Deeper Understanding Through Problem Posing

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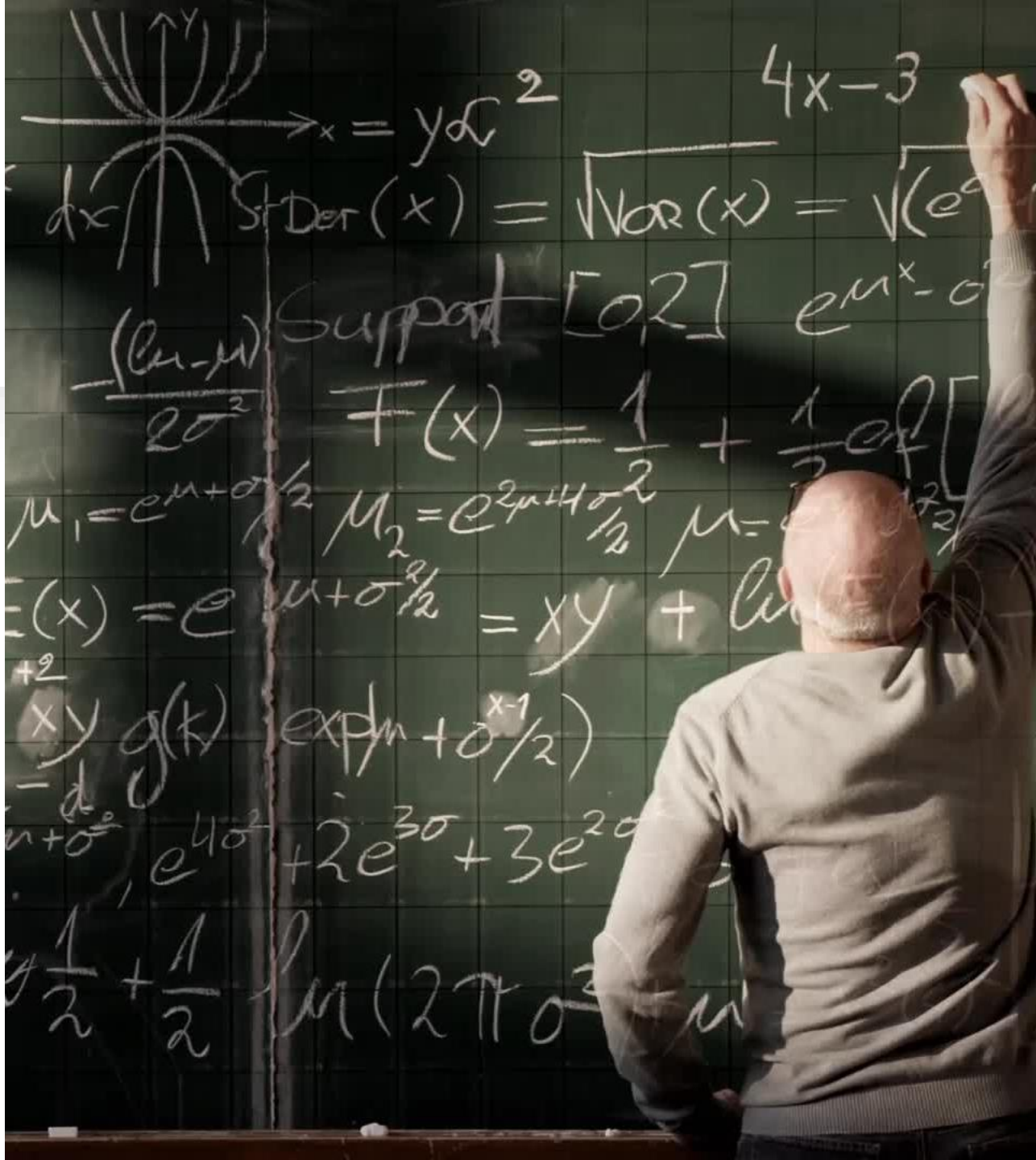
Inspiration

- In 1819, Anton Diabelli invited 51 prominent composers to submit one variation to a waltz he had composed.
- Beethoven submitted 33.
- Beethoven's were the most original of all the entries.
- Even after seeing Beethoven's compositions, composers of the time submitted much tamer variations.
- Hattie (2023) Problem-posing increases creativity: ES 0.62

