How and Why to Teach Intro Physics Without Grades

Ben Pollard

TANDEM Workshop 2023, Sacramento CA
Land Acknowledgement

Aaron Carapella, http://www.tribalnationsmaps.com/
• To provide **formative feedback**
  • To **rank and sort** students
  • To **motivate** students
• To **evaluate ourselves** as teachers
• To tell **employers** how smart (some) students are
  • Because **the institution** expects us to
  • ...*and many other reasons*

**Why do teachers grade students?**

We ask grades to do **a lot** of work
<table>
<thead>
<tr>
<th>Outline of workshop</th>
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Ungrading

• De-emphasizing or removing grades as a motivation for learning
  • Make room for intrinsic motivation
  • Under the larger umbrella of “Alternative Grading Strategies”

• More established in K-12 settings, growing in higher education STEM

• Emphasizing formative feedback

• Increased flexibility: **logistical** and **epistemic**
  • Logistical – variation and choice in course structure
    • Due dates, accountability mechanisms, in-class time, etc.
  • Epistemic – variation and choice in content / topics
    • What “counts” as knowledge in the course. What is learned.
  • Not everyone needs to learn the same thing, in the same way, to be successful
Equity matters for ungrading

- **Lower systemic barriers in formal education**
- **Logistical flexibility** accommodates students with childcare/eldercare responsibilities
- **Epistemic flexibility** allows for different ways of learning, knowing, and being
  - Neurodivergent folks, especially those with learning exceptionalities
  - Those with identities that STEM culture marginalizes
- **Different structure** can be a challenge to navigate
- **Self-evaluation** is subject to imposter phenomenon and stereotype threat
Dimensions to ungrading philosophy
...our “degrees of freedom”

Student agency
- Agency over content
- Agency over structure

Student motivation
- Learning orientation
- Reward orientation
- Peer comparison orientation

Metacognitive practices
- Peer feedback
- Self-reflection
- Revision and iteration

What is rewarded
- Effort
- Improvement
- Mastery

Types of feedback
- Formative feedback
- Summative feedback

You do not need to do all of these at once

PICK ONE, MAYBE TWO

[J. Caleb Speirs, W. Brian Lane]
[C. A. Wolters, S. L. Yu, and P. R. Pintrich, Learn Individ Differ 8, 211 (1996)]
Examples of Alternative Grading Strategies

• 4-point scale
• Exam revisions
• Mastery-based / Standards-based / Specifications-based
• Contract-based / Labor-based
• Narrative evaluations / Portfolios
• Self evaluation
• Peer evaluation (e.g. peer badging)
• No grades at all (pass/fail, everyone gets an A)

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What aspect resonates with you?

Think – Pair – Share
### Outline of workshop

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Self-reflection and metacognition

- Without grades, students need to monitor their own learning

Think of 2-3 academic mentors you’ve had.

At what levels of Bloom’s Taxonomy did they operate?

Productive failure model adapted from Manu Kapur by Beatriz Salazar and Brendan Griffiths.
Productive failure activity

h/t Beatriz Salazar, Brendan Griffiths, CU Boulder A&S Academic Coaching
Think on your own

Write notes for yourself if you’d like to

(I will ask you to share some of this with those around you)

In your careers so far…

What failures are you grateful for?

What successes do you wish you hadn’t gotten away with?
Share with those around you

In your careers so far…

What failures are you grateful for?

What successes do you wish you hadn’t gotten away with?
Maximizes long term learning
Minimizes short term performance

Minimizes long term learning
Minimizes short term performance

Maximizes long term learning
Maximizes short term performance

Minimizes long term learning
Maximizes short term performance

*Adapted from writings by Manu Kapur (2016)
Slide credit: Brendan Griffiths and Beatriz Salazar
Talk with those around you

Sort the things you talked about before into productive/unproductive successes and failures.
Metacognition activity

h/t RIT IMPRESS, Berkley Compass Project, The Access Network
Counting Vowels in 45 seconds

How accurate are you?

Count all the vowels
in the words on the next slide.
<table>
<thead>
<tr>
<th>Dollar Bill</th>
<th>Cat Lives</th>
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<tbody>
<tr>
<td>Dice</td>
<td>Bowling Pins</td>
</tr>
<tr>
<td>Tricycle</td>
<td>Football Team</td>
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<tr>
<td>Four-leaf Clover</td>
<td>Dozen Eggs</td>
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<tr>
<td>Hand</td>
<td>Unlucky Friday</td>
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<tr>
<td>Six-Pack</td>
<td>Valentine’s Day</td>
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<tr>
<td>Seven-Up</td>
<td>Quarter Hour</td>
</tr>
<tr>
<td>Octopus</td>
<td></td>
</tr>
</tbody>
</table>
How many *words* or *phrases* do you remember?

