

The ARC Center Tri-State Student Achievement Study

A Report of the ARC Center
at
The Consortium for Mathematics and Its Applications (COMAP)

Sheila Sconiers, Project Director
COMAP

Andy Isaacs
THE UNIVERSITY OF CHICAGO

Traci Higgins
TERC

James McBride, Statistician
THE UNIVERSITY OF CHICAGO

Catherine Randall Kelso
THE UNIVERSITY OF ILLINOIS AT CHICAGO



Funded by the National Science Foundation,
Proposal No. ESI-9729328

This study was prepared with the support of the National Science Foundation. However, any opinions, findings, conclusions, and/or recommendations herein are those of the authors and do not necessarily reflect the views of the NSF.

©2003 COMAP, Inc.

Table of Contents

1. Introduction	3
1.1. Background	5
1.1.1. Motivation	5
1.2. Objectives	5
1.3. Scope	
2. Literature Review	
2.1. Introduction	
2.2. Methodology	
2.3. Results and Discussion	
2.4. Conclusion	
2.5. References	11
3. Methodology	11
3.1. Introduction	12
3.2. Data Collection	16
3.3. Data Analysis	1
3.4. Results and Discussion	20
4. Results and Discussion	20
5. Conclusion	21
References	23
Appendix	2
Bibliography	33
Bibliography 1-14	

2000 2001, \dots ()

$E = M t, t; M t$

I, t, t, N, D, t, \dots

2000.3 \dots 100,000 \dots 51,340

\dots 4,535

\dots

\dots (3 5) \dots 34

\dots 2 \dots

... (1) ...

... (2) ...

1.1 C

... (3) ...

- ...
- ...
- ...
- ...
- ...
- ...
- ...
- ...
- ...

... (4) ...

1.2 R

... (5) ...

... (2002) ...

... (2002) ...

... (2002) ...

... (2003) ...

... (2003) ...

... (2003) ...

• \mathbb{R}^3 中的向量 $\vec{a}, \vec{b}, \vec{c}$ 满足 $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$ 且 $\vec{a} \cdot \vec{a} = 1$, 证明 $\vec{b} - \vec{c}$ 与 \vec{a} 垂直.

• 设 $\vec{a}, \vec{b}, \vec{c}$ 是 \mathbb{R}^3 中的单位向量, $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$, 证明 $\vec{a}, \vec{b}, \vec{c}$ 共面. (1) 考虑 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c})$, 利用 $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$ 和 $\vec{a} \cdot \vec{a} = \vec{b} \cdot \vec{b} = \vec{c} \cdot \vec{c} = 1$ 计算 $(\vec{a}, \vec{b}, \vec{c})^2$. (2) 利用 $(\vec{a}, \vec{b}, \vec{c})^2 = |\vec{a}|^2 |\vec{b}|^2 |\vec{c}|^2 \sin^2 \theta$, 其中 θ 是 $\vec{a}, \vec{b}, \vec{c}$ 所成的二面角, 证明 $\theta = 0$ 或 π , 从而 $\vec{a}, \vec{b}, \vec{c}$ 共面.

• 设 $\vec{a}, \vec{b}, \vec{c}$ 是 \mathbb{R}^3 中的单位向量, $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$, 证明 $\vec{a}, \vec{b}, \vec{c}$ 共面. (2) 考虑 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c})$, 利用 $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$ 和 $\vec{a} \cdot \vec{a} = \vec{b} \cdot \vec{b} = \vec{c} \cdot \vec{c} = 1$ 计算 $(\vec{a}, \vec{b}, \vec{c})^2$. (3) 利用 $(\vec{a}, \vec{b}, \vec{c})^2 = |\vec{a}|^2 |\vec{b}|^2 |\vec{c}|^2 \sin^2 \theta$, 其中 θ 是 $\vec{a}, \vec{b}, \vec{c}$ 所成的二面角, 证明 $\theta = 0$ 或 π , 从而 $\vec{a}, \vec{b}, \vec{c}$ 共面. (参考 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c}) = \vec{a} \cdot (\vec{b} \times \vec{c})$, 其中 $\vec{b} \times \vec{c}$ 是 \vec{b}, \vec{c} 所成的二面角的法向量.)

• 设 $\vec{a}, \vec{b}, \vec{c}$ 是 \mathbb{R}^3 中的单位向量, $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$, 证明 $\vec{a}, \vec{b}, \vec{c}$ 共面. (3) 考虑 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c})$, 利用 $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$ 和 $\vec{a} \cdot \vec{a} = \vec{b} \cdot \vec{b} = \vec{c} \cdot \vec{c} = 1$ 计算 $(\vec{a}, \vec{b}, \vec{c})^2$. (4) 利用 $(\vec{a}, \vec{b}, \vec{c})^2 = |\vec{a}|^2 |\vec{b}|^2 |\vec{c}|^2 \sin^2 \theta$, 其中 θ 是 $\vec{a}, \vec{b}, \vec{c}$ 所成的二面角, 证明 $\theta = 0$ 或 π , 从而 $\vec{a}, \vec{b}, \vec{c}$ 共面. (参考 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c}) = \vec{a} \cdot (\vec{b} \times \vec{c})$, 其中 $\vec{b} \times \vec{c}$ 是 \vec{b}, \vec{c} 所成的二面角的法向量.)

• 设 $\vec{a}, \vec{b}, \vec{c}$ 是 \mathbb{R}^3 中的单位向量, $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$, 证明 $\vec{a}, \vec{b}, \vec{c}$ 共面. (4) 考虑 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c})$, 利用 $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$ 和 $\vec{a} \cdot \vec{a} = \vec{b} \cdot \vec{b} = \vec{c} \cdot \vec{c} = 1$ 计算 $(\vec{a}, \vec{b}, \vec{c})^2$. (5) 利用 $(\vec{a}, \vec{b}, \vec{c})^2 = |\vec{a}|^2 |\vec{b}|^2 |\vec{c}|^2 \sin^2 \theta$, 其中 θ 是 $\vec{a}, \vec{b}, \vec{c}$ 所成的二面角, 证明 $\theta = 0$ 或 π , 从而 $\vec{a}, \vec{b}, \vec{c}$ 共面. (参考 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c}) = \vec{a} \cdot (\vec{b} \times \vec{c})$, 其中 $\vec{b} \times \vec{c}$ 是 \vec{b}, \vec{c} 所成的二面角的法向量.)

1.3

• 设 $\vec{a}, \vec{b}, \vec{c}$ 是 \mathbb{R}^3 中的单位向量, $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$, 证明 $\vec{a}, \vec{b}, \vec{c}$ 共面. (5) 考虑 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c})$, 利用 $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c} = \vec{b} \cdot \vec{c} = \frac{1}{2}$ 和 $\vec{a} \cdot \vec{a} = \vec{b} \cdot \vec{b} = \vec{c} \cdot \vec{c} = 1$ 计算 $(\vec{a}, \vec{b}, \vec{c})^2$. (6) 利用 $(\vec{a}, \vec{b}, \vec{c})^2 = |\vec{a}|^2 |\vec{b}|^2 |\vec{c}|^2 \sin^2 \theta$, 其中 θ 是 $\vec{a}, \vec{b}, \vec{c}$ 所成的二面角, 证明 $\theta = 0$ 或 π , 从而 $\vec{a}, \vec{b}, \vec{c}$ 共面. (参考 $\vec{a}, \vec{b}, \vec{c}$ 的混合积 $(\vec{a}, \vec{b}, \vec{c}) = \vec{a} \cdot (\vec{b} \times \vec{c})$, 其中 $\vec{b} \times \vec{c}$ 是 \vec{b}, \vec{c} 所成的二面角的法向量.)

1. \mathbb{N} 10% \mathbb{N} H EM, M, IN D

2.

\mathbb{N} H EM, M, IN D

2.1

\mathbb{N} H EM, M, IN D

- $I \rightarrow t \rightarrow A \rightarrow t \rightarrow t \rightarrow 3) \rightarrow 3$
- $I \rightarrow t \rightarrow A \rightarrow t \rightarrow t \rightarrow 3) \rightarrow 5$
- $M \rightarrow n \rightarrow C \rightarrow A \rightarrow t \rightarrow t \rightarrow (\rightarrow) \rightarrow 4$
- $I \rightarrow t \rightarrow B \rightarrow (\rightarrow) \rightarrow 3(\rightarrow) \rightarrow 1$
- $I \rightarrow t \rightarrow A \rightarrow t \rightarrow t \rightarrow L \rightarrow (\rightarrow) \rightarrow 4$

