NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

# Unequal Distribution of Educational Resources for K–12 Science Instruction

NARST

APRIL 2, 2019

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Horizon RESEARCH, INC.

# Who We Are

**Horizon Research, Inc. is an education research and evaluation firm specializing in STEM education, located in Chapel Hill, NC.**

# 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.**

# 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
- National Council of Supervisors of Mathematics
- National Council of Teachers of Mathematics
- National Earth Science Teachers Association
- National Education Association
- National Science Education Leadership Association
- National Science Teachers Association

# Situating the Work

- **The 2018 NSSME+ was NOT designed primarily as an equity study.**
- **We are experts in large-scale survey research.**
- **We are NOT equity experts.**

# NARST 2019 Theme

**“Creating and Sustaining Collective Activism through Science Education Research”**

# 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

# Topics Addressed

- Characteristics of the science/mathematics/ computer science teaching force
- Instructional practices
- Factors that shape teachers' decisions about content and pedagogy
- Use of instructional materials
- Opportunities teachers have for professional growth
- How instructional resources are distributed

# Interpreting Results

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

**Why should you care?**

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

# Approach

## Equitable distribution of education resources:

- Well-prepared teachers
- Supportiveness of context
- Nature of instruction

# Approach

## Factors historically associated with differences in students' educational opportunities:

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

# Correlations Between Factors

## Correlations between:

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

# Symposium Structure

- **Three 15 minute talks**
  - Well-prepared teachers
  - Material resources
  - Nature of instruction

- **10 minutes for group discussion following each talk**
  - padlet

# Well-Prepared Teachers

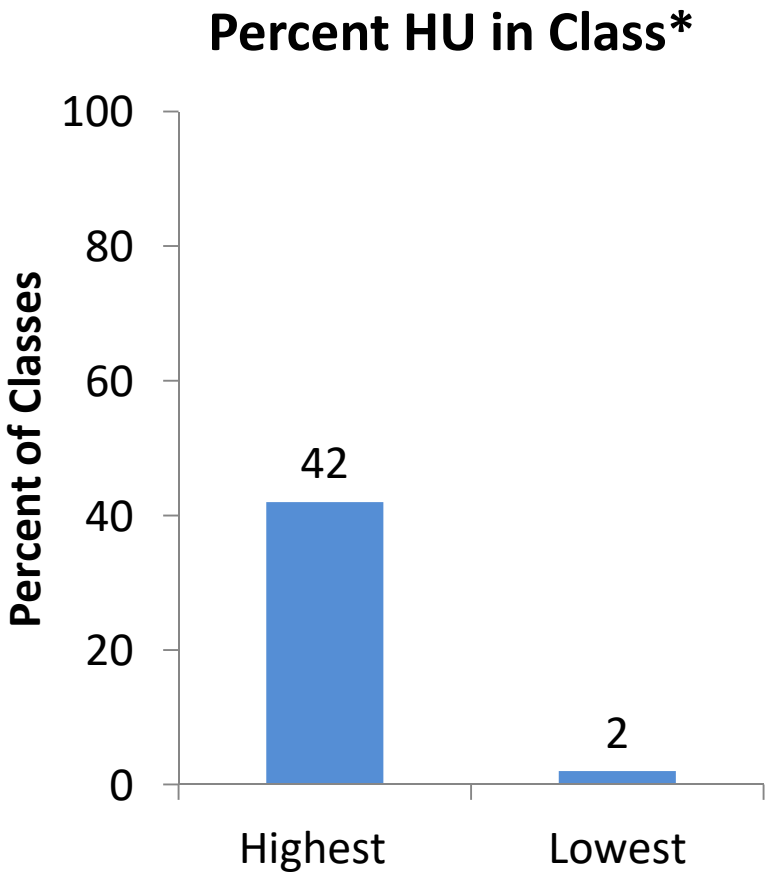
**NSSME+ collected data on teachers including:**

- **Background**
- **Perceptions of preparedness (content & pedagogical)**
- **Professional development opportunities**

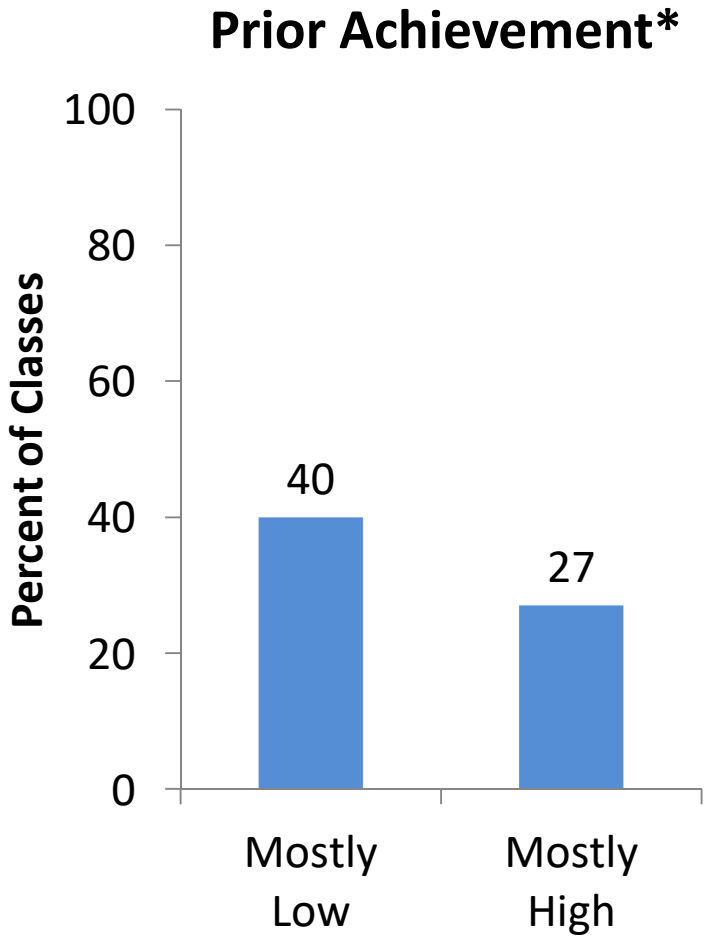
# Characteristics of the Teaching Force

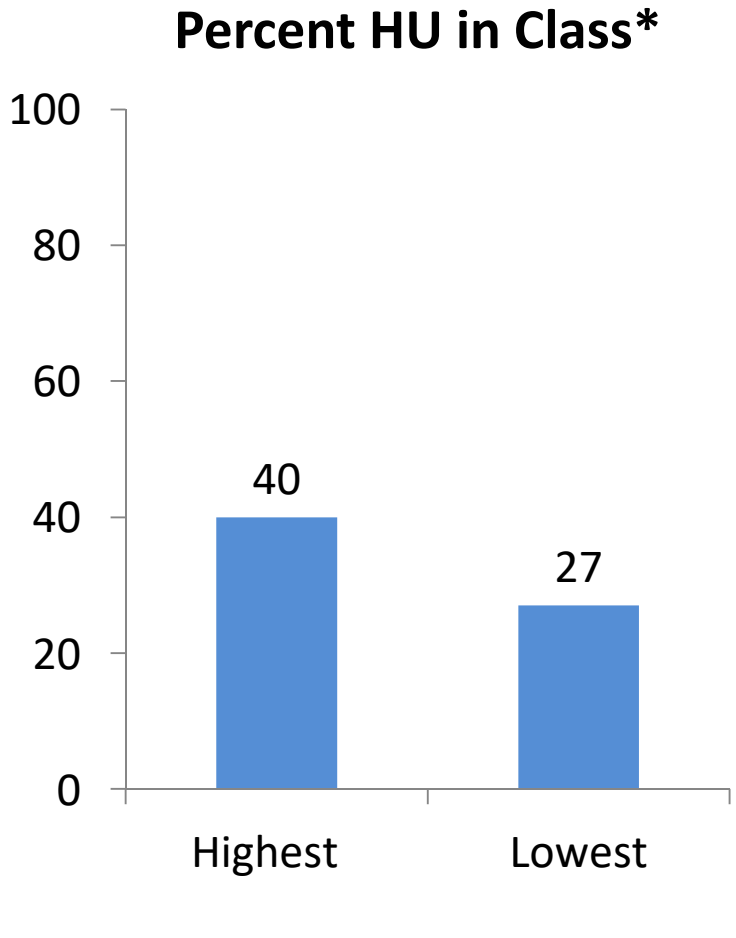
| | Percent of Teachers | | |
|---|---|---|---|
| | **Elementary** | **Middle** | **High** |
| **Sex** | | | |
| Female | 94 | 71 | 57 |
| Male | 6 | 28 | 43 |
| **Race/Ethnicity** | | | |
| White | 88 | 91 | 91 |
| Black or African-American | 8 | 8 | 5 |
| Hispanic or Latino | 9 | 7 | 6 |
| Asian | 2 | 2 | 5 |
| American Indian/Alaskan Native | 1 | 2 | 2 |
| Native Hawaiian/Other Pacific Islander | 1 | 0 | 0 |

# Classes Taught by Teachers from Historically Underrepresented Groups



# Classes Taught by Novice Teachers



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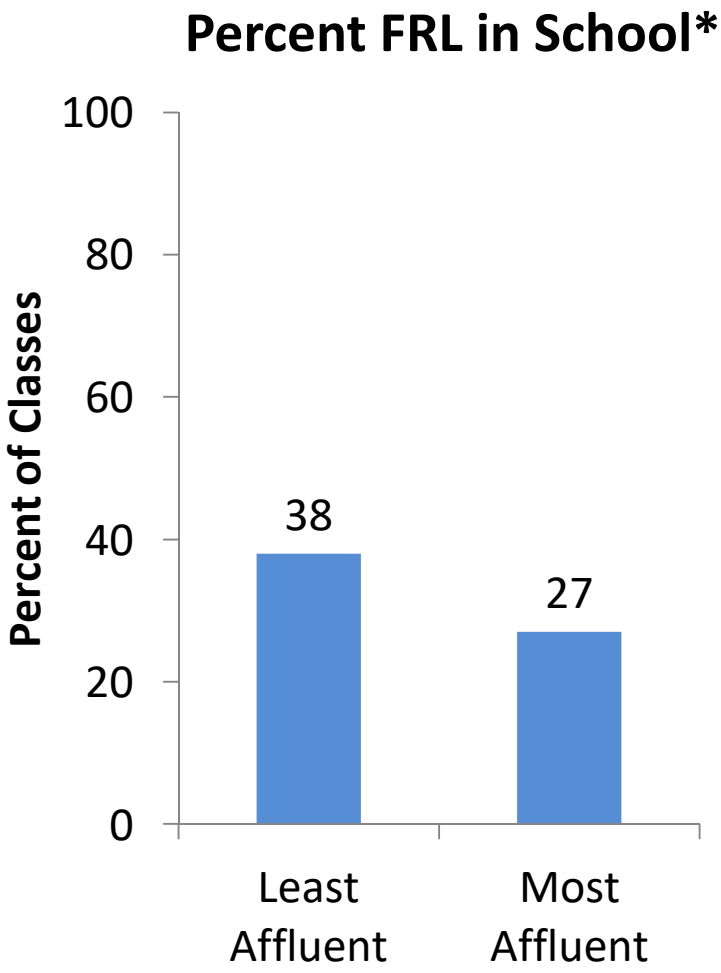
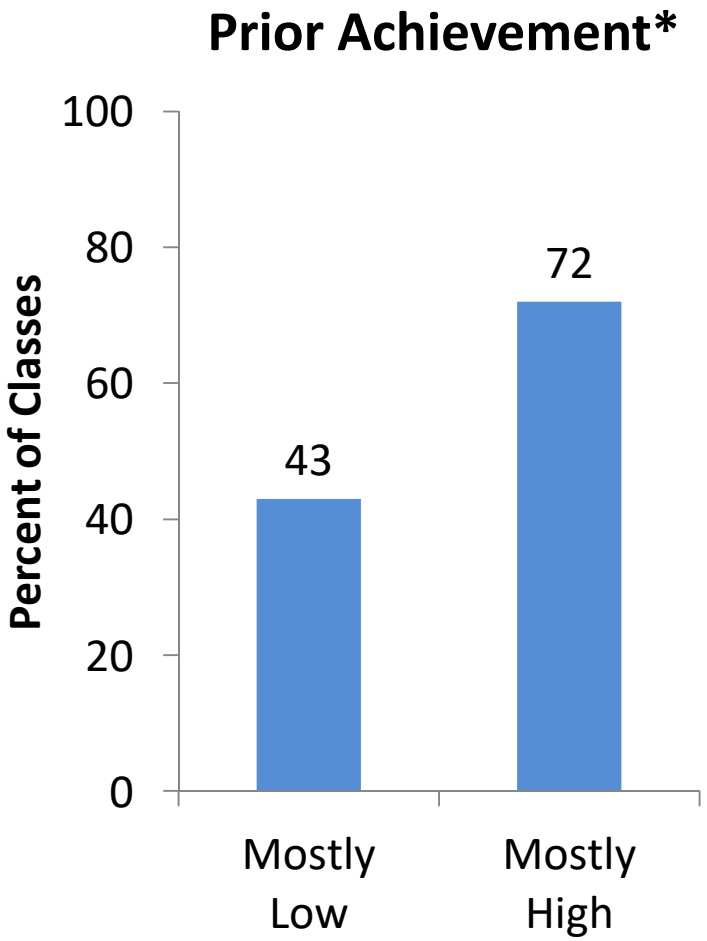
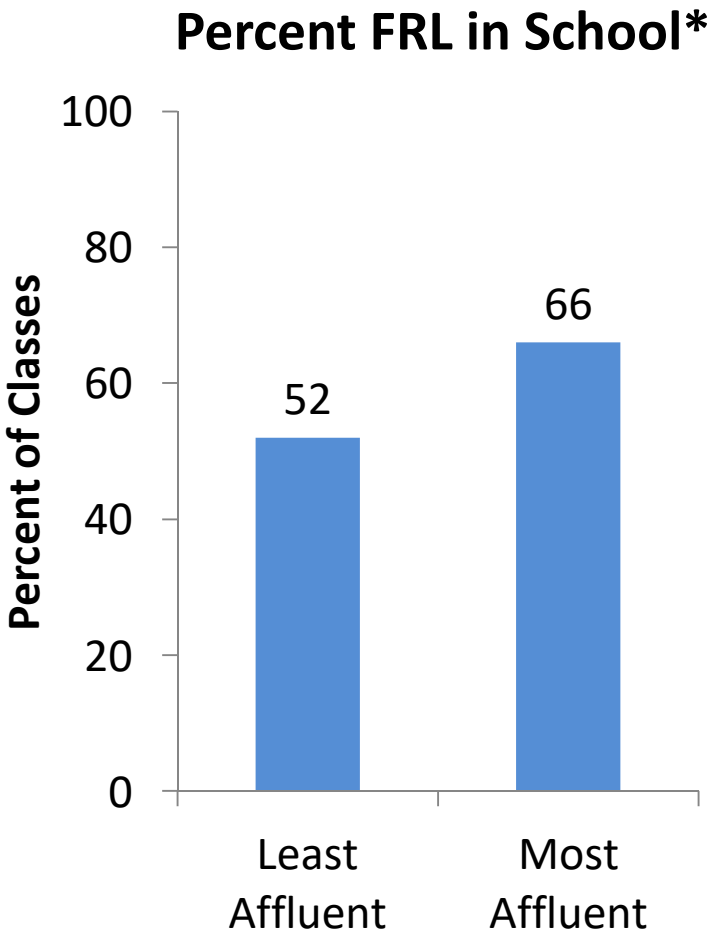


# Classes Taught by Teachers with a Substantial Science Content Background



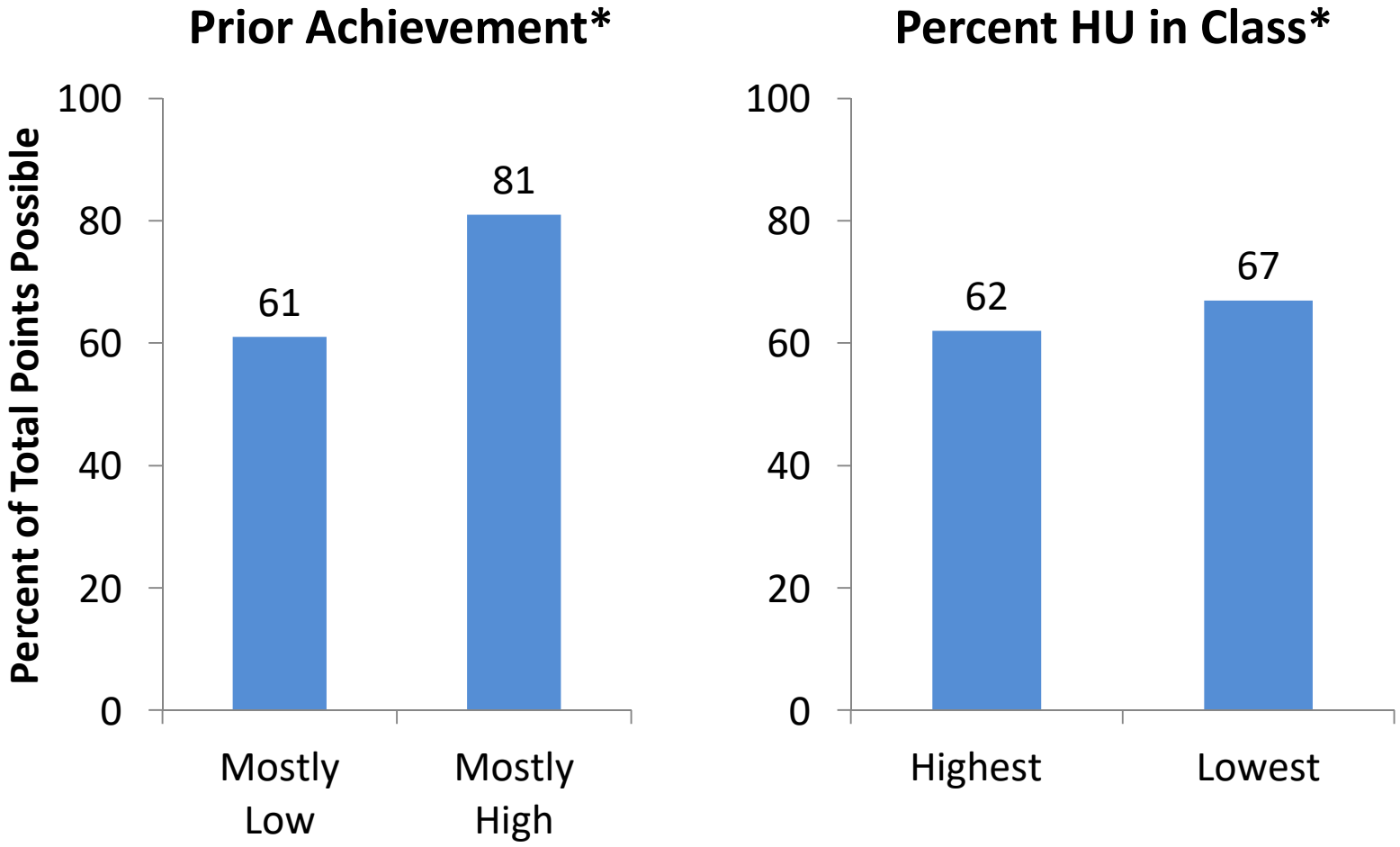



# Teacher Preparedness

## Preparedness to Teach Science Content Composite:

- Calculated based on topics taught in a randomly selected class
- Defined differently across subjects and grade ranges
- Earth Science:
  - Earth's features and physical processes
  - The solar system and the universe
  - Climate and weather

