NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Equity in K–12 Mathematics Education: Highlights from the 2018 NSSME+

NCTM RESEARCH CONFERENCE
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Kristen A. Malzahn
Courtney L. Plumley
Evelyn M. Gordon

horizon RESEARCH, INC.

Symposium Structure

Three 15 minute talks

- **Mathematics teaching contexts**
- **Well-prepared teachers**
- **Nature of instruction**

Time for small and large group discussion following each talk

Conclude with final takeaways

About the 2018 NSSME+

- The 2018 NSSME+ is the sixth in a series of surveys dating back to 1977
- It is the only survey specific to STEM education that provides nationally representative results

2018 NSSME+

The 2018 NSSME+, and this presentation, is based upon work supported by the National Science Foundation under Grant No. DGE-1642413. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Topics Addressed

Program Questionnaire

- School programs & practices
- Course offerings
- Influences on instruction
- PD offerings

Teacher Questionnaire

- Background & preparation
- Pedagogical beliefs
- PD opportunities
- Instruction & materials
- Influences on instruction

Sample

Two-stage random sample that targeted:

- **2,000 schools (public and private)**
- **Over 10,000 K–12 teachers**

Very good response rate:

- **1,273 schools participated**
- **86 percent of program representatives**
- **78 percent of sampled teachers**

Endorsing Organizations

- American Association of Chemistry Teachers
- American Association of Physics Teachers
- American Federation of Teachers
- Association of Mathematics Teacher Educators
- American Society for Engineering Education
- Association of State Supervisors of Mathematics
- Association for Science Teacher Education
- Council of State Science Supervisors
- Computer Science Teachers Association
- National Association of Biology Teachers
- National Association of Elementary School Principals
- National Association of Secondary School Principals
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Interpreting Results

After data collection, design weights were computed, adjusted for nonresponse, and applied to the data

Why is this important?

The sampling and weighting processes mean that the results are national estimates of schools, teachers, and classes—not characteristics of the respondents

Situating the Work

- The 2018 NSSME+ was not designed primarily as an equity study
- We are not equity experts
- However, the survey provides a rich source of data for examining K-12 mathematics education and the extent to which opportunities are equitably available

Approach

Equitable distribution with respect to:

- Mathematics teaching contexts
- Well-prepared teachers
- Nature of instruction

Factors Associated with Differences in Educational Opportunities

Class-level Factors

- Prior achievement level of students in the class
- Percentage of students in the class from race/ethnicity groups historically underrepresented in STEM (HU)

School-level Factors

- Percentage of students in the school eligible for free or reduced-price lunch (FRL)
- School size
- School community type (rural, urban, suburban)

Correlated Factors

- Percent of students from historically underrepresented groups and percent of students eligible for free or reduced-price lunch
- Prior achievement and percent of students from historically underrepresented groups
- School size and community type

Contexts for Mathematics Instruction

Contexts for Mathematics Instruction

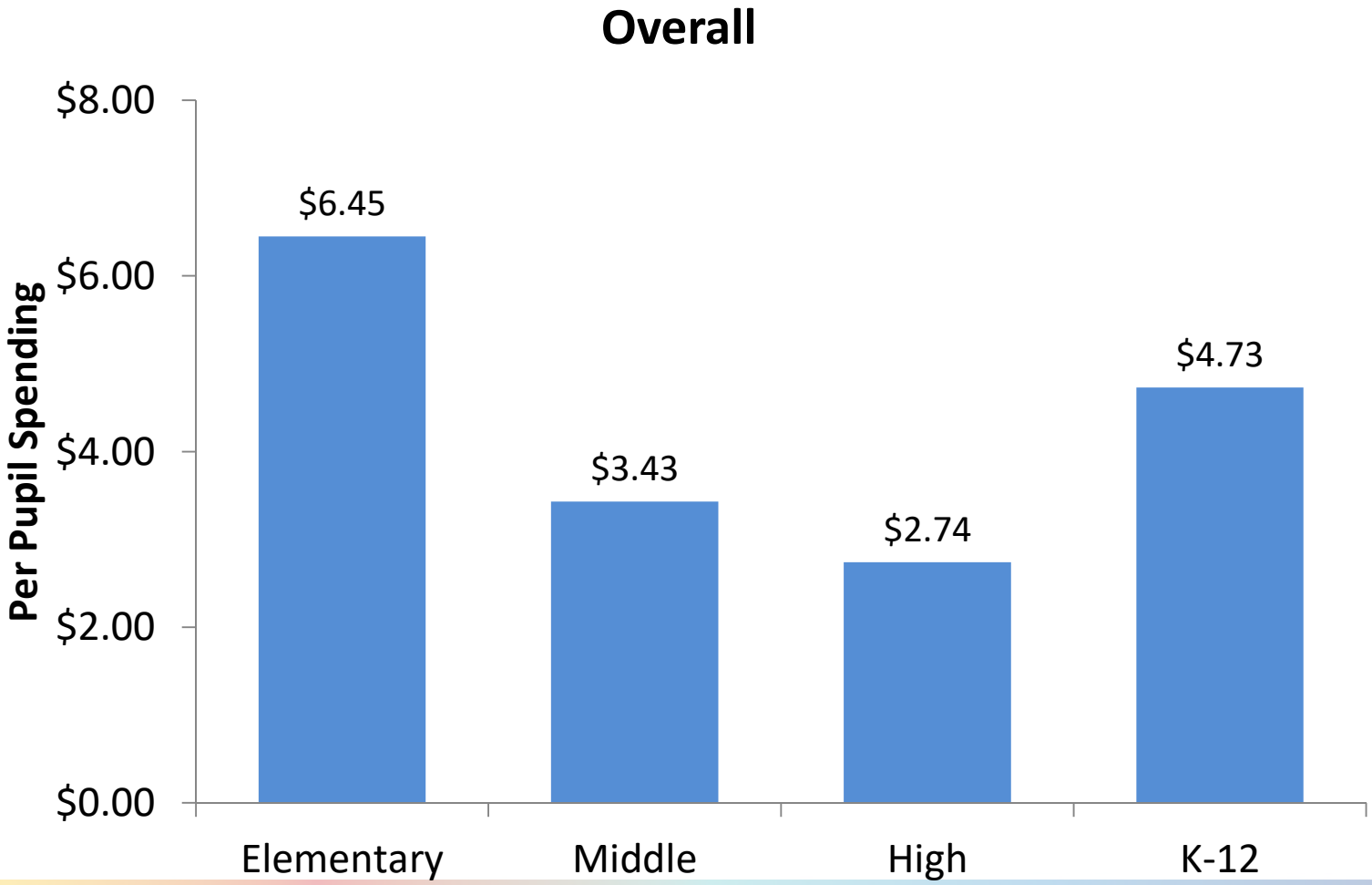
- Resources available for mathematics instruction
- School programs and practices for enhancing students' interest in mathematics
- Extent to which various issues are problematic for mathematics instruction
- Extent to which policies/people promote effective mathematics instruction

Money Spent on Mathematics Instruction

Annual school spending on:

- Consumable supplies (e.g., graph paper)
- Non-consumable supplies (e.g., calculators, protractors, manipulatives)
- Software specific to mathematics instruction (e.g., dynamic geometry software)

Median School Spending Per Pupil for Mathematics



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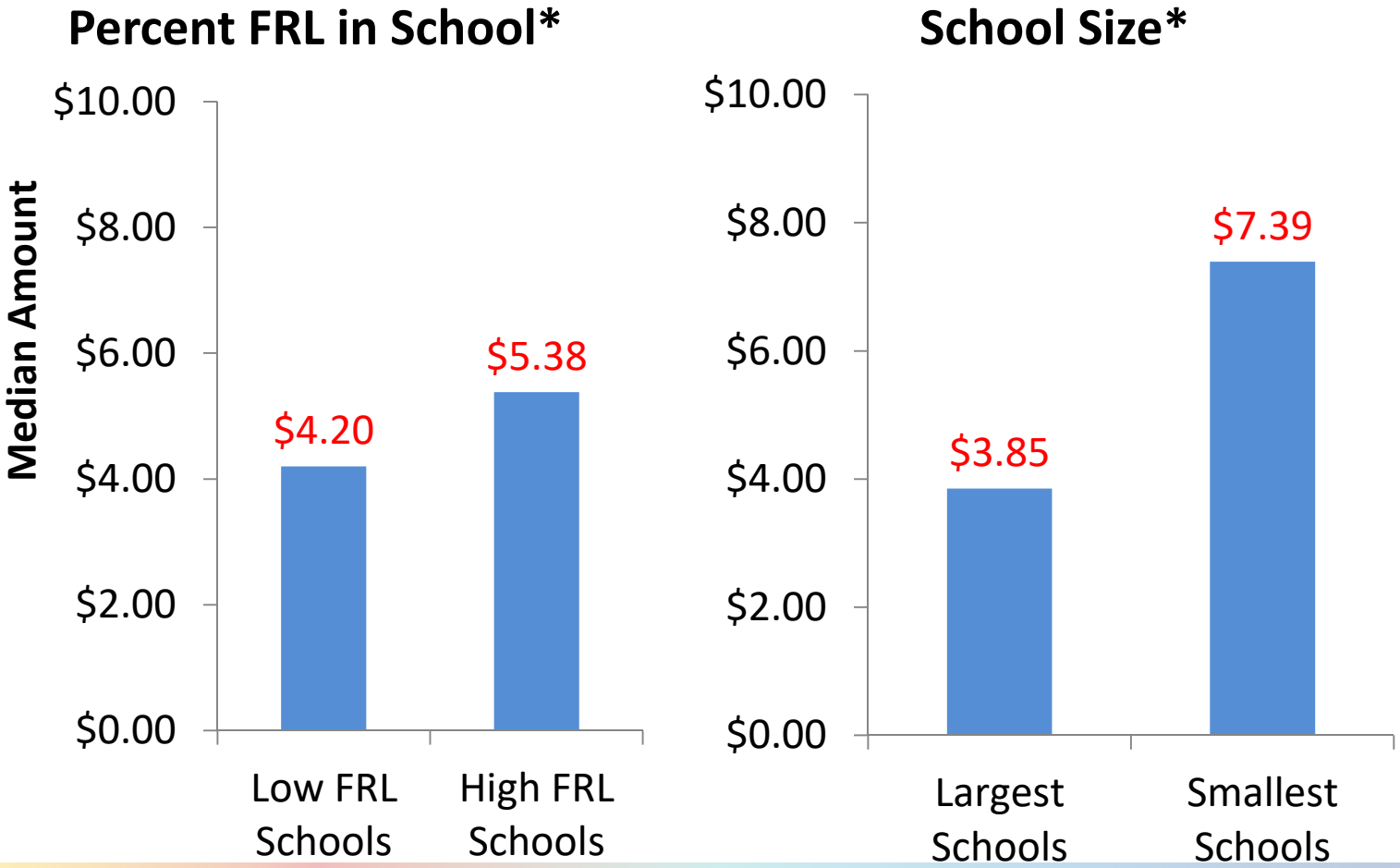

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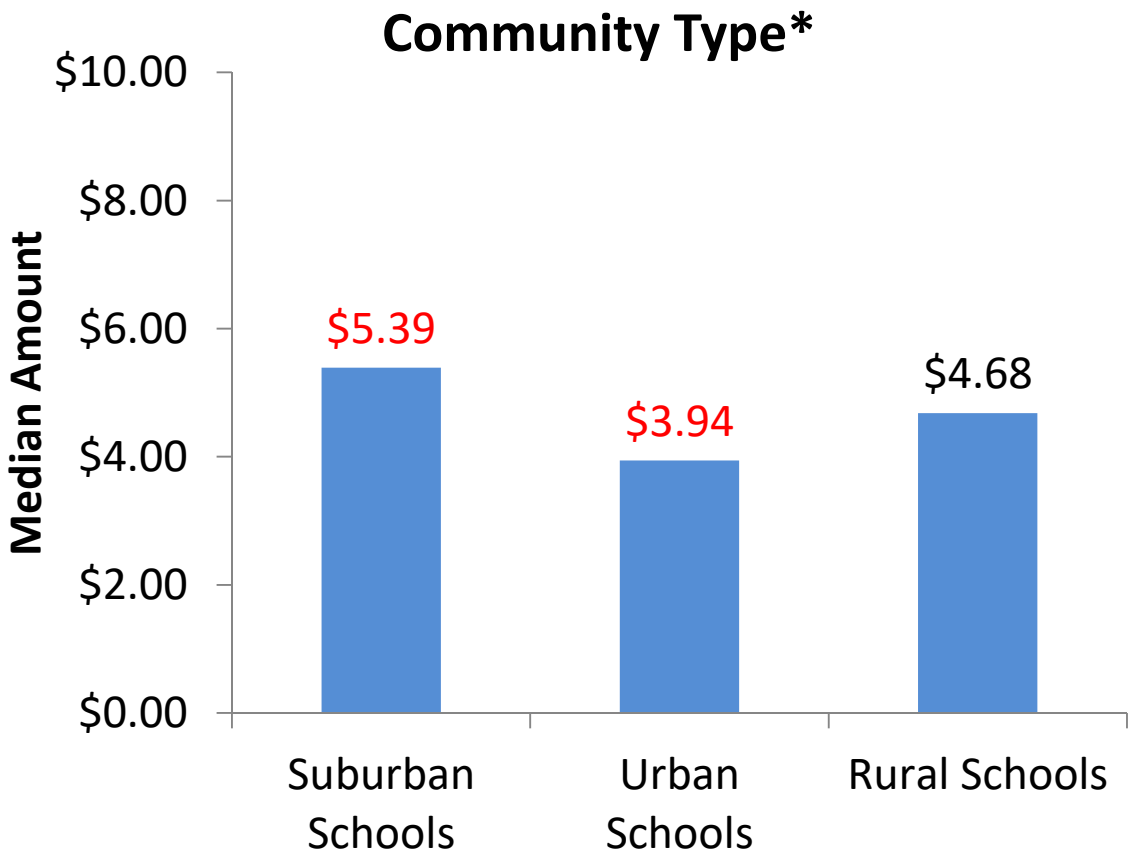
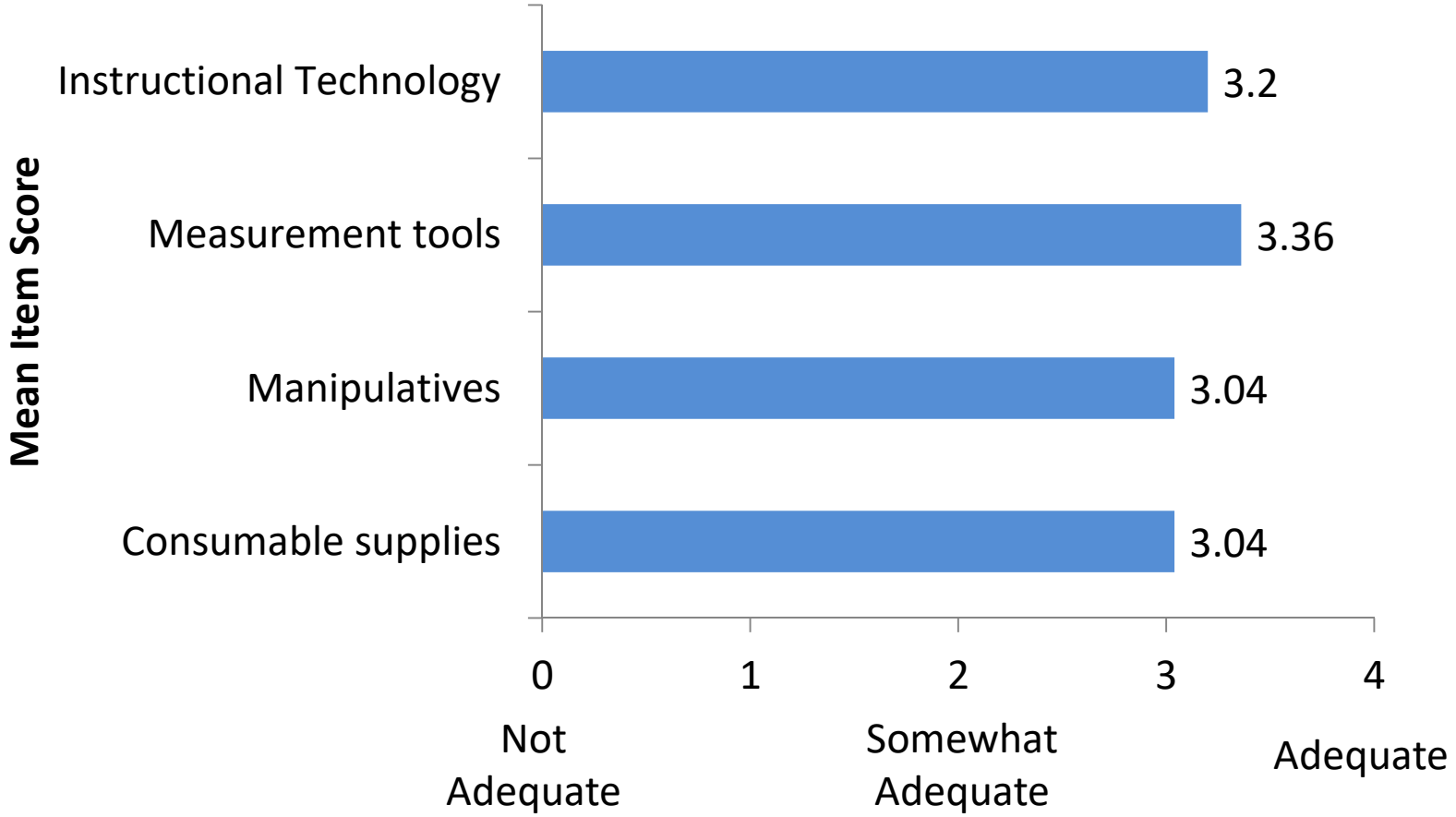


Adequacy of Resources for Mathematics Instruction

Teachers rated the adequacy of their:

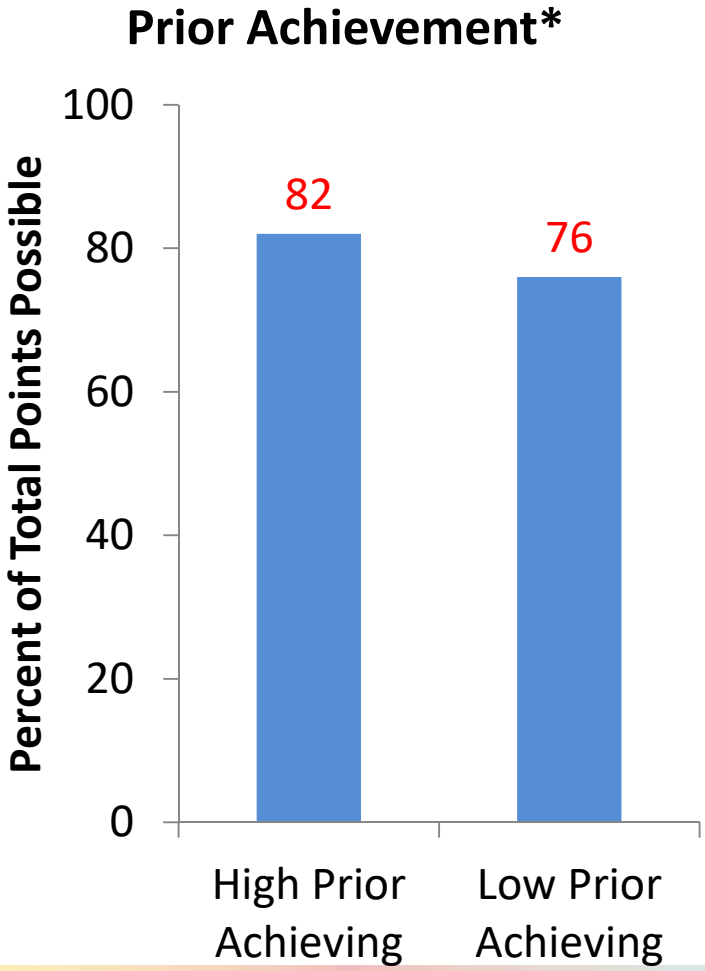
- instructional technology (e.g., calculators, computers, probes/sensors)
- measurement tools (e.g., protractors, rulers)
- manipulatives (e.g., pattern blocks, algebra tiles)
- consumable supplies (e.g., graph paper, batteries)

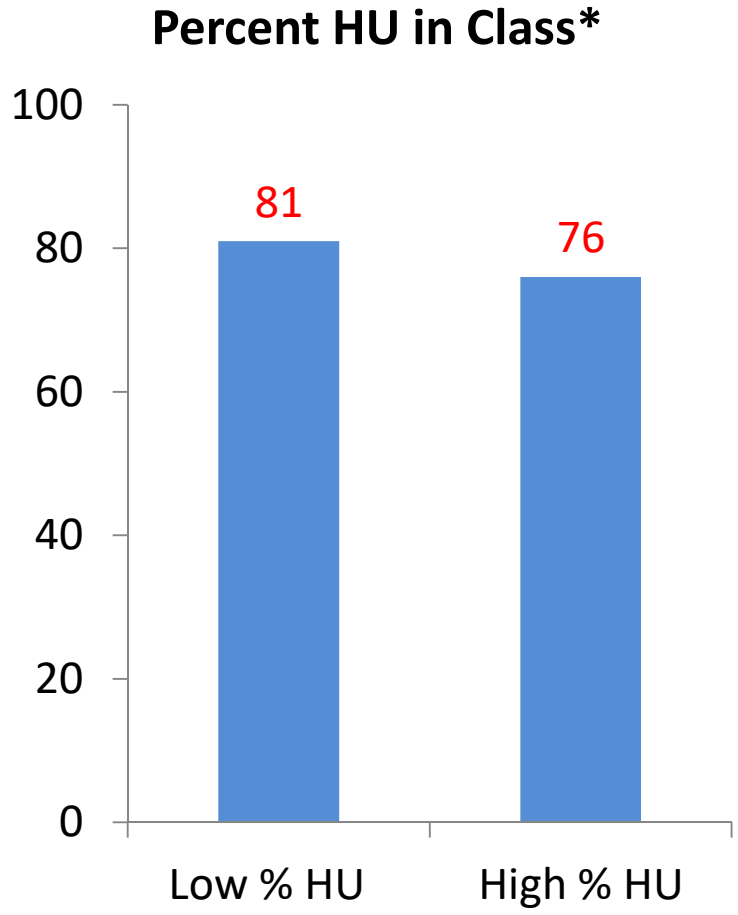
Adequacy of Resources for Mathematics Instruction



Overall mean composite score: 79

Adequacy of Resources Composite





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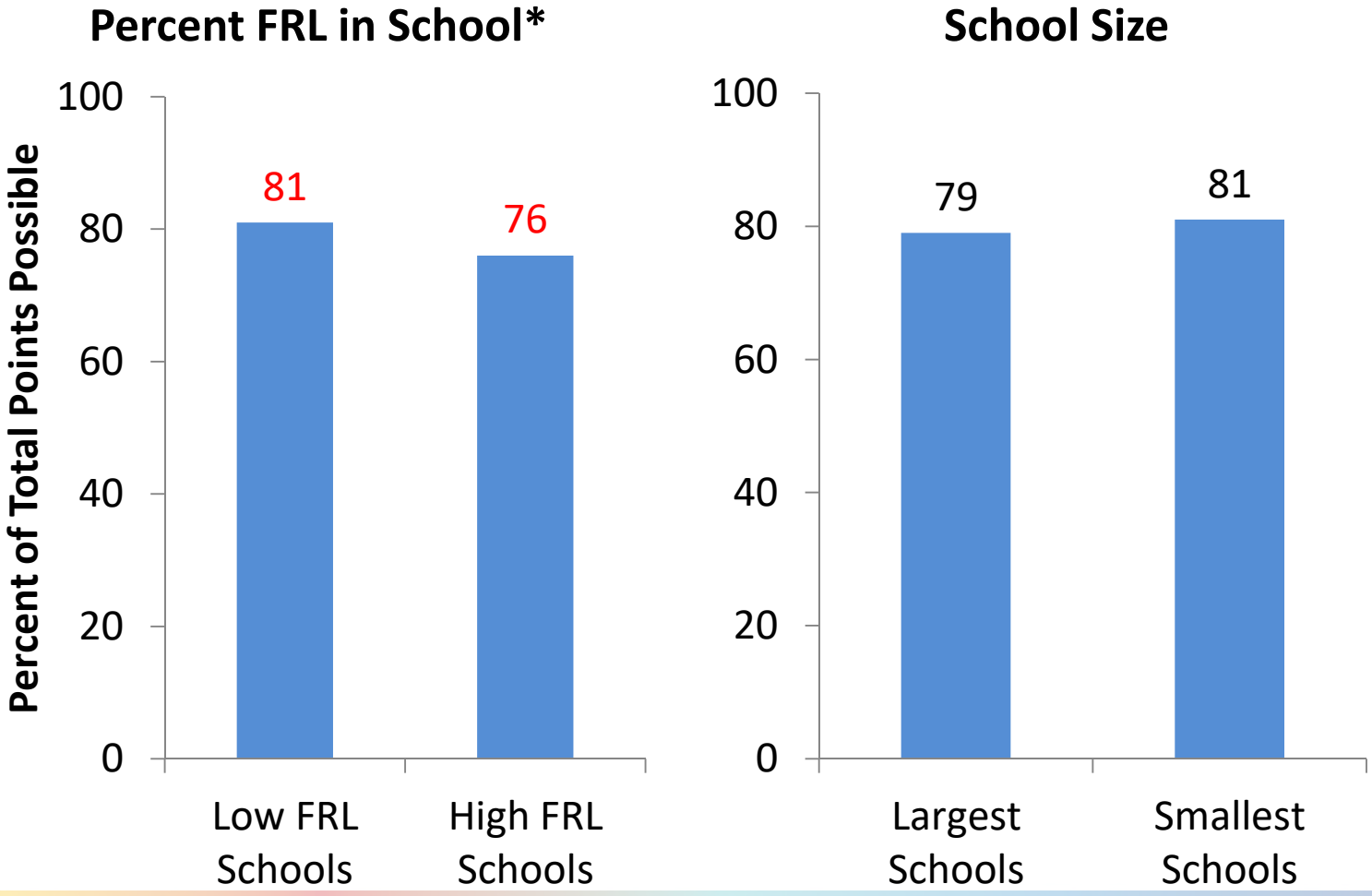