\mathbb{N} H EM, M, IN D

2.2

\mathbb{N} H EM, M, IN D 0%

\mathbb{N} H EM, M, IN D 0%

- $\frac{1}{2} \times 100 = 50\%$ (100% - 50%) = 50% (100% - 50%) = 50%
- $\frac{1}{3} \times 100 = 33\frac{1}{3}\%$ (100% - 33\frac{1}{3}\%) = 66\frac{2}{3}\%
- $\frac{1}{4} \times 100 = 25\%$ (100% - 25%) = 75%
- $\frac{1}{5} \times 100 = 20\%$ (100% - 20%) = 80%
- $\frac{1}{6} \times 100 = 16\frac{2}{3}\%$ (100% - 16\frac{2}{3}\%) = 83\frac{1}{3}\%
- $\frac{1}{7} \times 100 = 14\frac{2}{7}\%$ (100% - 14\frac{2}{7}\%) = 85\frac{5}{7}\%
- $\frac{1}{8} \times 100 = 12\frac{1}{2}\%$ (100% - 12\frac{1}{2}\%) = 87\frac{1}{2}\%
- $\frac{1}{9} \times 100 = 11\frac{1}{9}\%$ (100% - 11\frac{1}{9}\%) = 88\frac{8}{9}\%
- $\frac{1}{10} \times 100 = 10\%$ (100% - 10%) = 90%
- $\frac{1}{11} \times 100 = 9\frac{1}{11}\%$ (100% - 9\frac{1}{11}\%) = 90\frac{10}{11}\%
- $\frac{1}{12} \times 100 = 8\frac{1}{3}\%$ (100% - 8\frac{1}{3}\%) = 91\frac{2}{3}\%
- $\frac{1}{13} \times 100 = 7\frac{6}{13}\%$ (100% - 7\frac{6}{13}\%) = 92\frac{6}{13}\%
- $\frac{1}{14} \times 100 = 7\frac{1}{7}\%$ (100% - 7\frac{1}{7}\%) = 92\frac{6}{7}\%
- $\frac{1}{15} \times 100 = 6\frac{2}{3}\%$ (100% - 6\frac{2}{3}\%) = 93\frac{1}{3}\%
- $\frac{1}{16} \times 100 = 6\frac{1}{4}\%$ (100% - 6\frac{1}{4}\%) = 93\frac{3}{4}\%
- $\frac{1}{17} \times 100 = 5\frac{8}{17}\%$ (100% - 5\frac{8}{17}\%) = 94\frac{9}{17}\%
- $\frac{1}{18} \times 100 = 5\frac{5}{9}\%$ (100% - 5\frac{5}{9}\%) = 94\frac{4}{9}\%
- $\frac{1}{19} \times 100 = 5\frac{2}{19}\%$ (100% - 5\frac{2}{19}\%) = 94\frac{17}{19}\%
- $\frac{1}{20} \times 100 = 5\%$ (100% - 5%) = 95%
- $\frac{1}{21} \times 100 = 4\frac{4}{7}\%$ (100% - 4\frac{4}{7}\%) = 95\frac{3}{7}\%
- $\frac{1}{22} \times 100 = 4\frac{4}{11}\%$ (100% - 4\frac{4}{11}\%) = 95\frac{7}{11}\%
- $\frac{1}{23} \times 100 = 4\frac{4}{23}\%$ (100% - 4\frac{4}{23}\%) = 95\frac{19}{23}\%
- $\frac{1}{24} \times 100 = 4\frac{1}{6}\%$ (100% - 4\frac{1}{6}\%) = 95\frac{5}{6}\%
- $\frac{1}{25} \times 100 = 4\%$ (100% - 4%) = 96%
- $\frac{1}{26} \times 100 = 3\frac{7}{13}\%$ (100% - 3\frac{7}{13}\%) = 96\frac{6}{13}\%
- $\frac{1}{27} \times 100 = 3\frac{7}{27}\%$ (100% - 3\frac{7}{27}\%) = 96\frac{20}{27}\%
- $\frac{1}{28} \times 100 = 3\frac{5}{7}\%$ (100% - 3\frac{5}{7}\%) = 96\frac{6}{7}\%
- $\frac{1}{29} \times 100 = 3\frac{3}{29}\%$ (100% - 3\frac{3}{29}\%) = 96\frac{26}{29}\%
- $\frac{1}{30} \times 100 = 3\frac{1}{3}\%$ (100% - 3\frac{1}{3}\%) = 96\frac{2}{3}\%
- $\frac{1}{31} \times 100 = 3\frac{1}{31}\%$ (100% - 3\frac{1}{31}\%) = 96\frac{28}{31}\%
- $\frac{1}{32} \times 100 = 3\frac{1}{8}\%$ (100% - 3\frac{1}{8}\%) = 96\frac{7}{8}\%
- $\frac{1}{33} \times 100 = 3\frac{1}{3}\%$ (100% - 3\frac{1}{3}\%) = 96\frac{2}{3}\%
- $\frac{1}{34} \times 100 = 2\frac{17}{17}\%$ (100% - 2\frac{17}{17}\%) = 97%
- $\frac{1}{35} \times 100 = 2\frac{2}{7}\%$ (100% - 2\frac{2}{7}\%) = 97\frac{5}{7}\%
- $\frac{1}{36} \times 100 = 2\frac{8}{9}\%$ (100% - 2\frac{8}{9}\%) = 97\frac{1}{9}\%
- $\frac{1}{37} \times 100 = 2\frac{4}{37}\%$ (100% - 2\frac{4}{37}\%) = 97\frac{33}{37}\%
- $\frac{1}{38} \times 100 = 2\frac{2}{19}\%$ (100% - 2\frac{2}{19}\%) = 97\frac{17}{19}\%
- $\frac{1}{39} \times 100 = 2\frac{2}{39}\%$ (100% - 2\frac{2}{39}\%) = 97\frac{37}{39}\%
- $\frac{1}{40} \times 100 = 2\frac{1}{2}\%$ (100% - 2\frac{1}{2}\%) = 97\frac{1}{2}\%
- $\frac{1}{41} \times 100 = 2\frac{2}{41}\%$ (100% - 2\frac{2}{41}\%) = 97\frac{39}{41}\%
- $\frac{1}{42} \times 100 = 2\frac{2}{21}\%$ (100% - 2\frac{2}{21}\%) = 97\frac{19}{21}\%
- $\frac{1}{43} \times 100 = 2\frac{2}{43}\%$ (100% - 2\frac{2}{43}\%) = 97\frac{41}{43}\%
- $\frac{1}{44} \times 100 = 2\frac{2}{11}\%$ (100% - 2\frac{2}{11}\%) = 97\frac{9}{11}\%
- $\frac{1}{45} \times 100 = 2\frac{2}{9}\%$ (100% - 2\frac{2}{9}\%) = 97\frac{7}{9}\%
- $\frac{1}{46} \times 100 = 2\frac{1}{23}\%$ (100% - 2\frac{1}{23}\%) = 97\frac{22}{23}\%
- $\frac{1}{47} \times 100 = 2\frac{1}{47}\%$ (100% - 2\frac{1}{47}\%) = 97\frac{46}{47}\%
- $\frac{1}{48} \times 100 = 2\frac{1}{12}\%$ (100% - 2\frac{1}{12}\%) = 97\frac{11}{12}\%
- $\frac{1}{49} \times 100 = 2\frac{1}{49}\%$ (100% - 2\frac{1}{49}\%) = 97\frac{48}{49}\%
- $\frac{1}{50} \times 100 = 2\%$ (100% - 2%) = 98%
- $\frac{1}{51} \times 100 = 1\frac{49}{51}\%$ (100% - 1\frac{49}{51}\%) = 98\frac{2}{51}\%
- $\frac{1}{52} \times 100 = 1\frac{24}{26}\%$ (100% - 1\frac{24}{26}\%) = 98\frac{1}{13}\%
- $\frac{1}{53} \times 100 = 1\frac{23}{53}\%$ (100% - 1\frac{23}{53}\%) = 98\frac{30}{53}\%
- $\frac{1}{54} \times 100 = 1\frac{18}{27}\%$ (100% - 1\frac{18}{27}\%) = 98\frac{8}{9}\%
- $\frac{1}{55} \times 100 = 1\frac{18}{11}\%$ (100% - 1\frac{18}{11}\%) = 98\frac{4}{11}\%
- $\frac{1}{56} \times 100 = 1\frac{14}{28}\%$ (100% - 1\frac{14}{28}\%) = 98\frac{1}{2}\%
- $\frac{1}{57} \times 100 = 1\frac{14}{57}\%$ (100% - 1\frac{14}{57}\%) = 98\frac{43}{57}\%
- $\frac{1}{58} \times 100 = 1\frac{14}{29}\%$ (100% - 1\frac{14}{29}\%) = 98\frac{15}{29}\%
- $\frac{1}{59} \times 100 = 1\frac{14}{59}\%$ (100% - 1\frac{14}{59}\%) = 98\frac{45}{59}\%
- $\frac{1}{60} \times 100 = 1\frac{16}{15}\%$ (100% - 1\frac{16}{15}\%) = 98\frac{4}{15}\%
- $\frac{1}{61} \times 100 = 1\frac{16}{61}\%$ (100% - 1\frac{16}{61}\%) = 98\frac{45}{61}\%
- $\frac{1}{62} \times 100 = 1\frac{16}{31}\%$ (100% - 1\frac{16}{31}\%) = 98\frac{15}{31}\%
- $\frac{1}{63} \times 100 = 1\frac{14}{45}\%$ (100% - 1\frac{14}{45}\%) = 98\frac{31}{45}\%
- $\frac{1}{64} \times 100 = 1\frac{12}{32}\%$ (100% - 1\frac{12}{32}\%) = 98\frac{3}{4}\%
- $\frac{1}{65} \times 100 = 1\frac{12}{65}\%$ (100% - 1\frac{12}{65}\%) = 98\frac{53}{65}\%
- $\frac{1}{66} \times 100 = 1\frac{11}{33}\%$ (100% - 1\frac{11}{33}\%) = 98\frac{2}{3}\%
- $\frac{1}{67} \times 100 = 1\frac{11}{67}\%$ (100% - 1\frac{11}{67}\%) = 98\frac{56}{67}\%
- $\frac{1}{68} \times 100 = 1\frac{11}{34}\%$ (100% - 1\frac{11}{34}\%) = 98\frac{23}{34}\%
- $\frac{1}{69} \times 100 = 1\frac{11}{69}\%$ (100% - 1\frac{11}{69}\%) = 98\frac{58}{69}\%
- $\frac{1}{70} \times 100 = 1\frac{10}{7}\%$ (100% - 1\frac{10}{7}\%) = 98\frac{6}{7}\%
- $\frac{1}{71} \times 100 = 1\frac{10}{71}\%$ (100% - 1\frac{10}{71}\%) = 98\frac{61}{71}\%
- $\frac{1}{72} \times 100 = 1\frac{10}{36}\%$ (100% - 1\frac{10}{36}\%) = 98\frac{5}{9}\%
- $\frac{1}{73} \times 100 = 1\frac{10}{73}\%$ (100% - 1\frac{10}{73}\%) = 98\frac{63}{73}\%
- $\frac{1}{74} \times 100 = 1\frac{10}{37}\%$ (100% - 1\frac{10}{37}\%) = 98\frac{27}{37}\%
- $\frac{1}{75} \times 100 = 1\frac{4}{3}\%$ (100% - 1\frac{4}{3}\%) = 98\frac{2}{3}\%
- $\frac{1}{76} \times 100 = 1\frac{4}{19}\%$ (100% - 1\frac{4}{19}\%) = 98\frac{15}{19}\%
- $\frac{1}{77} \times 100 = 1\frac{4}{77}\%$ (100% - 1\frac{4}{77}\%) = 98\frac{73}{77}\%
- $\frac{1}{78} \times 100 = 1\frac{4}{39}\%$ (100% - 1\frac{4}{39}\%) = 98\frac{35}{39}\%
- $\frac{1}{79} \times 100 = 1\frac{4}{79}\%$ (100% - 1\frac{4}{79}\%) = 98\frac{75}{79}\%
- $\frac{1}{80} \times 100 = 1\frac{3}{2}\%$ (100% - 1\frac{3}{2}\%) = 98\frac{1}{2}\%
- $\frac{1}{81} \times 100 = 1\frac{3}{81}\%$ (100% - 1\frac{3}{81}\%) = 98\frac{78}{81}\%
- $\frac{1}{82} \times 100 = 1\frac{3}{41}\%$ (100% - 1\frac{3}{41}\%) = 98\frac{38}{41}\%
- $\frac{1}{83} \times 100 = 1\frac{3}{83}\%$ (100% - 1\frac{3}{83}\%) = 98\frac{80}{83}\%
- $\frac{1}{84} \times 100 = 1\frac{3}{28}\%$ (100% - 1\frac{3}{28}\%) = 98\frac{25}{28}\%
- $\frac{1}{85} \times 100 = 1\frac{3}{17}\%$ (100% - 1\frac{3}{17}\%) = 98\frac{14}{17}\%
- $\frac{1}{86} \times 100 = 1\frac{3}{43}\%$ (100% - 1\frac{3}{43}\%) = 98\frac{40}{43}\%
- $\frac{1}{87} \times 100 = 1\frac{3}{87}\%$ (100% - 1\frac{3}{87}\%) = 98\frac{84}{87}\%
- $\frac{1}{88} \times 100 = 1\frac{3}{44}\%$ (100% - 1\frac{3}{44}\%) = 98\frac{41}{44}\%
- $\frac{1}{89} \times 100 = 1\frac{3}{89}\%$ (100% - 1\frac{3}{89}\%) = 98\frac{86}{89}\%
- $\frac{1}{90} \times 100 = 1\frac{1}{3}\%$ (100% - 1\frac{1}{3}\%) = 98\frac{2}{3}\%
- $\frac{1}{91} \times 100 = 1\frac{1}{91}\%$ (100% - 1\frac{1}{91}\%) = 98\frac{90}{91}\%
- $\frac{1}{92} \times 100 = 1\frac{1}{46}\%$ (100% - 1\frac{1}{46}\%) = 98\frac{45}{46}\%
- $\frac{1}{93} \times 100 = 1\frac{1}{93}\%$ (100% - 1\frac{1}{93}\%) = 98\frac{92}{93}\%
- $\frac{1}{94} \times 100 = 1\frac{1}{47}\%$ (100% - 1\frac{1}{47}\%) = 98\frac{46}{47}\%
- $\frac{1}{95} \times 100 = 1\frac{1}{19}\%$ (100% - 1\frac{1}{19}\%) = 98\frac{18}{19}\%
- $\frac{1}{96} \times 100 = 1\frac{1}{96}\%$ (100% - 1\frac{1}{96}\%) = 98\frac{95}{96}\%
- $\frac{1}{97} \times 100 = 1\frac{1}{97}\%$ (100% - 1\frac{1}{97}\%) = 98\frac{96}{97}\%
- $\frac{1}{98} \times 100 = 1\frac{1}{49}\%$ (100% - 1\frac{1}{49}\%) = 98\frac{48}{49}\%
- $\frac{1}{99} \times 100 = 1\frac{1}{99}\%$ (100% - 1\frac{1}{99}\%) = 98\frac{98}{99}\%
- $\frac{1}{100} \times 100 = 1\%$ (100% - 1%) = 99%

