Resources for Robot Competition Success

Assessing Math Use in
Grade-School-Level Engineering Design

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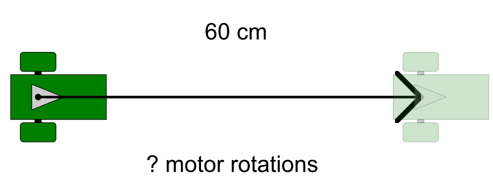
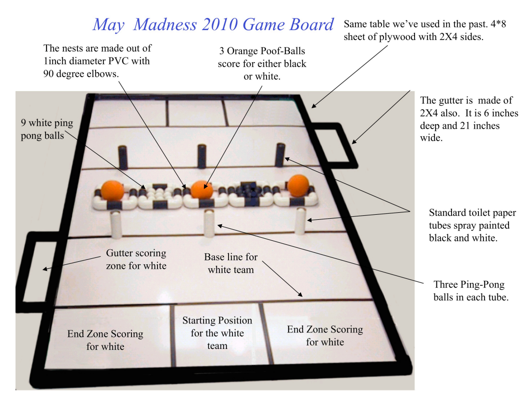
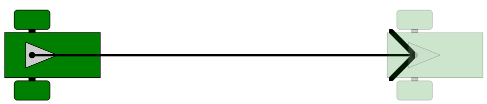




Robot Competitions – Is Math Useful?

- Popular, engaging context for integrated STEM problem solving
  (Verner & Ahlgren, 2004)
- But ... do teams use math?
  (Cardella, 2010; Gainsburg, 2006)