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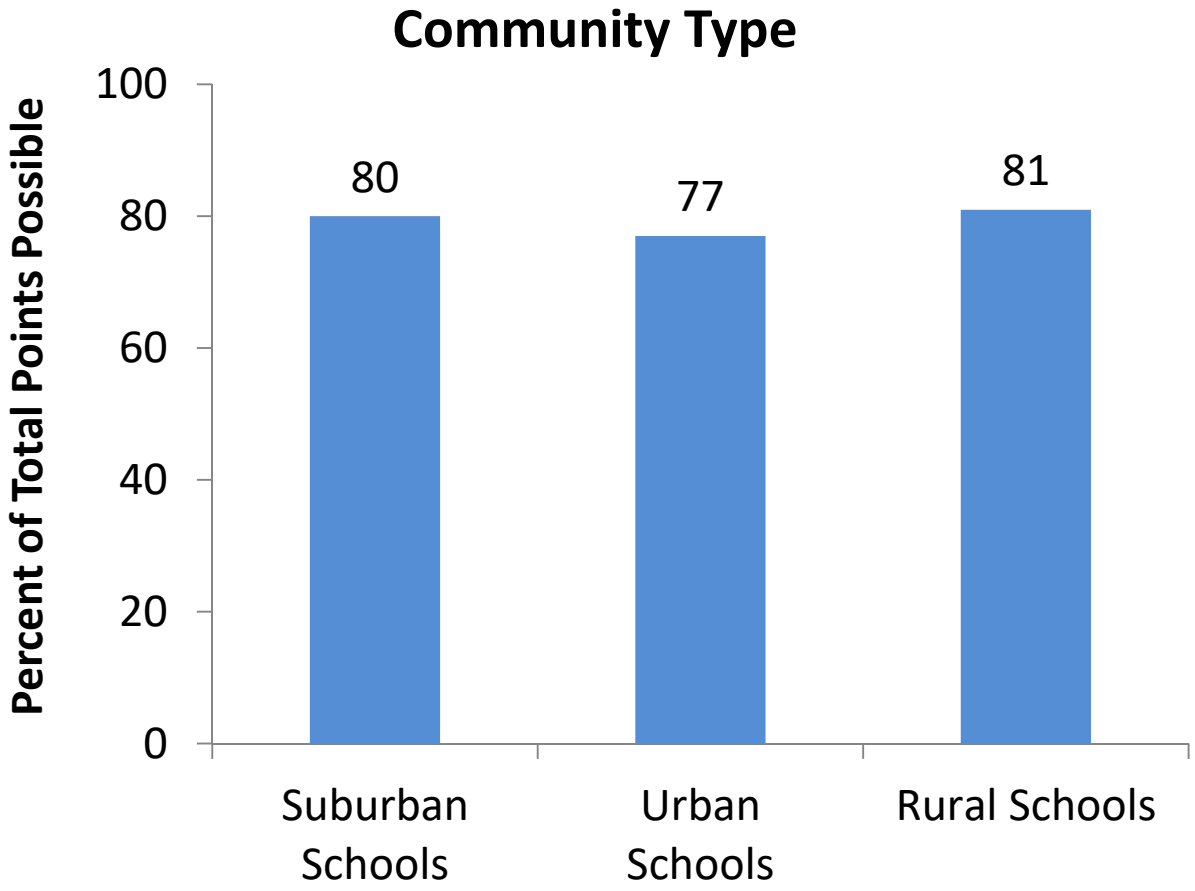


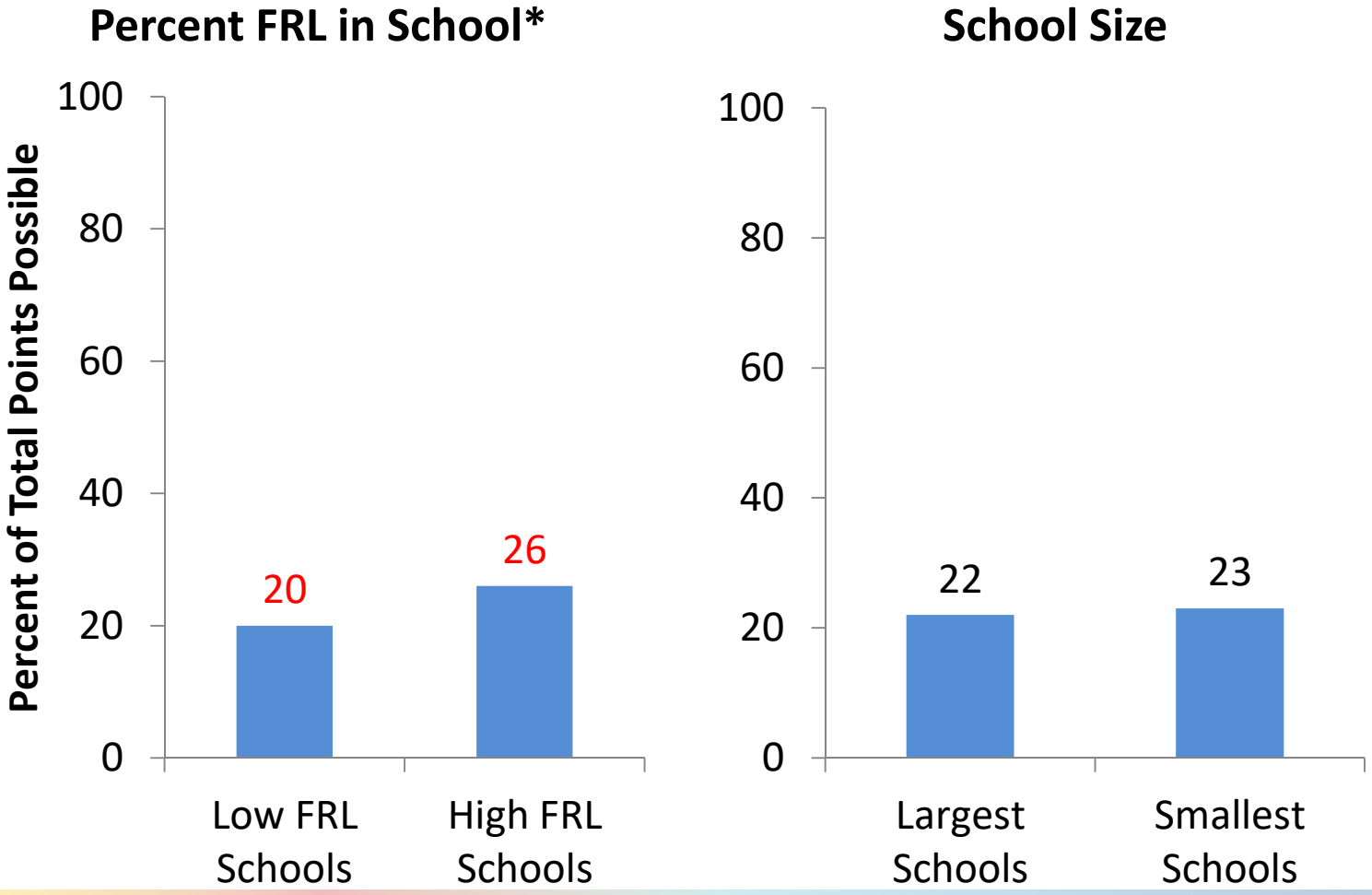
Extent to Which Lack of Resources is Problematic Composite

Examples:

- lack of equipment and supplies
- inadequate funds for purchasing supplies
- poor quality textbooks

Overall Score: 21

Extent to Which Lack of Resources is Problematic Composite

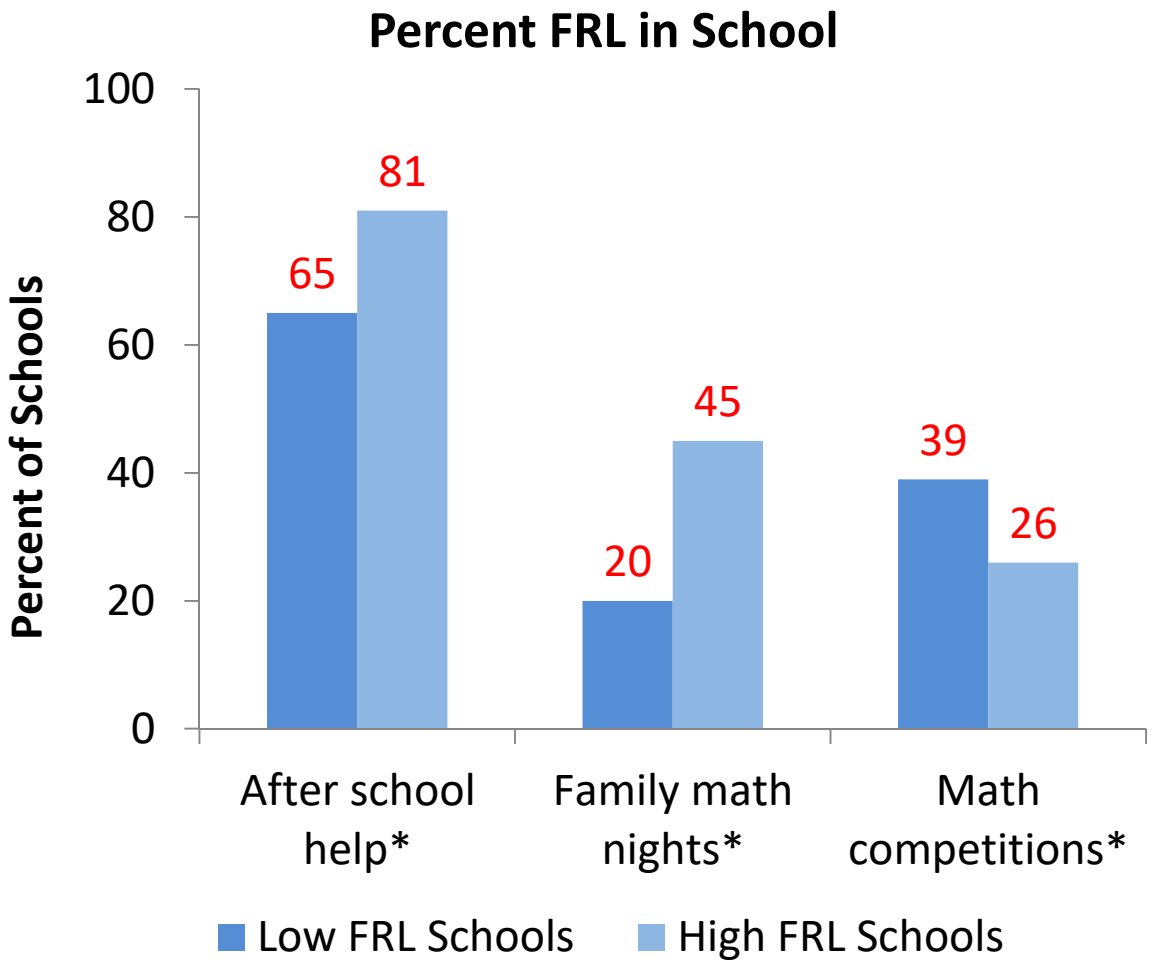


School Programs and Practices for Enhancing Students' Interest in Mathematics

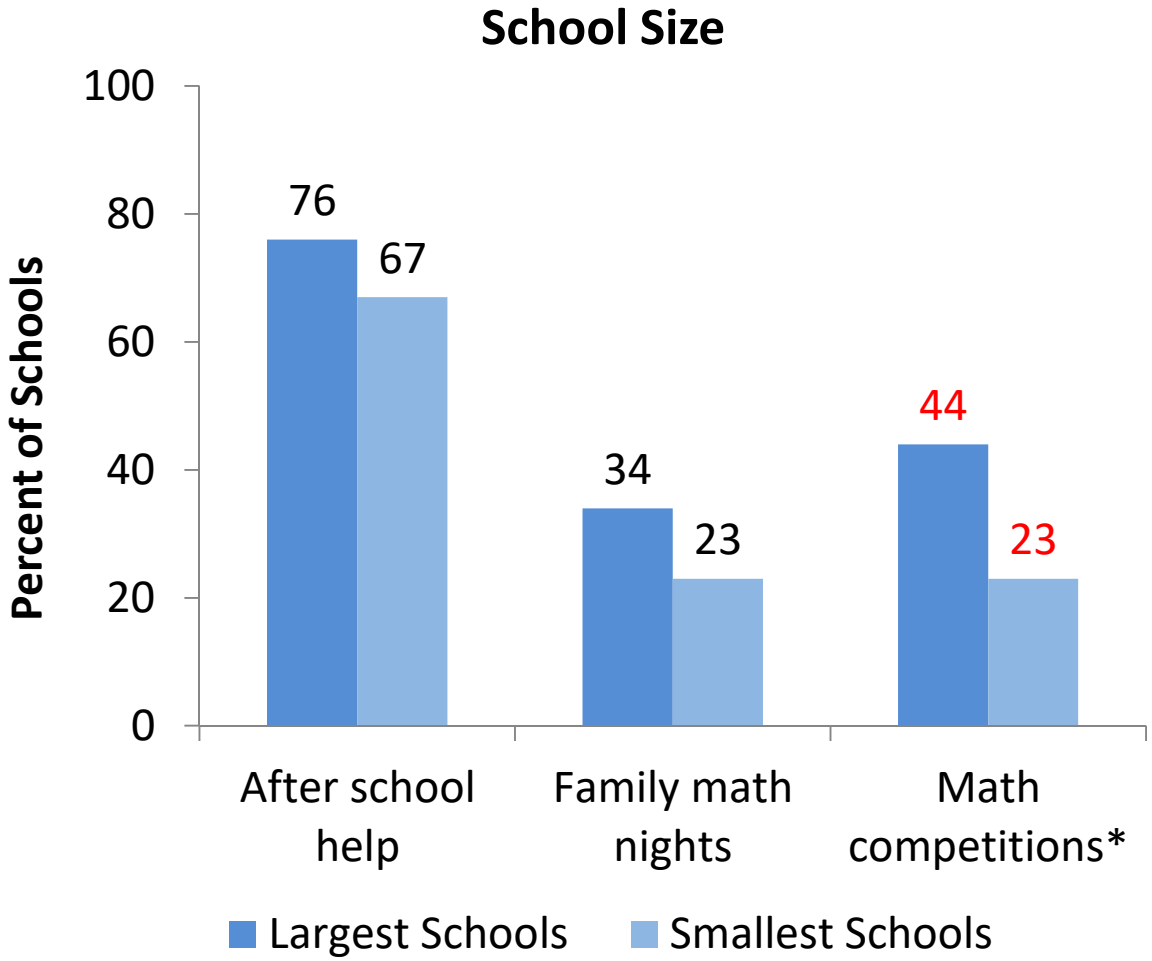
Examples:

- After-school help in mathematics (e.g., tutoring)
- Family math nights
- One or more teams participating in mathematics competitions (e.g., Math Counts)

School Programs and Practices, by FRL Status



School Programs and Practices, by School Size



Factors Promoting Mathematics Instruction (Teachers' Opinions)

- Extent to which stakeholders promote effective mathematics instruction
- Extent to which school support promotes effective mathematics instruction
- Extent to which the policy environment promotes effective mathematics instruction

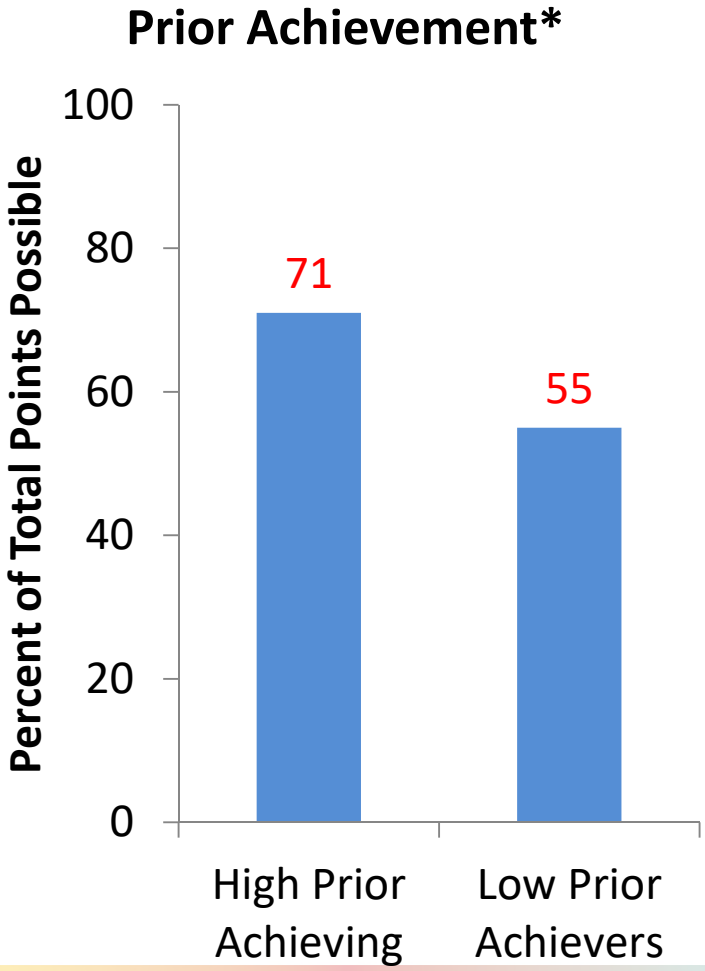
Extent to Which Stakeholders Promote Effective Instruction Composite

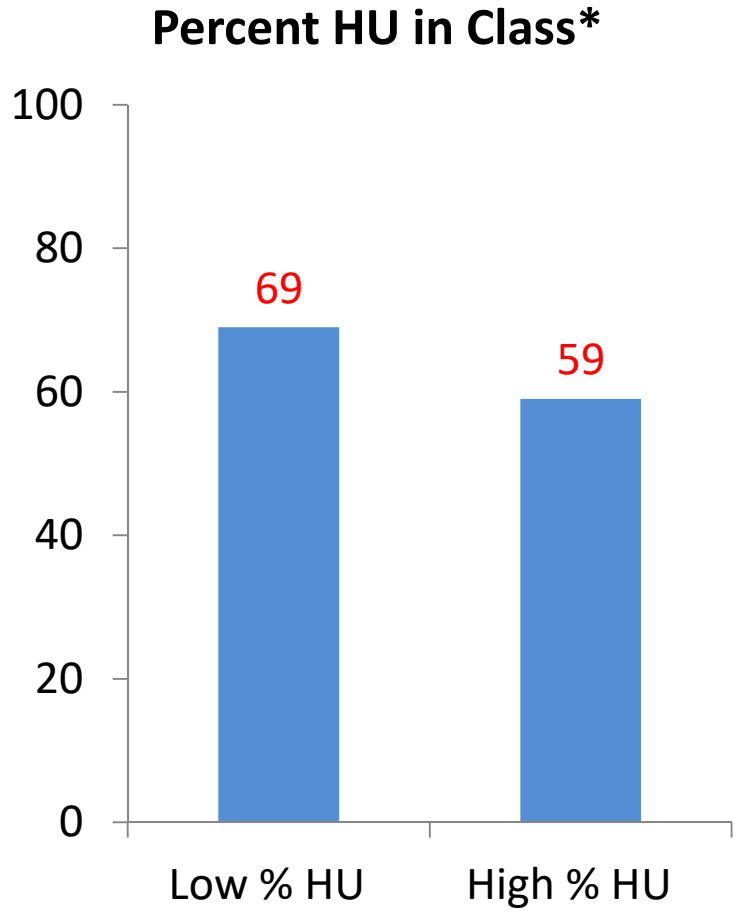
Teachers rated the impacts of the following on effective mathematics instruction:

- students' prior knowledge and skills
- students' motivation, interest, and effort in mathematics
- parent/guardian expectations and involvement

Overall Score: 64

Extent to Which Stakeholders Promote Effective Instruction Composite





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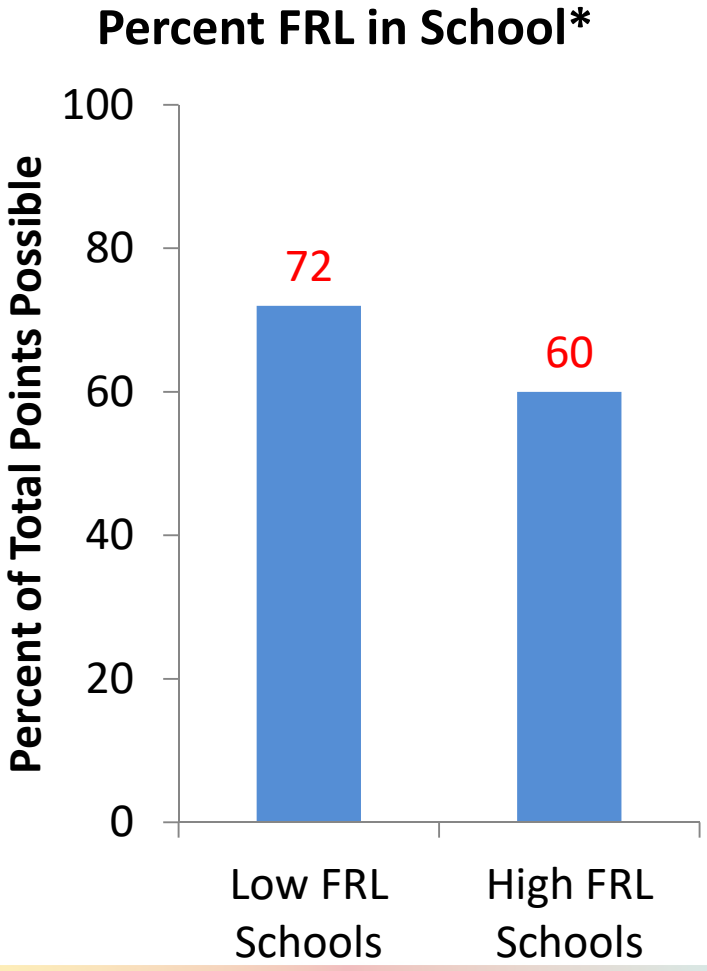
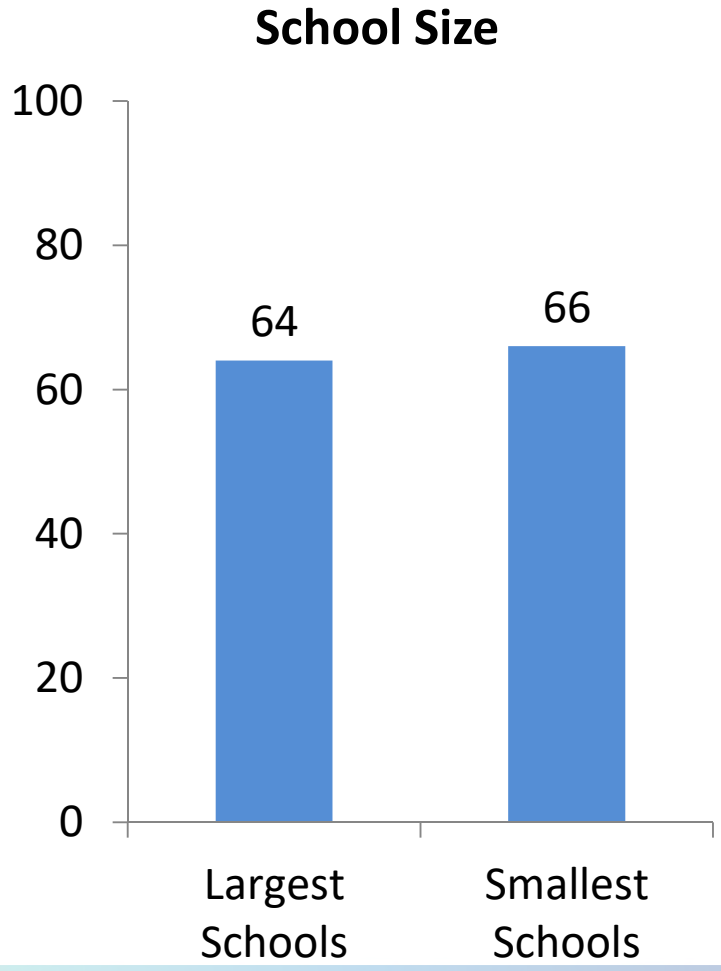




