Evaluating the M in STEM: Math anxiety as a predictor of quantitative course success

L. A. WOLFSKILL, DANHONG CHEN, ROOZBEH IRANI-KERMANI, AND SHYAM S. NAIR
DEPARTMENT OF AGRICULTURAL SCIENCES
SAM HOUSTON STATE UNIVERSITY

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Context: **MATH: Misery At The Highest!**

- Who hasn’t run into teaching *slowdowns* due to student math skills?
- We’re not math teachers, but is there anything systematic going on that we can influence?
- I teach Ag Finance and Ag Futures and Options
  - We Add, we Subtract, we Multiply, and we Divide
  - We don’t even use all of PEMDAS (who remembers?)
- So why are students so scared of it?
Purpose of this Research Piece

• **Primary**: Understand students’ attitudes toward basic math skills, and how they can predict student success in our quantitative agriculture courses

• **Secondary**: Identify relationships that we can use to help alleviate the scariness, and get students back to thinking and using basic math skills that they all can do
Research Questions

• RQ1: Can self-perceived mathematics anxiety predict final grades in quantitative agribusiness courses?

• RQ2: Which demographic factors are correlated with higher course grade outcomes?
Methods and Procedures

• Data
  ◦ Basic Math Quiz administered to 18 course sections between 2013 and 2019 (N = 394)
  ◦ 102 had taken it previously, so first-timer N = 292
  ◦ Included an open-ended question on level of anxiety in the math seen on the quiz
  ◦ Aligned with course grades, GPA, and student info from university

• Descriptive statistics
Brush up your math: Basic math quiz Course: ____________

Write the answer in the space after the question. Name: ____________________________

Use the back of the page if you need work area. Date: ____________________________

1. $627 + 183 = ________ 

Taken before? Yes  No  This sem. ____  Prev. sem. ____

2. $20 - 3 \times 5 = ________

3. 0.001 is equal to which of the following? Circle the letter.

   \[
   \begin{array}{cccc}
   & 1 & 1 & 1 \\
   10 & 100 & 1000 \\
   \end{array}
   \]

   (a) ___  (b) ___  (c) ___  (d) None of these answers are correct.

4. $\frac{3}{4} + 0.6 = ________

5. If $y = x - 2$, what is the value of $x$ when $y = 6$? ________
5. If \( y = x - 2 \), what is the value of \( x \) when \( y = 6 \)?

6. Write “3.75 million dollars” out in full digits.

7. \( \sqrt{3^2 + 4^2} = \) _______

8. What is 2½% of $10? _______

9. If cheese is $4.40 per kilogram, how much should I pay for 200 grams?

10. If cheese is $4.40 per lb, how much should I pay for 3 oz.? _______

11. Round 1675.8578 correctly to the hundredths.

12. Find the (x,y) point where these lines cross:
   \[ 2X + 6Y = 40 \]
   \[ 4X + 3Y = 26 \]
Methods and Procedures

• Seemingly Unrelated Regression (STATA)
  ◦ Econometric method useful when several regressions are to be done, and they share independent variables
  ◦ Shared variables = extra info to capture
  ◦ Also results in correlated error terms

• STATA SUR procedure (Zellner, 1962)
  ◦ Feasible Generalized Least Squares algorithm (Cameron & Trivedi, 2009)
  ◦ SUR is more efficient than OLS when error terms are correlated (Greene, 2008)
The Sample

- Dependent Variables (N=292)
  - AGBU2389 (n = 284, mean = 81.6, SD = 7.53)
  - AGBU3367 (n = 268, mean = 78.2, SD = 12.03)
  - AVEMATH (Average grade on all MATH and STAT courses taken; n = 291, mean = 80.6, SD = 7.77)

Note: final letter grades translated as follows:
A = 95, B = 85, C = 75, D = 65, F = 50
The Sample

• Independent Variables Available (not all were complete sets)
  ◦ NumRight (of 12 math questions)
  ◦ Panic (from quiz; 0=none, 1=slight; 2=much, 3=mucho!)
  ◦ Sex (168 M 57.5%, 124 F 42.5%)
  ◦ GPA (most recent in Univ. System)
  ◦ SAT (n=71, 24.3%; not used in analysis)
  ◦ AveAge (at time of quiz)
Descriptives

• Students generally did not do well on the quiz
• Mean = 6.73
• SD = 2.04
• Self-reported Panic Level was not as high as expected *(especially for how well they performed)*
## Student Characteristics

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<thead>
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<th></th>
<th>Mean</th>
<th>Std Dev</th>
<th>Max</th>
<th>Min</th>
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<tbody>
<tr>
<td>GPA</td>
<td>2.83</td>
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<td>3.90</td>
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<td>SAT</td>
<td>1045</td>
<td>104.8</td>
<td>1270</td>
<td>710</td>
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<td>Avg Math</td>
<td>80.6</td>
<td>7.8</td>
<td>95.0</td>
<td>45.0</td>
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<tr>
<td>Age</td>
<td>21.3</td>
<td>2.9</td>
<td>46</td>
<td>18.3</td>
</tr>
</tbody>
</table>

The pie chart shows that 58% of students are female and 43% are male.
Key Quiz Results
(Remember, no calculator allowed)

• Q1: 627 + 183 = __________
• Q2: 20 – 3 × 5 = __________
• Q9: If cheese is $4.40 per kilogram, how much should I pay for 200 grams?
• Q10: If cheese is $4.40 per lb, how much should I pay for 3 oz.?

<table>
<thead>
<tr>
<th>Question</th>
<th>% Correct</th>
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<tbody>
<tr>
<td>1</td>
<td>89.7%</td>
</tr>
<tr>
<td>2</td>
<td>72.6%</td>
</tr>
<tr>
<td>9</td>
<td>25.3%</td>
</tr>
<tr>
<td>10</td>
<td>8.9%</td>
</tr>
</tbody>
</table>
Results

When GPA was included in the model, it overwhelmed all else with p-values < 0.0005 for each Dependent Variable

- In other words, students with higher GPAs make higher grades. Doh.

- Number of Correct Responses on the quiz predicted course success, but only in Intro Finance (p<0.046)

- Self-reported panic level was not a good predictor for anything

- Male students had significantly higher Avg Math scores
Results with GPA removed from the model

The SUR then showed several interesting correlations:

• Number of Correct Responses on the quiz was a good predictor of course success in:
  ◦ Intro Finance (p<0.000)
  ◦ Advanced Finance (p=0.015)
  ◦ Average Math course grade (p=0.013)

• Self-reported panic level was not a good predictor for anything

• Male students had significantly higher Avg Math scores
Implications

- Is the Fear Factor really a thing?
  ◦ Maybe not as much as we expected
  ◦ Honestly, we really need a better experimental design and instrument to answer this question with generalizability

- How can we use this information to redesign courses and class events to mitigate the fear factor?

- What further areas do you see?
A few good references

• SUR:

• Perceptions and Efficacy in math/finance
Thank you for your time and interest.
Questions?