What impact do high school mathematics curricula have on college-level mathematics placement?

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Michael Fish

UW Center for Placement Testing

Math Background Survey

		Junior	Senior	Neither
1	Core Plus			
2	College Preparatory Math			
3	Integrated Math			
4	Pre-algebra, general math, business math			
5	Algebra I (first year algebra)			
6	Geometry			
7	Transition to College Math			
8	Algebra II or Advanced Algebra w/ Trig			
9	Trigonometry			
10	Precalculus or mathematical analysis			
11	Calculus or AP Calculus			
12	Statistics or AP Statistics			
13	Other mathematics			
14	No mathematics			

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4 groups

- Reform
  - Without Calculus (N = 1808)
  - With Calculus (N = 395)
- Traditional
  - Without Calculus (N = 10,564)
  - With Calculus (N = 4,669)

Percentages Correct

	MBSC	ALG	TRG	Overall
Reform w/o Calc	.57	.37	.37	.42
Reform w/ Calc	.81	.65	.62	.68
Trad w/o Calc	.64	.43	.43	.49
Trad w/ Calc	.88	.73	.68	.76

Average Placement Scores

	MBSC	ALG	TRG
Reform w/o Calc	455	446	448
Reform w/ Calc	620	592	585
Trad w/o Calc	498	477	479
Trad w/ Calc	672	643	620

- All Math Placement Scores have an average of 500 and a standard deviation of 100
  - Traditional w/ Calc group scored 1.4 standard deviations (141 points) higher than Traditional w/o Calc.
- No noticeable difference in standard deviations across groups
  - All approximately equal to 100.

Percentages Placing at Each Level

	Remedial		Inter. Alg		College Alg/Precalc		Trig	Calc
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Reform w/ o Calc	18	11	14	17	18	6	2	7	7
Reform w/ Calc	2	2	3	7	10	9	3	17	47
Trad w/o Calc	10	9	11	19	18	9	3	9	13
Trad w/ Calc	0	1	1	3	7	7	2	19	61

Roughly Similar Percentages for Levels 2 - 9

Percentage Placing at Each Level

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Nearly double remedial placements under Reform w/o Calculus

Nearly double calculus placements under Trad w/o Calculus

Percentage Placing at Each Level

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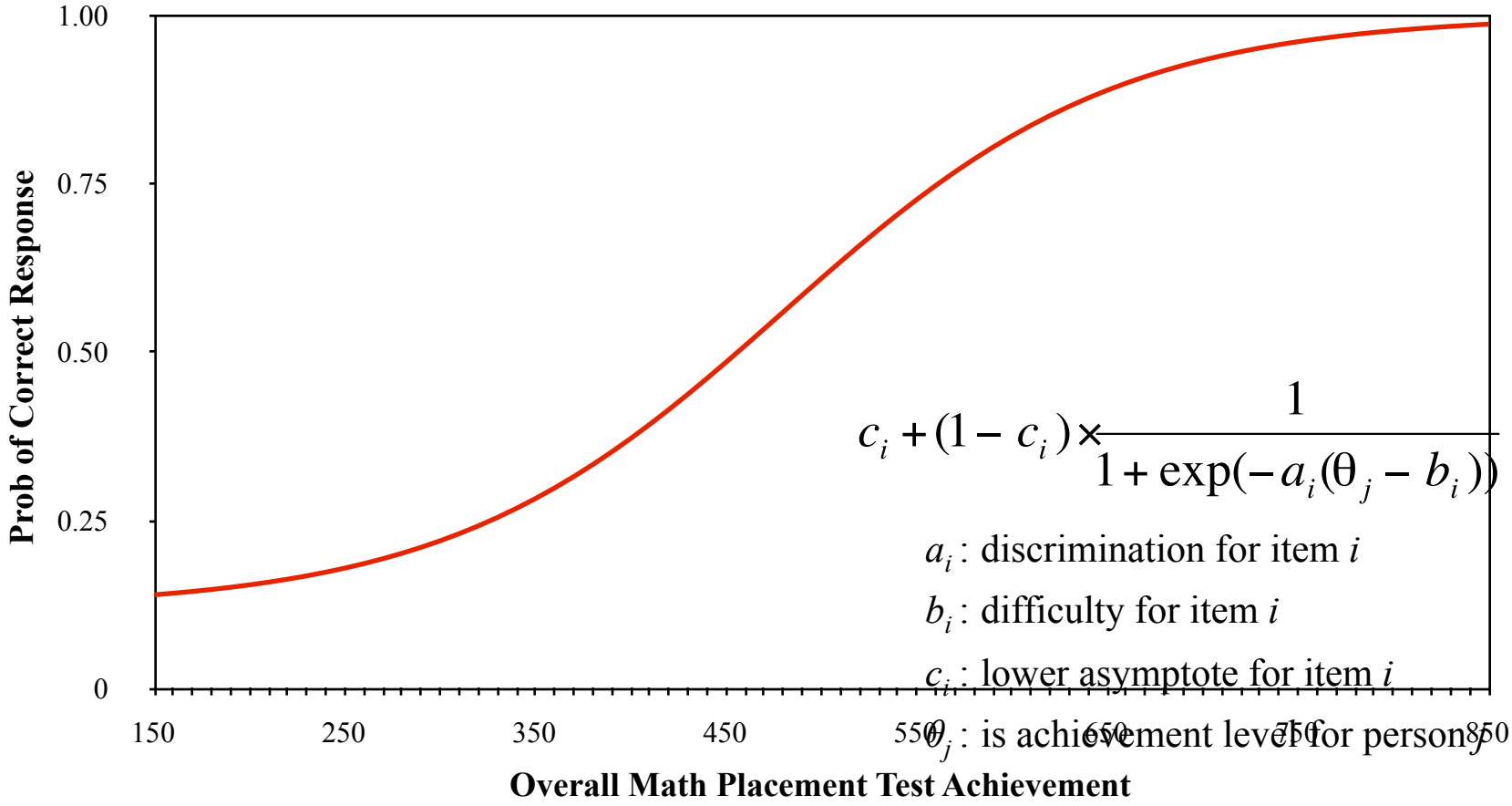
Significantly higher percentage of calculus placements under Traditional w/ Calculus

Purpose

- Purpose of this study is to better understand the relative strengths and weaknesses of different curricula with respect to specific math concepts measured by the placement test.