Extent to Which School Support and the Policy Environment Promote Effective Instruction Composites

School Support:

Overall Score: 71

- amount of time for you to plan, individually and with colleagues
- amount of time available for professional development

Policy Environment:

Overall Score: 65

- current state standards
- textbook selection policies
- teacher evaluation policies

Extent to Which School Support and the Policy Environment Promote Effective Instruction Composites

	School Support	Policy Environment
Prior Achievement		
High Prior Achieving	71	66
Low Prior Achieving	69	62
Percent HU in Class		
Low % HU	70	67
High % HU	71	64
Percent FRL in School		
Low FRL Schools	72	66
High FRL Schools	71	65
School Size*		
Largest Schools	70	64
Smallest Schools	70	71

Factors Affecting Mathematics Instruction at the School Level

- The school as a supportive context for mathematics instruction
- Extent to which teacher issues are problematic for mathematics instruction
- Extent to which student issues are problematic for mathematics instruction

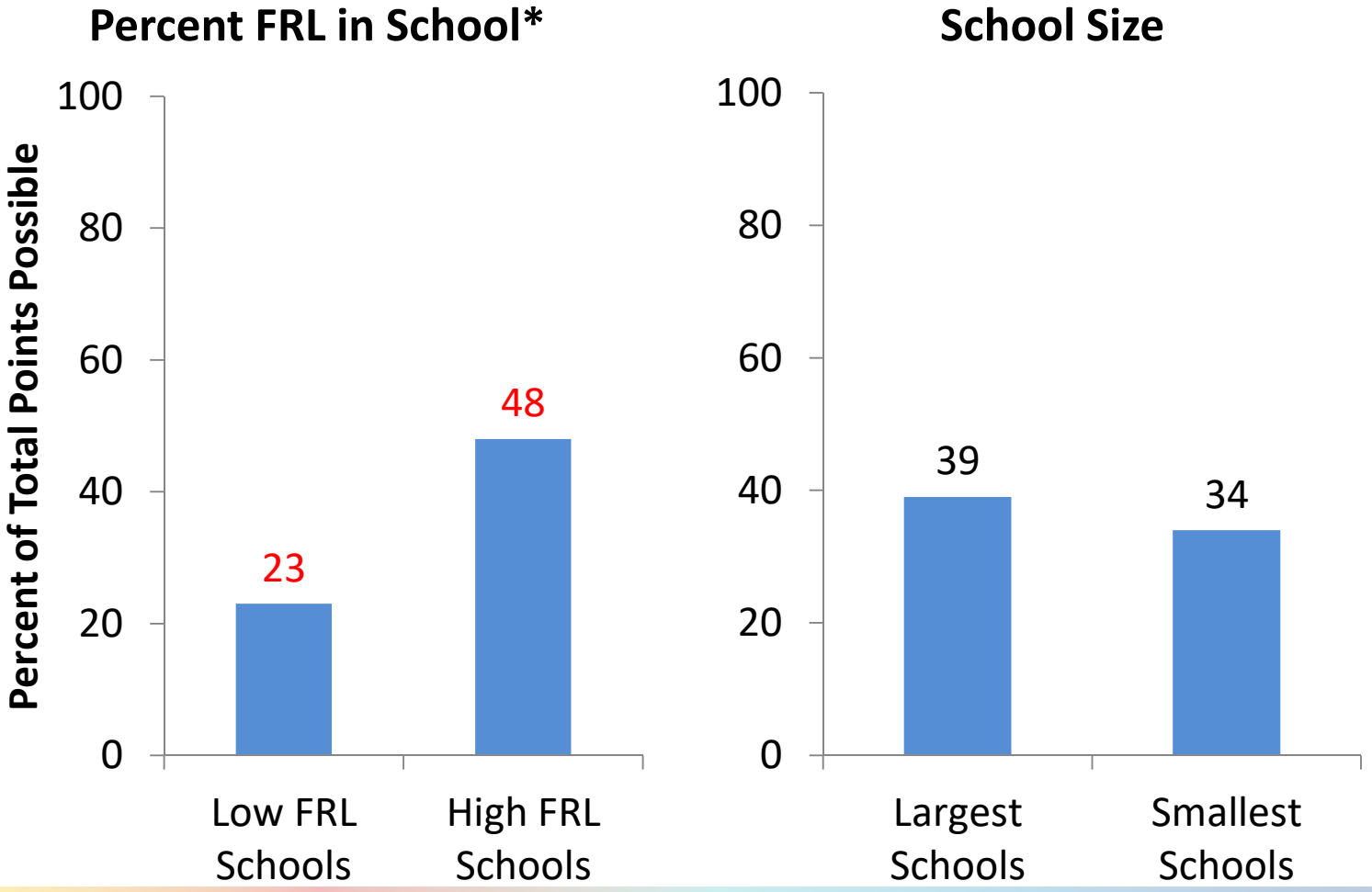
Extent to Which Student Issues are Problematic Composite

Examples:

- low student interest in mathematics
- low student prior achievement and skills in mathematics
- inappropriate student behavior

Overall Score: 37

Extent to Which Student Issues are Problematic Composite



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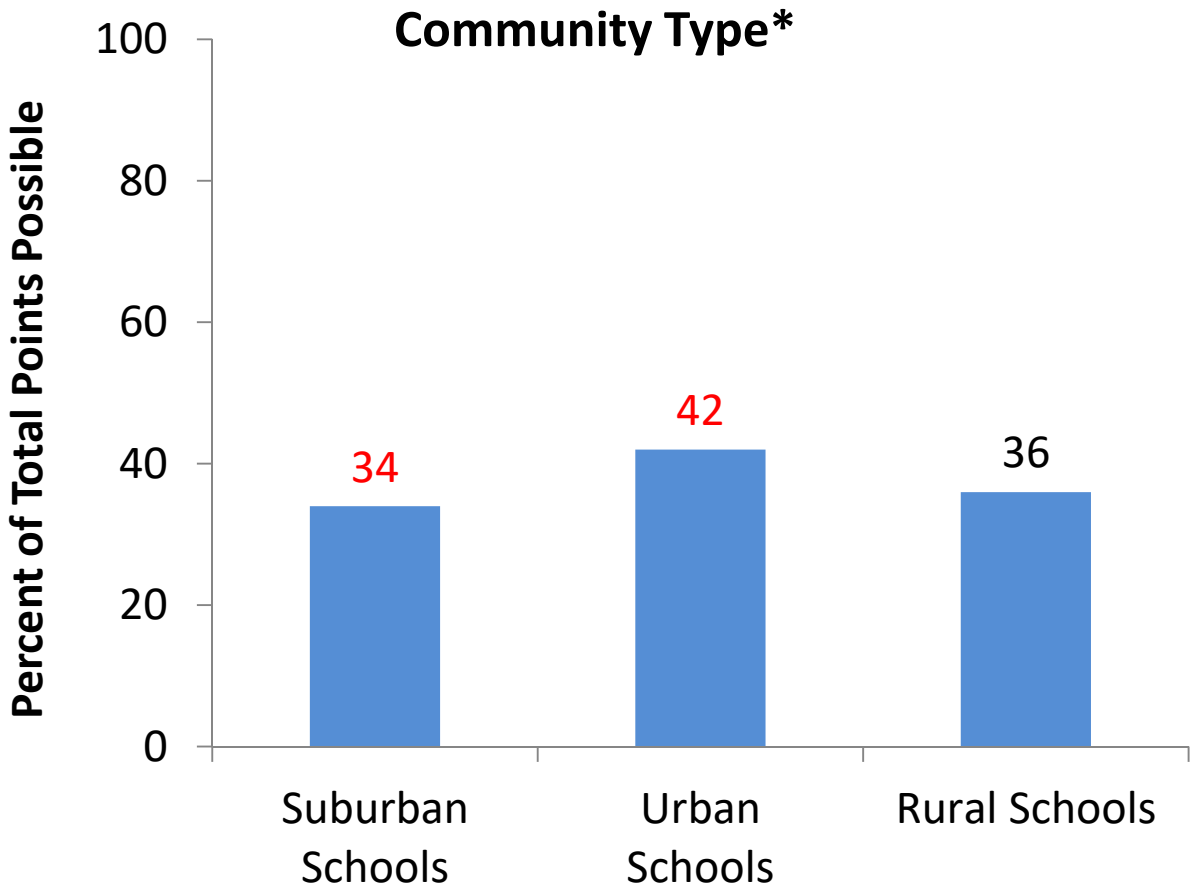


Discussion

How is what you are seeing in your work similar and/or different to what is seen at the national level?

Distribution of Well-Prepared Teachers

Well-Prepared Teachers

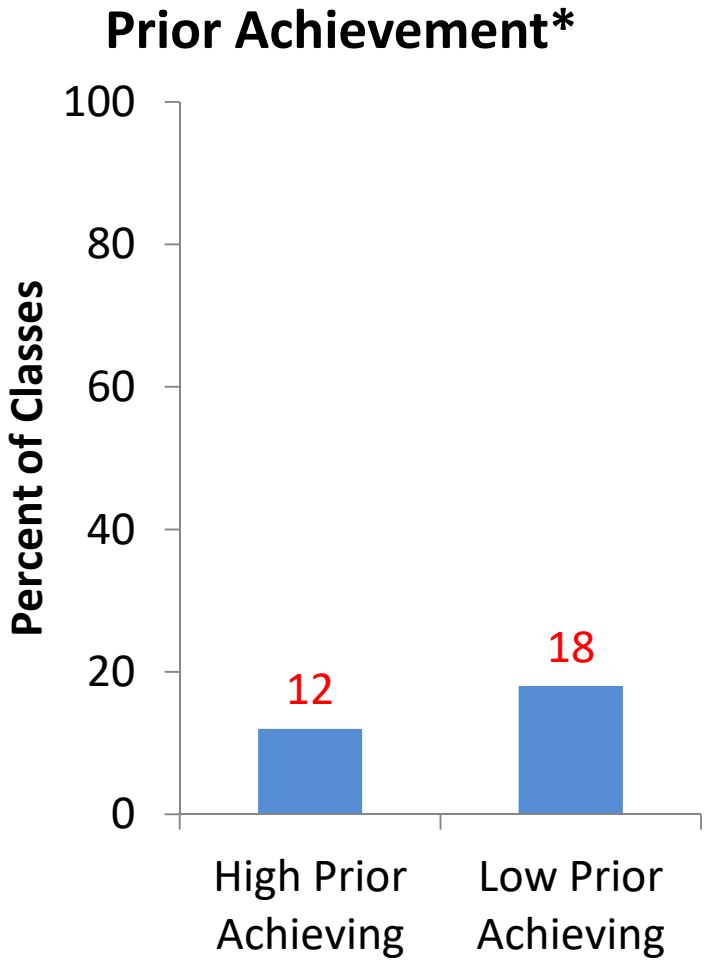
NSSME+ collected data on teachers including:

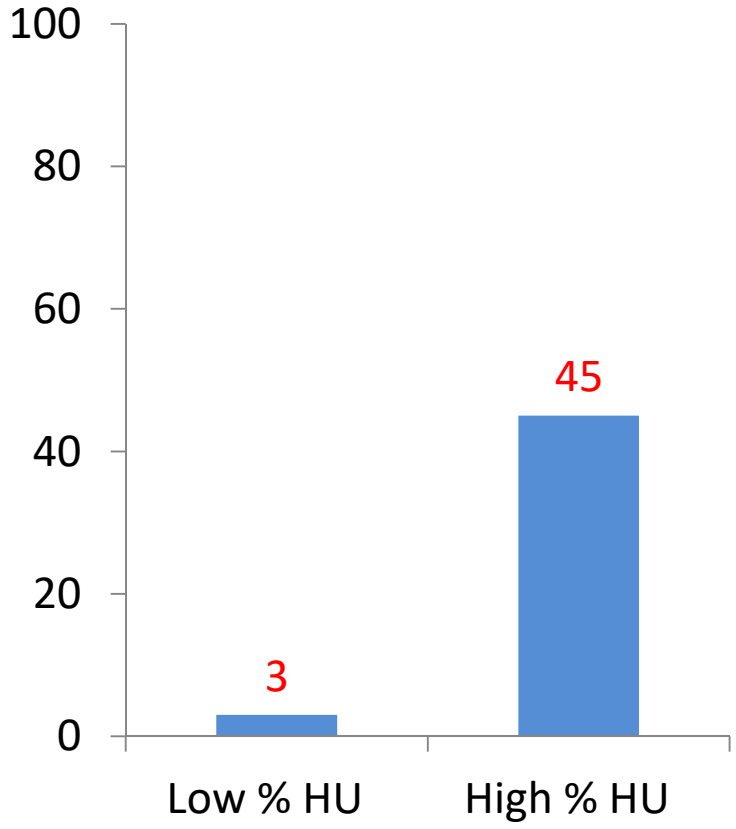
- **Teacher background and experience**
- **Pedagogical beliefs**
- **Perceptions of preparedness**
- **Professional development opportunities**

Characteristics of the Teaching Force

	Percent of Teachers		
	Elementary	**Middle**	**High**
Sex			
Female	94	70	60
Male	6	30	40
Race/Ethnicity			
White	89	89	91
Black or African-American	7	8	5
Hispanic or Latino	10	8	7
Asian	3	3	4
American Indian/Alaskan Native	1	1	2
Native Hawaiian/Other Pacific Islander	0	1	1

Classes Taught by Teachers from Historically Underrepresented Groups





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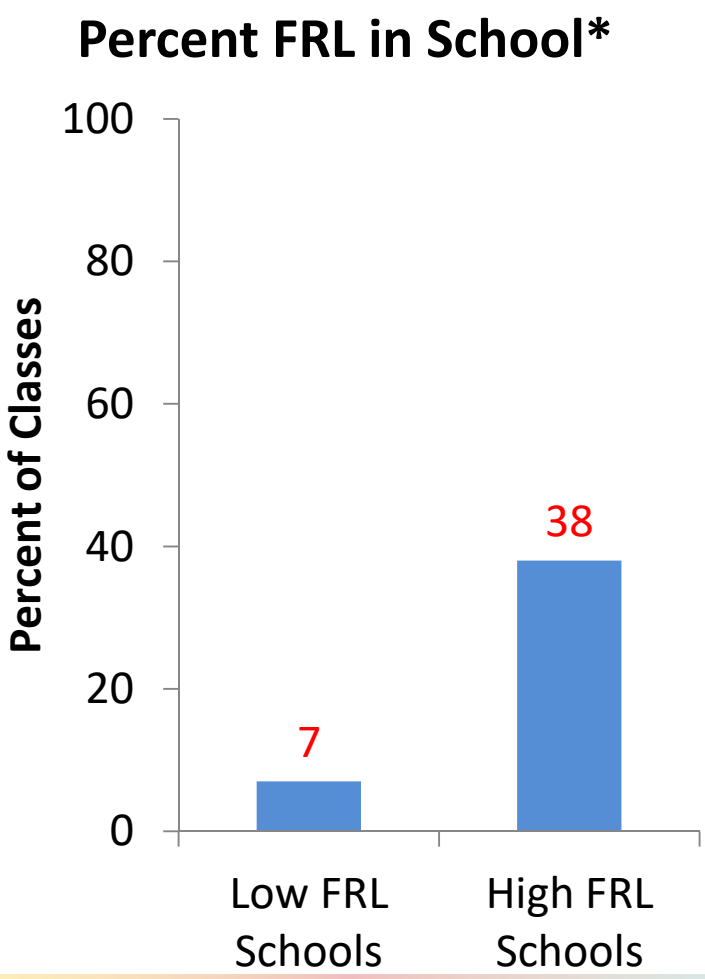

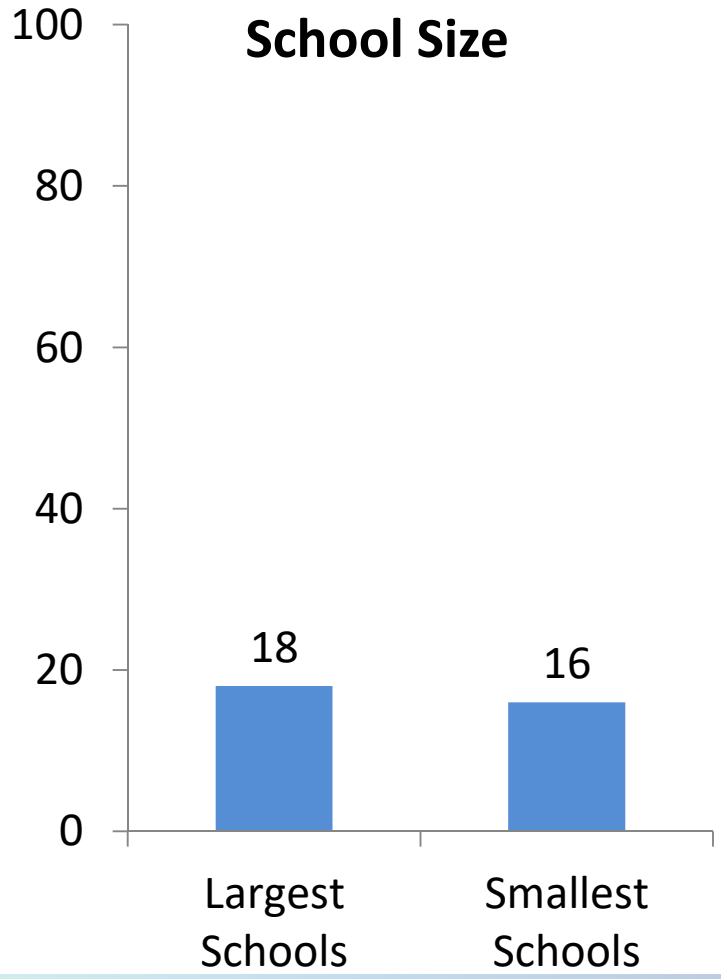

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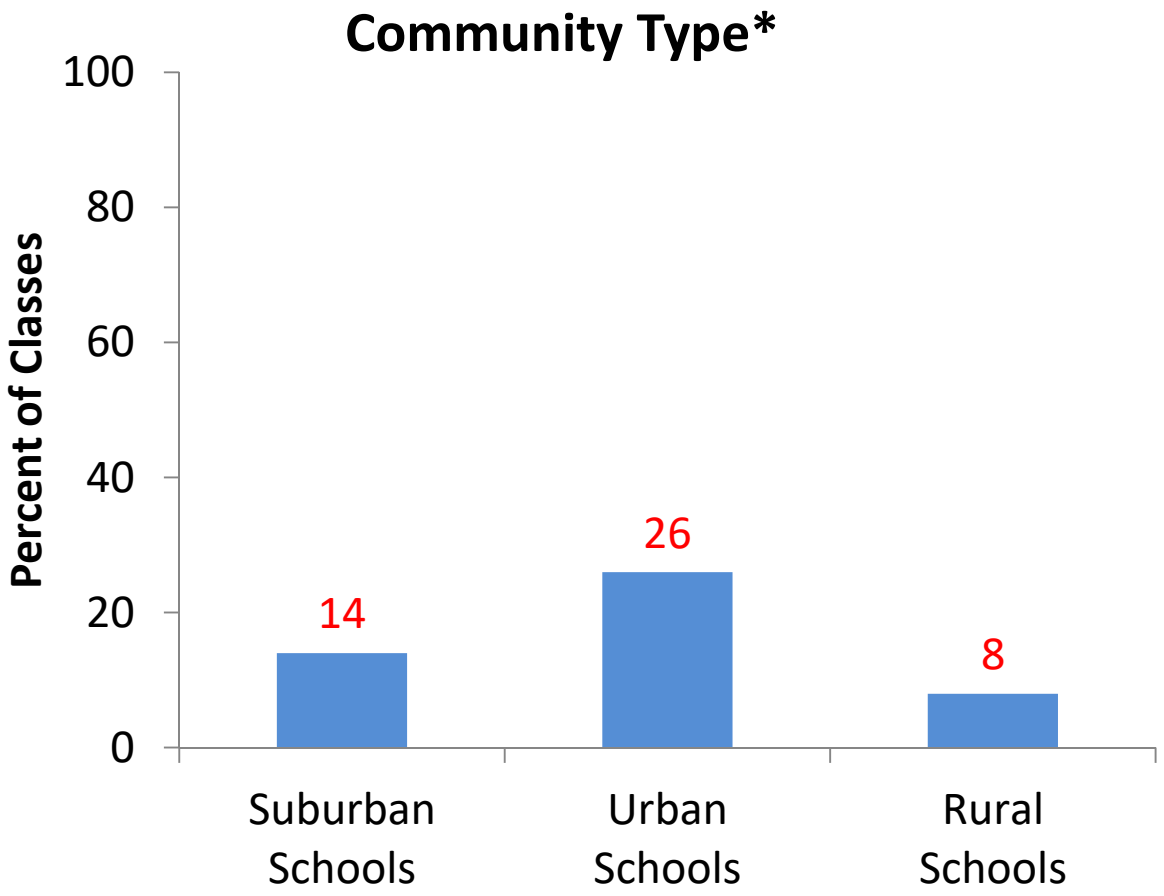
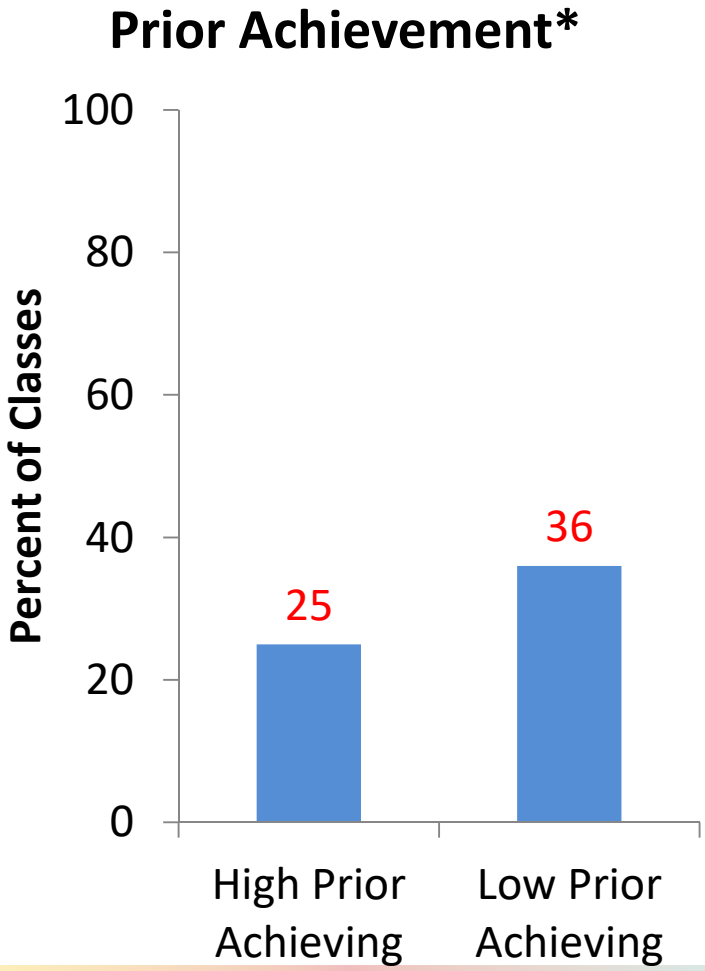
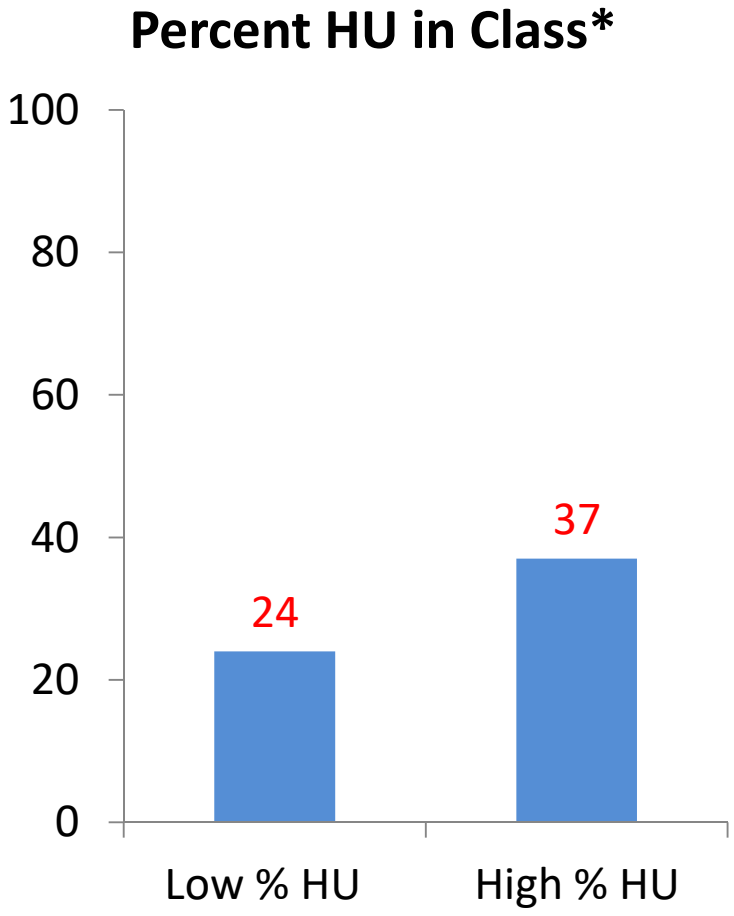