# Preparedness to Teach Science Content Composite



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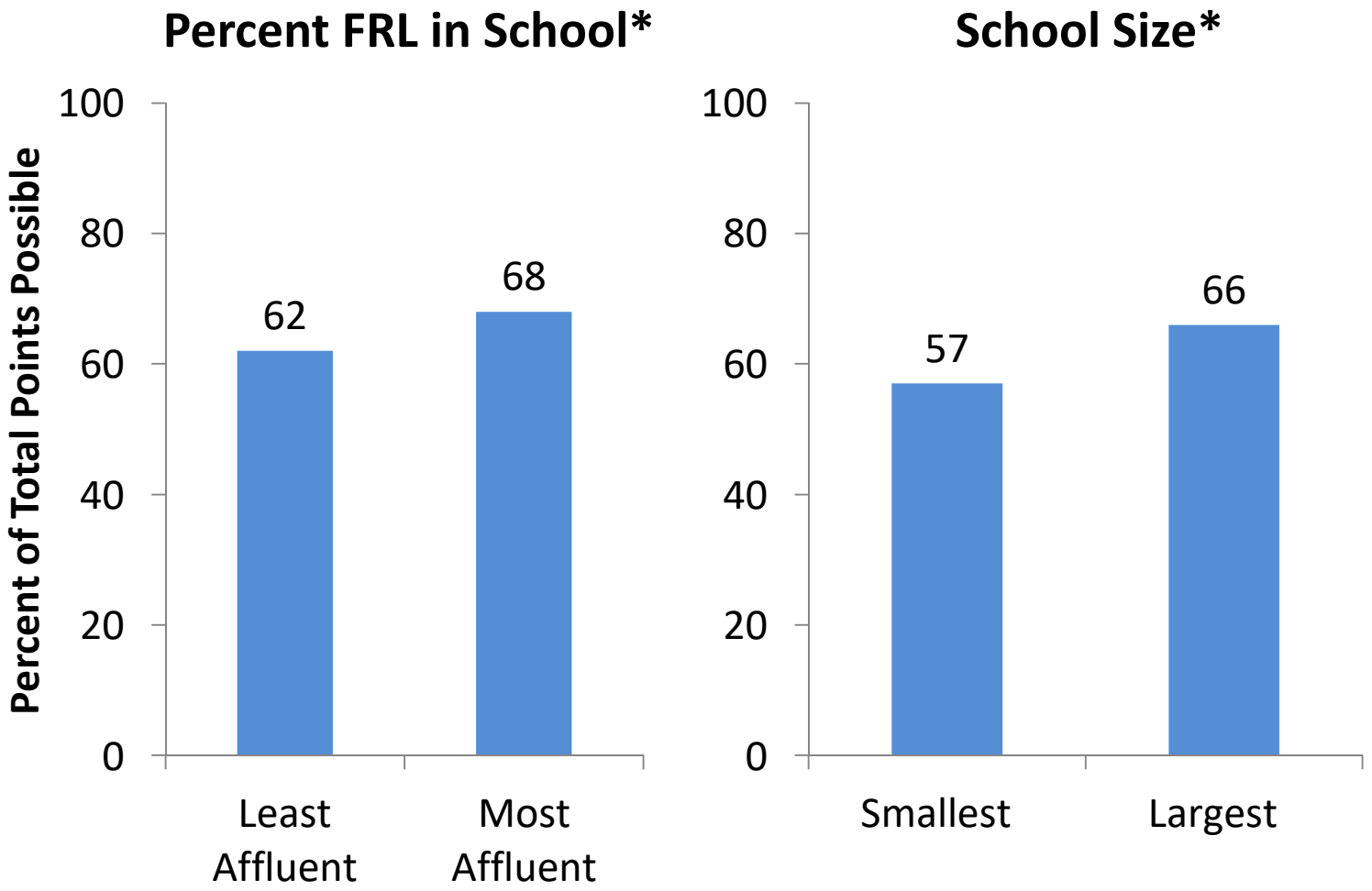
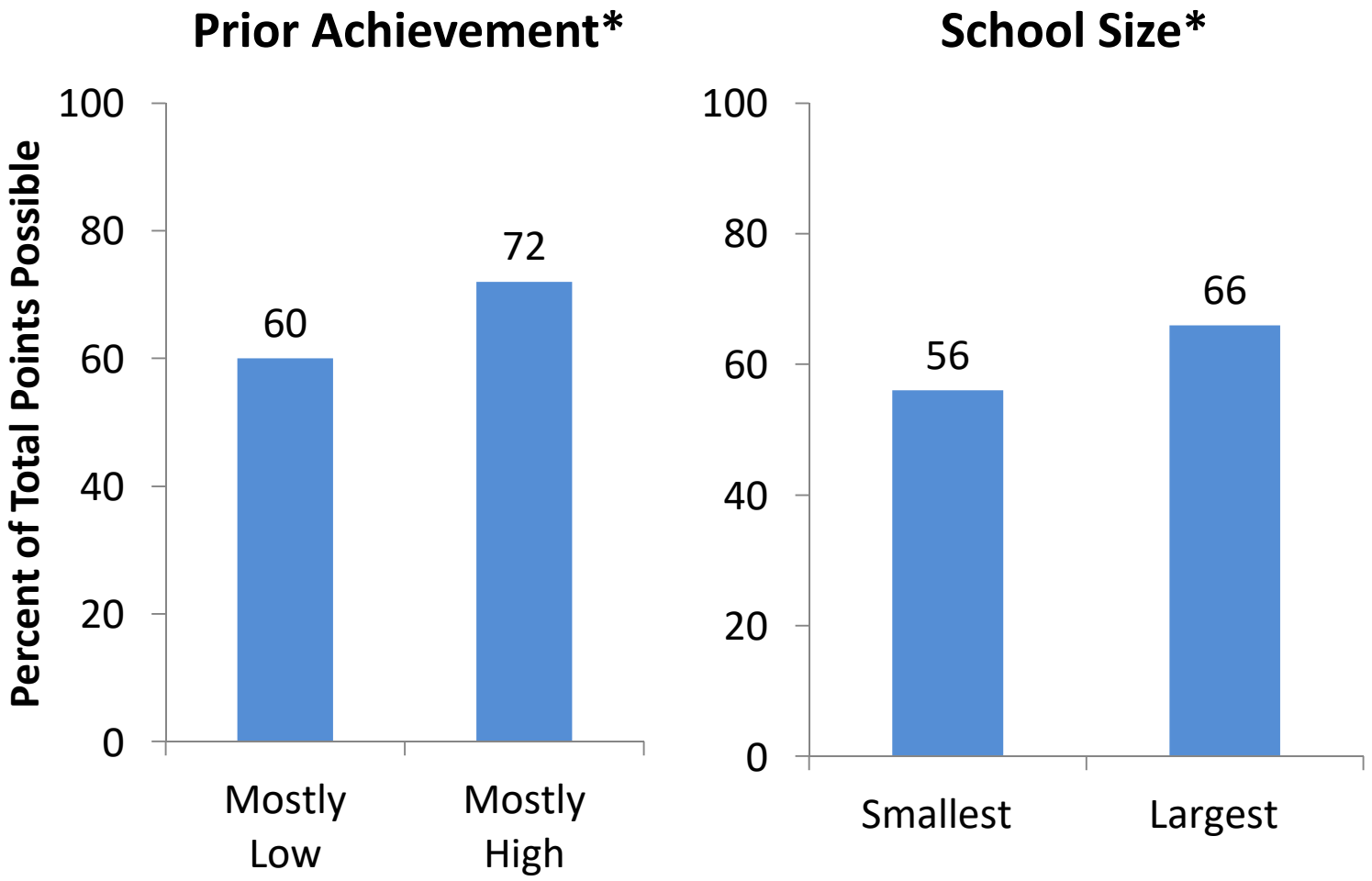


# Teacher Preparedness

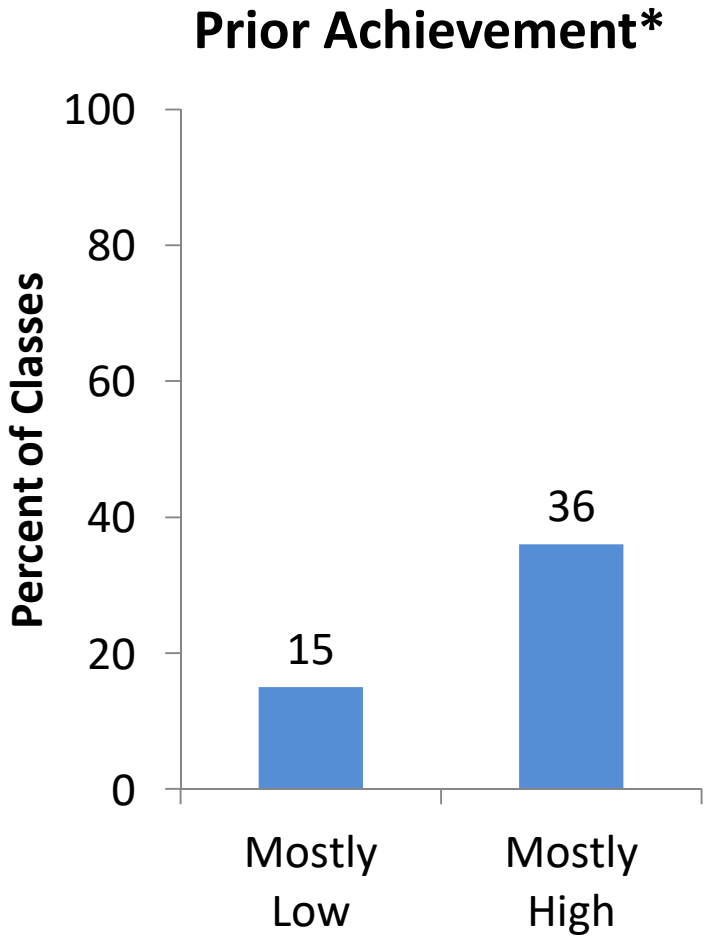
## Perceptions of Pedagogical Preparedness Composite:

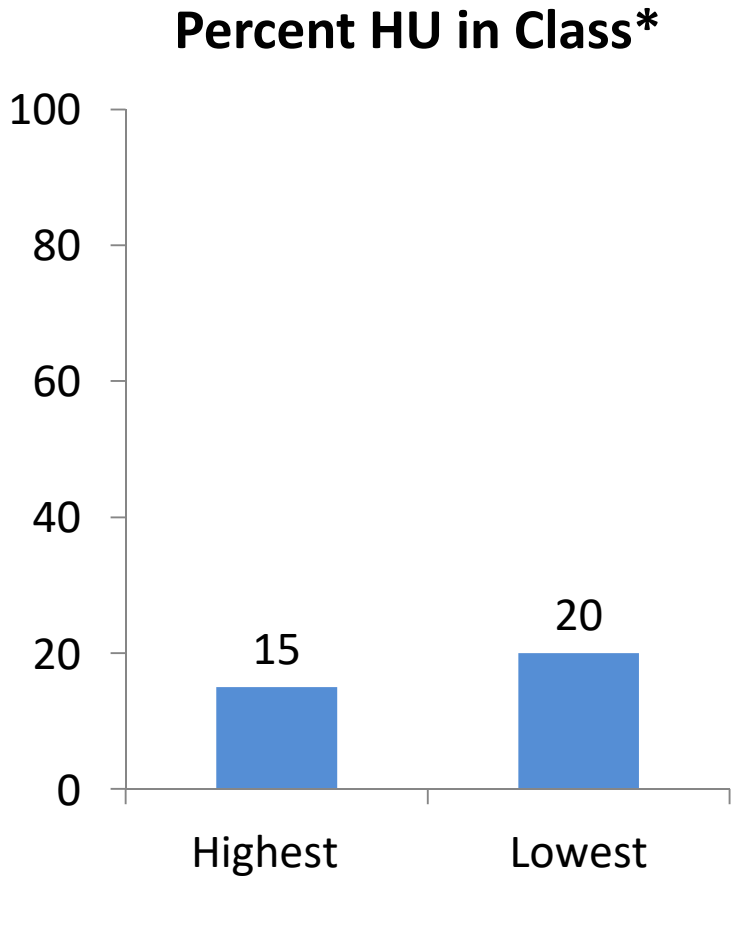
- Develop students' conceptual understanding of the science ideas you teach
- Develop students' abilities to do science
- Develop students' awareness of STEM careers
- Provide science instruction that is based on student's ideas about the topics you teach
- Use formative assessment to monitor student learning
- Differentiate science instruction
- Incorporate students' cultural backgrounds into science instruction
- Encourage students' interest in science and/or engineering
- Encourage participation of all students in science and/or engineering

# Pedagogical Preparedness Composite



# Classes Taught by Teachers With More Than 35 Hours of Science PD in the Last Three Years



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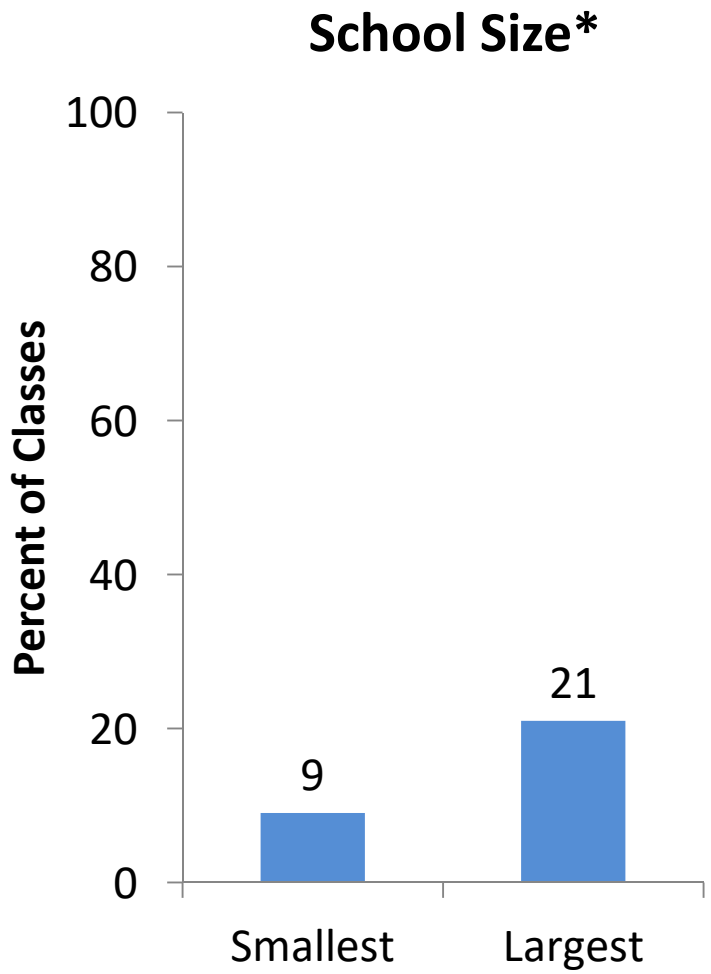


# Science-Focused Workshops

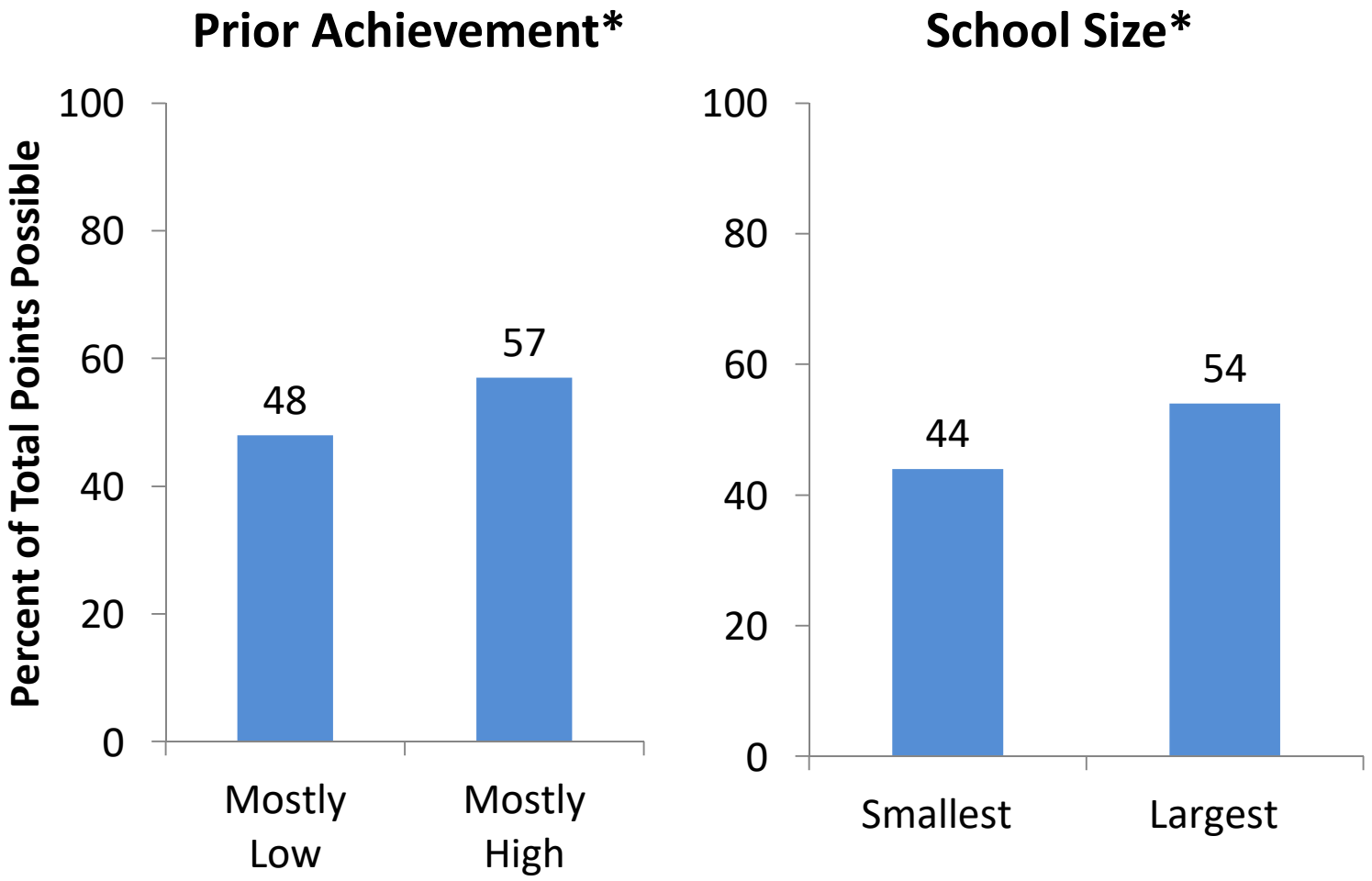
| | Percent of Schools |
|---|---|
| **Percent of Students in School Eligible for FRL*** | |
| Lowest Quartile | 44 |
| Highest Quartile | 56 |
| **School Size*** | |
| Smallest Schools | 42 |
| Largest Schools | 62 |
| **Community*** | |
| Rural | 37 |
| Suburban | 53 |
| Urban | 59 |

# Effective PD

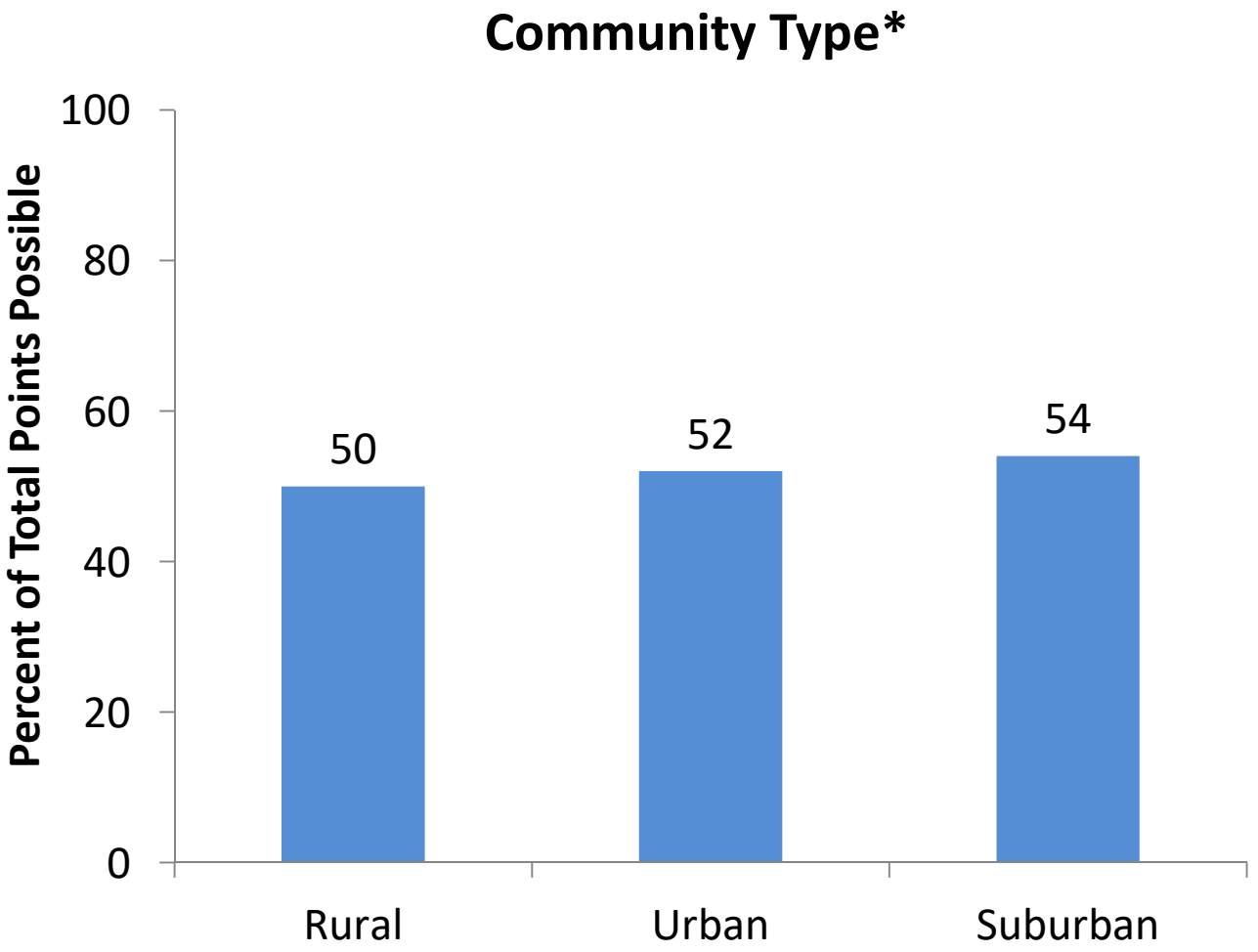
## Extent Professional Development Aligns with Elements of Effective Professional Development Composite:

- Worked closely with other teachers from their school
- Worked closely with other teachers who taught the same grade and/or subject whether or not from their school
- Had opportunities to engage in science investigations/ engineering design challenges
- Had opportunities to experience lessons as their students would
- 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
- Had opportunities to rehearse instructional practices

# Alignment with Elements of Effective PD Composite



# Alignment with Elements of Effective PD Composite

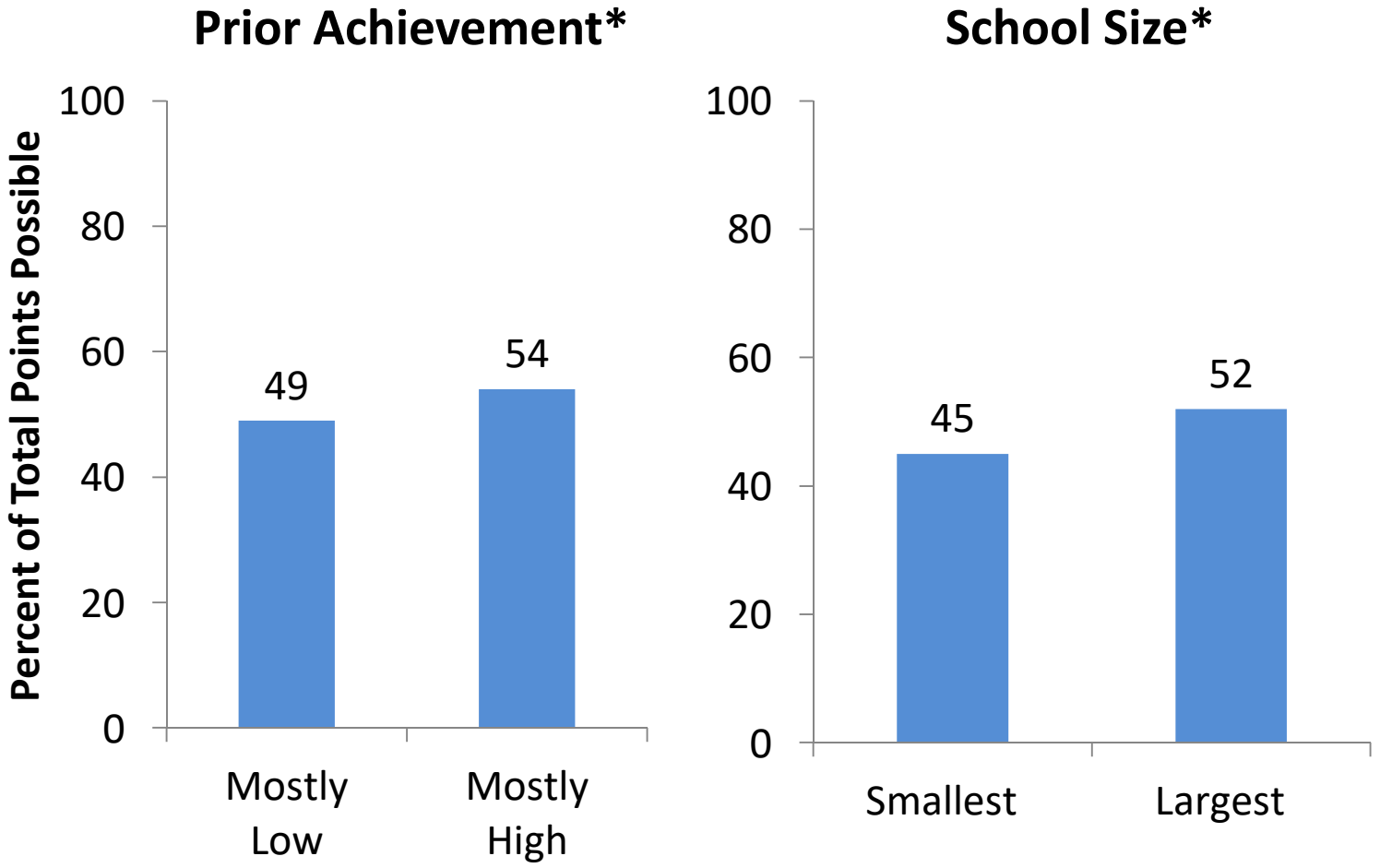


# PD Supports Student-Centered Instruction Composite

## Extent Professional Development Supports Student-Centered Instruction Composite:

- Deepening your own science content knowledge
- Deepening your understanding of how science is done
- Deepening your understanding of how engineering is done
- Implementing the science textbook/modules to be used in your classroom
- Learning about difficulties that students may have with particular science ideas
- Finding out what students think or already know prior to instruction on a topic
- Monitoring student understanding during science instruction
- Differentiating science instruction