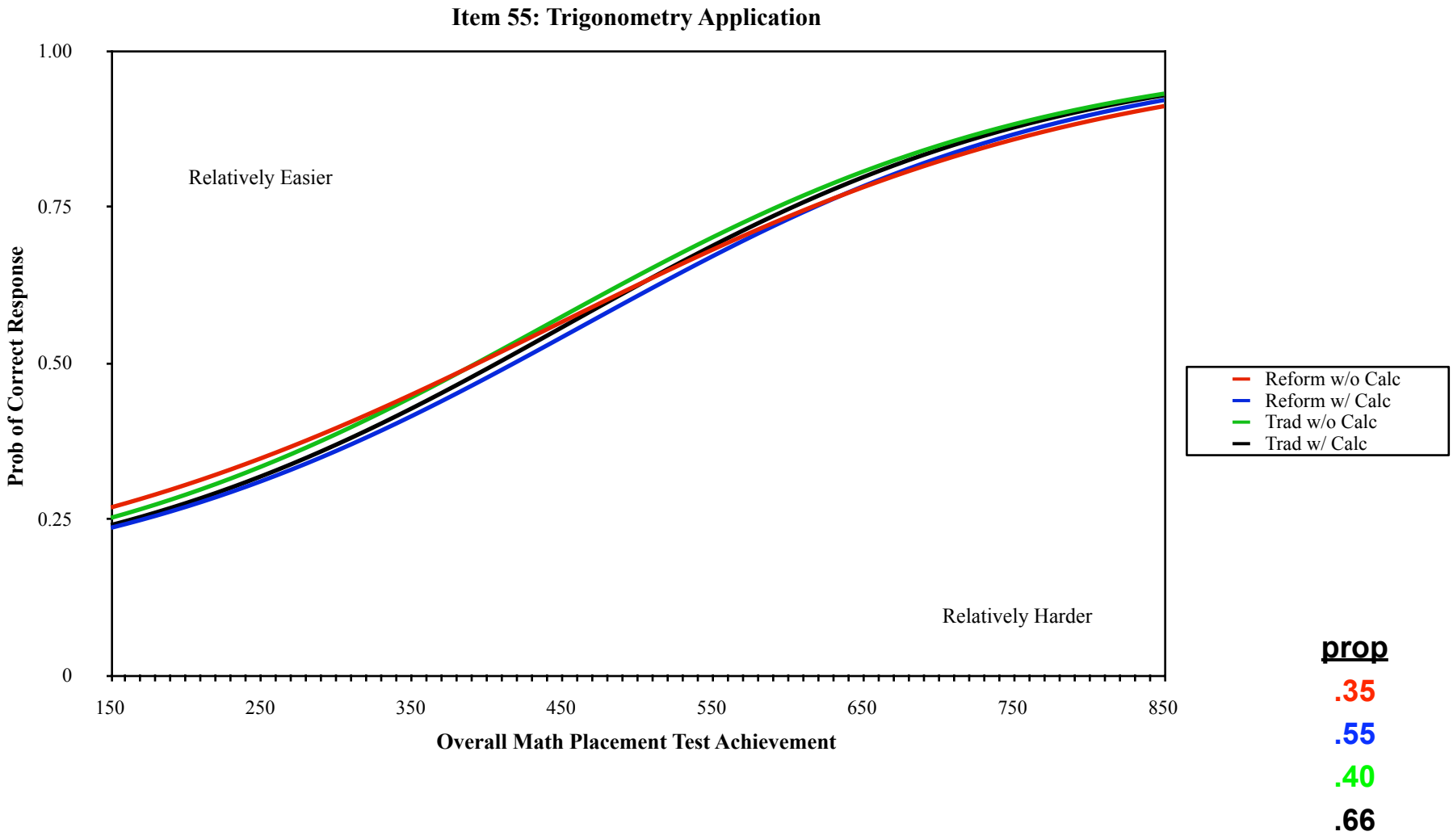
Characterizing Item Performance



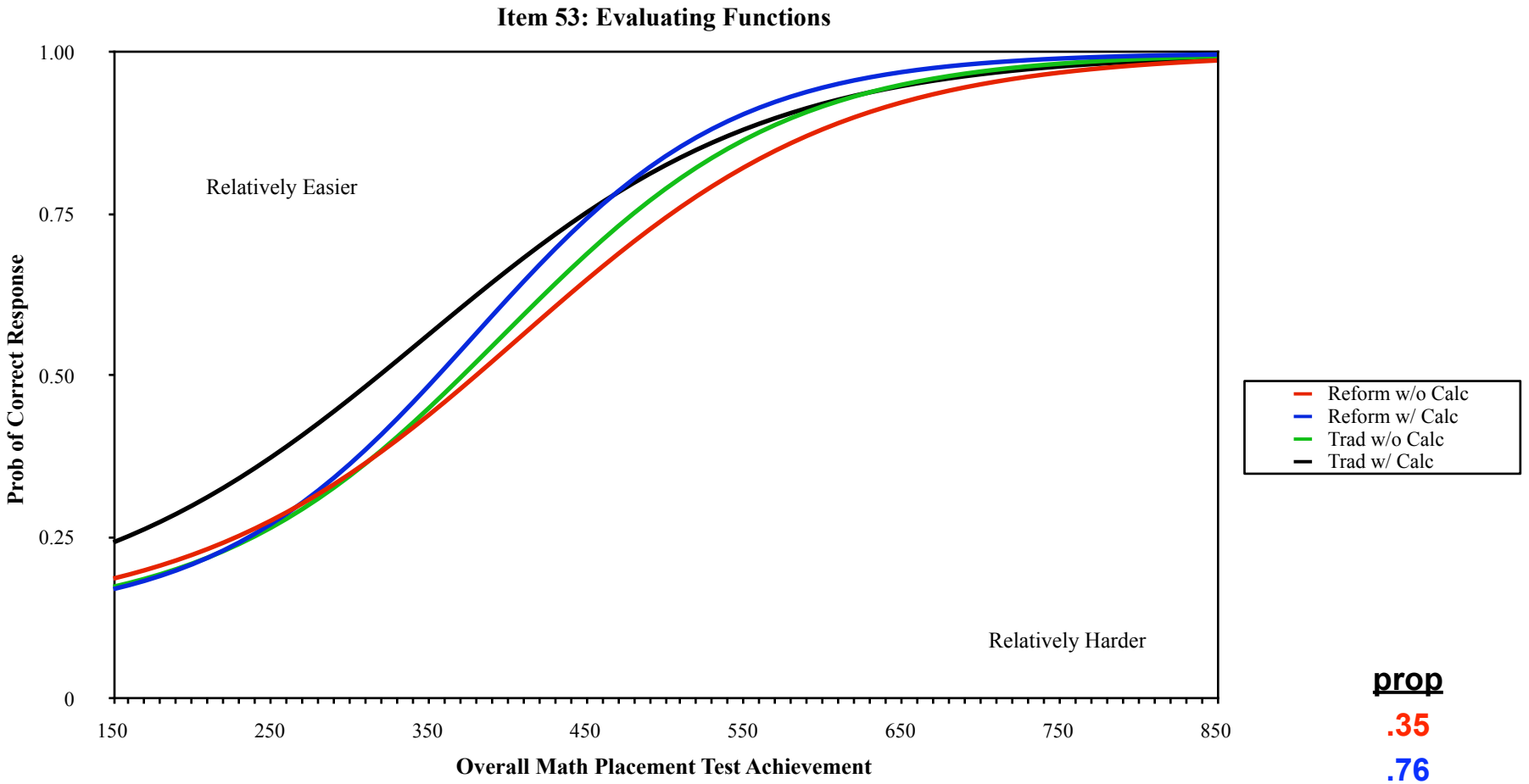
Differential Item Functioning

- One of the measurement assumptions is that the item characteristic curve (ICC) is identical for different subgroups of examinees.
- When the ICC is different for different subgroups for the same item, the item is said to function differentially.
- ICCs may be plotted for different subgroups and the differences may be studied to form hypotheses about why and where differences exist.
- Here, we examined differences in math placement test characteristics between groups of examinees, based on the type of HS math curriculum they reported.