Classes Taught by Novice Teachers





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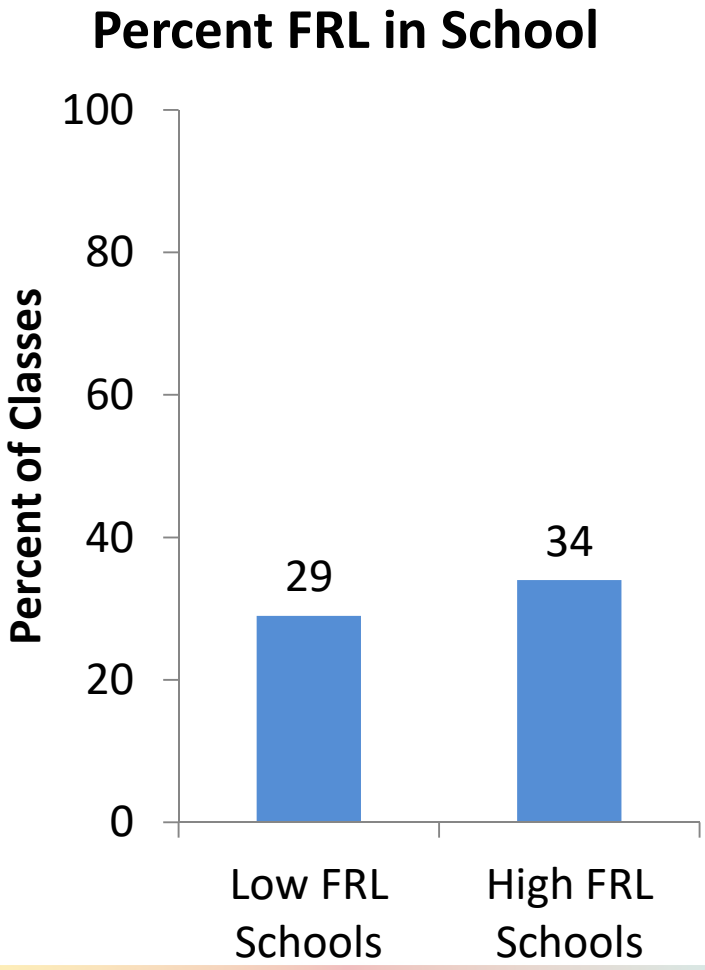
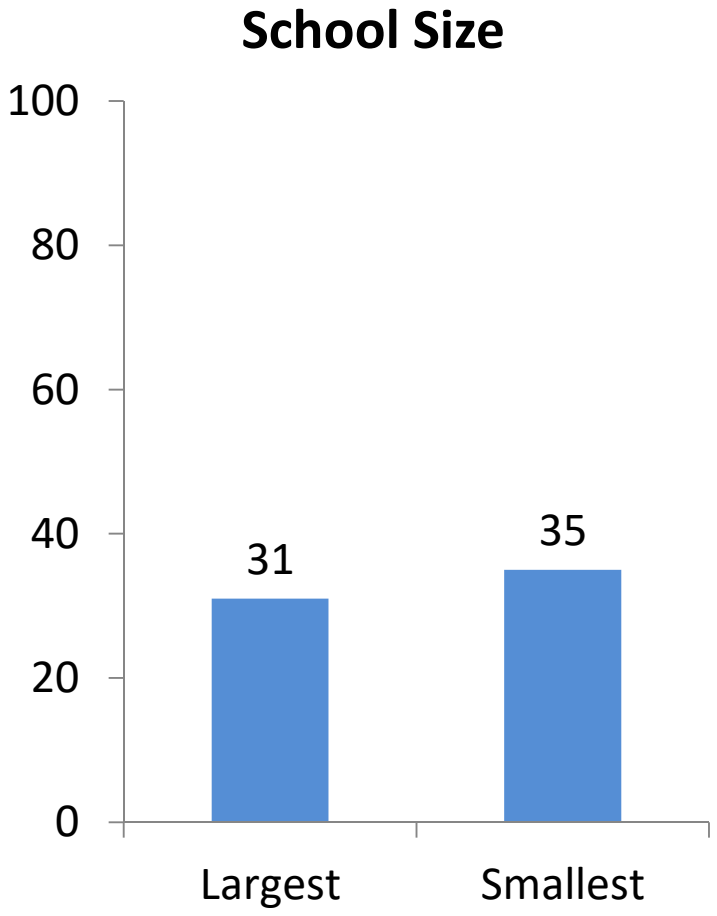
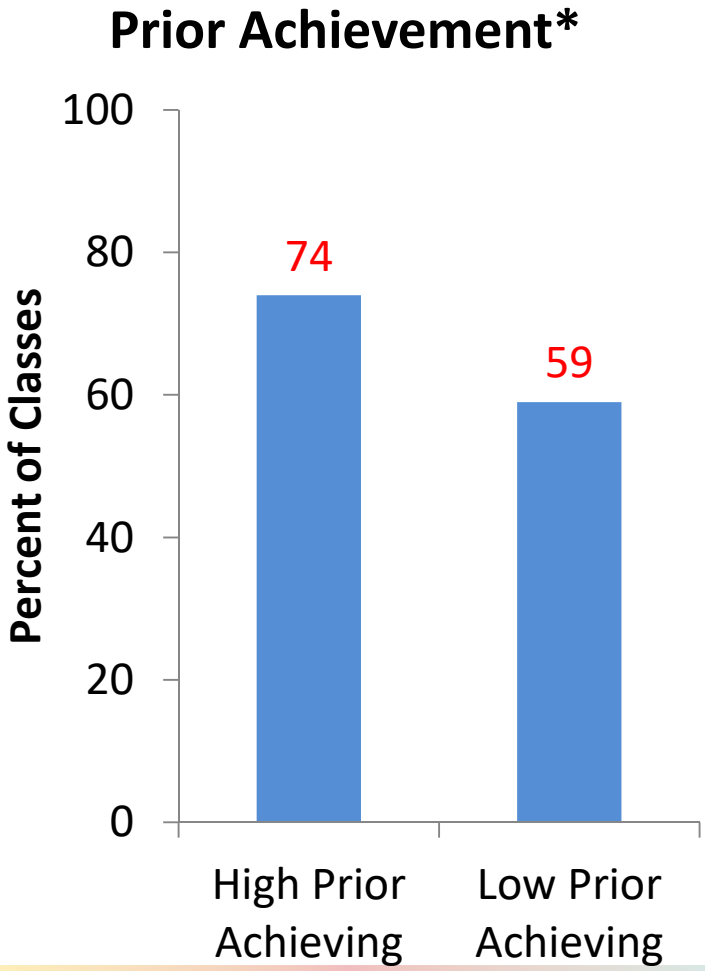
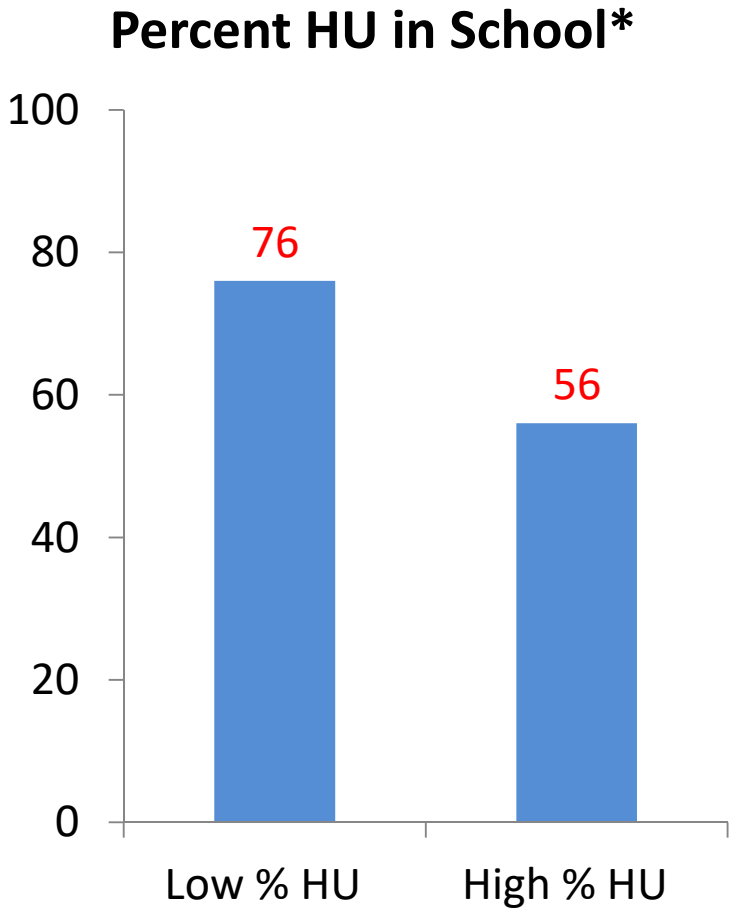




Secondary Teachers with a Degree in Mathematics or Mathematics Education





Pedagogical Beliefs

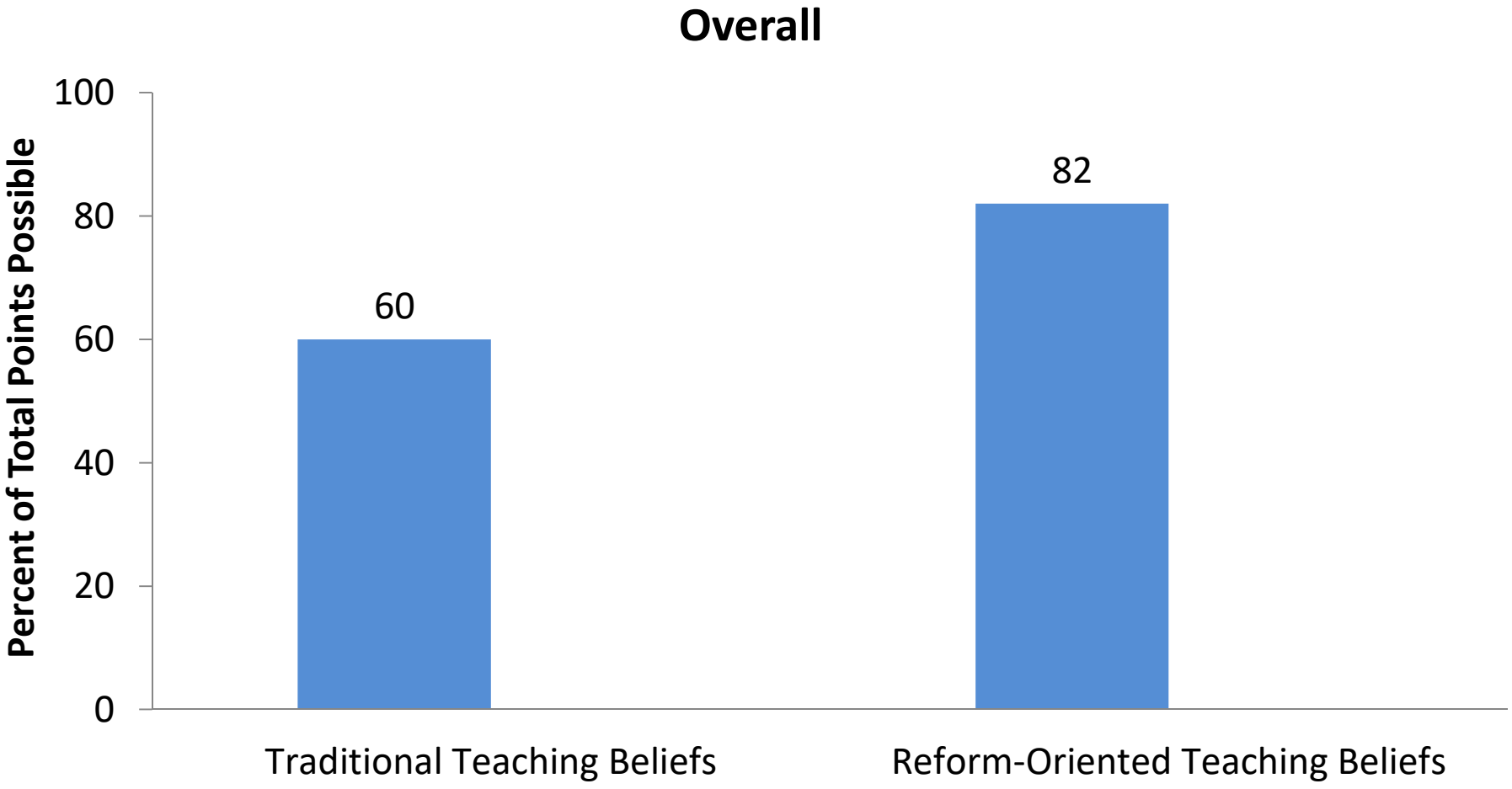
Traditional:

- Defining new vocabulary at the beginning of a unit
- Grouping students by ability
- Using hands-on/manipulatives to reinforce ideas
- Explaining ideas before students investigate them

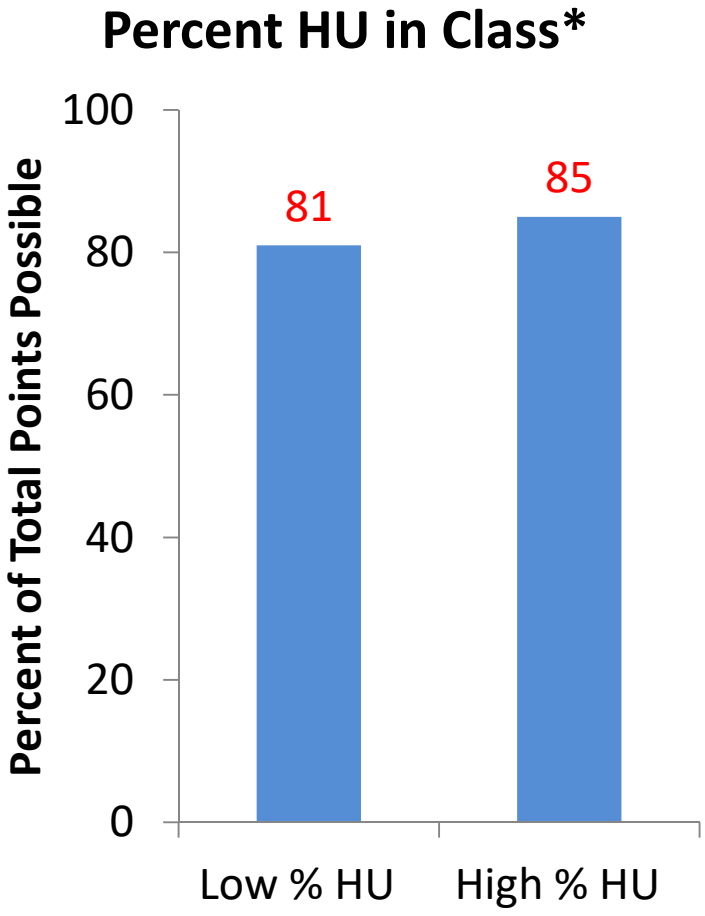
Reform-oriented:

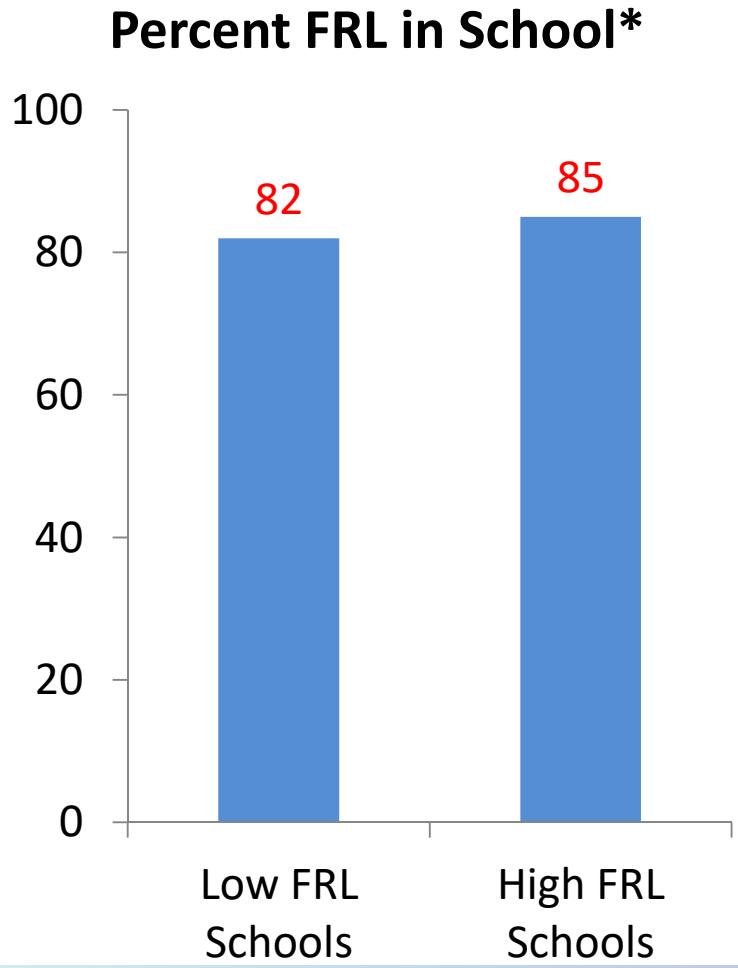
- Asking students to justify their thinking
- Having students share their thinking and reasoning
- Focusing on ideas more in-depth
- Connecting instruction to students' everyday lives

Teachers' Beliefs About Teaching and Learning Composites

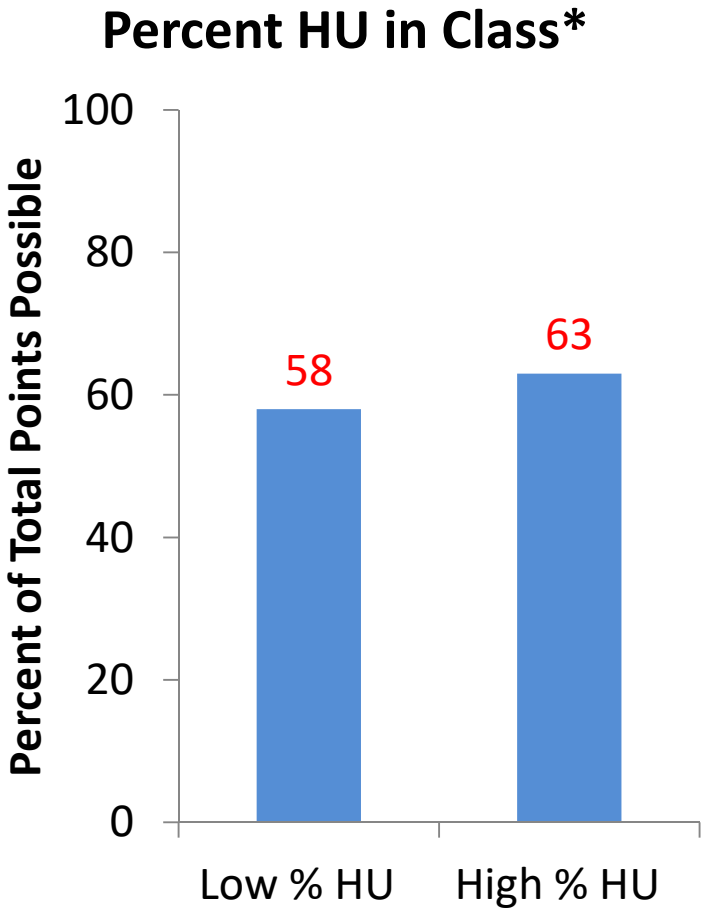


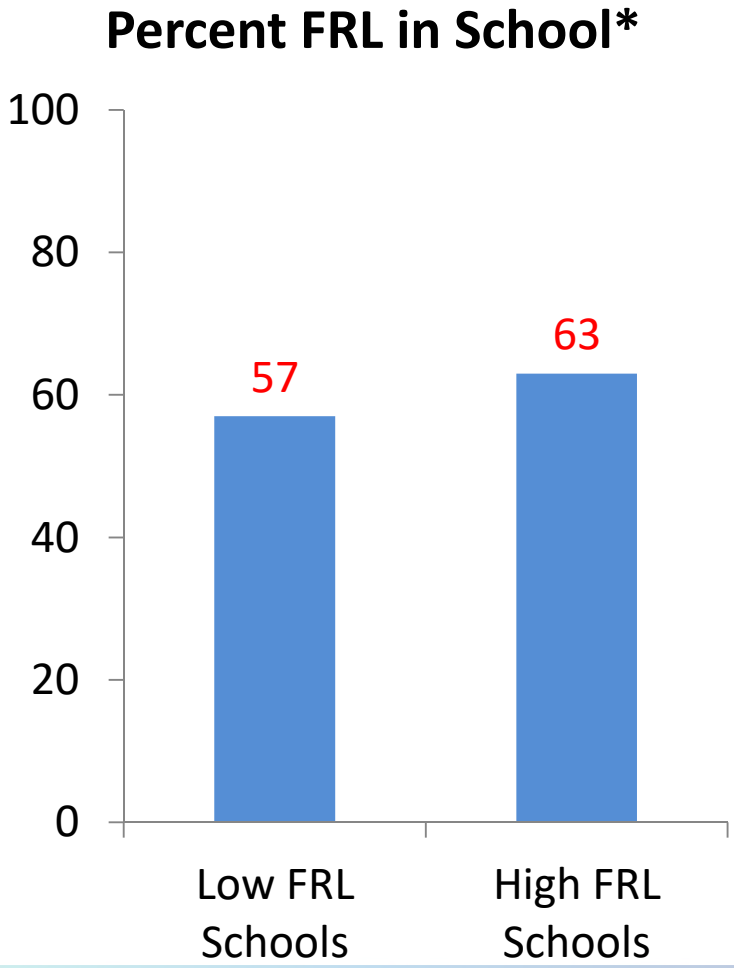
Teachers' Reform-oriented Beliefs about Teaching and Learning Composite





Teachers' Traditional Beliefs about Teaching and Learning Composite





Teacher's Perceptions of Preparedness

- Perceptions of preparedness to teach mathematics content
- Perceptions of pedagogical preparedness
- Perceptions of preparedness to implement instruction in the most recent unit

Perceptions of Preparedness to Teach Mathematics Content Composite

Elementary

- Number and Operation
- Early Algebra
- Geometry
- Measurement and Data representation

