

The Quantitative Reasoning for College Science (QuaRCS)

Assessment

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In collaboration with: Don McCarthy, Erin Dokter, Sanlyn Buxner and Ed Prather
With support from the NSF Transforming Undergraduate Education in STEM Program

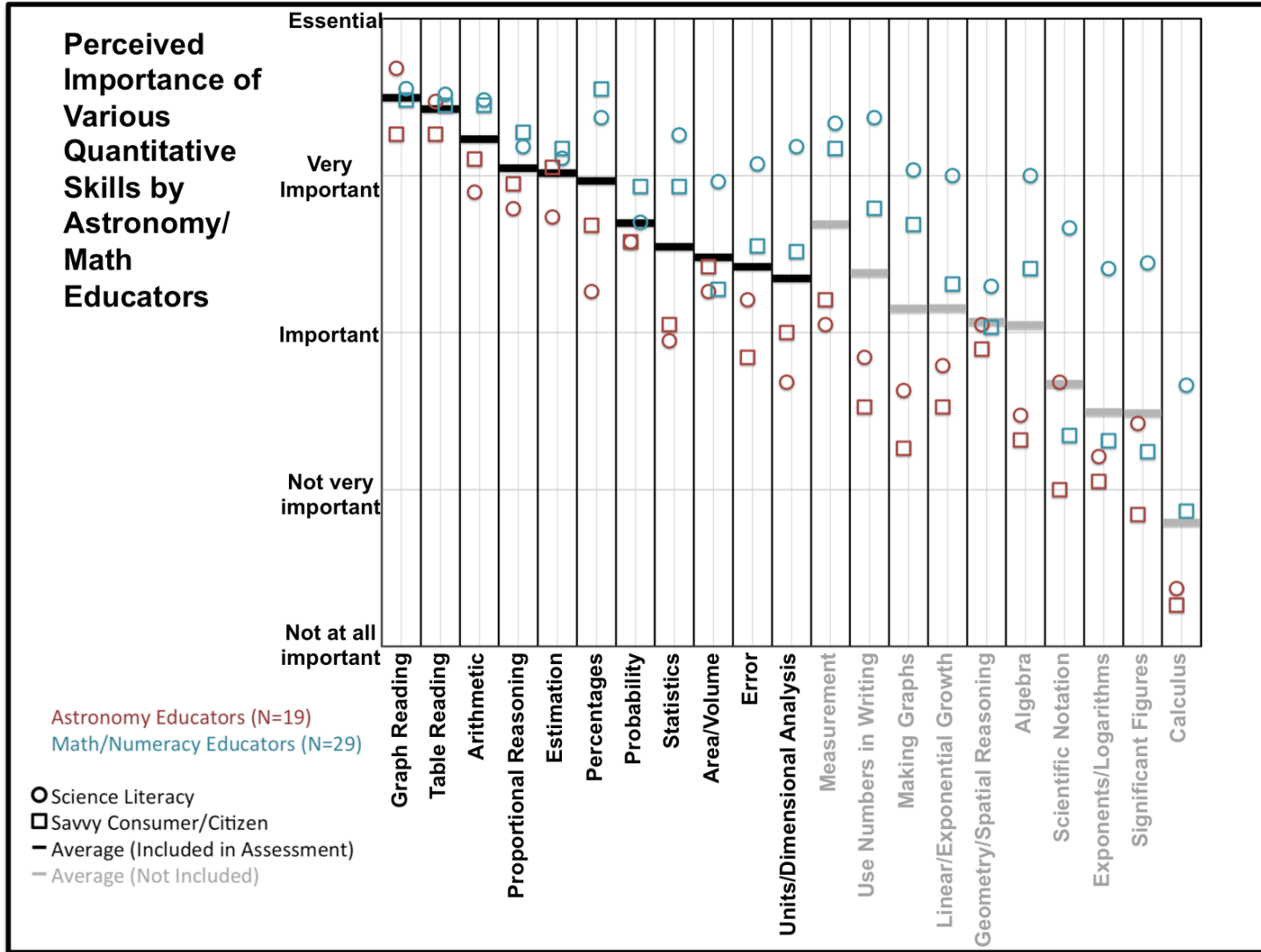


Which quantitative skills are important in STEM?

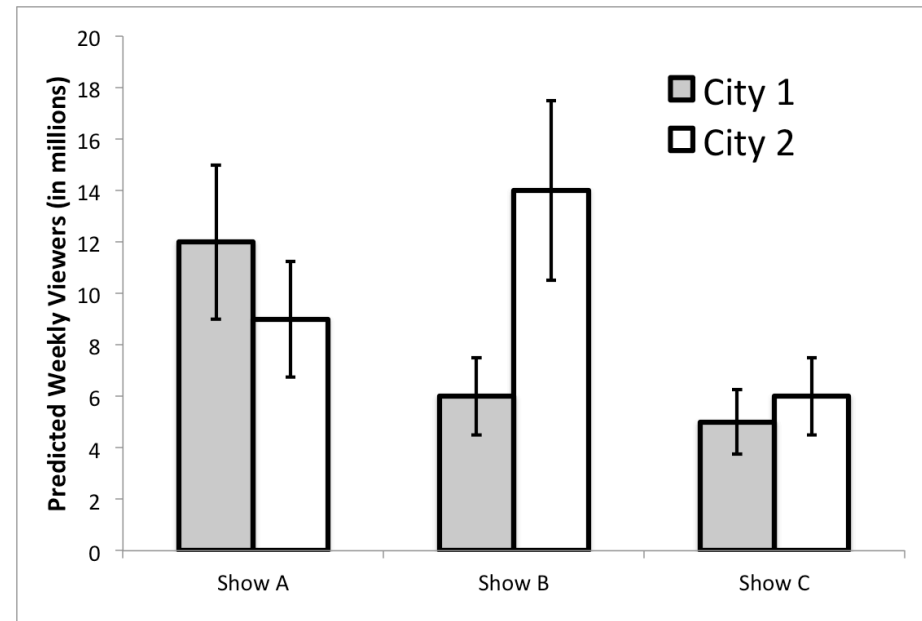
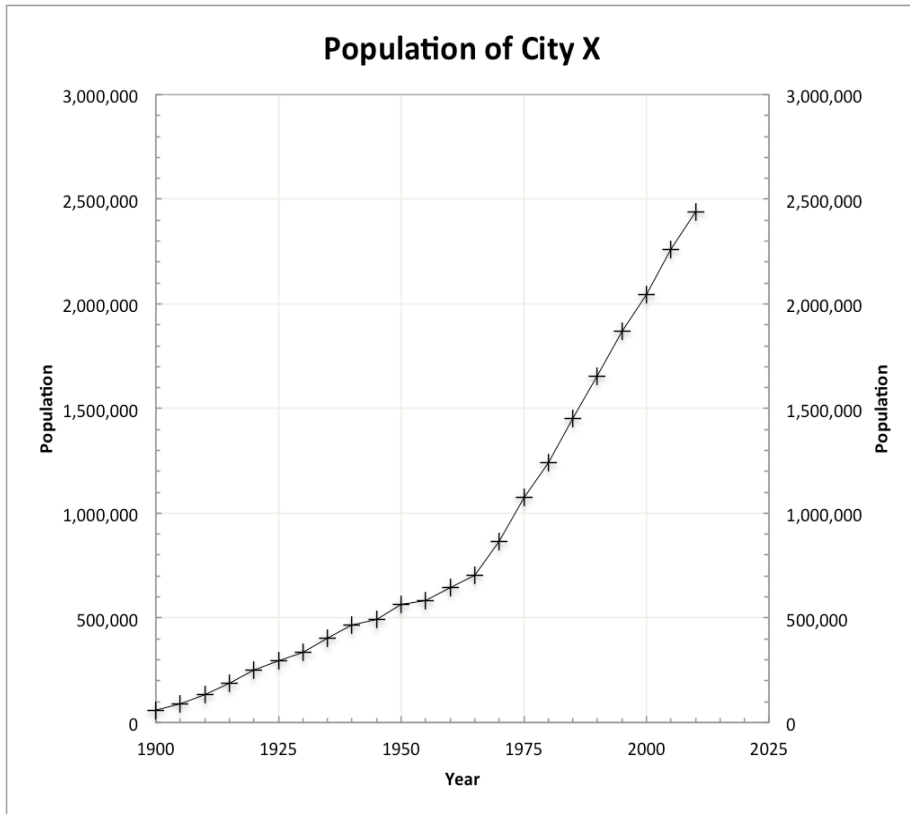
- Algebra
- Area and Volume
- Calculus
- Dimensional Analysis and Unit Conversions
- Error, Precision, Accuracy
- Estimation
- Exponents and Logarithms
- Geometry and Spatial Reasoning
- Interpret Graphs
- Interpret Tables
- Linear and Exponential Growth
- Measurement
- Percent and Percent Change
- Plotting/Making Graphs
- Probability, Odds, Risk
- Proportional Reasoning
- Scientific Notation
- Significant Figures
- Simple Operations (+/-/x/÷)
- Statistics
- Using Numbers in Written Work

In Life??