Vote here! No need to enter your name, just press “Skip”

https://PollEv.com/benpollard612
Let’s look at the words again...

This time, try to remember as many words and phrases as you can.
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How many *words* or *phrases* do you remember?

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Vote here! No need to enter your name, just press “Skip”
Let’s look at the words again...

How are they arranged?
According to what?
NOW, how many words or phrases do you remember?

https://PollEv.com/benpollard612

Vote here! No need to enter your name, just press “Skip”
What were two major differences between the three attempts?

1. We knew what the task was
2. We knew how the information was organized
Imposter phenomenon activity
What to keep in mind when self-evaluating
Imposter Phenomenon (aka Imposter “Syndrome”)

• An internal belief that one is inadequate or incompetent, despite external evidence to the contrary.

• Often comes with a fear of failure, fear of being exposed as a fraud, and feelings of self-doubt.

• Originated in the gender studies context, and applies broadly.

• Studies show that 70% of the general public report feeling Impostor Phenomenon (Sakulku & Alexander, 2011) and this percentage increases in academia.
Imposter Phenomenon: Why it matters

- This affects our perception of our performance!
- This makes self-evaluation difficult.
  - We're used to someone calculating a point total to tell us if we're succeeding
  - Deciding for ourselves if we're succeeding is much harder
  - After you graduate, you won't get "graded" (or the equivalent) nearly as often
  - You'll be expected to self-monitor, self-motivate, and self-evaluate
  - Many students are unprepared for that when they graduate
- And, again, those skills are hard to learn!
  - It's OK if self-evaluation feels uncomfortable and a bit stressful in the moment.
  - That's part of the learning.
Stereotype Threat

• The fear or anxiety of confirming a negative stereotype about one’s social group

• For those with marginalized identities, this can make honest self-evaluation even more difficult.

• Research shows a good way to counteract stereotype threat (on an individual level) is simply to be aware of it
  • The best way to counteract it on a systemic level is to counteract systemic oppression 😊
  • Research says a lot more too, and it’s complicated, so there are no easy answers.

• Another effective way to counteract it is self affirmation.
  • Like, when you tell yourself that you’re awesome in the mirror every morning.
  • Values affirmation also helps: remember what is important, what makes you who you are.
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My intro physics courses

- Newtonian mechanics for non-physics majors
- 80-100 students. Mostly first years.
- Studio-style classroom space
- “Flipped classroom” course structure
- Homework assignments online
- Regular quizzes/“check-ins”
- Group project

https://www.youtube.com/watch?v=FtmEYkWkDDY
Self-evaluation

- Students set goals at the beginning of the course
  - Where would you like to be by the end of the course in terms of...
  - ...your understanding of the physics covered in the course?”
  - ...having prepared for class and lab?
  - ...your participation in class and lab?
  - ...your work with other students?

- Students assigned their own grade at the end
  - I suggested guidelines: e.g. “an A is you met or exceeded all of your goals”

- In vast majority of cases, I entered the grade that the students assigned
  - In some cases, we communicated and came to an agreement
  - In very few cases (<1%), we cannot agree, and then I assign my grade
Where would you like to be by the end of the term in terms of your understanding of the physics covered in the course?

Some example goals (not mutually exclusive):

- By the end of the term, I want to be able to repeat these ideas exactly, not the first time I try them, but by the end of the term and the exam, I will prepare you for the check-ins. The homework is designed to prepare you for the check-in problems.
- By the end of the term, I want to be able to repeat these ideas exactly, not the first time I try them, but by the end of the term and the exam, I will prepare you for the check-ins. The homework is designed to prepare you for the check-in problems.
- On each [solo check-in/homework], I hope to know it well enough to solve it on my own without help without reviewing the solution.
- On each [solo check-in/homework], I hope to know it well enough to solve it on my own without help without reviewing the solution.

These goals are the right idea, but by themselves are bit too vague:

