Ungrading A Modern Physics Course

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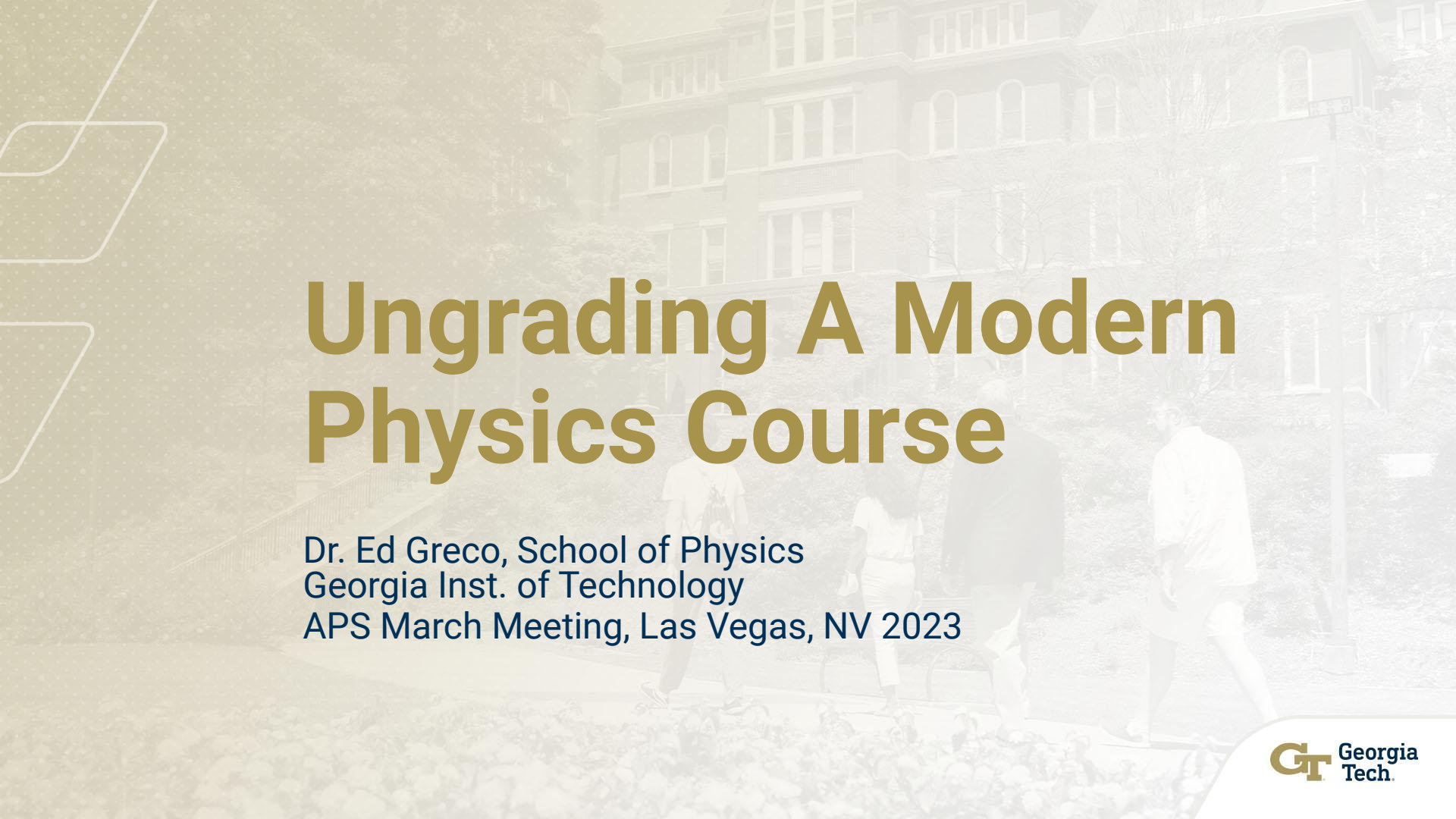