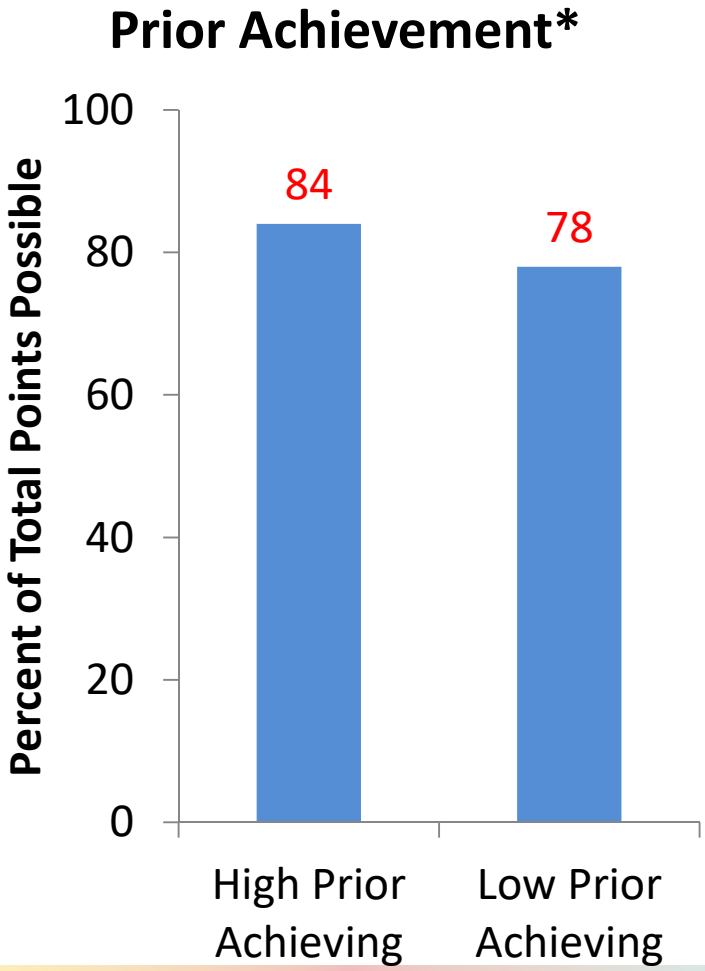
Overall score: 81

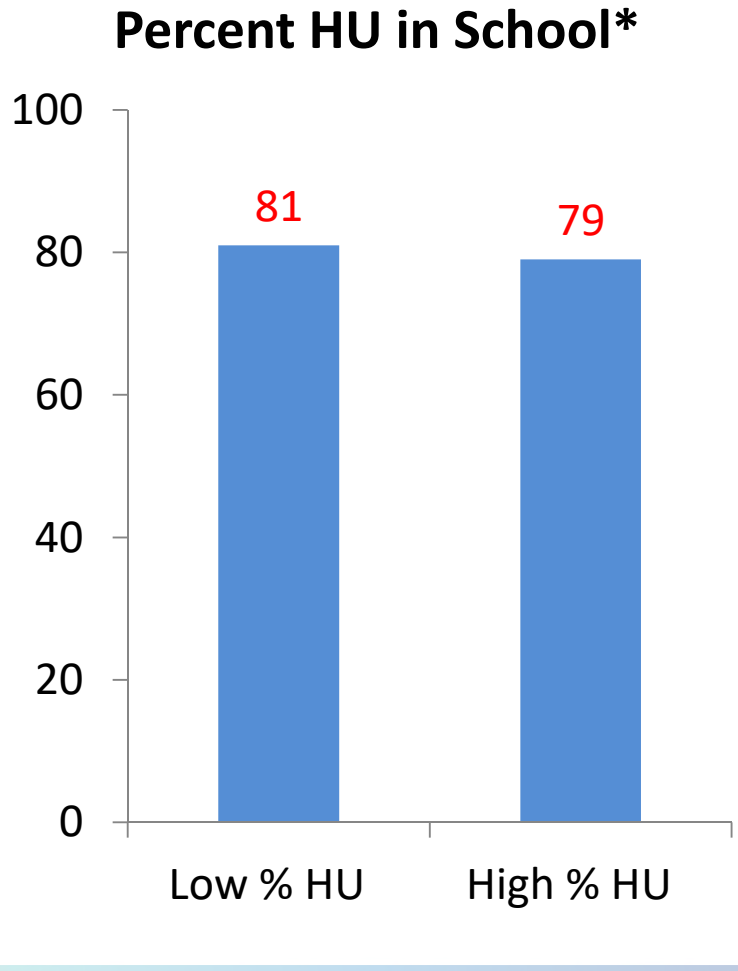
Secondary

- Number system
- Algebraic thinking
- Functions
- Modeling
- Geometry
- Statistics and probability
- Discrete mathematics

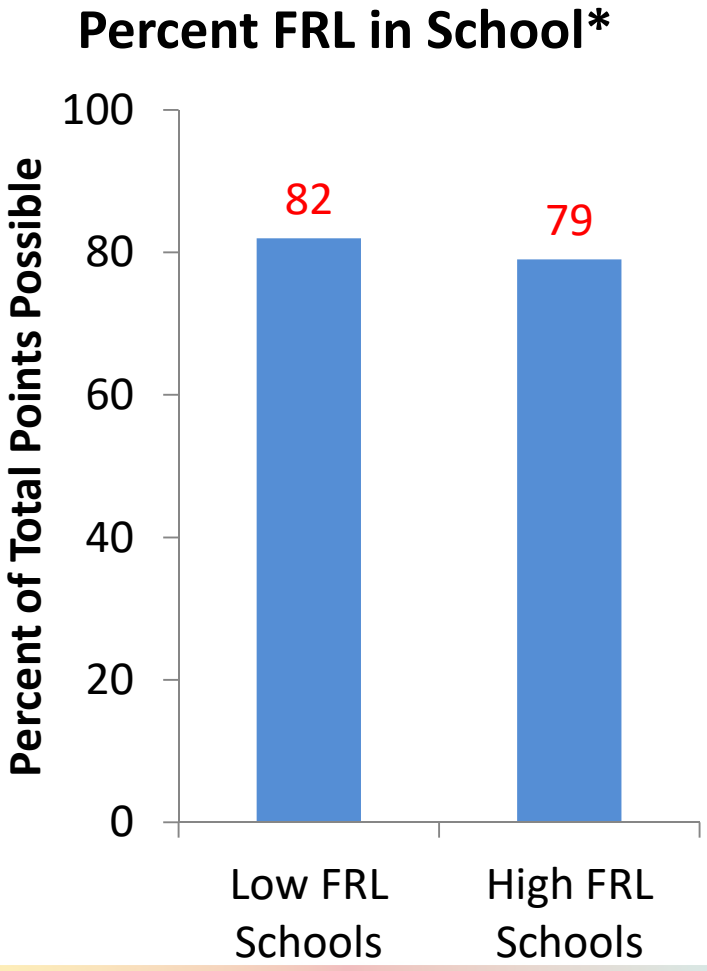
Overall score: 81

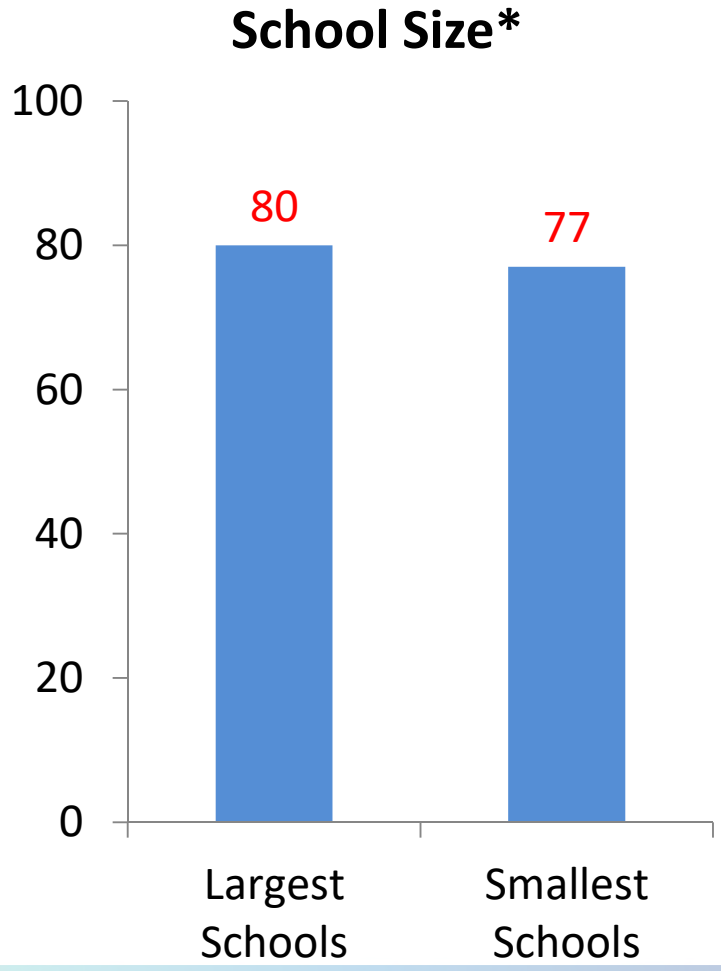
Perceptions of Preparedness to Teach Mathematics Content Composite





Perceptions of Preparedness to Teach Mathematics Content Composite





Perceptions of Pedagogical Preparedness Composite

Examples:

- Develop students' conceptual understanding
- Develop students' abilities to do mathematics
- Use formative assessment to monitor understanding
- Differentiate instruction to meet diverse learners' needs
- Incorporate students' cultural backgrounds

Overall score: 70

Perceptions of Pedagogical Preparedness Composite

	Class Mean Scores
Prior Achievement	
High Prior Achieving	71
Low Prior Achieving	69
Percent Historically Underrepresented*	
Low % HU	68
High % HU	71
Percent of Students Eligible for FRL	
Low % FRL	71
High % FRL	71
School Size	
Largest	69
Smallest	70

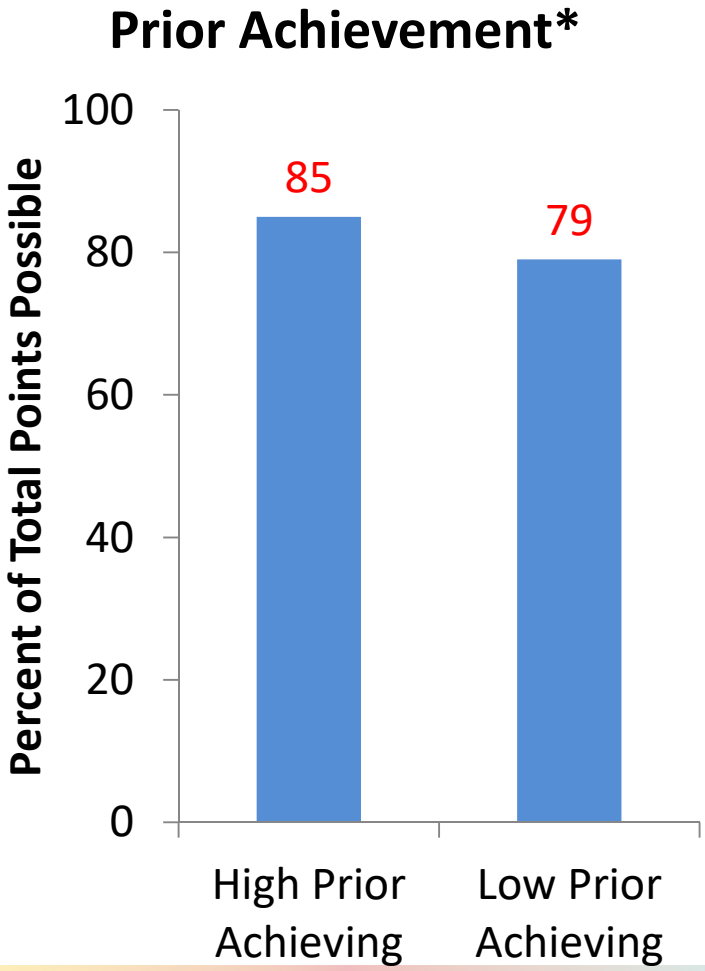
Perceptions of Preparedness to Implement Instruction in the Most Recent Unit Composite

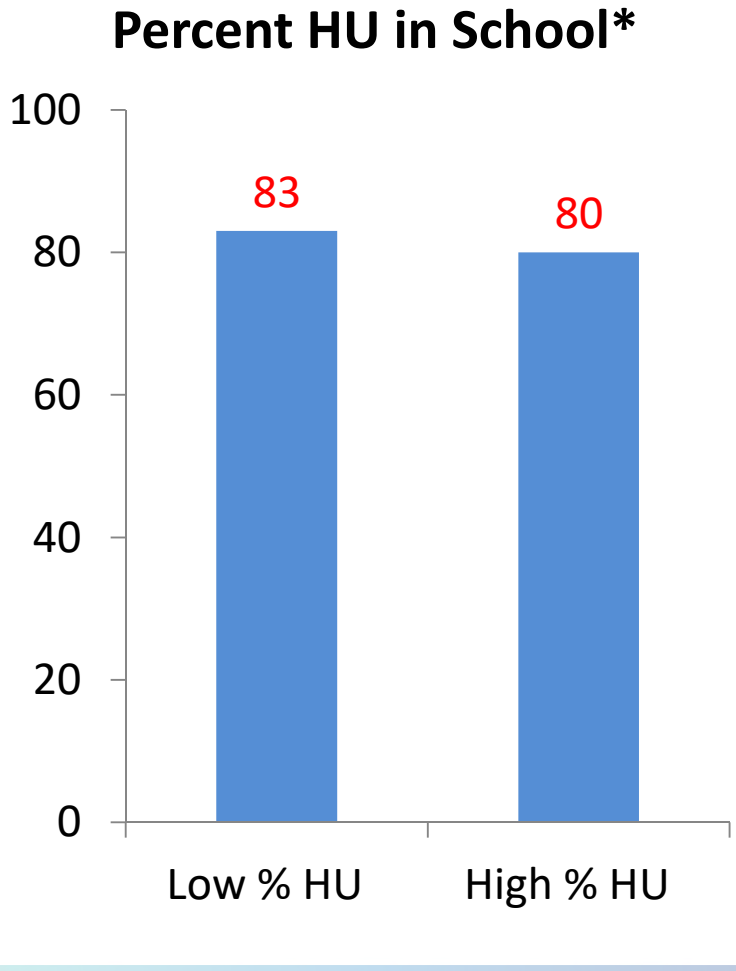
Examples:

- Anticipate difficulties students will have with mathematical ideas
- Implement instructional materials to be used in the unit
- Monitor student understanding during the unit
- Assess student understanding at the conclusion of the unit

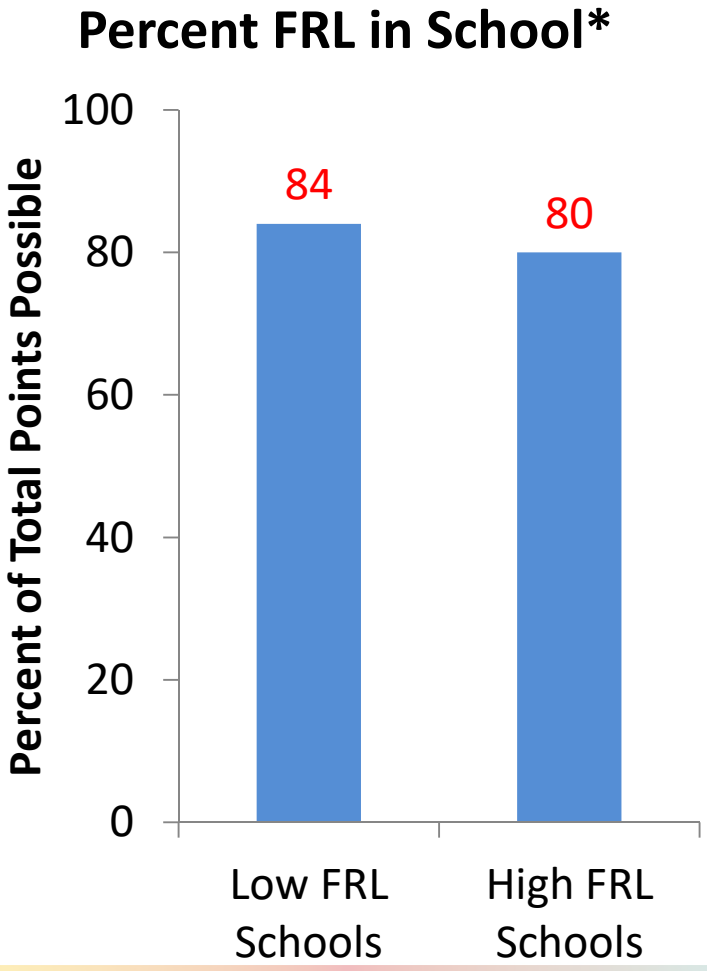
Overall score: 83

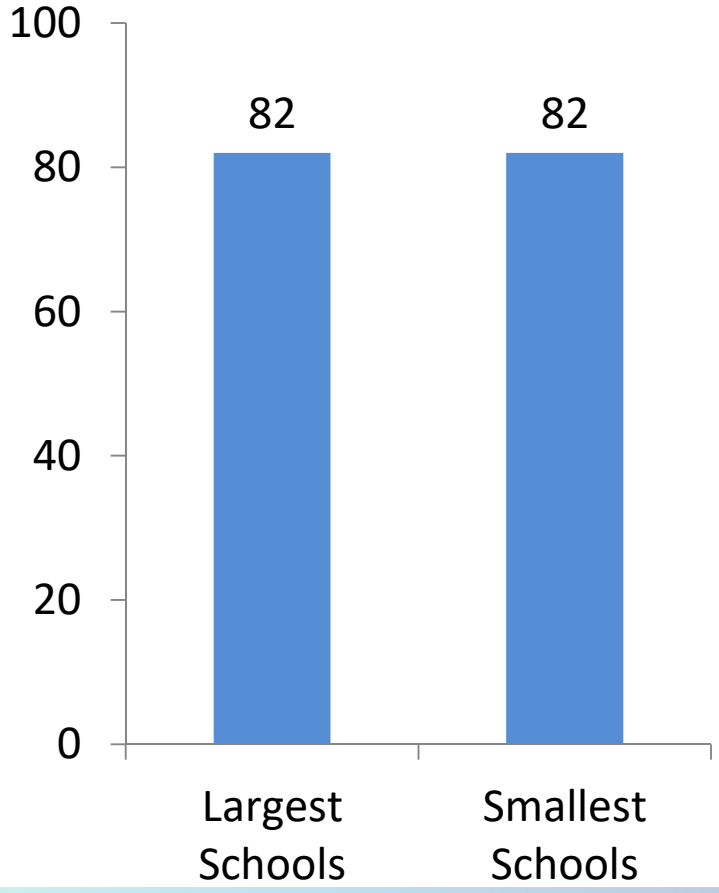
Perceptions of Preparedness to Implement Instruction in the Most Recent Unit Composite





Perceptions of Preparedness to Implement Instruction in the Most Recent Unit Composite

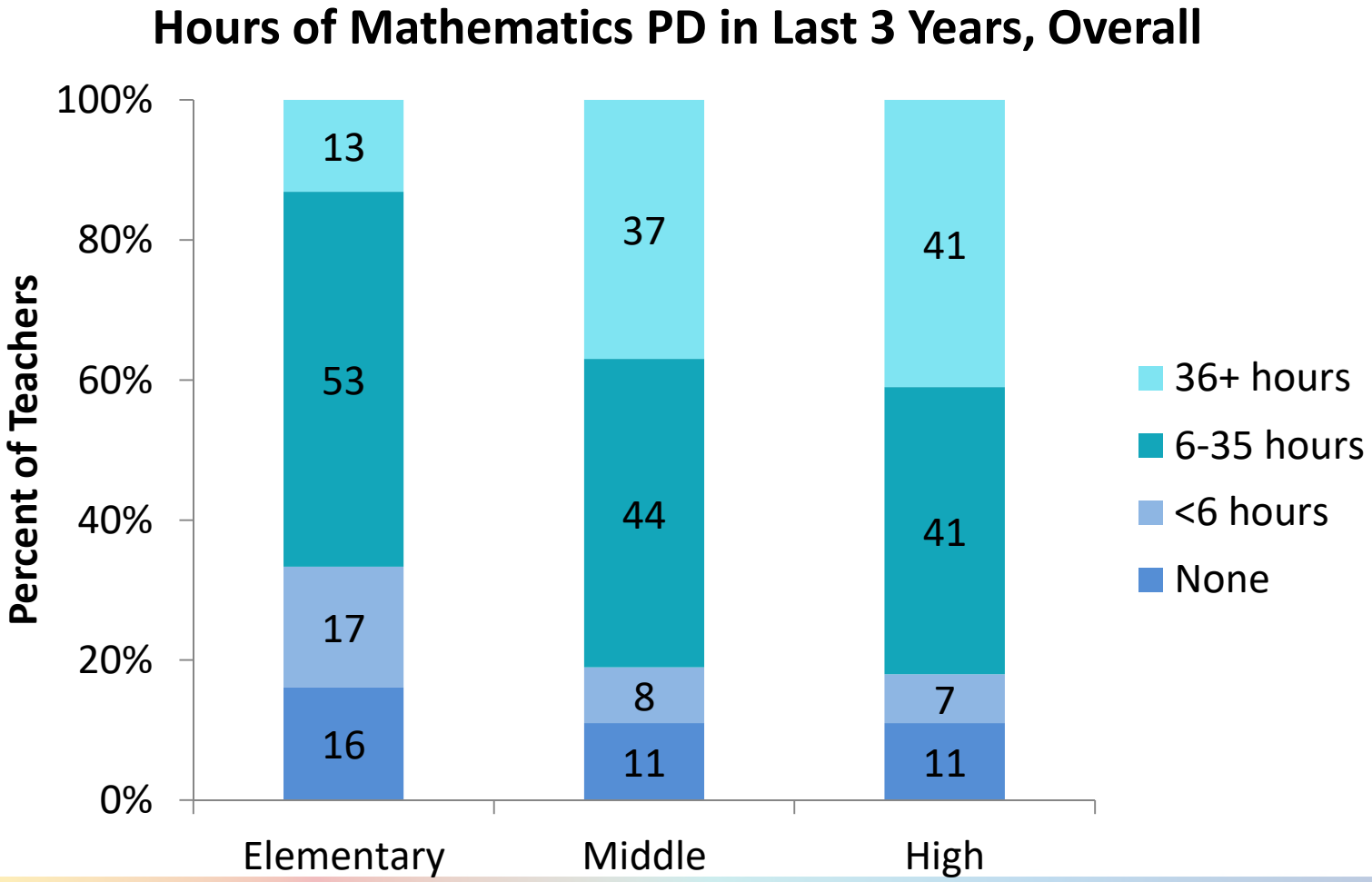




Professional Development Experiences

- Amount of mathematics-focused professional development
- Nature of professional development (composite)
- Emphasis of professional development (composite)

Amount of Professional Development



Classes Taught by Teachers with More Than 35 hours of Math PD in Last Three Years

	Percent of Classes
Prior Achievement	
High Prior Achieving	36
Low Prior Achieving	34
Percent Historically Underrepresented*	
Low % HU	25
High % HU	33
Percent of Students Eligible for FRL	
Low % FRL	26
High % FRL	32
School Size	
Largest	29
Smallest	26

Extent PD Aligns with Elements of Effective PD Composite

Examples:

- Worked closely with other teachers from their school
- Had opportunities to engage in mathematical investigations
- Had opportunities to apply what they learned to their class room and then come back and talk about it
- Had opportunities to examine classroom artifacts

Overall score: 58

Extent PD Supports Student-Centered Instruction Composite

Examples:

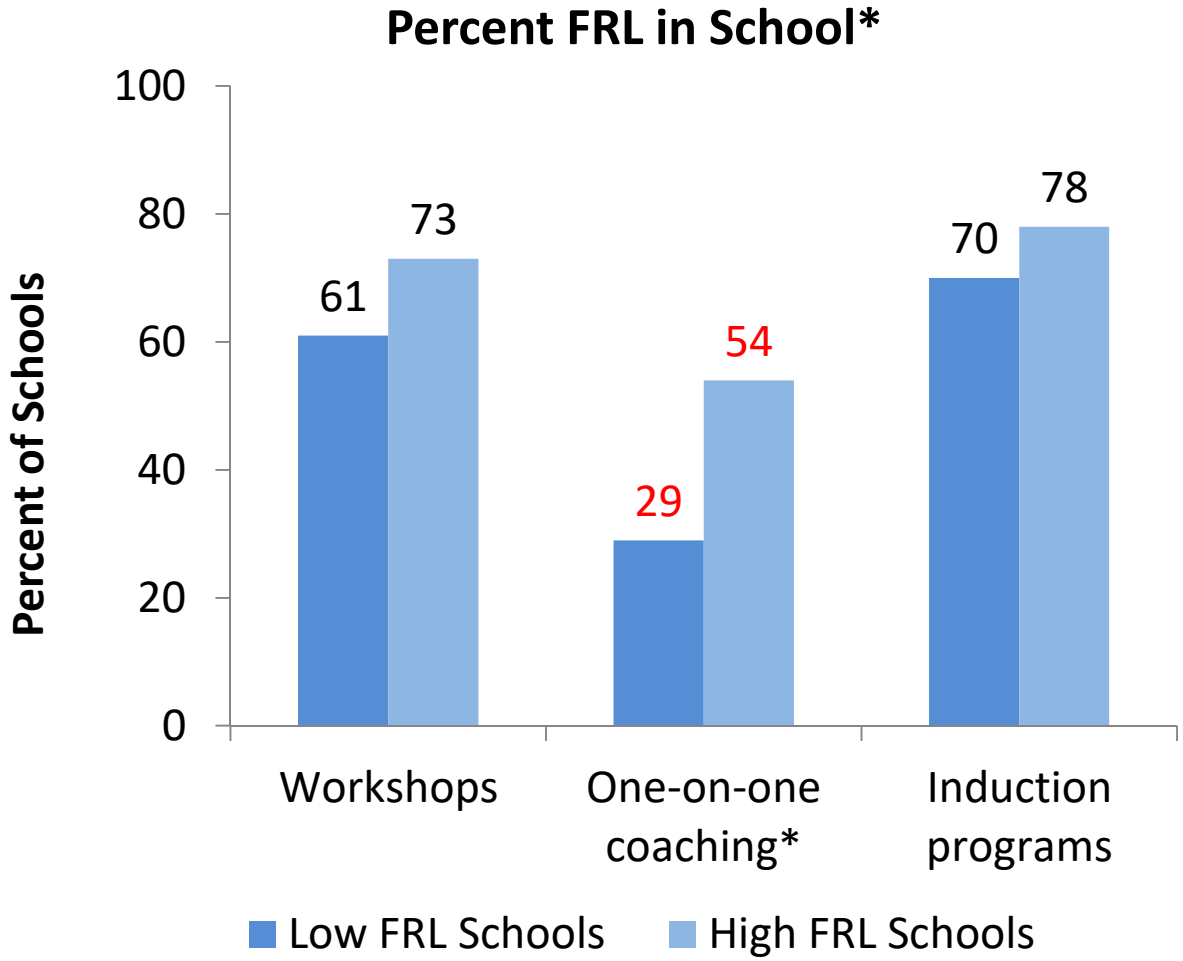
- Deepening understanding of how mathematics is done
- Learning how to use hands-on/manipulatives
- Learning about difficulties students may have with mathematical ideas
- Monitoring student understanding
- Differentiating to meet diverse learners' needs

Overall score: 57

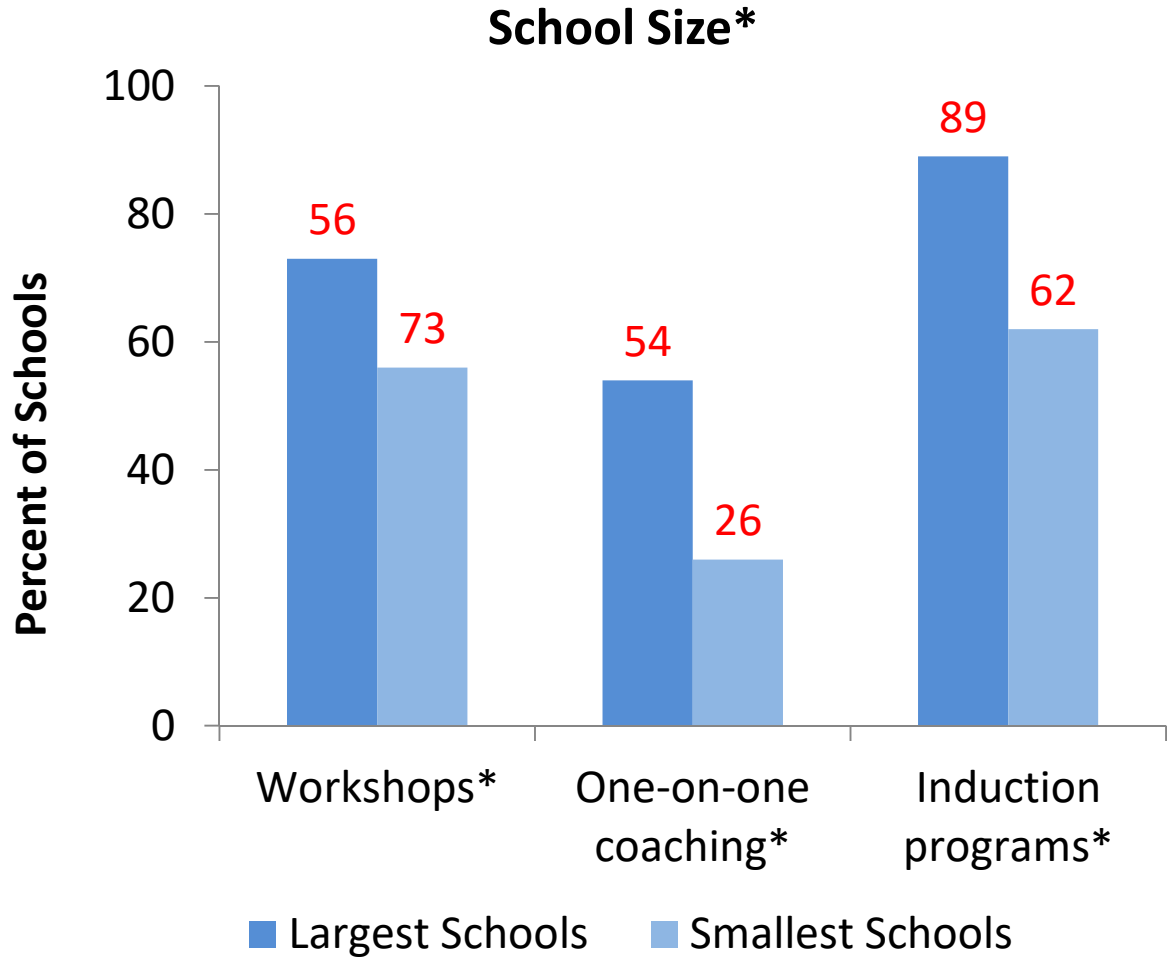
Professional Development Composites

	Alignment with Elements of Effective PD	Supports Student-Centered Instruction
Prior Achievement*		
High Prior Achieving	56	55
Low Prior Achieving	61	60
Percent HU in Class		
Low % HU	58	59
High % HU	61	62
Percent FRL in School		
Low FRL Schools	57	58
High FRL Schools	60	62
School Size		
Largest Schools	59	57
Smallest Schools	55	61

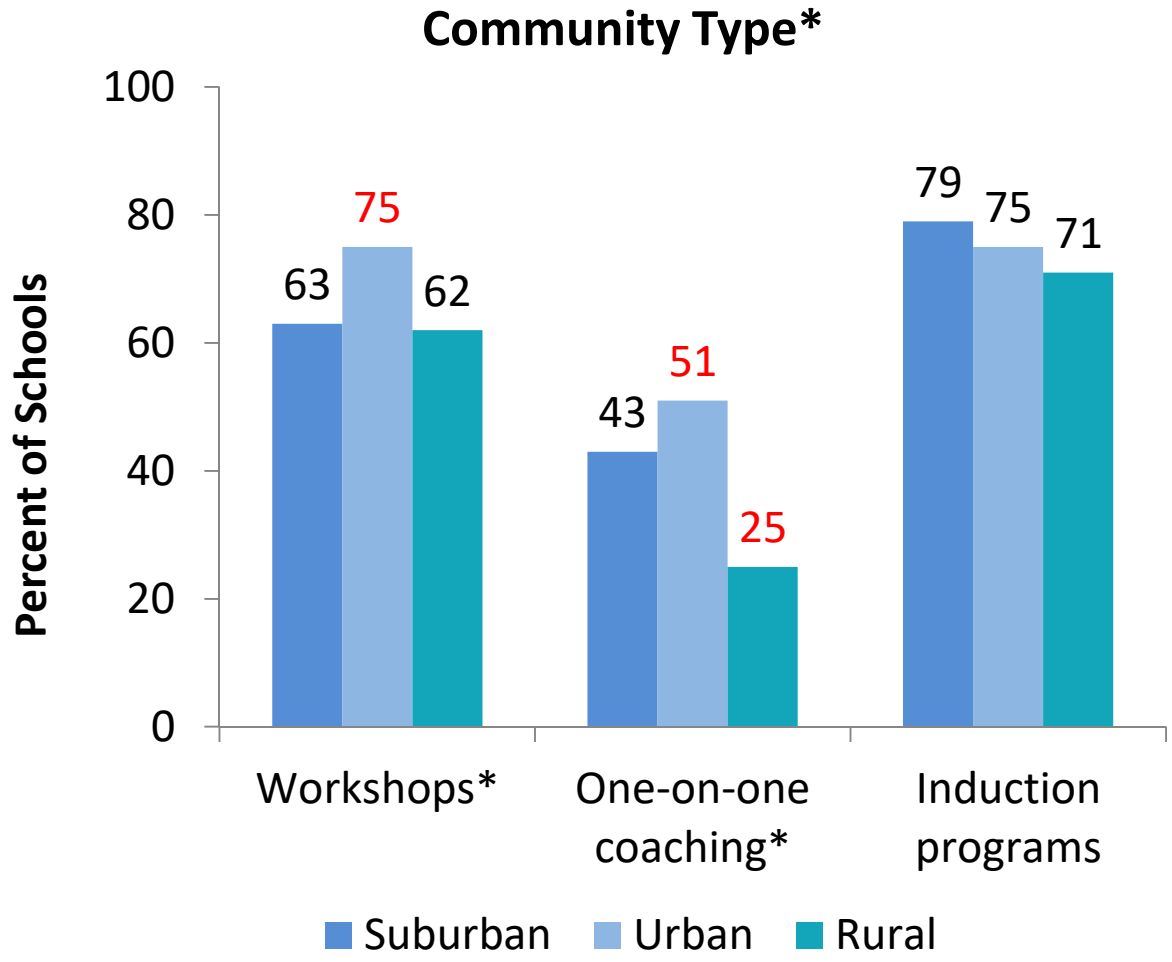
Professional Development Offered at School, by FRL Status



Professional Development Offered at School, by School Size



Professional Development Offered at School, by Community Type



Discussion

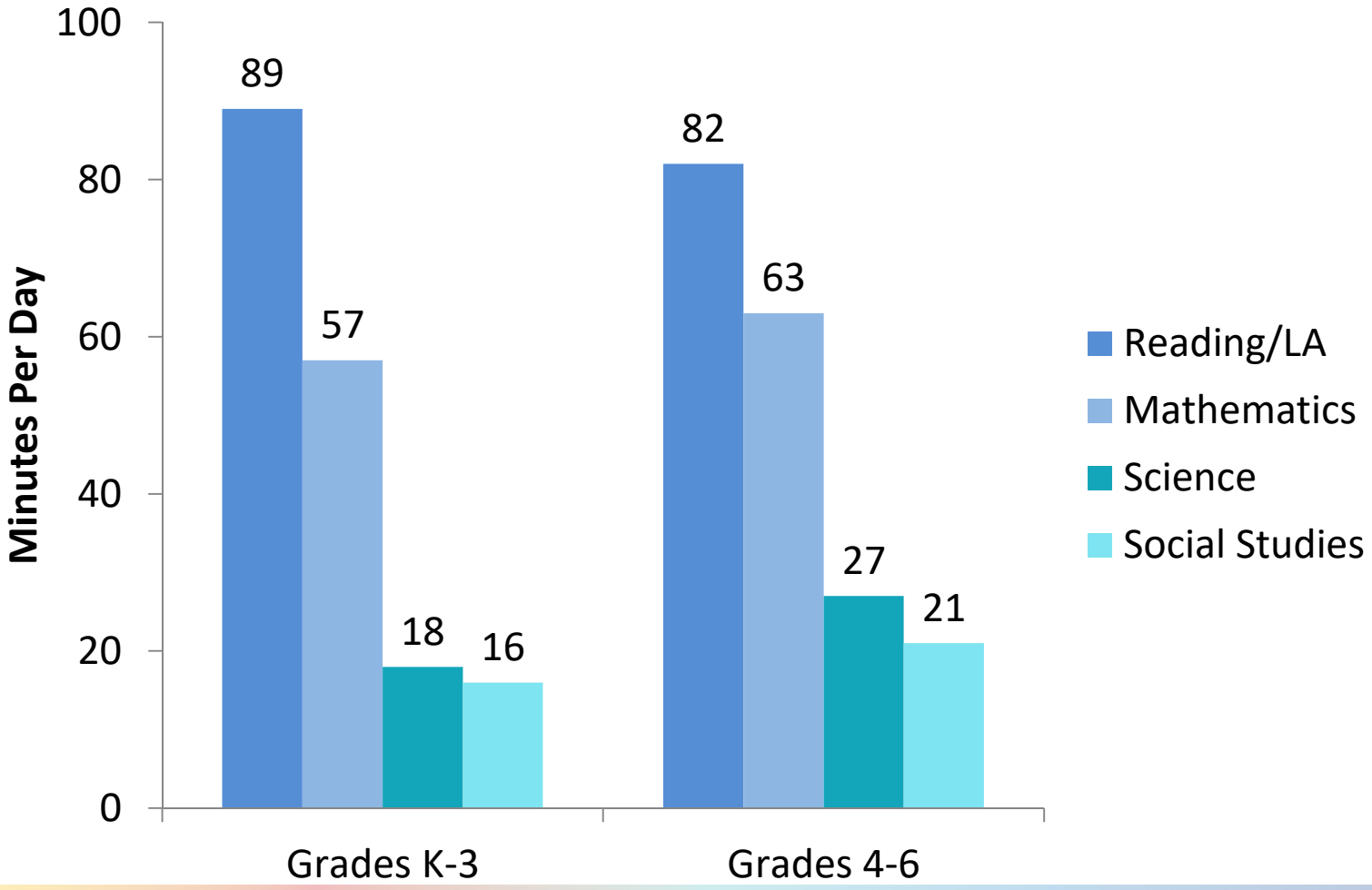
What insights do you have about methods/ strategies to address inequitable distribution of well-prepared teachers in your work context?

Nature of Mathematics Instruction

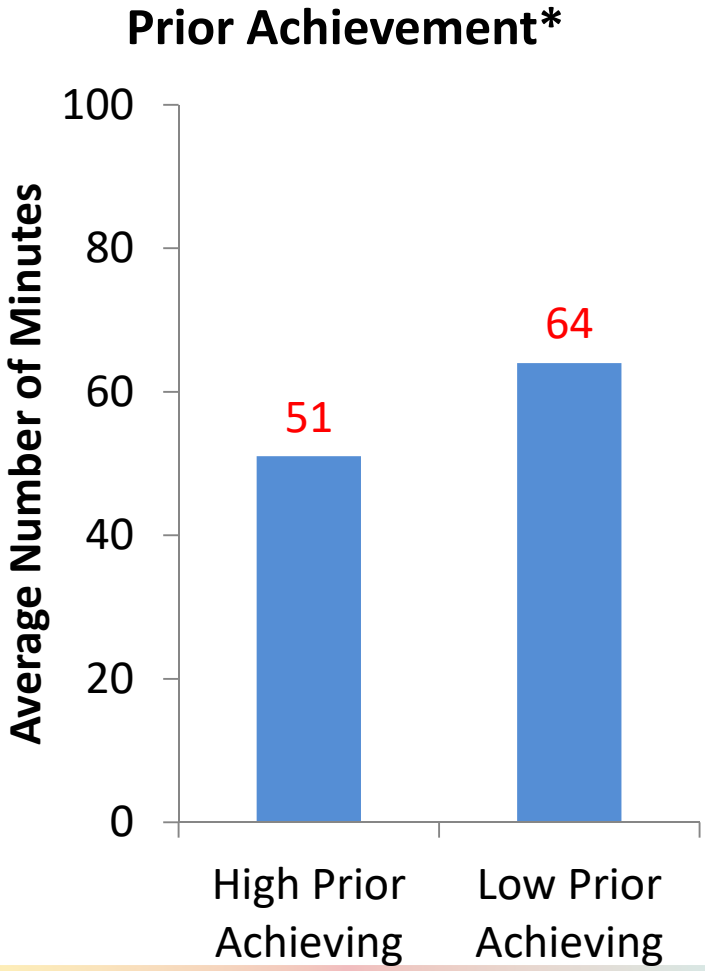
Nature of Mathematics Instruction

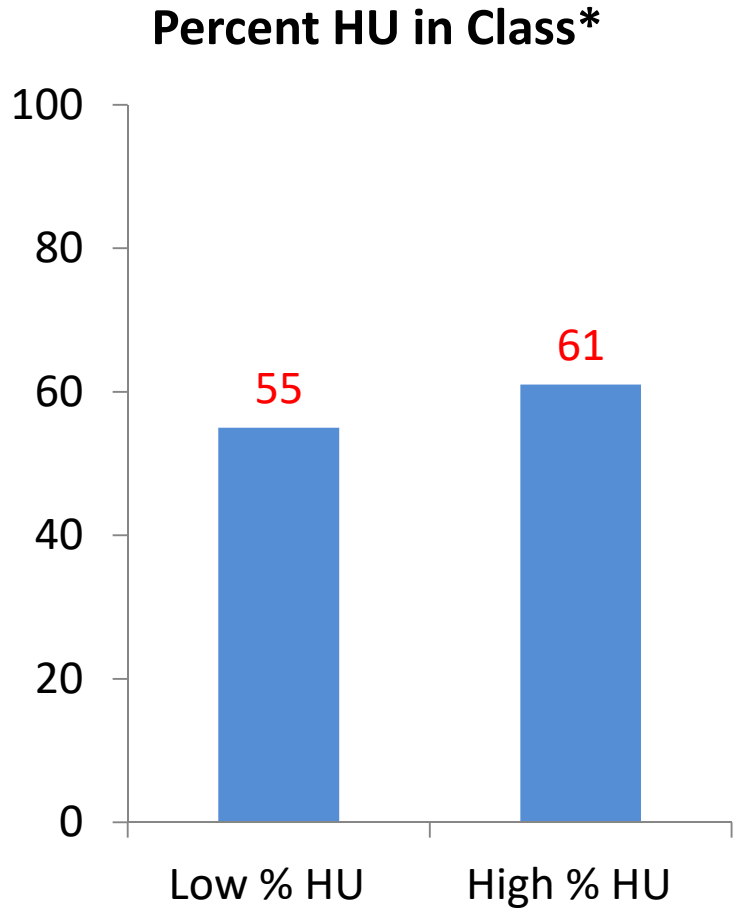
- Instructional time
- Course offerings and enrollment
- Frequency of external testing
- Emphasis on reform-oriented instructional objectives
- Student engagement with mathematical practices
- Teachers' perceived control over curriculum and pedagogy

Instructional Time: Elementary

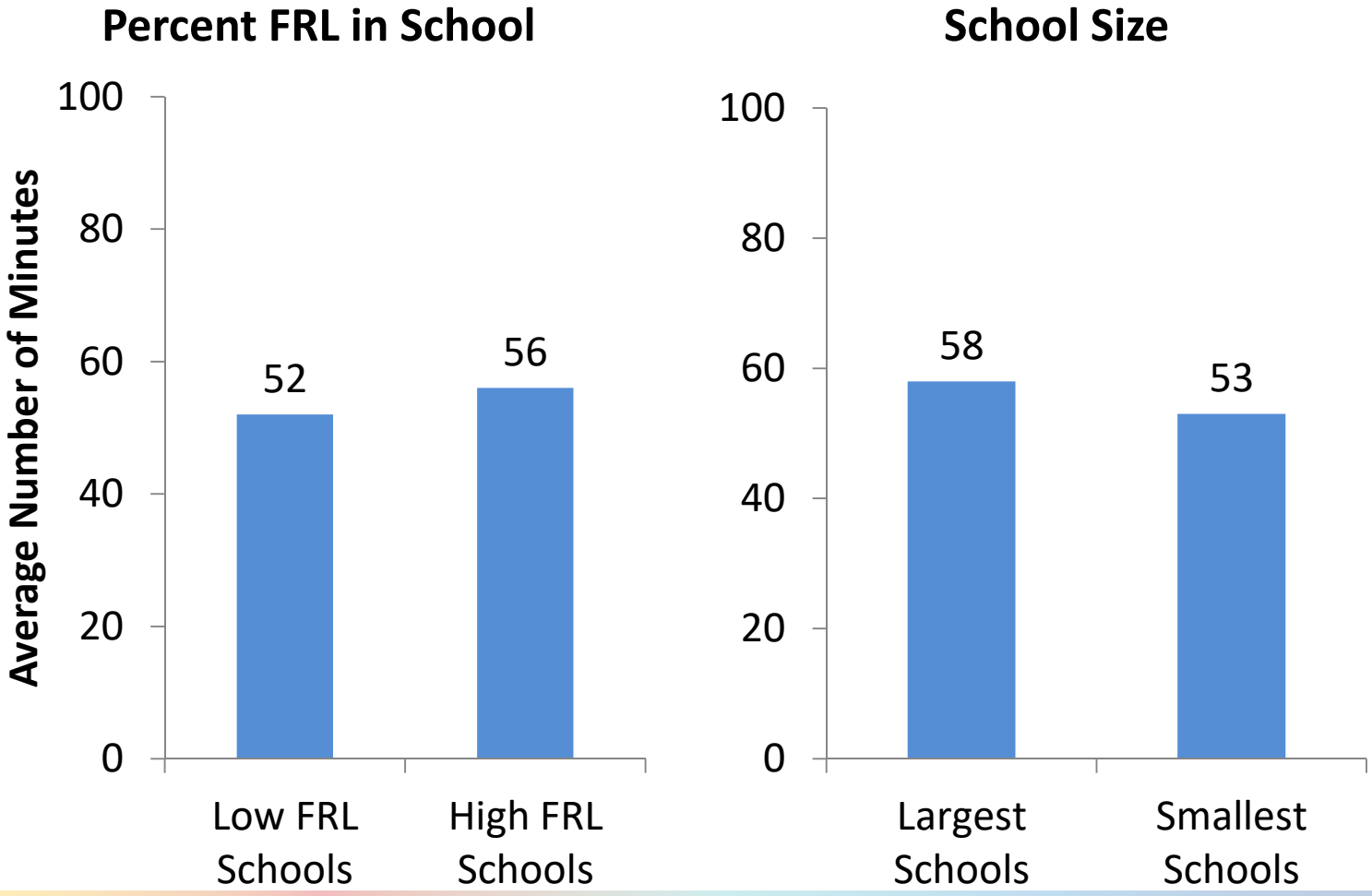


Minutes Per Day on Elementary Mathematics





Minutes Per Day on Elementary Mathematics



Course Offerings and Enrollment

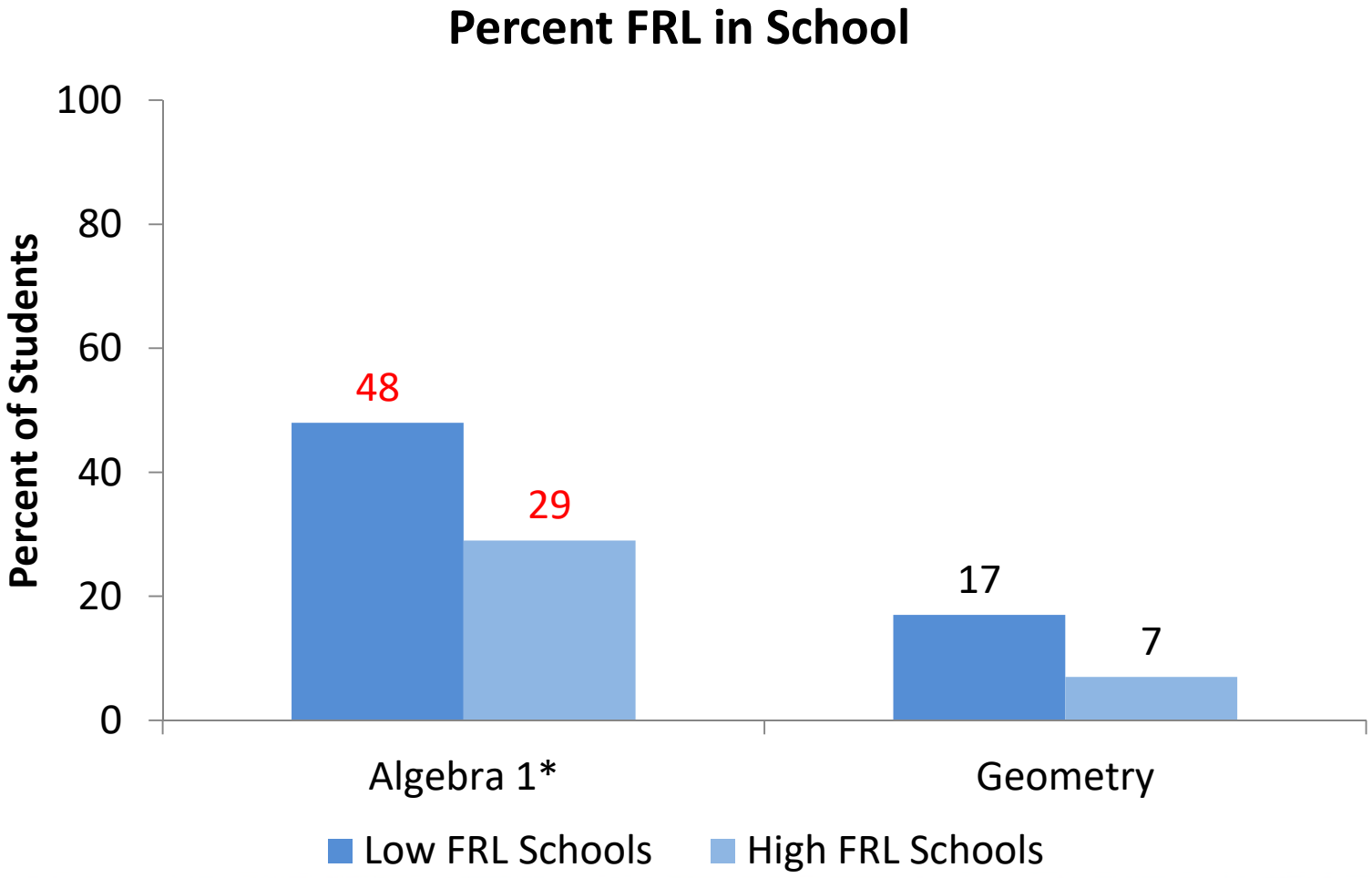
- 8th grade students completing Algebra 1, Geometry
- High schools offering formal advanced mathematics courses (e.g., Algebra 2, pre-calculus, AP Calculus)
- Availability of AP courses
- Enrollment in high school mathematics courses

