Solving Physics Problems: The Students' Perspective

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Overview

- Motivation and Introduction
- Talk-aloud Procedure
- Analysis and Discussion
- Summary and Future Direction

Motivation and Introduction

Newtonian Concepts

- Force Concept Inventory (FCI)
  - Traditional (Trad) vs. Matter & Interactions (M&I)
  - M&I performance quite a bit worse
  - Gain scores calculated (post-pre)
  - Items yielded up to a 25% difference in gain scores
  - Ten items for further investigation

Students' Perspective

- Question: "What are they thinking?"
  - Want to understand thought process, reasoning
  - Approach to problem solving
- Use systematic methodology
  - Quantify this information
  - Analyze data
- Greater insight

Talk-aloud Procedure

Talk-aloud Protocol

- Before experiment
  - Recruited and trained participants
- During experiment
  - Solved 10 FCI questions
  - Video/audio recorded
- After experiment
  - Transcribed
  - Developed coding system
  - Analyzed data

Results and Discussion

Item #8

Two metal balls are the same size but one weighs twice as much as the other. The balls are dropped from the roof of a single story building at the same instant of time. The time it takes the balls to reach the ground below will be:

(A) about half as long for the heavier ball as for the lighter one.

(B) about half as long for the lighter ball as for the heavier one.

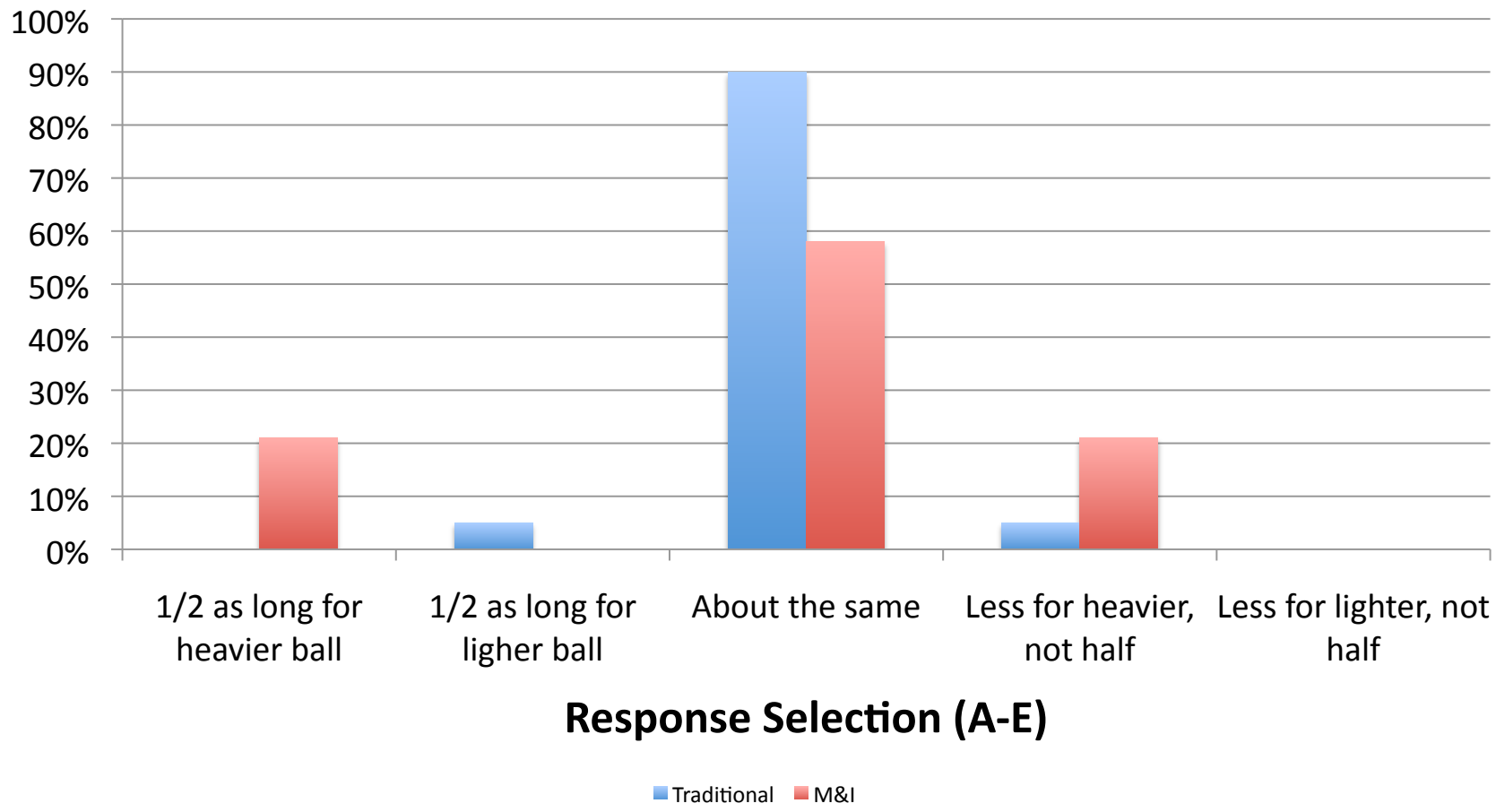
(C) about the same for both balls.

(D) considerably less for the heavier ball, but not necessarily half as long.

(E) considerably less for the lighter ball, but not necessarily half as long.

Metal balls ($m_1 > m_2$) dropped,
Time to reach ground…

Response Fingerprint



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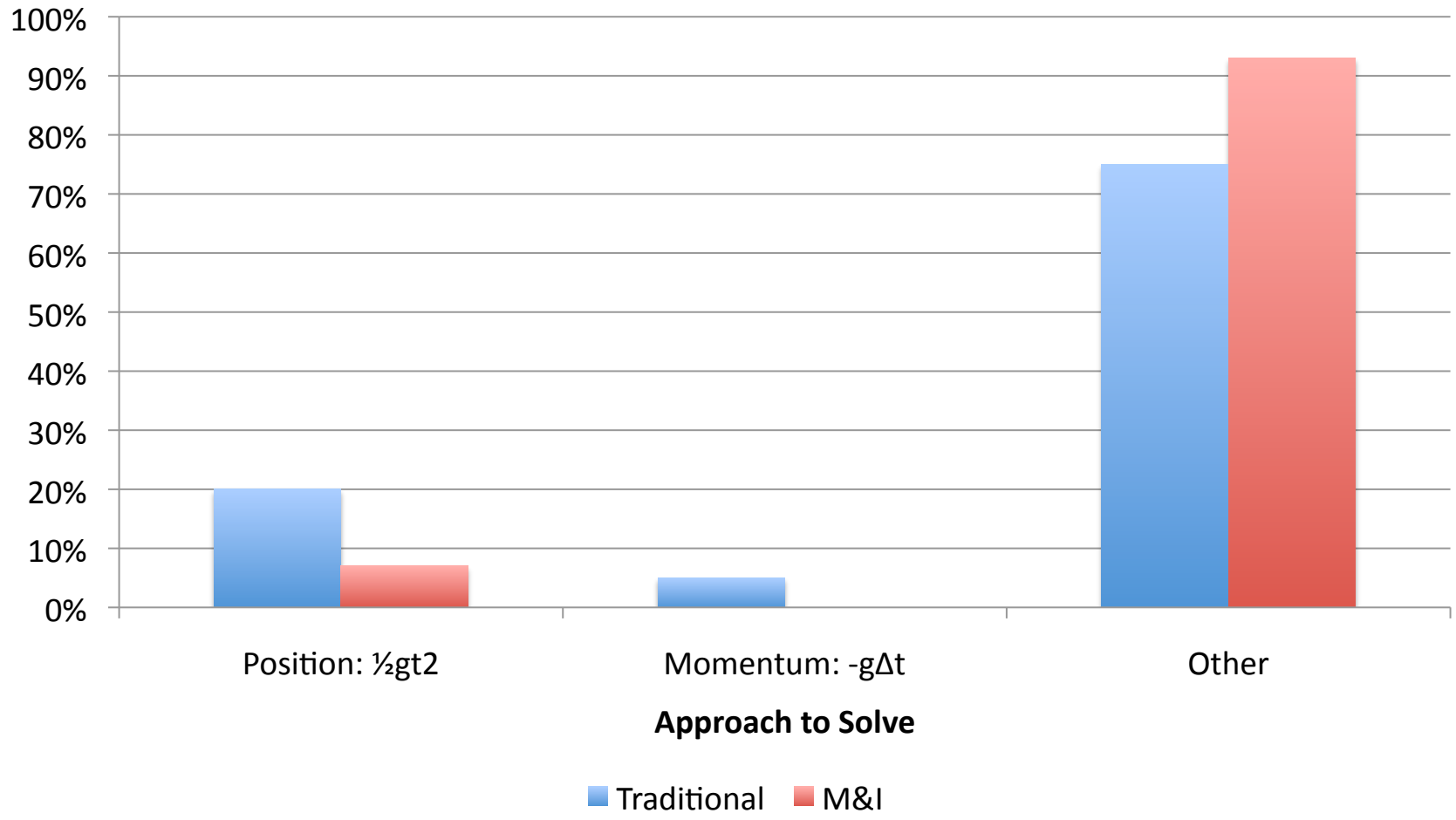
Apriori Analysis



