NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Secondary Science Teaching in the US: Current Status, Trends over Time, and Factors Affecting Instruction

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Session Overview

- About the 2018 NSSME+
- Changes in the K-12 science education system between 2012 and 2018
- How novice science teachers compare to veterans
- Factors associated with NGSS-aligned instruction
- Discussion

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.

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

Six different survey instruments

- Characteristics of the science/mathematics/ computer science teaching force:
  - demographics
  - preparation for teaching
  - beliefs about teaching and learning
  - perceptions of preparedness
- 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

Who's In the 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

Interpreting Results

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

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

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Several reports and other products are available on our website, including:

- Technical report
- Highlights report
- Compendium of Tables
- Trends report
- Novice teacher report

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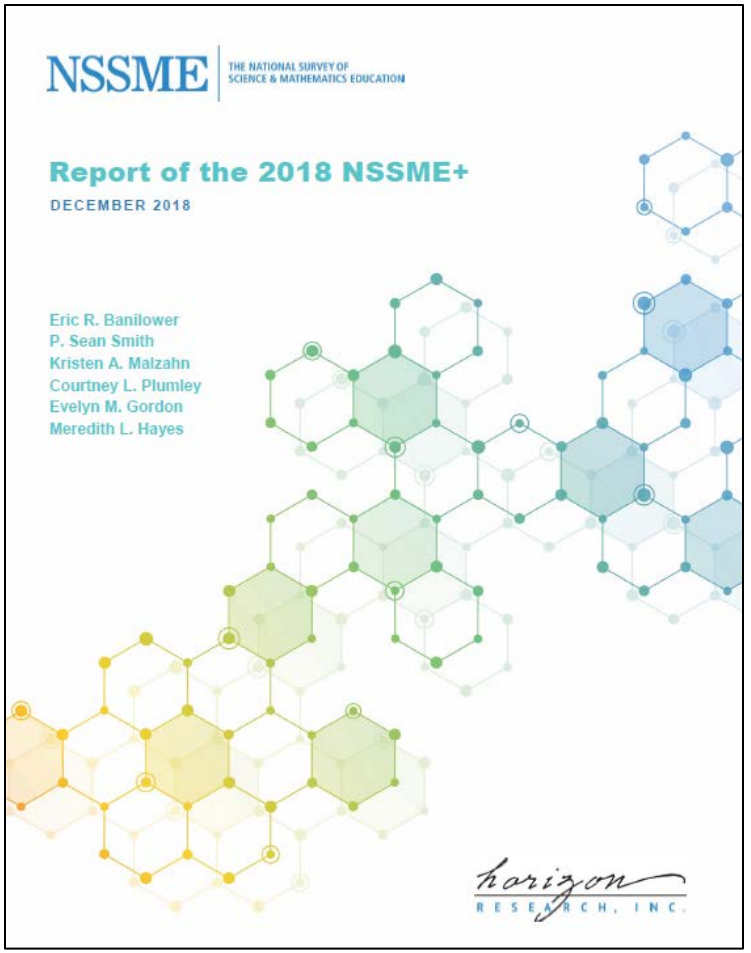

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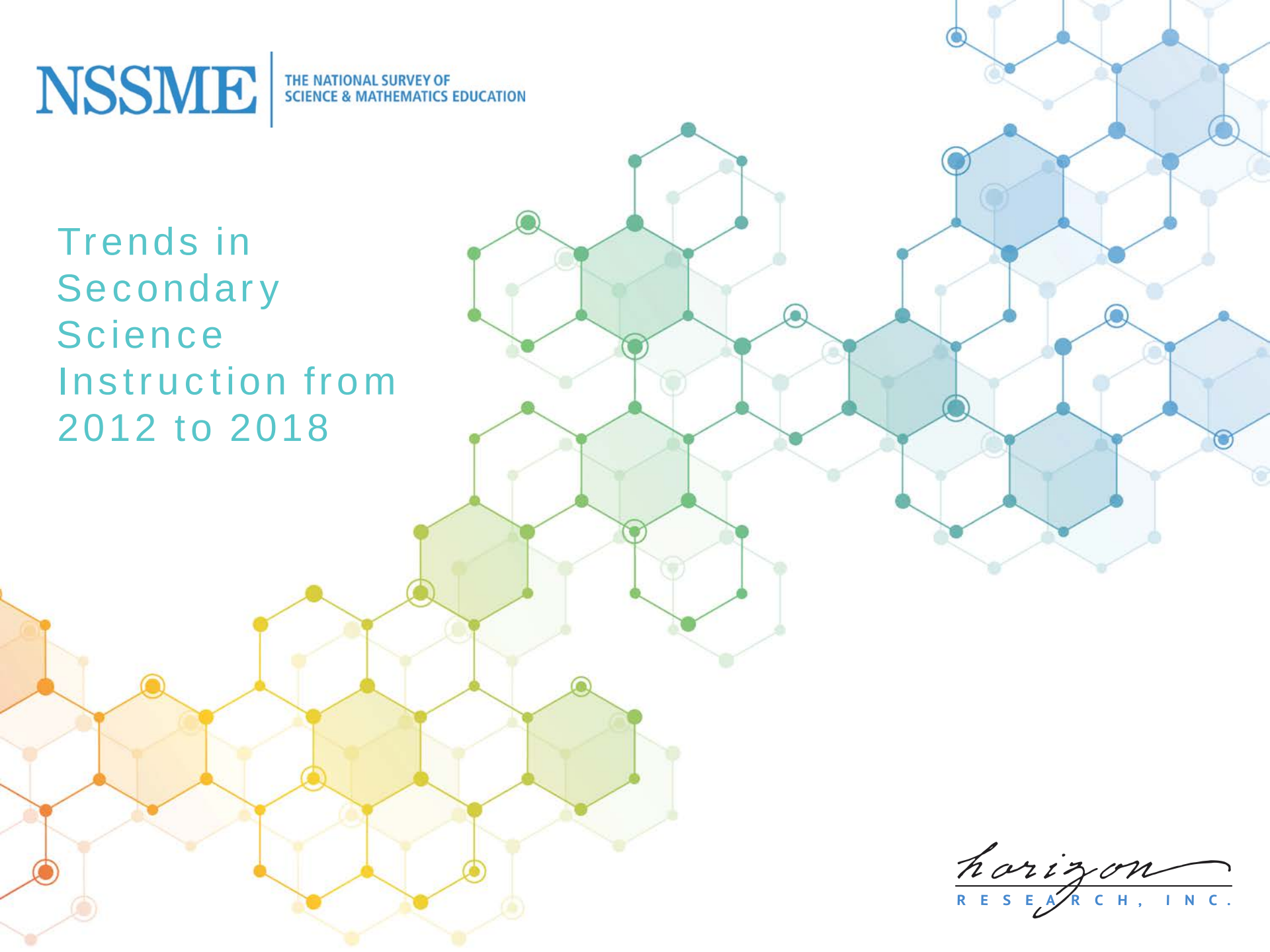
Trends in Secondary Science Instruction from 2012 to 2018