2.5 $Y_1, Y_1 D, Y_1$

1. Y_1 is a random variable with a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant.

2. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D .

3. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

4. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

5. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

3. \mathbb{R}

1. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

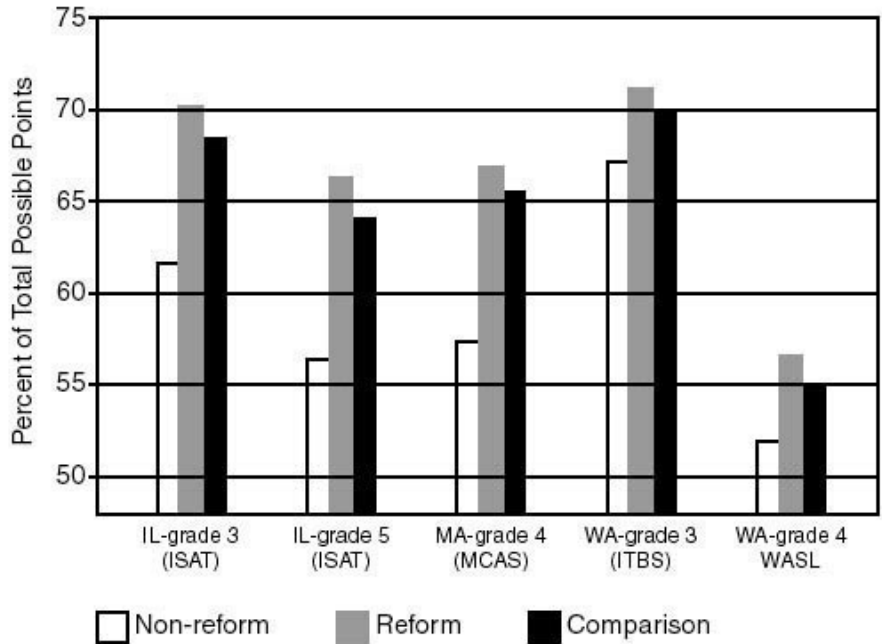
2. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

3. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

4. The random variable Y_1 has a normal distribution with mean μ_1 and variance σ_1^2 . The random variable $Y_1 D$ is defined as $Y_1 D = Y_1 \cdot D$, where D is a constant. The random variable Y_1 is independent of D . The random variable $Y_1 D$ has a normal distribution with mean $\mu_1 D$ and variance $\sigma_1^2 D^2$.

1.3) $\frac{1}{2}$ of the total score variable "total," by state/grade and reform status.

Figure 1: Averages for the overall test score variable "total," by state/grade and reform status.



1.3) $\frac{1}{2}$ of the total score variable "total," by state/grade and reform status.

2) $\frac{1}{2}$ of the total score variable "total," by state/grade and reform status.

Figure 2a: Test variable averages for IL grade-3, by reform status.

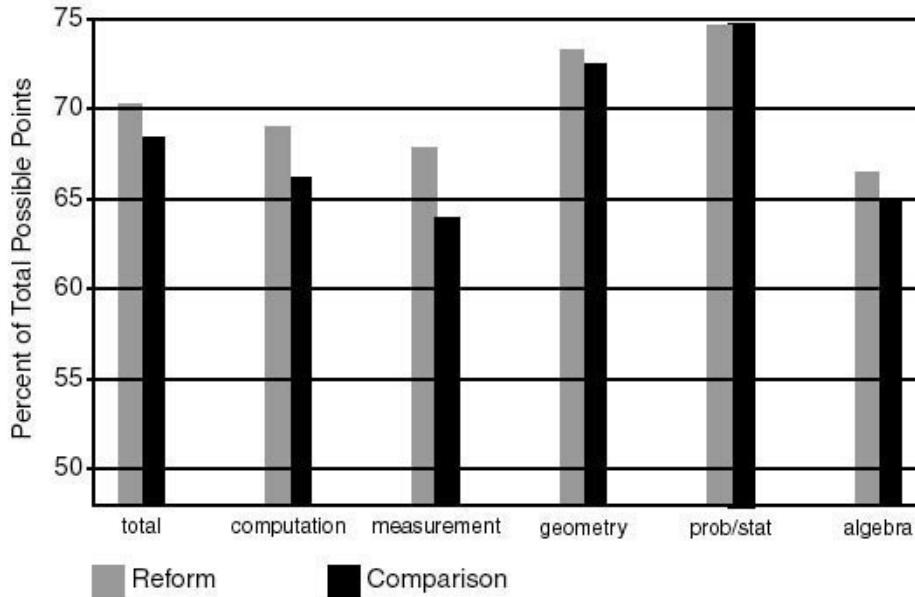


Figure 2b: Test variable averages for IL-grade 5, by reform status.

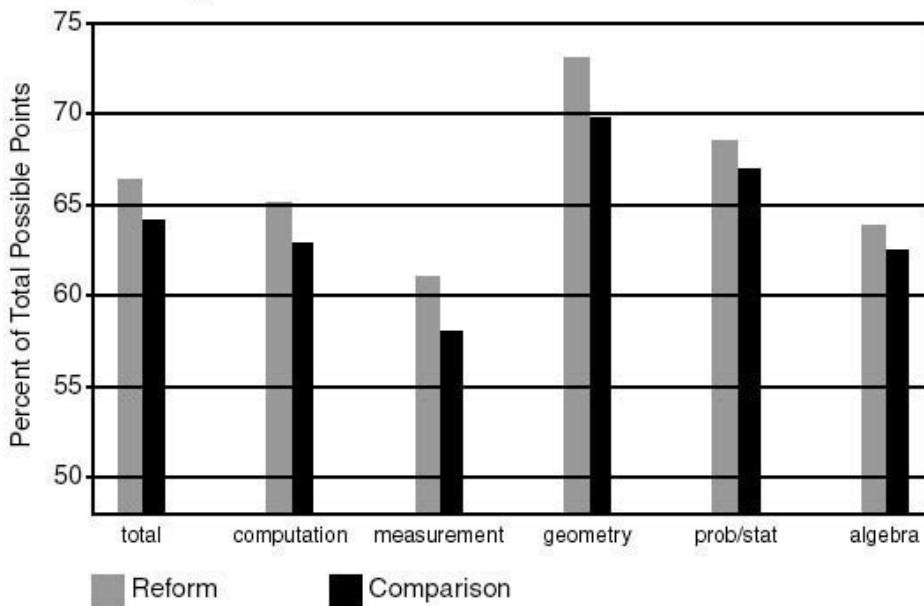


Figure 2c: Test variable averages for MA-grade 4, by reform status.