60 cm



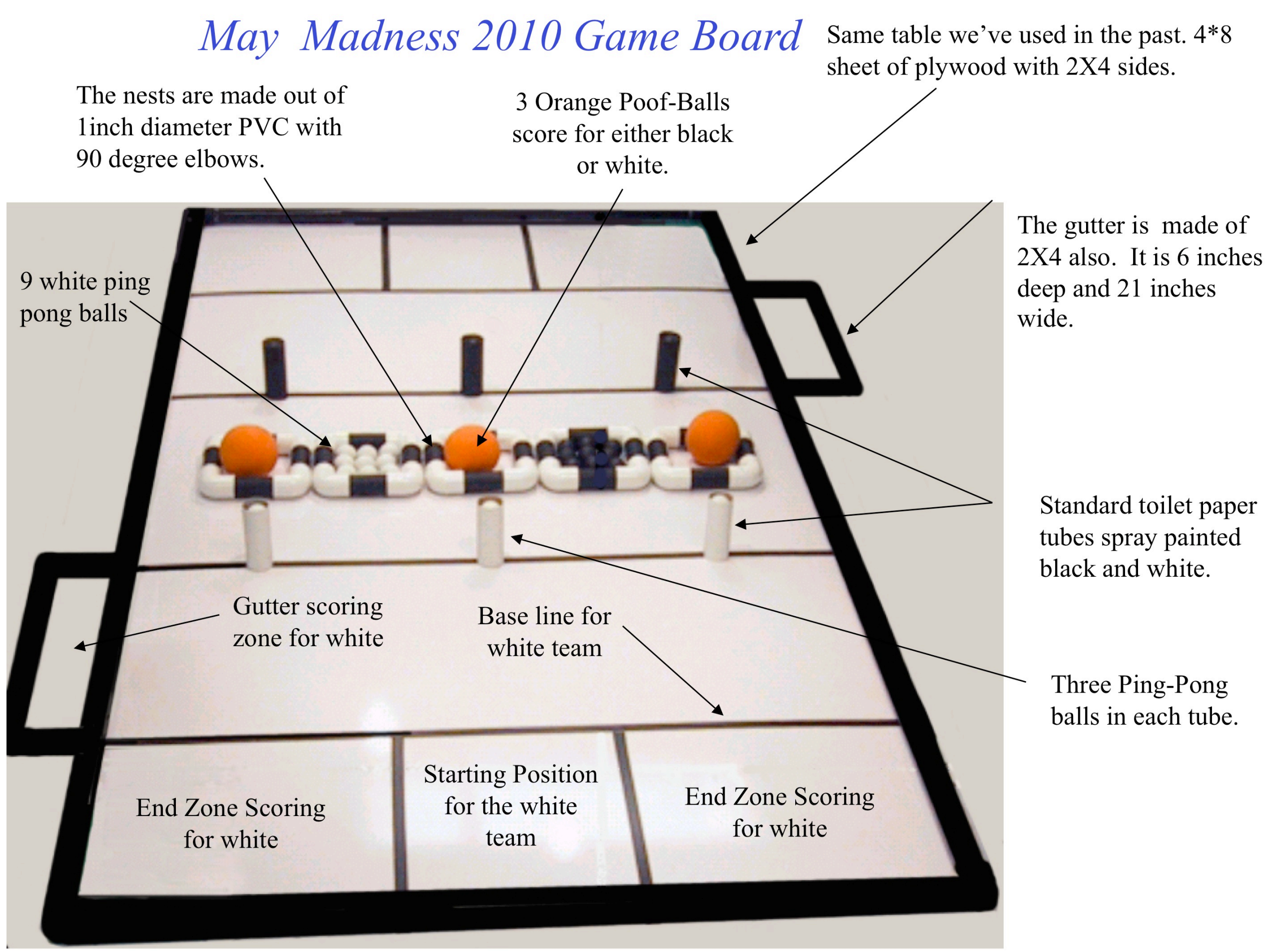
? motor rotations

Distance =
Motor Rotations × Wheel Circumference

- Does using math help in the competition? (Titus et al., 2008)
- Does using math help in other ways? (Melchior et al., 2009)

Method – Ask Teams at a Competition

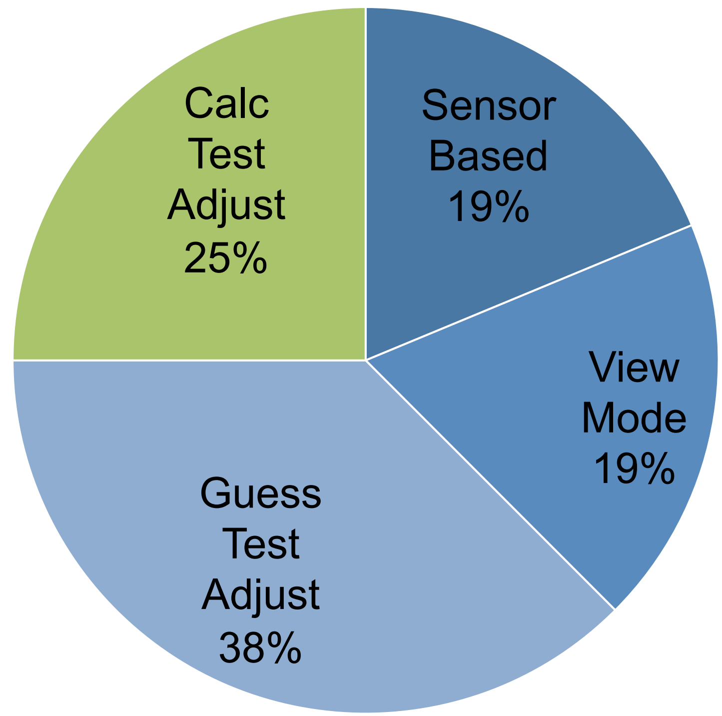
- Local competition
- 16 teams
  - Tell me about...
  - your team
  - your solution
- 4 *Focus Teams*
  - Pre/post surveys
  - Problem solving
    - 12 items
  - Attitudes (13 items)
    - Robotics interest
    - Math interest
    - Math value for robotics

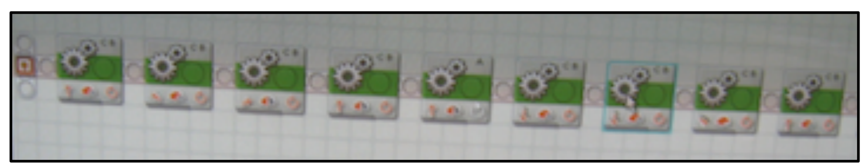


Results – What Strategies do Teams Use?