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Teacher Characteristics

The 2018 NSSME+ collected data on:

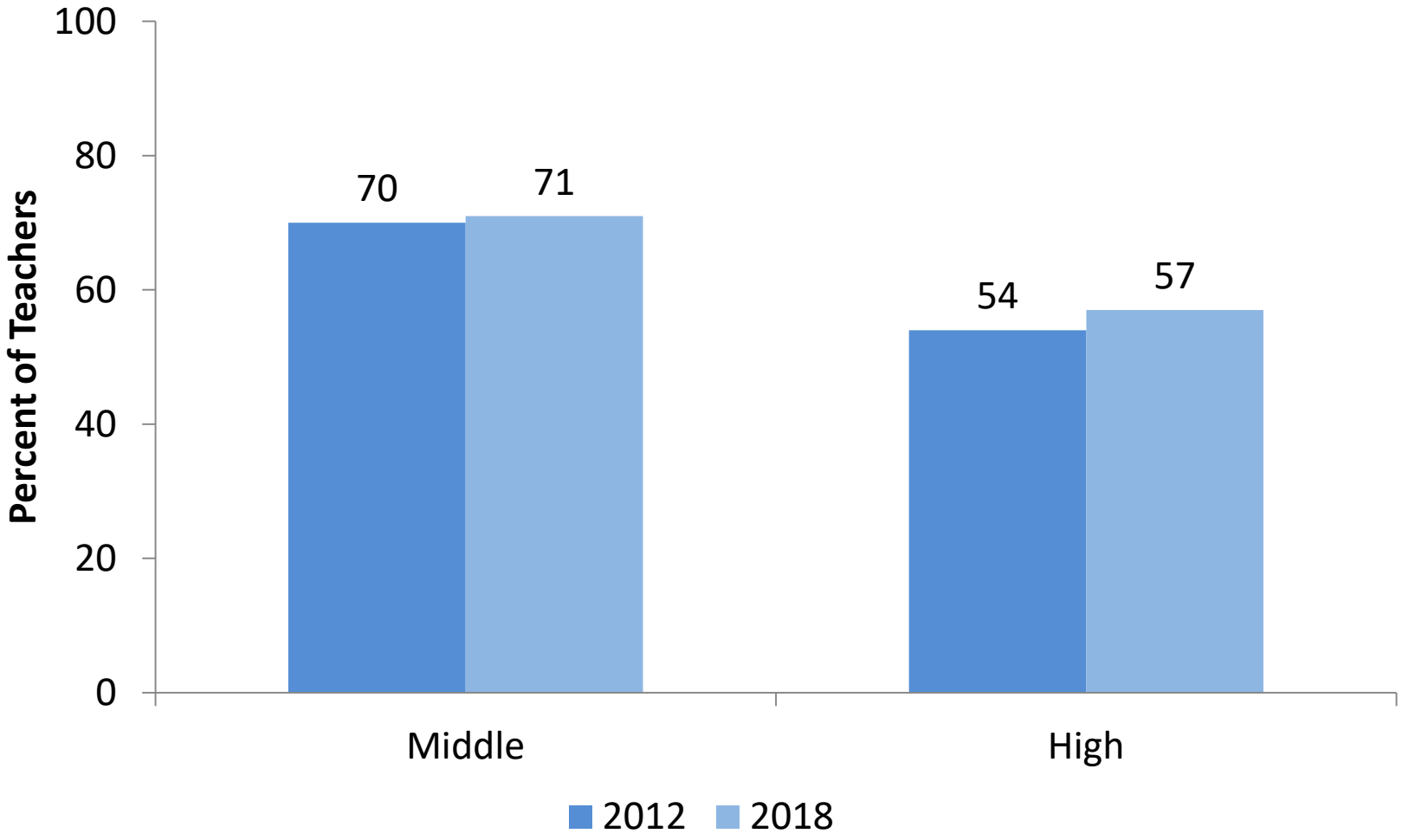
- Gender
- Race/ethnicity
- Age
- Years of teaching experience
- Content background (courses and degrees)
- Preparedness
- Beliefs

Note: In the charts that follow, an asterisk indicates a significant difference ($p < 0.05$) in the contrast of interest.

