}C$ values vary over the year (hint: think about environmental changes and plant responses to these changes). Use specific leaf-level physiology to explain these patterns.

3. Based on your data and interpretations from parts 1a and 1b, what would you tell Rubin about the ecological habitats from which these three plants grow?

Method 3: Exams as Formative Assessment

- Formative Assessment - gives students feedback on their mastery of the material but is not graded. Students get points for completing the exam.
- Another option is do an exam that is worth points (summative assessment) but let them take it multiple times until they pass.

- You would then assess students through another type of assessment (e.g. case study, lab report, presentation, etc.). This other assessment would use the skills practiced in the formative assessment.