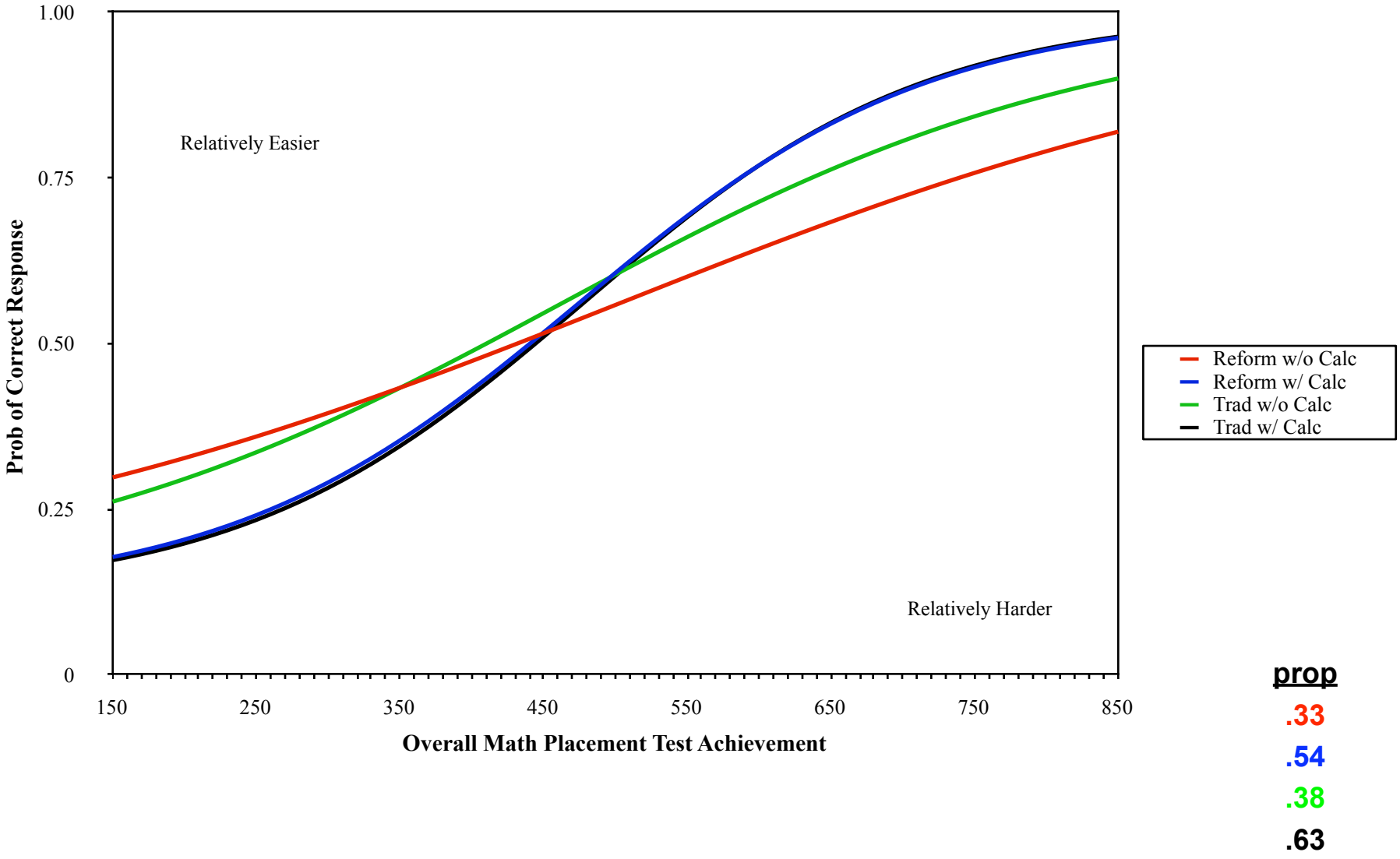
Example of Typical Item Without DIF



Differential Item Functioning

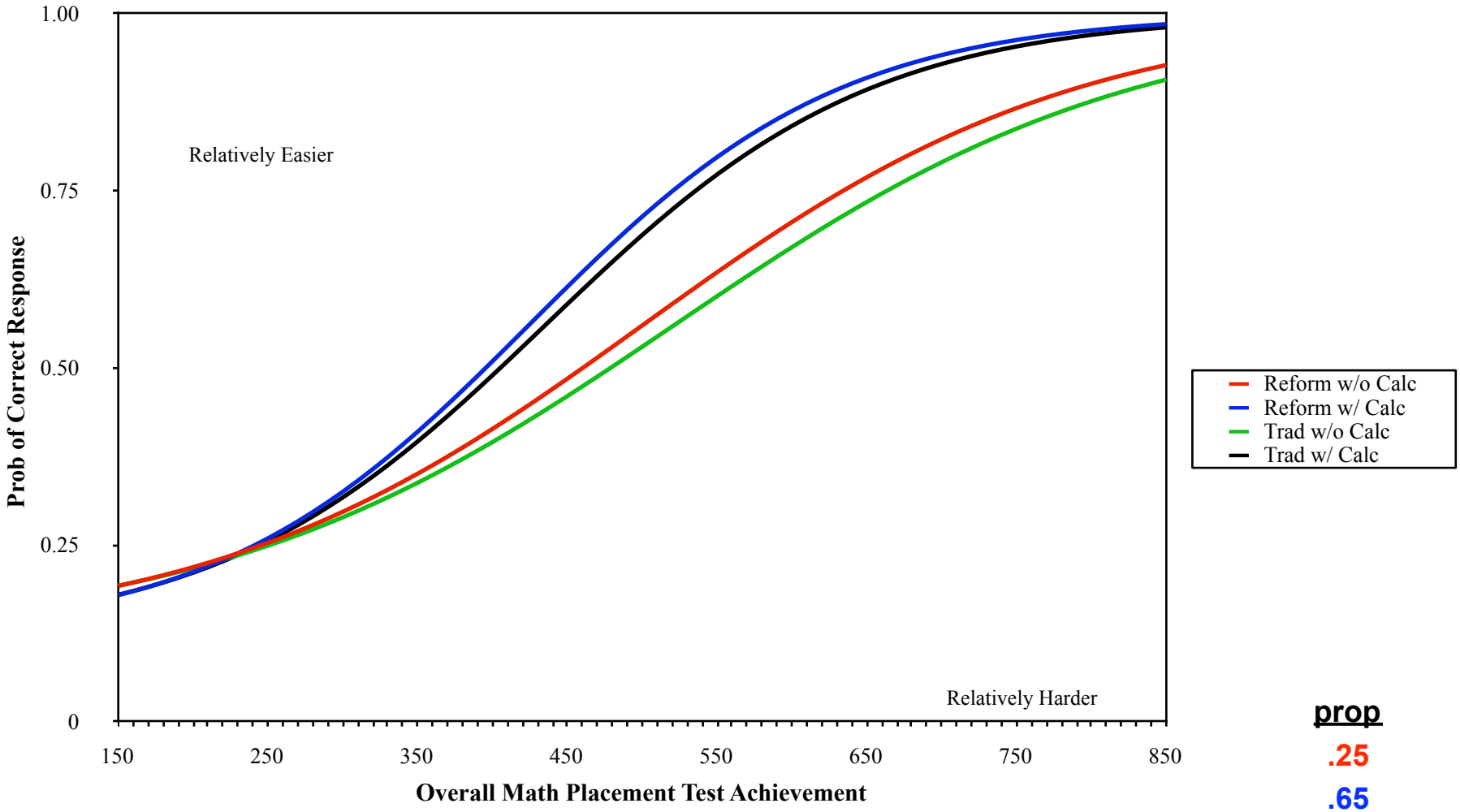


Item 70: Trigonometry Identities



prop
.33
.54
.38
.63

Item 71: Find inverse of function

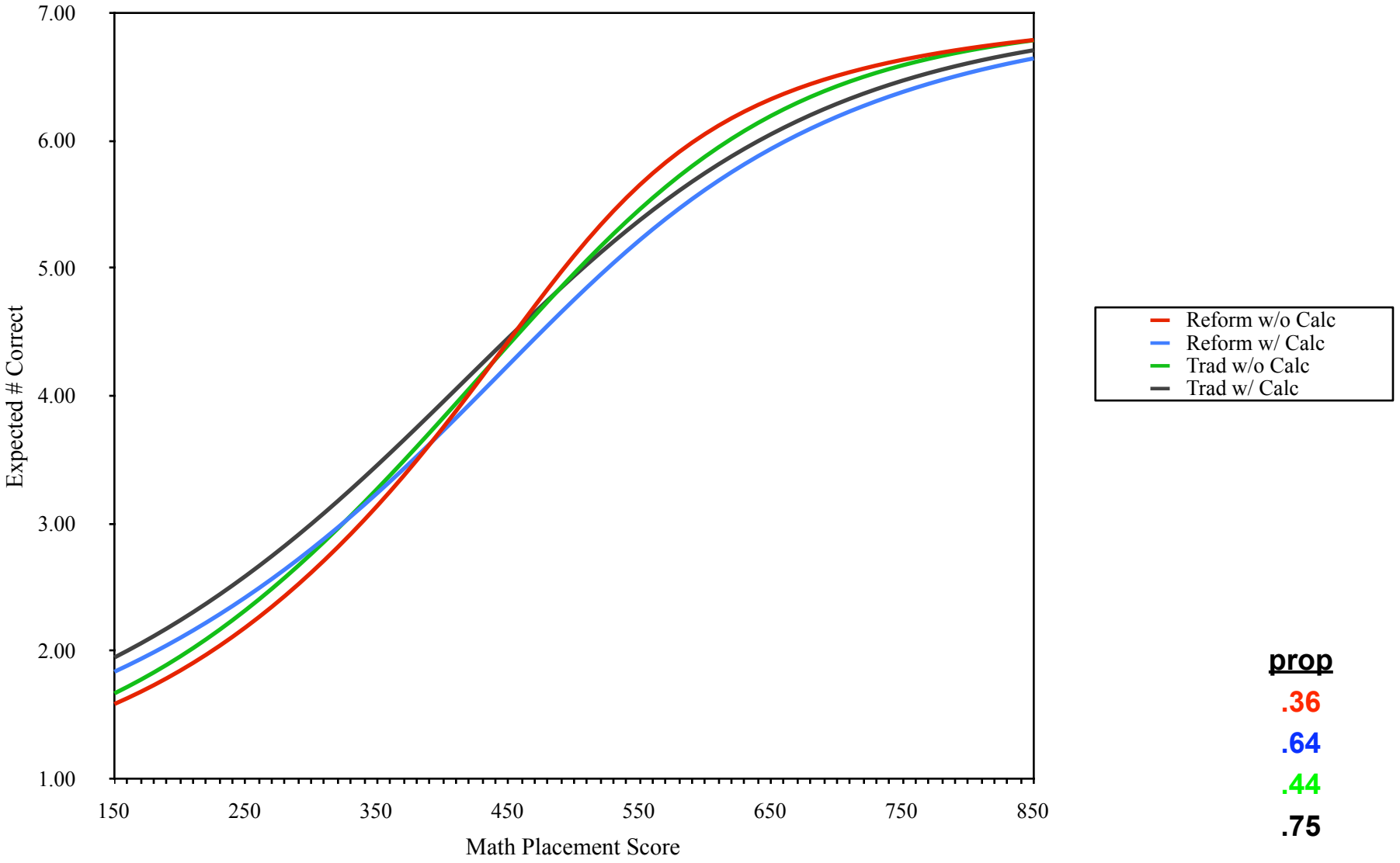


prop
.25
.65
.28
.72