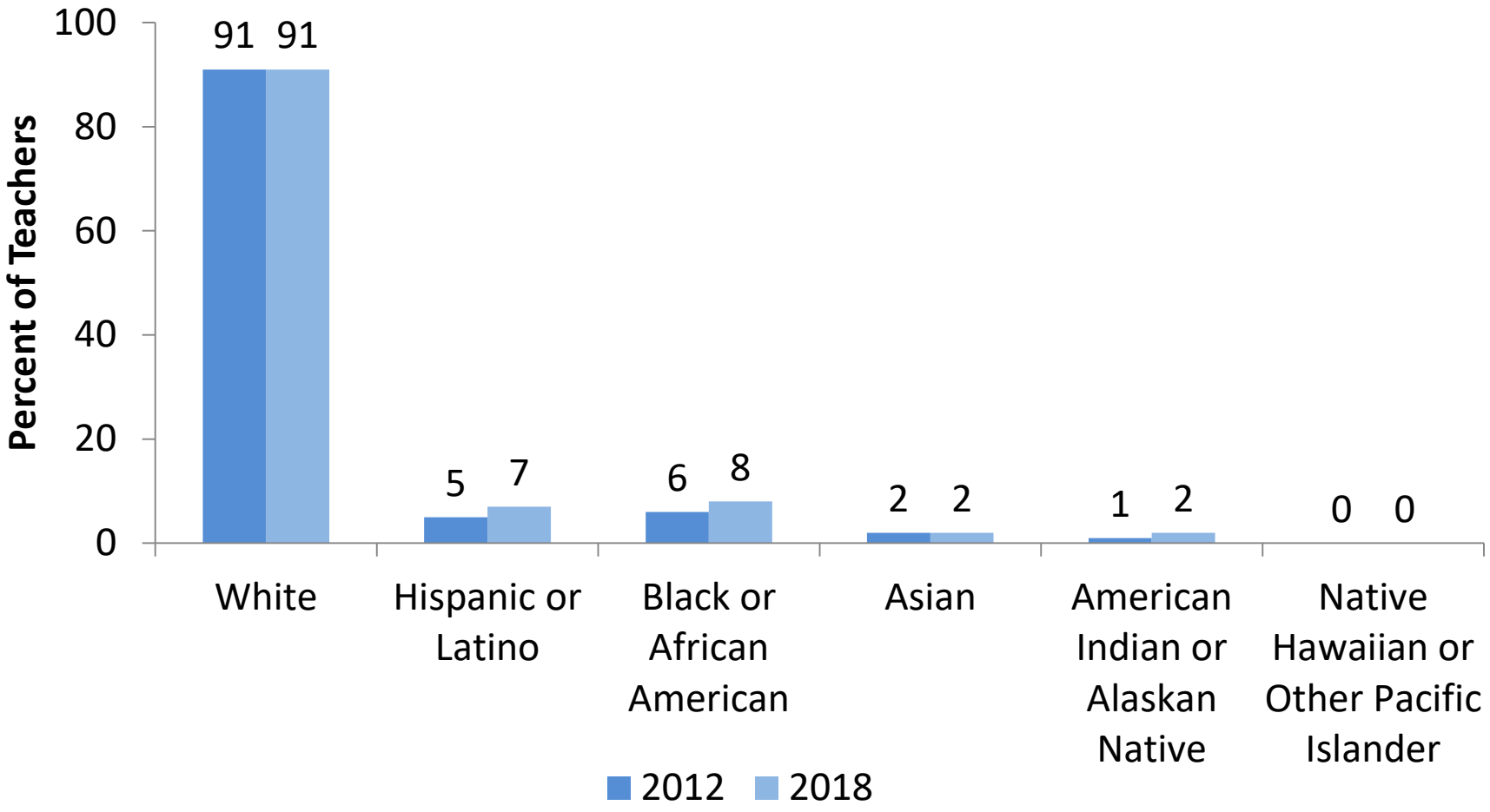
Gender and Race/Ethnicity

Between 2012 and 2018, the science teaching force did not change in terms of gender or race/ethnicity.