# PD Supports Student-Centered Instruction Composite



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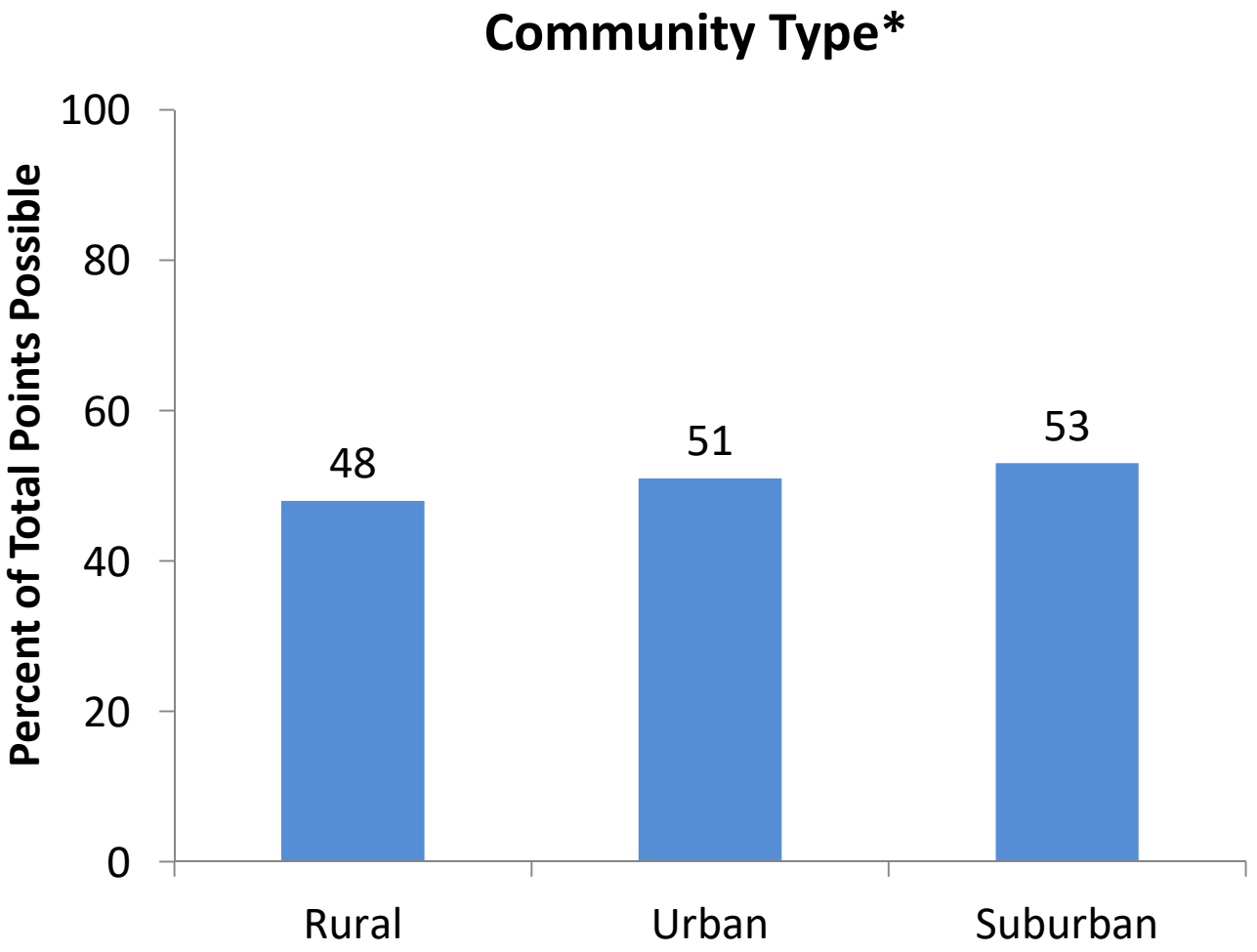


# Discussion (10 minutes)

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

2. What insights do you have about effective methods/strategies to address inequitable distribution of resources in the context in which you work?

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

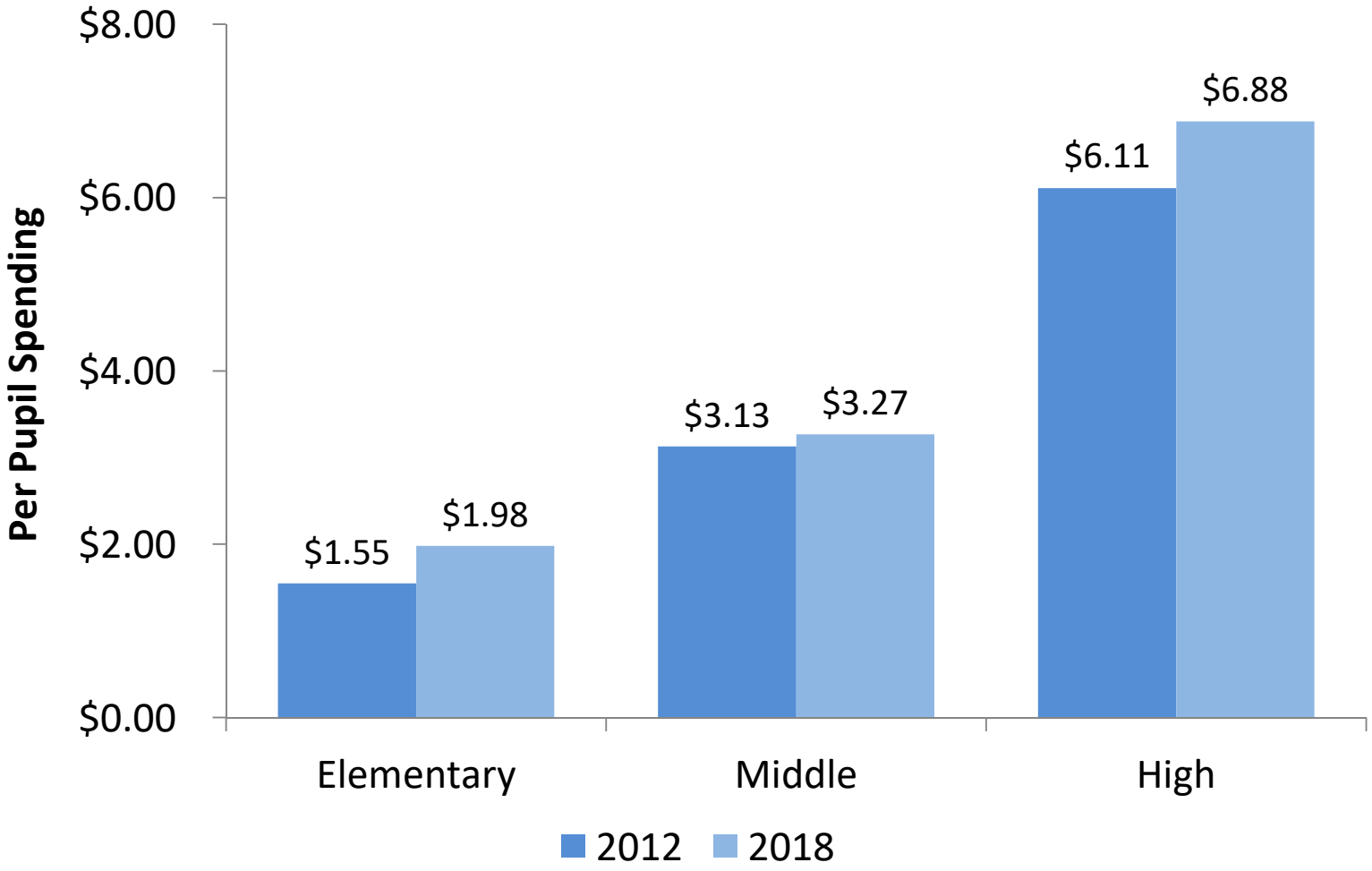
https://bit.ly/2U2R9m3

# Supportiveness of Context for Science Instruction

**NSSME+ collected data on contextual factors including:**

- Resources for science instruction
- Science enrichment opportunities
- Students and teachers
- Policies

# Median School Spending Per Pupil for Science



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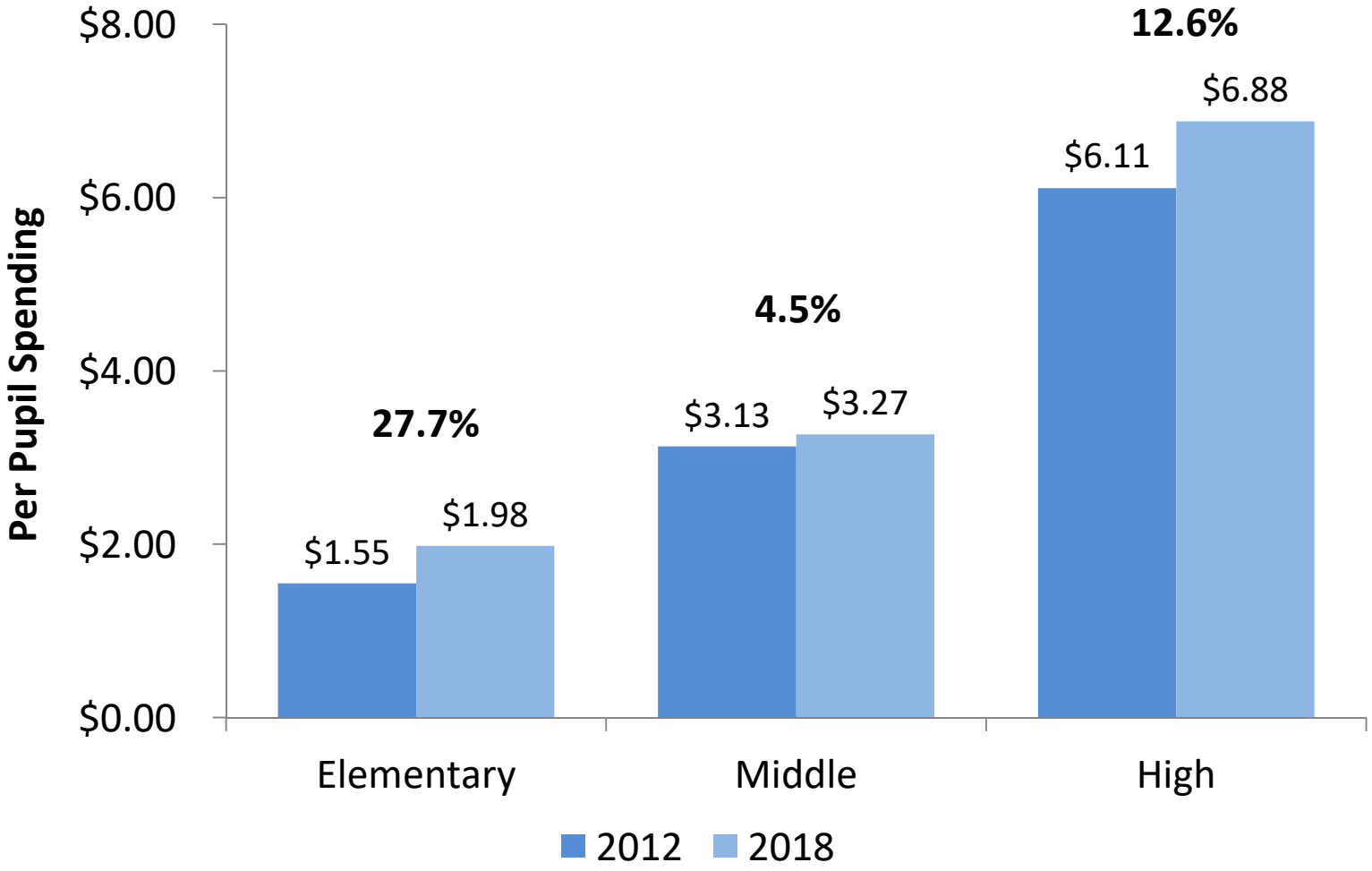
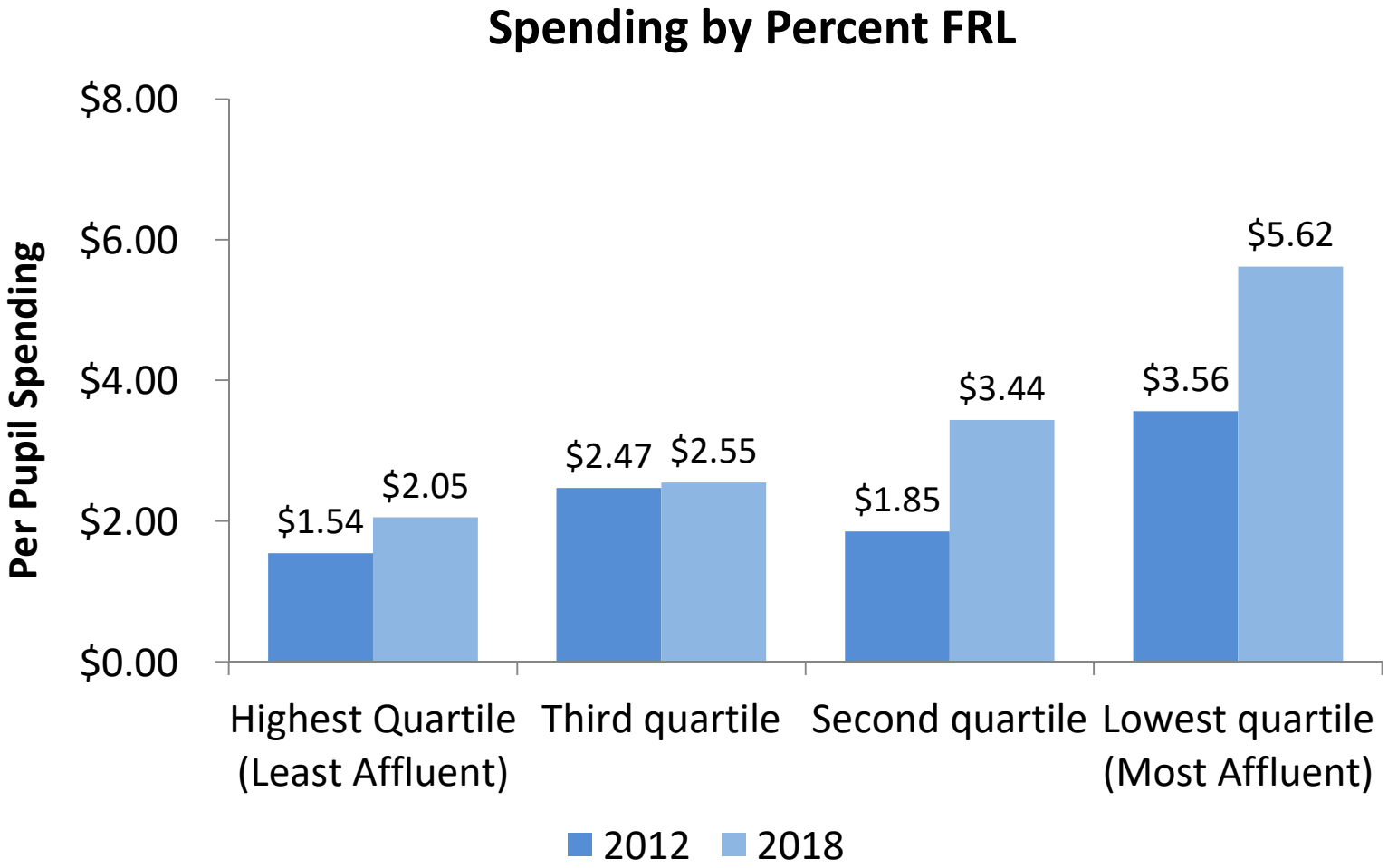


# Equity Analysis



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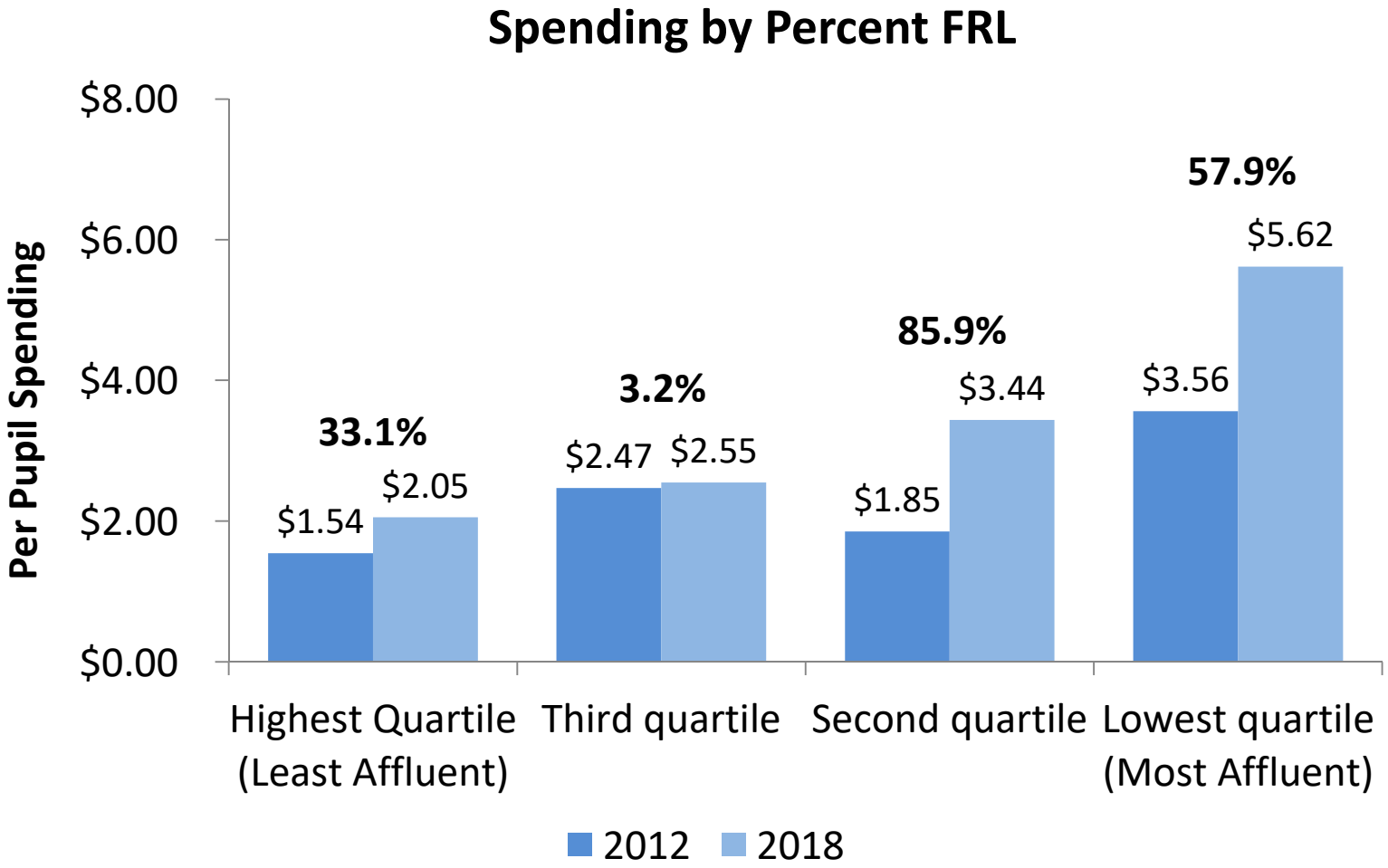
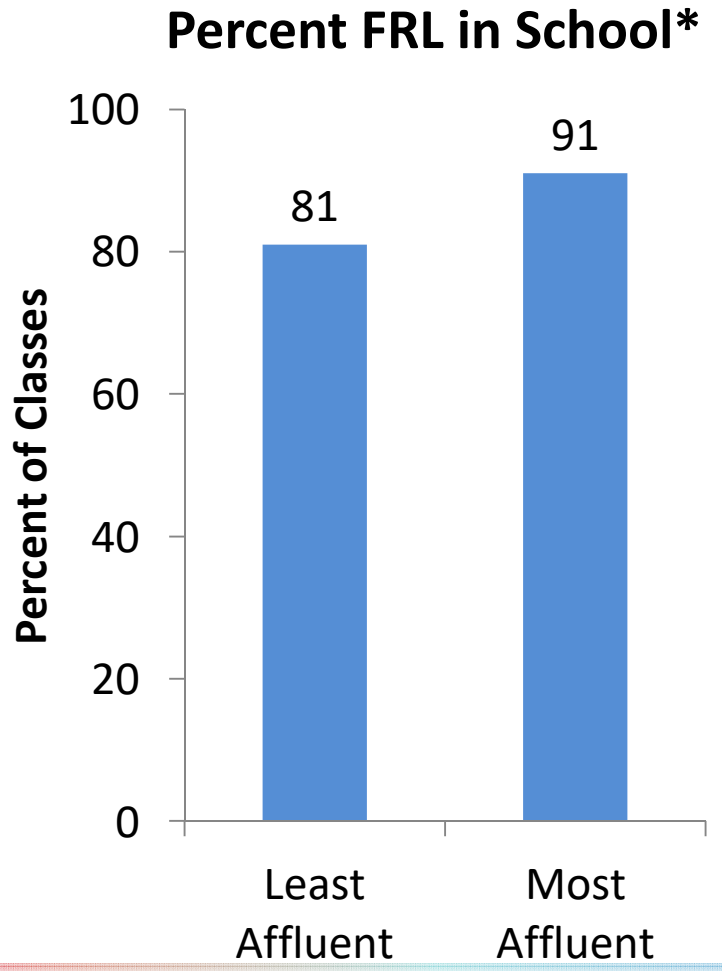