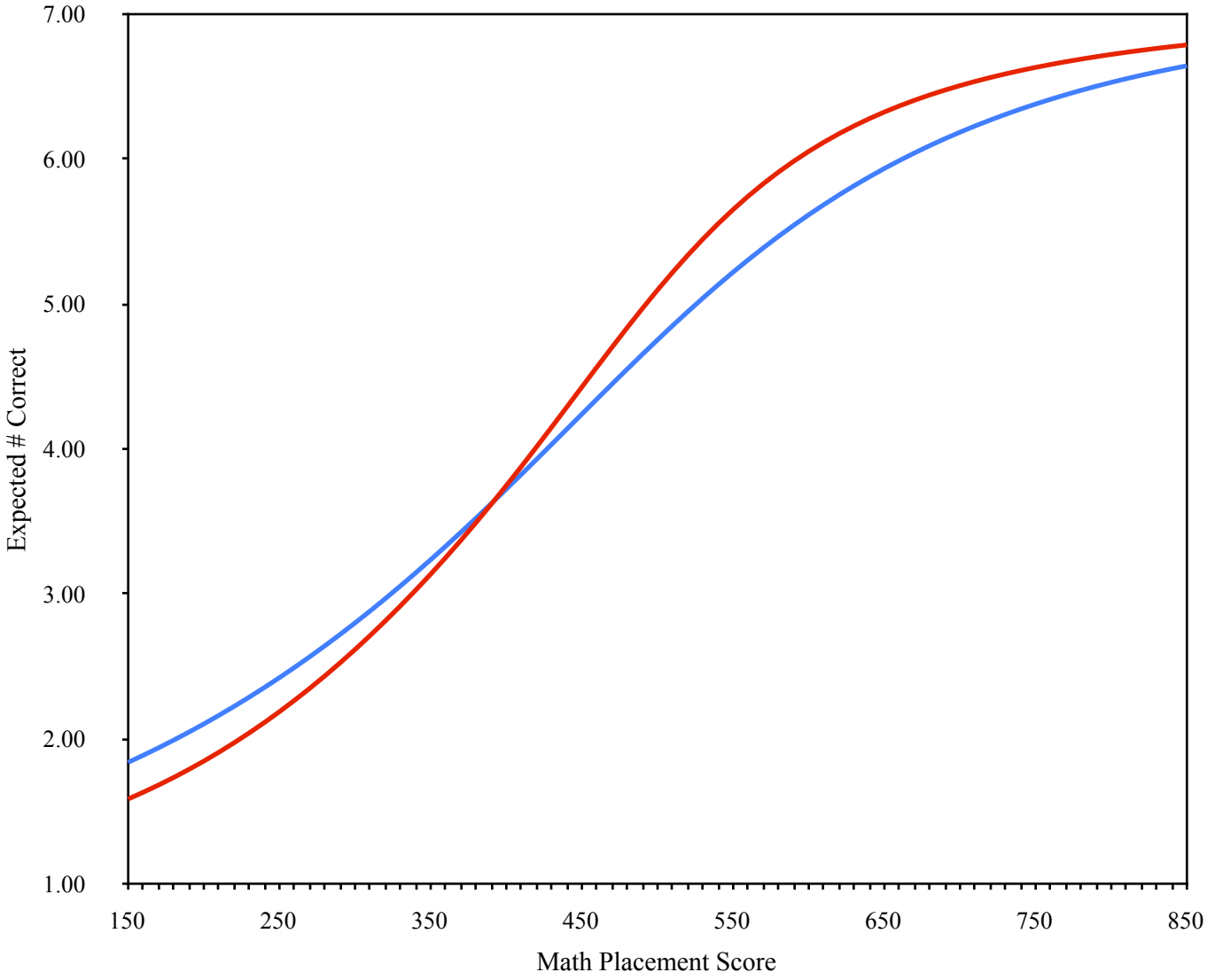
Design

- Estimated DIF curves for each of the 75 items on the test
- Examined the test content/test objectives for the items showing the most DIF
- Analyzed patterns of items showing DIF to identify sets of thematically similar items.
- Repeated a DIF analysis for each of these subgroups