STEM Educator Survey



Sample Questions



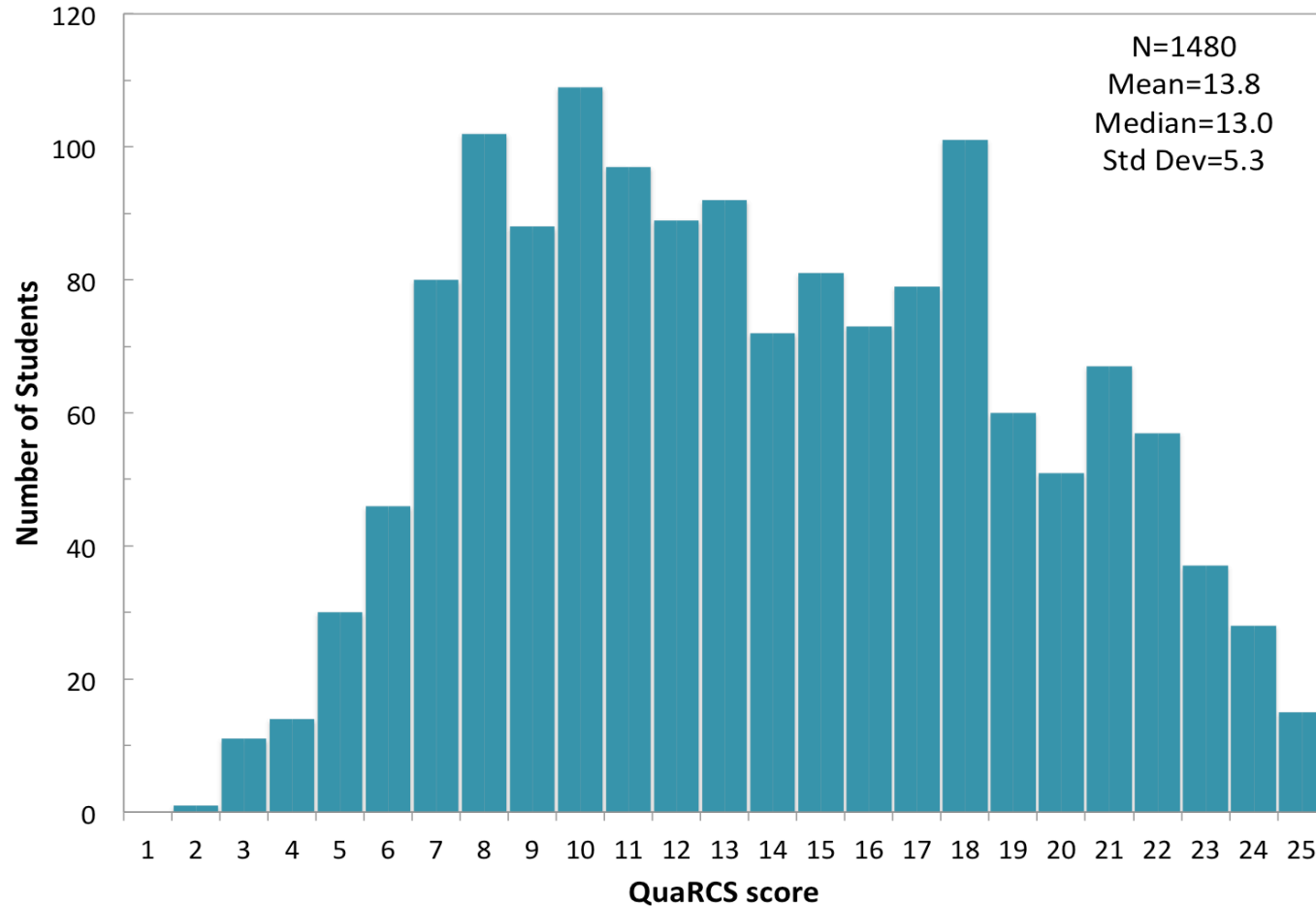
Your cable bill is \$36 per month from January 1 through September 30 and then doubles to \$72 per month starting October 1. What is your average monthly bill over the course of the entire calendar year (January-December)?

Number of Injuries by Ability Level for Skiers at Resort Y in the Years 2000-2010

Level of Expertise	Total Visitors	Number of Minor Injuries	Number of Severe Injuries	Number of Deaths
Novice	12,152	384	122	1
Intermediate	9,498	96	65	0
Expert	802	11	16	5
Totals	22,452	491	203	6

Score Distribution

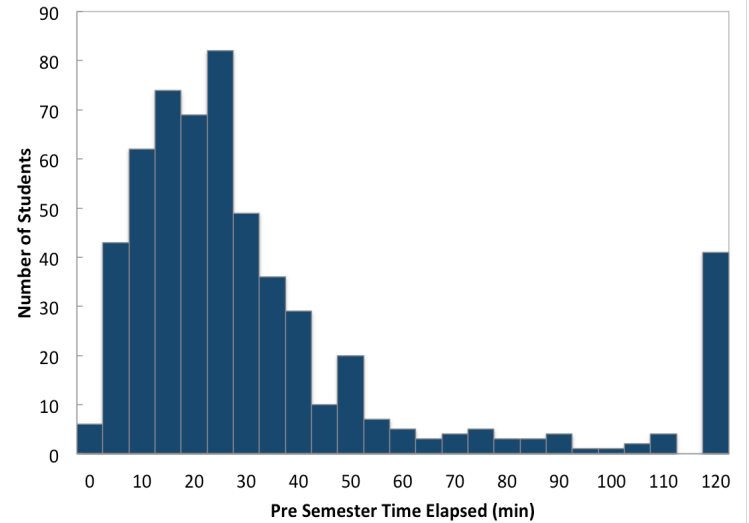
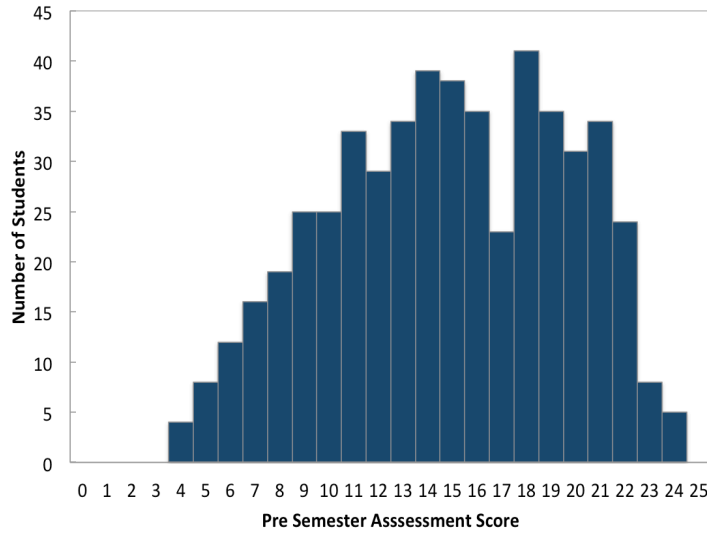
QuaRCS Score Distribution for General Education Science Students



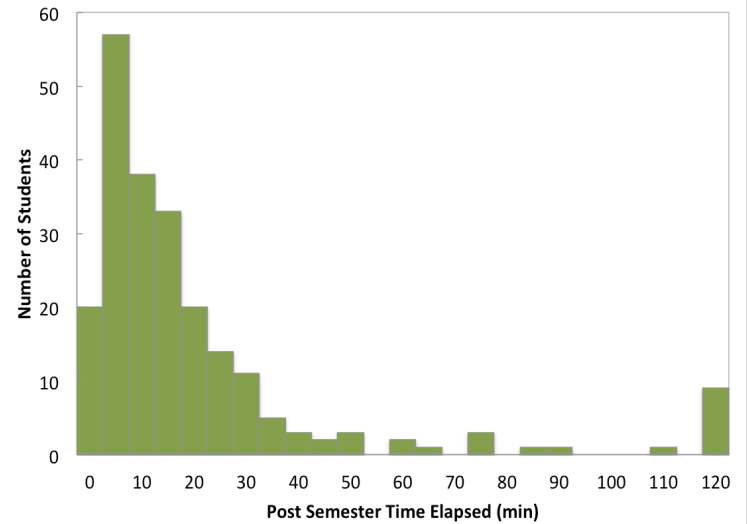
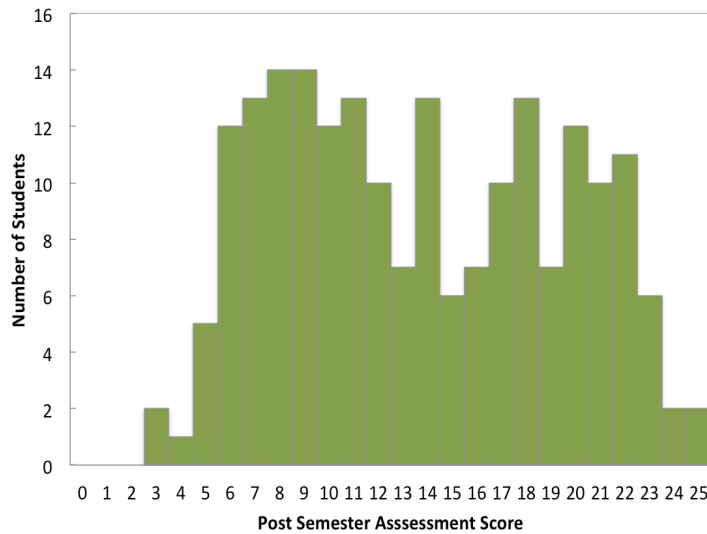
SCORE