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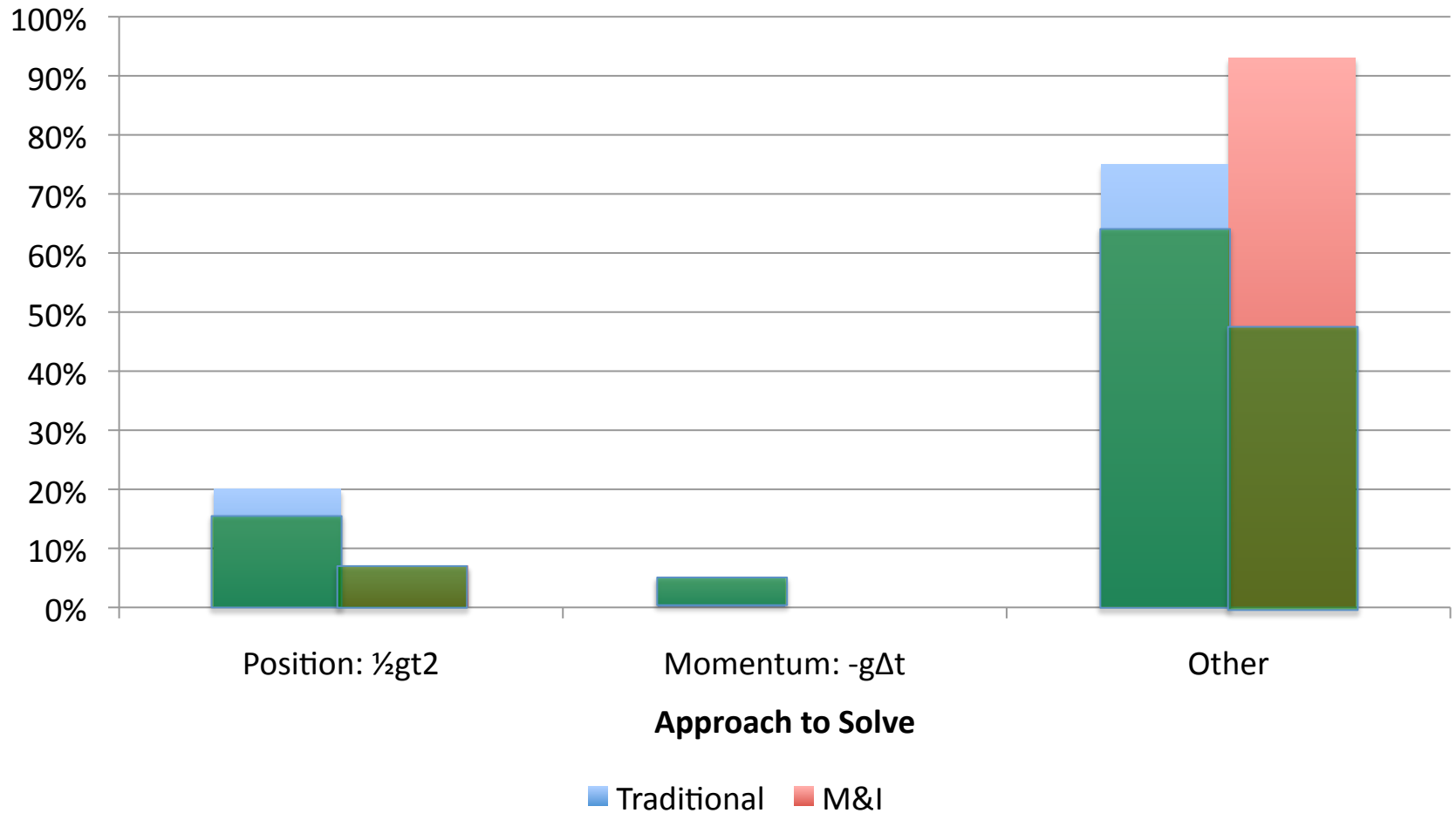

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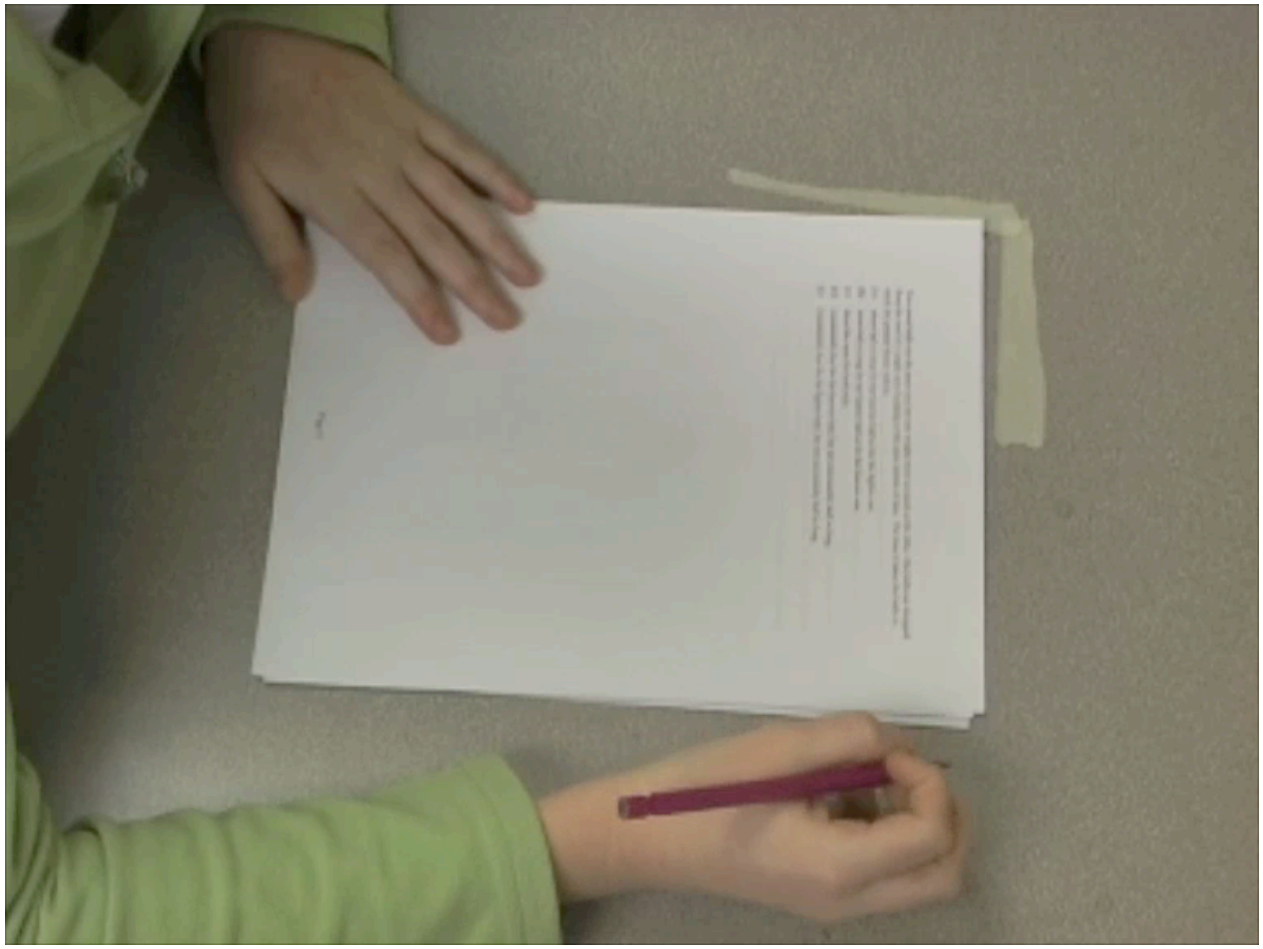