Simplify Questions



Simplify Questions

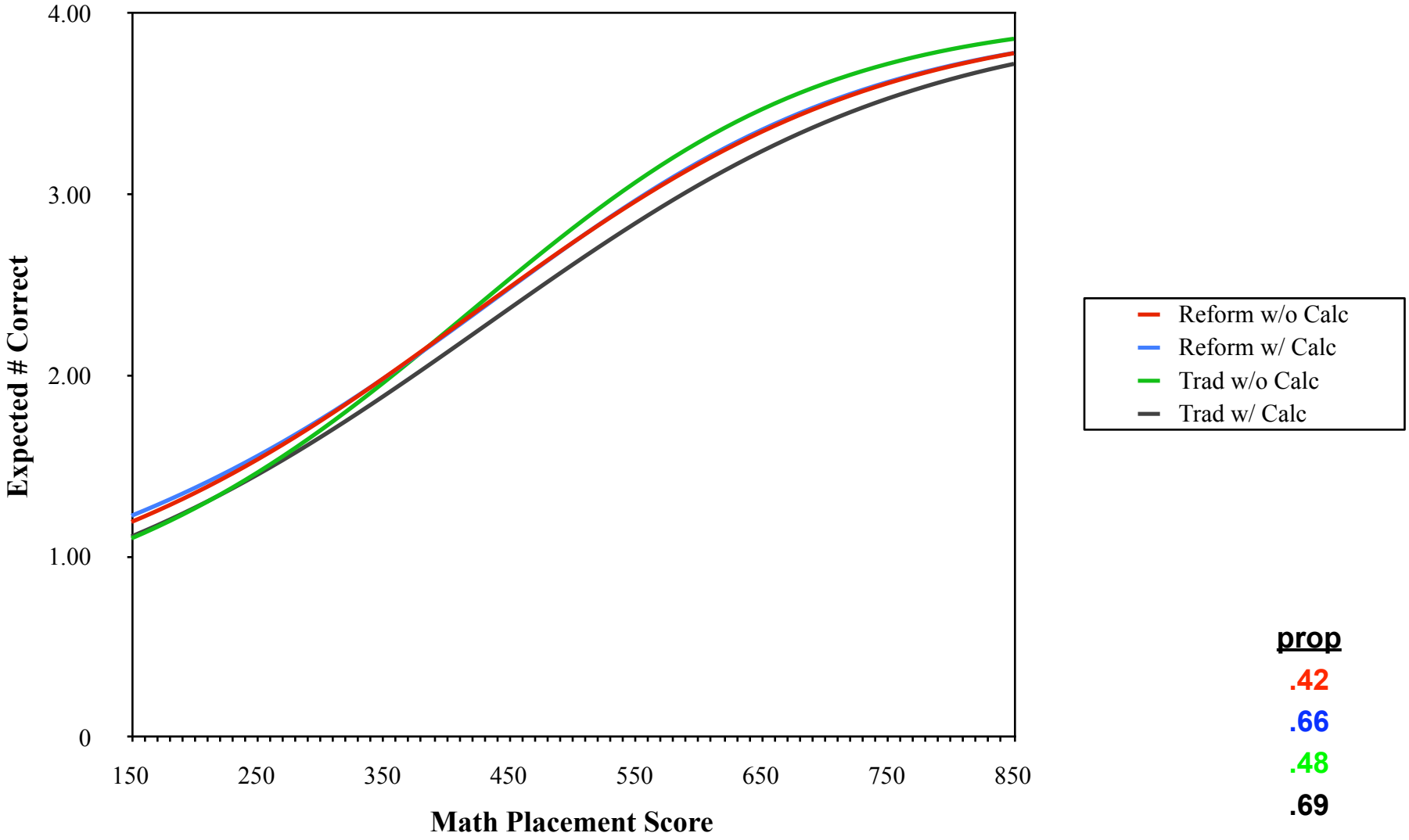


prop

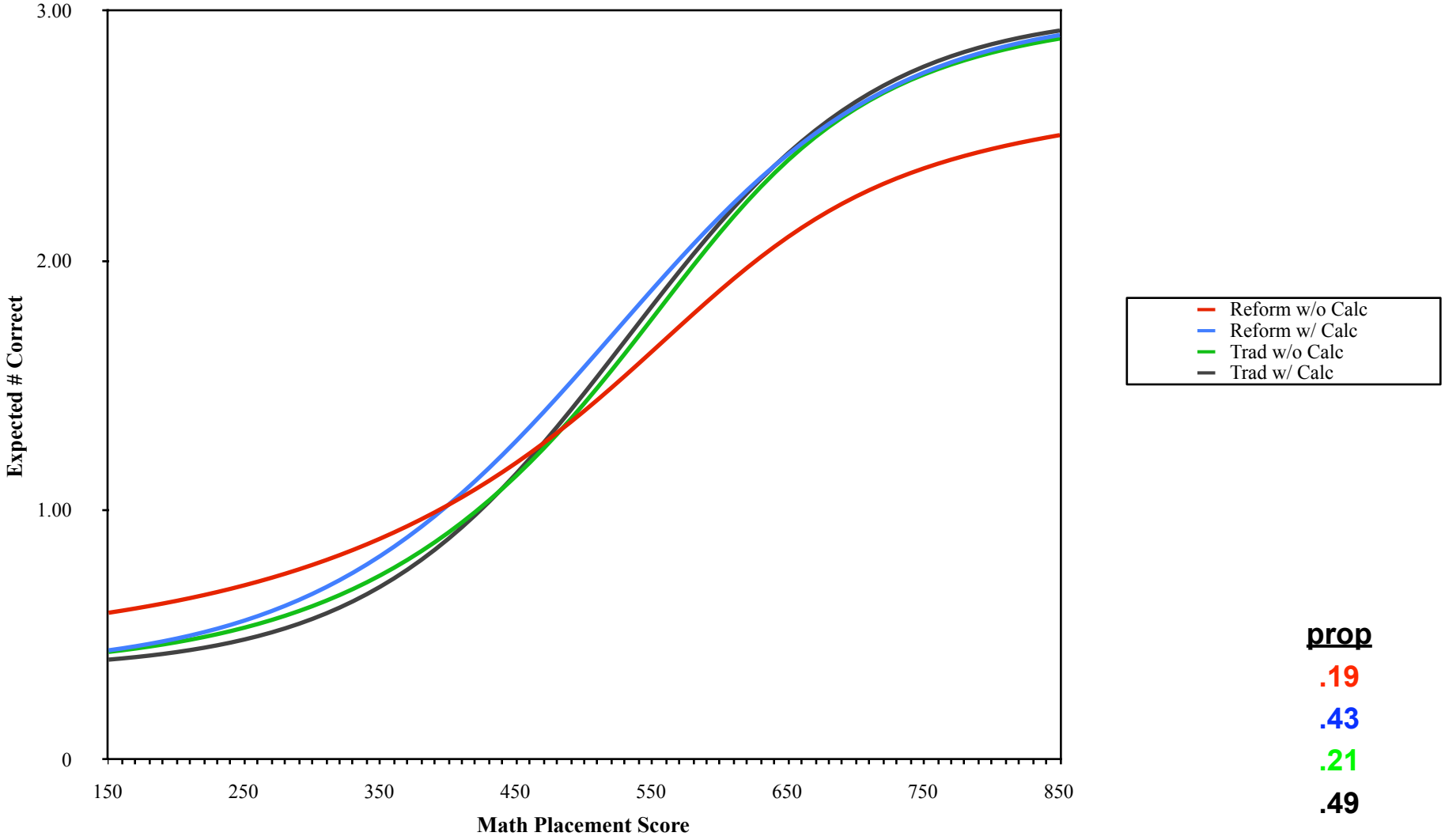
.36

.64

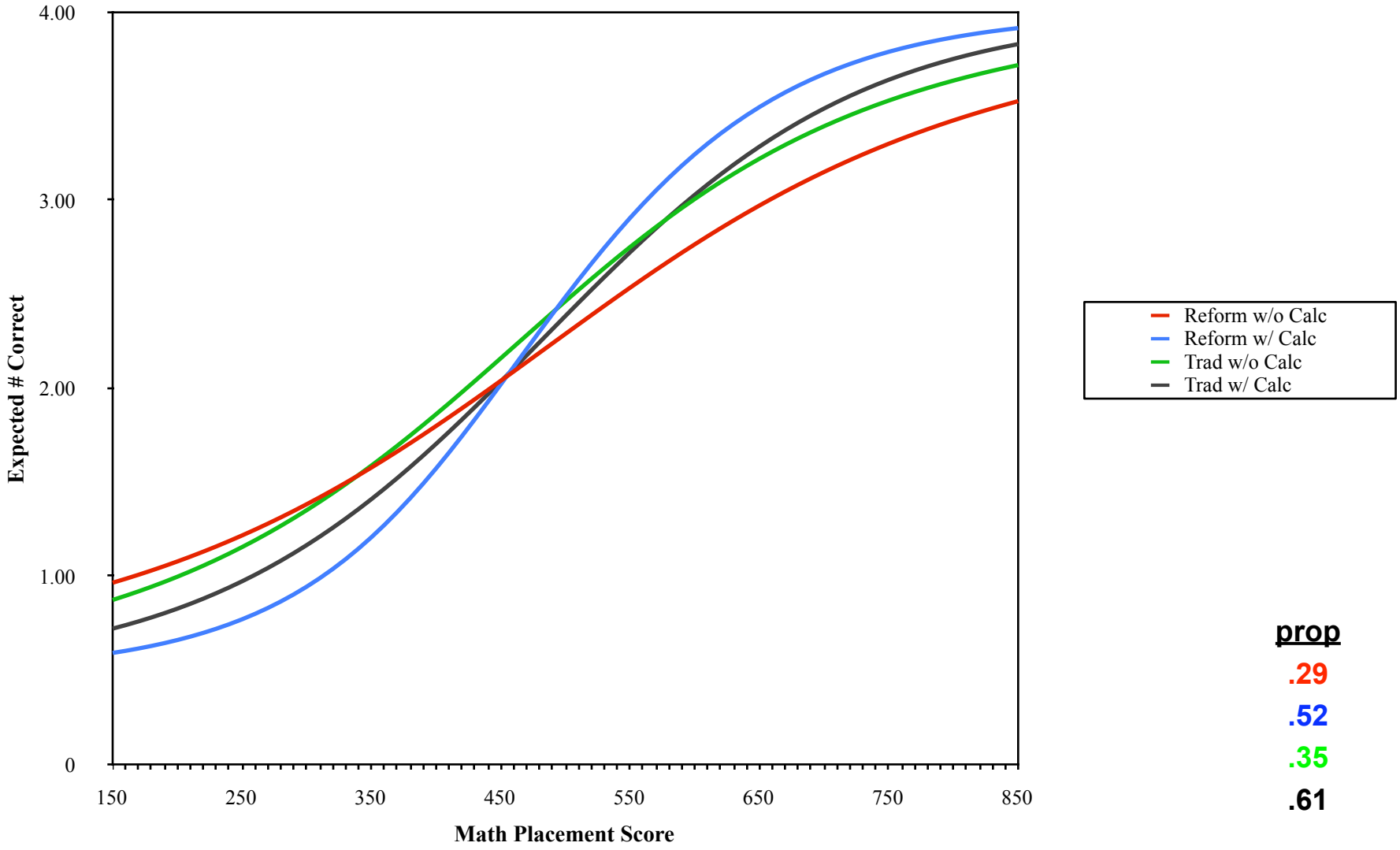
Geometry of Triangles Questions