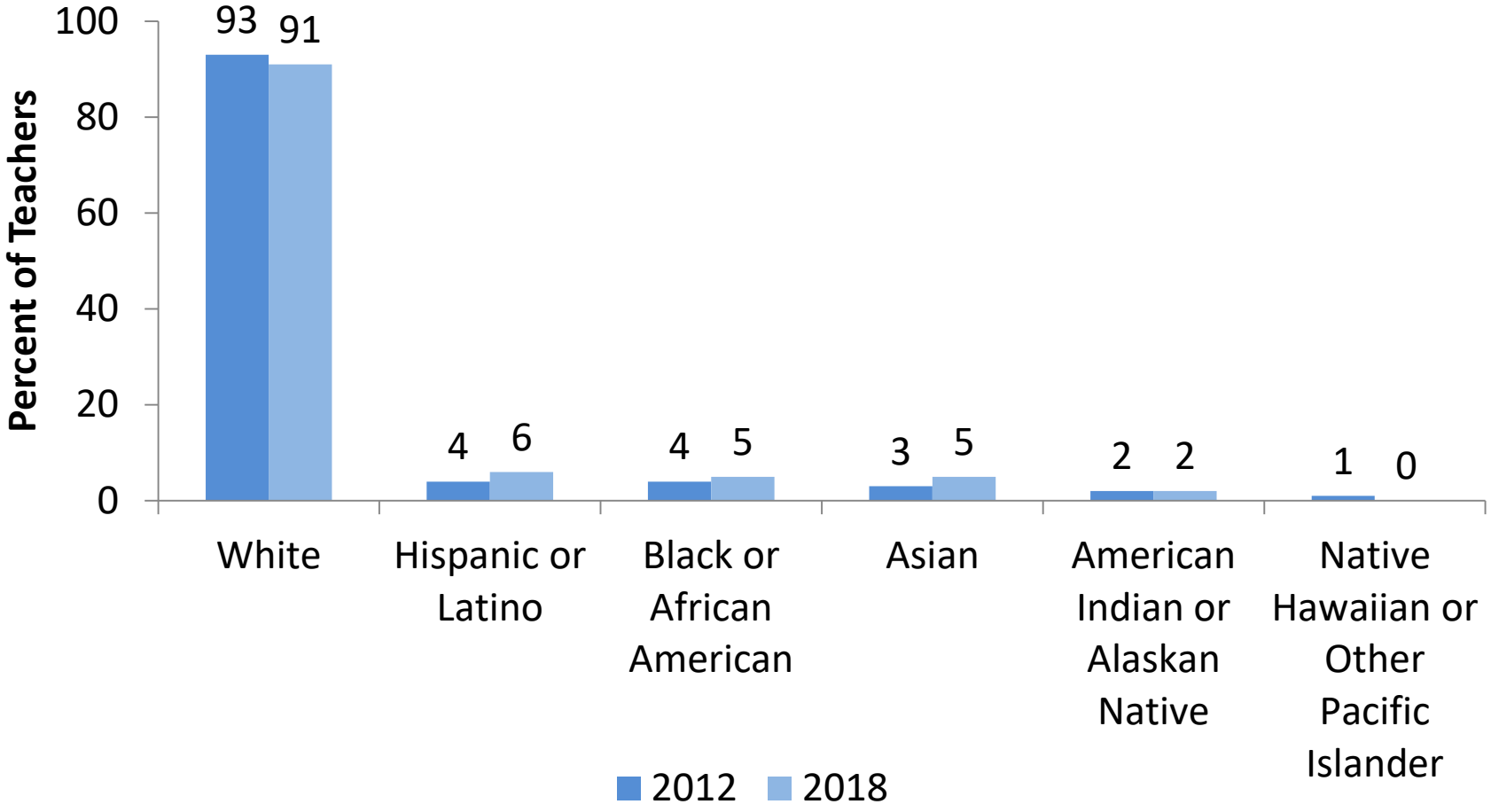
Female Teachers



Race/Ethnicity of Middle School Science Teachers



Race/Ethnicity of High School Science Teachers



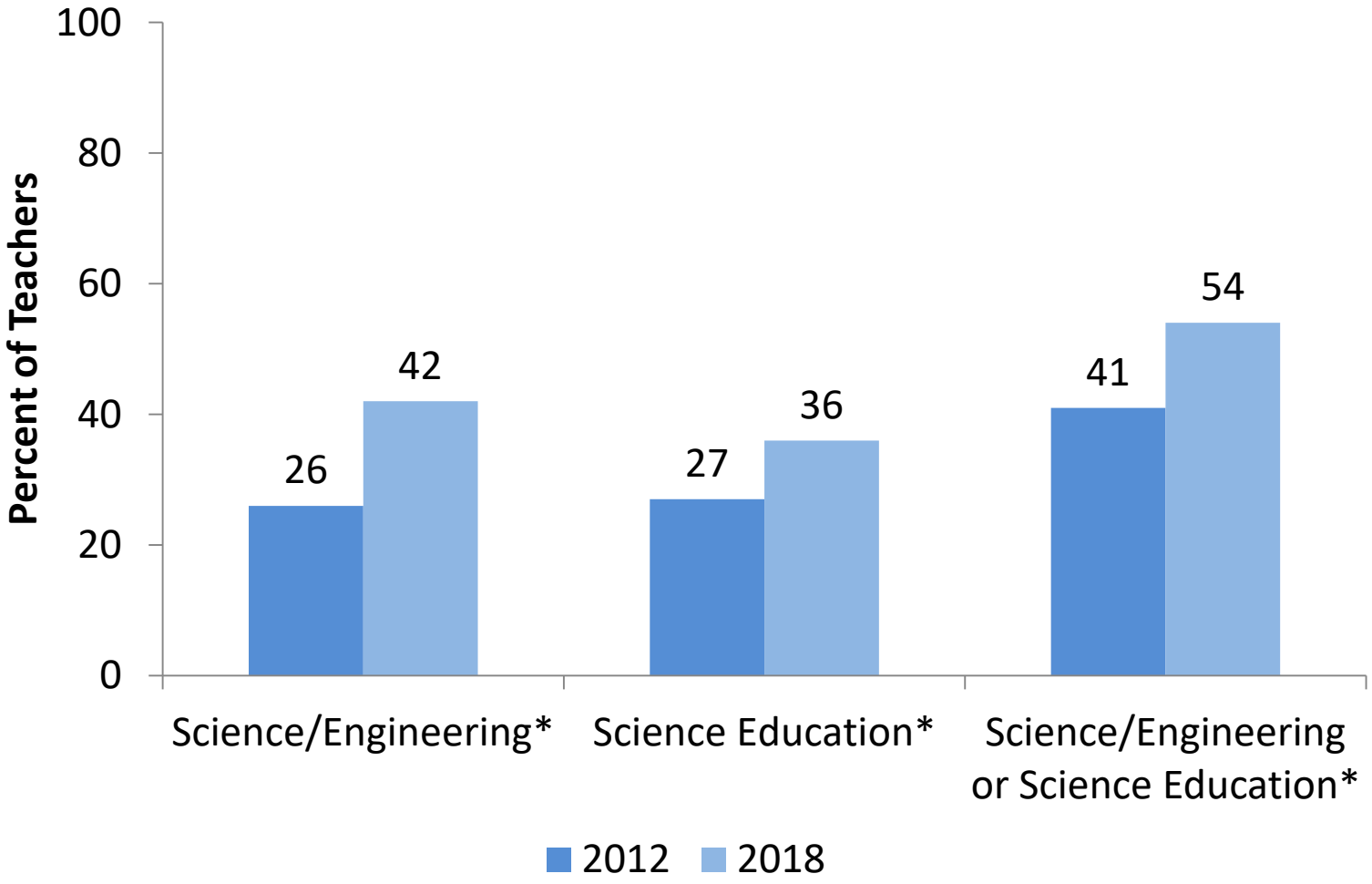
Degrees Earned

Both middle and high school science teachers were more likely in 2018 than in 2012 to have a degree in science/engineering or science education.