- I want to be able to explain these ideas to anyone off the top of my head.
- I want to have a general idea of the big ideas, so I can go back and refresh myself on the details when they come up in my life.
- I want to know what I need to know for my major or field of study.
<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Mon</th>
<th>Tues</th>
<th>Wed</th>
<th>Thurs</th>
<th>Fri</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jan 9-18</td>
<td>—</td>
<td>(Monday schedule)</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<td></td>
<td></td>
<td></td>
<td>No class</td>
<td>Class intro, and...</td>
<td></td>
<td>Pre-class work “due” Sam</td>
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<td></td>
<td></td>
<td></td>
<td>Ch 1: Units etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Jan 16-20</td>
<td>Break</td>
<td>9:00-10:50am, Unity 520</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Ch 3: 1D motion</td>
<td>How to be smart</td>
<td></td>
<td>Ch 4: 2D motion</td>
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<td></td>
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<td></td>
<td>Pre-class work “due” Sam</td>
<td></td>
<td></td>
<td>Goals survey due 5pm</td>
</tr>
<tr>
<td>3</td>
<td>Jan 23-27</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Ch 5: Newton’s Laws</td>
<td>Solo check-in</td>
<td></td>
<td>Ch 6: Applying Newton’s Laws</td>
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<td></td>
<td>Pre-class work “due” Sam</td>
<td>Vectors, 1D motion, 2D motion</td>
<td></td>
<td>Pre-class work “due” Sam</td>
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<td></td>
<td>(Ch 1-4)</td>
<td></td>
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<tr>
<td>4</td>
<td>Jan 30 - Feb 3</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
<td>Wellness Day</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<td>Ch 8: Potential Energy</td>
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<td>Pre-class work “due” Sam</td>
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<tr>
<td>5</td>
<td>Feb 6 - 10</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<td></td>
<td></td>
<td></td>
<td>Ch 9: Linear momentum and collisions</td>
<td>Solo check-in: Forces, Work, and Energy (Ch 5-8)</td>
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<td></td>
<td>Pre-class work “due” Sam</td>
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<td>6</td>
<td>Feb 13 - 17</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<td></td>
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<td></td>
<td>Ch 10: Rotation and torque</td>
<td>How to self-evaluate</td>
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<td>Ch 11: Angular momentum</td>
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<td>Practice self-evaluation due 5pm</td>
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<td>7</td>
<td>Feb 20 - 24</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
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<td></td>
<td></td>
<td>Ch 11: Angular momentum</td>
<td>Solo check-in: Momentum and Rotation</td>
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<td></td>
<td></td>
<td>Pre-class work “due” Sam</td>
<td>(Ch 9-11)</td>
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<td>8</td>
<td>Feb 27 - Mar 3</td>
<td>No class</td>
<td>9:00-10:50am, Unity 520</td>
<td>10:00-10:50am, Fuller Upper</td>
<td>No class</td>
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<td>Ch 12: Static equilibrium,</td>
<td>How to study well</td>
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<td>Ch 13: Final self-evaluation</td>
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<td>and Project day</td>
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Color key:
- **Active lecture / group activity**
- **Solo check-in**
- **Ungrading stuff**
- **Project stuff**
- **WPI breaks**
Final self-evaluation

Assign yourself a grade in this course based on your goals and how well you've met them during the course.

I recommend the following guidelines for deciding on your final grade:

- Met or exceeded all your goals: A
- Met or exceeded some goals, made progress on others: B
- Made progress on all goals, but did not meet most of them: C
- Did not make meaningful progress on most goals: NR

What other considerations, if any, went into your choice of final grade that aren't included in what you wrote above?
Most important part: talk about why

• No matter your approach, getting students to buy in is critical
  • They’ve spent 12+ years being traditionally graded
  • The rest of the world is pushing them to stress about grades

• Be transparent...
  • ...about what will happen
  • ...about why you are doing it

• Do this early and often
  • Students are busy and stressed, and all this is very new to them
  • They will need to be reminded
  • Show and tell that you’re “for real” until they actually believe you
**Ungrading**

- Grades suck, and they don’t support learning.
- Formative feedback supports learning.
- The ability to self-reflect and self-evaluate is a really important skill.

So, your grade is this class will be determined by your own self-evaluation at the end of the course.

- You will write out your goals in a “goals survey” on Canvas **due Fri Jan 20 at 5pm**. You can refer back to them anytime.
- I recommend the following guidelines for your final grade:

<table>
<thead>
<tr>
<th>Performance at end of course</th>
<th>Letter Grade</th>
</tr>
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<tbody>
<tr>
<td>Met or exceeded all your goals</td>
<td>A</td>
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<td>Met or exceeded some goals, made progress on others</td>
<td>B</td>
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<tr>
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<td>C</td>
</tr>
<tr>
<td>Did not make meaningful progress on most goals</td>
<td>NR</td>
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- You will get scores on assignments, but they are just feedback for you.
- *See syllabus for more information. Syllabus is on Canvas.*
Metacognition and self-reflection

- You will be learning for the rest of your life. It won’t stop when you graduate.
- It is critical to learn how to learn effectively and efficiently.
  - For me, “learning how to learn” is just as important as learning physics
- There are two (related) skills that we’ll focus on in this course:
  - Metacognition – “thinking about thinking”
  - Self-reflection / self-evaluation – learning from past experiences