Exponentials & Logarithms Questions



Trigonometry Identities Questions



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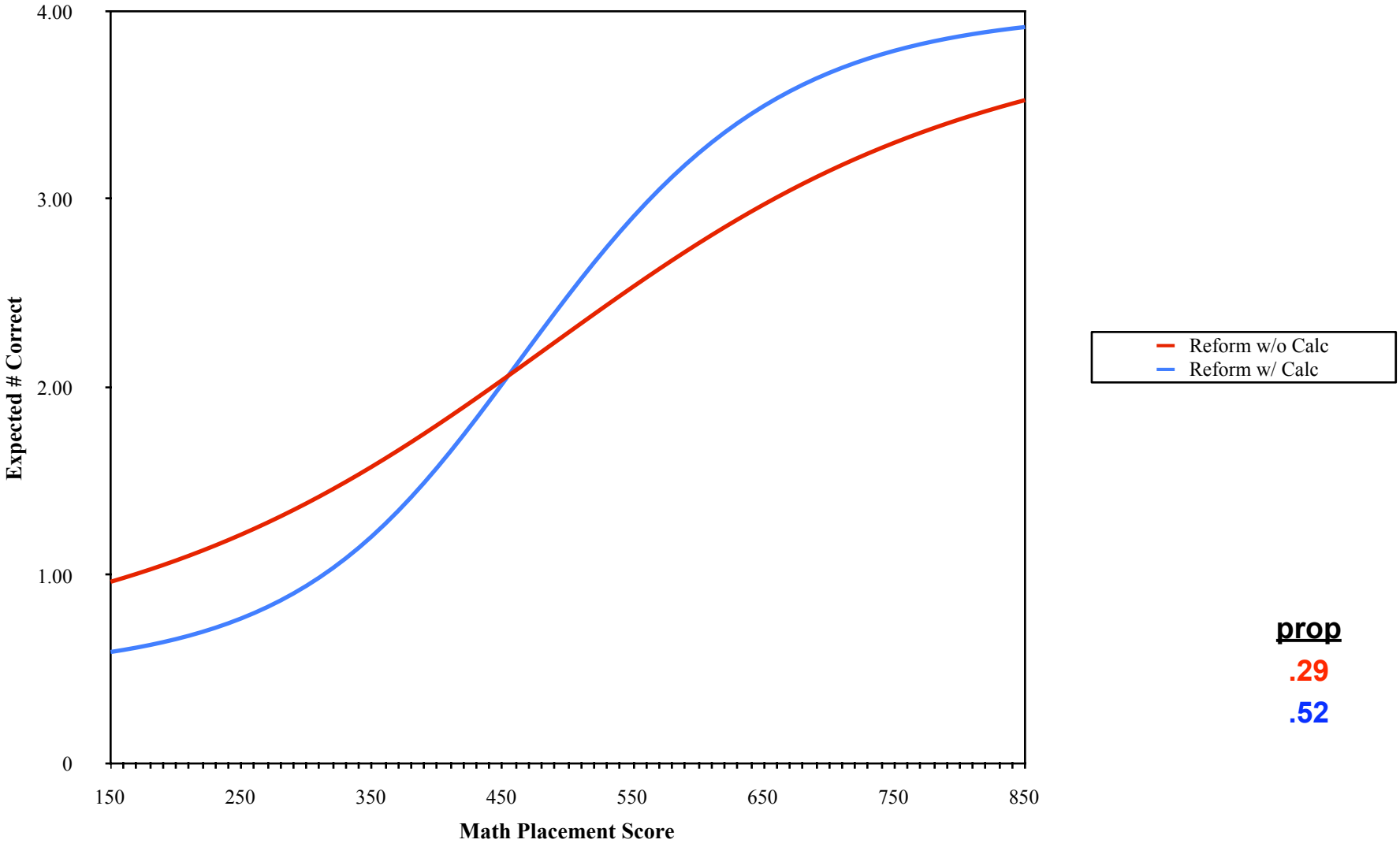
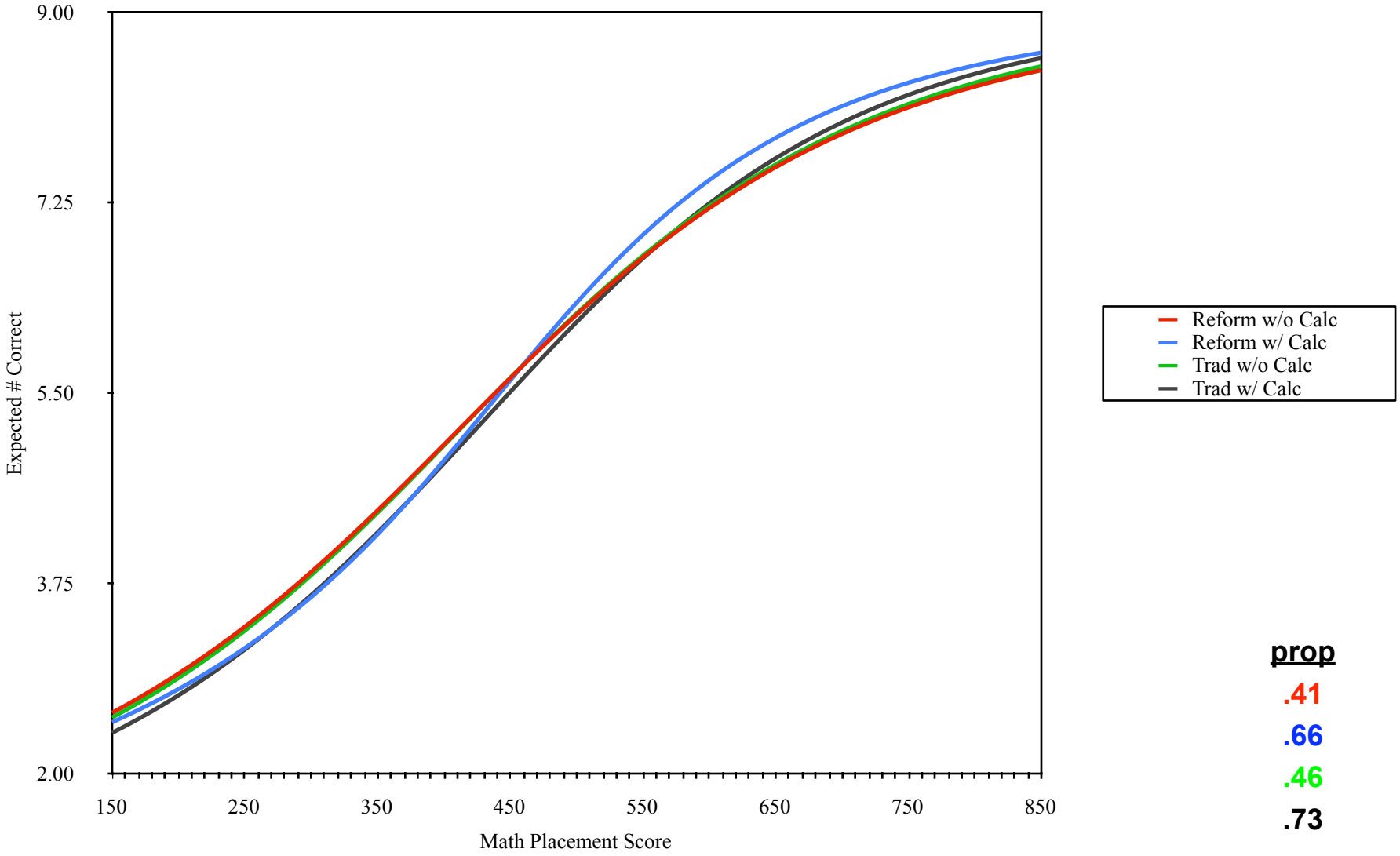
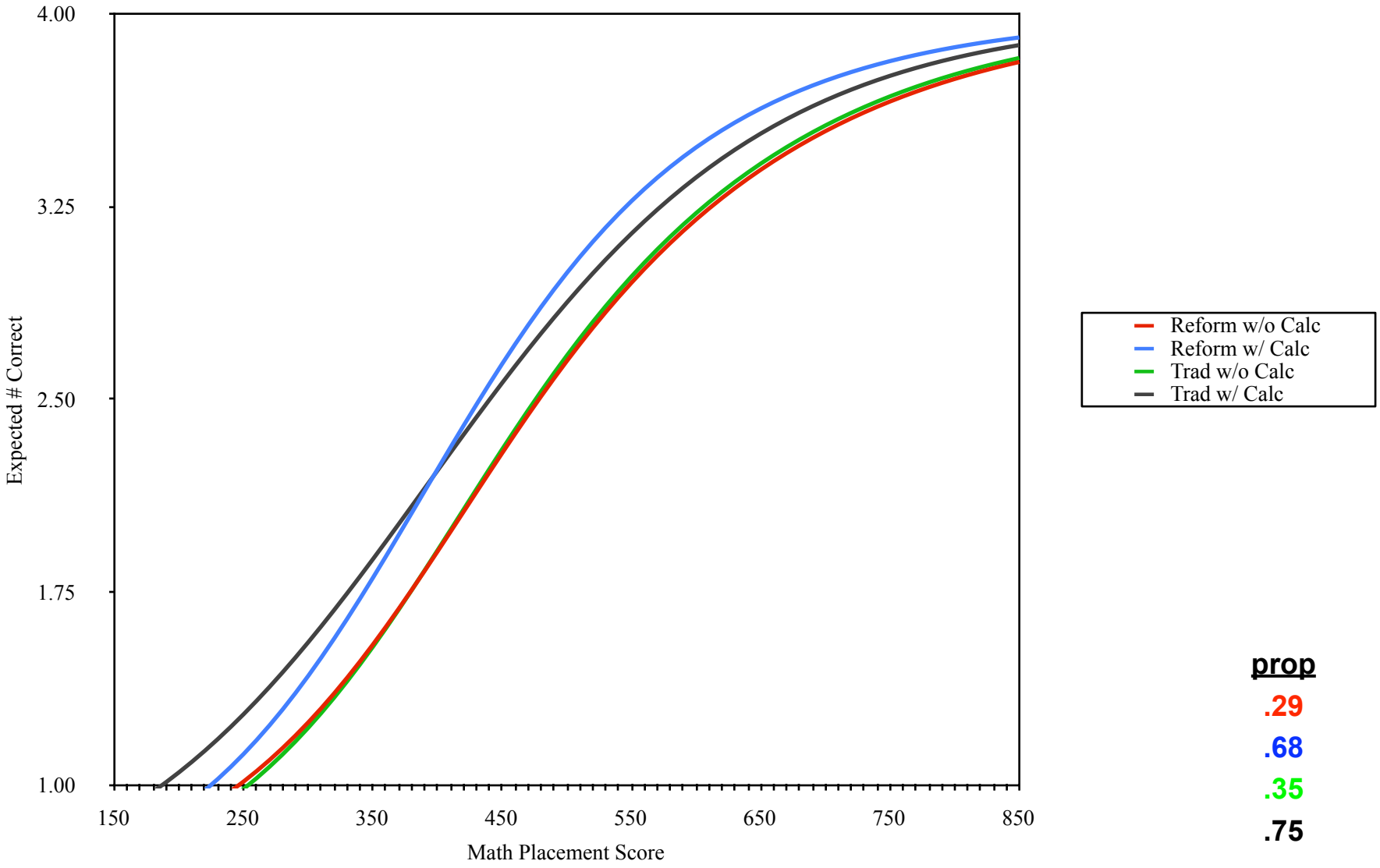