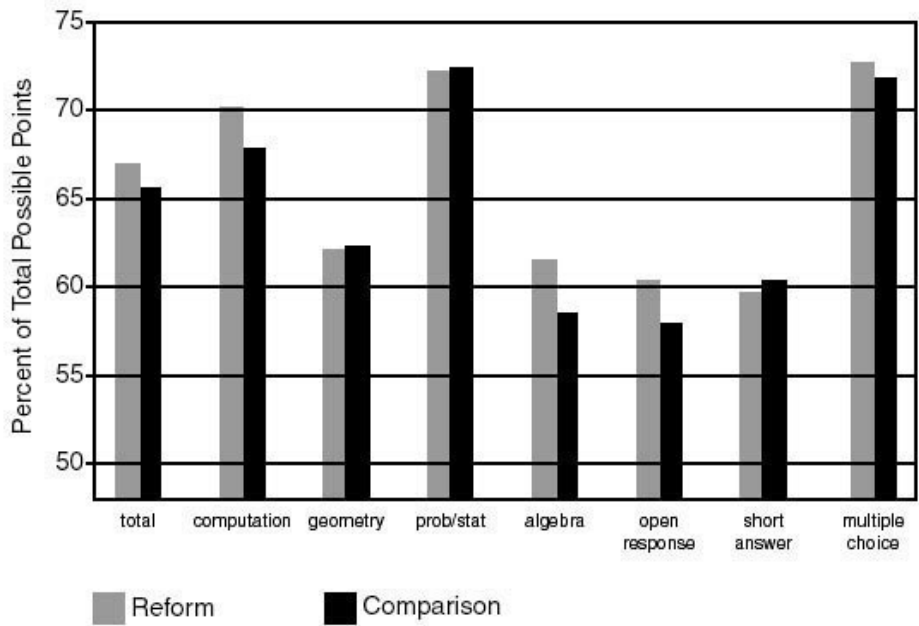


Figure 2d: Test variable averages for WA-grade 3, by reform status.

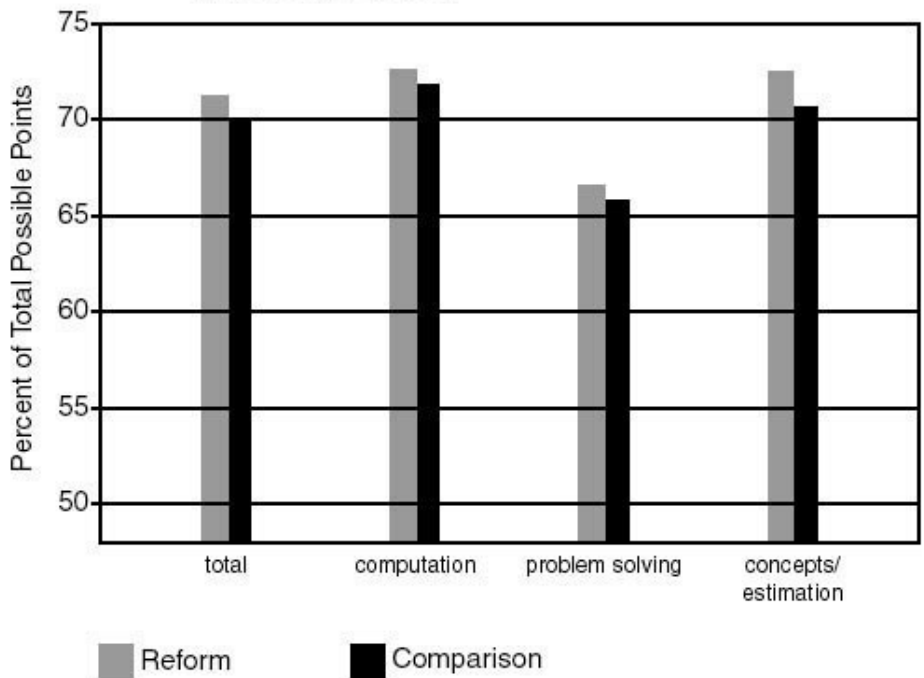
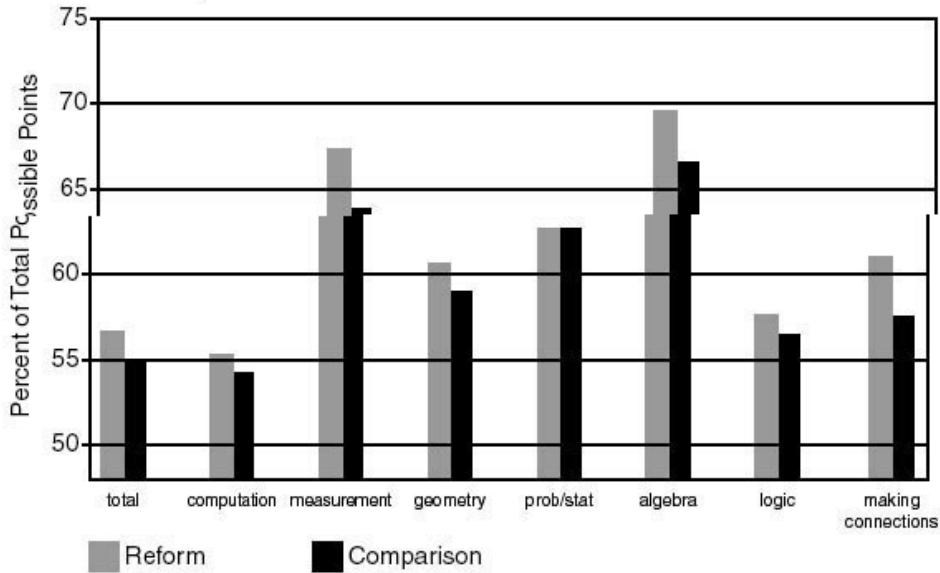


Figure 2e: Test variable averages for WA-grade 4, by reform status.



Averages for "problem solving" and "communicating" are not shown because they do not fit within the vertical scale. For "problem-solving", the reform students' average is 38.82, and the comparison student's average is 36.31. For "communicating", the averages are 45.03 and 45.06, respectively.

2] 2 ... 3 ... 10- 15- 30- ...

3.2 C

... 3 ... 10- 15- 30- ...

³ ... 2] 2 ...

2010-11 school year, the percentage of students who were proficient in mathematics was 74 percent for the reform group and 73 percent for the comparison group. The percentage of students who were proficient in reading was 71 percent for the reform group and 70 percent for the comparison group. The percentage of students who were proficient in science was 68 percent for the reform group and 67 percent for the comparison group. The percentage of students who were proficient in social studies was 65 percent for the reform group and 64 percent for the comparison group. The percentage of students who were proficient in art was 62 percent for the reform group and 61 percent for the comparison group. The percentage of students who were proficient in music was 59 percent for the reform group and 58 percent for the comparison group. The percentage of students who were proficient in physical education was 56 percent for the reform group and 55 percent for the comparison group. The percentage of students who were proficient in health was 53 percent for the reform group and 52 percent for the comparison group. The percentage of students who were proficient in computer science was 50 percent for the reform group and 49 percent for the comparison group. The percentage of students who were proficient in foreign languages was 47 percent for the reform group and 46 percent for the comparison group. The percentage of students who were proficient in career and technical education was 44 percent for the reform group and 43 percent for the comparison group. The percentage of students who were proficient in life skills was 41 percent for the reform group and 40 percent for the comparison group. The percentage of students who were proficient in all subjects was 38 percent for the reform group and 37 percent for the comparison group.

2010-11 school year, the percentage of students who were proficient in mathematics was 74 percent for the reform group and 73 percent for the comparison group. The percentage of students who were proficient in reading was 71 percent for the reform group and 70 percent for the comparison group. The percentage of students who were proficient in science was 68 percent for the reform group and 67 percent for the comparison group. The percentage of students who were proficient in social studies was 65 percent for the reform group and 64 percent for the comparison group. The percentage of students who were proficient in art was 62 percent for the reform group and 61 percent for the comparison group. The percentage of students who were proficient in music was 59 percent for the reform group and 58 percent for the comparison group. The percentage of students who were proficient in physical education was 56 percent for the reform group and 55 percent for the comparison group. The percentage of students who were proficient in health was 53 percent for the reform group and 52 percent for the comparison group. The percentage of students who were proficient in computer science was 50 percent for the reform group and 49 percent for the comparison group. The percentage of students who were proficient in foreign languages was 47 percent for the reform group and 46 percent for the comparison group. The percentage of students who were proficient in career and technical education was 44 percent for the reform group and 43 percent for the comparison group. The percentage of students who were proficient in life skills was 41 percent for the reform group and 40 percent for the comparison group. The percentage of students who were proficient in all subjects was 38 percent for the reform group and 37 percent for the comparison group.

Figure 3: Averages for the overall test score variable "total," by state/grade, race/ethnicity, and reform status.