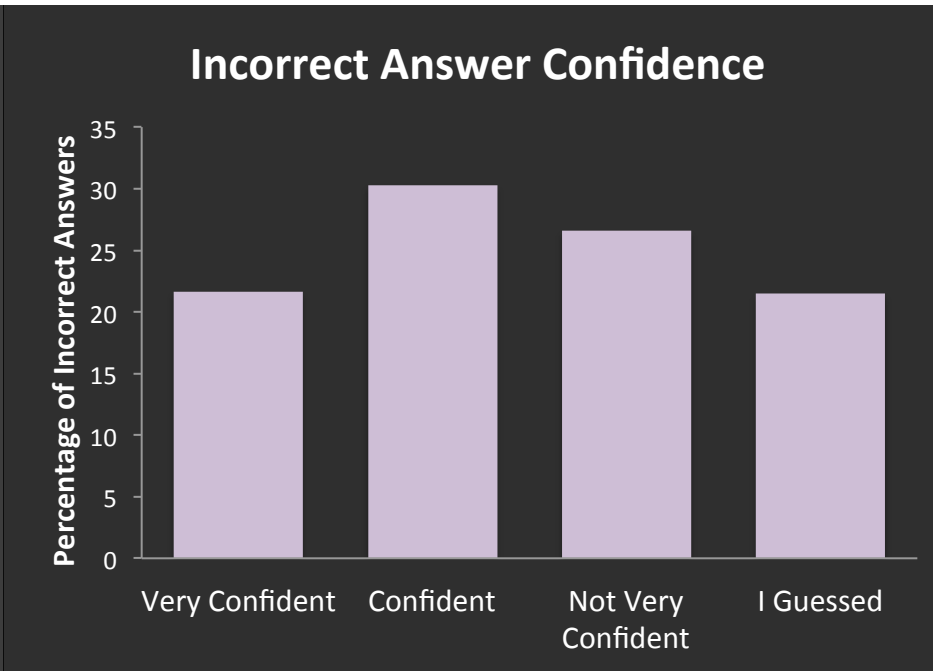
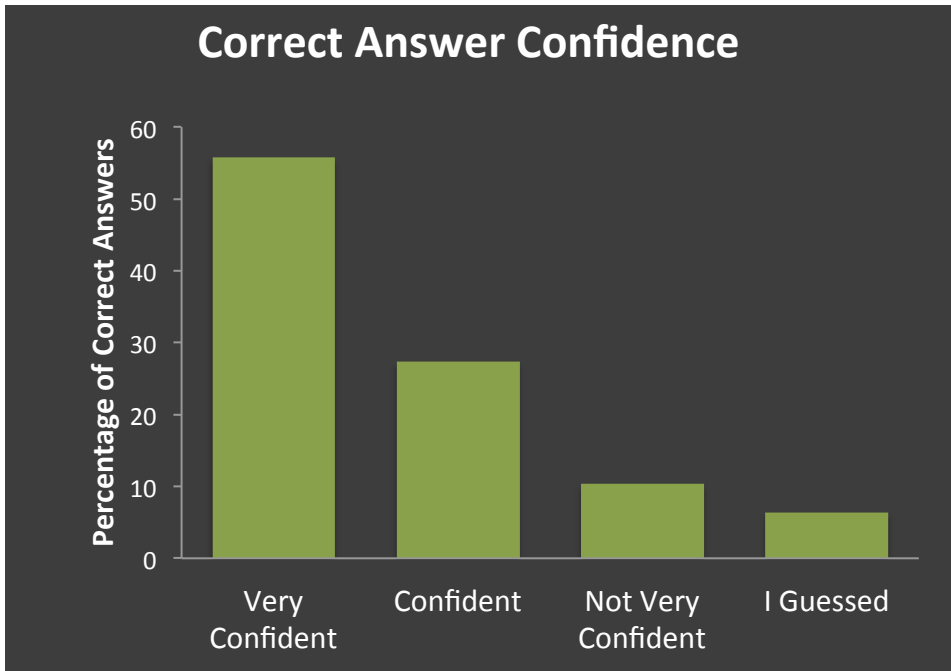
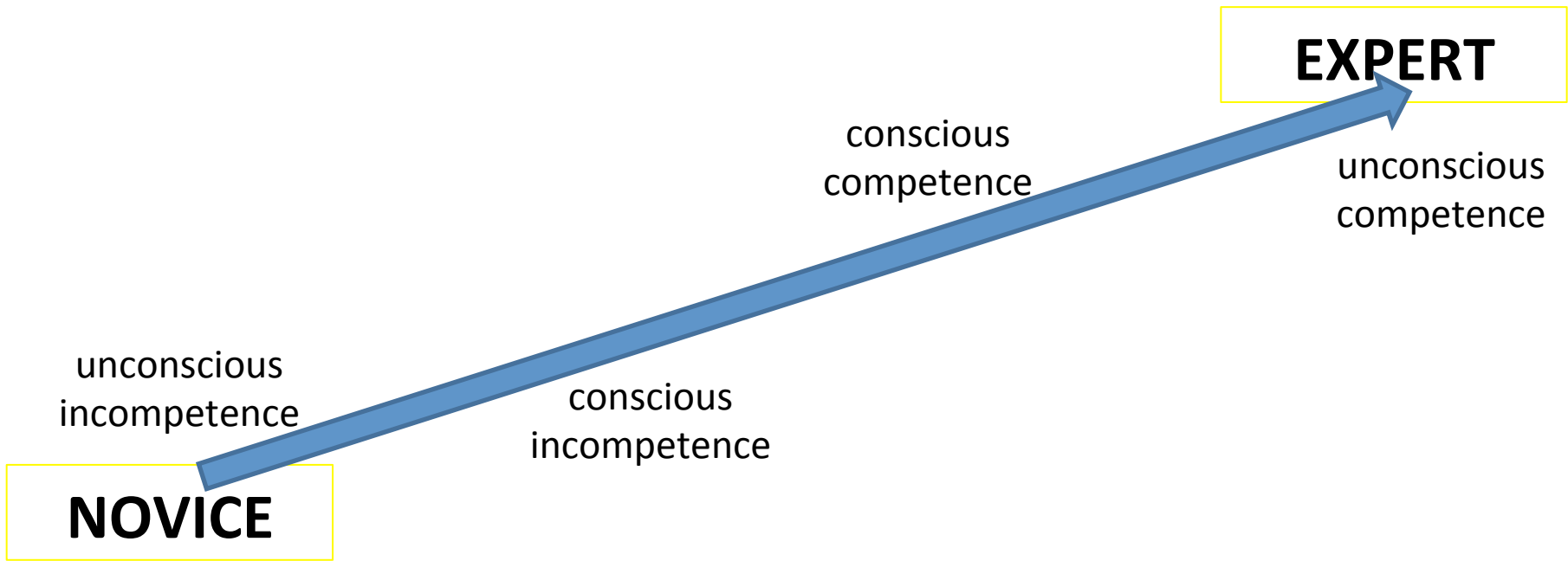
TIME

PRE



POST

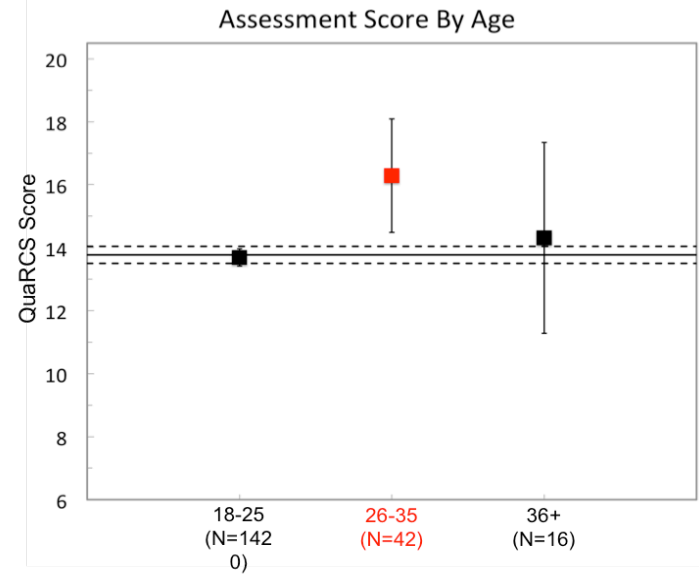
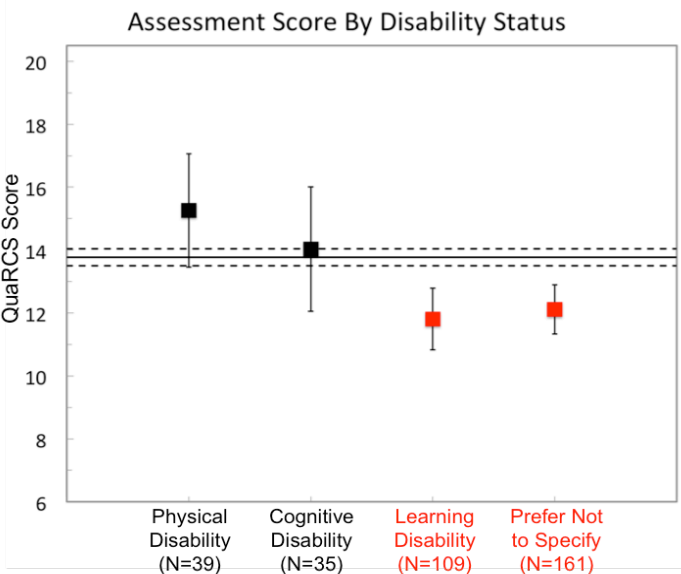
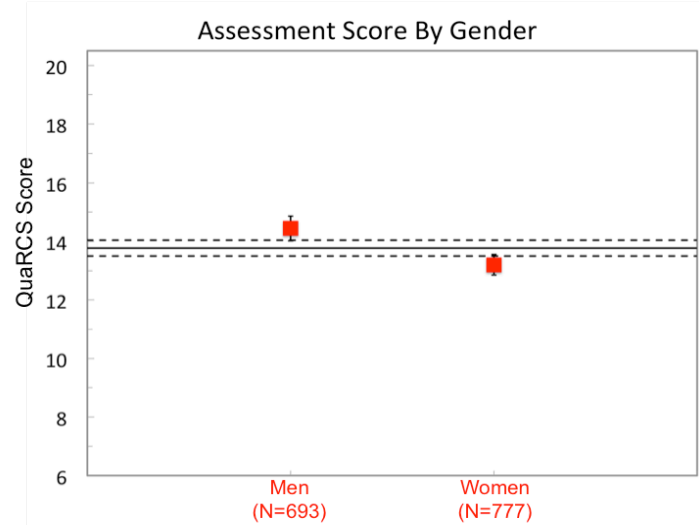
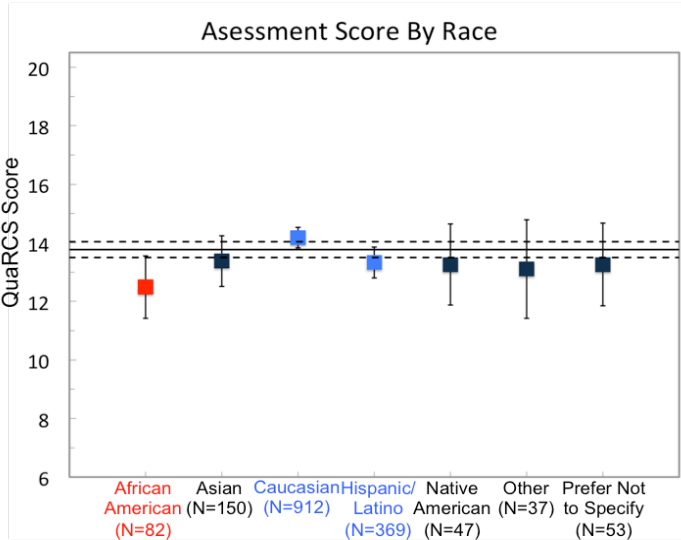