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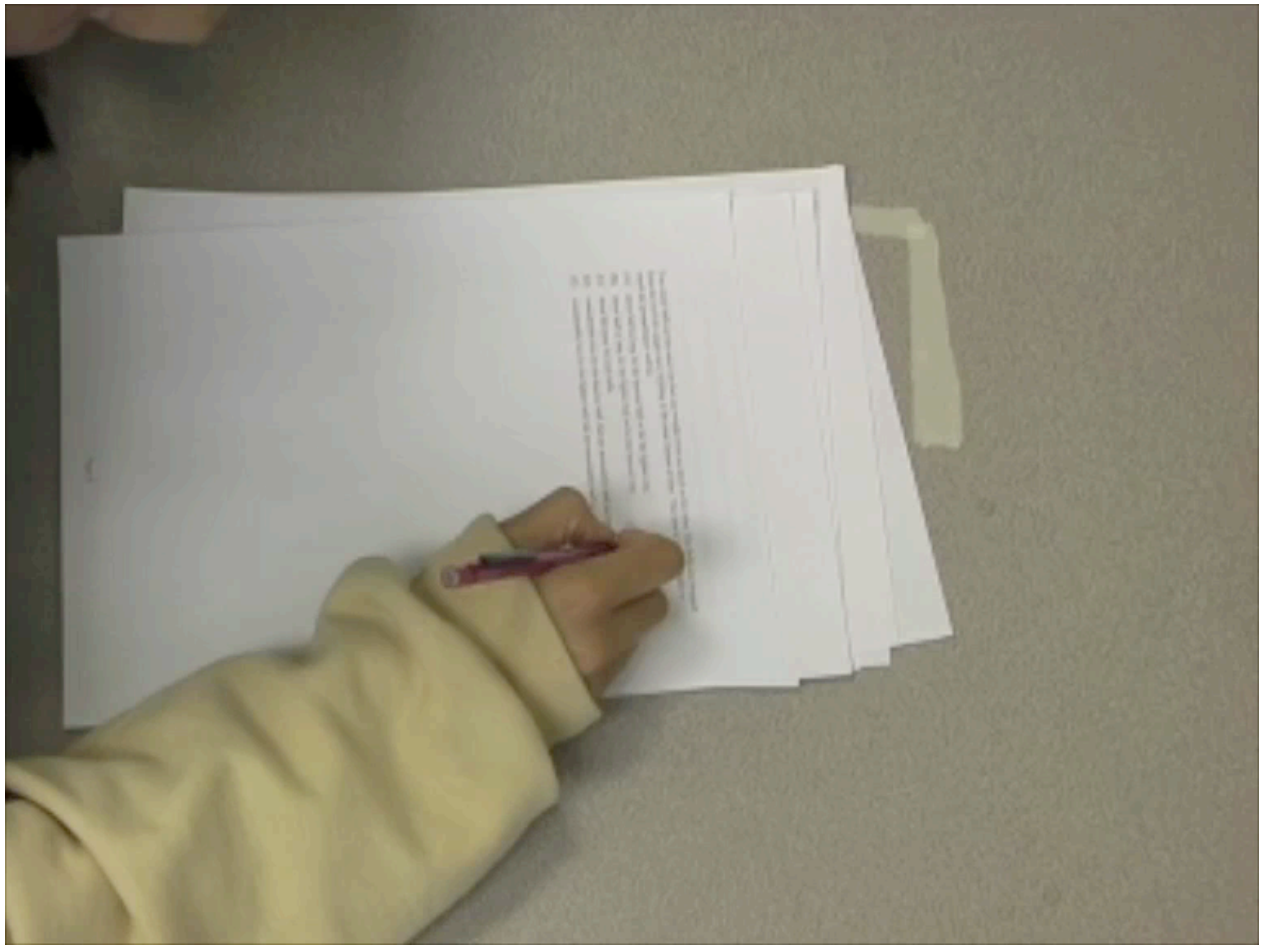

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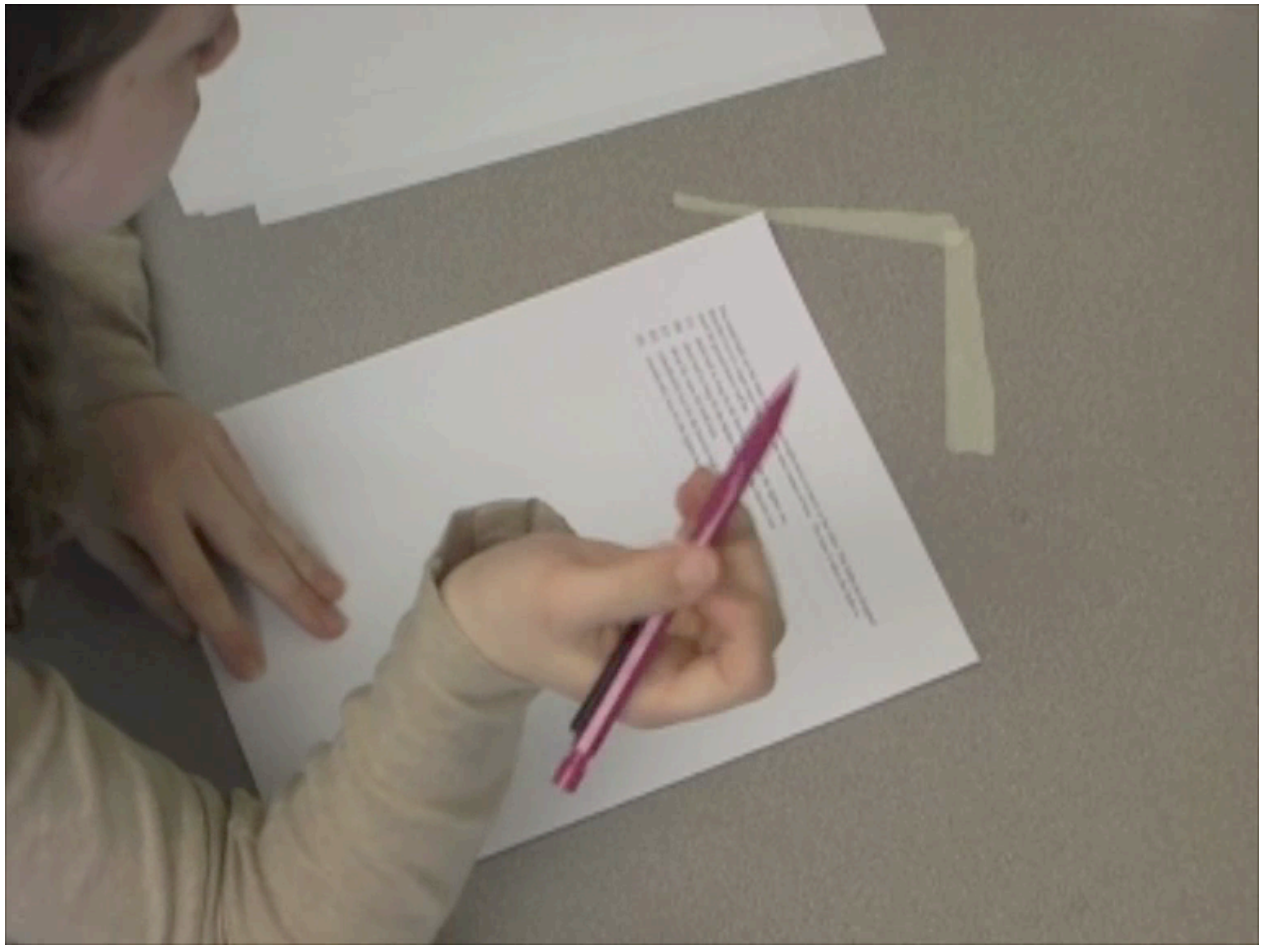

