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

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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: _____

GRADE: of 12

1. 627 + 183 = _____ Taken before? Yes No This sem. ____ Prev. sem. ___

2. 20 – 3 × 5 = _____

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

   (a) $\frac{1}{10}$ (b) $\frac{1}{100}$ (c) $\frac{1}{1000}$ (d) None of these answers are correct.

4. ¾ + 0.6 = _____

5. If $y = x - 2$, what is the value of x when $y = 6$? _____

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6. Write "3.75 million dollars" out in full digits. _____

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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:

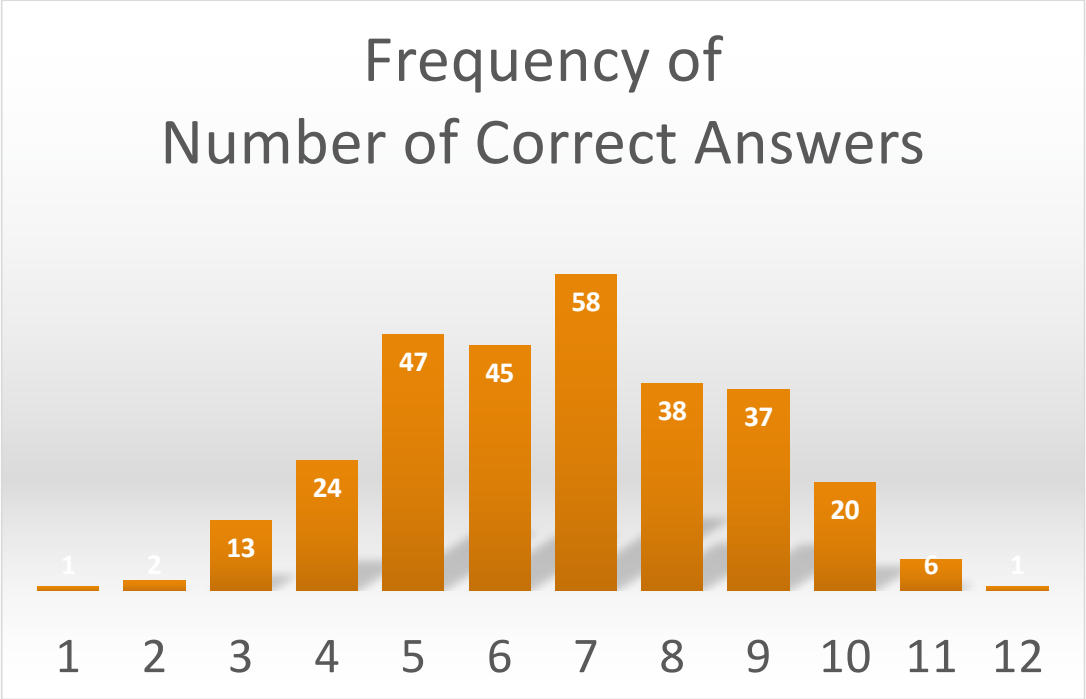
A = 95, B = 85, C = 75, D = 65, F = 50

The Sample

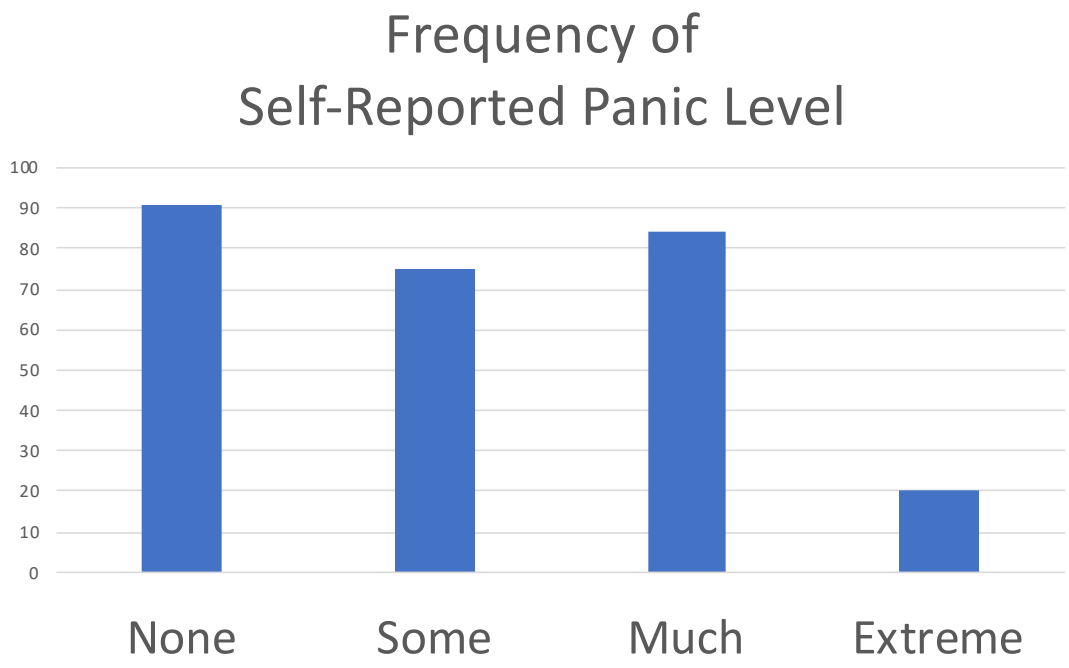
- Independent Variables Available (not all were complete sets)
  - NumRight (of 12 math questions)
  - Panic (from quiz; 0=none, 1=slight; 2=much, 3=mucho!)
  - Sex (168 M 57.5%, 124 F 42.5%)
  - GPA (most recent in Univ. System)
  - SAT (n=71, 24.3%; not used in analysis)
  - AveAge (at time of quiz)

Descriptives