Attitude Questions

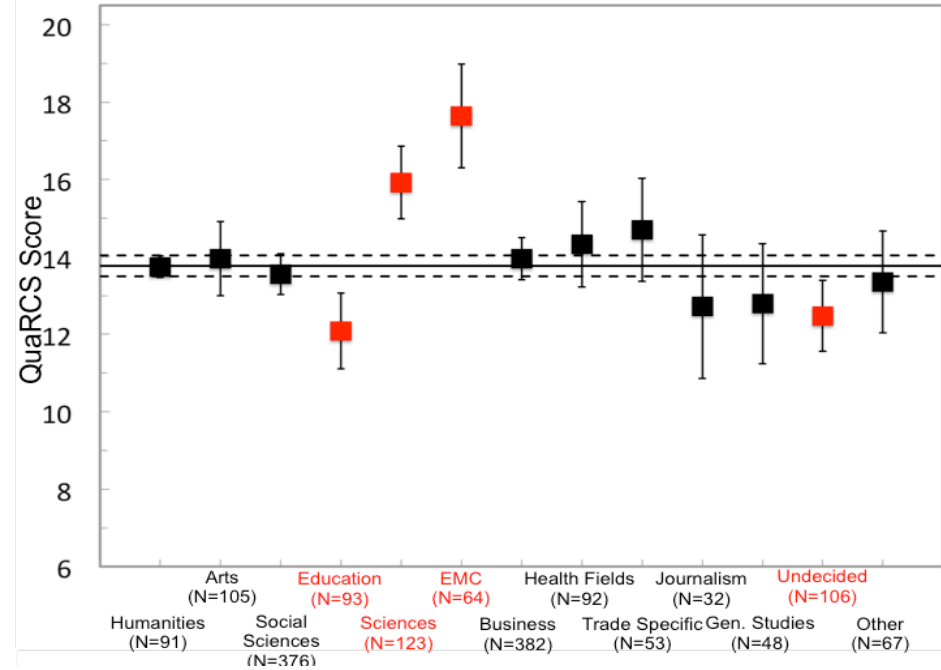
- Basic demographics: race, gender, age, disability status
- Academic demographics: class, major, most recent math course, intended math/science coursework, reason for choosing course/major
- Attitudes/perceptions about numbers, graphs and mathematics