Middle School Students Completing Algebra 1 and Geometry

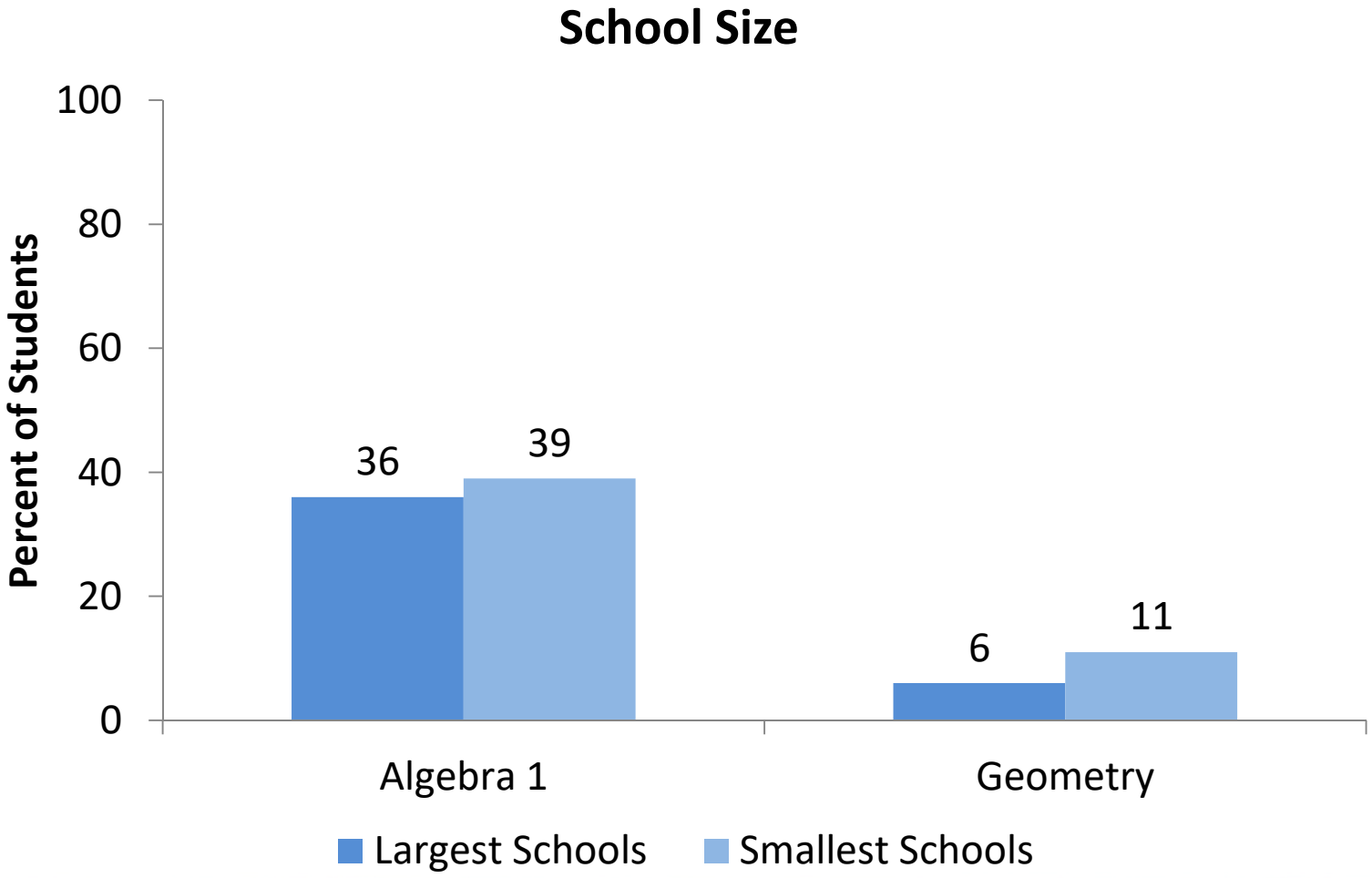
- About ¾ of middle schools have at least some students completing Algebra 1 prior to 9th grade

- About ¼ of middle schools have students completing Geometry

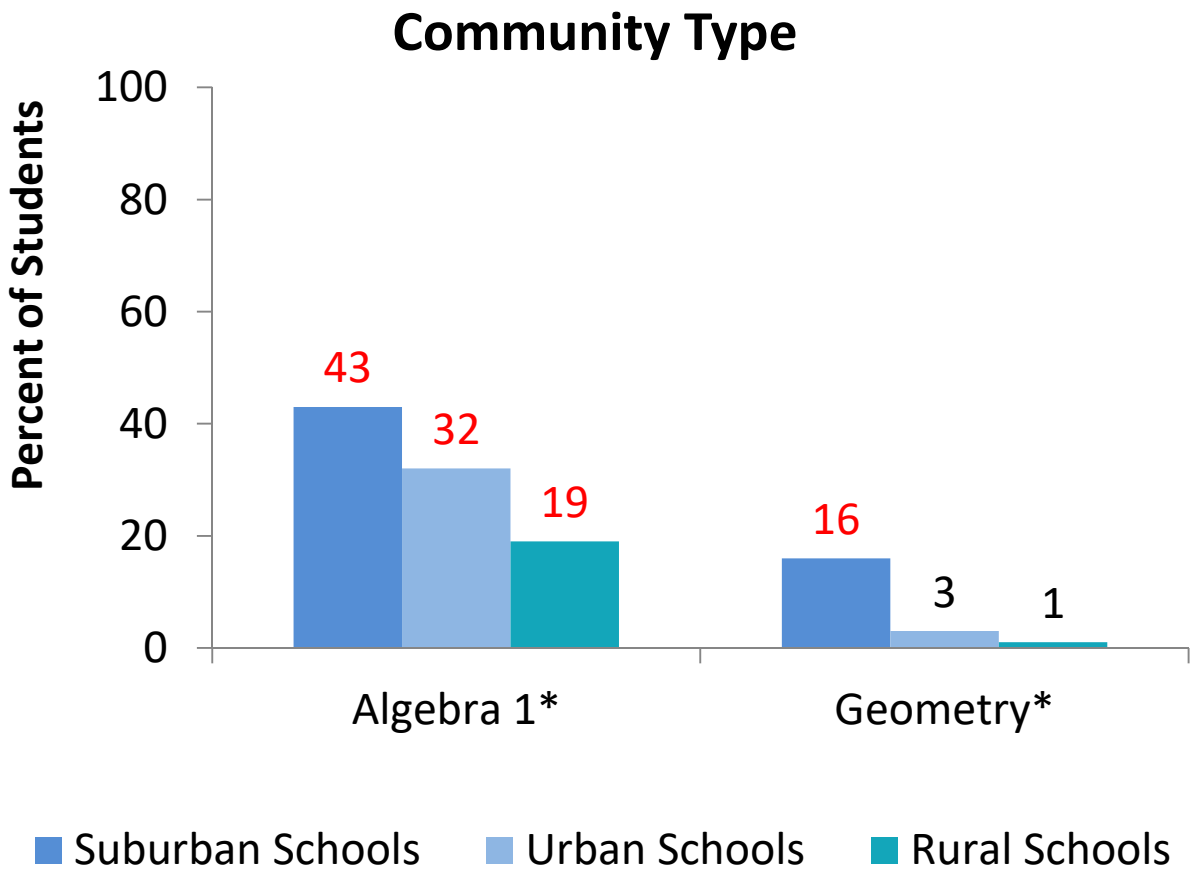
Average Percentage of 8th Graders Completing Algebra 1 & Geometry



Average Percentage of 8th Graders Completing Algebra 1 & Geometry



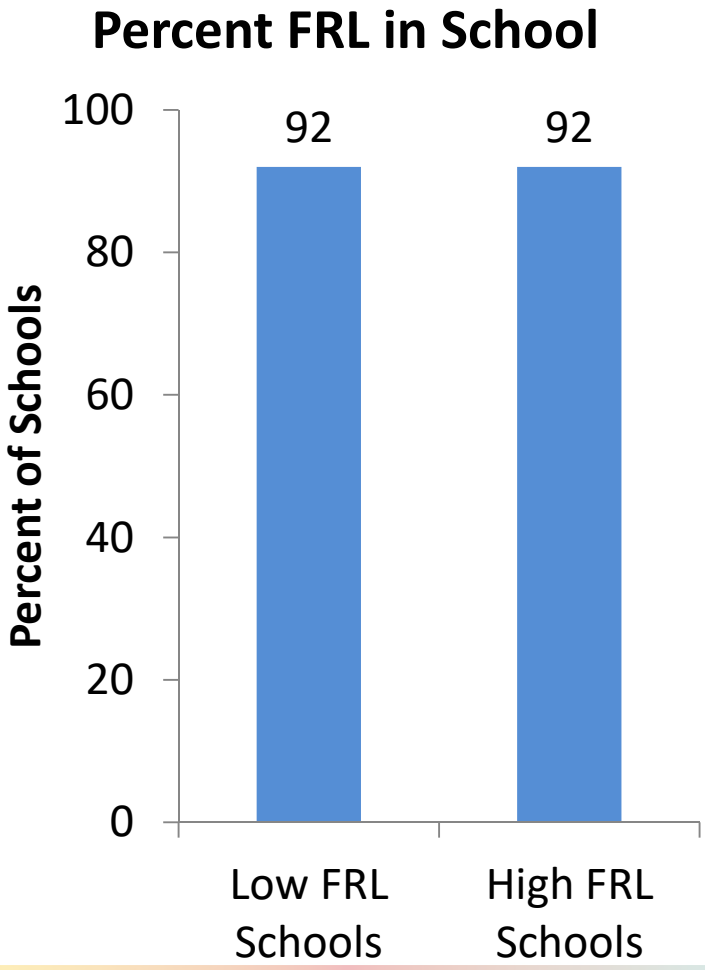
Average Percentage of 8th Graders Completing Algebra 1 & Geometry

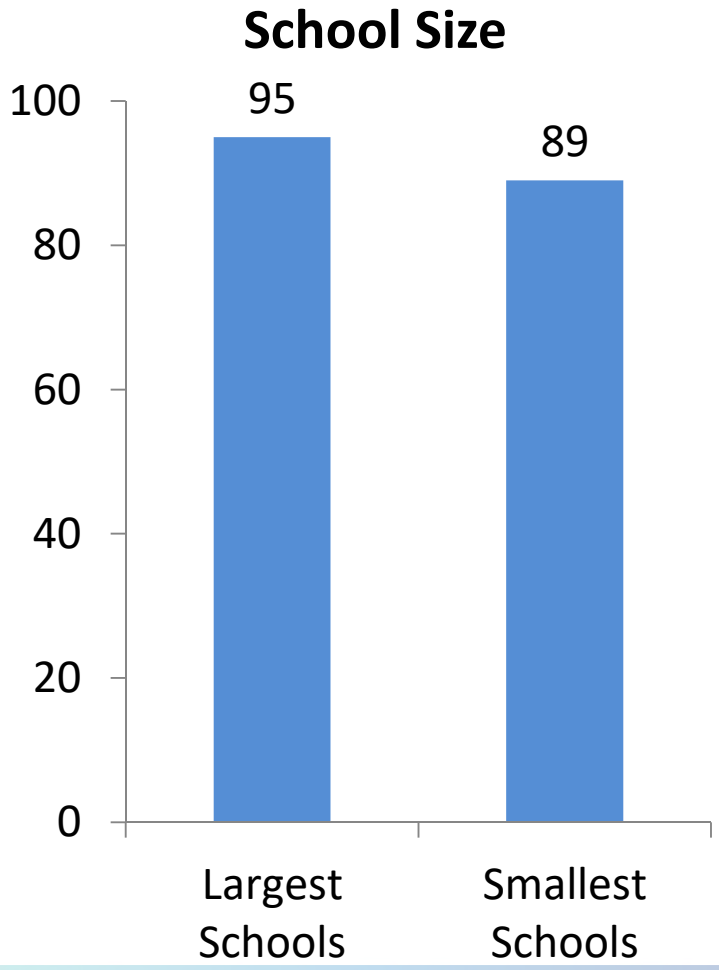


High Schools Offering Various Mathematics Courses

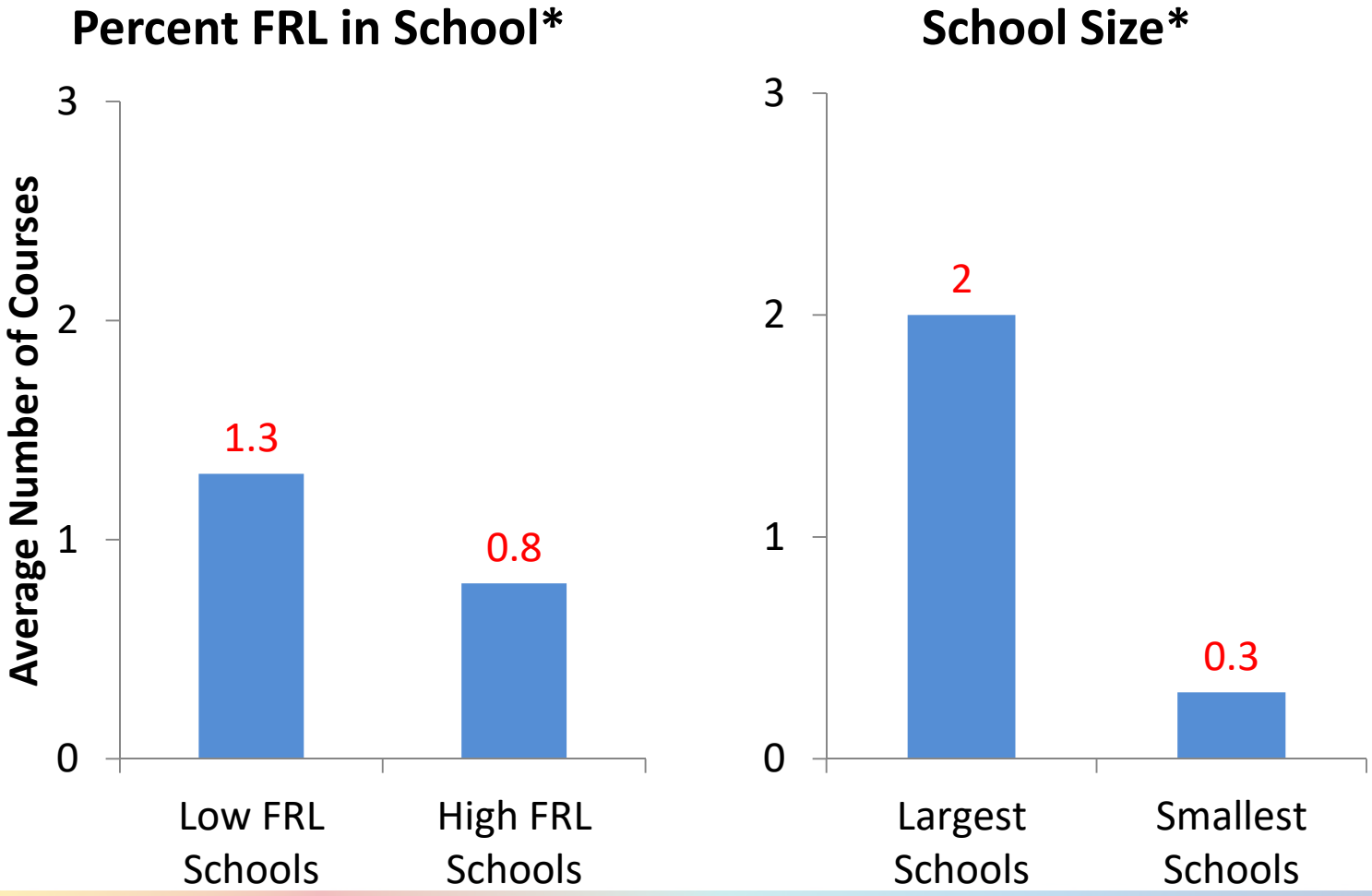
	Percent of Schools
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	79
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	98
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	93
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	91
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	90
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	72

High Schools Offering Formal Advanced Mathematics Courses

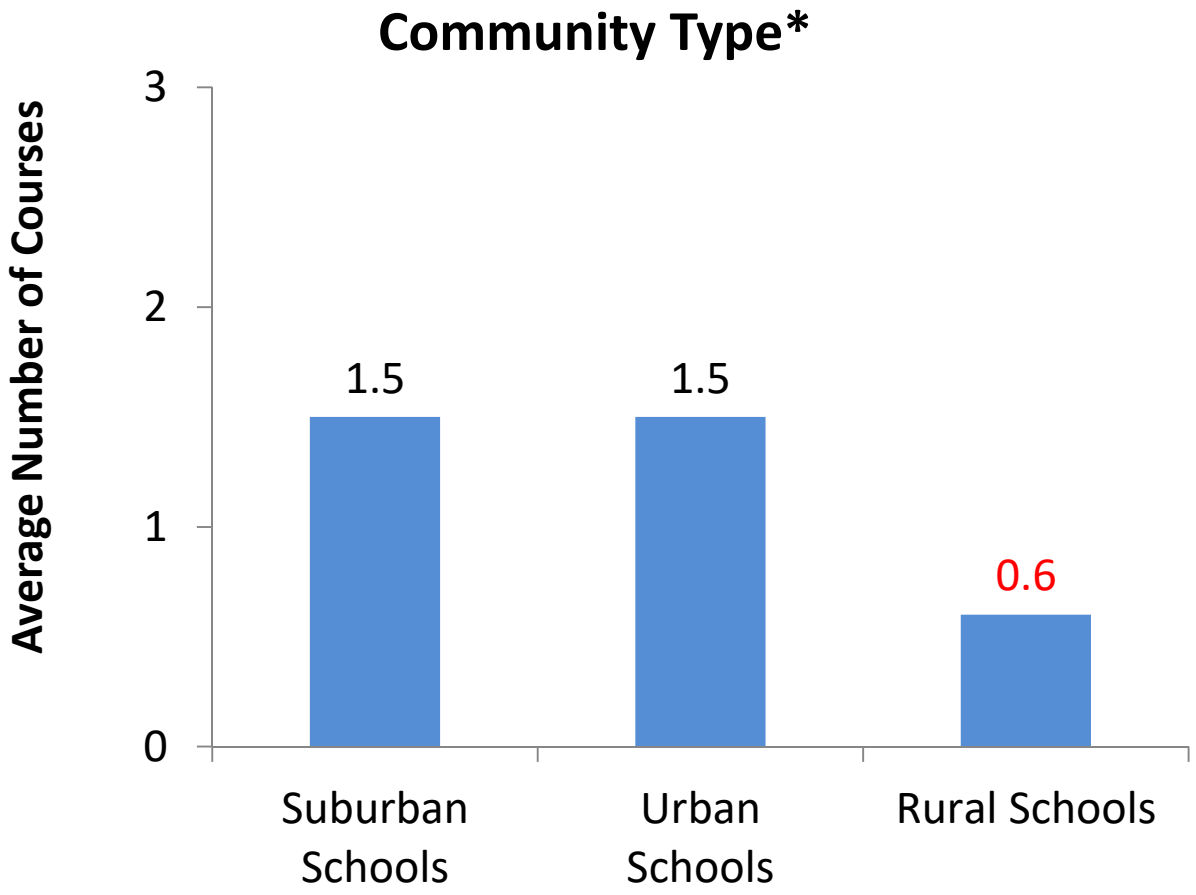




Average Number of AP Mathematics Courses Offered



Average Number of AP Mathematics Courses Offered



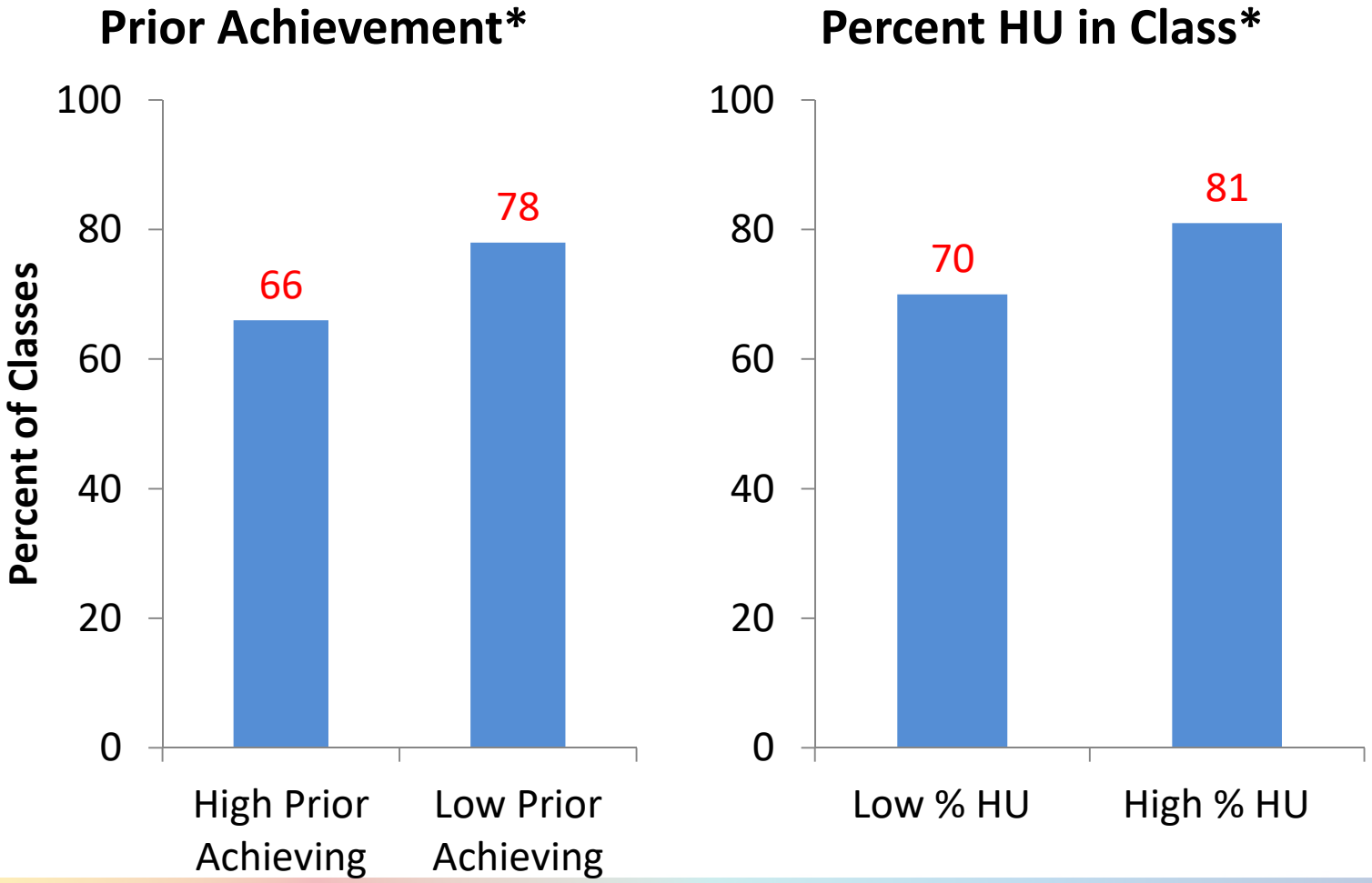
Average Percentages of HU Students in High School Mathematics Courses