Metal balls ($m_1 > m_2$) dropped,
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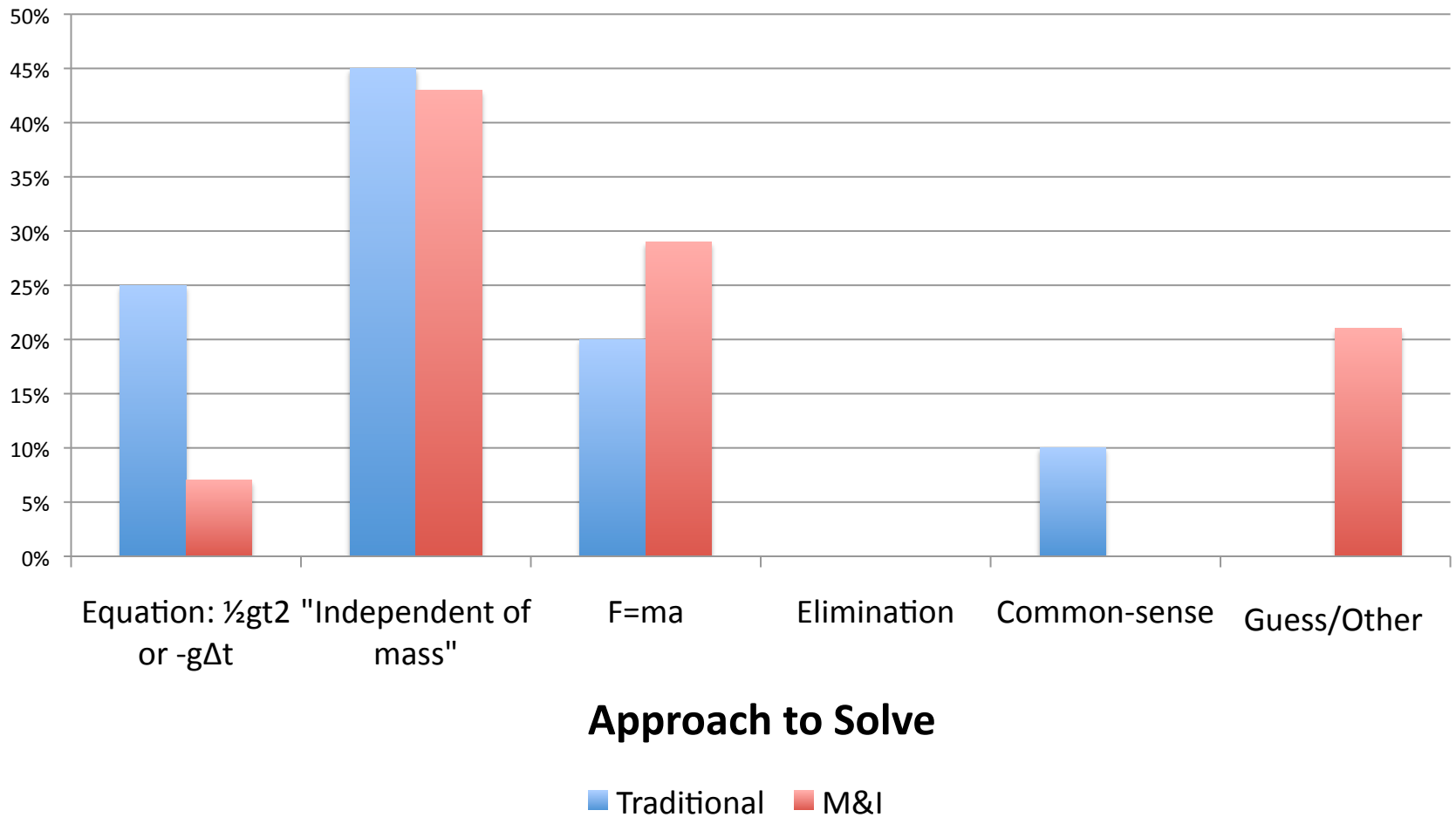
Post hoc Analysis



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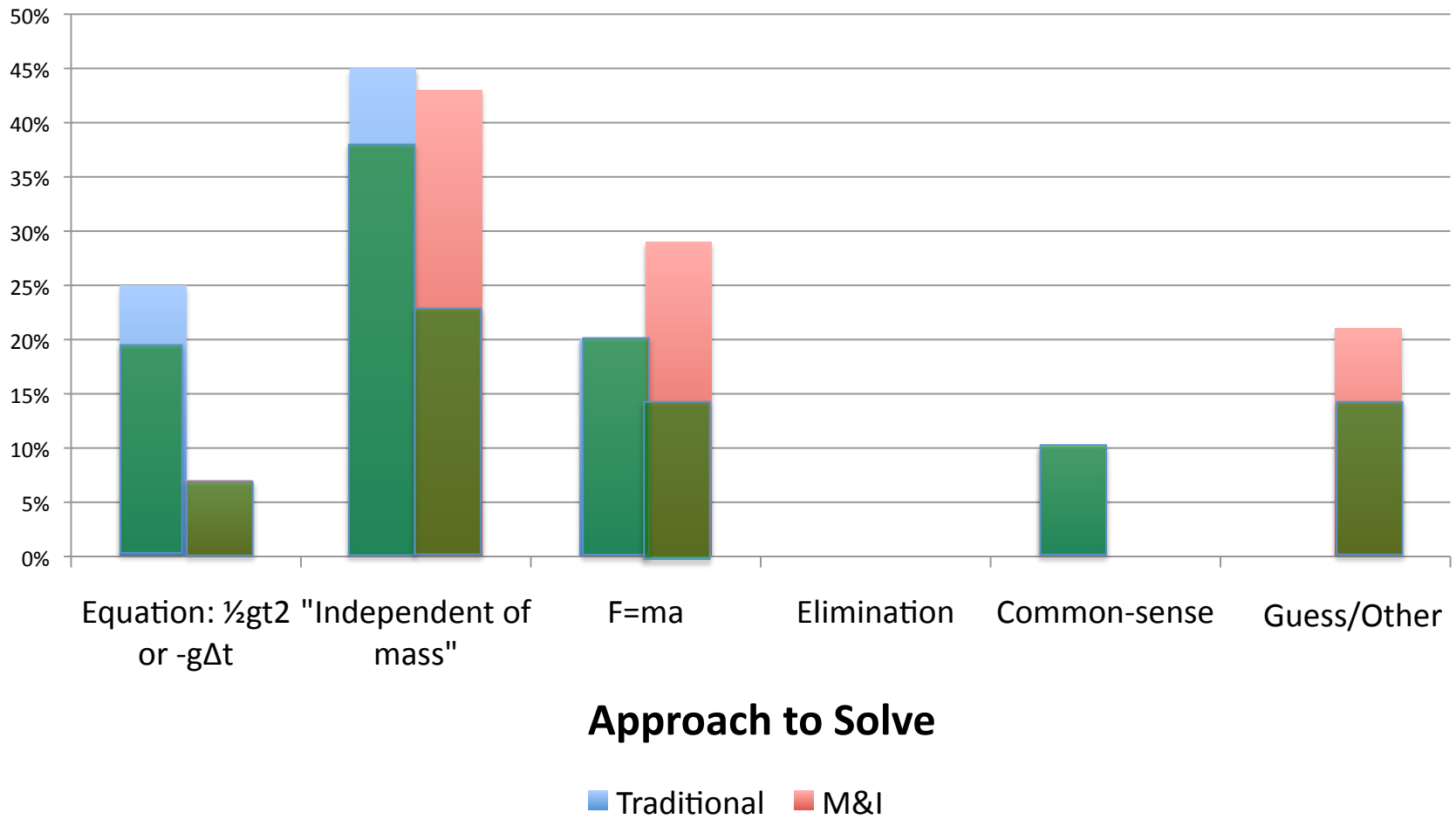