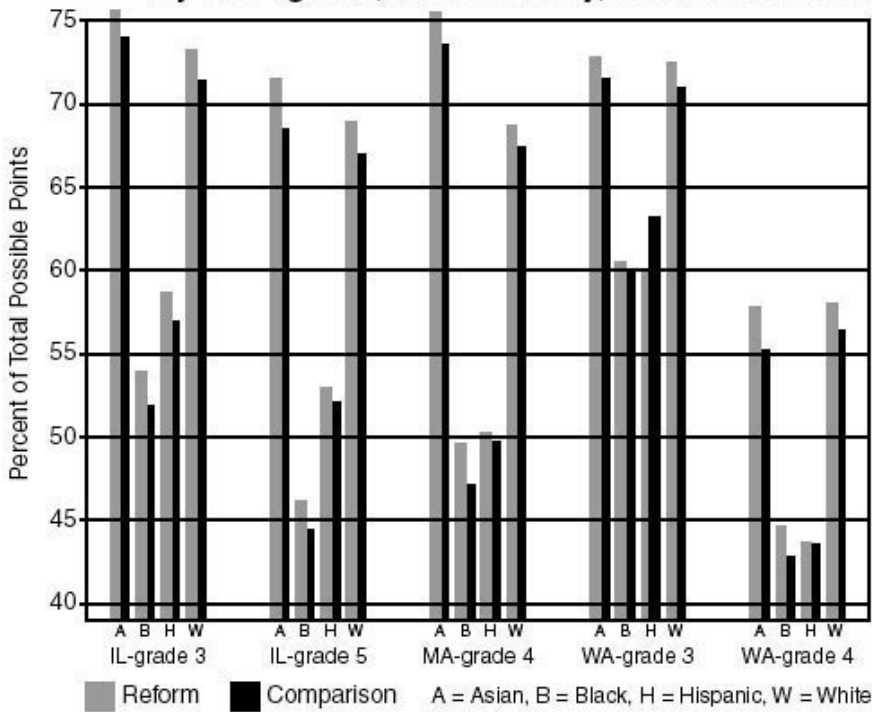


Figure 3: Averages for the overall test score variable "total," by state/grade, race/ethnicity, and reform status.

- The 2010-11 school year, the percentage of students who were proficient in mathematics was 74 percent for the reform group and 73 percent for the comparison group.
- The 2010-11 school year, the percentage of students who were proficient in reading was 71 percent for the reform group and 70 percent for the comparison group.
- The 2010-11 school year, the percentage of students who were proficient in science was 68 percent for the reform group and 67 percent for the comparison group.
- The 2010-11 school year, the percentage of students who were proficient in social studies was 65 percent for the reform group and 64 percent for the comparison group.

3.3 C

$$k_1 = k_2$$

Die beiden Reaktionen sind über die gleiche Halbwertszeit $t_{1/2}$ miteinander verknüpft. Die Halbwertszeit $t_{1/2}$ ist durch die Gleichung $t_{1/2} = \frac{\ln 2}{k}$ gegeben. Da $k_1 = k_2$, gilt $t_{1/2,1} = t_{1/2,2}$.

Die Halbwertszeit $t_{1/2}$ ist eine charakteristische Eigenschaft einer Reaktion. Sie ist unabhängig von der Anfangskonzentration des Reaktanten. In diesem Fall sind die Halbwertszeiten beider Reaktionen gleich, was auf einen gleichzeitigen Zerfall beider Spezies hinweist.

Die Reaktionsgeschwindigkeit v ist durch $v = -\frac{d[A]}{dt}$ definiert. Für eine Reaktion erster Ordnung gilt $v = k[A]$. Da $k_1 = k_2$, ist die Reaktionsgeschwindigkeit zu jedem Zeitpunkt gleich. Die Halbwertszeit $t_{1/2}$ ist die Zeit, die benötigt wird, bis die Konzentration des Reaktanten auf die Hälfte der Anfangskonzentration sinkt. Dies ist für beide Reaktionen der Fall.

Die Halbwertszeit $t_{1/2}$ ist eine wichtige Kenngröße für die Stabilität von Substanzen. Ein kleiner Wert für $t_{1/2}$ deutet auf eine schnelle Zersetzung an, während ein großer Wert auf eine langsame Zersetzung hinweist.

Die Halbwertszeit $t_{1/2}$ ist durch die Gleichung $t_{1/2} = \frac{\ln 2}{k}$ gegeben.

- Die Halbwertszeit $t_{1/2}$ ist eine charakteristische Eigenschaft einer Reaktion.
- Die Halbwertszeit $t_{1/2}$ ist unabhängig von der Anfangskonzentration des Reaktanten.
- Die Halbwertszeit $t_{1/2}$ ist durch die Gleichung $t_{1/2} = \frac{\ln 2}{k}$ gegeben.
- Die Halbwertszeit $t_{1/2}$ ist eine wichtige Kenngröße für die Stabilität von Substanzen.
- Die Halbwertszeit $t_{1/2}$ ist durch die Gleichung $t_{1/2} = \frac{\ln 2}{k}$ gegeben.

Die Halbwertszeit $t_{1/2}$ ist durch die Gleichung $t_{1/2} = \frac{\ln 2}{k}$ gegeben.

Die Halbwertszeit $t_{1/2}$ ist eine wichtige Kenngröße für die Stabilität von Substanzen. Ein kleiner Wert für $t_{1/2}$ deutet auf eine schnelle Zersetzung an, während ein großer Wert auf eine langsame Zersetzung hinweist.

Figure 4: Averages for the overall test score variable "total," by state/grade, SES and Title IS status, and reform status.

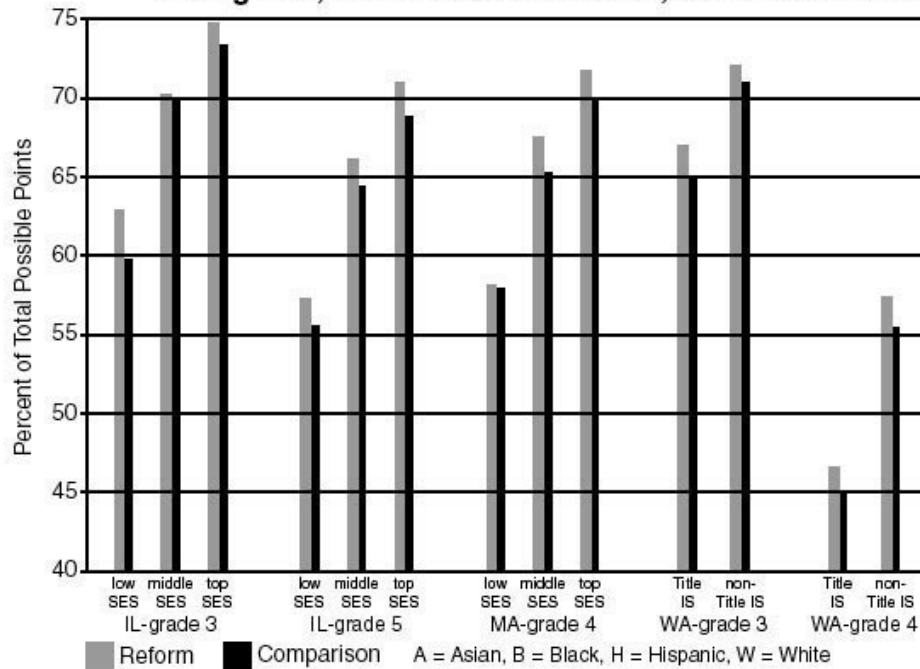


Figure 4 shows the average overall test scores for the variable "total" across different states and grades. The chart compares the performance of students in reform states (light gray bars) versus comparison states (dark gray bars) across five categories: IL-grade 3, IL-grade 5, MA-grade 4, WA-grade 3, and WA-grade 4. The Y-axis represents the Percent of Total Possible Points, ranging from 40 to 75. The X-axis shows the state/grade and Title IS status (low, middle, top SES or Title IS vs. non-Title IS).

Key findings from the chart include:

- In IL-grade 3, the top SES group in reform states scored significantly higher (75%) compared to comparison states (73%).
- In IL-grade 5, the top SES group in reform states scored higher (71%) than in comparison states (69%).
- In MA-grade 4, the top SES group in reform states scored higher (72%) than in comparison states (70%).
- In WA-grade 3, the non-Title IS group in reform states scored higher (72%) than in comparison states (71%).
- In WA-grade 4, the non-Title IS group in reform states scored higher (57%) than in comparison states (55%).

The legend indicates that the data is broken down by race/ethnicity: A = Asian, B = Black, H = Hispanic, W = White.

5. REFERENCES

- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 25(9), 603-616.
- Alford, D., & Jones, D. (2000). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 69(1), 52-61. <http://www.cse.ucla.edu/CRESST/Reports/TECH528.pdf>
- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 26(4), 451-461.
- Alford, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 28(2), 23-42.
- Alford, D., & Jones, D. (2003). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 72(1), 1-10. *Chironomus tentans* L. in relation to the water table? *Chironomus tentans* L. in relation to the water table?
- Alford, D., & Jones, D. (2003). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 72(1), 1-10. *Chironomus tentans* L. in relation to the water table? *Chironomus tentans* L. in relation to the water table?
- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 22(1), 3-21.
- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 27, 403-434.
- Alford, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 2002.
- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 21, 10-206.
- Alford, D., & Jones, D. (2000). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 31(3), 2-25.
- Alford, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 2002.
- Alford, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 30(1), 3-11.
- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 30, 3-3425.
- Alford, D., & Jones, D. (1966). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 14, 251-23.
- Alford, D. (2003). The behaviour of the *Chironomus tentans* L. in relation to the water table. *Journal of Animal Ecology*, 72(1), 1-10. *Chironomus tentans* L. in relation to the water table? *Chironomus tentans* L. in relation to the water table?