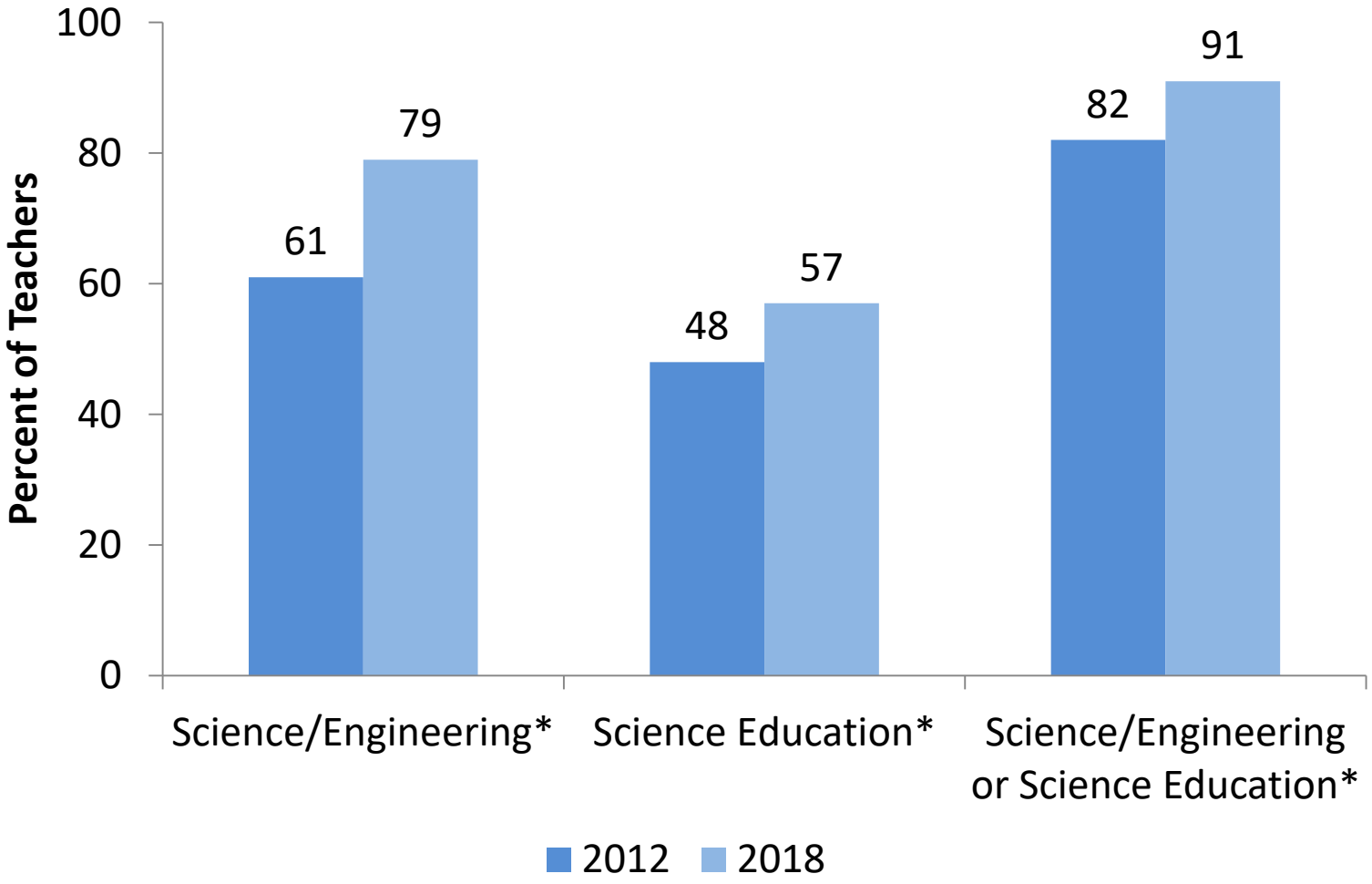
In 2018, middle and high school life science/ biology teachers were more likely to have a degree in their field than they were in 2012.

Likewise, high school chemistry teachers were more likely to have a degree in their field than in 2012.

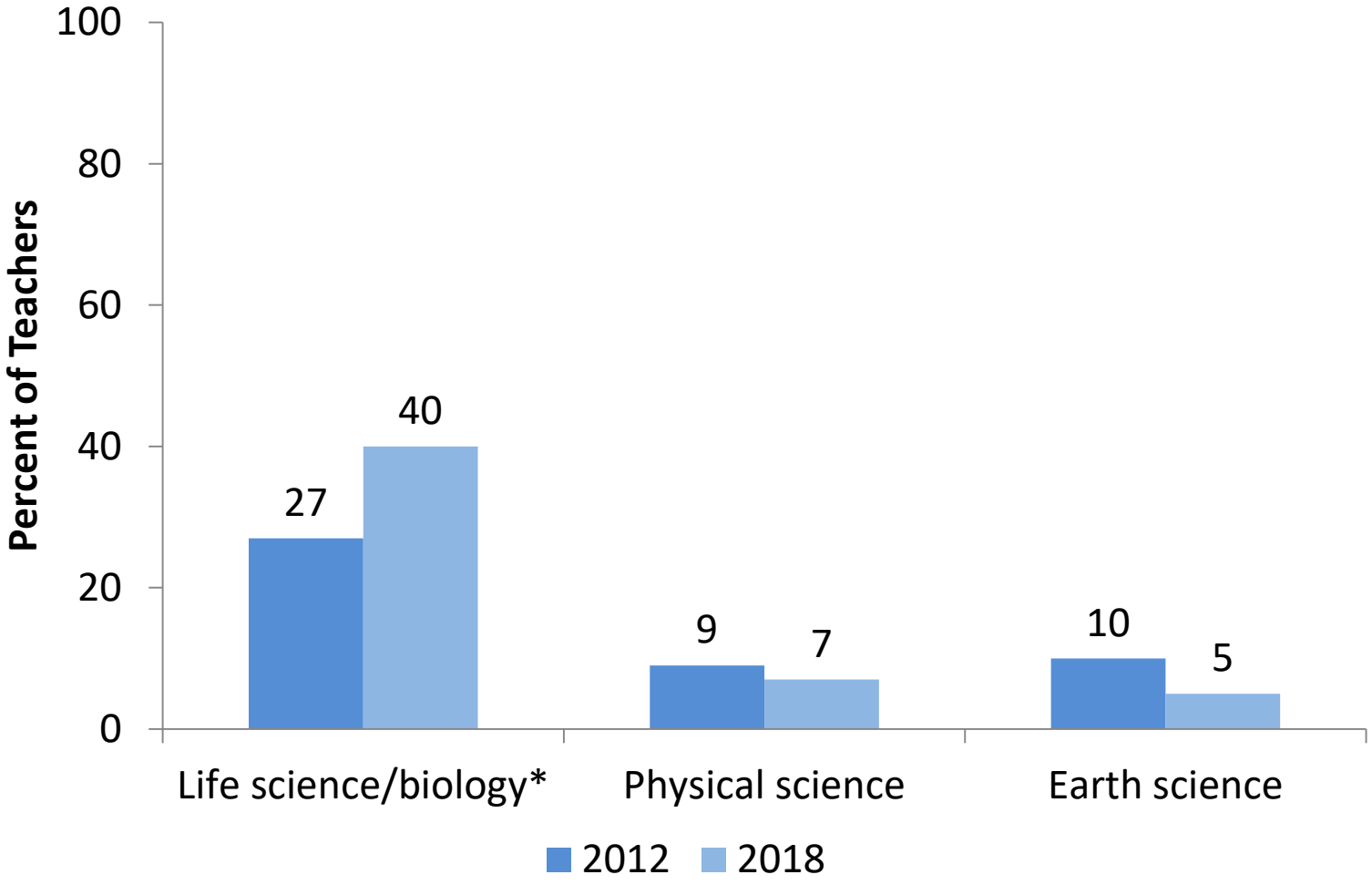
Degrees Earned by Middle School Science Teachers