# Availability of Balances



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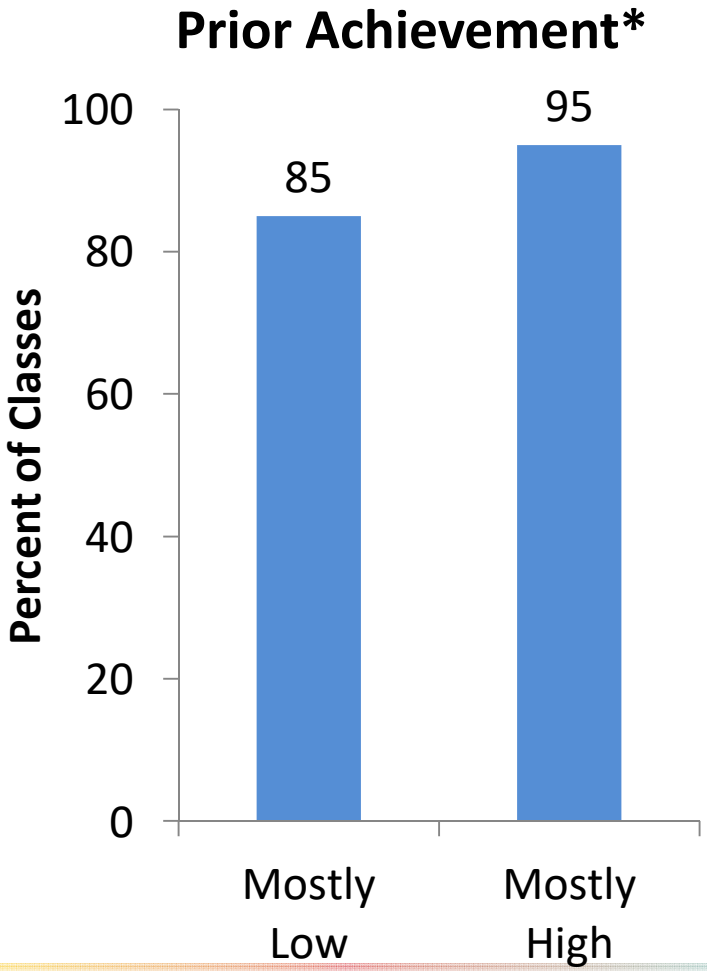
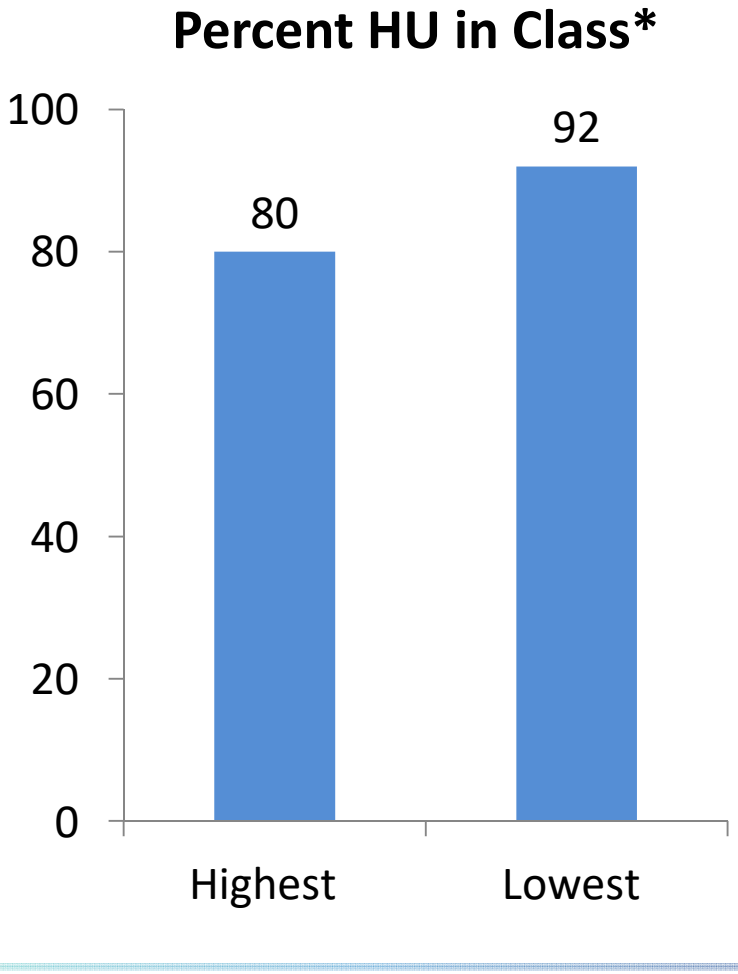
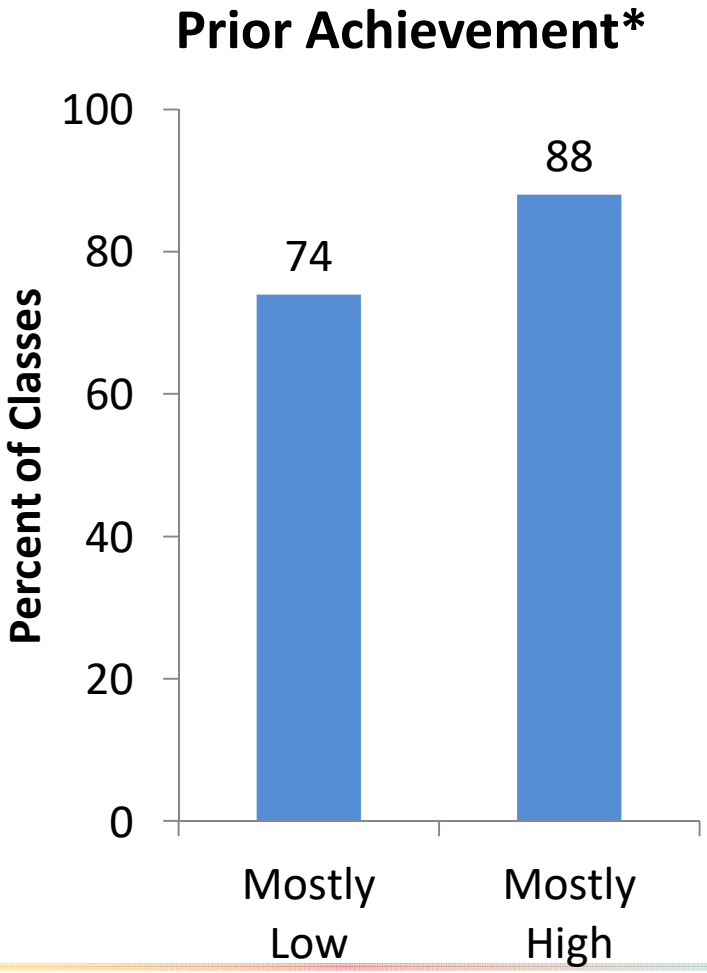
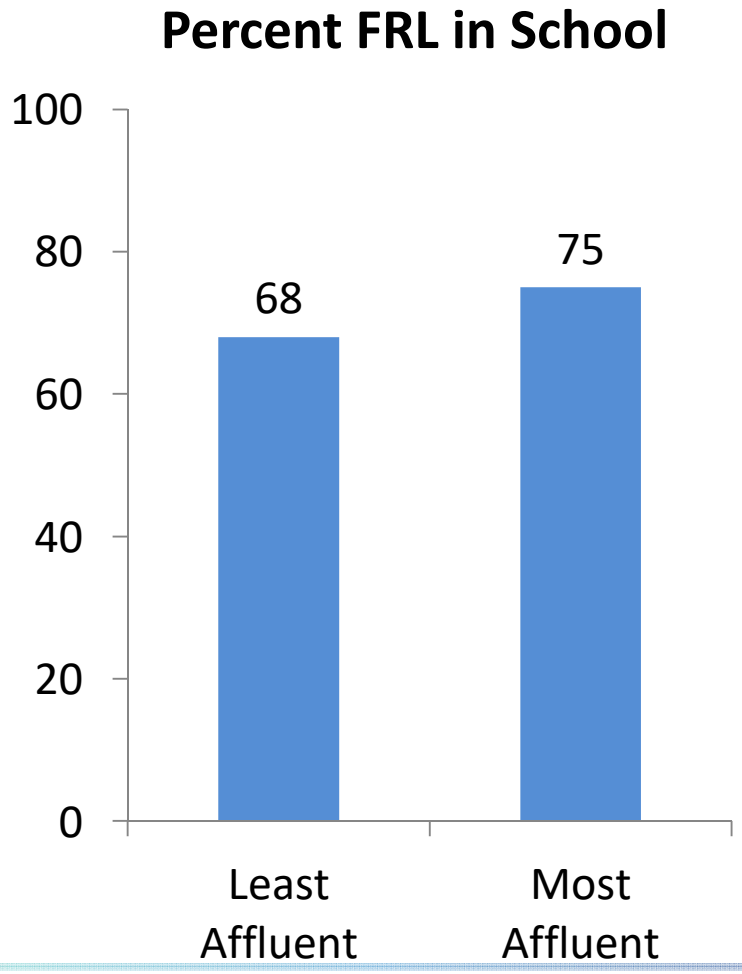


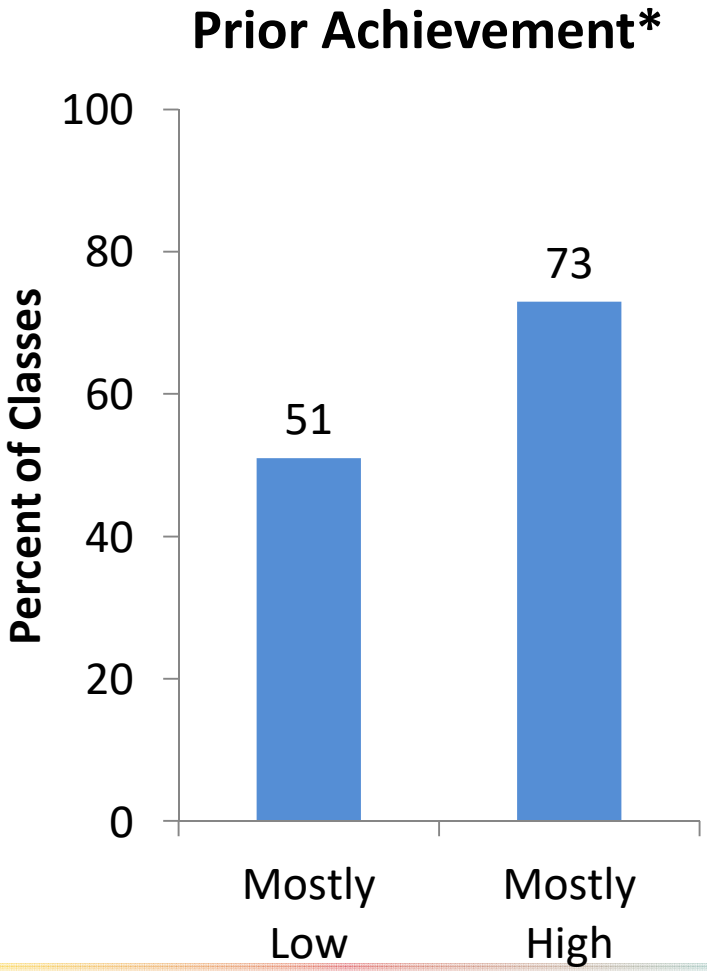



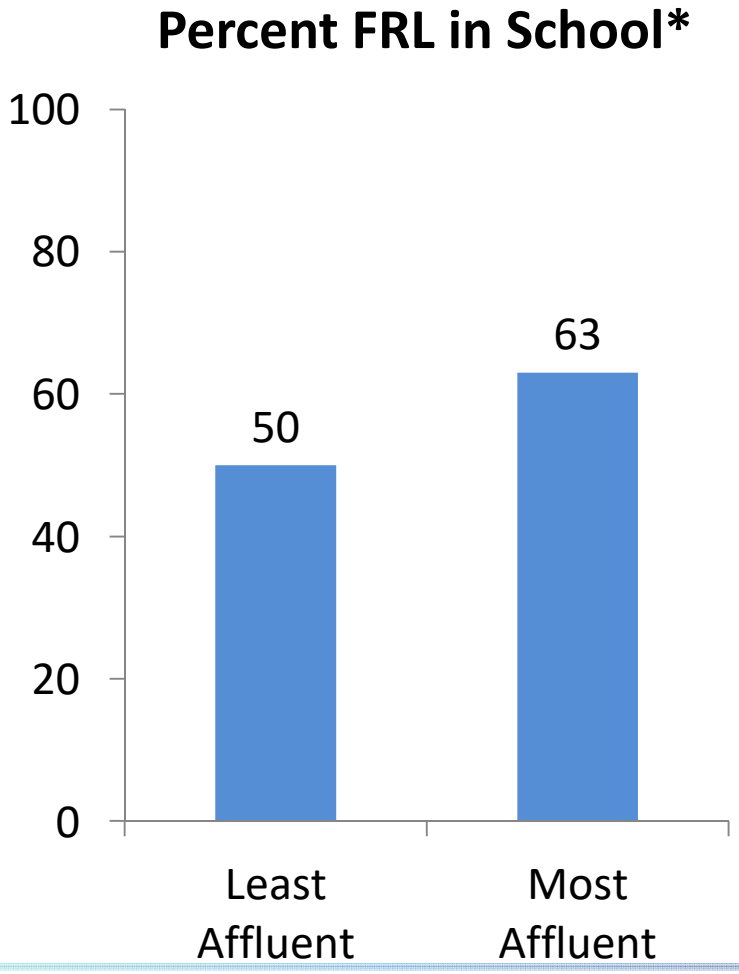
# Availability of Microscopes



# Availability of Probes for Collecting Data



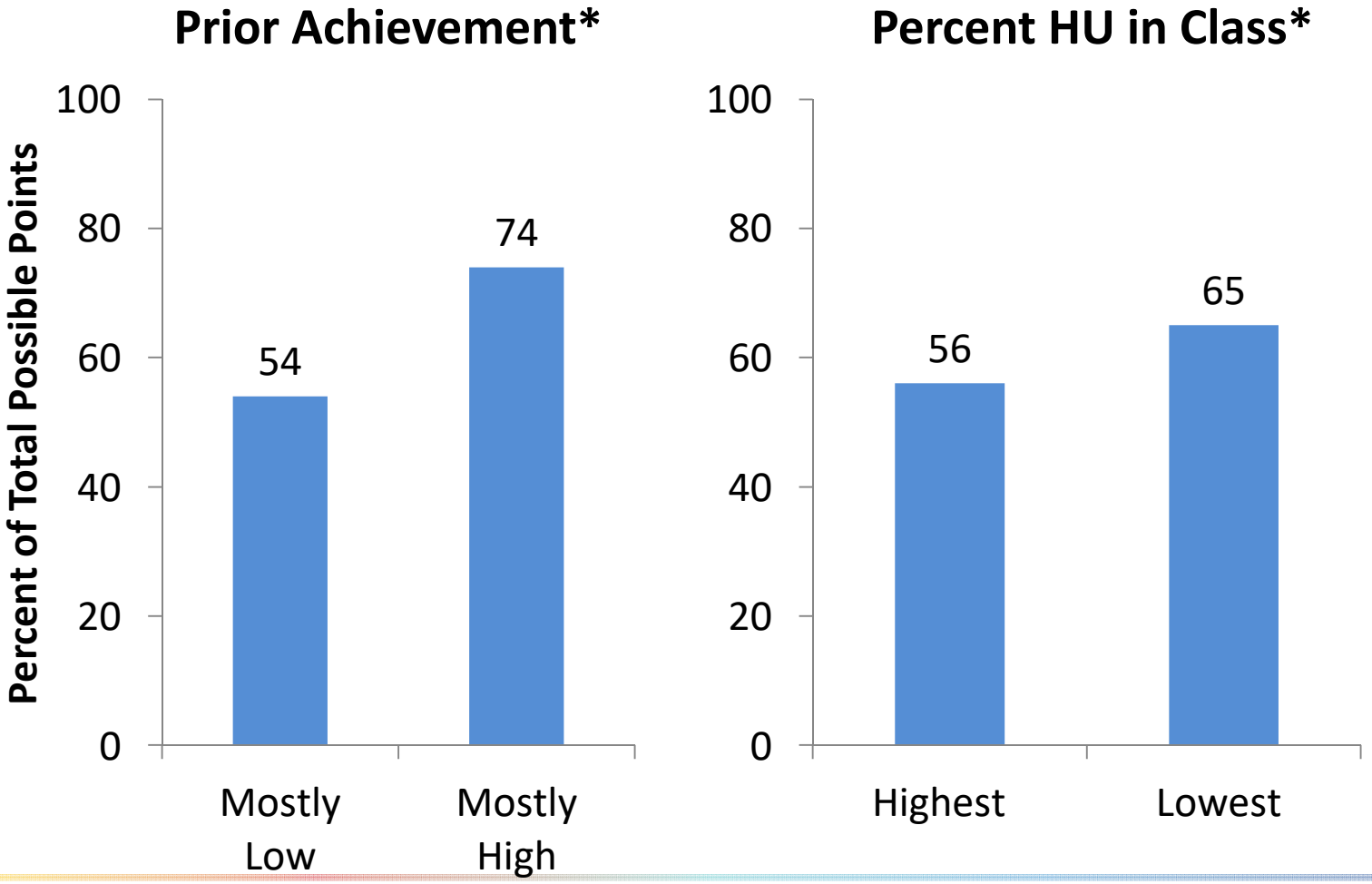



# Adequacy of Resources

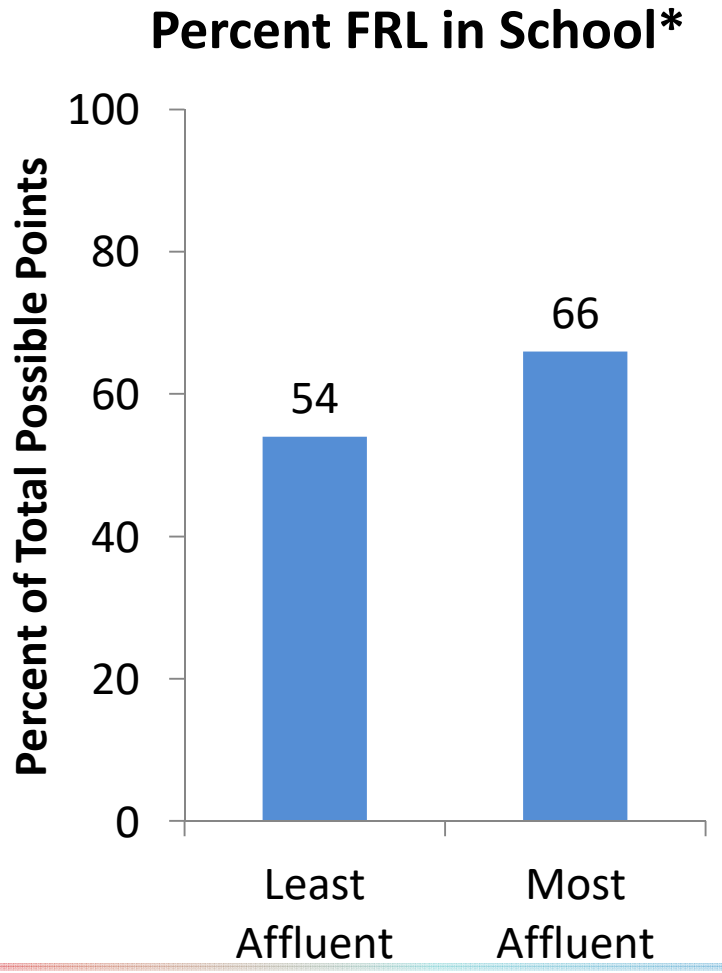
**Several survey items were combined into a composite variable titled Adequacy of Resources:**

- Instructional technology
- Consumable supplies
- Equipment
- Facilities

# Adequacy of Resources—Composite



# Adequacy of Resources—Composite

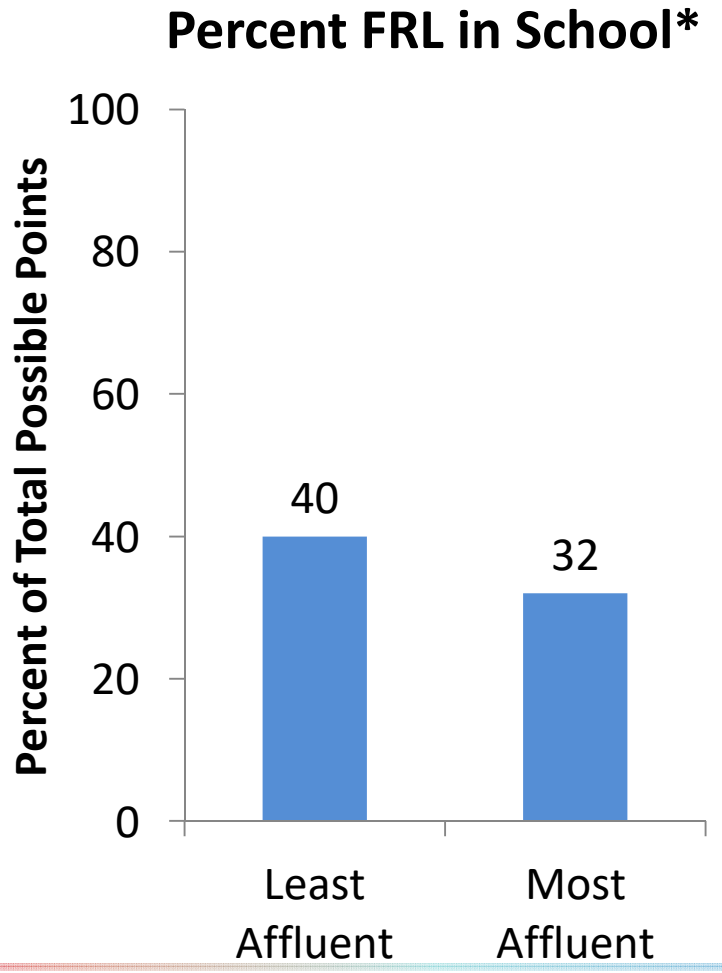


# Extent to Which Lack of Resources Is Problematic—Composite

## Survey items include:

- Lack of science facilities
- Inadequate funds for purchasing science equipment and supplies
- Lack of science textbooks/modules
- Poor quality science textbooks/modules
- Inadequate materials for differentiating science instruction

# Lack of Resources Is Problematic—Composite



# School-Based Programs to Enhance Interest or Achievement

## After-school help in science and/or engineering

- More likely in high %FRL schools

## After-school enrichment programs in science and/or engineering

- More likely in largest schools

## Science clubs

- More likely in largest schools

## Engineering clubs

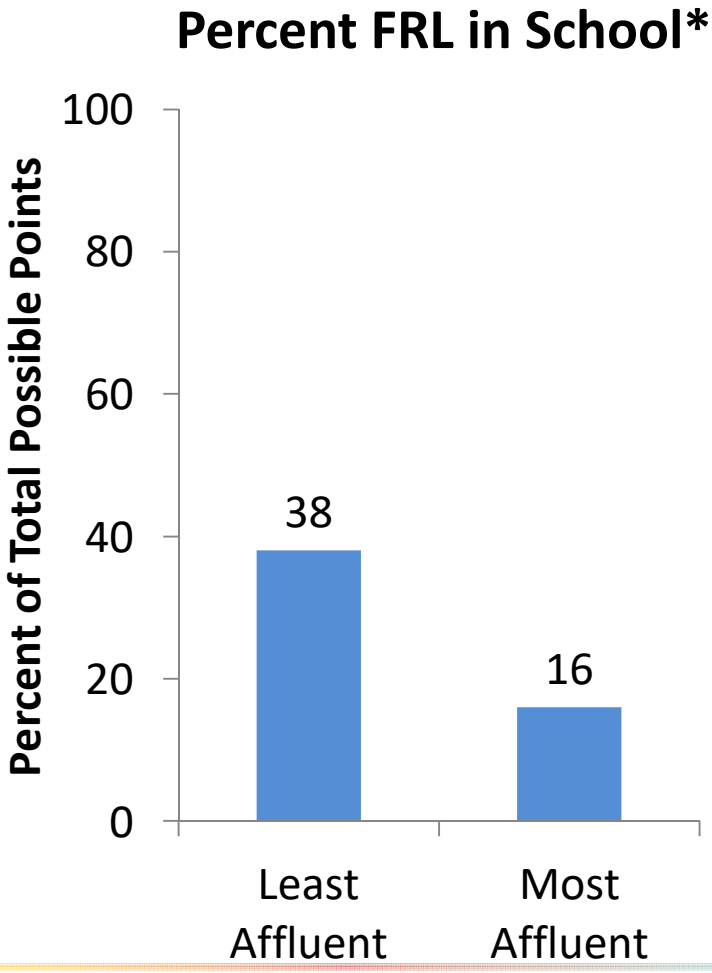
- More likely in low %FRL schools and in largest schools