Metal balls (m_1>m_2) dropped,
Time to reach ground…

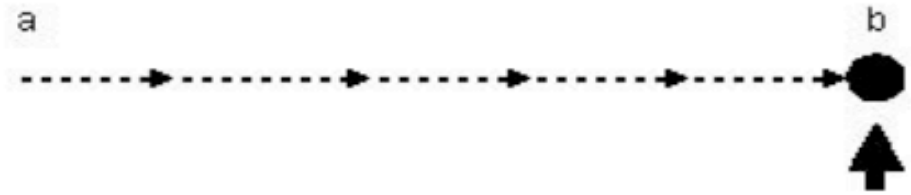
Discussion

- Traditional students
  - Using correct approaches a bit more often
  - Get answers correct even with “wrong” approach
- M&I students
  - Even when using correct approach, still having trouble identifying answer
- Both
  - Many students seem to “know” the answer, but not exactly why

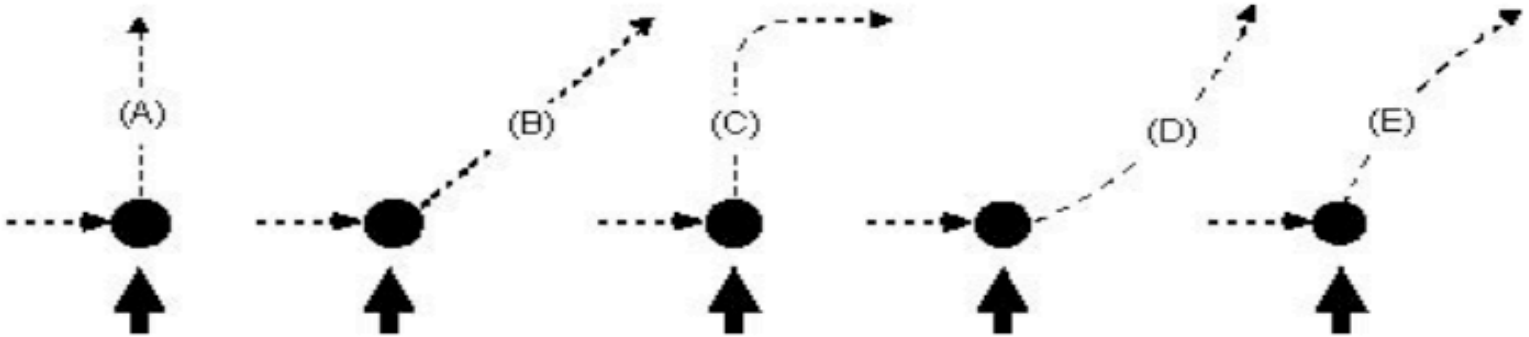
Item #4

USE THE STATEMENT AND FIGURE BELOW TO ANSWER THE NEXT FOUR QUESTIONS.

The figure depicts a hockey puck sliding with constant speed v_o in a straight line from point "a" to point "b" on a frictionless horizontal surface. Forces exerted by the air are negligible. You are looking down on the puck. When the puck reaches point "b," it receives a swift horizontal kick in the direction of the heavy print arrow. Had the puck been at rest at point "b," then the kick would have set the puck in horizontal motion with a speed v_k in the direction of the kick.

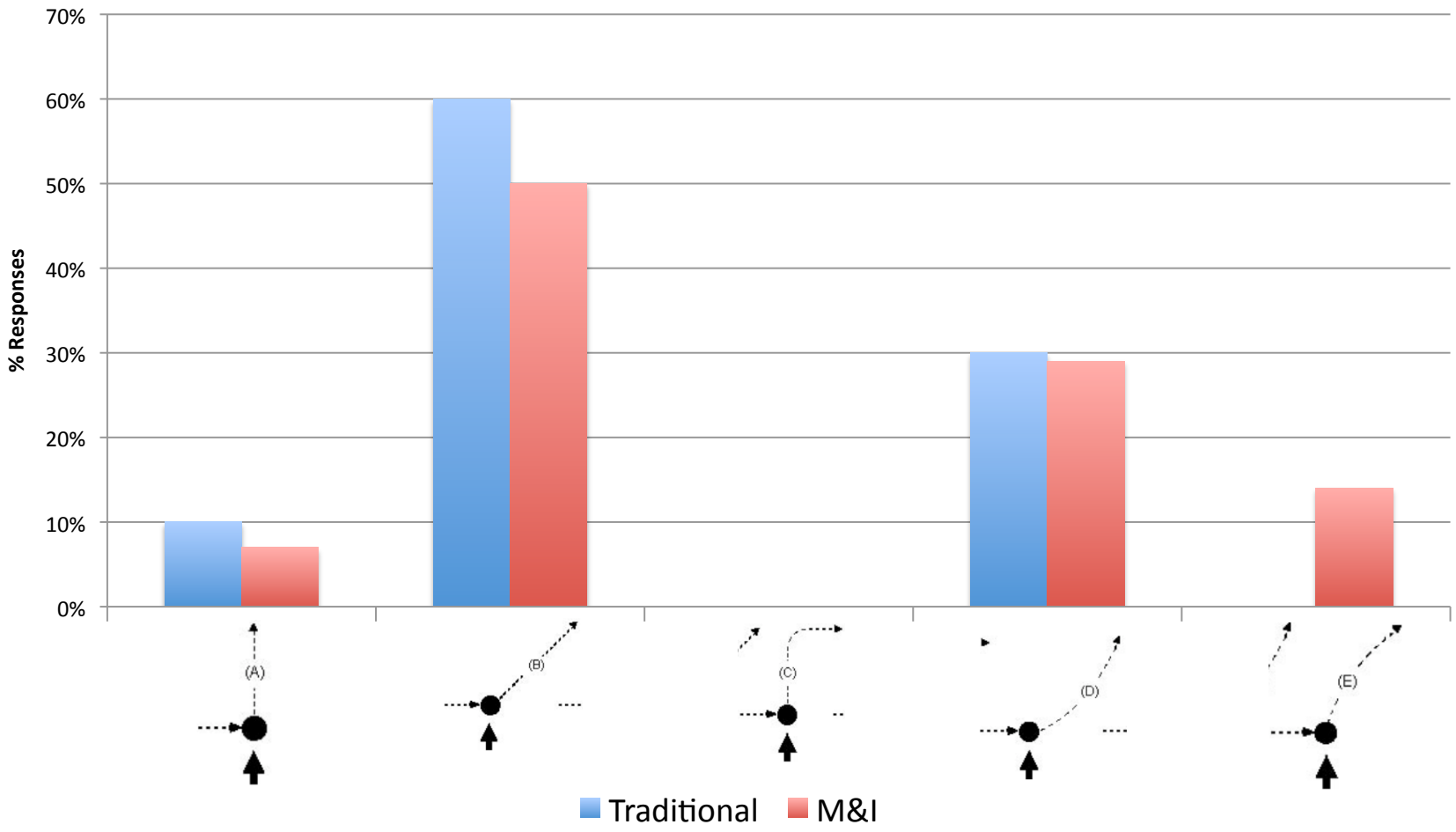


Which of the paths below would the puck most closely follow after receiving the kick?



Moving puck kicked,
what is the new path?