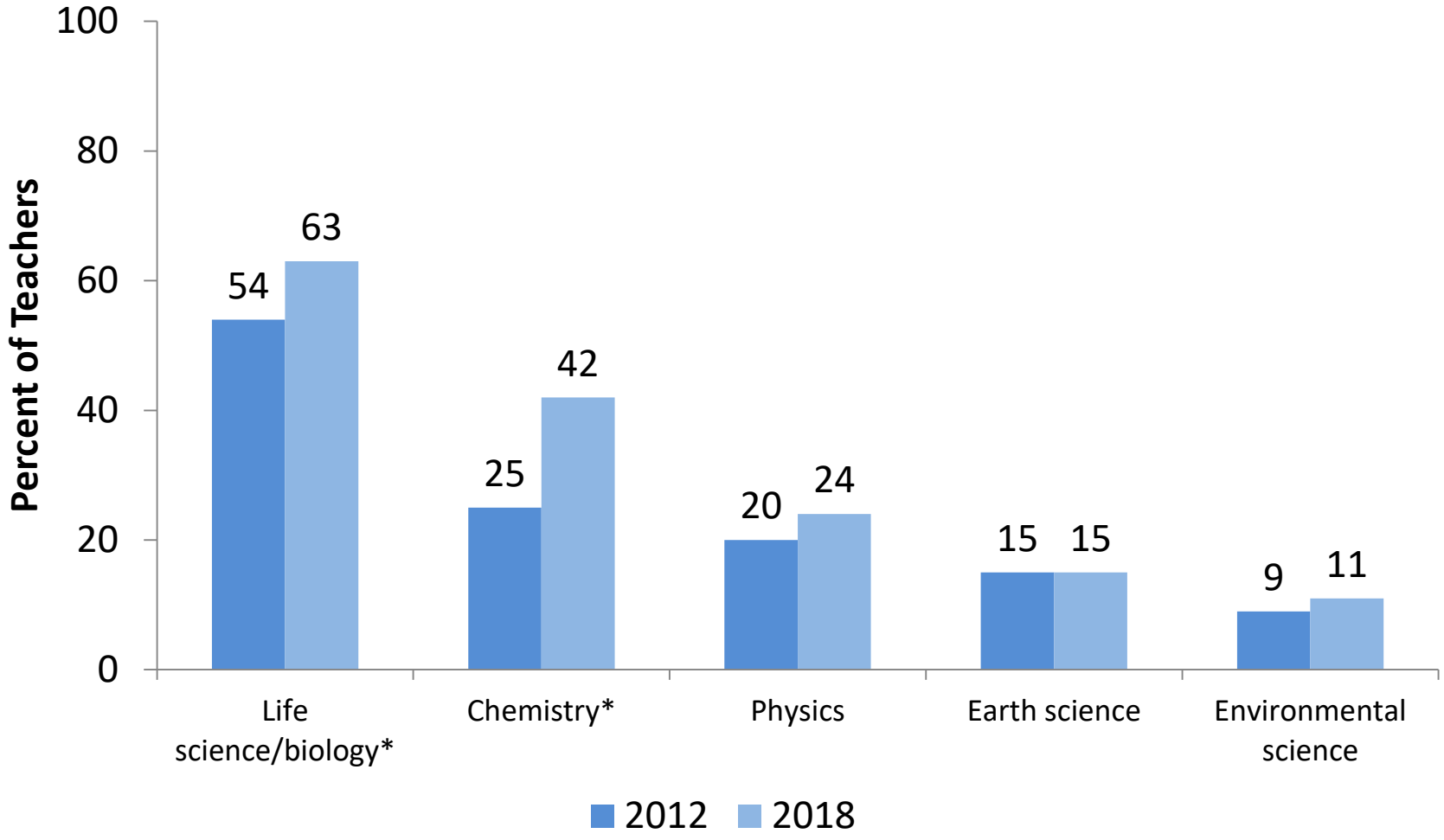
Degrees Earned by High School Science Teachers