Basic Demographics

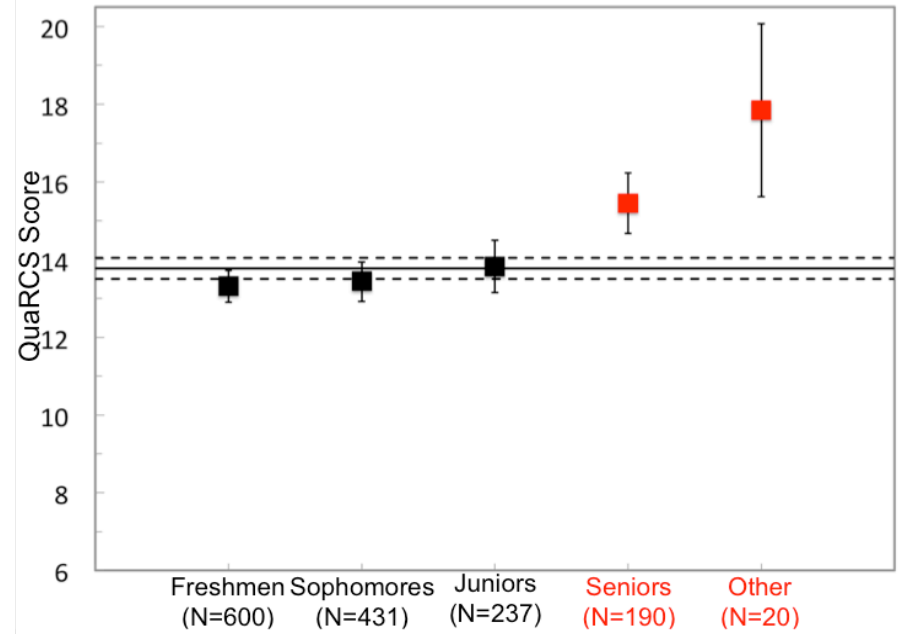


Academic Demographics

Assessment Score By Major

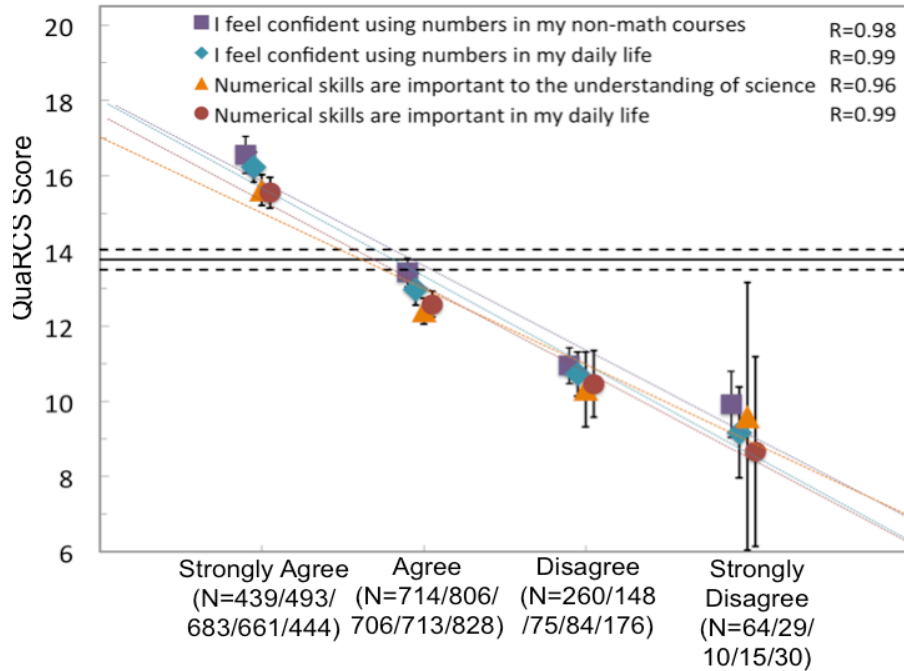


Assesment Score By Class

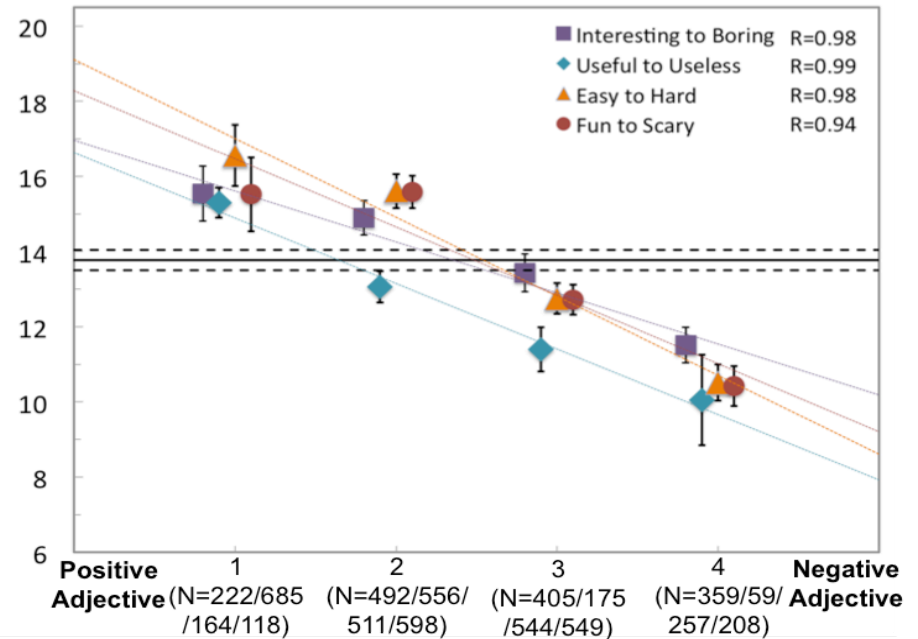


Attitudinal Correlations

Assessment Score By Level of Agreement with Statements



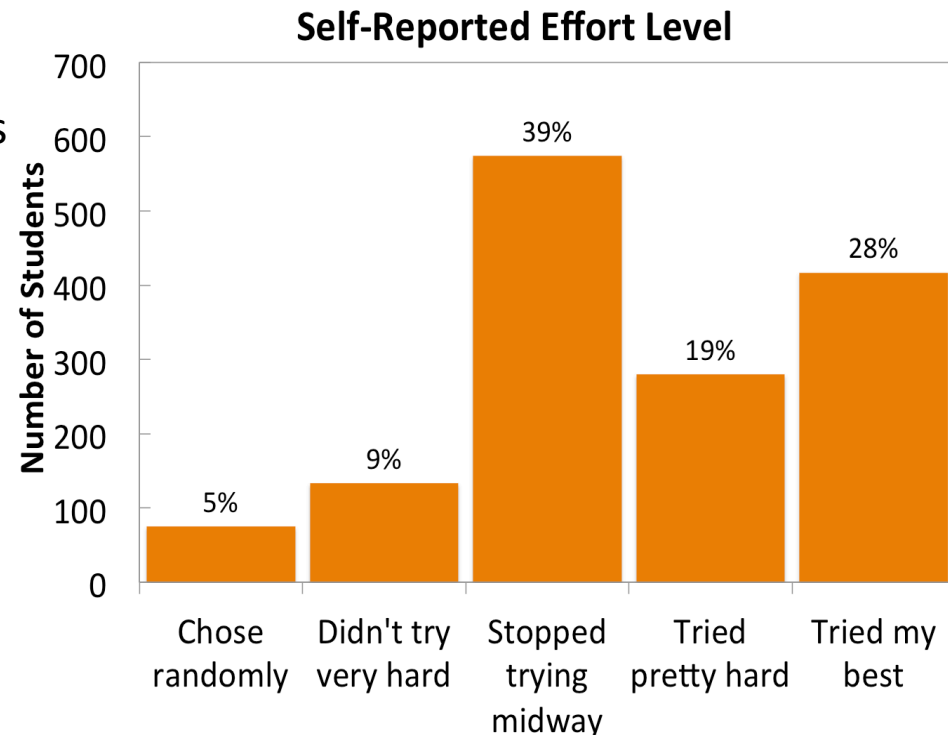
Assessment Score By Opinions About Doing Mathematics



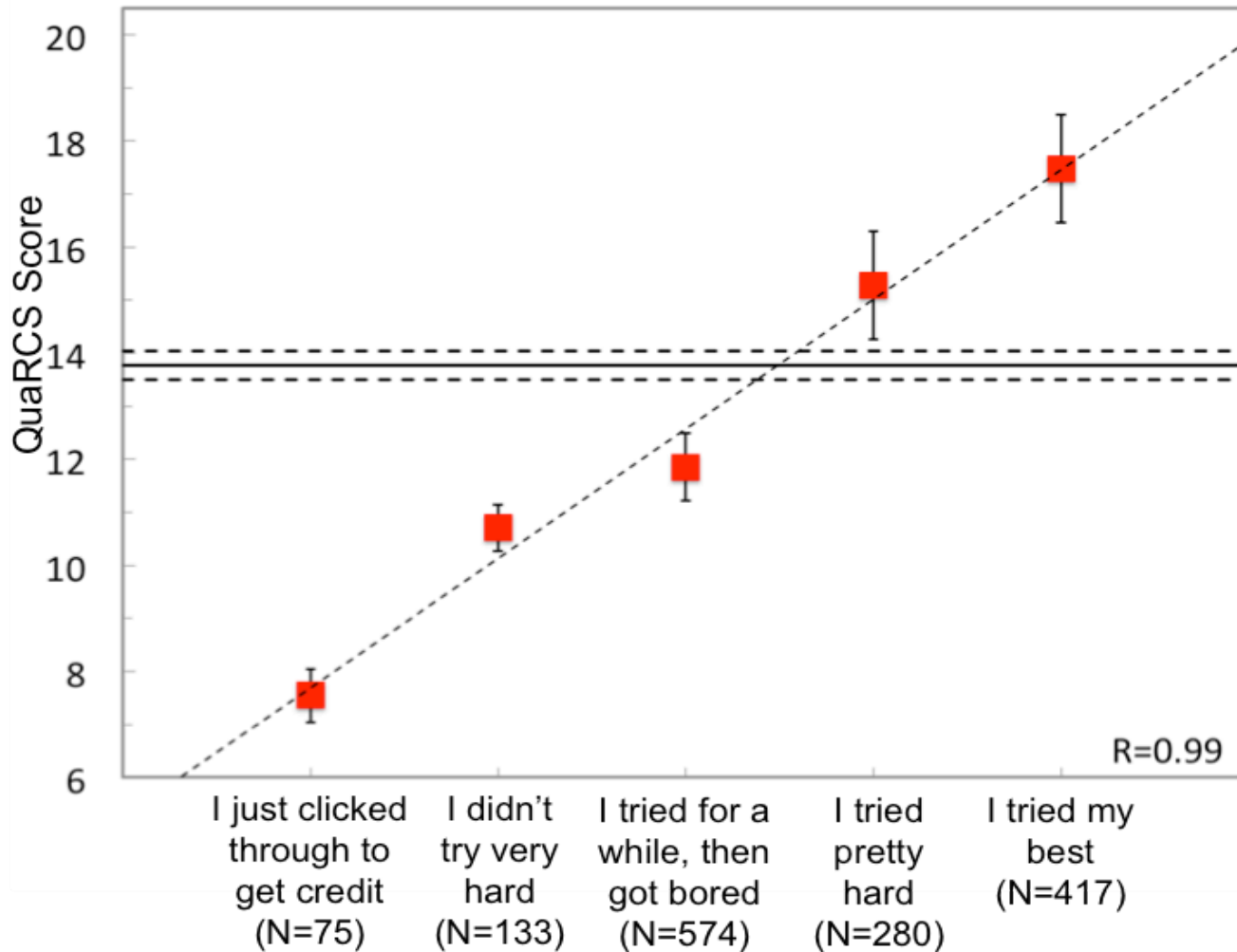
Self-Reported Effort

Knowing that this survey is being used for research to try to improve courses like yours and that your answer to this question will not be shared with your instructor, please honestly describe the amount of effort that you put into this survey.

- a) I just clicked through and chose randomly to get the participation credit
- b) I didn't try very hard
- c) I tried for a while and then got bored
- d) I tried pretty hard
- e) I tried my best on most of the questions