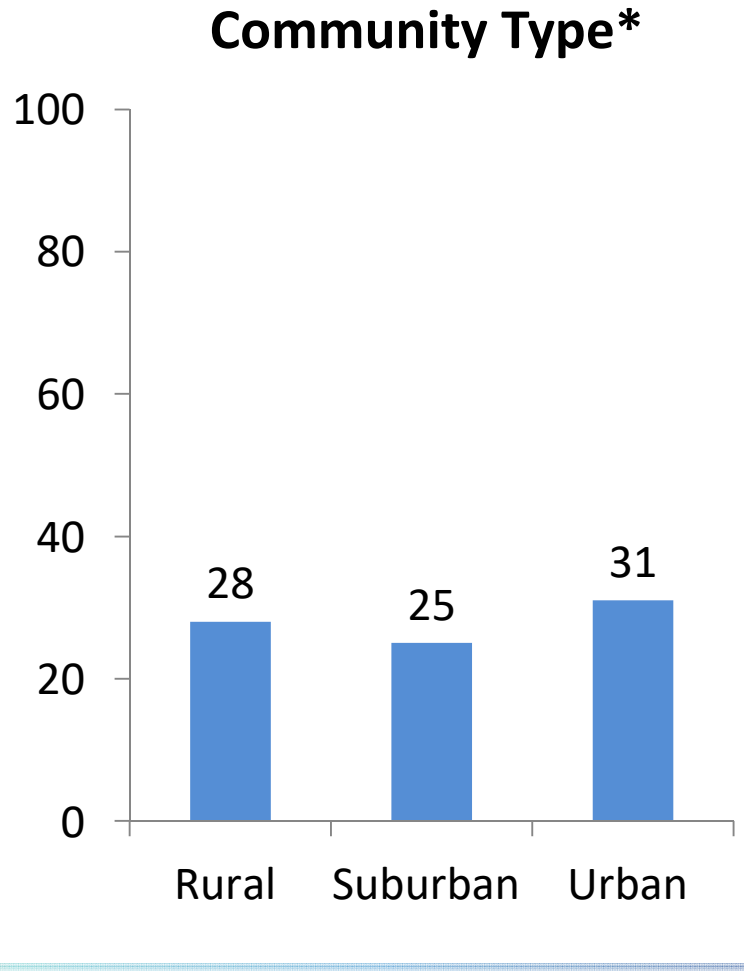
# Extent to Which Student Issues Are Problematic—Composite

## Survey items include:

- Low student interest in science
- Low student prior knowledge and skills
- High student absenteeism
- Inappropriate student behavior
- Lack of parent/guardian support and involvement
- Community resistance to the teaching of "controversial" issues in science (e.g., evolution, climate change)

# Extent to Which Student Issues Are Problematic—Composite



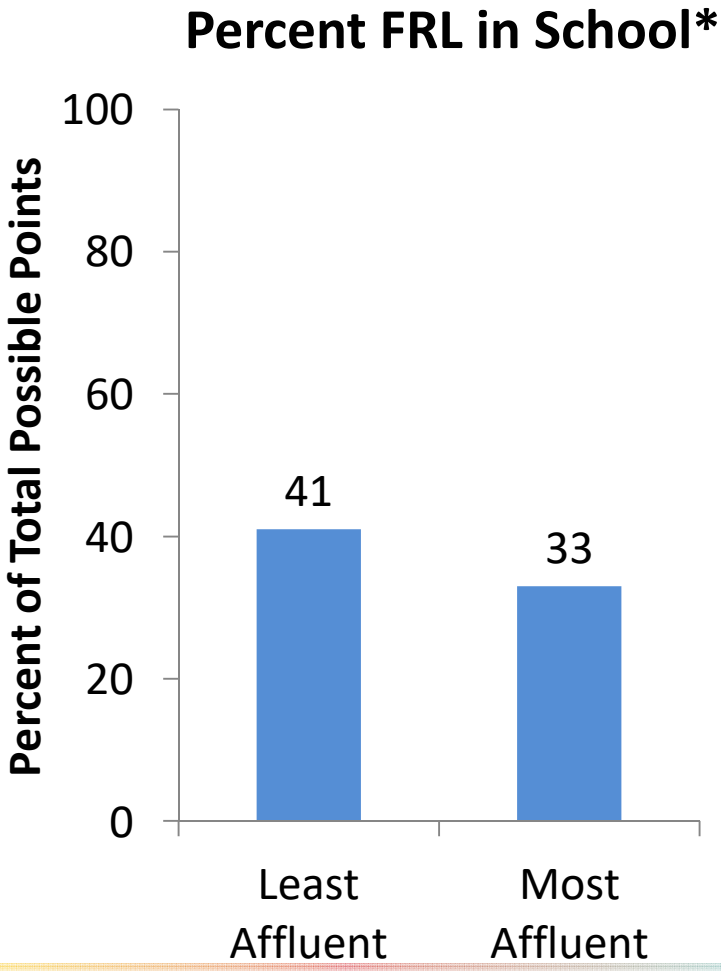



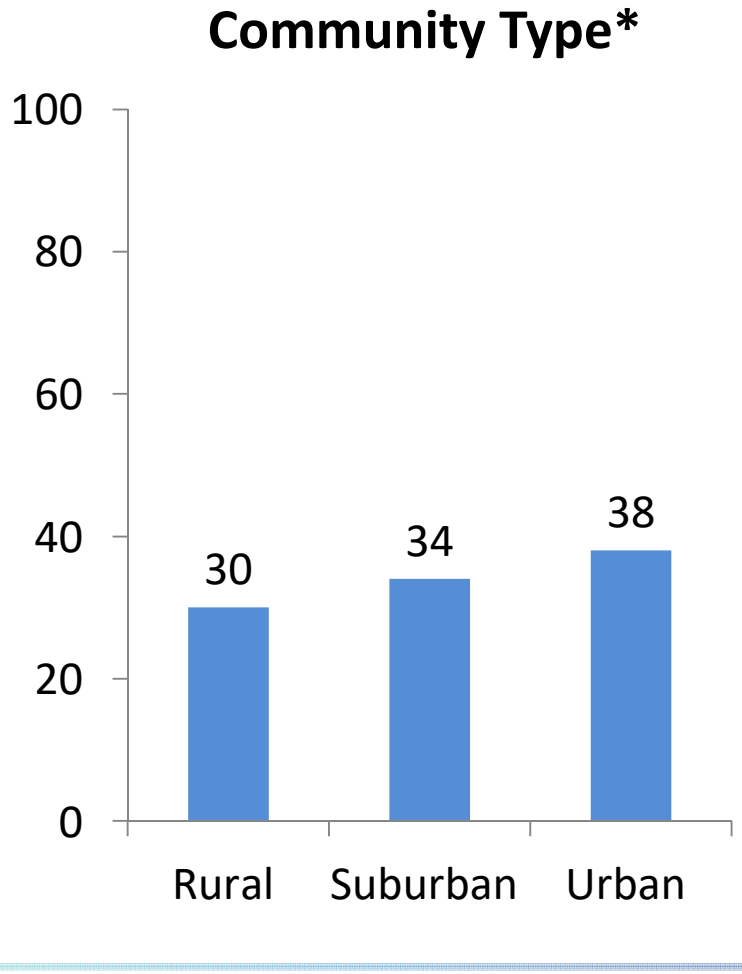
# Extent to Which Teacher Issues Are Problematic—Composite

## Survey items include:

- Lack of teacher interest in science
- Inadequate teacher preparation to teach science

# Extent to Which Teacher Issues Are Problematic—Composite



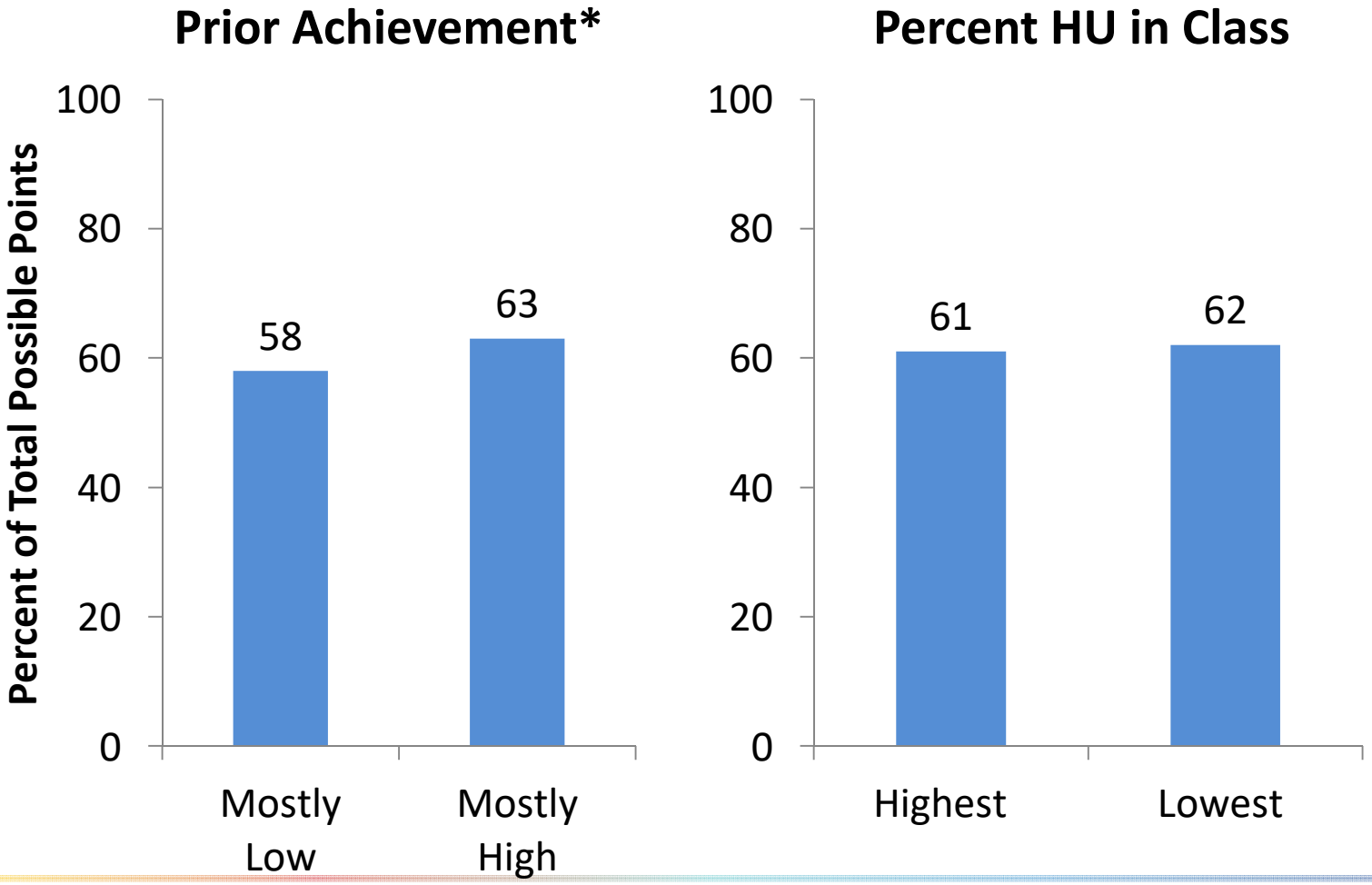



# Extent to Which Policy Environment Promotes Effective Instruction—Composite

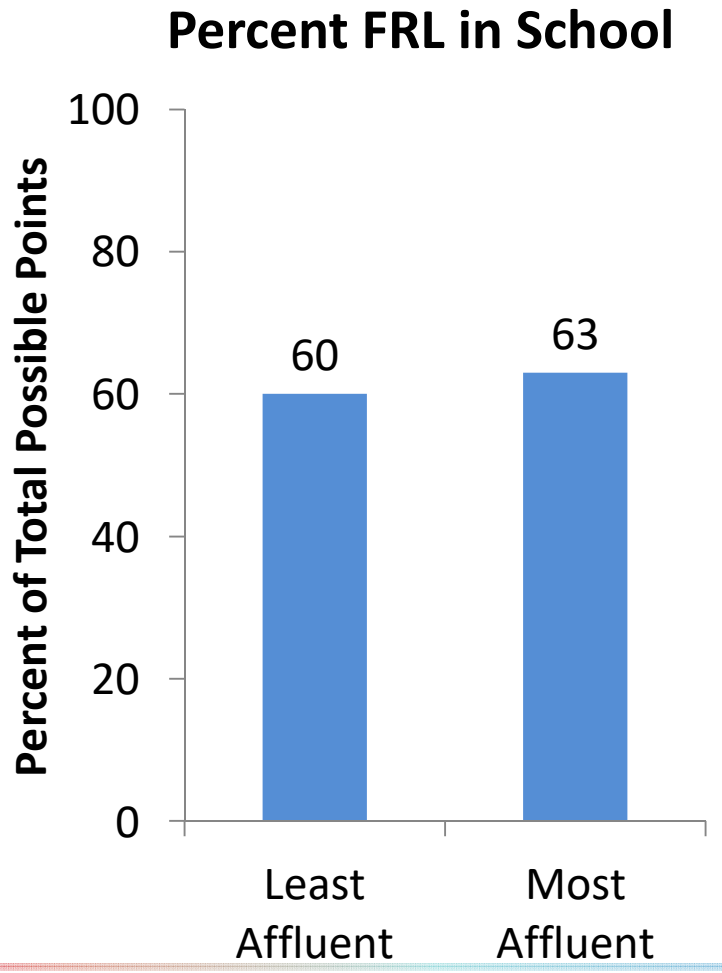
## Survey items include:

- Current state standards
- School/District pacing guides
- State/District testing/accountability policies
- Textbook/module selection policies
- Teacher evaluation policies

# Teacher Opinion of Policy Environment Support—Composite



# Teacher Opinion of Policy Environment Support—Composite



# Discussion (10 minutes)

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

2. What insights do you have about effective methods/strategies to address inequitable distribution of resources in the context in which you work?

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

https://bit.ly/2V0tmQ1

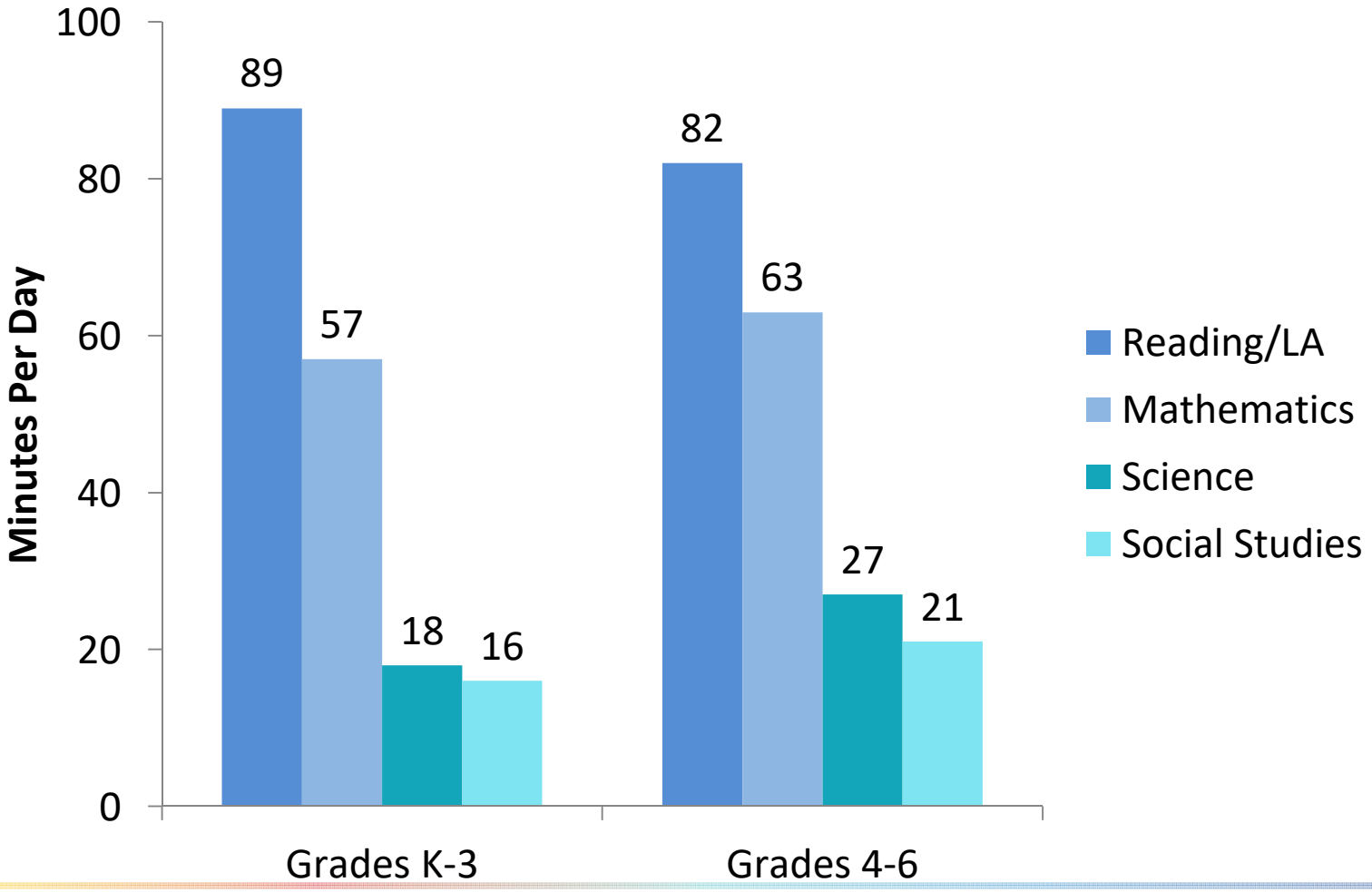
# Science Instruction*

## What science learning opportunities do students have in schools?

## The 2018 NSSME+ collected data on:

- Time on science in elementary grades
- Course offerings in secondary schools
- Instructional objectives
- Classroom practices
- Engagement of students with science practices

# Instructional Time: Elementary



# Science Instructional Time: Elementary

| | Average Minutes per Day |
|---|---|
| **Prior Achievement Level of Class** | |
| Mostly High | 22 |
| Mostly Low | 22 |
| **Percent Historically Underrepresented Students in Class*** | |
| Lowest | 17 |
| Highest | 23 |
| **Percent of Students in School Eligible for FRL** | |
| Most Affluent | 18 |
| Least Affluent | 20 |
| **School Size*** | |
| Smallest | 17 |
| Largest | 21 |
| **Community*** | |
| Rural | 18 |
| Suburban | 19 |
| Urban | 22 |

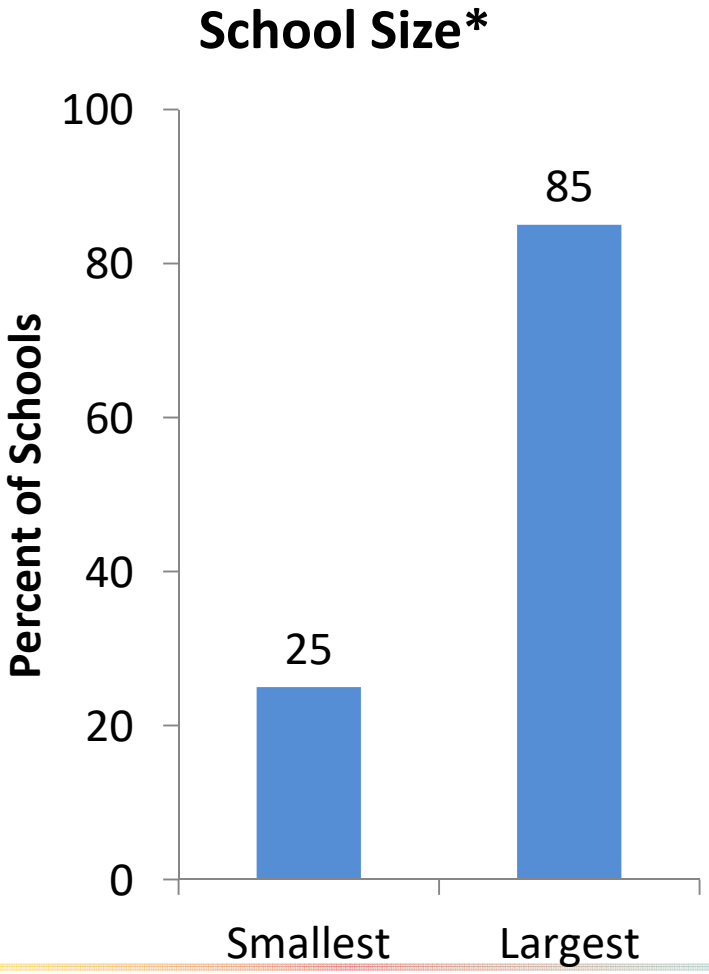
# Courses Offered: High School

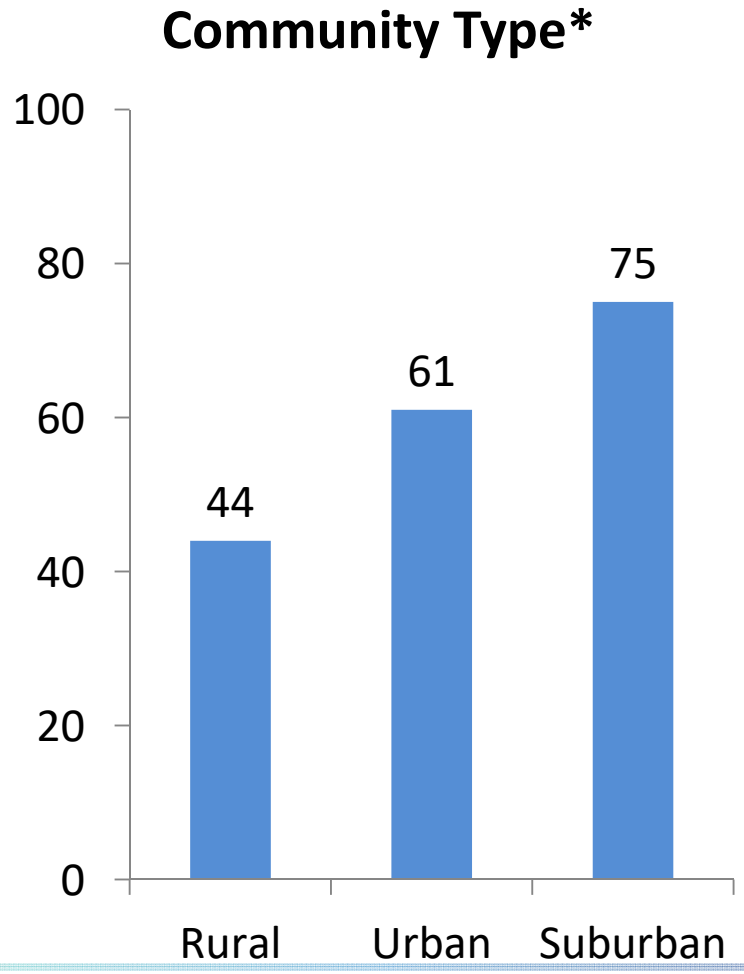
The vast majority of high schools offer introductory courses in biology, chemistry, and physics