Rationale

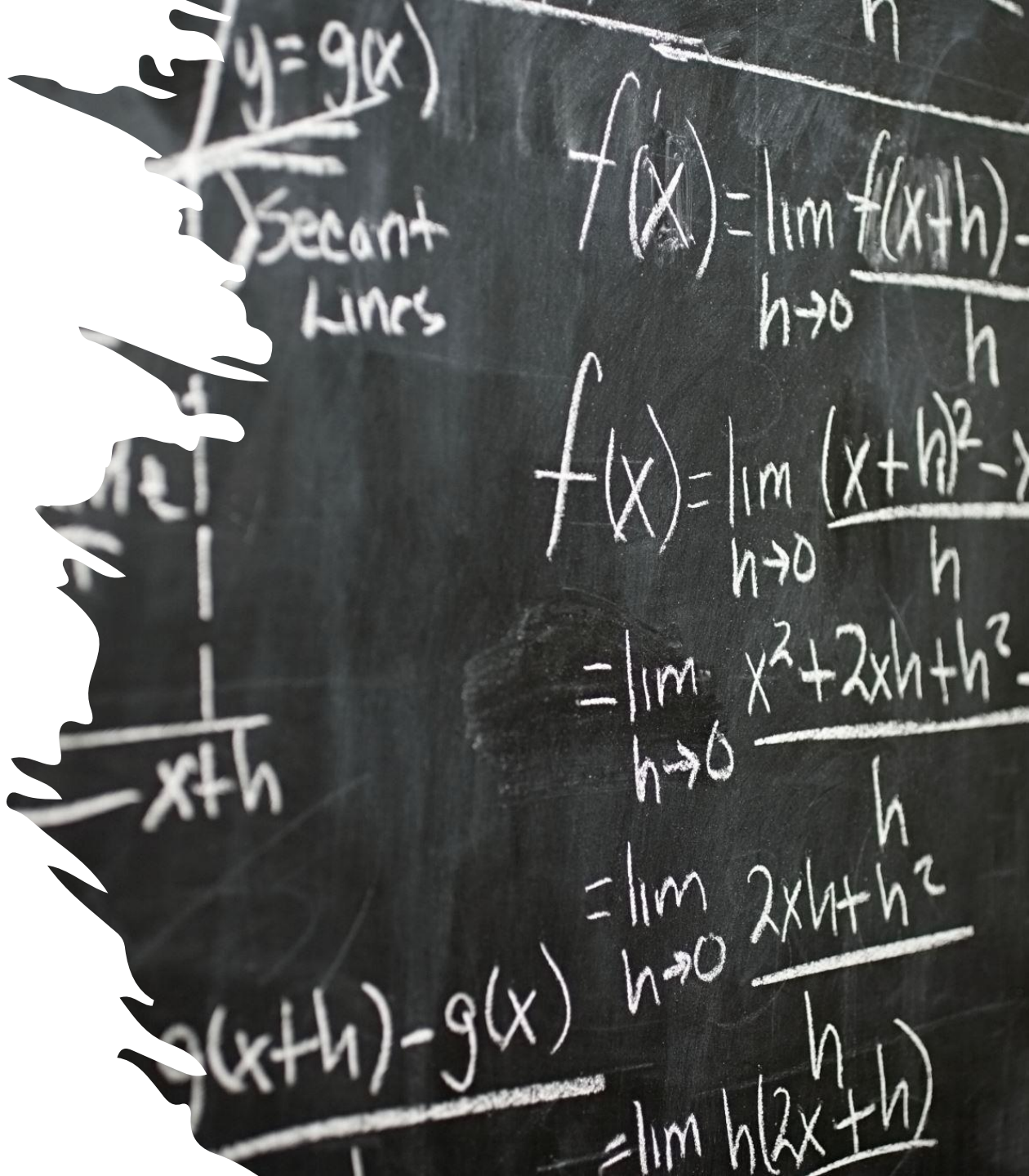
Problem-posing ability related to problem-solving ability (Calabrese et al., 2022)

Problem-posing is considered a critical thinking skill requiring higher-order thinking, imagination, and active learning (NCTM, 2000)



Objective

To determine if problem-posing increases AP Mechanics C achievement.



Problem-Posing Research

2002	2010	2014	2022	2022
Mestre demonstrated Problem posing could be used as an assessment	Ergun found that it had a positive effect on first-year university physics achievement.	Rosli, Capraro, and Capraro conducted a meta-analysis on problem posing and its effect on mathematics achievement. They found a positive effect. ES: 1.31.	Calabrese, Capraro, and Thomson conducted a systematic review and found that results were mixed for math achievement, and more research was needed.	Yet, in 2022, Wang, Walkington, and Rouse conducted a meta-analysis and again found a positive effect. ES: 0.64

Procedure

For each AP Mechanics C unit:

- Students completed a series of free response questions.
- Then for review, each student designed a University-level practice problem with 5 parts.
- Students switched problems and solved their partners' problems.
- Two physics instructors graded the difficulty level of the designed problem. Scale: 1 - 5
- Criteria:
  - Class example with minor changes
  - Combining class examples
  - Algebraic
  - Calculus
  - Graphing
  - Multiple objects
  - Incline
- At the end of the unit, students took an AP Mechanics C unit exam, 50 percent multiple choice (n = 24), 50 percent free response (n = 3).