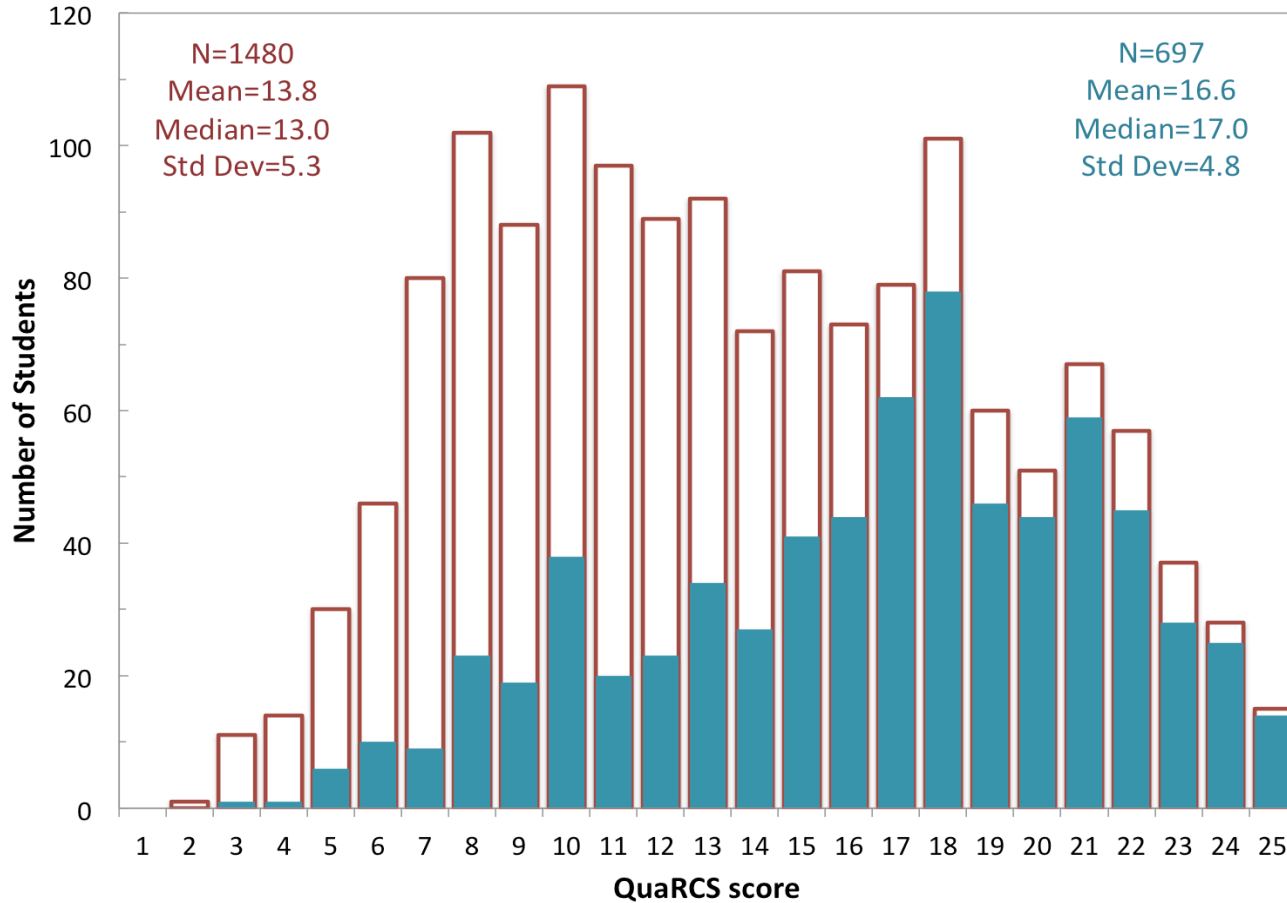
Assessment Score By Effort



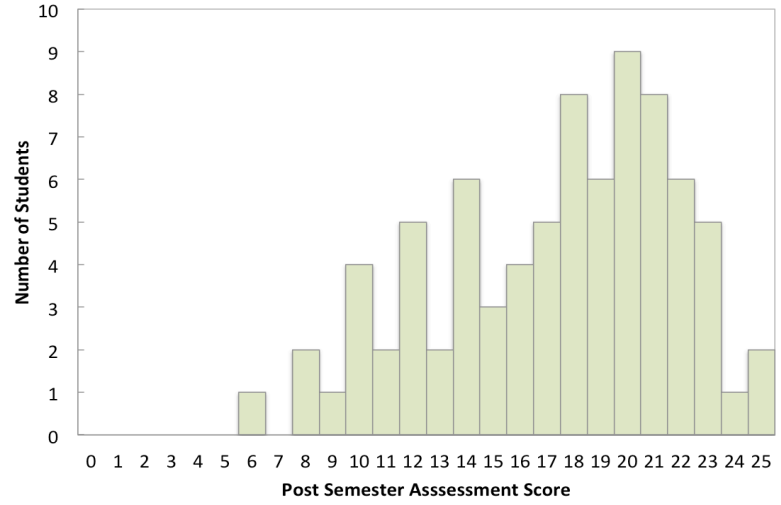
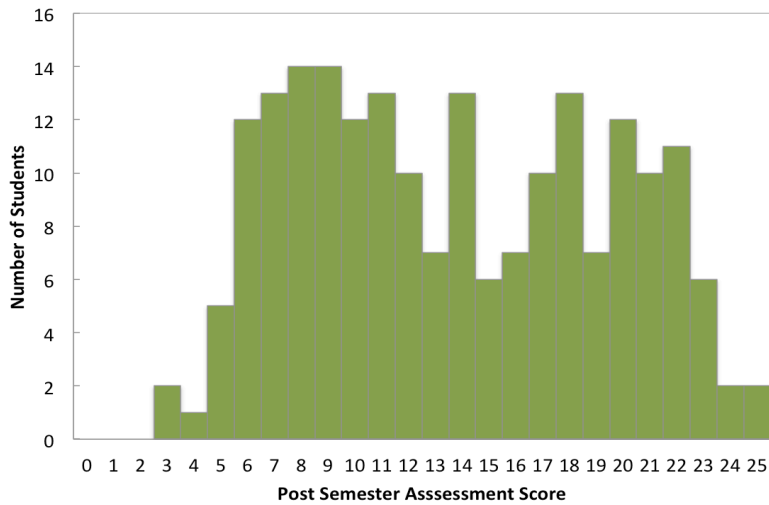
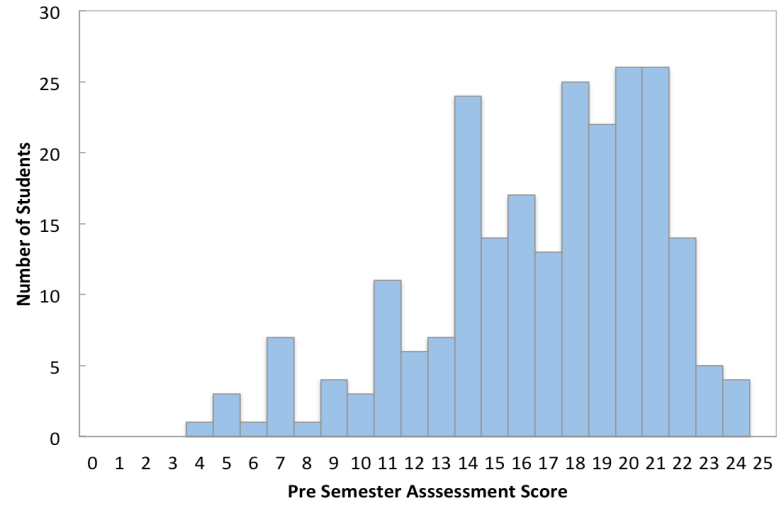
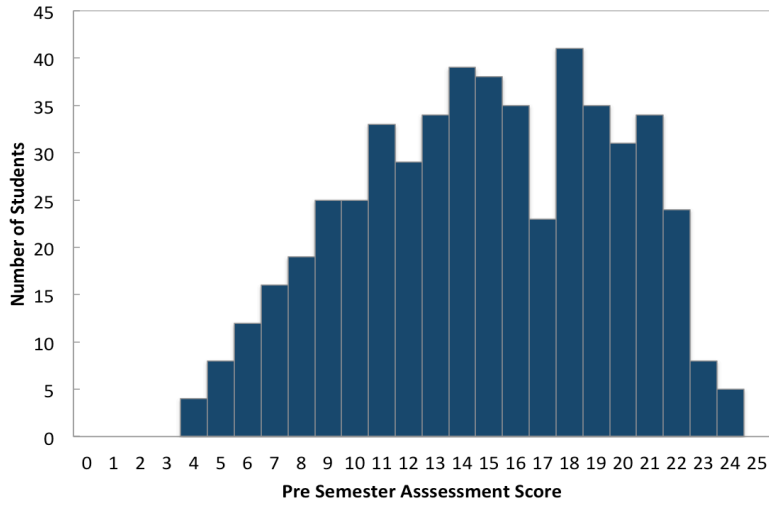
Explains 29% of variation in QuaRCS score

Scores by Effort

QuaRCS Score Distribution for General Education Science Students



Pre/Post Scores



Class 1 (N=145,122)

Adjective	Pre to Post Change
Interesting	5.66%
Useful	2.72%
Useless	-1.09%
Boring	-4.19%
Hard	-3.11%

Classes 2&3 (N=42,28)

Adjective	Pre to Post Change
Interesting	3.50%
Useful	7.73%
Useless	-3.11%
Boring	-6.11%
Hard	-2.00%

Classes 4,5 & 6 (N=72, 30)

Adjective	Pre to Post Change
Interesting	-9.94%
Useful	-2.43%
Useless	1.07%
Boring	10.38%
Hard	0.93%

Class 7 (N=416,336)

Adjective	Pre to Post Change
Interesting	3.09%
Useful	0.78%
Useless	-1.21%
Boring	-1.47%
Hard	-1.19%

Conclusions

Thank You!

Funding



Collaborators

Don McCarthy

Erin Dokter

Ed Prather

Sanlyn Buxner

For More Information:

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www.katefollette.com/QL

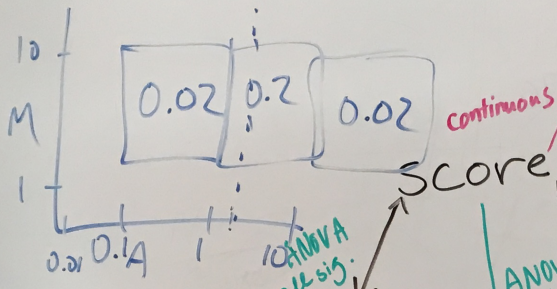
“Re-Numerate”
Newsletter



QuaRCS
Development
and Validation
Article in
Numeracy



- BASIC DEMOGRAPHICS**
- race
 - gender
 - age
 - disability status



Variations

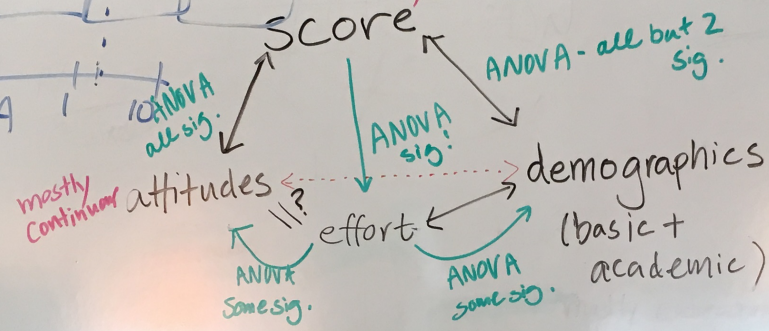
- 70 effort
- 10 perc. diff
- 20 LK 2

Attitudes

- Math is scales x 4
- Likert's
 - ③ Num. skills important in daily life
 - ④
- perceived diff.
- how-freq. encounter
 - ① similar sits.
 - ② graphs/tables
 - ③ use numbers

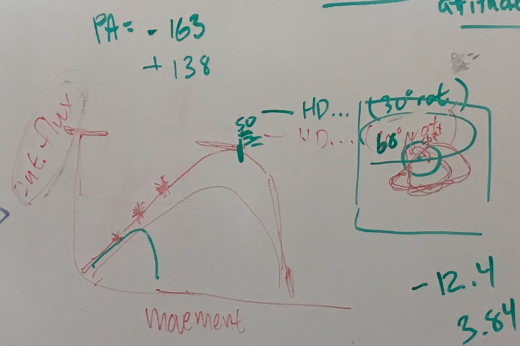
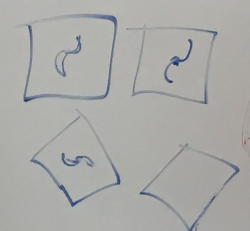
ACADEMIC

- major
- class
- intended # math
- " " science
- most recent math
- why major
- why course



too many variables!