Response Fingerprint



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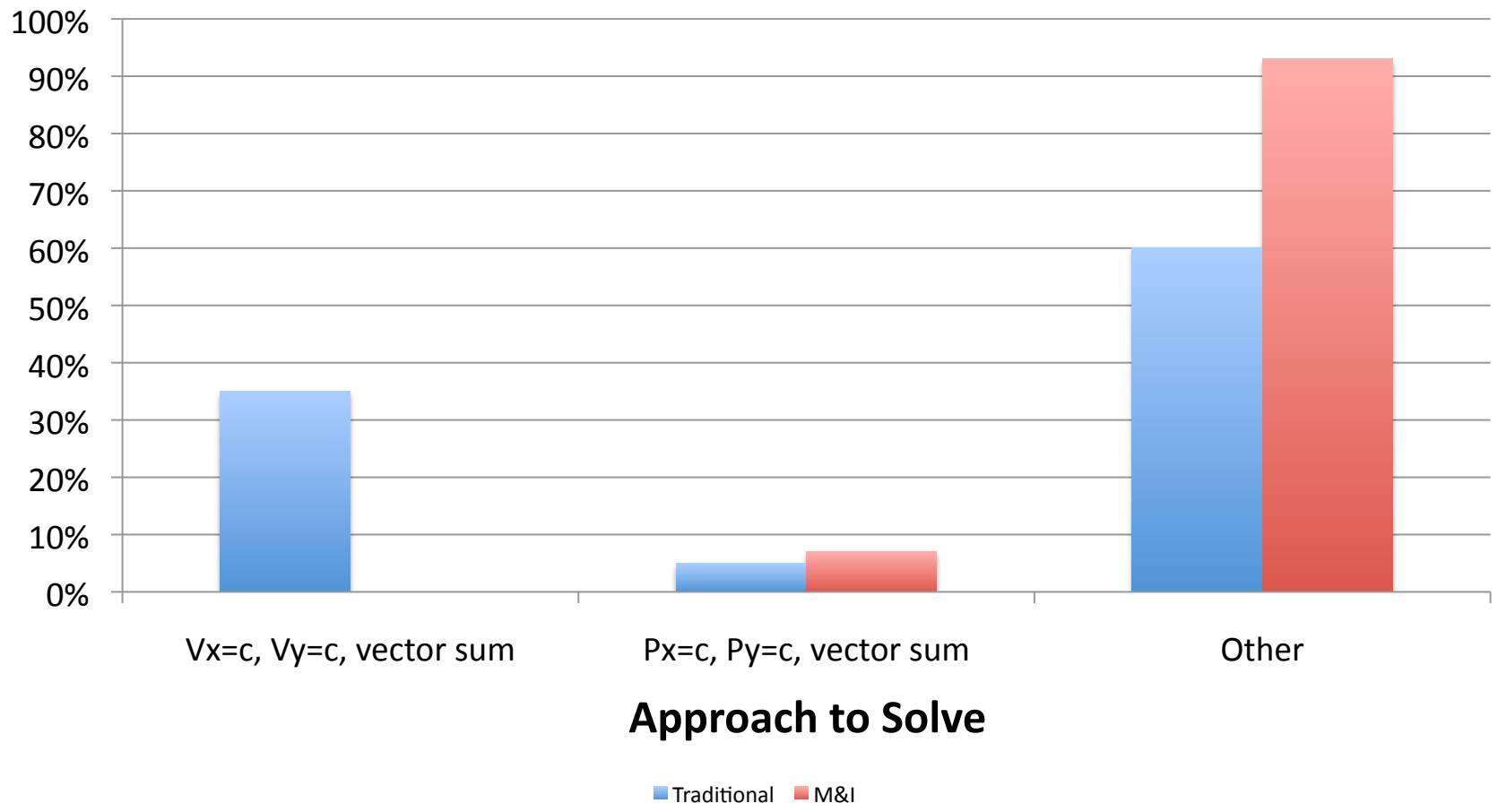

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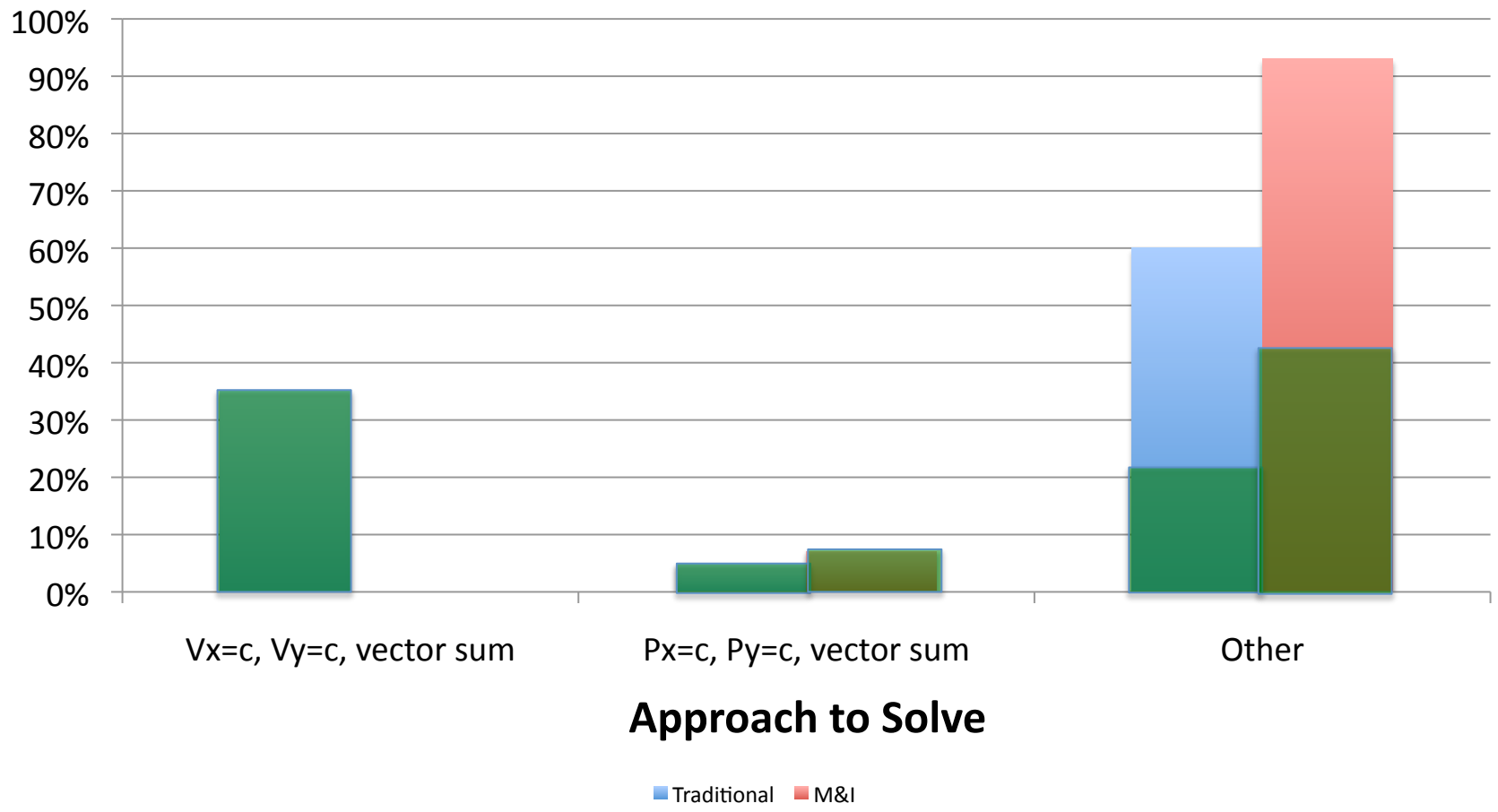