<table>
<thead>
<tr>
<th>Success</th>
<th>Productive</th>
<th>Unproductive</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>😊</td>
<td>OK in short-term, bad in long-term</td>
</tr>
<tr>
<td>Failure</td>
<td></td>
<td>Still good in long-term</td>
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<tr>
<td></td>
<td></td>
<td>😞</td>
</tr>
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[https://www.colorado.edu/artssciences-advising/resource-library/life-skills/productive-failure]
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Preliminary results: Ungrading does no harm

- Started using research-based assessment instruments to measure **learning gains**
  - Post score – pre score
- Force Concept Inventory (FCI)
  - Conceptual understanding of Newtonian mechanics
  - Oldest, most established in PER
- Indications so far: ungrading is **equivalent** to traditional on FCI metrics
  - However, the point of ungrading is **not** to increase FCI scores...

[From Korff et al., Am. J. Phys 84 (12) (2016)]

*These distributions are similar to other professors teaching the same course*
Deeper insight

- Numbers don’t tell the full story
- Ungrading is about more than conceptual understanding
- In particular, we wanted to answer these questions:
  - What is the emotional impact on students when utilizing ungrading compared to traditional grading?
  - How does ungrading affect student motivation?
  - What are students’ perceptions of fairness in ungraded classes?
Deeper insight – qualitative methods

- Reached out to students in ungraded courses at WPI (not just physics) with a survey

- Students then had the option to participate in an hour-long interview
  - Paid $20 for participating

- Also interviewed professors who used ungrading

- Interviews were transcribed and analyzed to identify common themes
  - 11 interviews in total (3 were professors)
  - “Coding” process / Thematic analysis

- Focus on emotional impact, motivation, and fairness
  - What went well and what can be improved

Motivation

“I think that’s really good for students, because it like, keeps you self motivated. Because you're working for your goals that are specific to you”

Students said they found self motivation and a desire to dive deeper into the topics they find interesting.

“I think a benefit [to traditional grading] would be we know exactly what we're supposed to be doing and don't have to figure anything out.”

Students said the most important improvement to be made is instructors laying out objectives, since numerical scales are absent
Fairness

"I feel like it's more inclusive, in the sense that it allows you to find out which way you learn best."

Students and teachers spoke about the freedom ungrading gave students to learn in their own style and at their own pace.

“You can't just like, throw them into the deep end of the pool, like swim. Tell me what grade you think [you got].”

“The place where the unfairness gets…is the interface point to the expected knowledge in the next class in the sequence.”

The outside world still demands grades, and there is tension at the interface. No matter what, assigning a grade is tricky.
Emotional Impact

“I'd say positively I've been a lot less stressed in this class. And I actually want to do the work in it…”

Students and teachers both expressed less stress from the course

“So, I think definitely changing from the grading scale zero to 100 to pass fail is definitely an adjustment for a lot of students.”

Some found it difficult to shift their mentality from the way they’ve always been graded
Ungrading and group work

- Semi-structured interviews on how ungrading influenced group dynamics in group project settings

- Key findings:
  - Regarding **identity**-mediated group dynamics, ungrading put everyone on an even playing field, creating equality among group members.
  - Regarding **motivation** in groupwork, ungrading mitigates the negative effects of unmotivated team members.
Ungrading and neurodivergence

- Neurodivergence is a broad term encompassing many identities
  - Some are associated with medical diagnoses, others not
  - Oppressive systems result in neurodivergent people being marginalized

- We asked participants to self-identify along general categories of neurodivergence
  - We used some language that pathologizes neurodivergence...
  - ...we chose to use it in this study because it is language that is most recognizable and understood by our study population
  - Participants who did not identify with any of these categories, nor with an open-response “Other” option, were characterized as neurotypical

- Conducted four focus groups / interviews
Ungrading and neurodivergence

Students with Developmental Disabilities

- Lack of confidence in creating their own course structure

Students with Mental Health Disorder (esp. depression)

- Difficulty with inflexible deadlines and grading policies in graded courses

Neurotypical Students

- A desire for clear instructions

- Flexibility to study on their own terms was helpful

Ungraded classes allow for knowledge to be the primary motivation for coursework

- Less pressure makes coursework more manageable

- Flexibility with time constraints makes coursework more manageable

- Struggle with lack of deadlines or concrete tasks in ungraded classes

Ana Gaby Cano
# Outline of workshop

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Summary

• Grades are inequitable and bad for learning

• There are many reasons to do ungrading
  • Logistic flexibility – course structure, deadlines, etc.
  • Epistemic flexibility – topics, content...what is learned

• There are many approaches to ungrading
  • It will never be one-size-fits-all

• Ungrading research in higher ed STEM is nascent, but promising
What do you intend to do the next time you teach?

Write it down
Share it with someone here
(optional) Schedule a check-in phone/Zoom call
Thank you!