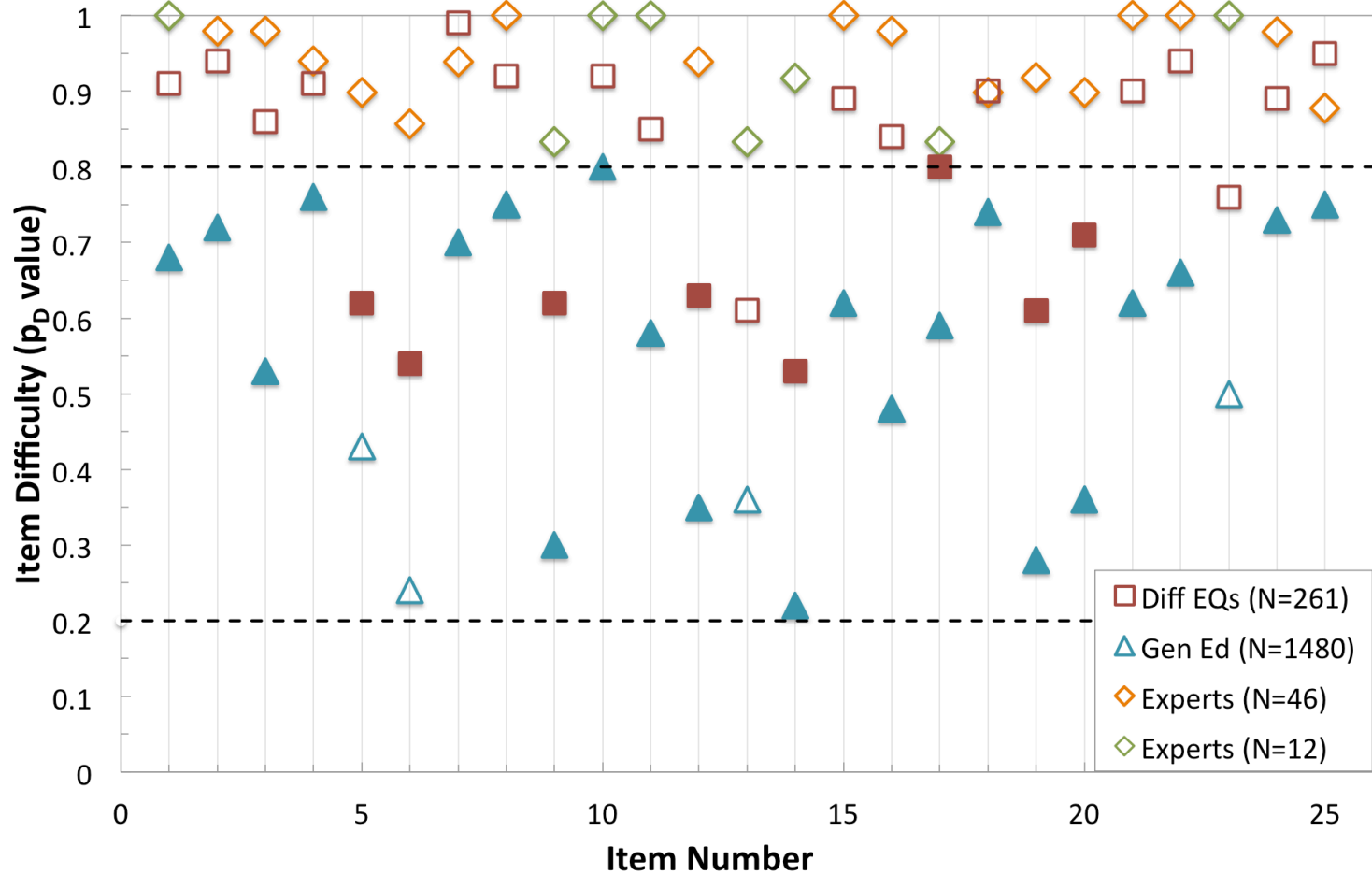
Combine attitudes into attitude score?



Effort

- Confidence?
- calc usage
 - perceived diff?
 - chose major b/c good at it
 - add up conf. rankings

Population Validation

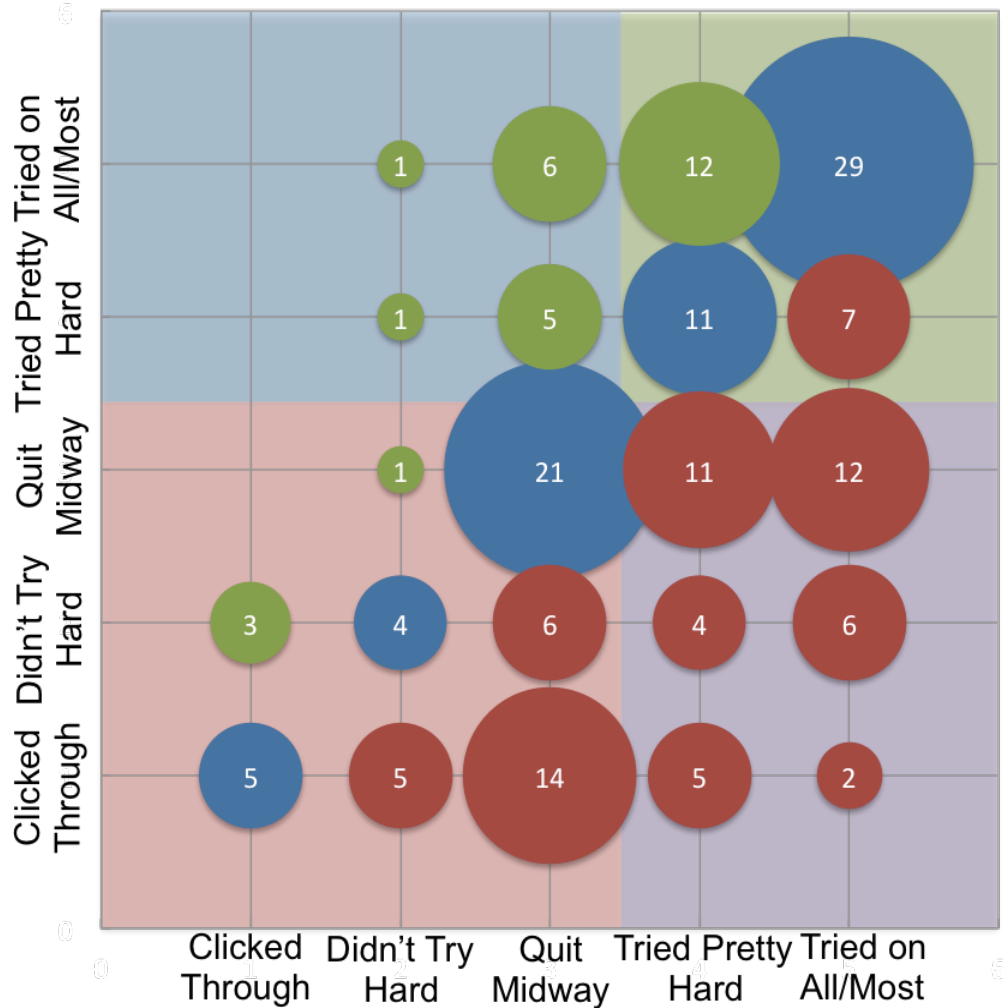


Instrument Statistics

Instrument Evolution

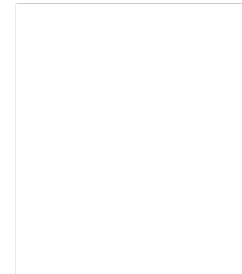
Form	N Students	N Questions	Mean (%)	Standard Deviation (%)	Cronbach's α
Spring 2011	68	10	66	22	0.692
Fall 2011	190	22	63	19	0.767
Spring 2012	574	22	58	18	0.749
Fall 2013	518	25	59	19	0.801
Fall 2013*	343	25	63	20	0.825
Fall 2014	276	25	55	23	0.865
Fall 2014*	166	25	62	24	0.885
Spring 2015	1480	25	55	21	0.843
Spring 2015*	906	25	60	22	0.868