- Sensor-Based (n = 3)
  - Move until touch sensor pressed
- View-Mode (n = 3)

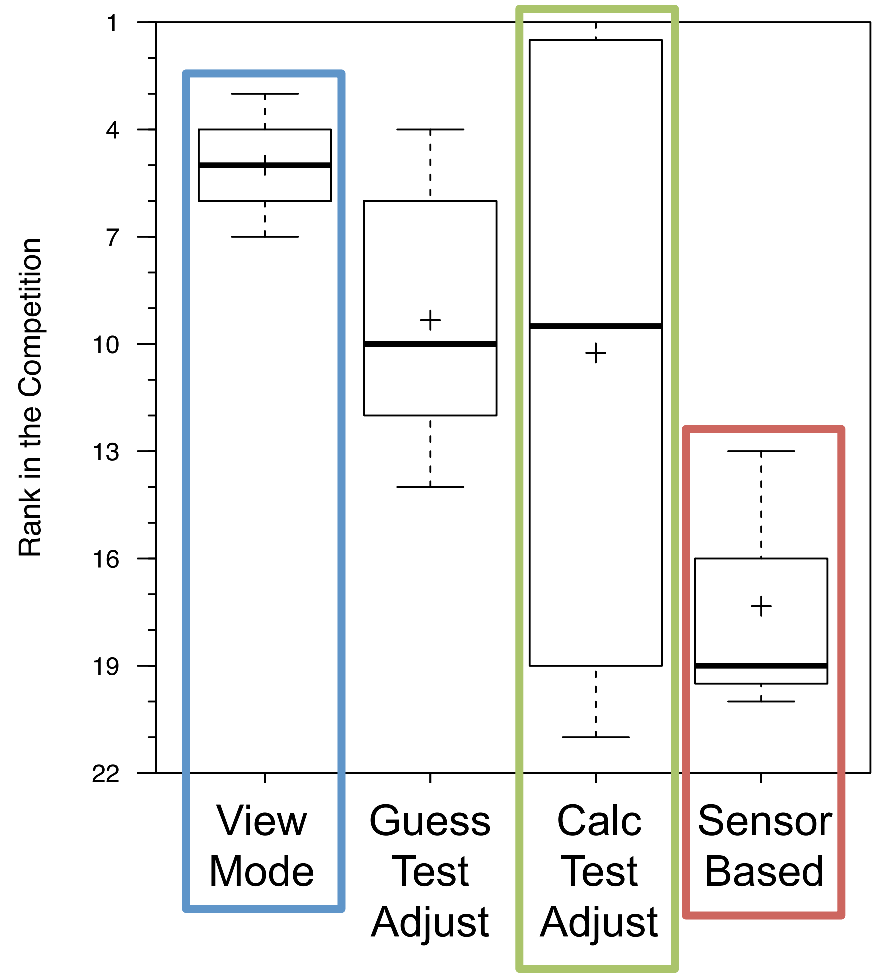
- Guess-Test-Adjust (n = 6)
- Calc-Test-Adjust (n = 4)
  - Explicitly math-based
  - Measurement
  - Prediction (1-rotation-distance)





Results – Which Strategies are Successful?

