

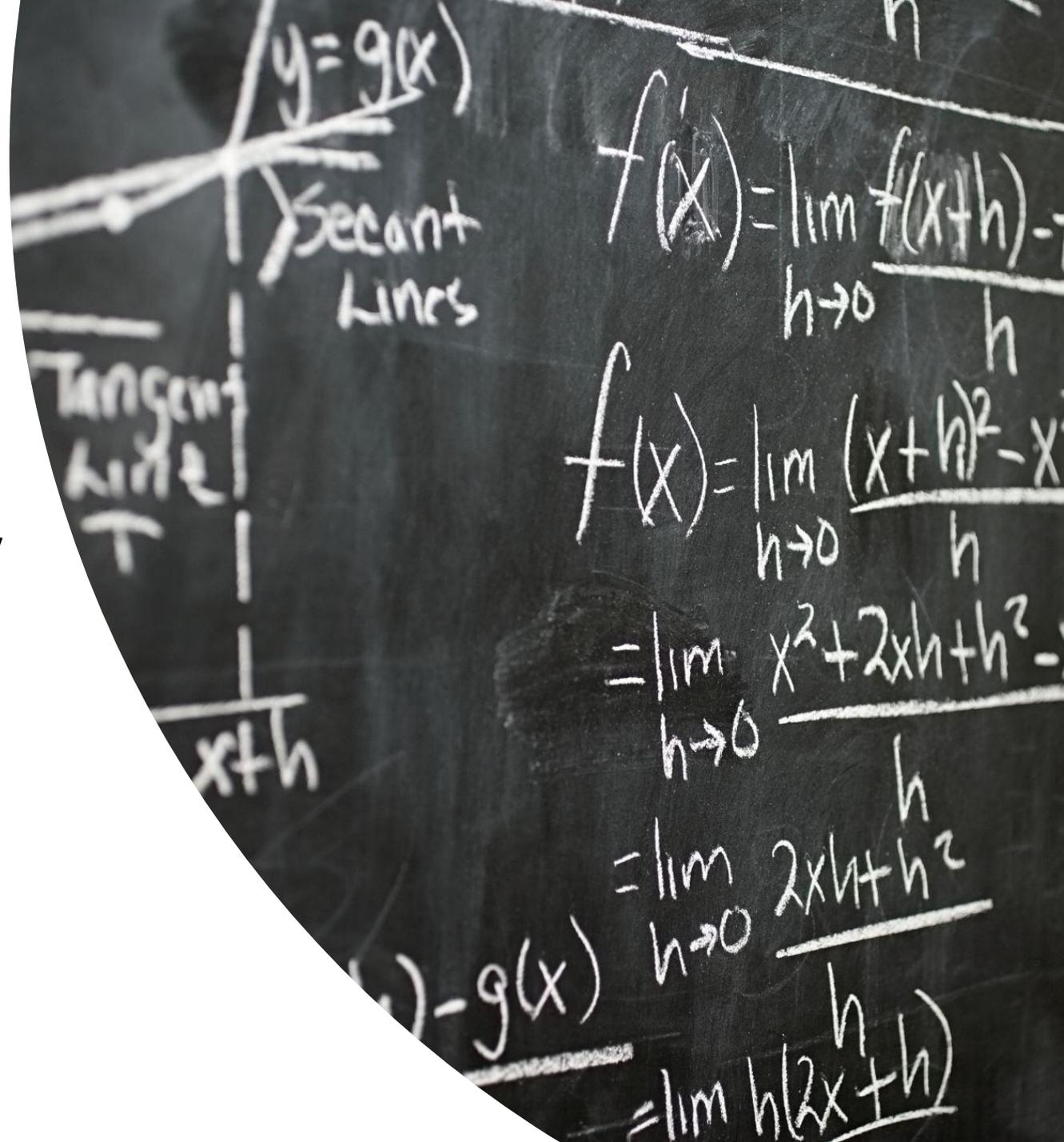
Effectiveness of Simulation-based Lessons in Introductory Physics Classes

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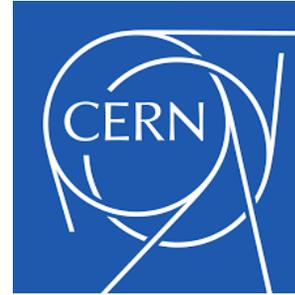
Motivation

- Physics/Physical Science is one of the most challenging subjects (especially when the students are non-STEM majors or even Biology or pre-MED majors)
- Many students find it difficult to understand
 - Teacher
 - Weak class presentation
 - Students
 - Weak Math Background
 - Previous not-so-good experience
 - No interest