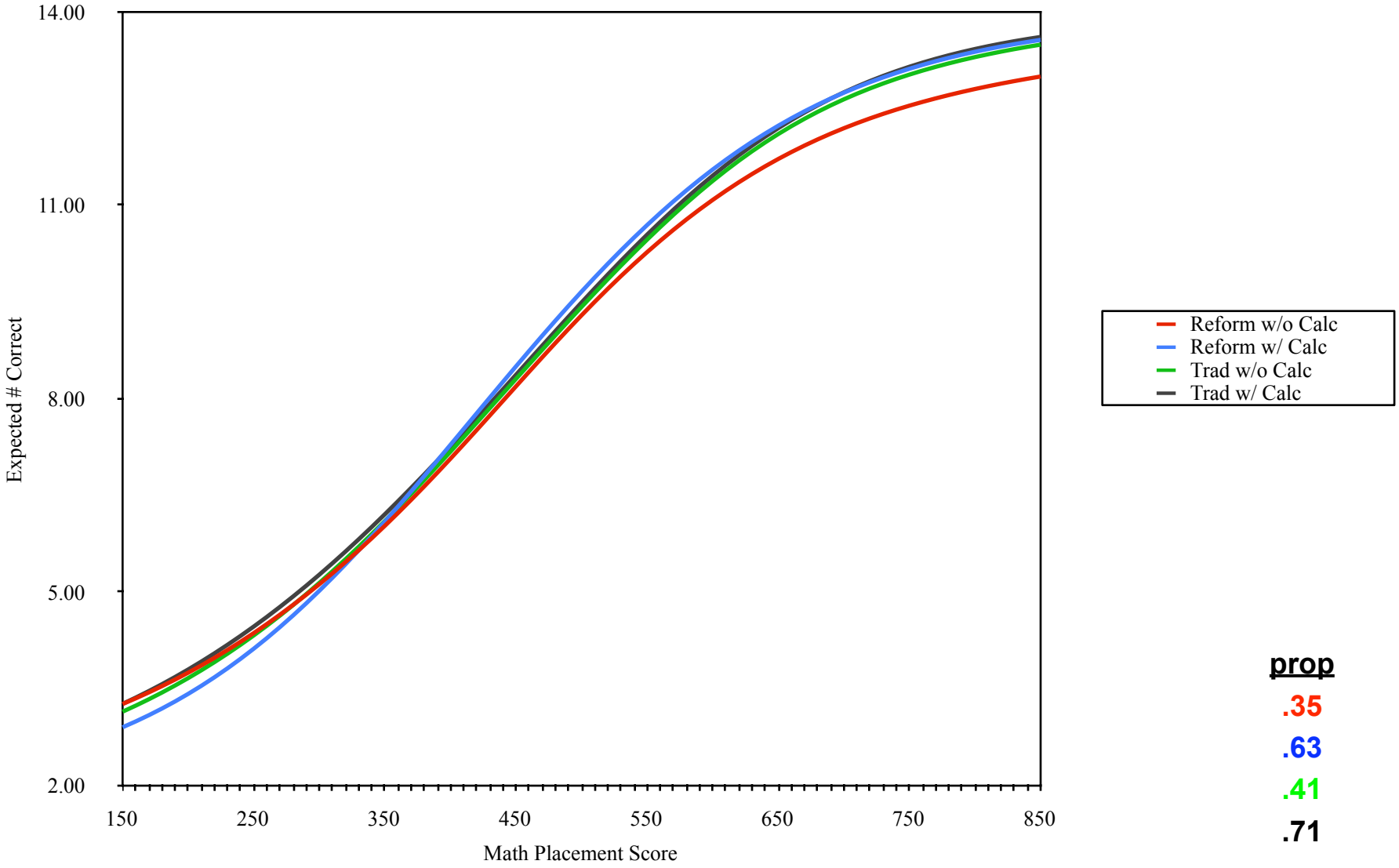
Understanding Trig Questions



Functions Questions



Advanced Algebra Questions



Summary

- Generally only very small differences between comparable Traditional and Reform groups, after accounting for overall achievement differences
  - Implication is that MPT is fair as a tool for assessing undergraduate math readiness, regardless of HS curriculum.
  - Traditional groups outperformed Reform groups by 7-8% overall and within each of the three subscores.
- Reform w/ Calc versus Reform w/o Calc showed biggest differences
  - Exp. & Log
  - Trig Identities
  - Functions
  - Advanced Algebra

$$c_i + (1 - c_i) \times \frac{1}{1 + \exp(-a_i(\theta_j - b_i))}$$

Case Study: Nekoosa High School Study

- Study examined the change over time in
  - ACT-Math scores
  - UW Math Placement Test scores
    - Math Basics, Algebra, Trigonometry
  - Actual math placements (using UW-SP math algorithm)
    - Remedial Math
    - Intermediate Algebra
    - College Algebra / Trigonometry
    - Calculus

Participants

- Nekoosa High School students who
  - graduated between 1998 and 2007
  - graduated in the top 50 of their HS class
  - subsequently took the UW Math Placement Test
- 283 of the 500 students (56.6%) met the eligibility criteria
  - Annual sample sizes: 25 – 32

Curricula Studied

- Graduating years

  1998 – 2001

  - Purely traditional math
    - Introductory algebra through pre-calculus

  2002 – 2003

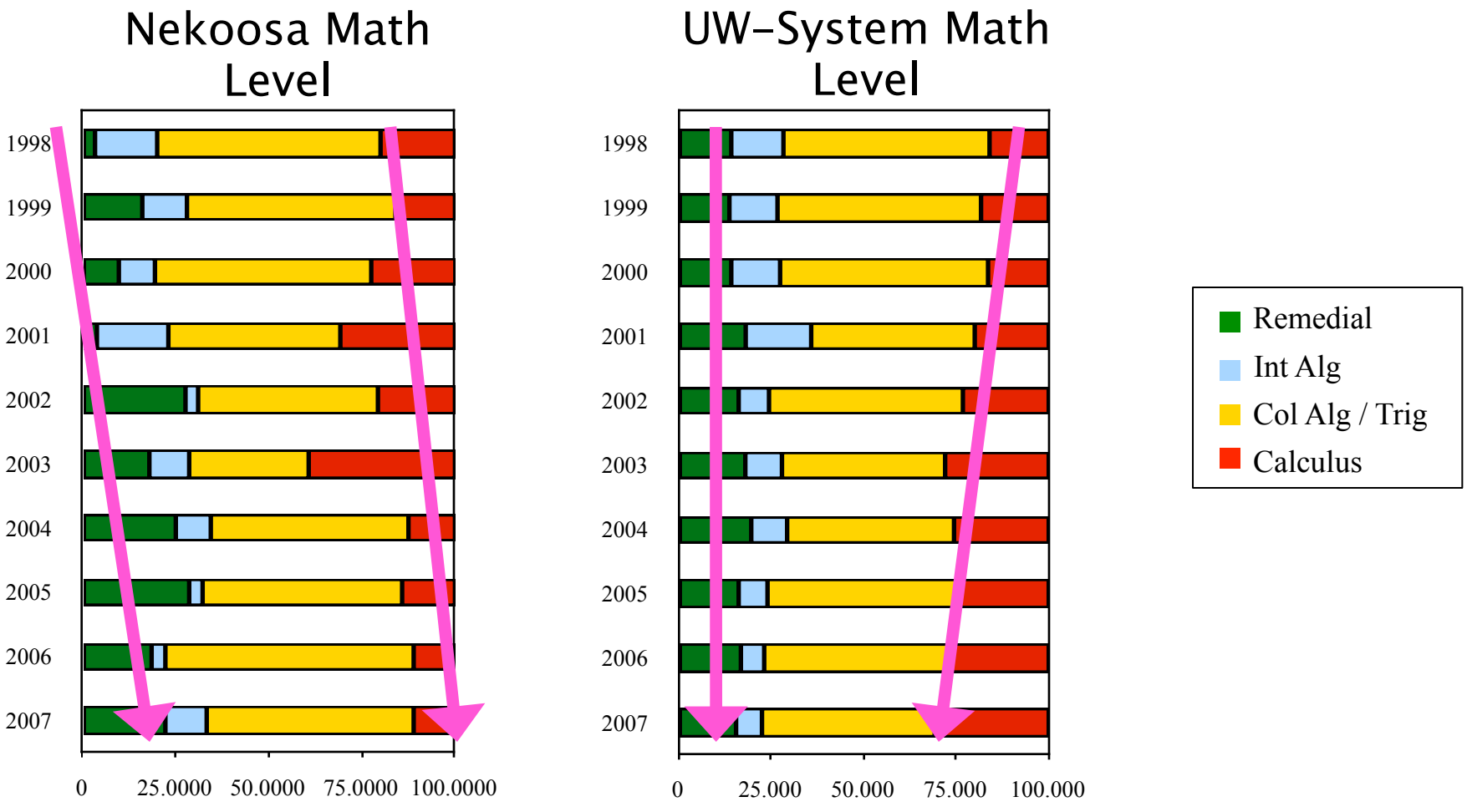
  - Dual track, including both traditional math and Core Plus math