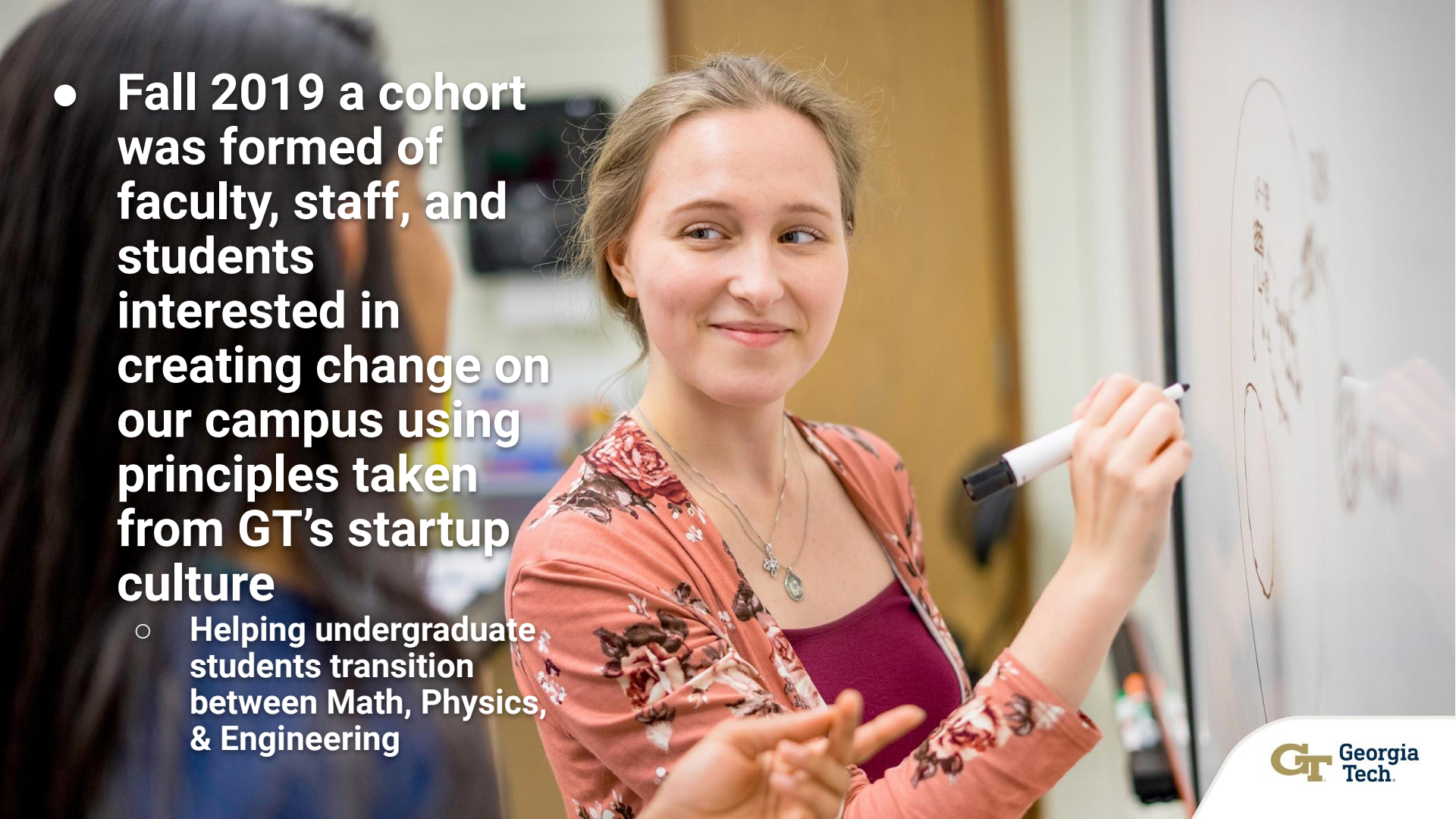
Georgia Inst. of Technology
APS March Meeting, Las Vegas, NV 2023