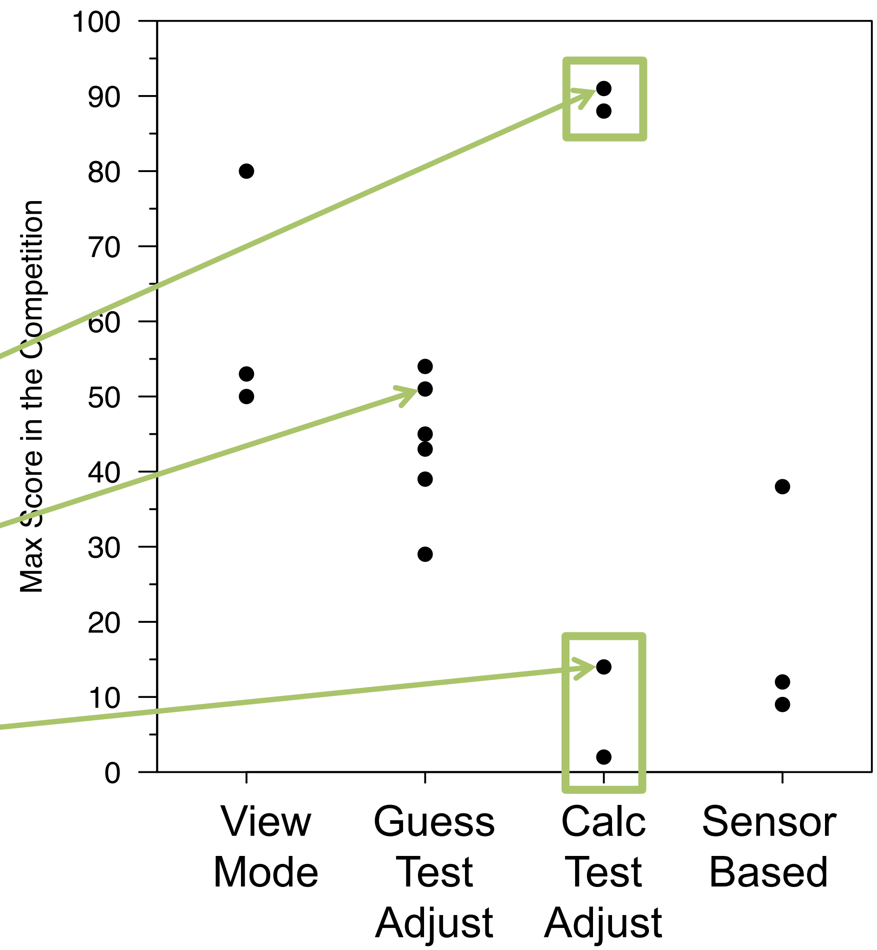
- Sensor-Based
  - Least successful
- View-Mode
  - Most reliable and most reliably successful
- Math-Based
  - Mid-level overall success on average
  - But highly variable
  - What's going on?



Results – Is Using Math Successful?

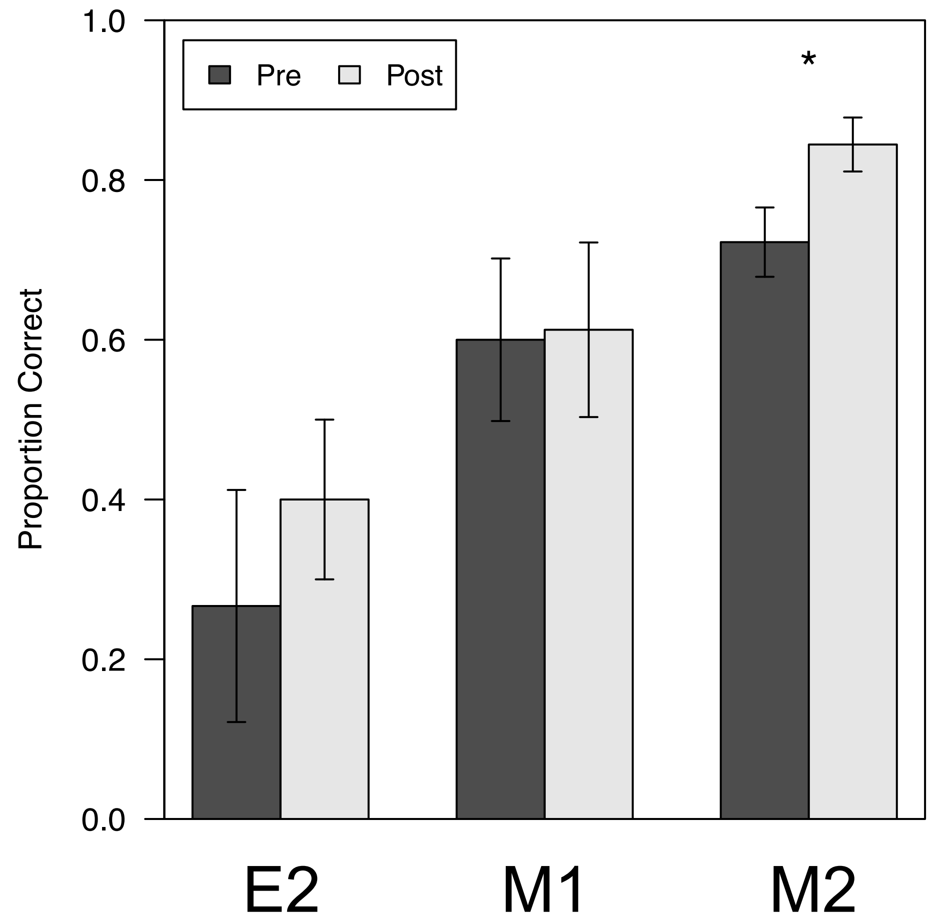
- Top 2 performers
  - Both middle/experienced
- 2 low-performers
  - Both elementary/rookies
- Success depends on how (well) the math is used