About two-thirds offer introductory courses in Earth science and environmental science

2nd year/advanced courses are less commonly offered

# Schools Offering 2nd Year Biology

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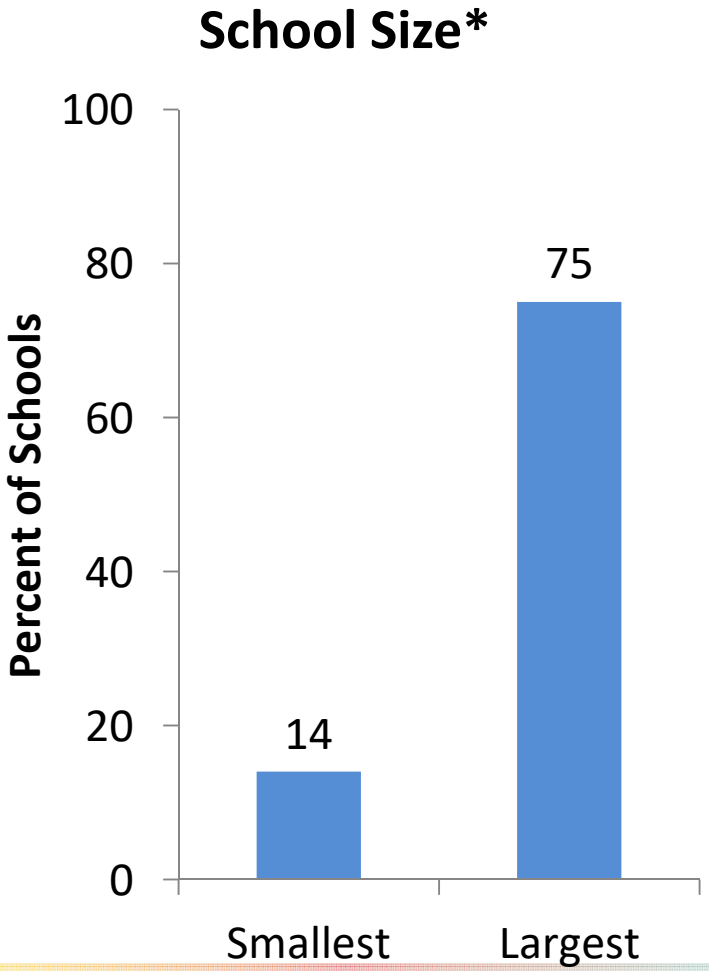
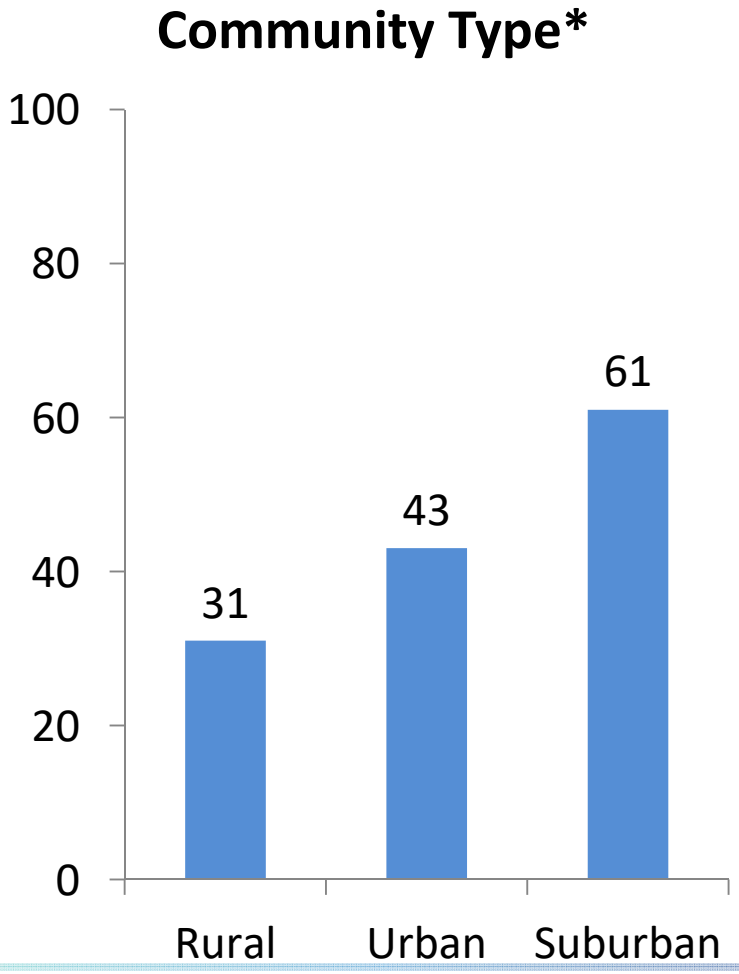
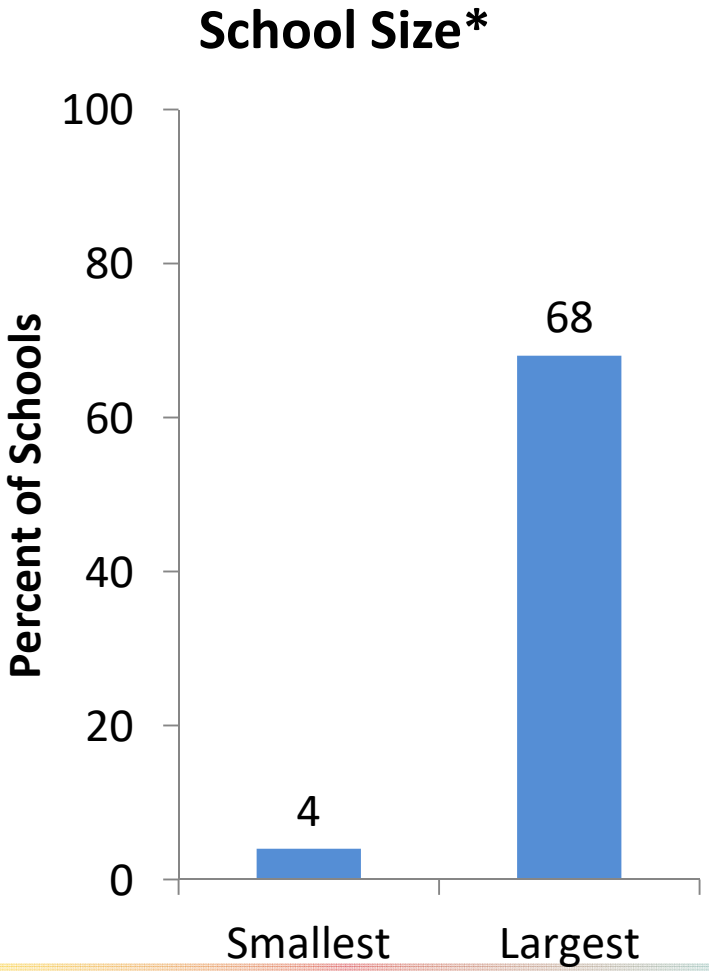
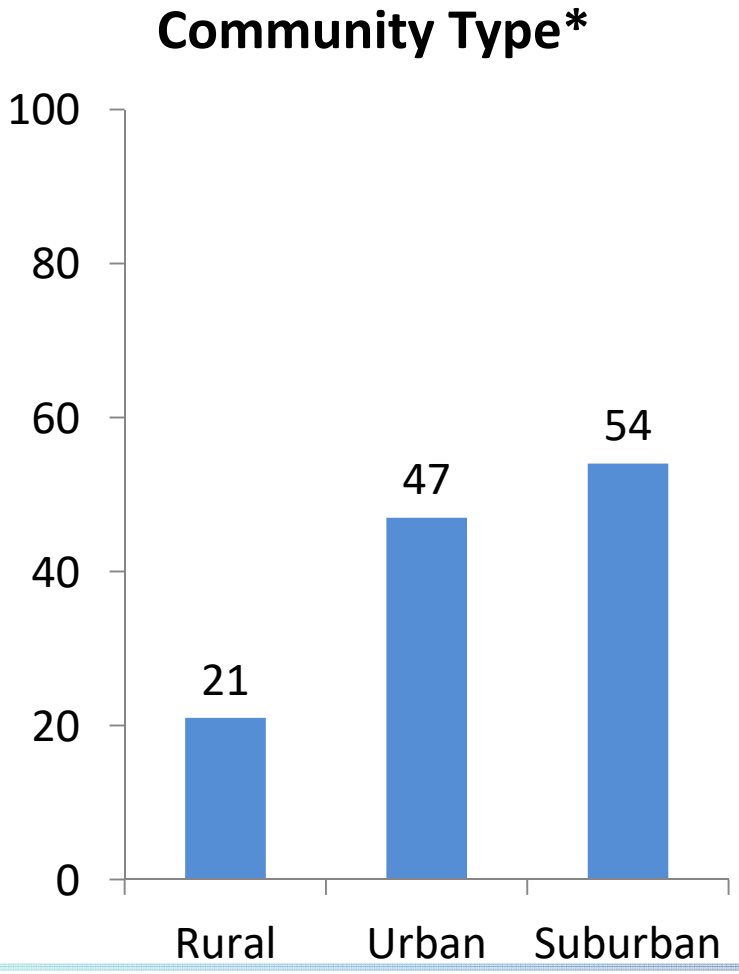
# Schools Offering 2nd Year Chemistry



# Schools Offering 2nd Year Physics




NSSME THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

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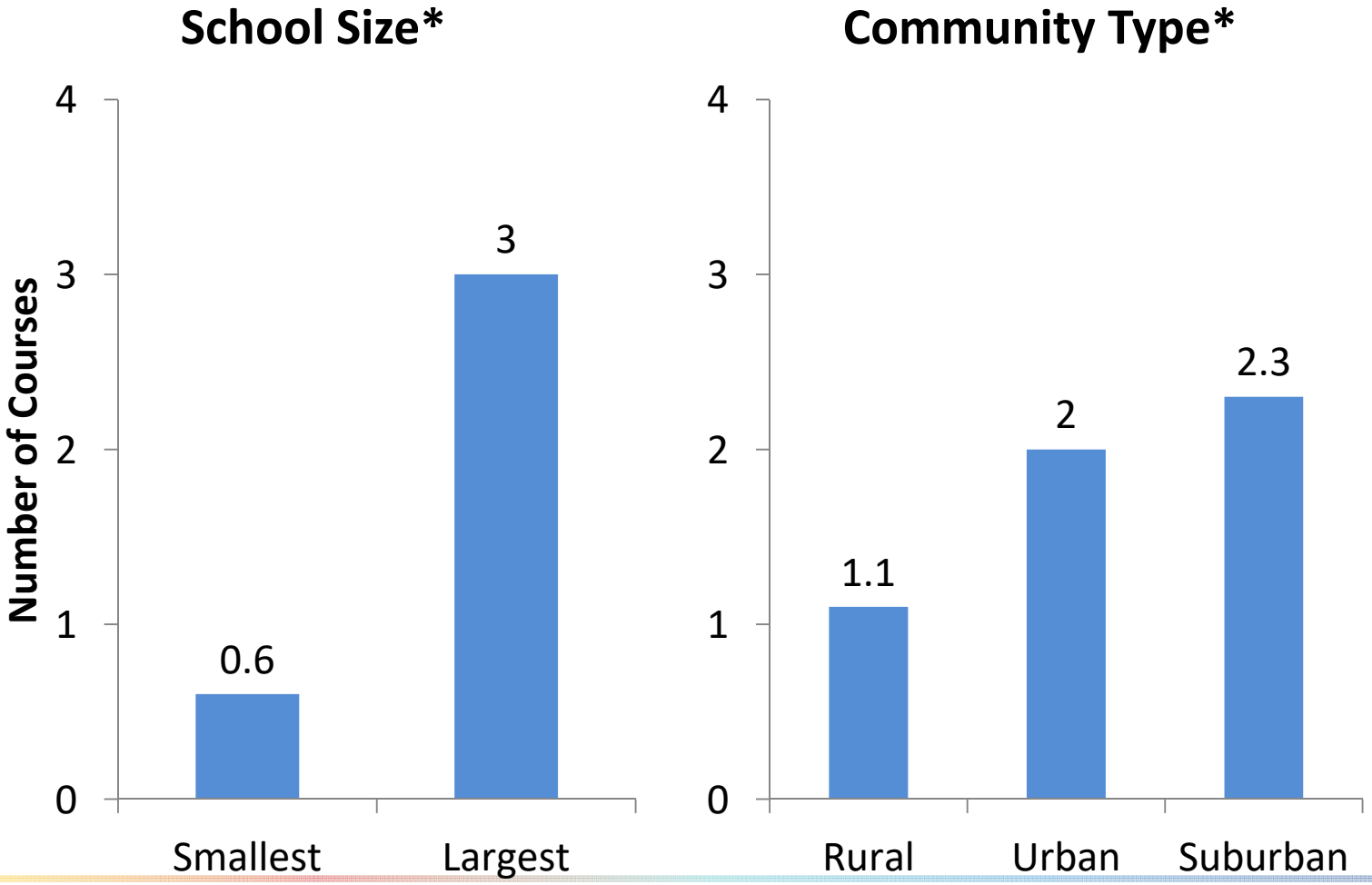
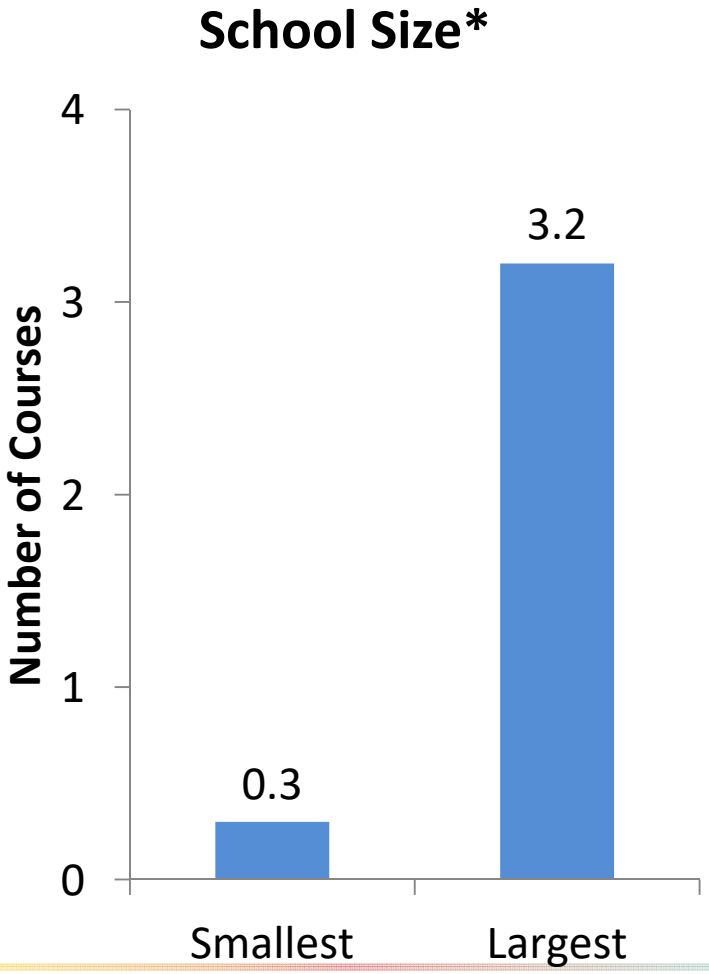
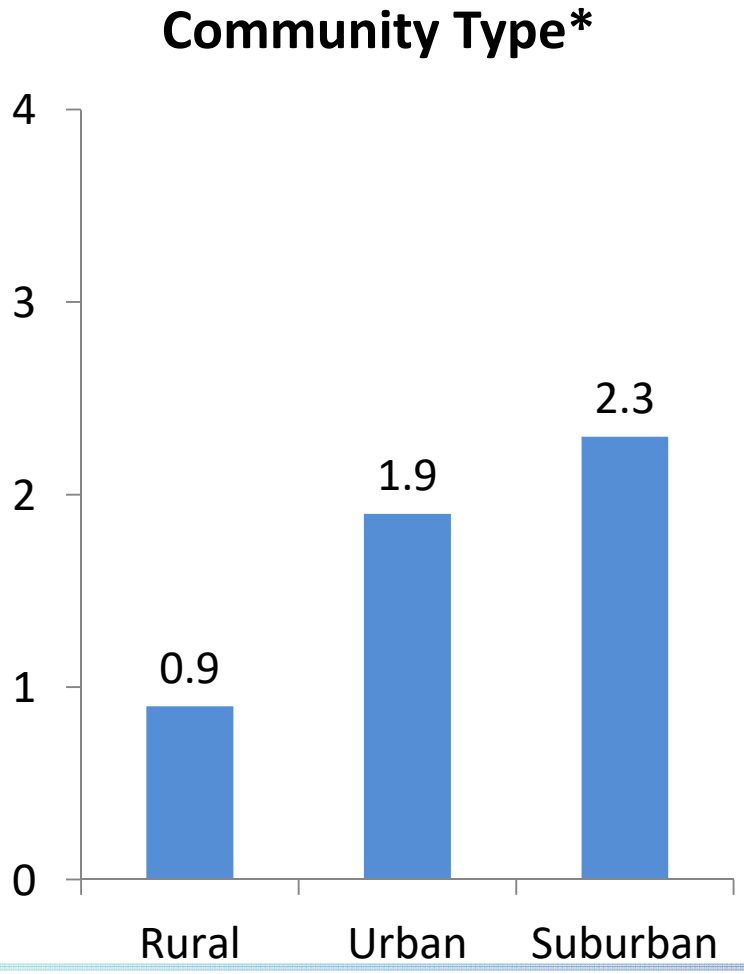
# Average Number of 2nd Year Science Courses Offered (out of 5)