- Fall 2019 a cohort was formed of faculty, staff, and students interested in creating change on our campus using principles taken from GT's startup culture
  - Helping undergraduate students transition between Math, Physics, & Engineering

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Conducting interviews

- Looking for behaviors centered around students struggling to succeed in a course
  - *“What does it look like when you get stuck in a course”*
  - *“How do you help students who are struggling in your class”*
- We found a gap between faculty expectations and student behaviours
  - **Faculty:** Read this textbook and engage in discussion
    - Students do not seek access to the book
  - **Faculty:** Complete this homework to gain mastery of the material from lecture before an exam
    - Students google/chegg for answers and fail an exam
  - **Faculty:** Please visit office hours and ask for help
    - Students spend hours sifting through YouTube videos

- Grades and by extension GPA created a gap that both faculty and students struggle to accommodate

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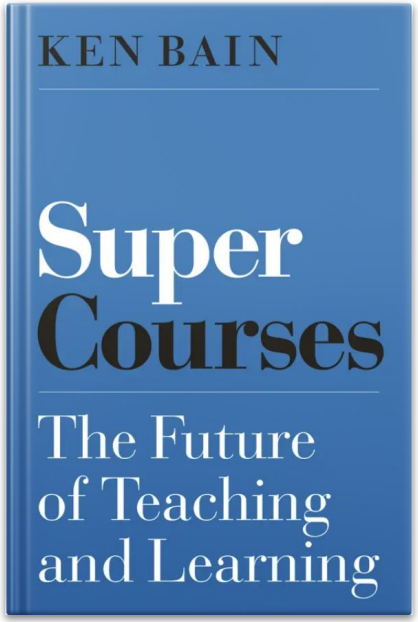
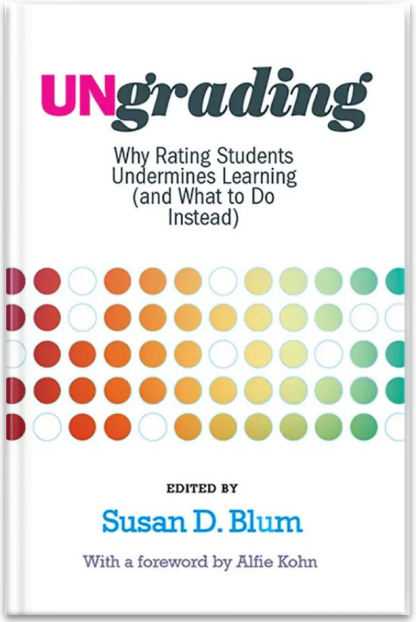
Grades are counterproductive to learning!

Decades of research in education and psychology have determined that grades:

1. Cause students to focus on the grade and not on learning
2. Do a poor job of motivating students to learn and take intellectual risk
3. Create a transactional relationships between students and faculty that result in the course gamification
4. Are the leading cause of stress and anxiety for college students





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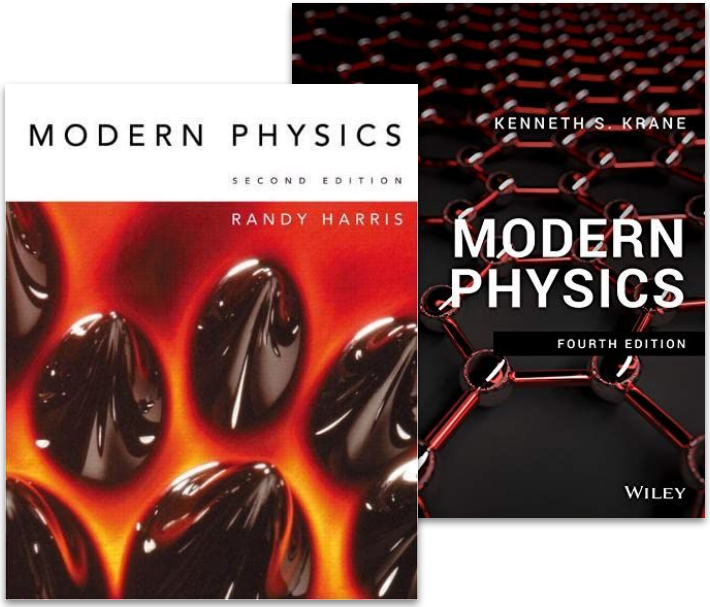
Introduction to modern physics ~ 30 students

- Topics
  - Special relativity, Waves and Oscillators, The photoelectric effect, The Schrodinger Equation, Atomic line spectra, Hydrogen atom, Maxwell-Boltzmann Distribution, Entropy and the second law, Specific heat of a solid
- Learning objectives
  - Understand and discuss ideas/experiments from 20th century physics
  - Solve problems in special relativity, elementary quantum mechanics, and statistical mechanics
  - Effectively communicating scientific ideas and work on a project in a team



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A tale of two courses

Graded Spring 2022

25% Class participation
- "Flipped" lecture format

20% Three Test

20% Group Project
- Poster presentation

10% Weekly HW

10% Weekly Reading

5% Test Wrappers

5% Wikitext edits

5% Colloquium review

Ungraded Fall 2022

Three required conferences

1. Student identify learning goals and propose activities (or use mine)
2. Student determine how they will assess progress
   a. How will they grade?
   b. Required growth and flexibility
3. Students specify grade
   a. What supporting evidence do you have?
   b. Instructor reserves veto rights when deviating!