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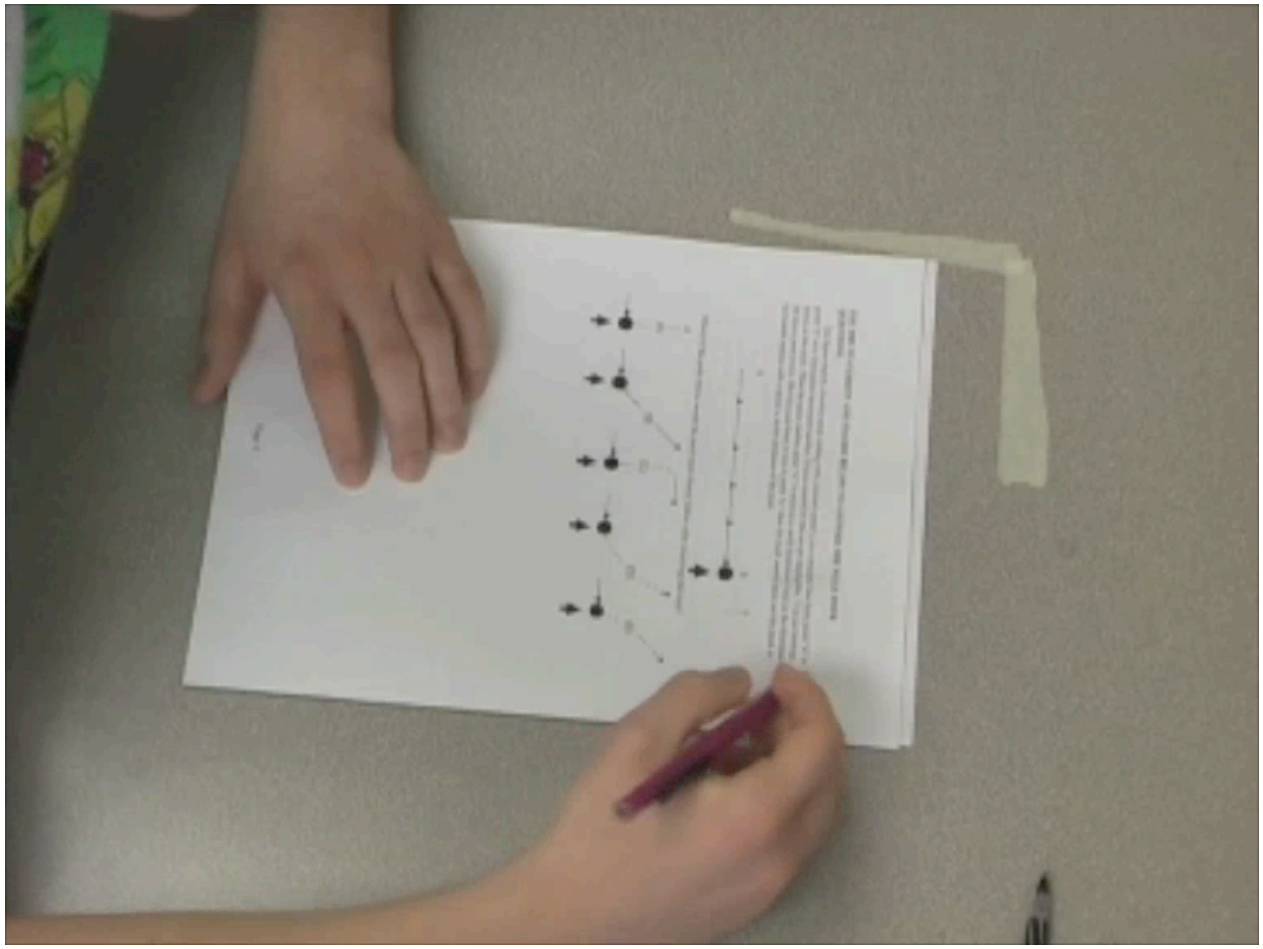

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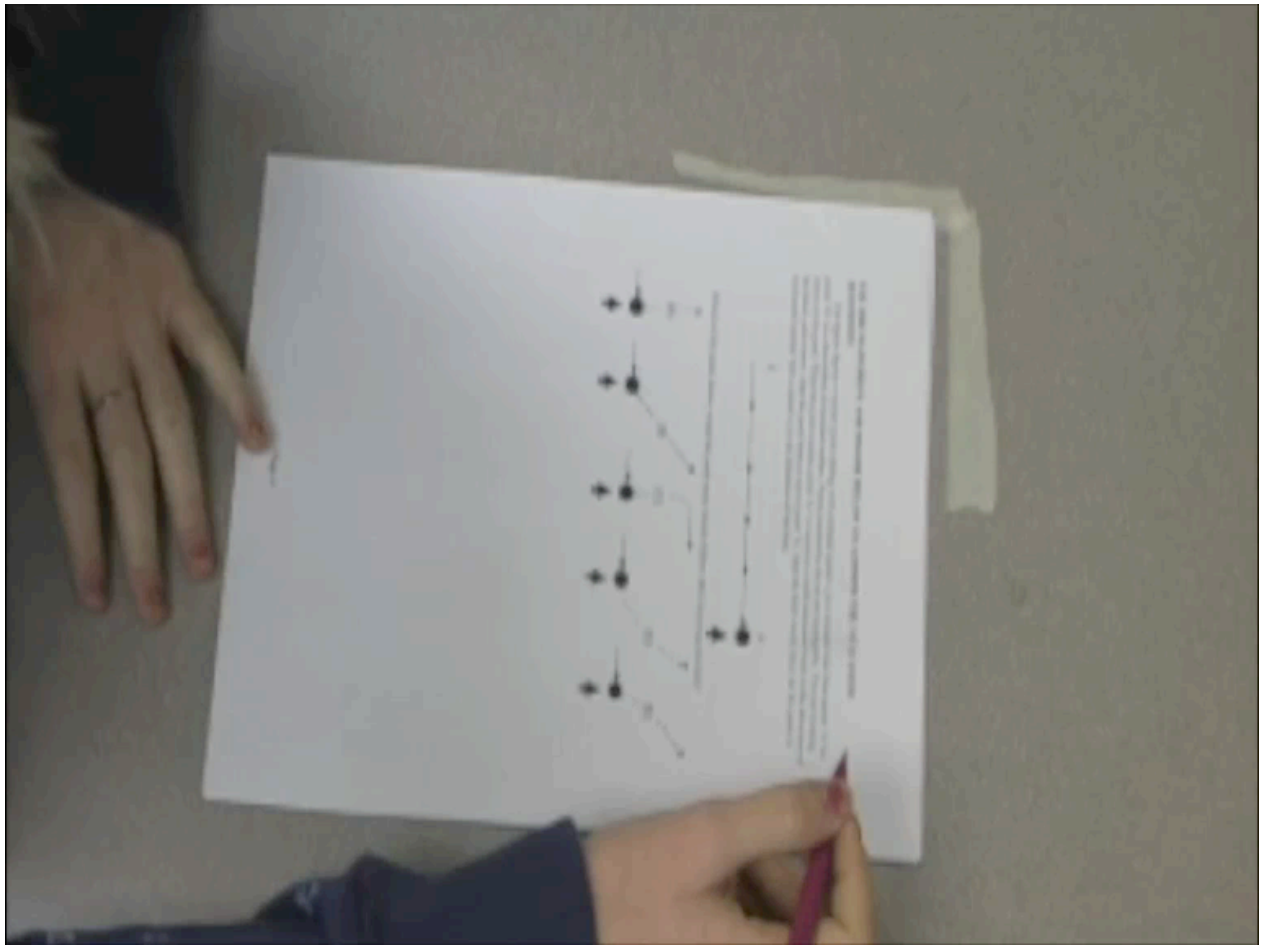