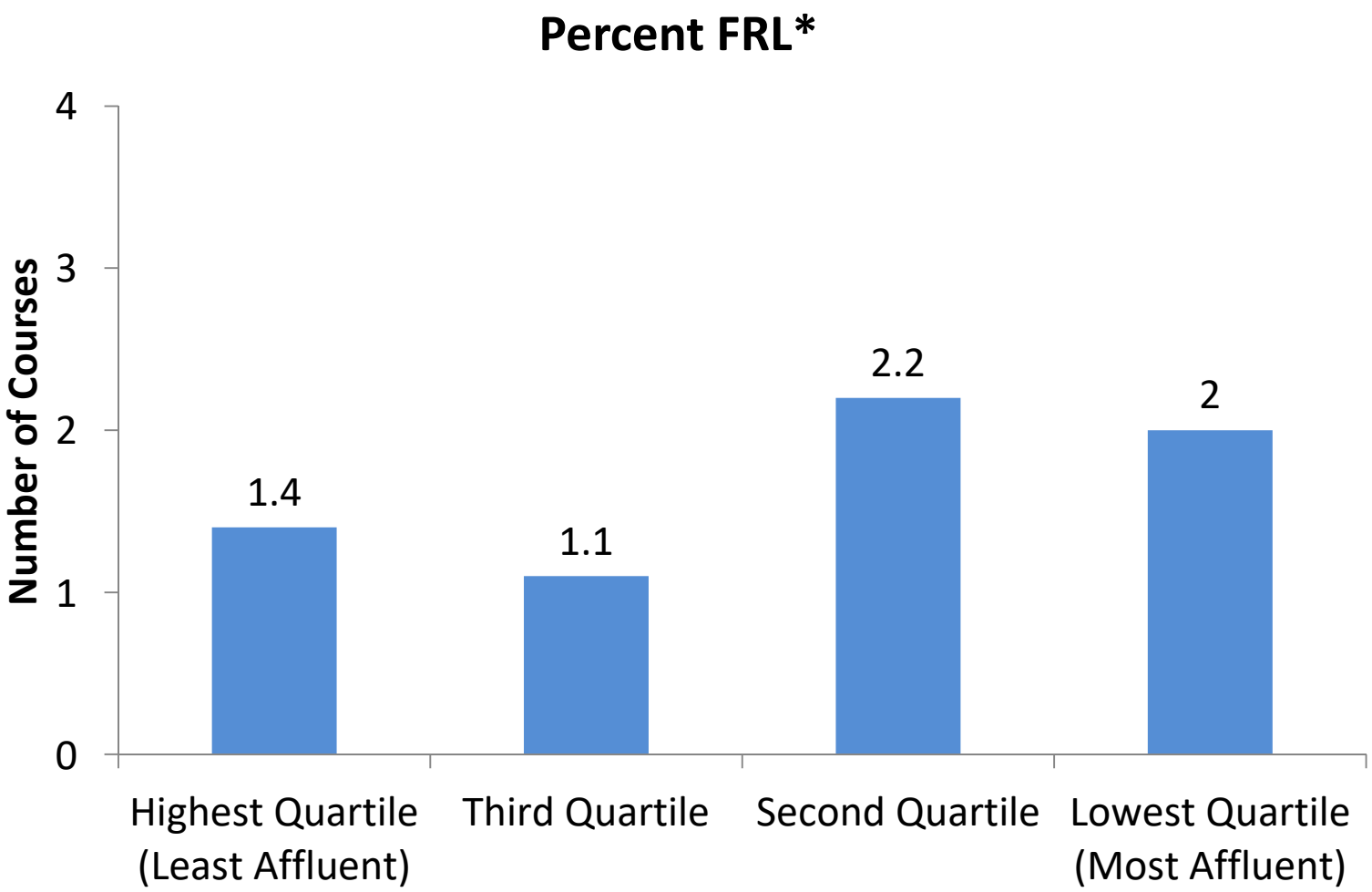


# AP Course Access (out of 7)

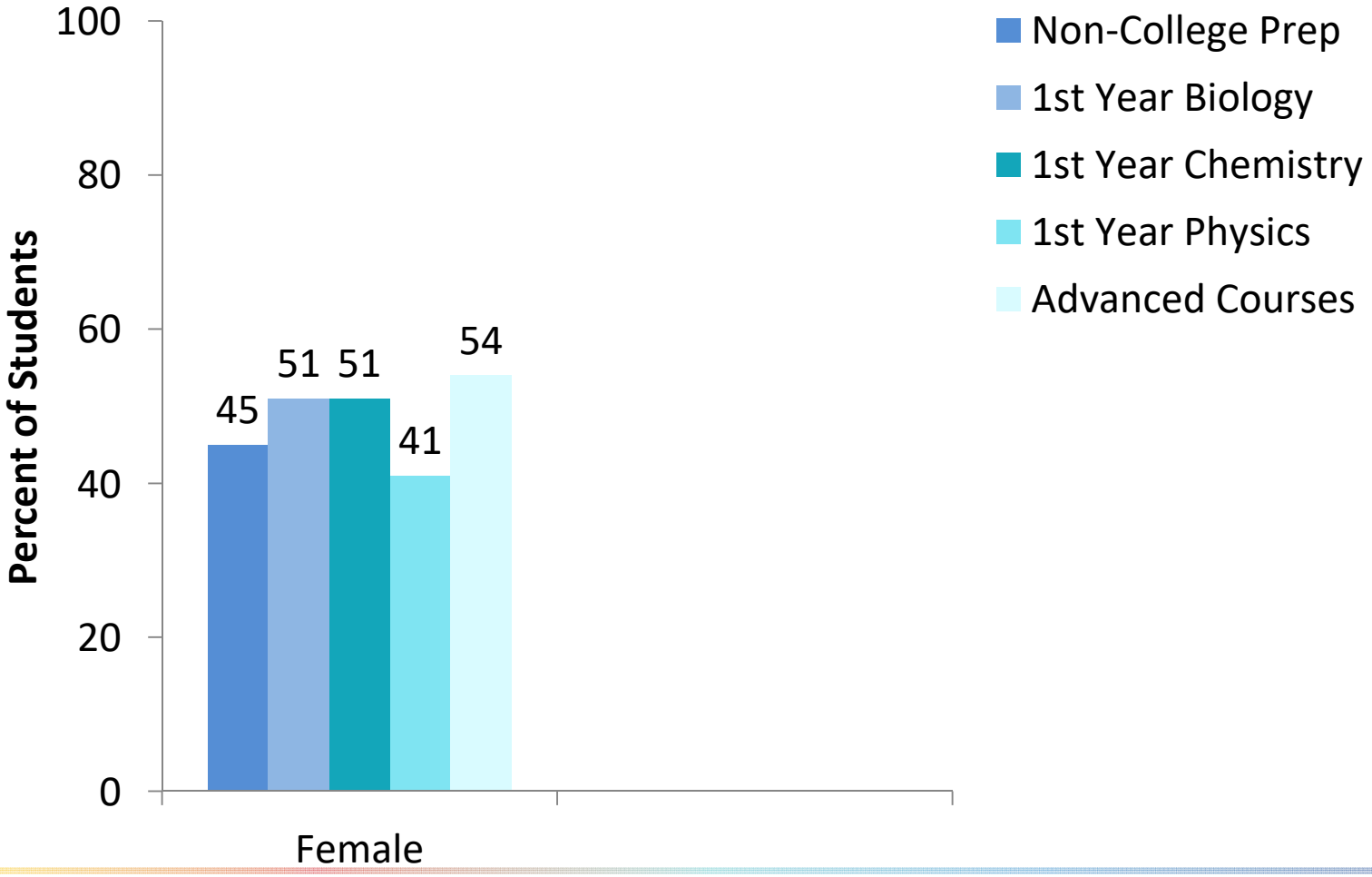


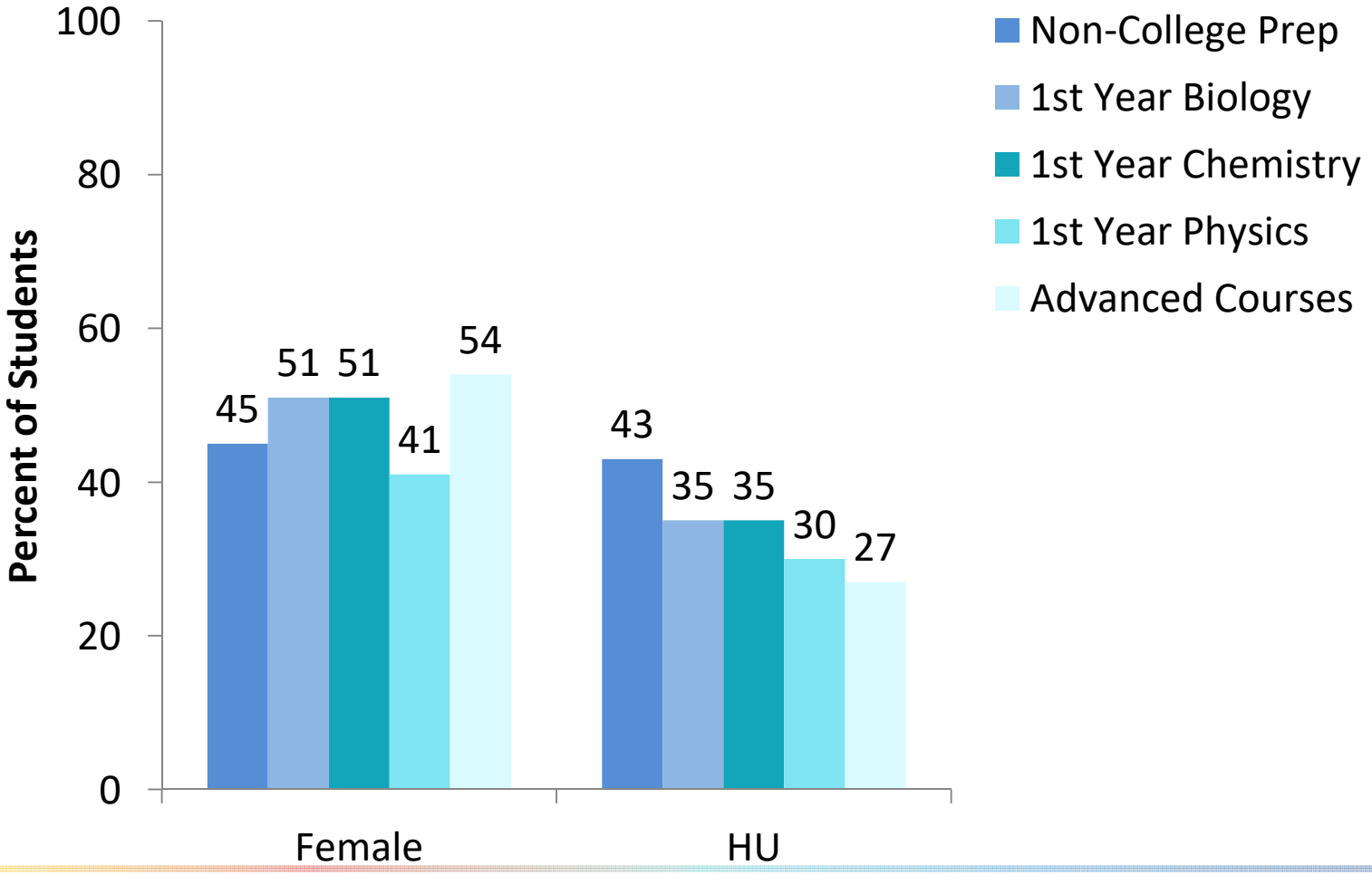
# AP Course Access (out of 7)



# Course Enrollment



# Course Enrollment



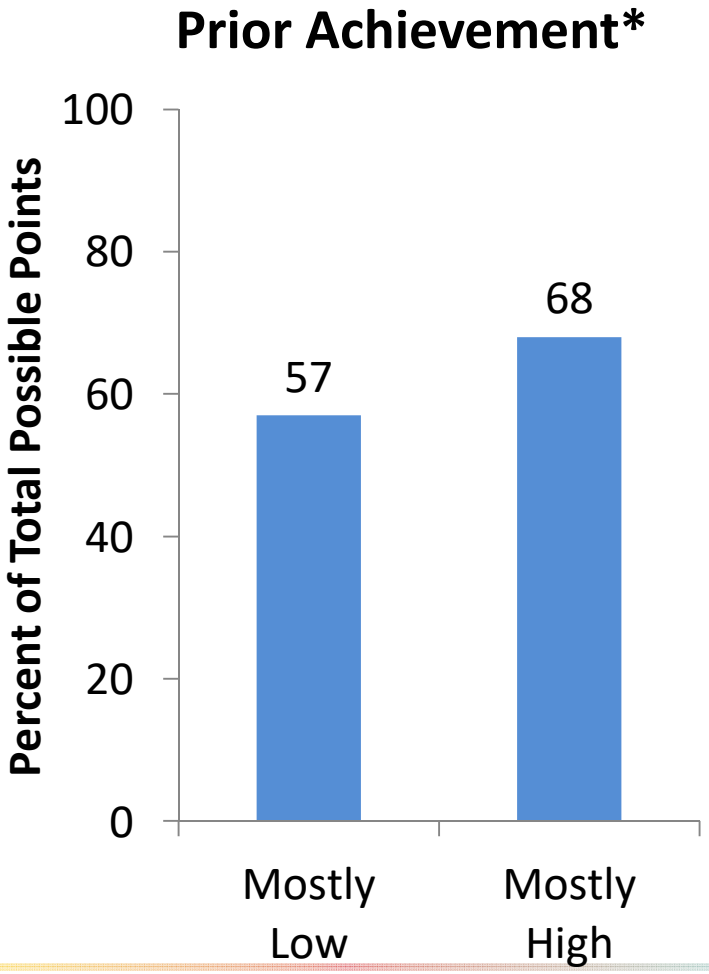
# Instructional Objectives

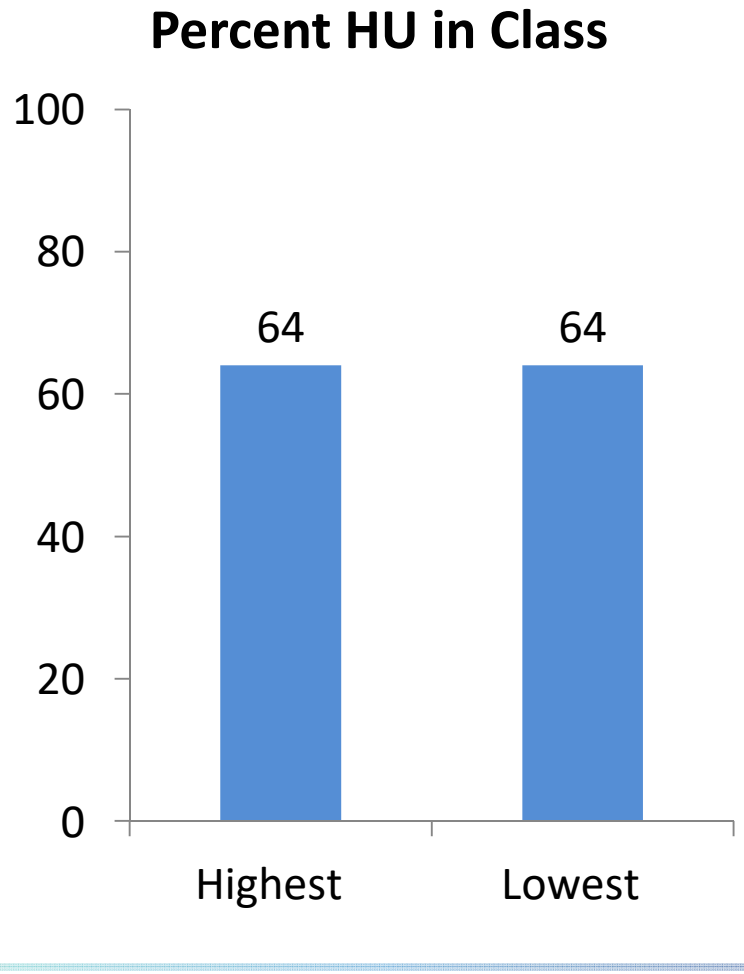
**The 2018 NSSME+ included a set of items asking teachers about goals for their randomly selected class.**

**Several combined into a composite variable titled Reform-Oriented Instructional Objectives:**

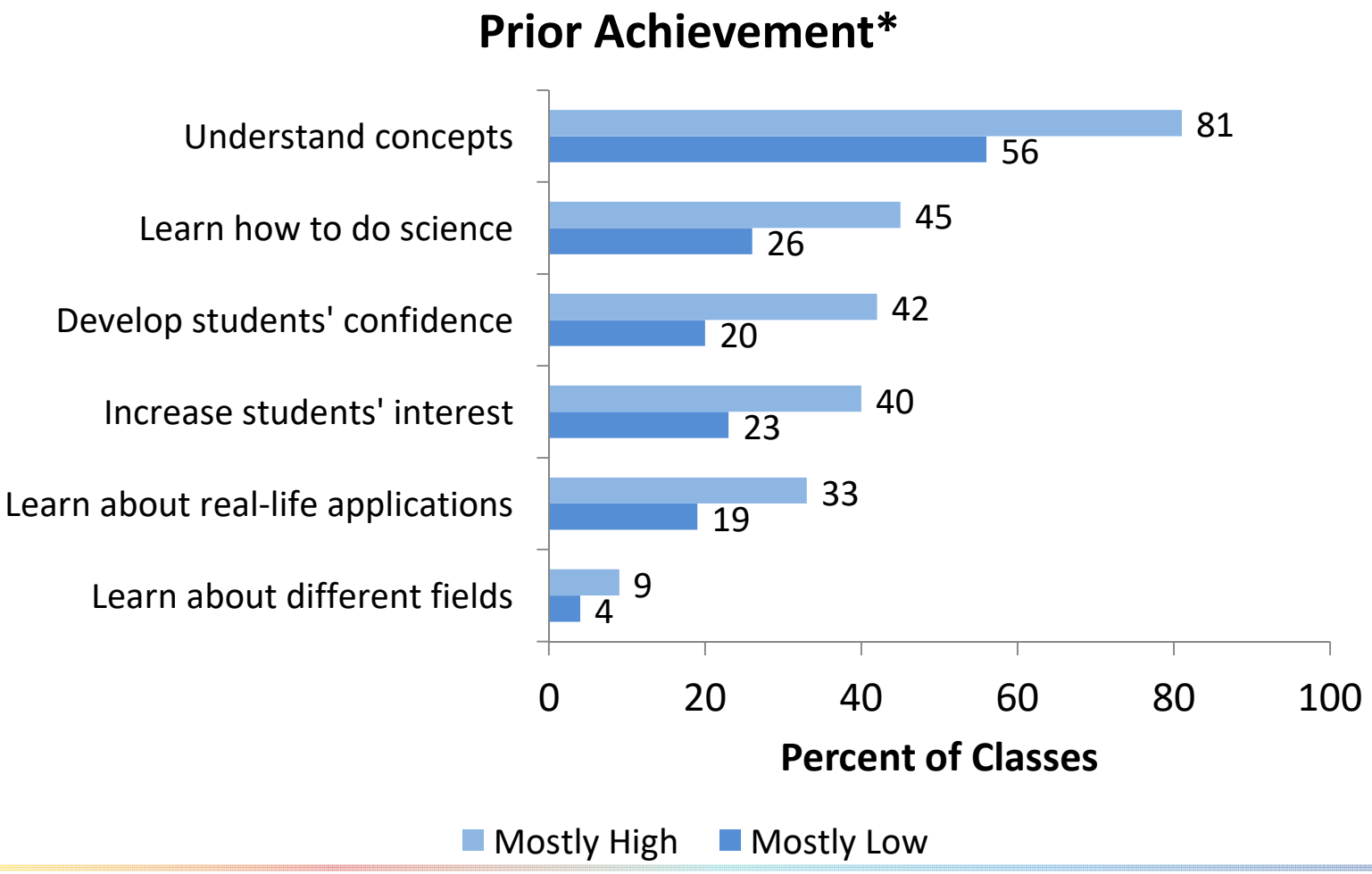
- Understanding science concepts
- Learning how to do science
- Learning how to do engineering
- Learning about different fields of science/engineering
- Learning about real-life applications
- Increasing students' interest in science
- Developing students' confidence that they can successfully pursue careers in science/engineering

# Reform-Oriented Objectives

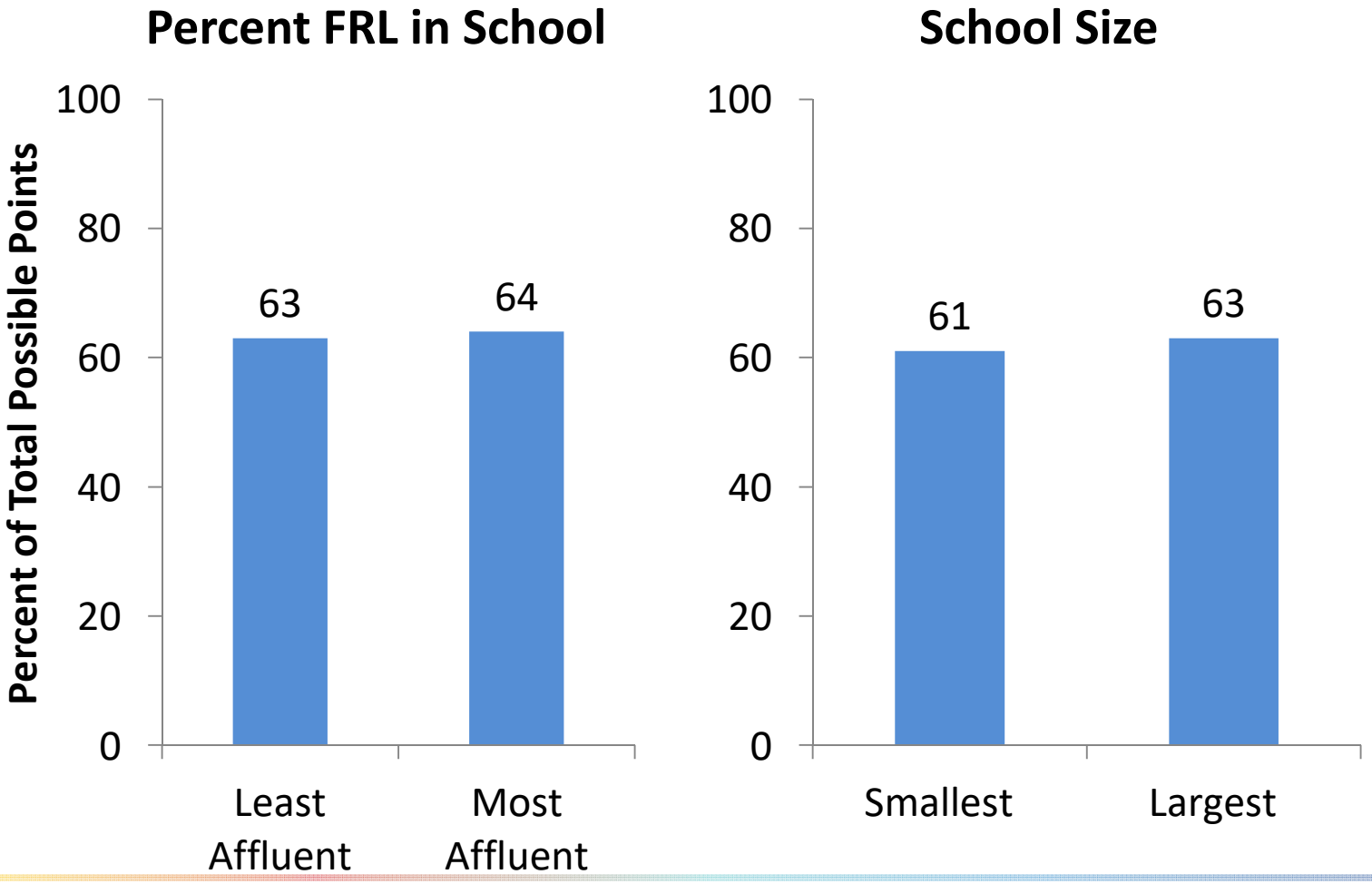


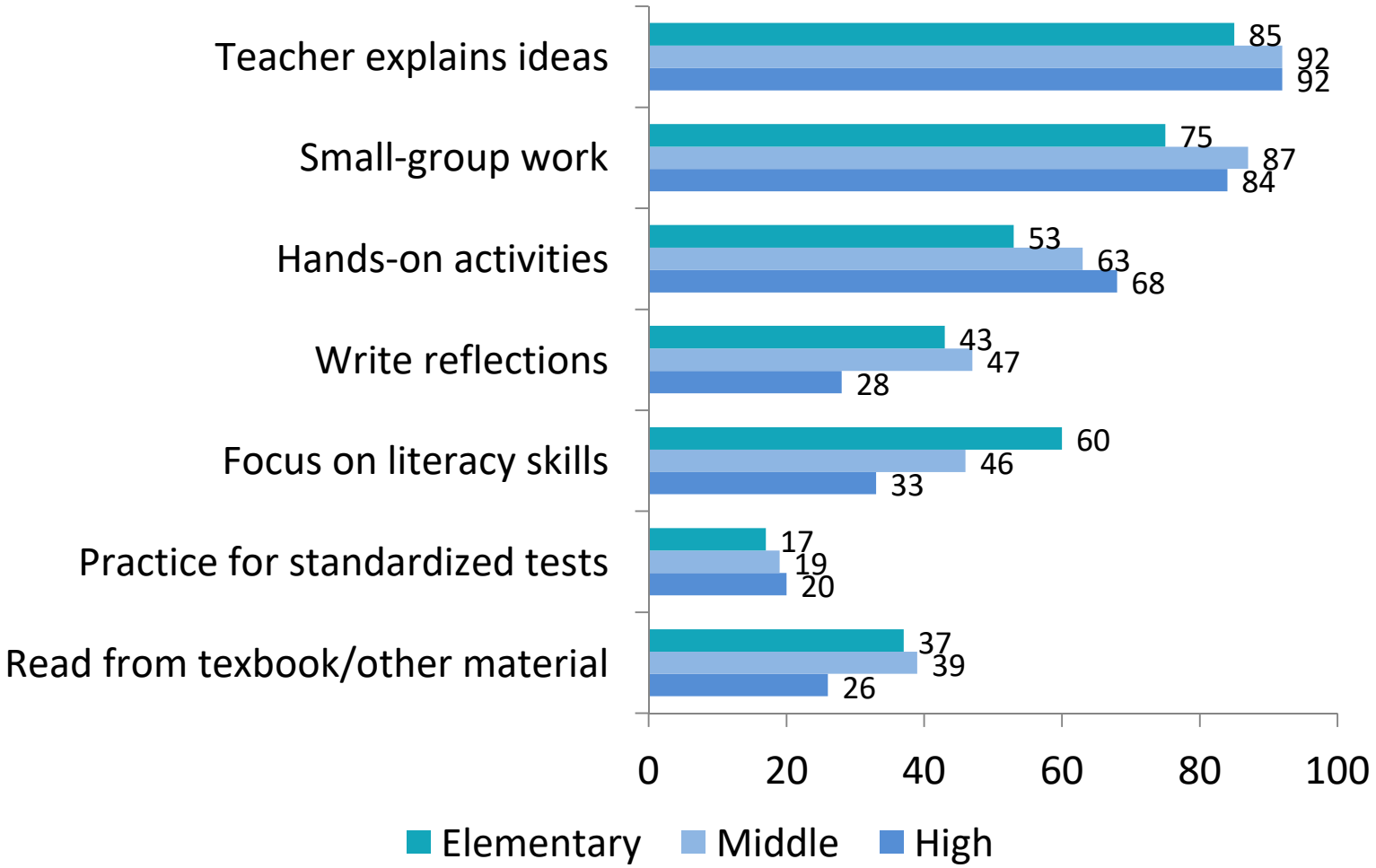
# Instruction Objectives Profile



# Reform-Oriented Objectives



# Instructional Activities: Weekly



# Instructional Activities: Weekly

## Lecture

- No differences by equity factors

## Small group work

- More likely in classes of high prior achieving students

## Hands-on/laboratory activities

- More likely in class of high prior achieving students and classes with low %HU, and in most affluent schools