1. ... & ... (1963, 1964). ...
 2. ... (1964, 1965). ...
 3. ... (1965). ...
 4. ... (1966). ...
 5. ... (1967). ...
 6. ... (1968). ...
 7. ... (1969). ...
 8. ... (1970). ...
 9. ... (1971). ...
 10. ... (1972). ...
 11. ... (1973). ...
 12. ... (1974). ...
 13. ... (1975). ...
 14. ... (1976). ...
 15. ... (1977). ...
 16. ... (1978). ...
 17. ... (1979). ...
 18. ... (1980). ...
 19. ... (1981). ...
 20. ... (1982). ...
 21. ... (1983). ...
 22. ... (1984). ...
 23. ... (1985). ...
 24. ... (1986). ...
 25. ... (1987). ...
 26. ... (1988). ...
 27. ... (1989). ...
 28. ... (1990). ...
 29. ... (1991). ...
 30. ... (1992). ...
 31. ... (1993). ...
 32. ... (1994). ...
 33. ... (1995). ...
 34. ... (1996). ...
 35. ... (1997). ...
 36. ... (1998). ...
 37. ... (1999). ...
 38. ... (2000). ...
 39. ... (2001). ...
 40. ... (2002). ...
 41. ... (2003). ...
 42. ... (2004). ...
 43. ... (2005). ...
 44. ... (2006). ...
 45. ... (2007). ...
 46. ... (2008). ...
 47. ... (2009). ...
 48. ... (2010). ...
 49. ... (2011). ...
 50. ... (2012). ...
 51. ... (2013). ...
 52. ... (2014). ...
 53. ... (2015). ...
 54. ... (2016). ...
 55. ... (2017). ...
 56. ... (2018). ...
 57. ... (2019). ...
 58. ... (2020). ...

Appendi A

A.1 The Matching Procedure

The matching procedure is based on the following steps:

- **Initial:** Set of initial parameters, E_{AA} , LEP, ...
- **Matching:** Set of parameters, E_{AA} , ...
- **Energy:** Set of parameters, T, IM, E_{AA} , ...

Initial, E_{AA} , S, ... T, IS, T, I (A, 40% ... 27% ... 20% ... T, IS, I, E, ... T, IM, ...)

A, ... LEP, ... 2, ... T, IM, ... M, ... E, ...

P, ... Fr, ... A, ... T, ... Pr, ... 10%, ... T, ...

A, ... 2%, ... M, ... E, ... 5%, ... (A, ... 2, ... O, ... I, ...

... A ...

A.2 Exclusions and Missing Data Procedures

T... 5 ...

- C... A ...
- C... B ... IEP, ...
- C... C ...
- C... D ... C.A ...

N... R ... (1.2% ... N r ... S...

A... 3% ... I... E... T... 7... I... 3,4... I... 5, ... 1... E... 3... N... E... M...

- FrI... (r... 3... 5), ... S... R... C... A... |E... |E... |E...
- FrE... (r... 3... 4), ... |E... |E... (r... 3) ... |E... |E...

A.3 Construction of Case Weights for Comparison Students

C... (T... 4... 7 11) ...

T... E... T... 5: I R ... M... M... E T... 5:

- ... = (# Rr r... |E...) / (# Mr r... |E...) .

A.4 Corrective Adjustment for Matching Differences

The following table shows the relationship between the variables in the model and the variables in the ANCOVA model. The variables in the ANCOVA model are defined as follows:

The variables in the ANCOVA model are defined as follows:

1. $C = \text{Pr}(r = 1 | r = 1) - \text{Pr}(r = 1 | r = 0)$

Interpretation: The difference in the probability of a response of 1 between the two groups.

$E = \text{Pr}(r = 1 | r = 1) - \text{Pr}(r = 1 | r = 0) - \text{Pr}(r = 1 | r = 1) + \text{Pr}(r = 1 | r = 0)$

2. $C = \text{Pr}(r = 1 | r = 1) - \text{Pr}(r = 1 | r = 0) - \text{Pr}(r = 1 | r = 1) + \text{Pr}(r = 1 | r = 0)$

3. $L = \text{Pr}(r = 1 | r = 1) - \text{Pr}(r = 1 | r = 0) - \text{Pr}(r = 1 | r = 1) + \text{Pr}(r = 1 | r = 0)$

4. $L = O(r) - \text{Pr}(r = 1 | r = 1) - \text{Pr}(r = 1 | r = 0) + \text{Pr}(r = 1 | r = 1) + \text{Pr}(r = 1 | r = 0)$

The following table shows the relationship between the variables in the model and the variables in the ANCOVA model. The variables in the ANCOVA model are defined as follows:

A.5 Calculation of Effect Sizes and Their Standard Errors

The following table shows the relationship between the variables in the model and the variables in the ANCOVA model. The variables in the ANCOVA model are defined as follows:

$r_{CA} = \frac{\sigma_{R,CA}}{\sigma_{R,CA} + \sigma_{C,CA}}$, $r_{CA} = \frac{\sigma_{R,CA}}{\sigma_{R,CA} + \sigma_{C,CA}}$, $r_{CA} = \frac{\sigma_{R,CA}}{\sigma_{R,CA} + \sigma_{C,CA}}$

$C = r_{CA}(\sigma_{R,CA} + \sigma_{C,CA})$, $r_{CA} = \frac{\sigma_{R,CA}}{\sigma_{R,CA} + \sigma_{C,CA}}$, $r_{CA} = \frac{\sigma_{R,CA}}{\sigma_{R,CA} + \sigma_{C,CA}}$

$$r_{CA}(\sigma_{R,CA} + \sigma_{C,CA}) = r_{CA}\sigma_{R,CA} + r_{CA}\sigma_{C,CA}$$

$$= (1 - r_{CA})\sigma_{R,CA} + r_{CA}\sigma_{C,CA}$$

$$r_{CA}\sigma_{R,CA} - r_{CA}\sigma_{R,CA} = r_{CA}\sigma_{C,CA} - r_{CA}\sigma_{C,CA}$$

$$0 = 0.81 \dots / r_{CA} \dots$$

$$Fr_{CA} \dots, I_{CA} \dots, r_{CA} \dots 90\% \dots$$

$$r_{CA} \dots 94\%, \dots 96\%$$

$$= 0.90 \cdot 0.94 \cdot 0.96 = 0.81$$

$$Fr_{CA} \dots \sigma_{R,CA}^2 \approx \sigma_{C,CA}^2 \dots r_{CA} \approx C(\dots)$$

$$r_{CA}(\sigma_{R,CA} + \sigma_{C,CA}) \approx 1.19\sigma_{C,CA}^2 / r_{CA}$$

$$Fr_{CA} \dots (\sigma_{R,CA} + \sigma_{C,CA}) / C, \dots \sigma_{C,CA}$$

$$\dots 1.09 / r_{CA}$$

$$T_{CA} \dots / r_{CA} \dots r_{CA}(\sigma_{R,CA} + \sigma_{C,CA}) / C$$

$$\dots A.4. M r \dots \Sigma (r_{CA} / N)$$

$$(\sigma_{R,CA} + \sigma_{C,CA}) / C, \dots r_{CA} \dots N = \Sigma \dots$$

$$\dots r_{CA} \approx 1.09 / r_{CA}(N). Fr_{CA} \dots$$

A. $r_{CA} \dots 25 \dots 50\%$. $T_{CA} \dots < 0.01 \dots < 0.001$.

A.6 Validity of Results

Reliability of measures and regression artifacts

T. $S = 2.4$, A. A.1. $M \dots Fr_{CA} \dots S \dots T \dots M \dots$

E. $r_{CA} \dots (S - T) \dots A. \dots Fr_{CA} \dots 3, \dots 5 \dots S, R, C \dots T \dots 0.98$

IEP ()

T : I 0.90. T () ()

B : 0.99. T 0.99.

A

B. T 13

N :

- T 13 . P
- F (0.99 , 0.98) , 4 5% , 10%.
- E , 10% , 20%

An alternative anal sis

S

I

A T T 14

F / :

- D (A) T 7, A A. A. A.4
- D (B) T A A.4
- D (C) T

T (B) 8% (A) T (B)

T (C) 20% (A) T (C)

U T

T 6. (F) C

M /

¹I M

... r r - r r . I ... r r - r r ... r r ... r r ...
r r r r r . A ... , ... r r ... (C) ...
r r ... r r ... r r ... r r ... r r ... r r ... r r ...
r r ... r r ... r r ...

Appendix B

The ARC Center study includes data from five state-mandated tests administered in the spring of 2000. Table 15 compares the five tests based on the number and type of questions, time limits, and use of calculators and other tools.

Table 15: State Tests Comparison

	MA	IL	IL	WA	WA
--	----	----	----	----	----

Name of Test

grade 4

grade 3

grade 5

grade 3

grade 4

Information and sample items are available at www.isbe.state.il.us/assessment/isat.htm.

The *W* *A* *S* *L* (WASL) is designed to measure the mathematics proficiency of students according to the state *E* *A* *L* *R* (EALR). Administration of the test in grade 4 was voluntary in 1997 and required since 1998. A total math score is reported along with scores in the following content and process strands:

- Number Sense
- Measurement Concepts
- Geometric Sense
- Probability and Statistics
- Algebraic Sense
- Solving Problems
- Reasoning Logically
- Communicating Understanding
- Making Connections

Information and sample items are available at www.k12.wa.us

The *I* *w* *T* *B* *S* (ITBS) is a norm-referenced test. Since 1999, grade 3 students in Washington State have taken the ITBS (Form M). National norms for the test were established in 1995. The mathematics portion of the test consists of three sections:

- Math Concepts and Estimation
The Math Concepts portion includes number properties and operations, algebra, geometry, measurement, and probability and statistics. The Estimation portion measures students' mental arithmetic and estimation skills.
- Math Problem Solving and Data Interpretation
The Problem Solving and Data Interpretation test includes word problems and interpretation of tables and graphs.
- Math Computation
Each problem in the Math Computation test requires the use of one arithmetic operation—addition, subtraction, multiplication, or division.

Information on the ITBS is available at www.riverpub.com/products/group/itbs and www.uiowa.edu/~itp/itbs.htm.

The *M* *C* *A* *S* (MCAS) was first administered in 1998. Early versions, including the spring 2000 version, were based on the 1996 *M* *C* *F* *w* . The following mathematics content strands were tested:

- Number Sense
- Patterns, Relation, and Functions
- Geometry and Measurement
- Statistics and Probability

The test items from the spring 2000 administration of the MCAS are available at <http://www.doe.mass.edu/mcas/2000/release/>.