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What did Ungraded students do?

- Activities in common with the graded course
  - 94% of students included class participation and exams
    - Two students attended some lectures and never tested
  - 97% of students completed a final group project and presentation
    - One student presented independently
  - 87% of students submitted homework
  - 28% of students completed assigned readings and discussions (Perusall)
  - 25% created a wiki page for www.physicsbook.gatech.edu

- Unique to the ungraded course
  - 25% of students wrote a review of a modern physics publication
  - 12% of students created physics videos
    - One student created series of problem solving tutorials (not public)
  - One student taught a lecture and developed a peer feedback rubric
  - One student created a learning journal with notes, art, worked examples
  - One student completed a series of independent projects

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How did ungraded students assign grades?

- 52% of students chose a standards based grading approach
  - Every student had a unique mix of standards and thresholds
- 48% of students chose a traditional points based approach
  - 56% went with a 10 point scale (90 - 100 A, 80 - 89 B, etc.)
  - 44% went with a 15 point scale (85 - 100 A, 70 - 84 B, etc.)

- Nearly every student factored in some form of Mastery grading into their assessment plan
  - The ability to redo work or complete additional activities to replace a score or demonstrate meeting a standard
  - One student had a difficulty time decided what to do and reported high levels of stress at having to decide themselves
  - One student did not participate or communicate

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Hours Conferencing with Students

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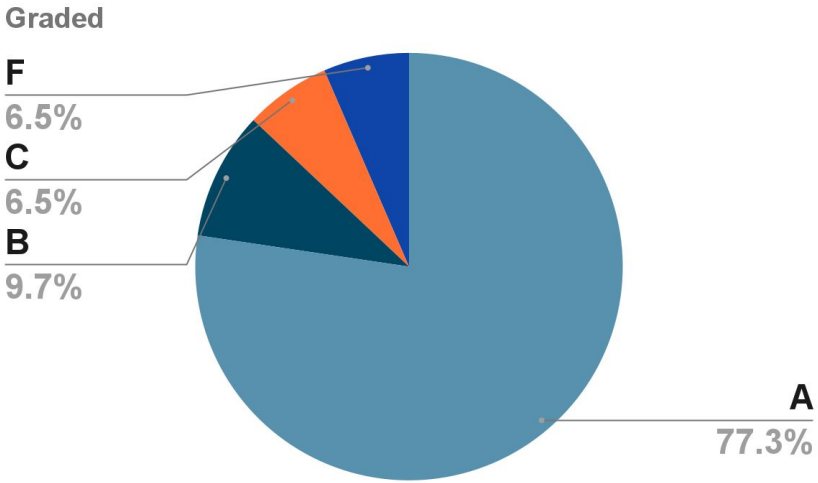
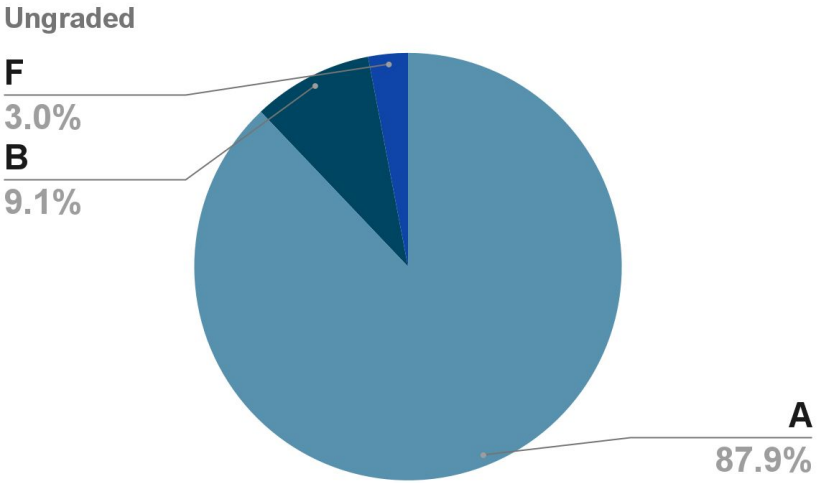
Final Grade Outcomes