- Focus Teams
  - #1 Team M2
    - Middle, exp. mentor/students
  - #6 Team M1
    - Middle, exp. mentor/students
  - #17 Team E2
    - Neighborhood team
    - Rookie mentors and students



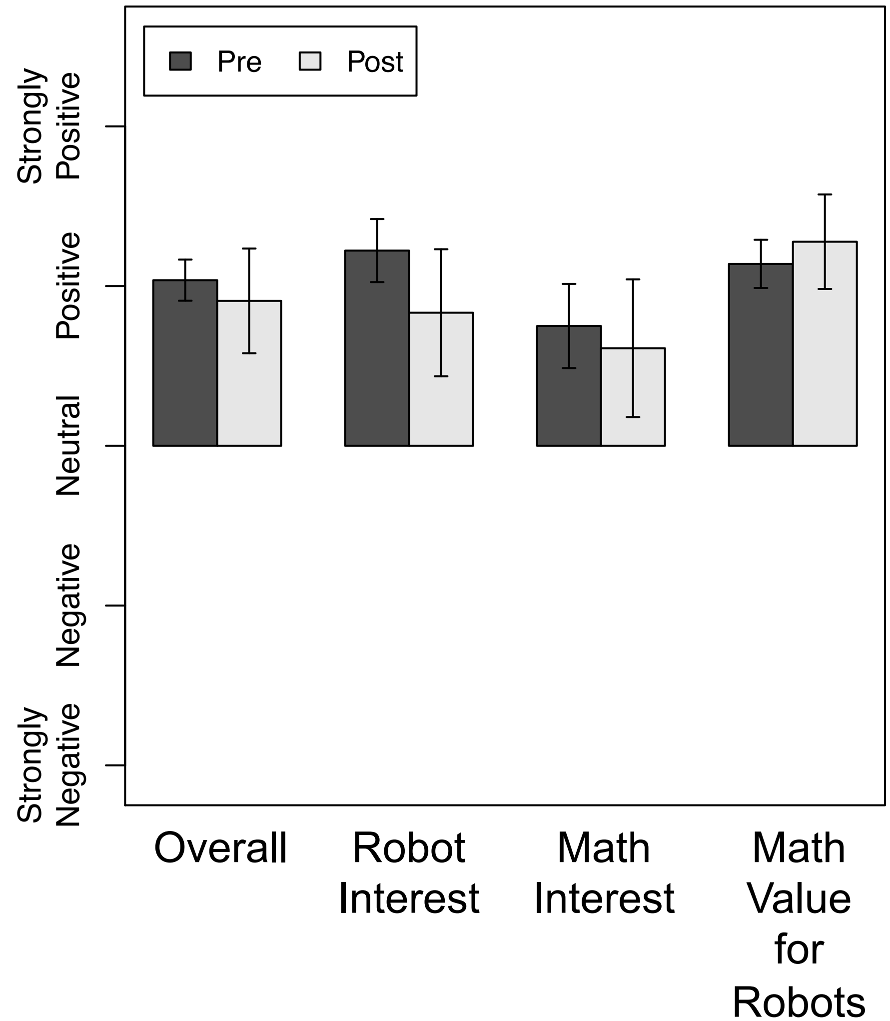
Results – Gains in Problem Solving

- Both math-using (E2 & M2) teams improve from pre to post
  - Middle school teams higher at pre
- Team M2
  - Make efficient and reliable movements
    - Simpler programs (up, back)