An idea from Particle Physics Experiment

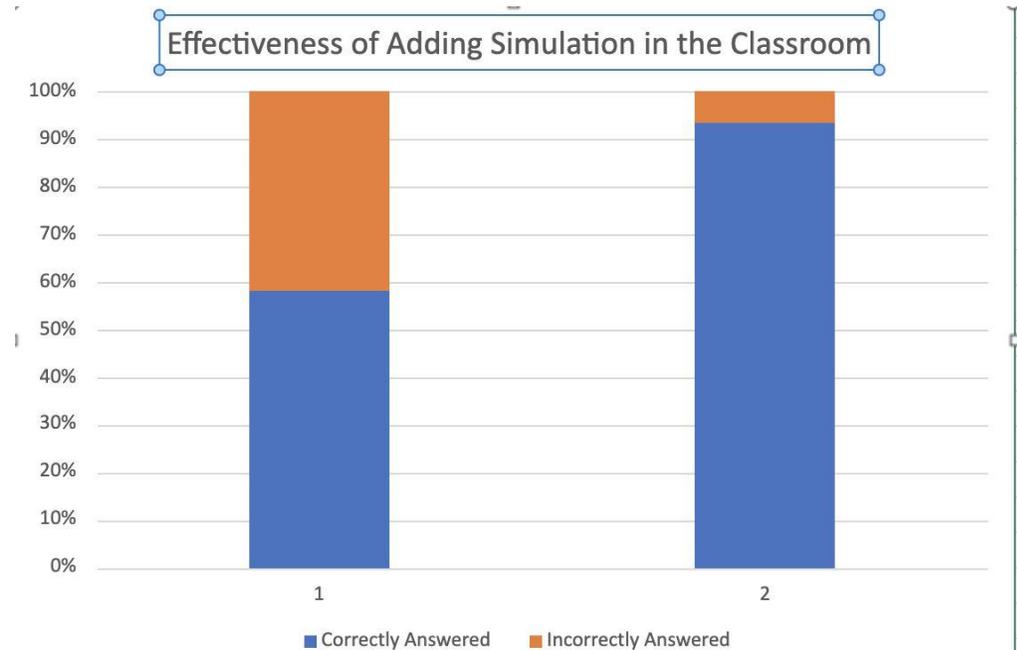
- Educators are trying different ideas.
- In particle physics experiments, Monte Carlo Simulations are used to study and understand any physics before real data are analyzed.



The first test (Traditional vs Sim-based)

- **Question:** When you exhale, all of the air in your lungs must exit through the trachea. If you exhale through your nose, this air subsequently leaves through your nostrils. The area of your nostrils is less than that of your trachea. How does the speed of the air in the trachea compare to that in the nostrils?
- [Fluid Pressure and Flow](#)

Fall 2020 at Northwest Florida State College
Students are non-STEM Majors
~25 students in each class



Spring 21, NWFSC, Physical Science (Students' Feedback)

- “There is a profound difference between being a subject matter expert, and being an effective instructor. You can be one, and not necessarily the other. When you are both, you are a true teacher. This is Prof. Pal. In my opinion, he did so many things right during the course. He captured my attention with his very first lecture and I looked forward to every other lecture afterwards. One of the things I most appreciated about Prof. Pal was how thoroughly he covered a topic and how flawless his knowledge was on everything he taught. He organized his lectures in a way that made learning the topics easier. He provided us with ample materials to learn the topics...the interactive learning aids were particularly helpful in my learning.”
- “He prepared the lectures very well. He taught the subject and had videos and simulations to help us understand. He always kept the classroom in a light and positive environment!”
- “I loved his teaching skills, and the fact he always tried to push us asking questions if something was unclear or if we had problems with a topic. He was to make us understand the subject, and the fact he succeeded into finally making me understand a subject that I don't really like.”
- “I truly feel that if I didn't have Professor Pal I would not have done well in physics. He made this class manageable and never once was I stressed about this class and that is amazing because I was terrified to take physics, it seems intimidating, however he really made it possible, and I am so lucky I had him this semester.”

Fall 21 and Spring 22 (Marywood, Algebra-based General Physics)

- Fall 21 -> Traditional only, 35 students (3.2/5)
- Spring 22 -> Sim-based, 25 students (4.0/5 with many good feedbacks)
- Fall 22 -> Sim-based, 34 students

A Sample Chapter (Work, Energy, & Power)

- Work
 - Kinetic Energy & Work-Energy Theorem
 - Gravitational PE
 - Elastic PE
 - Conservation of Mechanical Energy
 - Conservation of Energy
 - Power
- Work
 - KE, Work-Energy Theorem
 - Gravitational PE
 - Elastic PE, Hooke's Law, More Elastic PE
 - Area under the F vs d curve is work
 - Conservation of ME, Conservation of ME
 - Conservation of Energy
 - Power

Plan

- We are currently using a commercial textbook with open-source simulations. Our plan is to redesign algebra-based General Physics courses with all OER.