- ***Graded*** *Typical course distribution since 2020. Two students did not participate in the course and did not withdraw. One student withdrew before midterms*

- ***Ungraded*** *114% increase in "A" grades. Grades are roughly shifted up one lettergrade. One student did not participate in the course but did not withdraw.*

Data available at https://lite.gatech.edu/

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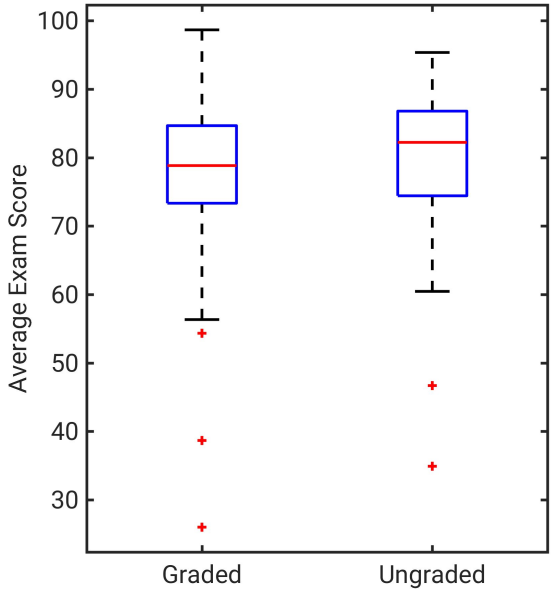
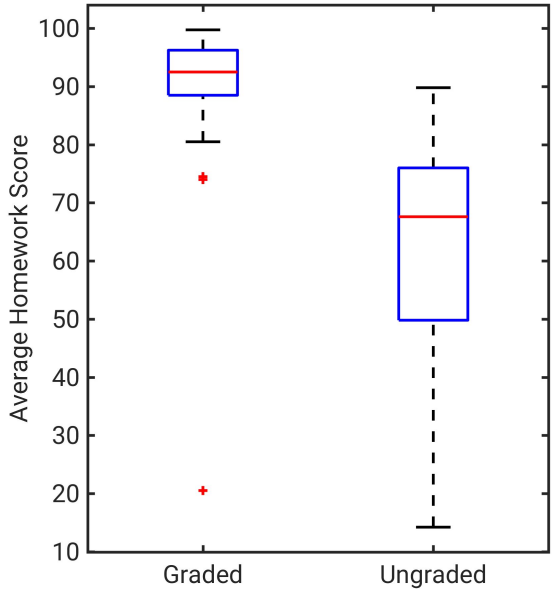
How do students compare on Exams and Homeworks

- 94% of Ungraded students chose to take proctored exams
  - Different exams questions, same rubric and topic coverage
- 87% of Ungraded students chose to submit homework
  - Same homework and grading rubric across semesters





- ***Ungraded*** *students did not require themselves to complete every homework assignment and never asked for a regrade on exams or homeworks*

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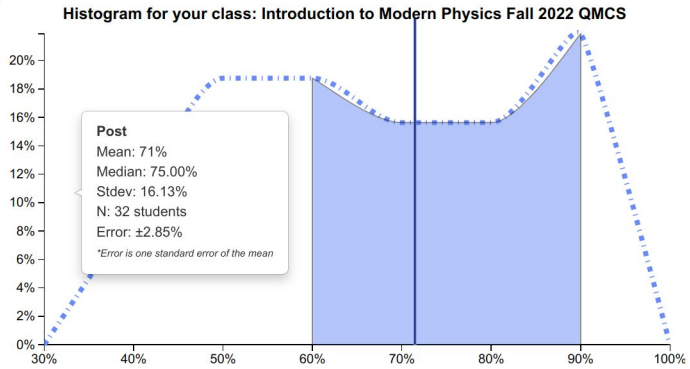
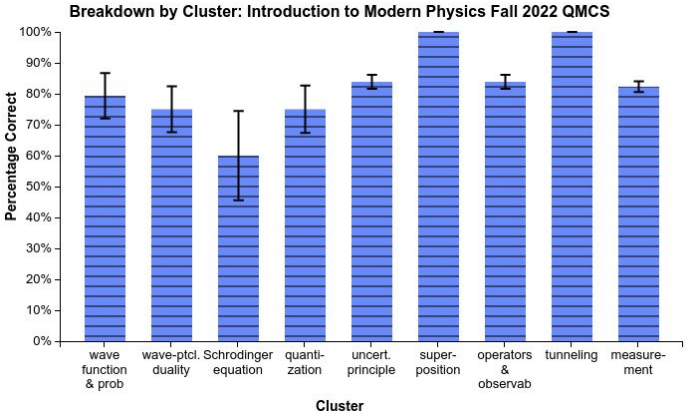
Ungraded Quantum Mechanics Conceptual Survey results





