

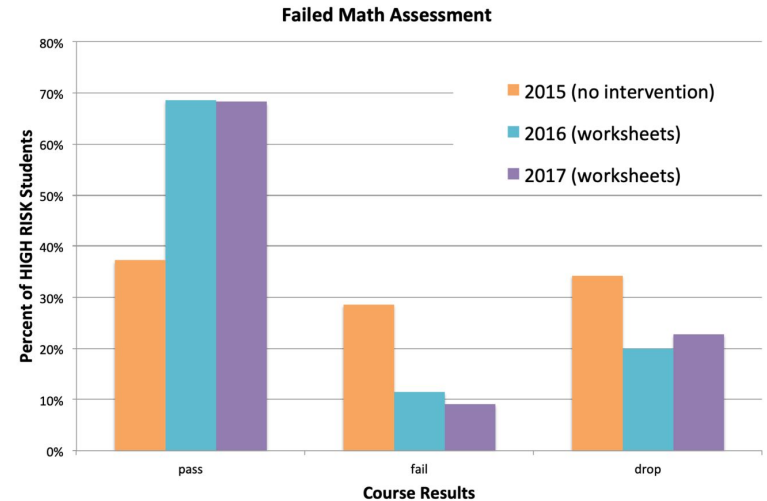
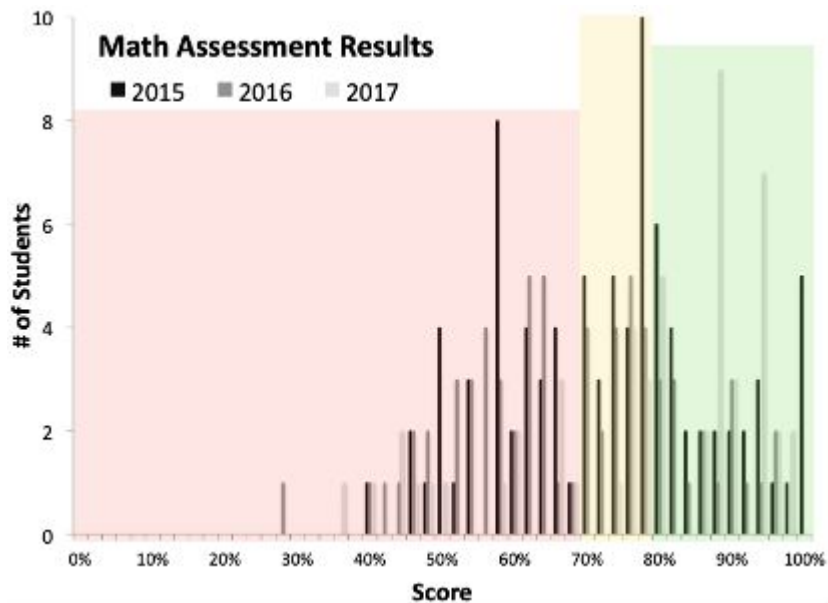


Embedded Support in Introductory Physics

Spring 2021 Sabbatical Project

The Problem: Math is foundational to Physics

Math background is the single greatest indicator to success in physics





The Problem: Math is foundational to Physics

We used to approach this with a deficit mindset and think students were “unprepared” and we needed to work with math to fix this/change prerequisites, but... we surveyed and found:

Students who fail or drop

- 43% took calculus more than 2 years ago
- 22% took their last non-calculus math class over 5 years ago
- 70% say they do not like math
- 57% performed poorly in, did not take, or failed a prerequisite math course
- **89% said they did not know how to find resources to improve math skills when not provided**