## Read from textbook, write reflections, focus on literacy skills, and practice for standardized tests

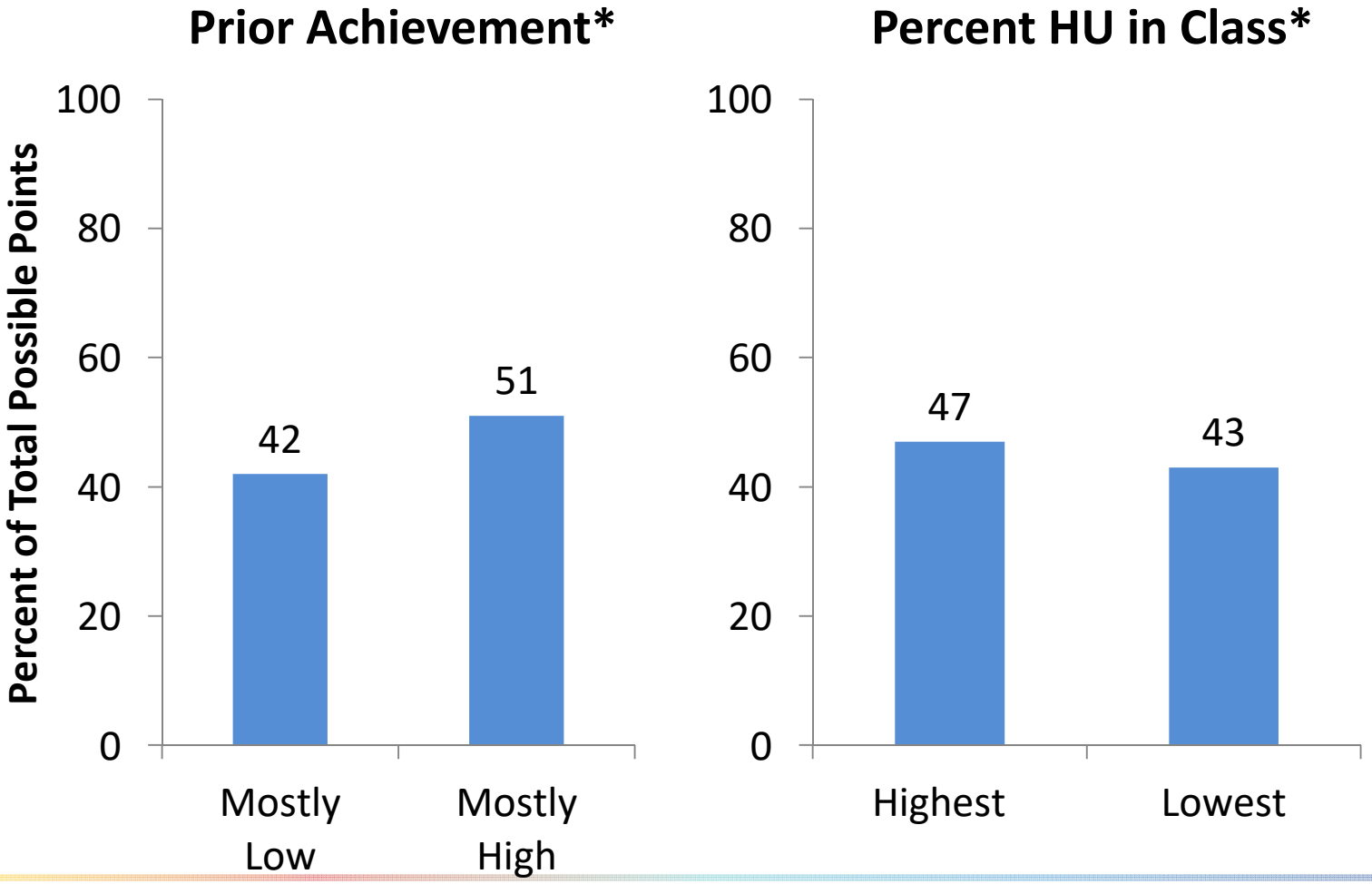
- More likely in least affluent schools and in classes with high %HU

# Engagement in Science Practices

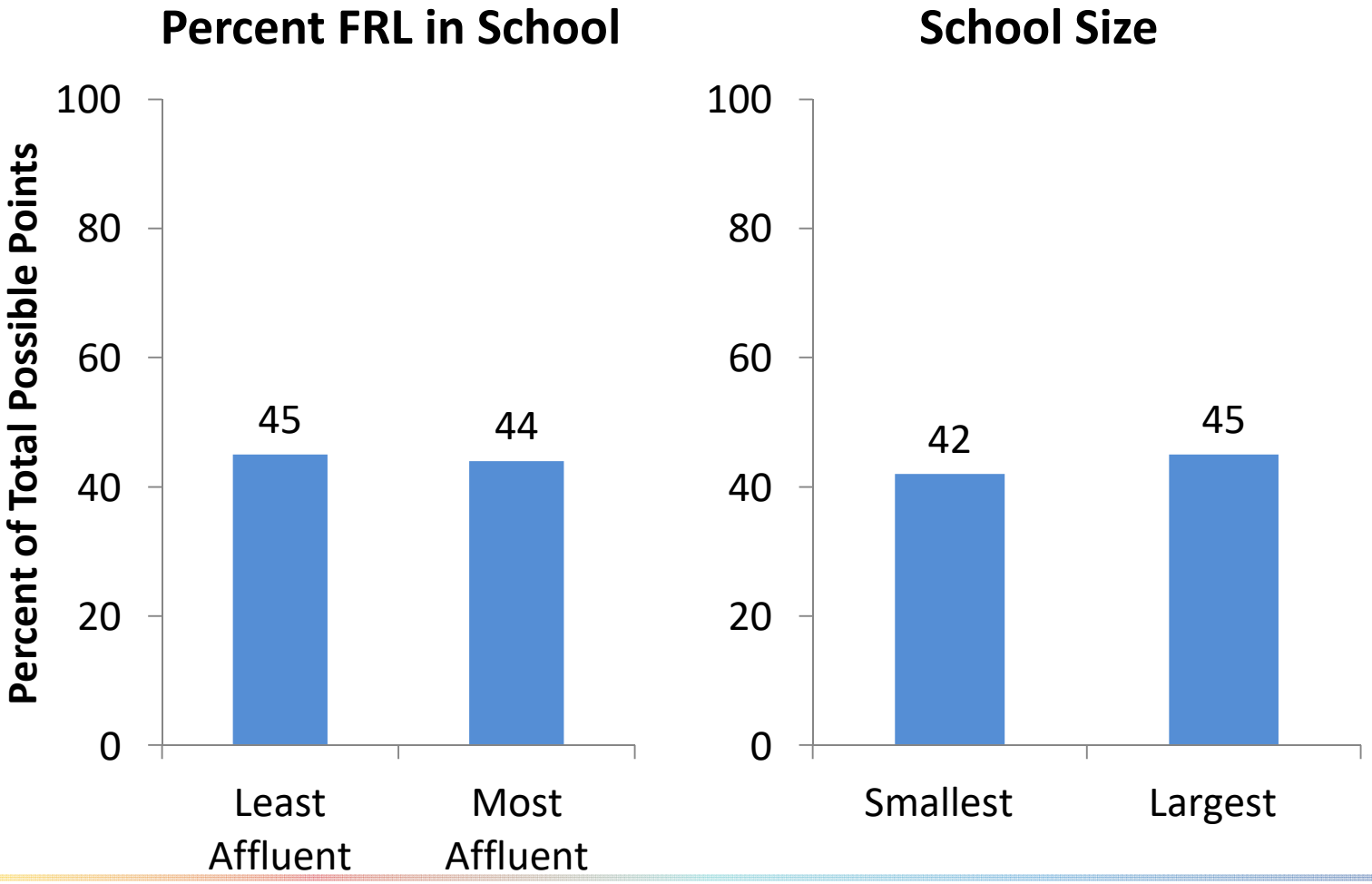
**The 2018 NSSME+ included a series of items asking how often students were engaged in aspects of the science practices:**

1. Asking questions/defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations/designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

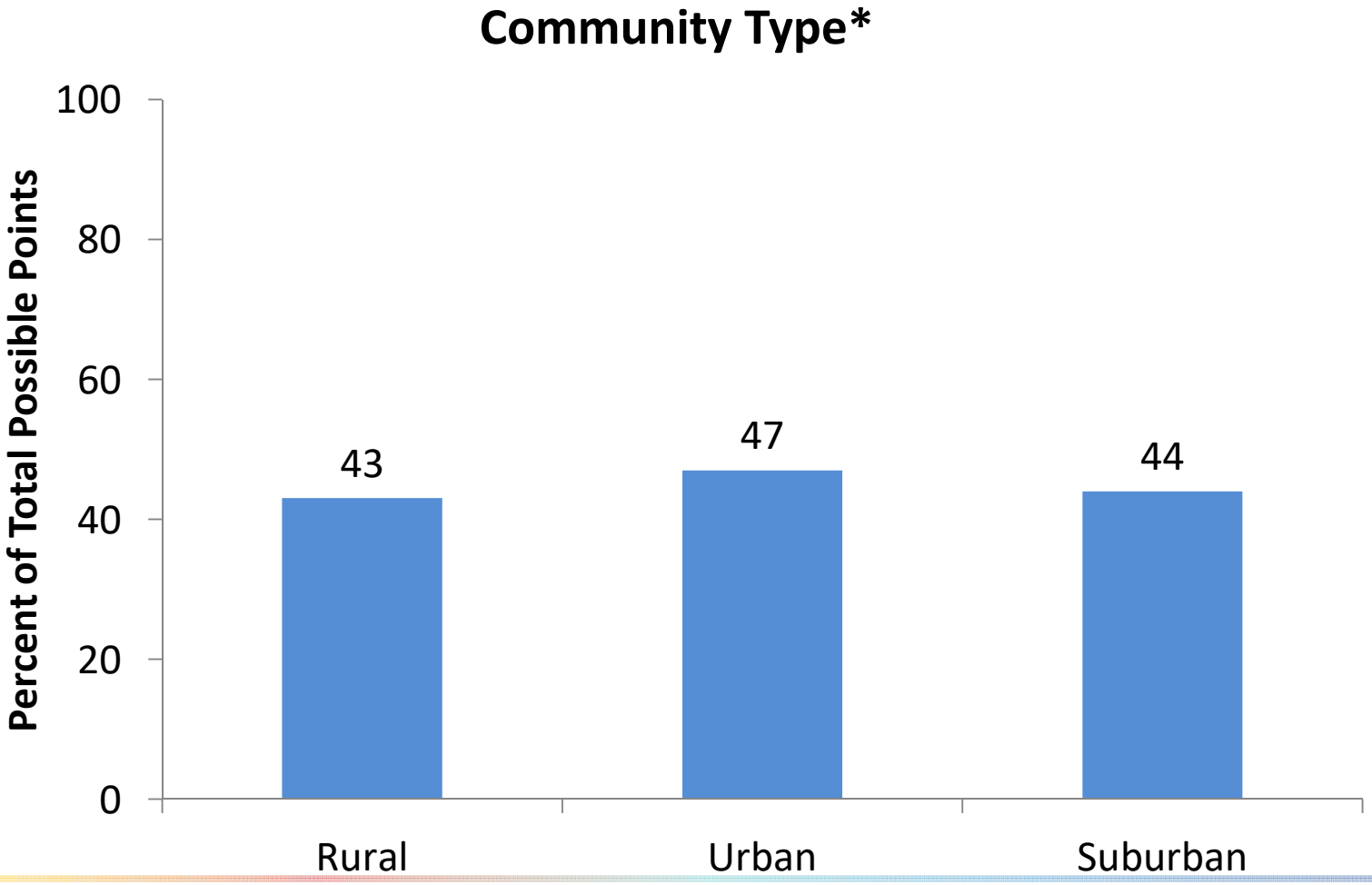
# Engagement in Science Practices



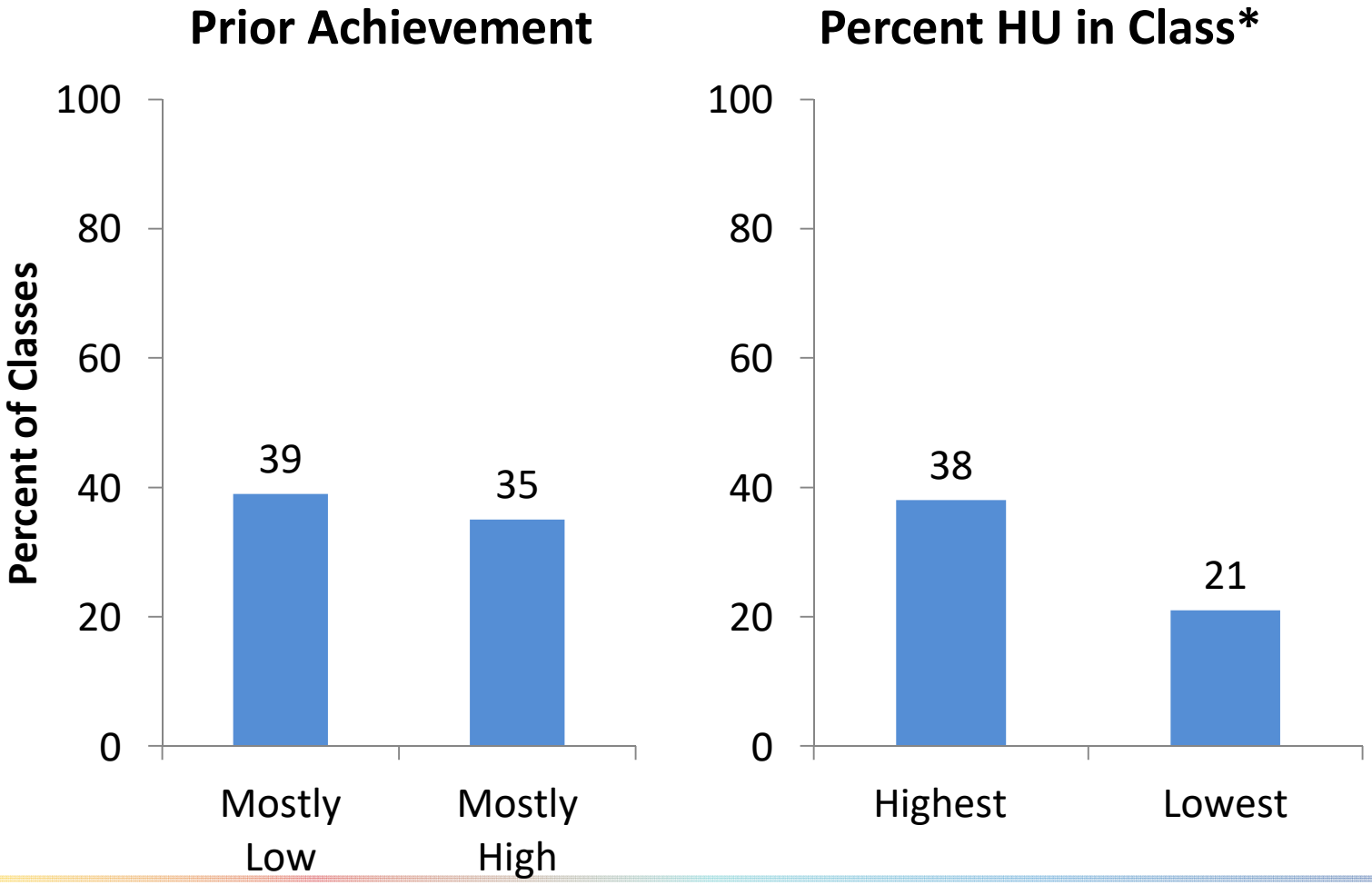
# Engagement in Science Practices



# Engagement in Science Practices



# Required External Assessments (2x or more per year)



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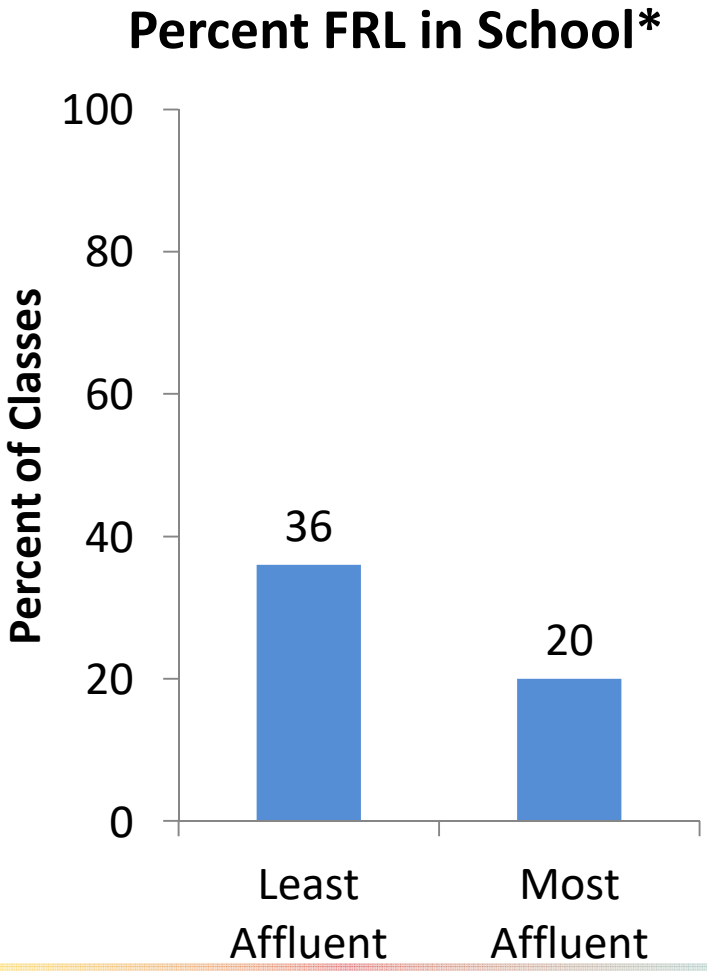
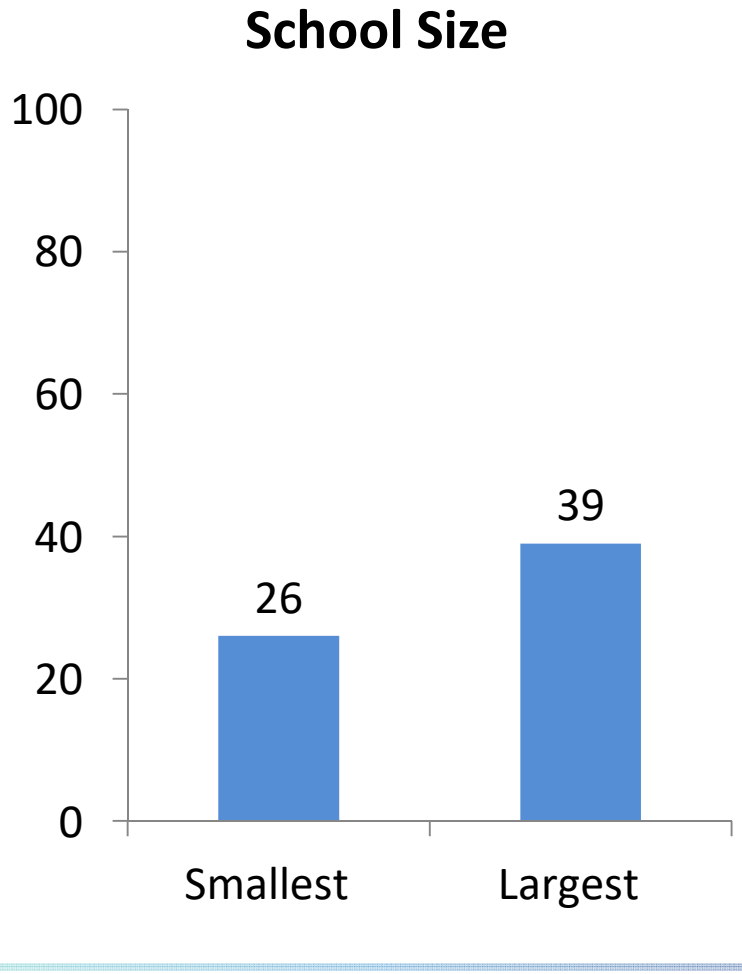


# Curriculum and Pedagogy Control Composites

| | Curriculum | Pedagogy |
|---|---|---|
| **Prior Achievement Level of Class*** | | |
| Mostly High | 65 | 90 |
| Mostly Low | 46 | 79 |
| **Percent Historically Underrepresented Students in Class*** | | |
| Lowest | 63 | 87 |
| Highest | 49 | 79 |
| **Percent of Students in School Eligible for FRL*** | | |
| Most Affluent | 56 | 84 |
| Least Affluent | 47 | 79 |
| **School Size*** | | |
| Smallest | 60 | 88 |
| Largest | 48 | 83 |
| **Community*** | | |
| Rural | 61 | 87 |
| Suburban | 52 | 81 |
| Urban | 52 | 82 |

# Discussion (10 minutes)

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

2. What insights do you have about effective methods/strategies to address inequitable distribution of resources in the context in which you work?

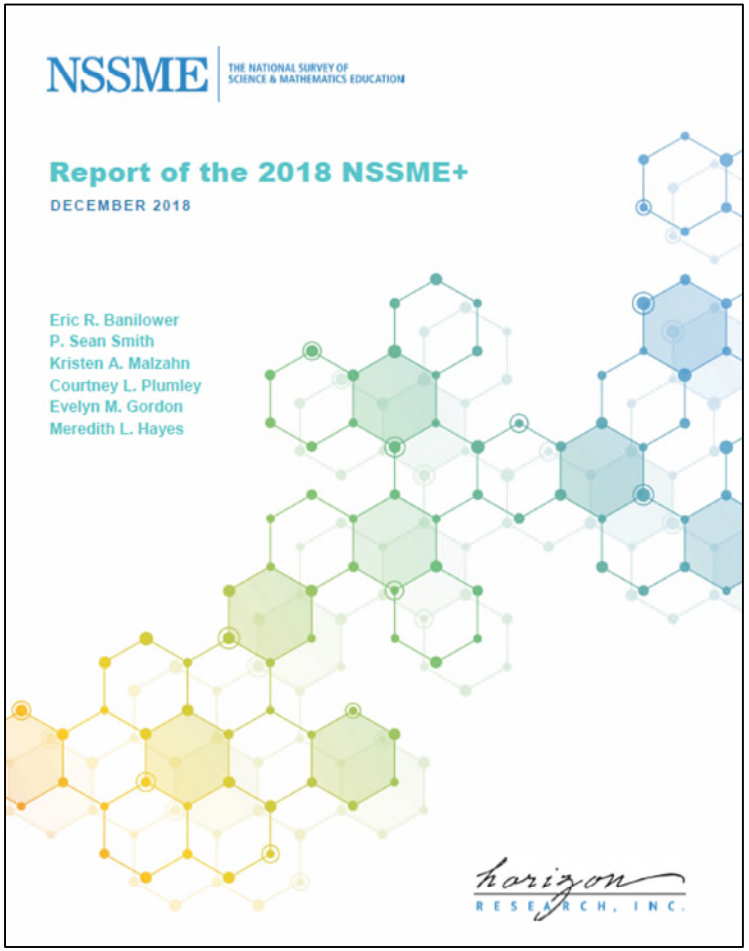
3. What have you seen in your work that might explain some of these national results?

https://bit.ly/2HZUvPq

# www.horizon-research.com/NSSME

Current reports:

- Technical report
- Highlights report
- Compendium of Tables

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