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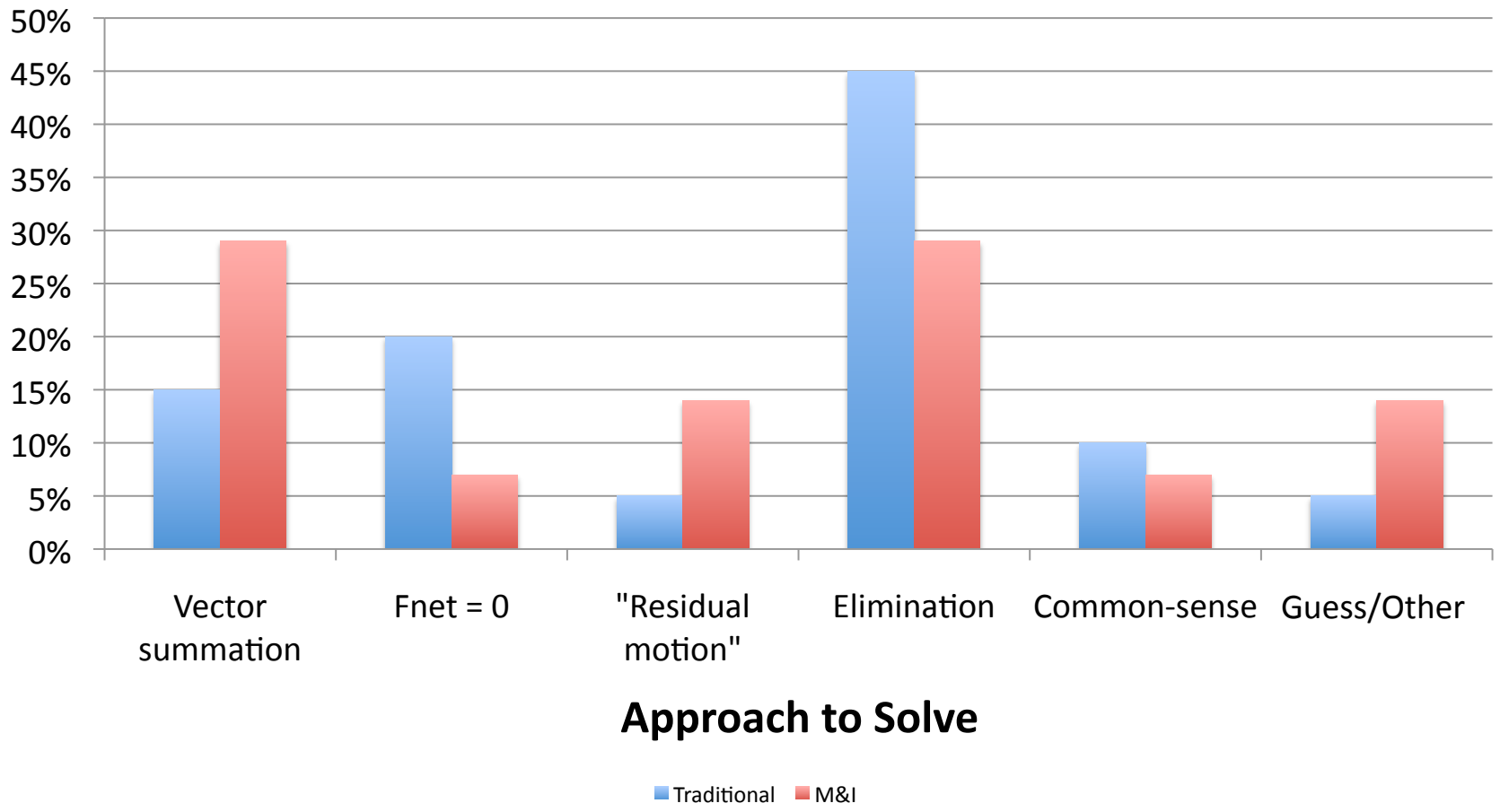

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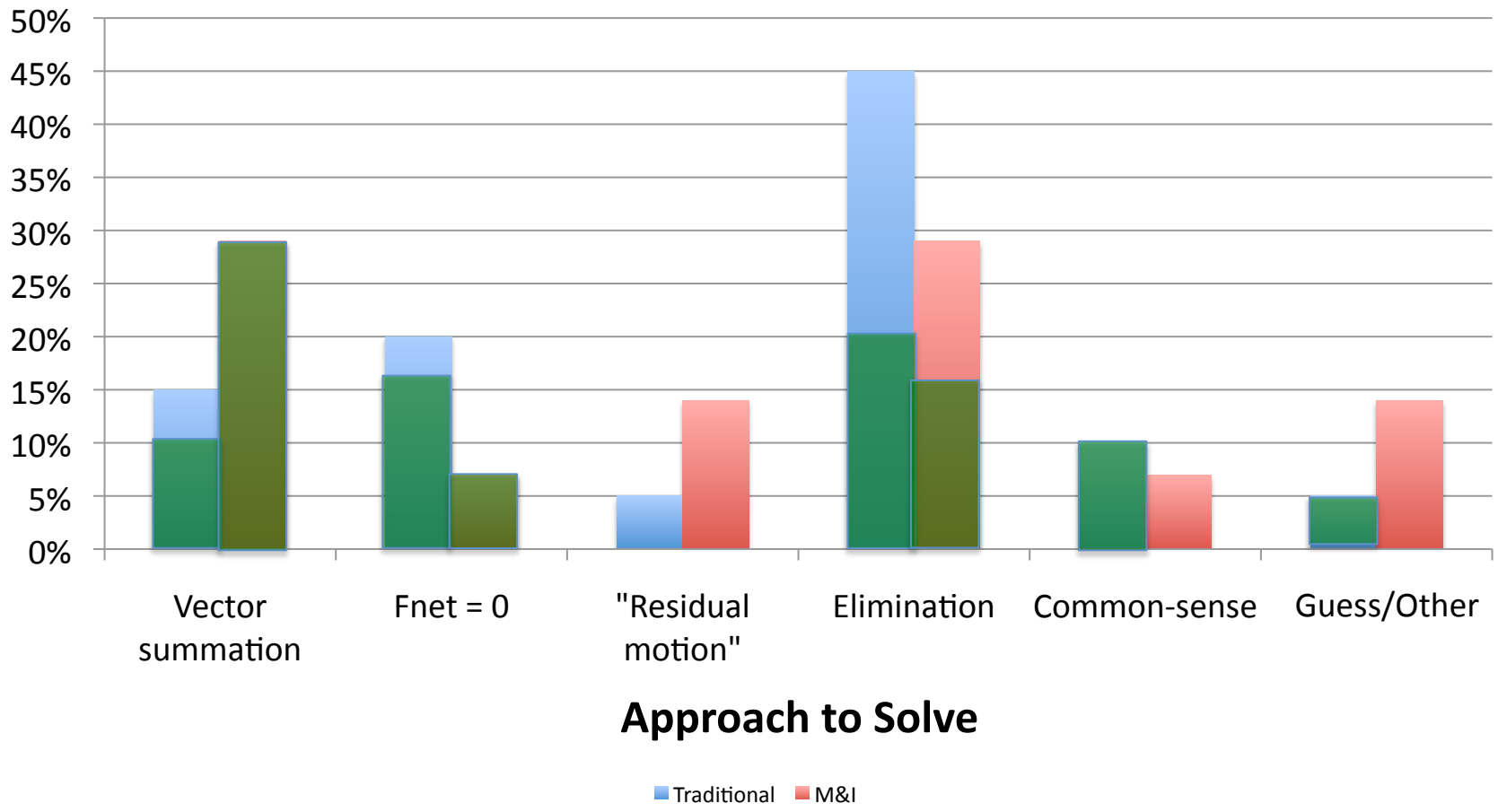

Moving puck kicked,
what is the new path?

Discussion

- Both
  - Greater spread across types of approaches
  - Elimination used often, poor performance
- Residual motion
  - Many try to describe, unsure of why
  - Zero correct responses
- M&I
  - Vector summation used more often, works well
- Traditional
  - Focusing heavily on elimination

Summary and Future Direction

Conclusion

- Current analysis
  - Traditional students seem have more success with more approaches
  - M&I students seem to be trying to apply approaches incorrectly
- Further coding of data
  - Review other questions in detail
  - Analyze for trends in multi-part questions

Thank you

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