Sample Items

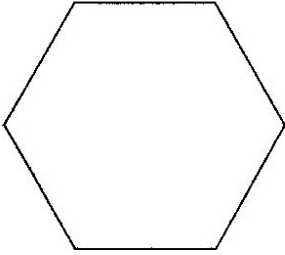
The format of the items on the tests varies widely. As shown in Table 15, all of the tests include multiple-choice items. Figure a shows two sample items from the grade3 ISAT in the Estimation/Number Sense/Computation standard set. Figure b shows a released multiple-choice item from the grade 4 MCAS from the Number Sense

reporting category and Fractions and Decimals substrand. Note that students are encouraged to use their toolkit to help solve the problem.

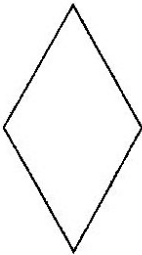
<p>9. Between what two numbers would 325 appear?</p> <p><input type="radio"/> (A) 240 and 315</p> <p><input checked="" type="radio"/> (B) 270 and 436</p> <p><input type="radio"/> (C) 420 and 526</p> <p><input type="radio"/> (D) 524 and 626</p>	<p>11. Sheila's little brother is $1\frac{1}{2}$ years old. How many months old is he?</p> <p><input type="radio"/> (A) 10 months</p> <p><input type="radio"/> (B) 12 months</p> <p><input checked="" type="radio"/> (C) 18 months</p> <p><input type="radio"/> (D) 24 months</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Figure a. Sample multiple-choice items from the grade 3 ISAT

Use the figures below and the shapes in your tool kit to answer question 32.



hexagon



rhombus

32. If the hexagon equals one whole, what fractional part of the hexagon is one rhombus?

A. $\frac{1}{3}$ B. $\frac{1}{2}$ C. $\frac{1}{6}$ D. $\frac{1}{4}$

Figure b. Released multiple-choice item from the grade 4 MCAS

The state tests in Washington and Massachusetts included short-answer questions. Figure c shows two short-answer questions from the grade 4 MCAS. One is from the Number Sense reporting category and the Number Computation substrand and the other is from the Geometry and Measurement reporting category and the Measurement substrand.


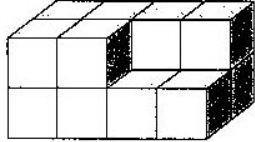
<p>11. Compute:</p> $\begin{array}{r} 536 \\ \times 25 \\ \hline \end{array}$ <p>Correct Answer: 13,400</p>	<p>12. The volume of this cube is 1 cubic centimeter.</p> <div style="text-align: right;">  = 1 cubic cm </div> <p>What is the volume of this figure?</p> <div style="text-align: right;">  </div> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>Correct Answer: 14 cubic centimeters</p> </div>
--------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Figure c. Two short-answer questions from the grade 4 MCAS

In 2000, Washington and Massachusetts included results from open-response items in student scores. Figure d is a sample open-response item from the grade 4 WASL. Figure e is the corresponding scoring rubric.

Look at the following list of numbers.

9 18 27 36 45 54 63 72 81 90

Describe **two** different patterns you see in these numbers.

1.

2.

Figure d. Sample open-response item from the grade 4 WASL

2	<p>A 2-point response describes two different number patterns in the given list of numbers. Possible patterns include the following (or equivalent statements):</p> <ul style="list-style-type: none"> • All the numbers are multiples of 3. • All the numbers are multiples of 9. • The digit(s) in each number add up to 9. • The ones digit decreases by 1 in each number. • The tens digit increases by 1 in each number • You add 9 to get the next number. • Every other number is odd, or every other number is even.
1	<p>A 1-point response does one of the following:</p> <ul style="list-style-type: none"> • Describes one number pattern in the list of numbers. • Describes two different number patterns, but the descriptions may be vague, incomplete, or unclear (e.g., "the numbers are getting bigger").
0	<p>A 0-point response shows little or no understanding of algebraic sense.</p>

Figure e. Scoring rubric for open-response item from the grade 4 WASL

Appendix C

This Implementation Survey was administered in print and by follow-up phone interview to each school in the study using one of the reform curricula.

To:		From:	
		Phone:	
		Fax:	
Phone:		e-mail	
Fax:		Date:	
		Pages:	

The (name of project) at the (name of institution), with funding from the National Science Foundation and in collaboration with TERC, COMAP, The University of Chicago, and the University of Illinois at Chicago, is carrying out a study of student achievement with (name of curriculum) and two other reform-oriented curricula. As part of our study, we are surveying schools using these curricula.

The survey includes eight questions. We need this information about each school using (name of curriculum). Please look over the questions and answer them as accurately as possible. Thank you.

School: _____

Phone number and best time to call:

Name and position of person completing survey:

1. What was the primary mathematics program (the instructional materials) used by this school in each grade for mathematics during the 1999–2000 school year?

Grade	Primary Mathematics Program
2	
3	
4	
5	

2. What percentage of teachers for this school used (name of curriculum) or at least 75% of their math instruction during the 1999–2000 school year?

Grade	% of teachers fully using
2	
3	
4	
5	

3. As of June 2000, for this school at each grade, how many years had (name of curriculum) been fully implemented? (Use 'At least 75% of teachers using the curriculum for at least 75% of their mathematics instruction' as the definition of 'full implementation.')

Grade	Years at full?
2	
3	
4	
5	

4. As of June 2000, at each grade level, what was the total number of hours on average of staff development related to (name of curriculum) for a typical teacher using it (since 1994)?

Grade	# of hours of staff development (circle a range)			
2	0-6	7-30	31-99	100+
3	0-6	7-30	31-99	100+
4	0-6	7-30	31-99	100+
5	0-6	7-30	31-99	100+

5. How many actual minutes of mathematics instruction were there per day during the 1999-2000 school year?

Grade	Minutes per day
2	
3	
4	
5	

6. On average, for what percent of math time did teachers use (name of curriculum) during the 1999-2000 school year?

Grade	% of time
2	
3	
4	
5	

7. On average, during the 1999-2000 school year how many units (or lessons, or modules, as appropriate) did teachers complete?

Grade	# units
2	
3	
4	
5	

8. What supplementary mathematics materials (test prep, math facts practice, problem solving, etc.) were used during the 1999-2000 school year?

Grade	What supplementary materials were used?
2	
3	
4	
5	

Table 1: Number of school/grade case records coded for the implementation survey, by state and grade level

State	Grade					Total
	2	3	4	5		
Illinois	289	290*	275	254*	1,108	
Massachusetts	93	159	158*	81	491	
Washington	177	178*	178*	125	658	
Total	559	627	611	460	2,257	

* Student achievement data is available for these five state/grade combinations, which include a total of 1,058 school/grade case records.

Table 2: Number of eligible reform school/grade cases, by state, grade level, and reform program

State-Grade Level	Reform Program		Total
	Elementary	Middle	
Illinois-Grade 3	203	0	216
Illinois-Grade 5	168	0	174
Massachusetts-Grade 4	64	63	127
Washington-Grade 3	64	15	113
Washington-Grade 4	63	15	112
Total	562	93	742

3: Exclusionary discipline

State	Grade level	A	B	C	D	E
		Total schools at grade level	Exclusions*	Total schools available for matching	Number of reform schools to be matched	Matching ratio
Illinois	3	2,308	187	1,905	216	8.8 : 1
	5	2,184	191	1,819	174	10.5 : 1
Ohio	4	1,051	173	751	127	5.9 : 1
Washington	3	1,150	248	789	113	7.0 : 1
	4	1,149	254	783	112	7.0 : 1
		7,842	1,053	6,047	742	

* Exclusions are based on the number of students who are excluded from school for 10 or more days in a school year. The percentage of students excluded from school for 10 or more days in a school year is 9.4% for Illinois and 7.37% for Ohio.

h = high school; A = average; fh = full-time; EP = exclusionary percentage.

h = high school; E = exclusionary; fh = full-time.

4: h = high school; r = reform; f_r = full-time reform; h / r = high school / reform.

State-Grade Level	Matching Variable					
	Average percentage of:					
Illinois - 3	h	-	y	EP		
	f_r	165.75	74%	18%	13%	6%
	r	165.85	77%	18%	13%	5%
Illinois - 5	h	-	y	EP		
	f_r	164.46	76%	17%	11%	5%
	r	164.2	81%	18%	12%	4%
Ohio - 4	h	-	y**	EP**		
	f_r	236.99	77%	12%	16%	2%
	r	236.28	80%	14%	11%	1%
Washington - 3	h	-	l h	l		
	f_r	192.07	80%	2%	16%	
	r	191.97	82%	2%	16%	
Washington - 4	h	-	l h	1		
	f_r	412.46	80%	3%	6%	
	r	412.36	82%	3%	6%	

* A_r = average reform; f_r = full-time reform; h = high school; r = reform; l h = low high; l = low.

** ▼ r = reform; r k = reform; h = high school.

Table 5: Student record counts at various stages of exclusion, by state and grade level

State	Grade Level	A reform and comparison school records on state file prior to exclusions	B records after excluding math-disabled/IEP/special education students	C records after excluding students with incomplete math test data	D missing data		E* records in final file used for tabulations and constructing case weights
					reading score	race/ethnicity	
Illinois	3rd	32,923 8.7% are IEP	30,052	29,490	498	1,249	28,992 14,875 reform 14,117 comparison
	5th	30,807 9.9% are IEP	27,763	27,555	74	1,195	27,481 13,820 reform 13,661 comparison
Massachusetts	4th	17,822 15.8% are math-disabled	15,010	14,575	84	94	14,397 6,879 reform 7,518 comparison
	3rd	16,868 9.1% are spec-edn/IEP	15,333	14,794	125	458	14,669 7,813 reform 6,856 comparison
Washington	4th	17,702 11.1% are spec-edn	15,737	15,407	71	274	15,336 7,953 reform 7,383 comparison
	Total	116,122	103,895	101,821	852	3,270	100,875 51,340 reform 49,535 comparison

* Excepting Massachusetts, the total count in Column E is equal to the count in Column C minus the count for reading score in Column D. For Massachusetts, the total count in Column E is equal to the count in Column C minus the sum of the counts in Column D.