	Percent HU
Non-college prep (e.g., Remedial Math, General Math, Consumer Math)	53
Formal/College prep level 1 (e.g., Algebra 1, Integrated Math 1)	38
Formal/College prep level 2 (e.g., Geometry, Integrated Math 2)	39
Formal/College prep level 3 (e.g., Algebra 2, Algebra and Trigonometry)	37
Formal/College prep level 4 (e.g., Pre-Calculus, Algebra 3)	33
Courses that might qualify for college credit (e.g., AP Calculus, AP Statistics)	22

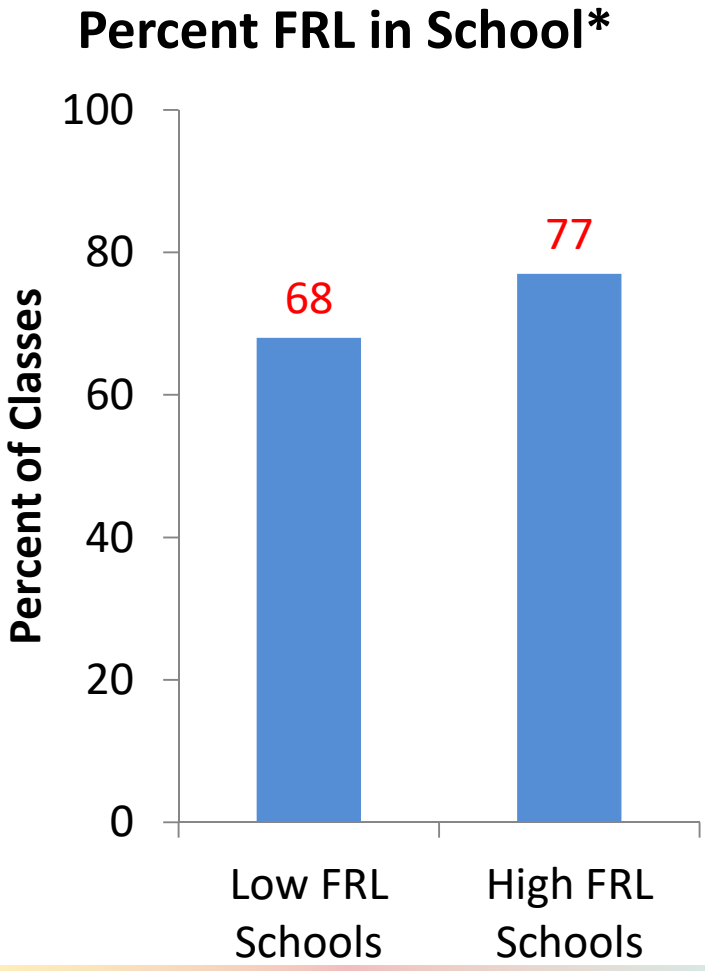
Frequency of External Mathematics Testing

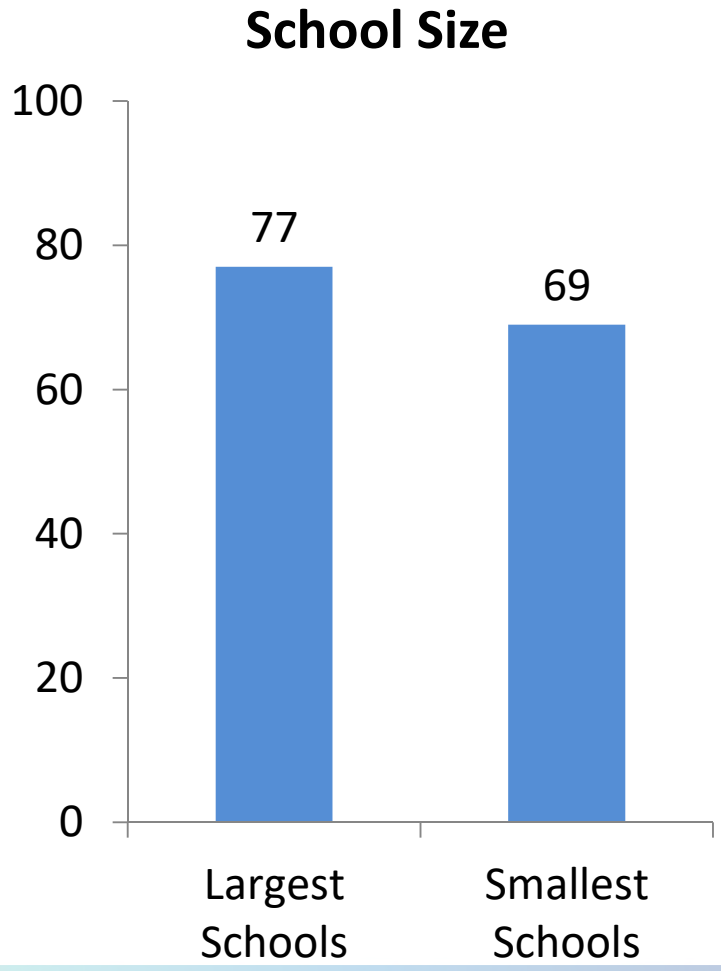
	Percent of Classes		
	Elementary	**Middle**	**High**
Never	9	1	20
Once a year	9	12	25
Twice a year	9	11	22
Three or four times a year	48	43	24
Five or more times a year	25	33	10

Two or More External Mathematics Assessments Per Year



Two or More External Mathematics Assessments Per Year





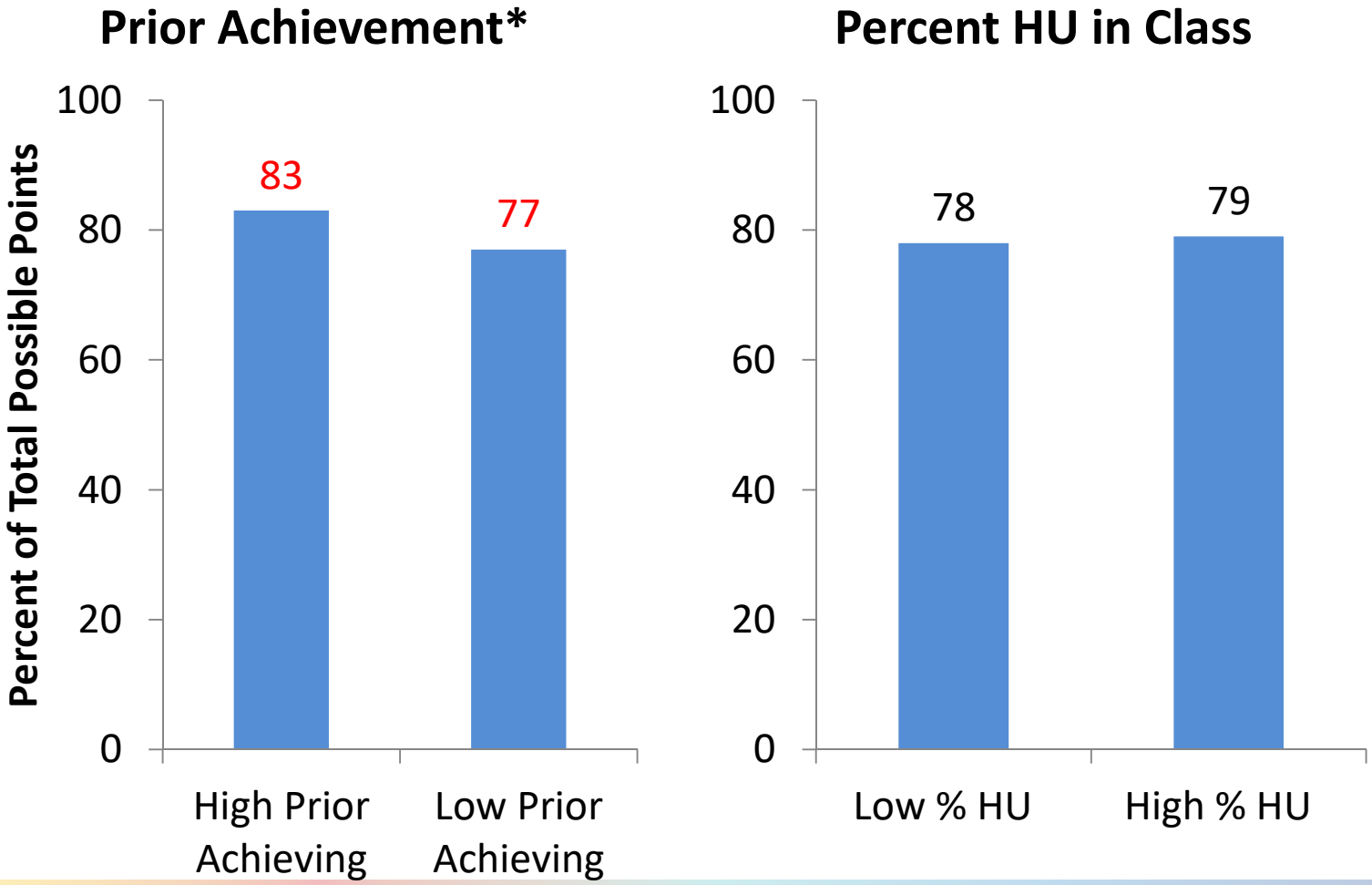
Reform-Oriented Instructional Objectives Composite

Items in composite:

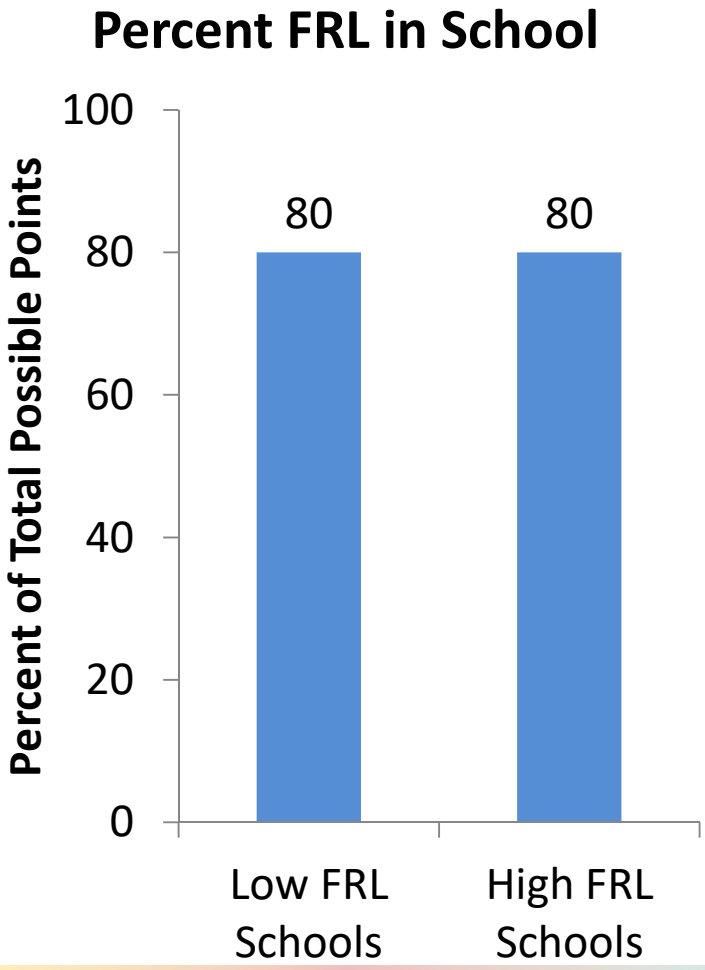
- Understanding mathematical ideas
- Learning how to do mathematics
- Learning about real-life applications of mathematics
- Increasing students' interest in mathematics
- Developing students' confidence that they can successfully pursue careers in mathematics

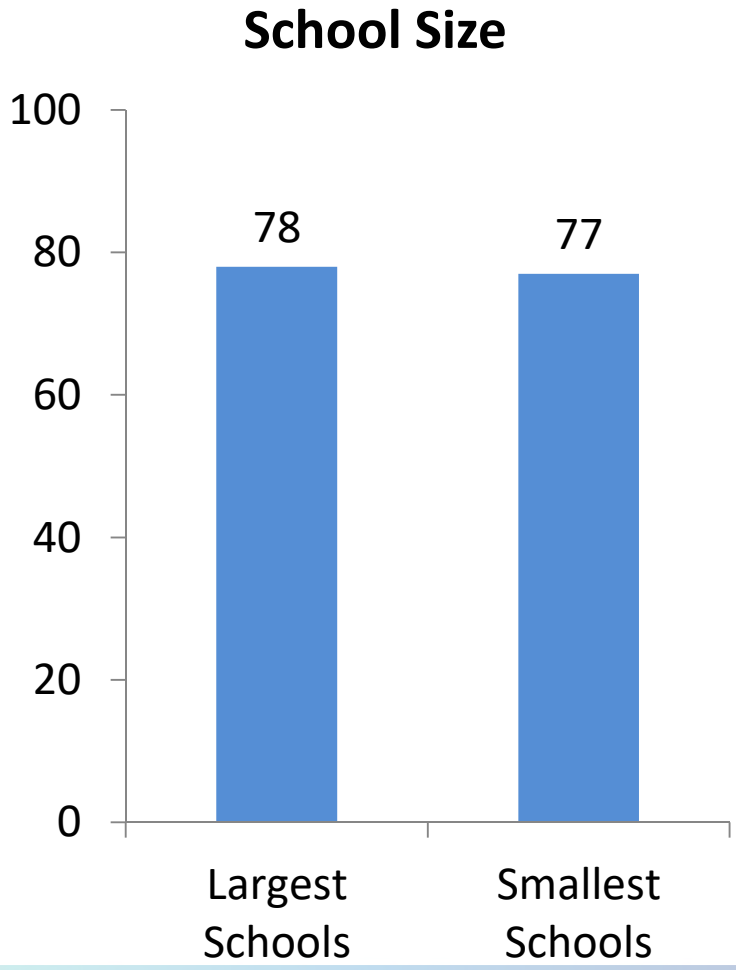
Overall Score: 78

Reform-Oriented Objectives Composite



Reform-Oriented Objectives Composite





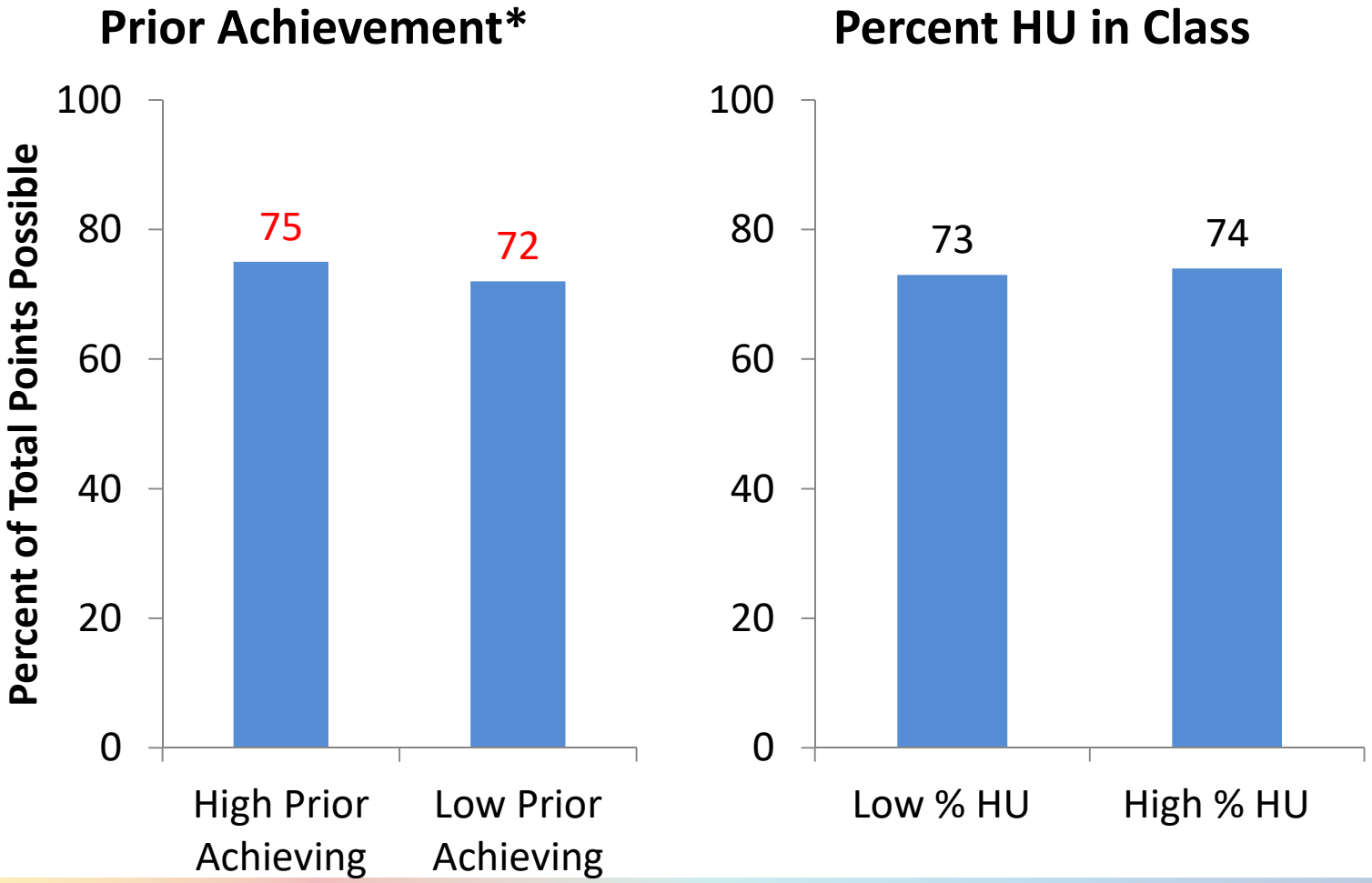
Engagement in Standards for Mathematical Practice

The 2018 NSSME+ included a series of items asking how often students were engaged in aspects of the mathematical practices:

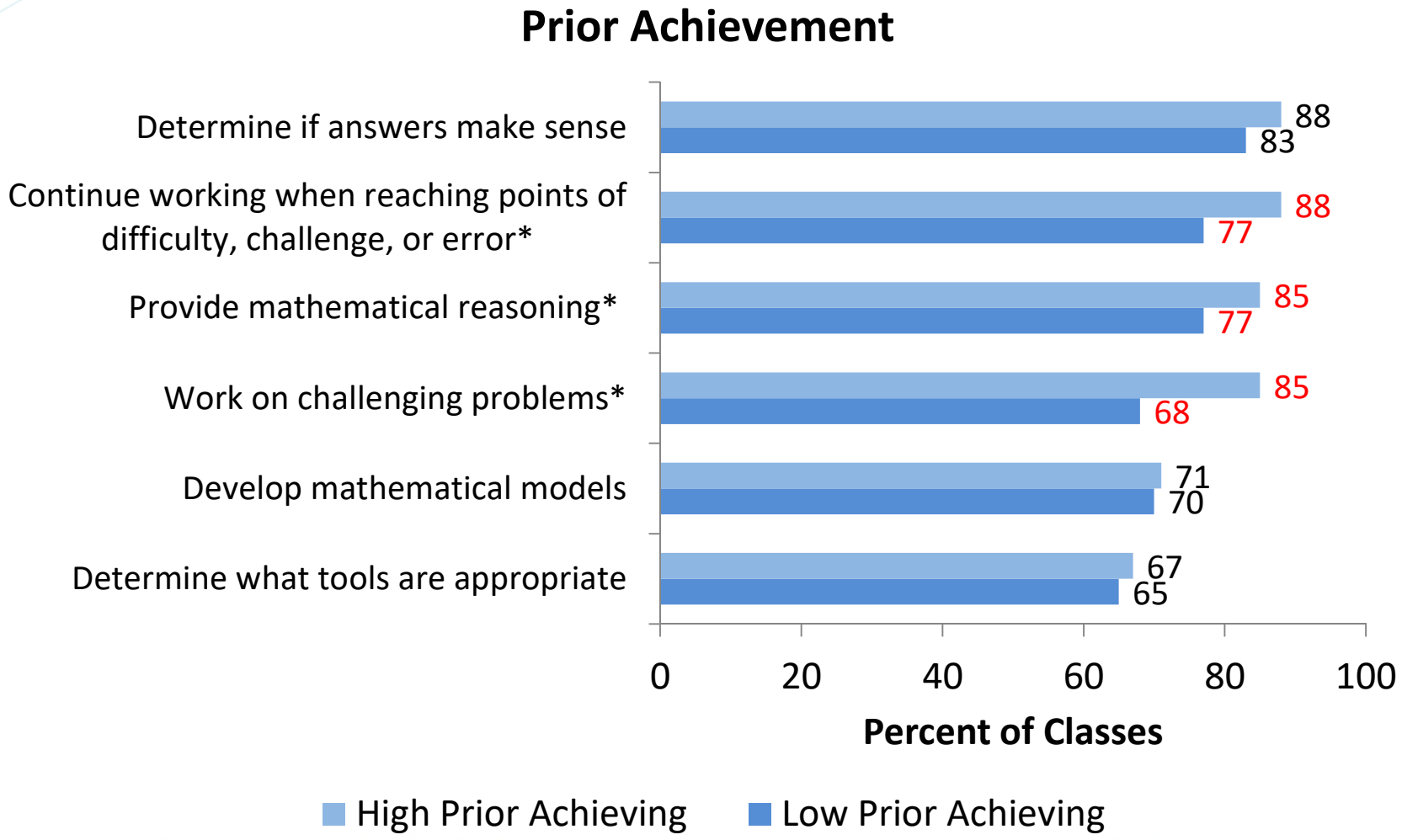
1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments/critique reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

Overall Score: 73

Engaging Students in Practices of Mathematics Composite



Mathematics Practices Profile



Teachers' Perceptions of Control

Curriculum Control:

Overall Score: 53

- Determining course goals and objectives
- Selecting curriculum materials
- Selecting content, topics, and skills to be taught
- Selecting the sequence in which topics are covered

Pedagogy Control:

Overall Score: 85

- Selecting teaching techniques
- Determining the amount of homework to be assigned
- Choosing criteria for grading student performance

Curriculum Control and Pedagogy Control Composites

	Curriculum Control	Pedagogy Control
Prior Achievement*		
High Prior Achieving	59	88
Low Prior Achieving	45	81
Percent HU in Class*		
Low % HU	56	85
High % HU	42	79
Percent FRL in School*		
Low FRL Schools	51	82
High FRL Schools	43	80
School Size*		
Largest Schools	43	82
Smallest Schools	61	84

Discussion

What have you seen in your work that might explain some of these national results?

Closing Thoughts

- Limitations (as with all research studies)
- NSSME+ provides an opportunity to examine some questions of access at national scale
- Interesting paradoxes
- Some hopeful findings
- Also evidence that historic inequities persist

- What other questions would you ask using this data set?

www.horizon-research.com/NSSME

Current reports:

- Technical report
- Highlights report
- Compendium of Tables

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