Effort on Post Semester Assessment

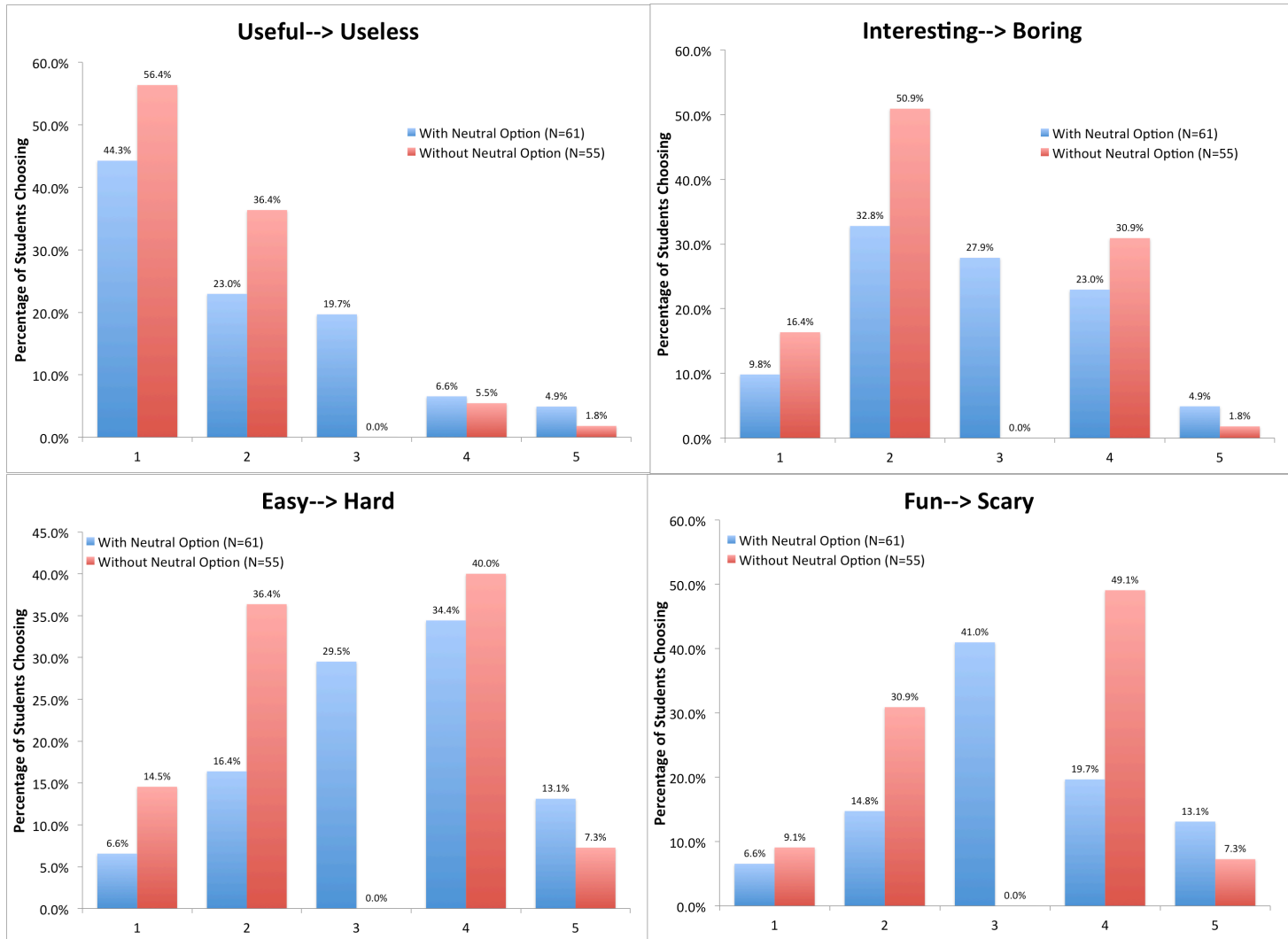


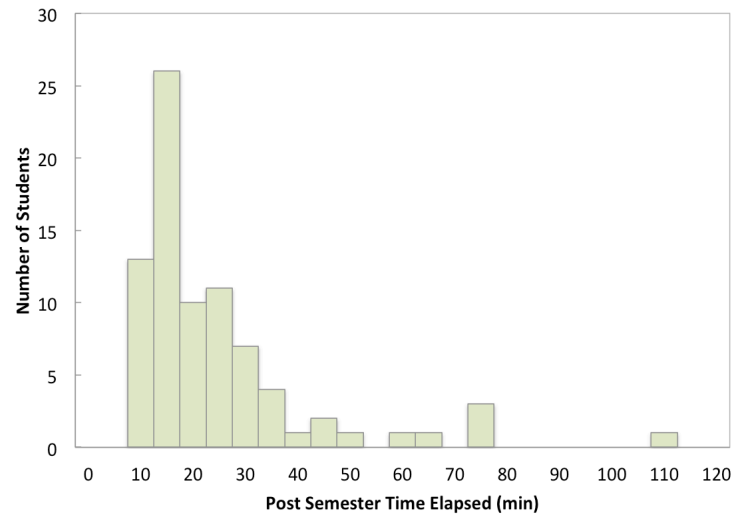
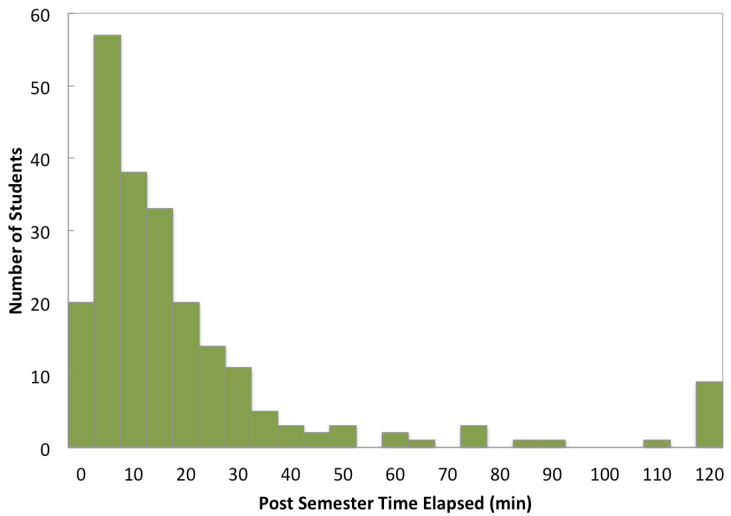
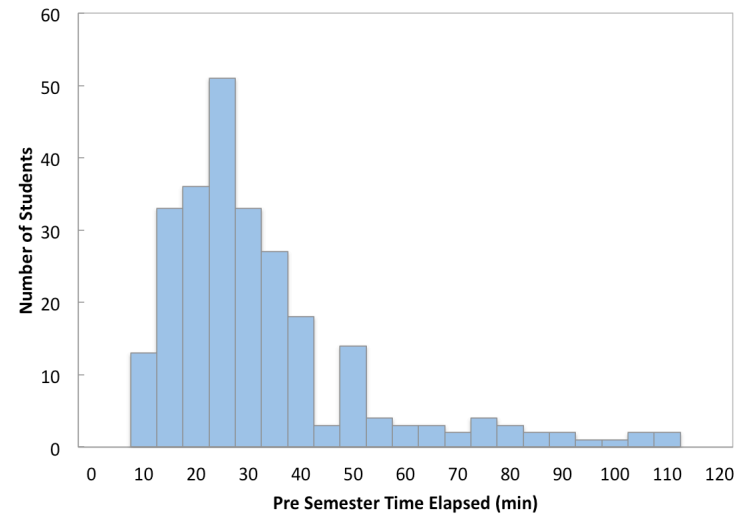
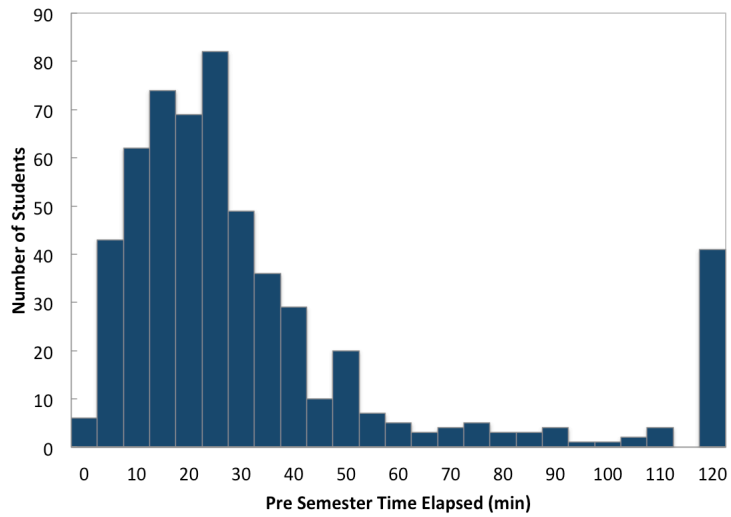
Effort on Pre Semester Assessment

- Same Effort (41%)
- Effort Increased (17%)
- Effort Decreased (42%)
- Included in both (35%)
- Included in neither (35%)
- Included in pre only (23%)
- Included in post only (8%)



Opinions About Math





Measured Skills

QuaRCS Skill Categories

Skill	Definition	Abbrev.	N _{Quest}	p_D -value range
Graph Reading	Read, interpret or extrapolate graphical data.	GR	5	0.22-0.76
Table Reading	Read and interpret information presented in tabular form.	TR	3	0.35-0.80
Arithmetic	Add, subtract, multiply or divide two or more numbers.	AR	21	0.24-0.80
Proportional Reasoning	Compare two or more numbers, rates, ratios, fractions.	PR	13	0.24-0.75
Estimation	Approximate an answer or choose the closest value to a precise calculation.	ES	4	0.24-0.76
Percentages	Compute or compare percentages	PC	5	0.28-0.73
Statistics and Probability	Statistics= interpretation of data, including distributions and descriptive statistics (mean, median, mode, etc). Probability = compute odds or risk or determine the most likely outcome.	SP	6	0.22-0.59
Area and Volume	Compute or compare areas or volumes	AV	5	0.48-0.68
Error	Evaluate uncertainty in graphs or numbers	ER	4	0.22-0.36
Unit Conversions and Dimensional Analysis	Unit Conversions = Use the relationship between two or more units to transform one number into another. Dimensional Analysis = Draw inferences about the relationship between two or more quantities based on the units attached to them.	UD	6	0.30-0.75