Analyses

Using R Core Team (2013). R: A language and environment for statistical computing, the following analyses were conducted:

- Box Q-Q Plot to identify any outliers. None found.
- Descriptive statistics and distribution plots for both problem posing and assessment.
- Bayesian machine learning was used to determine the magnitude and direction of arc causation.

Descriptive Statistics

Problem-posing Score:

N=15

Median: 3.00

Mean: 3.18

Std. dev.: 1.4

Min.: 1

Max.: 5

AP Unit Exam:

N=15

Median: 56.00

Mean: 54.91

Std. dev.: 8.65

Min.: 43.0

Max.: 67.0

Random/Generated Bayesian Network (bnlearn)

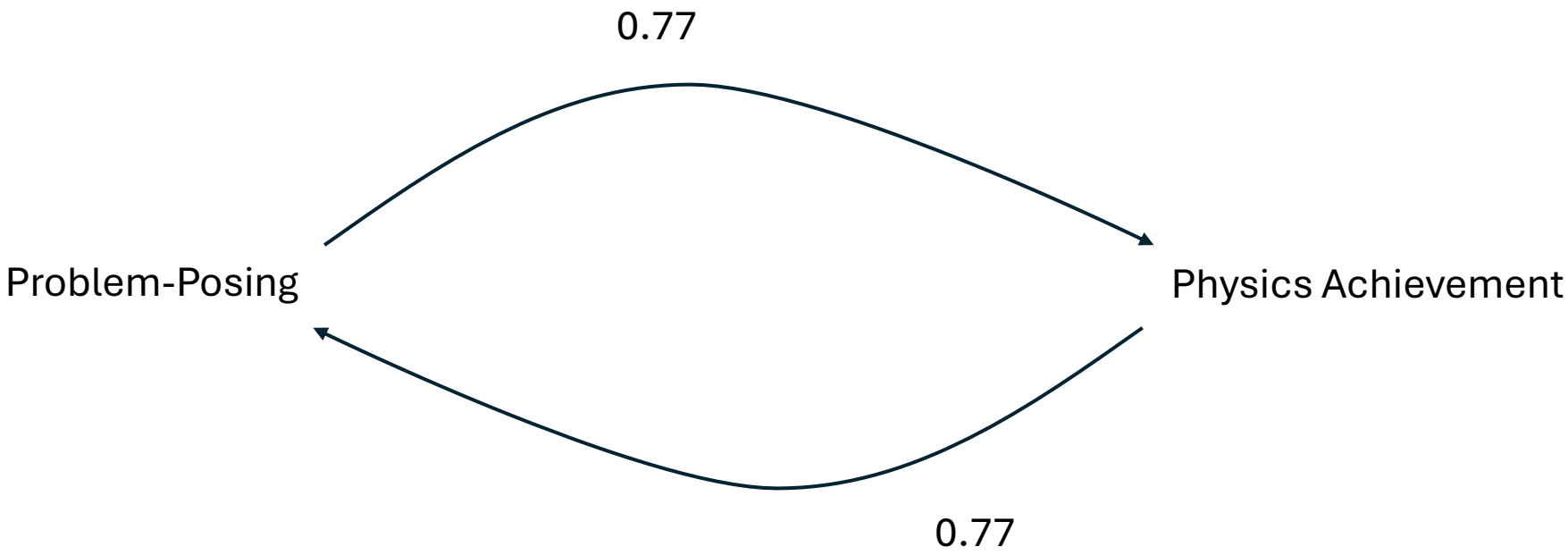
Nodes: 2

Correlation: 0.58

Arcs:	Strength*	Direction
Problem-posing → Physics Achievement:	0.77	0.5
Physics Achievement → Problem-posing:	0.77	0.5

* Maximum strength is 1.

Bayesian Network Plot



Results

- Problem-posing leads to better physics understanding and in turn better physics understanding leads to better problem-posing.
- Problem-posing can be used as both a tool to increase physics understanding and as an assessment to measure student physics understanding.
- Because prior understanding leads to better problem posing, I recommend its use as a review tool.

Future Directions

Conduct a comparison study using a larger sample.

Conduct a study with problem posing imbedded in the unit assessment.

Thank you!

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