Typical Results

Typical scores from McKagan et. al 2010:

Class	N Pre	Pre-test score (%)	N Post	Post-test score (%)
modern physics for engineering majors, traditional	60	34 ± 2	42	60 ± 3
modern physics for engineering majors, reformed	246	35 ± 1	202	67 ± 2
modern physics for physics majors, traditional	63	41 ± 2	57	50 ± 2
modern physics for physics majors, reformed			69	69 ± 2
junior QM			22	79 ± 4
graduate QM			16	81 ± 6

- ***Ungraded*** *students scored comparable to "reformed" modern physics students as measured in McKagan et. al 2010*

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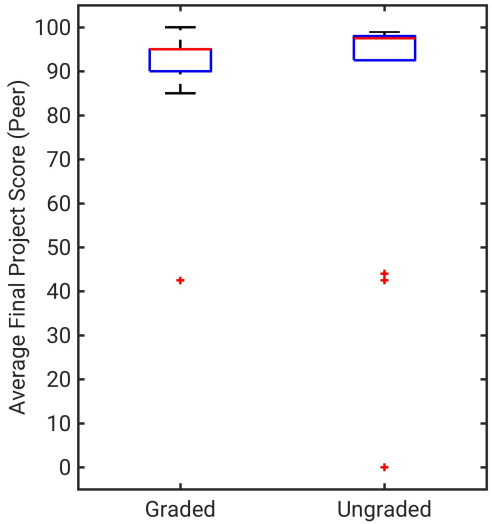
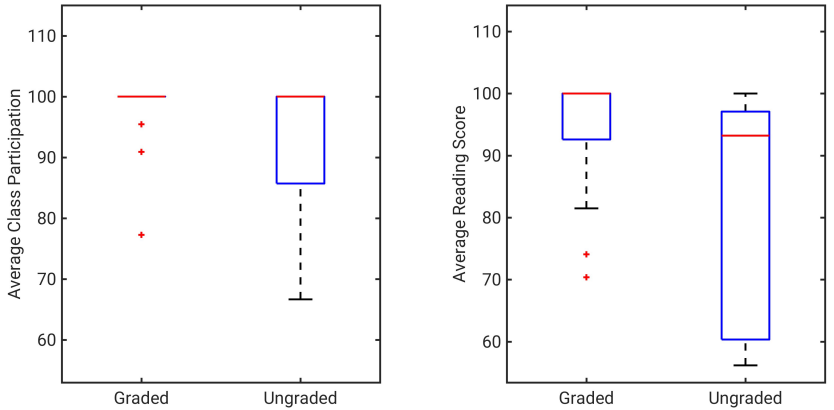
How did students engage with the course?

- Difficult to capture engagement for ungraded students participating in activities that did not map directly to graded course work



- ***Final Project*** *peer scores were improved for ungraded students. Ungraded students took on more risk favoring experimentation vs computation.*



- ***Participation*** *in activities like class discussion and reading assignments were similar. So few students participated in the other "graded" activities that a comparison was not meaningful.*

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Instructor Perspectives

The instructor and TA both felt the overall quantity and quality of engagement was improved for the ungraded students.

The group projects and presentations were more interesting and creative. One group is still working on their project.

End of course evaluations improved for the ungraded students. Overall feelings of inclusiveness, respect for students, and stimulating interest were boosted.

Performance on exams were comparable between graded and ungraded students. The instructor and TA spent less time grading!