  - Use math in optimizing strategy
    - Focus on highest point-value missions
    - Practice timing and sequence
    - Take strategic penalties
  - Comparable to Team M1
    - Team M1 from similar suburban school environment, with experienced mentors and students, access to multiple robots, etc.



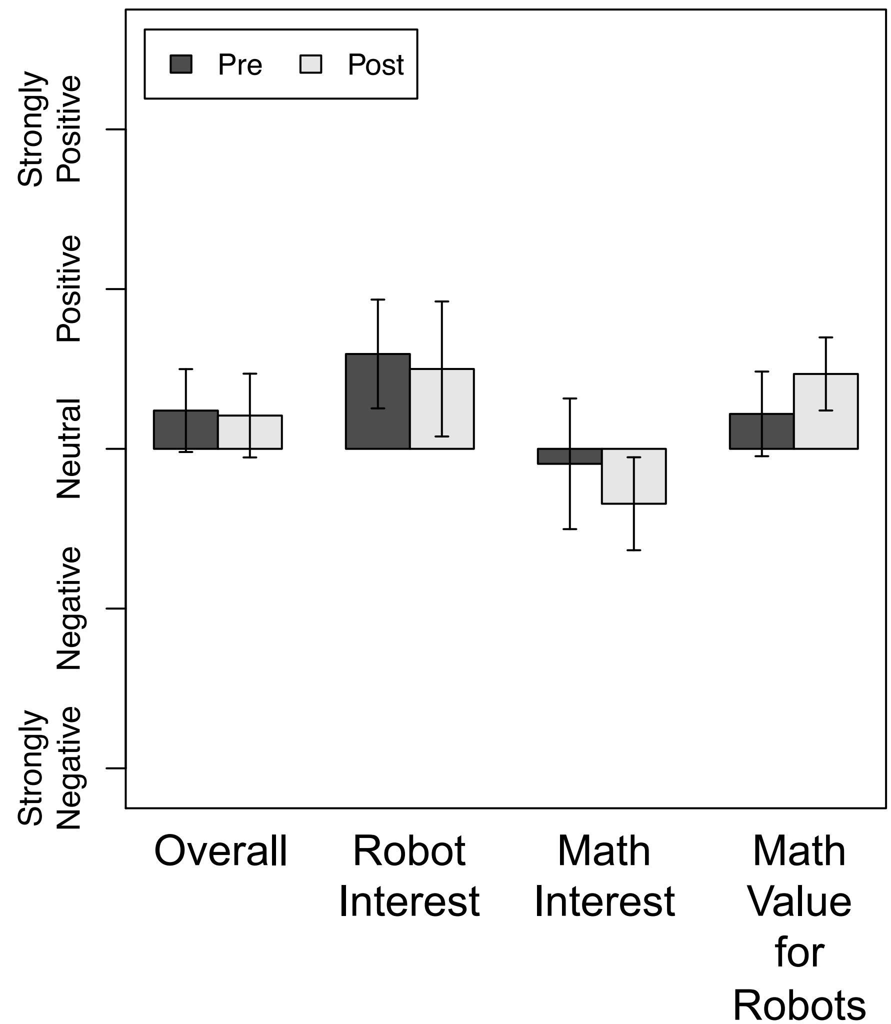
Results – Gains in Robot/Math Attitudes

- Team M2
  - Used a math strategy
  - High across the board at pre and post
  - But didn't improve