- Students generally did not do well on the quiz
- Mean = 6.73
- SD = 2.04

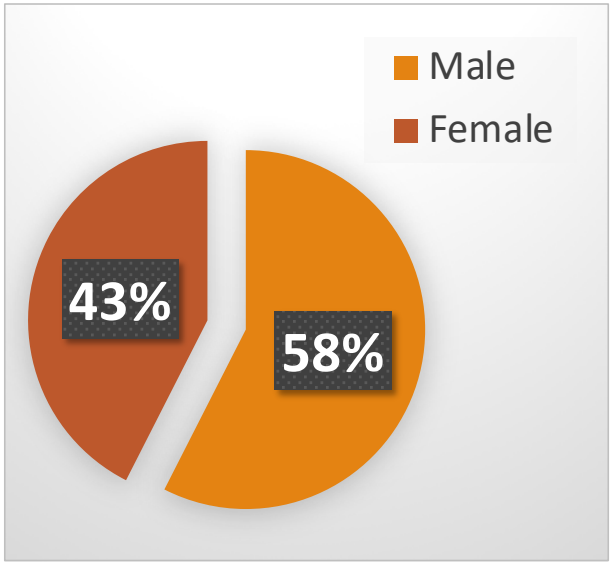


- Self-reported Panic Level was not as high as expected *(especially for how well they performed)*



Student Characteristics

	Mean	Std Dev	Max	Min
GPA	2.83	0.43	3.90	1.78
SAT	1045	104.8	1270	710
Avg Math	80.6	7.8	95.0	45.0
Age	21.3	2.9	46	18.3



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.?

Question	% Correct
1	89.7%
2	72.6%
9	25.3%
10	8.9%

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:
  - Zellner, 1962. An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. *J Amer Stat Assn*.

- Perceptions and Efficacy in math/finance
  - Ferreira, A., & Santoso, A. (2006). Do students' perception matter? A study of the effect of students' perception on academic performance. *Accounting and Finance*, 48, 209-231.
  - Pritchard, R. E., Romeo, G. C., & Saccuci, M.S. (2000). Quantitative skills and performance in principles of finance: Evidence from a Regional University. *Financial Practice and Educ J*, 2, 167-174.

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Thank you for your time and interest.
Questions?

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