Ungraded students self-reported spending 22% less time on this course compared to graded students. Similarly, ungraded students listed unexpected motivated factors for succeeding and created novel activities to support their learning

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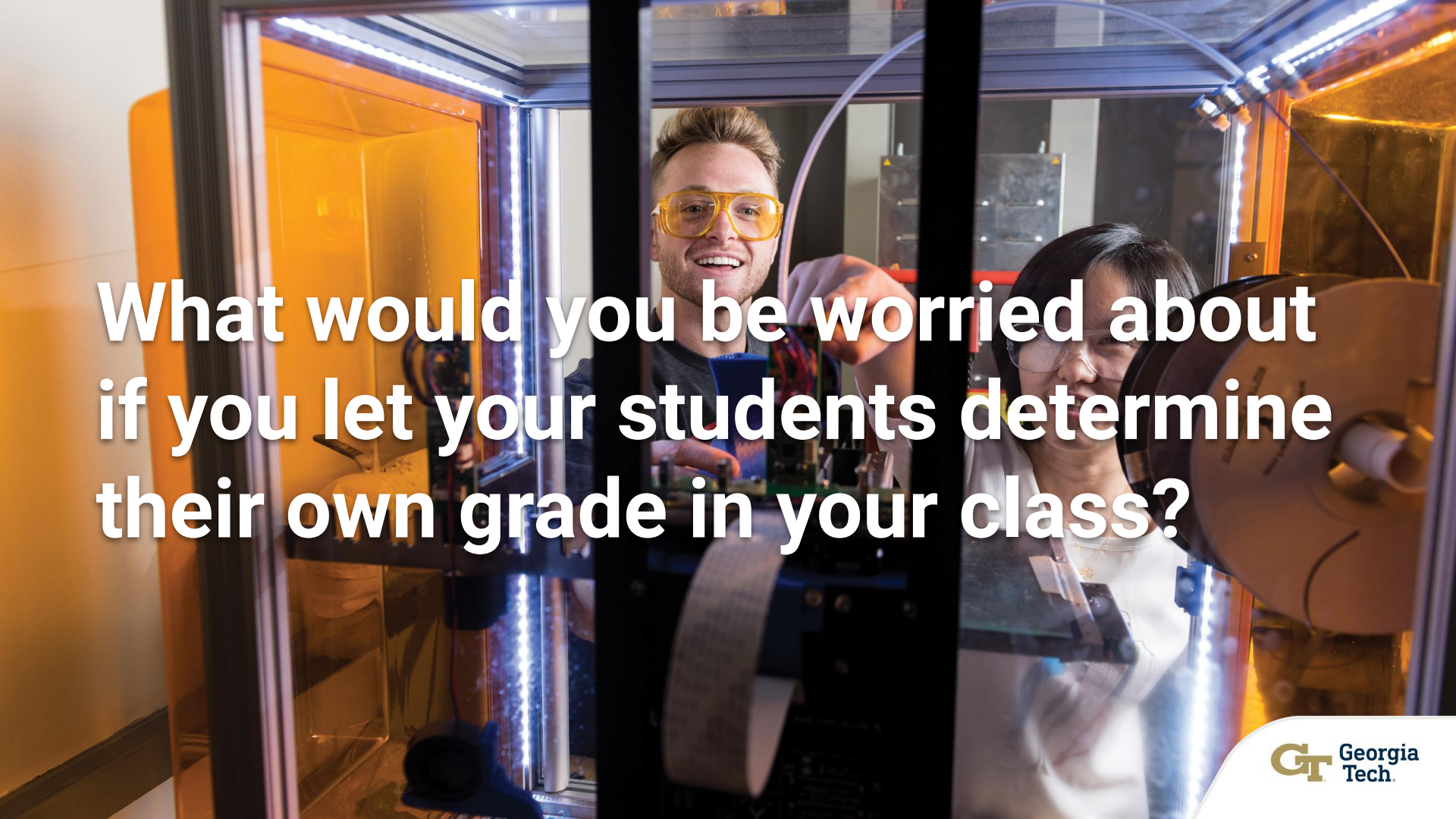

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Appendix: Student Evaluations