NOTE: 50% of students who drop did not do so for academic reasons

Solution: Free, embedded help within the course

Map the math topics to the physics topics

Topic	Physics Area	Essential Math	Helpful Math
1 graphing motion	Kinematics	graphical analysis	Integration (basic) Differentiation
2 position, velocity, acceleration	Kinematics	Vector decomposition Vector addition calc derivative calc integration basic algebra	
3 2D 3D motion	Kinematics	Vector decomposition Vector addition calc derivative calc integration basic algebra	
4 newton's laws - force diagrams	Dynamics	Vector decomposition Vector addition basic algebra systems of equations	
5 Circular motion	Dynamics Kinematics	Vector decomposition Vector addition trig basic algebra	
6 Energy	Energy	basic algebra graphical analysis Dot product	
7 Collisions	Energy Momentum	systems of equations basic algebra Vector decomposition Vector addition	
8 Moment of Inertia	Rotation	calc integration Vector decomposition	Integration (basic)
9 Center of Mass	Rotation	calc integration Vector decomposition	Integration (basic)
10 Torque	Rotation Dynamics	Cross Product Vector decomposition Vector addition	

39 records



Solution: Free, embedded help within the course

For each topic create a “Math Snack” module:

- Write quiz bank questions (5-8) that assess topic readiness
- Write and record short video with examples
- Find/make worksheets for practice



Solution: Free, embedded help within the course

Short 4 question “quizzes” catch students up by providing adaptive solutions

⋮	 Math Snack: Units! Aug 31 4 pts	Mastery Paths	✓	⋮
⋮	 Unit Conversion Video 1 pts	Multiple	✓	⋮
⋮	 Solving with Units 1 pts	Multiple	✓	⋮
⋮	 Dimensional Analysis Review 1 pts	2 pts - 0 pts	✓	⋮

ts

Details Questions Mastery Paths

Show Question Details

Units Pick 4 questions, 1 pts per question

Unit Analysis

If there are $(5/8)$ mile per km (kilometer) and 60 seconds in a minute, then 100 km/minute is about

- 3 miles/second
- 4,000 miles/second
- 6 miles/second
- 0.1 miles/second
- 1 mile/second

Correct Answer

Unit Analysis

You are throwing a pizza party for 15 people who you assume will eat about 4 slices each. Each pizza costs \$20 and is cut into 12 slices. If you have \$137, how much money will you have left over after you buy enough pizza for everyone (you can assume there are no additional costs outside the cost of the pizza)?



Details Questions Mastery Paths

4 pts

+

1 pts
Unit Conversion Video

3 pts

+

1 pts Solving with Units & 1 pts Unit Conversion Video

2 pts

+

1 pts Dimensional Analysis Review & 1 pts Solving with Units & 1 pts Unit Conversion Video

0 pts

Use mastery paths in Canvas to give students a choose your own adventure model!

4 pts

+

3 pts

1 pts

Unit Conversion Video



+

2 pts

1 pts

Solving with Units

&

1 pts

Unit Conversion Video

+

0 pts

1 pts

Dimensional Analysis Review

&

1 pts

Solving with Units

&

1 pts

Unit Conversion Video

YouTube video player interface for 'Unit Conversions 1' by WhyComponent.

Unit Conversion - canceling units

① Problem: 2 miles → [?] m

1 mile = 1.609 km
1 km = 1000 m
conversion factors

$$2 \text{ miles} \cdot \frac{1.609 \text{ km}}{1 \text{ mile}} \cdot \frac{1000 \text{ m}}{1 \text{ km}} = 6436 \text{ m}$$

② density of propane $36.28 \frac{\text{lb}}{\text{ft}^3} \rightarrow [?] \frac{\text{kg}}{\text{m}^3}$

$$\begin{cases} 1 \text{ lb} = 454 \text{ g} \\ 1 \text{ in} = 2.54 \text{ cm} \end{cases}$$

8 views · Aug 24, 2021

WhyComponent 73 subscribers

ANALYTICS EDIT VIDEO

A description of converting units with examples.

Use mastery paths in Canvas to give students a choose your own adventure model!

**Currently implementing this content
in my class. Hoping to see some good
results!**

Also created a catalog of example problem videos as supplemental class material.



Results

- 6 adaptive math modules (these will be moved to canvas commons once tested)
 - Quiz bank
 - Video
 - Worksheets
- Plans for 6 additional modules
- 20 full length example problems for the first two physics semesters