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)

- 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

May Madness 2010 Game Board
The nests are made out of 1 inch diameter PVC with 90 degree elbows.
3 Orange Poof-Balls score for either black or white.
9 white ping pong balls

Gutter scoring zone for white
Base line for white team
End Zone Scoring for white
Starting Position for the white team

The gutter is made of 2X4 also. It is 6 inches deep and 21 inches wide.
Standard toilet paper tubes spray painted black and white.
Three Ping-Pong balls in each tube.

Same table we’ve used in the past. 4*8 sheet of plywood with 2X4 sides.
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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References