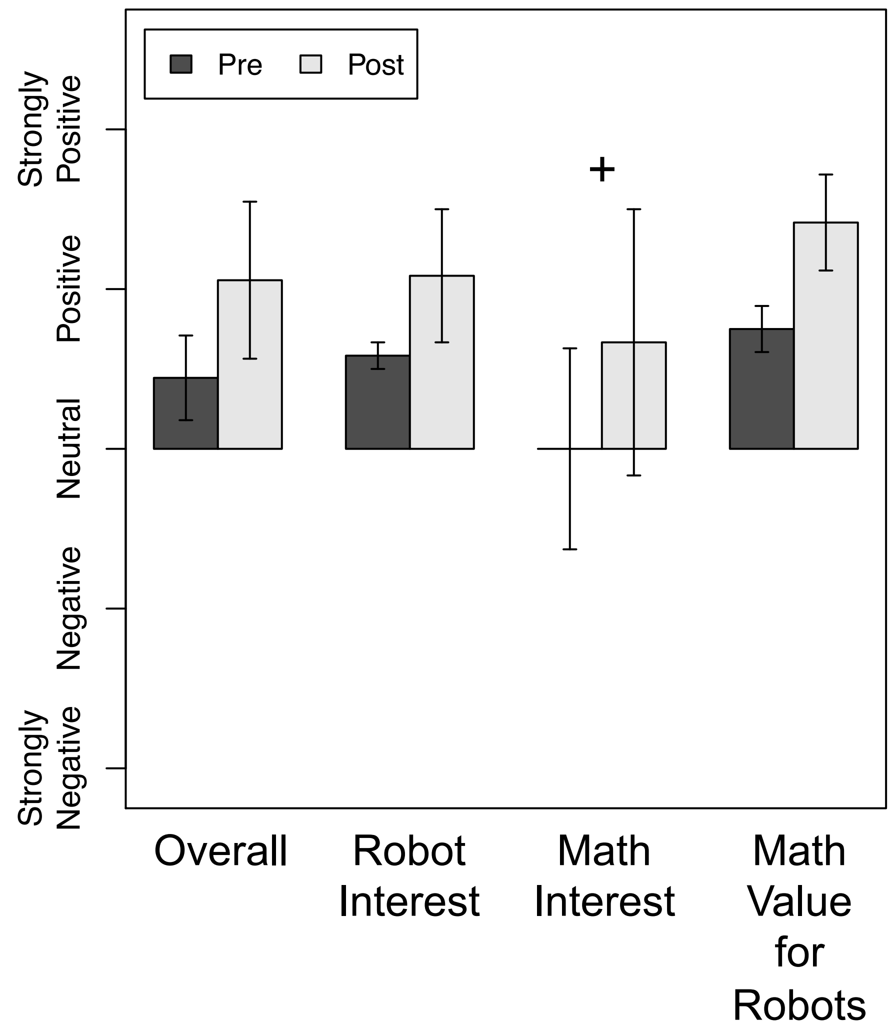
Results – Gains in Robot/Math Attitudes

- Team M1
  - Used a guessing strategy
  - Not as high at pre
  - But also didn't improve



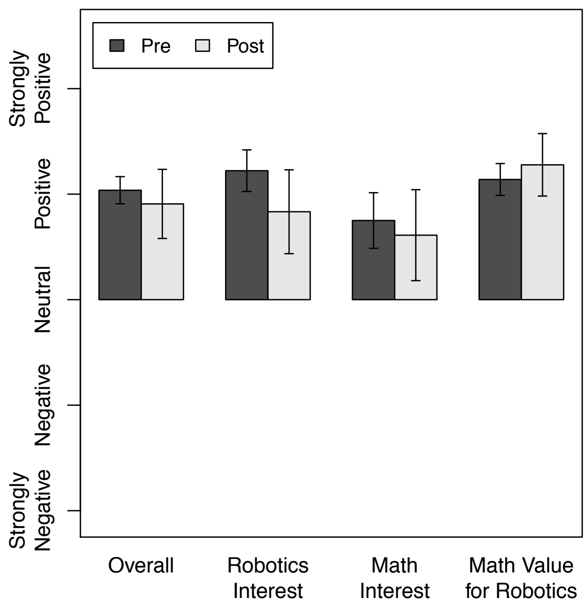
Results – Gains in Robot/Math Attitudes

- Team E2
  - Used a math strategy
  - Not as high at pre
    - Similar to M1 at pre
  - But made positive gains
    - Similar to M2 at post
  - Even though not successful in competition (17/22)