Graded

Question Text	N	Above Average			Average				Below Average		
		100%	-	70%	69%	-	-	30%	29%	-	1%
Hours per week spent on course	17	|-----	------	9.1	------	------	-----|				
Instructor: Feedback helpfulness (Greco)	17	|-----	------	4.1	-----|						
Instructor: Availability (Greco)	17	|-----	------	4.5	------	------	------	-----|			
Instructor: Stimulates interest (Greco)	17	|-----	------	4.3-|							
Instructor: Enthusiasm (Greco)	17	|-----	------	------	4.6	-----|					
Instructor: Inclusive (Greco)	17	|-----	------	------	------	4.7	------	------	------	-----|	
Instructor: Overall effectiveness (Greco)	17			|-----	------	4.2	------	-----|			
Instructor: Communicated how to succeed (Greco)	17		|-----	------	------	------	4.2	------	-----|		
Overall course effectiveness	17		|-----	------	------	------	3.9	------	------	-----|	
Instructor: Respect for students (Greco)	17		|-----	------	4.4	------	-----|				
Instructor Clarity (Greco)	17		|-----	4.3	-----|						
Assignments measured knowledge	17	|-----	------	3.9	------	------	-----|				
Amount learned in course	17	|-----	4.1	------	------	------	------	------	-----|		
Student preparedness to take subject	17	|-----	------	------	3.7	------	------	------	------	-----|	
Percentage of homework completed	17	|-----	------	------	92.9	------	------	------	-----|		
Percentage of classes attended	17	|-----	93.2|								

Ungraded

Question Text	N	Above Average			Average				Below Average		
		100%	-	70%	69%	-	-	30%	29%	-	1%
Hours per week spent on course	14			|-----	------	------	------	7.1	-----|		
Instructor: Feedback helpfulness (Greco)	14	|-----	4.4	------	-----|						
Instructor: Availability (Greco)	14	|-4.9	-----|								
Instructor: Stimulates interest (Greco)	14	|-4.6	-----|								
Instructor: Enthusiasm (Greco)	14	4.9									
Instructor: Inclusive (Greco)	14	5									
Instructor: Overall effectiveness (Greco)	14	|-----	------	------	4.4	------	------	-----|			
Instructor: Communicated how to succeed (Greco)	14	|-----	------	4.6	------	-----|					
Overall course effectiveness	14	|-----	------	------	4.2	------	------	------	------	-----|	
Instructor: Respect for students (Greco)	14	|-4.9	-----|								
Instructor Clarity (Greco)	14		|-----	------	------	3.9	------	------	-----|		
Assignments measured knowledge	14	|-----	4.1	------	-----|						
Amount learned in course	14	|-----	4.2	------	------	------	-----|				
Student preparedness to take subject	14	|-----	3.9	------	------	------	------	-----|			
Percentage of homework completed	14			|-----	------	------	------	90.4	-----|		
Percentage of classes attended	14	|-----	93.6|								

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Appendix: The GT Center for Deliberate Innovation

In Fall 2019 I joined a cohort of faculty, staff, and students interested in creating change on our campus using principles from GT startup culture

How to reduce the risk of failure for new initiatives:

1. Looking for “authentic demand”
2. Examining cognitive illusions and biases held by innovators and those who we hope to impact
3. Looking for the “Not-Not”
    a. Finding behaviours for which it is not ok to not do do something

White paper https://cdi.gatech.edu/

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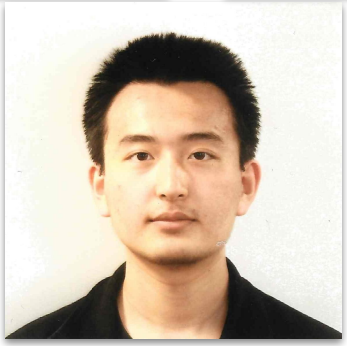
Past and current members of “Mind the Gap”

Past members: Dr. Neha Gupta (math faculty Emory), Dr. Don Pearl (retired), Peter Oliveira Soens (Yext), Garrett Price




Current members: Dr. Mike Schatz (physics), Dr. Merrick Furst (CDI, CS), Andrew Wu (physics)





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A Short Bibliography

- **Super Courses: The Future of Teaching and Learning**
  - Ken Bain, Princeton University Press; (March 9, 2021)
- **Ungrading: Why Rating Students Undermines Learning** (and What to Do Instead)
  - Susan D. Blum, West Virginia University Press; (December 1, 2020)
- **The Case against Grades by Alfie Kohn**
  - https://www.alfiekohn.org/article/case-grades/
- **Design and validation of the Quantum Mechanics Conceptual Survey**
  - McKagan, S. B. and Perkins, K. K. and Wieman, C. E., PRSPER, vol 6, issue 2, 2010
  - https://link.aps.org/doi/10.1103/PhysRevSTPER.6.020121