Table 6: Number of student records used for tabulated comparisons, by state, grade level, school status, and curriculum.

S	G	L	S	S	R		P	
					E	M	T	T
Illinois	3rd	Reform		13,840	0	1,035	14,875	
		Comparison		13,216	0	901	14,117	
	5th	Reform		12,988	0	832	13,820	
		Comparison		13,098	0	563	13,661	
	Massachusetts	4th	Reform		3,962	2,917	0	6,879
			Comparison		4,181	3,337	0	7,518
Washington	3rd	Reform		4,412	916	2,485	7,813	
		Comparison		3,923	783	2,150	6,856	
	4th	Reform		4,499	920	2,534	7,953	
		Comparison		4,063	907	2,413	7,383	
	T	Reform		39,701	4,753	6,886	51,340	
		Comparison		38,481	5,027	6,027	49,535	
				78,182	9,780	12,913	100,875	

Table 7: Average differences and effect sizes, by state/grade combination.

	math	total	computation	measurement	geometr	prob/stat	algebra	open response	short answer	multiple choice	making connections
IL grade3 (n=14,875)	difference effect size	1.39*** 0.098	1.82*** 0.099	2.78*** 0.141	3.84*** 0.164	0.76*** 0.038	0.06 0.003	1.44*** 0.073			
IL grade5 (n=13,820)	difference effect size	1.82*** 0.121	2.20*** 0.116	2.29*** 0.117	3.02*** 0.132	3.26*** 0.165	1.55*** 0.079	1.44*** 0.067			
MA grade 4 (n=6,879)	difference effect size	1.34*** 0.087	1.33*** 0.078	2.36*** 0.127	-0.19 -0.010	-0.16 -0.008	3.07*** 0.137	2.46*** 0.119	-0.62 -0.024	0.89*** 0.053	
WA grade3 (n=7,813)	difference effect size	1.34*** 0.073	1.27*** 0.078	0.74** 0.039				problem solving	concepts/ estimation	commun- icating	
WA grade4 (n=7,953)	difference effect size	3.02*** 0.093	1.77*** 0.093	1.02*** 0.041	3.43*** 0.120	1.61*** 0.078	0.00 0.000	2.51*** 0.090	1.17*** 0.040	-0.03 -0.001	3.55*** 0.116
Combined (n=51,340)	effect size percentile change	0.098*** +3.92%	0.097*** +3.88%	0.102*** +4.08%	0.142*** +5.68%	0.078*** +3.12%	0.025*** +1.00%	0.088*** +3.52%			

"Math" is scaled test score; "total" and remaining strand scores are percent of total possible points on entire test or appropriate strand portion of test.

The record counts in column one are the numbers of reform-student records used for tabulations. For an given tabulation, the weighted number of comparison-student records used is equal to the number of reform-student records used.

Two-sided significance levels are defined as follows: *** is $p < 0.001$, ** is $p < 0.01$, * is $p < 0.025$.

Table 8: Average effect sizes and percentage changes, broken down by race/ethnicity

	math	algebra	geometry	probability	measurement	geometry	probability	algebra
Asian (n=3,071)	0.106*** +4.24%	0.115*** +4.60%	0.097*** +3.88%	0.175*** +7.00%	0.162*** +6.48%	0.043 +1.72%	0.086*** +3.44%	
Black (n=3,509)	0.092*** +3.68%	0.101*** +4.04%	0.109*** +4.36%	0.129*** +5.16%	0.081*** +3.24%	0.029 +1.16%	0.087*** +3.48%	
Hispanic (n=3,002)	0.021 +0.84%	0.031 +1.24%	0.017 +0.68%	0.094*** +3.76%	0.049* +1.96%	-0.005 -0.20%	0.035 +1.40%	
White (n=37,609)	0.100*** +4.00%	0.100*** +4.00%	0.106*** +4.24%	0.144*** +5.76%	0.070*** +2.80%	0.020*** +0.80%	0.091*** +3.64%	
Combined (n=51,340)	0.098*** +3.92%	0.097*** +3.88%	0.102*** +4.08%	0.142*** +5.68%	0.078*** +3.12%	0.025*** +1.00%	0.088*** +3.52%	

"Math" is scaled score; "algebra" and remaining scores are percentage of total possible points on entire or appropriate and portion of

comparison

records are roughly equal to the number of reform records.

based on implementation.

The analyses for geometry, probability and algebra are based on 5-10% fewer records, because these records are not separated in the WA (grade 3) test.

the WA (grade 3) test.

Two-sided significance levels are defined as follows: *** is $p < 0.001$, ** is $p < 0.01$, * is $p < 0.025$

Table 1: Summary Statistics of the Sample

Variable	Mean	Standard Deviation	Minimum	Maximum	Skewness	Kurtosis	Jarque-Bera Statistic	Significance
ln(1 + growth)	0.114*** +4.5%	0.102*** +4.0%	0.103*** +4.12%	0.144*** +5.0%	0.152*** +0.0%	0.02* +1.0%	0.0	0.02*** +2.0%
ln(1 + growth)	0.0*** +3.0%	0.0*** +3.12%	0.124*** +4.0%	0.110*** +4.40%	0.000 +0.00%	0.004 +0.1%	0.0	0.01*** +3.24%
ln(1 + growth)	0.101*** +4.04%	0.10*** +4.32%	0.151*** +0.04%	0.150*** +0.00%	0.04*** +1.4%	0.03*** +1.5%	0.0	0.01*** +3.24%
ln(1 + growth)	0.0*** +3.4%	0.04*** +3.0%	0.04 +1.4%	0.05# +2.0%	0.032# +1.2%	-0.02# -1.04%	0.0	0.0# +3.4%
ln(1 + growth)	0.03*** +3.32%	0.05*** +3.40%	0.03*** +1.5%	0.125*** +5.00%	0.02*** +3.2%	0.003 +0.12%	0.11*** +4.4%	0.11*** +4.4%
ln(1 + growth)	0.0*** +3.2%	0.0*** +3.0%	0.102*** +4.0%	0.142*** +5.0%	0.0*** +3.12%	0.025*** +1.00%	0.0*** +3.52%	0.0*** +3.52%

Notes: The table reports the mean, standard deviation, minimum, maximum, skewness, kurtosis, and Jarque-Bera statistic for each variable. The Jarque-Bera statistic tests for normality. Significance levels are indicated by asterisks: *** p < 0.001, ** p < 0.01, * p < 0.05, # p < 0.1. The sample size is 50.

Table 10: Summary statistics for the monthly returns on the market

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability > Chi-Square(2)
Market Returns (25, 2)	0.03 +3.0%	0.09 +9.0%	0.105*** +4.20%	0.144*** +5.7%	0.01*** +3.24%	0.023*** +0.92%
Market Returns (24, 33)	0.03 +3.4%	0.094*** +9.4%	0.09*** +3.92%	0.140*** +5.0%	0.04*** +4.0%	0.024*** +0.9%
Market Returns (51, 340)	0.03 +3.92%	0.09*** +9.32%	0.102*** +4.0%	0.142*** +5.0%	0.07*** +3.12%	0.025*** +1.00%

Notes: All statistics are calculated using monthly returns from 1990 to 2000. The Jarque-Bera test is used to test for normality of the returns. The probability of exceeding the critical value of the chi-square distribution is reported in the last column. The critical values for the chi-square distribution are 5.991 for 2 degrees of freedom, 7.378 for 3 degrees of freedom, and 11.575 for 4 degrees of freedom. *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 11: Summary statistics for the monthly returns on the market, conditional on the state of the economy (1 = expansion, 2 = recession)

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability > Chi-Square(2)
Market Returns (25, 2)	0.03 +3.0%	0.09 +9.0%	0.105*** +4.20%	0.144*** +5.7%	0.01*** +3.24%	0.023*** +0.92%
Market Returns (24, 33)	0.03 +3.4%	0.094*** +9.4%	0.09*** +3.92%	0.140*** +5.0%	0.04*** +4.0%	0.024*** +0.9%
Market Returns (51, 340)	0.03 +3.92%	0.09*** +9.32%	0.102*** +4.0%	0.142*** +5.0%	0.07*** +3.12%	0.025*** +1.00%

Table 12: Variable * u | e

Variable	Grade 3 (ISAT)		Grade 4 (MCAS)		Grade 5 (ISAT)		Grade 3 (ITBS)		Grade 4 (WASL)	
	u	e	u	e	u	e	u	e	u	e
LEP (m)	u	e	u	e	u	e	u	e	u	e
m b.	u	e	u	e	u	e	u	e	u	e
w	u	e	u	e	u	e	u	e	u	e
T	u	e	u	e	u	e	u	e	u	e
SES	u	e	u	e	u	e	u	e	u	e
[MA]	u	e	u	e	u	e	u	e	u	e

* A variable ...
 F. ...
 (M) LEP (MA) ...

Table 13. Estimated bias due to regression artifacts.
(Typical results based on IL-grade 5 data.)

Test variable modeled	Covariates used	Assumed covariate reliabilities: read=0.99, lowincom=0.98, white=0.98		Assumed covariate reliabilities: read=0.97, lowincom=0.92, white=0.92	
		Estimated bias	Estimated bias	Estimated bias	Estimated bias
math	reading score	+4.2%	+8.2%		
math	low-income %	+1.2%	+21.9%		
math	reading score low-income %	+4.1%	+5.6%		
math*	reading score low-income % white %	+6.2%	+3.0%		
computation	reading score low-income %	+2.1%	+3.8%		
algebra	reading score low-income %	+6.3%	+13.4%		
algebra	reading score low-income % white %	-3.2%	+15.4%		

* Math was also modeled using these same covariates, but with unrealistically low assumed reliabilities: read=0.90, lowincom=0.90, and white=0.90. The estimated bias was +38.3%.

math total computation measurement geometry