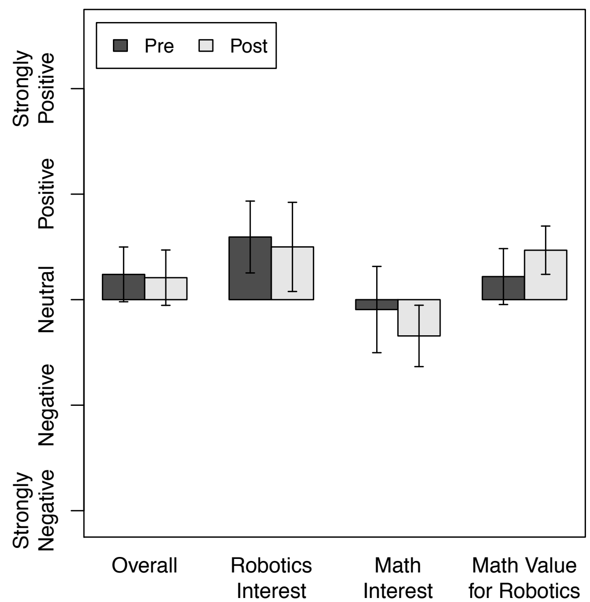


Results – Gains in Robot/Math Attitudes

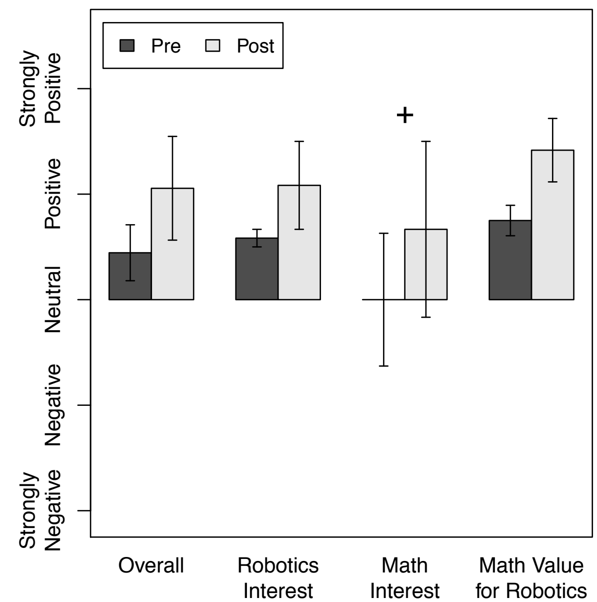
Team M2
(math strategy)



Team M1
(guessing strategy)



Team E2
(math strategy)



- Team M2 – high across the board at pre and post, but didn't improve
- Team M1 – not as high at pre as M2, but also didn't improve
- Team E2 – not as high at pre (like M1), but make gains across the board (like M2 at post)
  - Even though not successful in the competition

Conclusions & Discussion

- Summary of results
  - 25% (4/16) of teams used math in their solutions
  - Using math had highly variable competition success
    - Top 2 teams and 2 low-performing teams
    - The most reliably successful strategy was the View-Mode strategy
  - Using math did lead to problem solving gains
  - Using math unsuccessfully still resulted in attitude gains
- Why (under what conditions) does math lead to success?
  - Success was about fine-tuned, simple, reliable movements
    - So the math only helpful if it supports that
  - But the math can also be helpful in other optimization aspects
- Success even when teams don't perform well in the competition
  - Elementary teams may not have the background to do well
  - But just trying the math seems to have benefits to interest and value

Thank You

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