  2004 – 2007

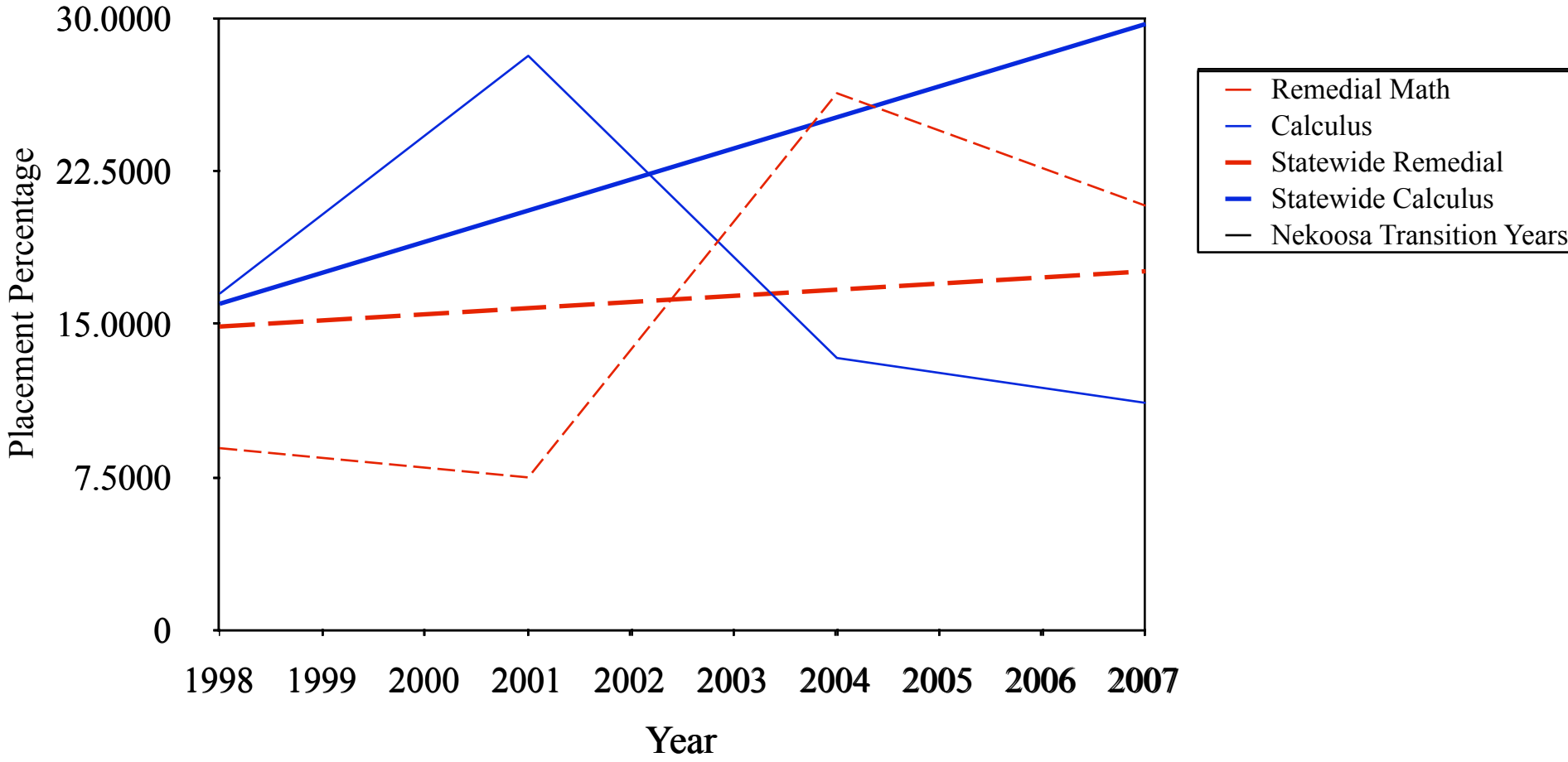
  - Purely Core Plus math
  - CORE I through CORE IV

  – AP-Calculus was adopted by school for 2000-01 school year
    - Available to a few traditional kids, but mostly CORE Plus students

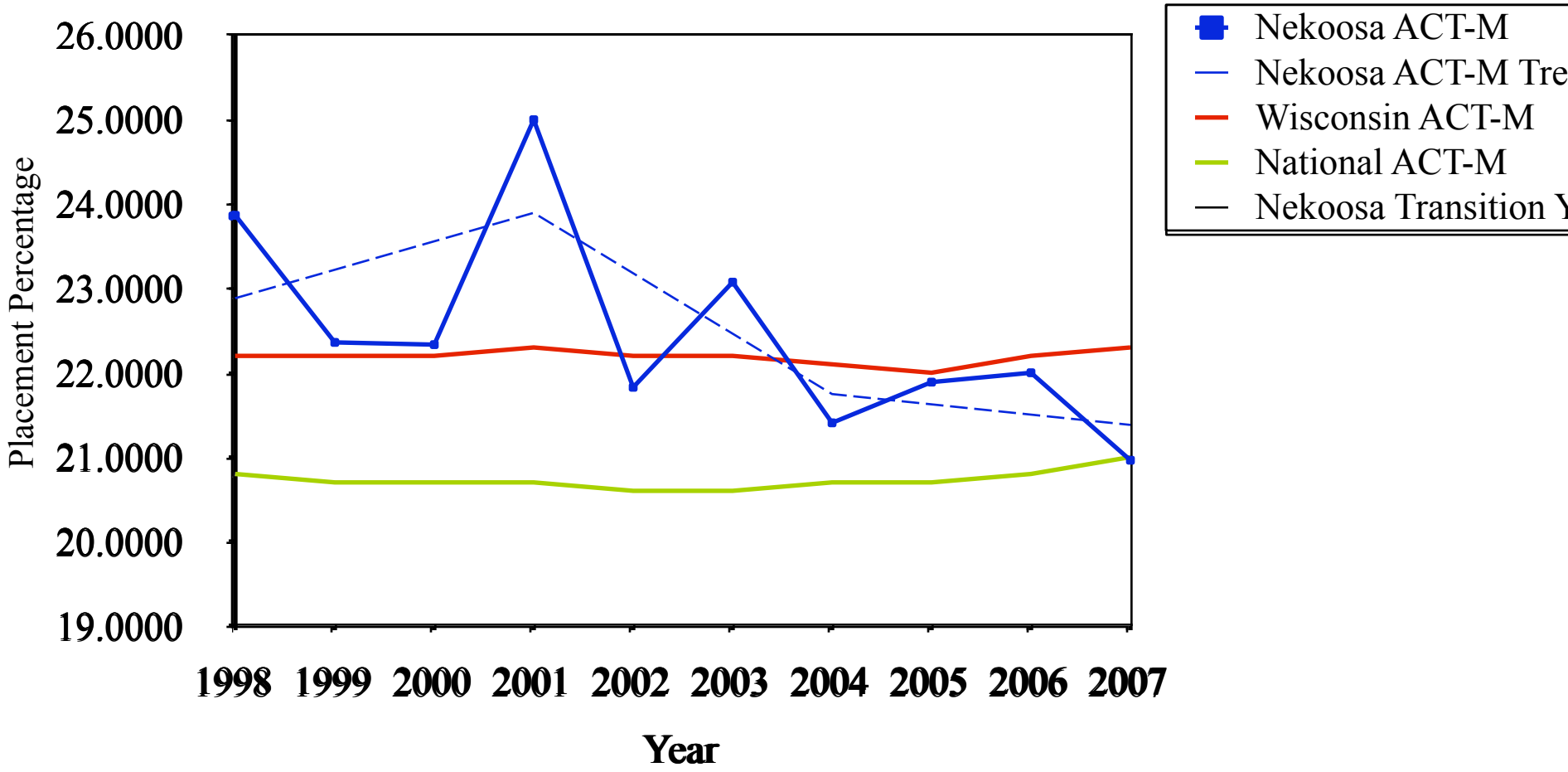
Percentage Placing at Each Math Level



Nekoosa Longitudinal Trends in Calculus vs. Remedial Placement



Nekoosa Longitudinal Trends in ACT-M Scores



Percentages of Students Placing at Each Level and Average ACT-M Scores by Math Curriculum

	Math Curriculum					
	CORE Plus Math			Traditional Math		
Level	No Calc	AP Calc	Total	No Calc	AP Calc	Total
1	33.3	5.6	28.9	9.4	0.0	9.0
2	10.5	0.0	8.8	11.3	0.0	10.8
3	53.1	55.6	53.5	54.7	14.3	53.0
4	3.1	38.9	8.8	24.5	85.7	27.1
ACT-	20.0	24.7	20.8	23.3	30.3	23.6
N	96	18	114	159	7	168

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Major Findings

- CORE-Plus students performed significantly less well on math placement test and ACT-M than did traditional students
- Change in performance was observed immediately after switch
- Score trends throughout CORE-Plus years actually decreased slightly
  - Inconsistent with a teacher learning-curve hypothesis
- CORE-AP students fared much better, but not as well as the traditional-AP students
  - Both sample sizes were low

Limitations / Alternative Explanations

- Placement Test Scores and Placement Algorithms changed in 2002.
  - To the extent that old and new scores/algorithms behave differently, interpretations are clouded
  - We conducted a study to estimate the new scores from the old scores (for students who tested before 2002).
    - Allowed a single placement algorithm to be used for all students
  - Reasons for Confidence in Findings
    - Old and new scores were highly correlated
    - Re-analysis provided results that mirrored exactly those from original study
    - ACT-M scores revealed same pattern as placement test scores

Limitations / Alternative Explanations

- Teacher Variables
  - Staffing changes
  - Teacher experience/quality
  - Familiarity with CORE-Plus
- Student Variables
  - How much and when was math taken
    - 4-years of math: 79% CORE-Plus, 77% Traditional
  - Can't control for quality of student who attended a UW campus
- School Variables
  - Declining enrollment
    - Slightly easier to rank in top 50 during CORE Plus years
  - Incoming quality and the effect of middle-school curricula
  - Changing demographics

Data Availability for Other Districts

- The Center for Placement Testing has begun to provide placement data to schools/districts (for most recent year) on a request basis
  - Resources for collaborations on a larger study are limited, but will be offered as possible
    - Please ask

Information Exchange

- Schools / Districts will need to provide the Center with an electronic file (ASCII or Excel) containing
  - Merge information
    - Students' (legal) names
    - Birthdates
  - Any other information to analyze
    - Highest math course
    - Years of language study
    - Class rank
- Center will provide
  - Summary statistics
    - Number of students testing, average score, and standard deviation
  - Histogram of placement scores (or subscores for math)
  - Table of placement decisions
  - Placement score breakdowns for extra information

Data Availability for Other Districts

- Contact information

<u>General info or to request a report</u>

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<u>About a possible collaboration</u>

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- Powerpoint slides for this presentation are available at

  http://www.testing.wisc.edu/conference papers.html

- For more information, please contact
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    UW Center for Placement Testing

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