Middle Grades Science Teachers With a Degree in Field



High School Science Teachers With a Degree in Field

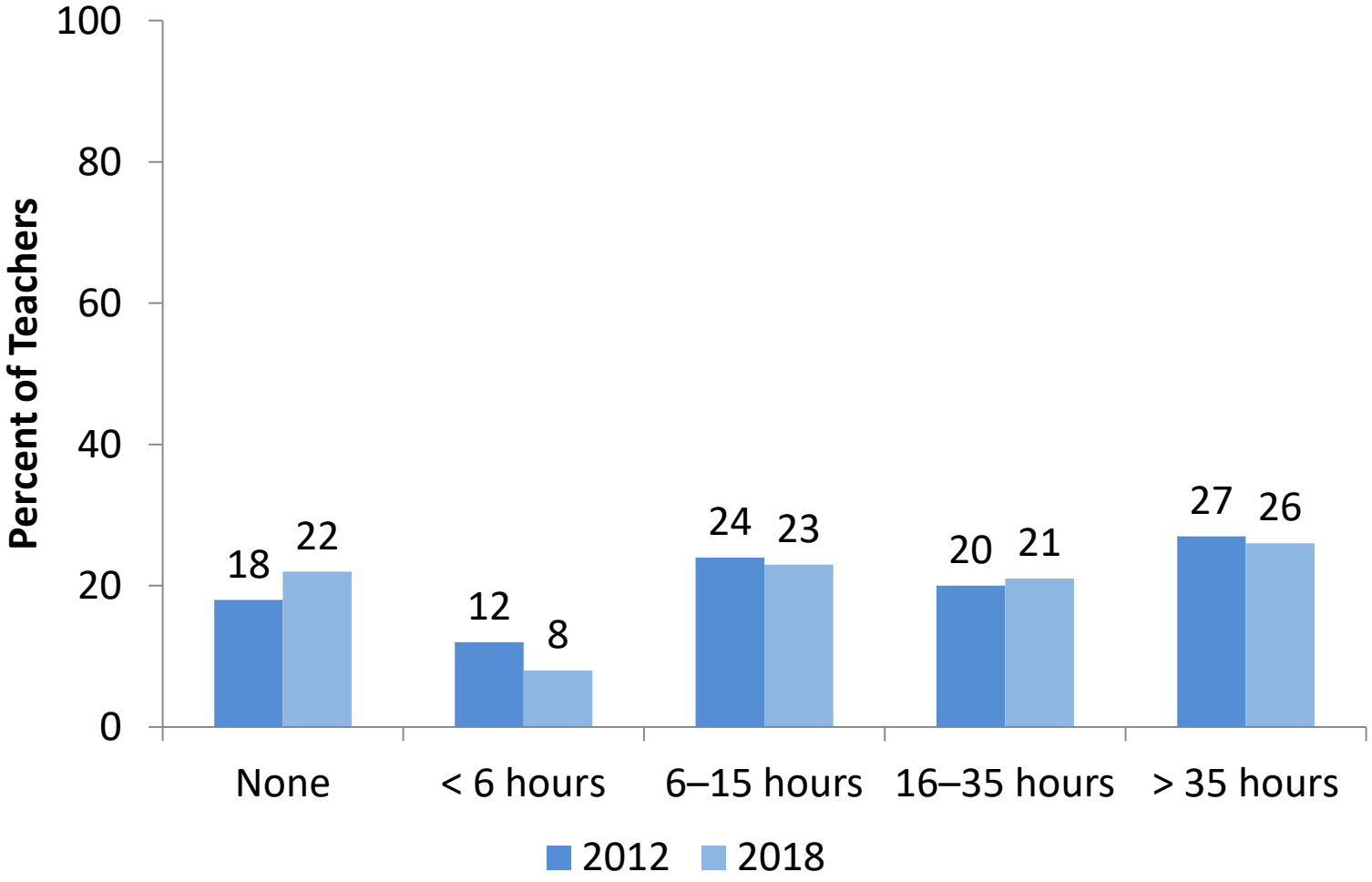


Professional Development

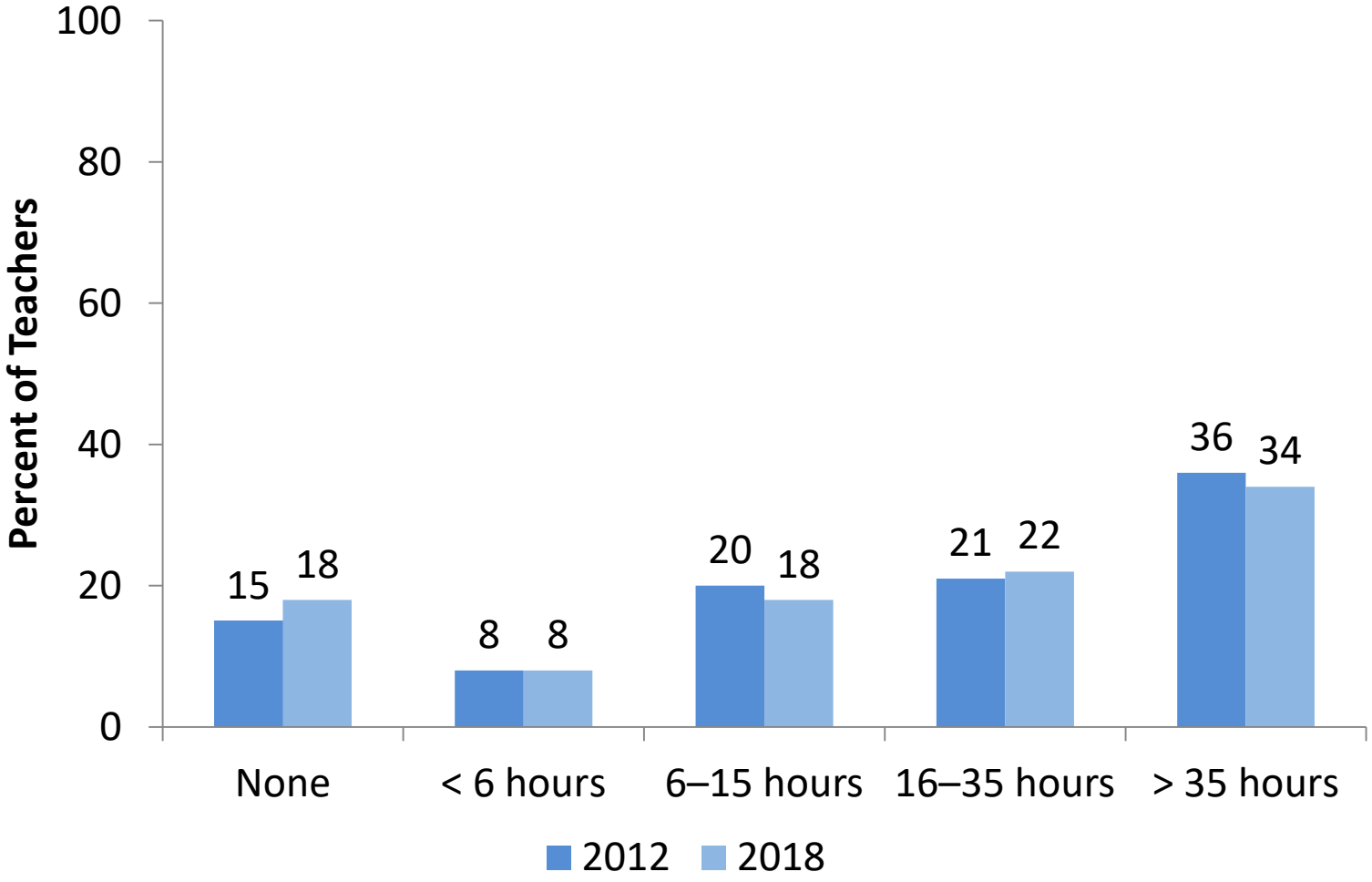
Between 2012 and 2018:

- there was no change in the amount of PD secondary science teachers participated in.
- teachers became less likely to participate in study groups and coaching.
- there was no change in the percentage of schools offering local, science-focused PD.

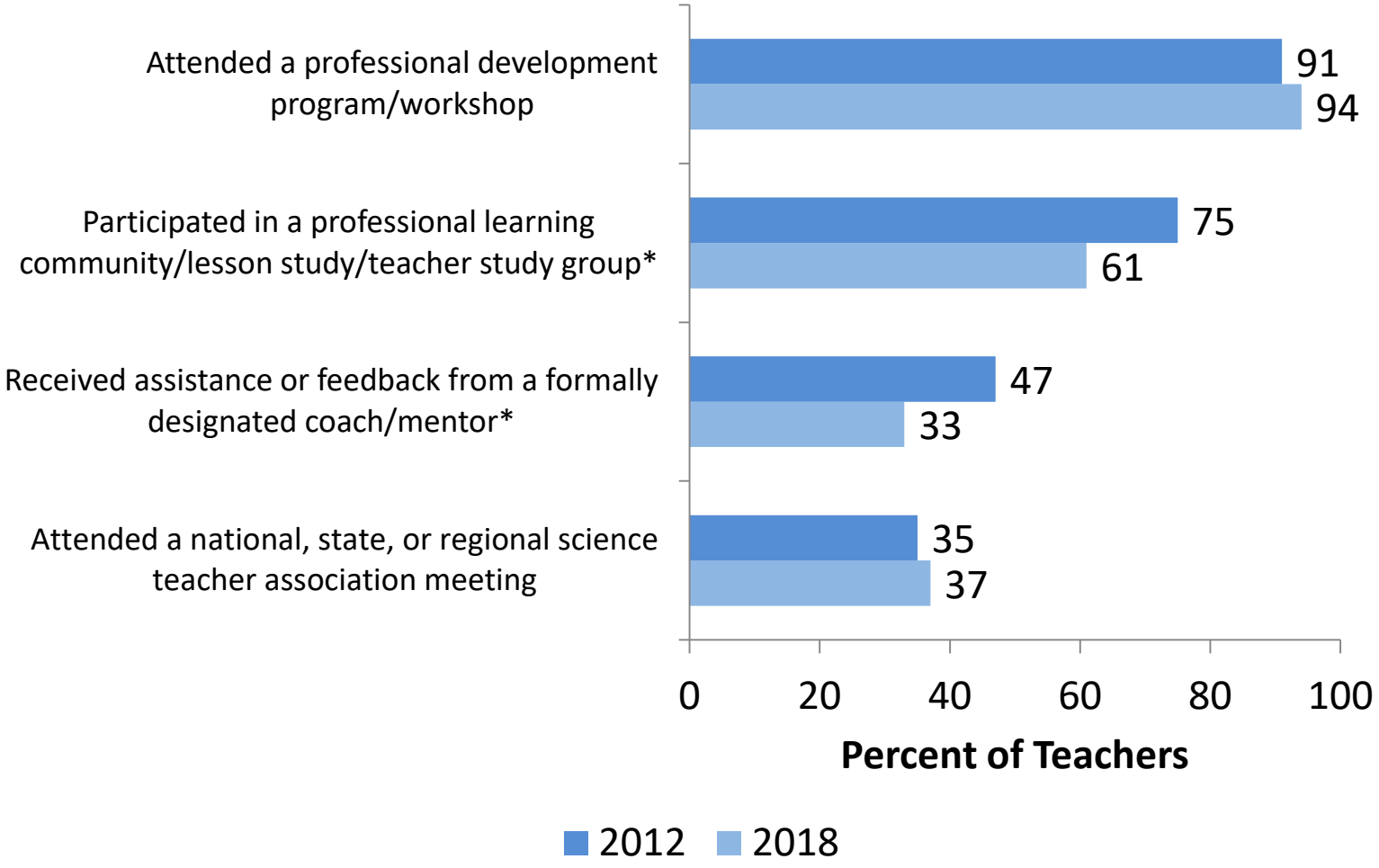
Amount of PD in Previous Three Years: Middle School Science Teachers



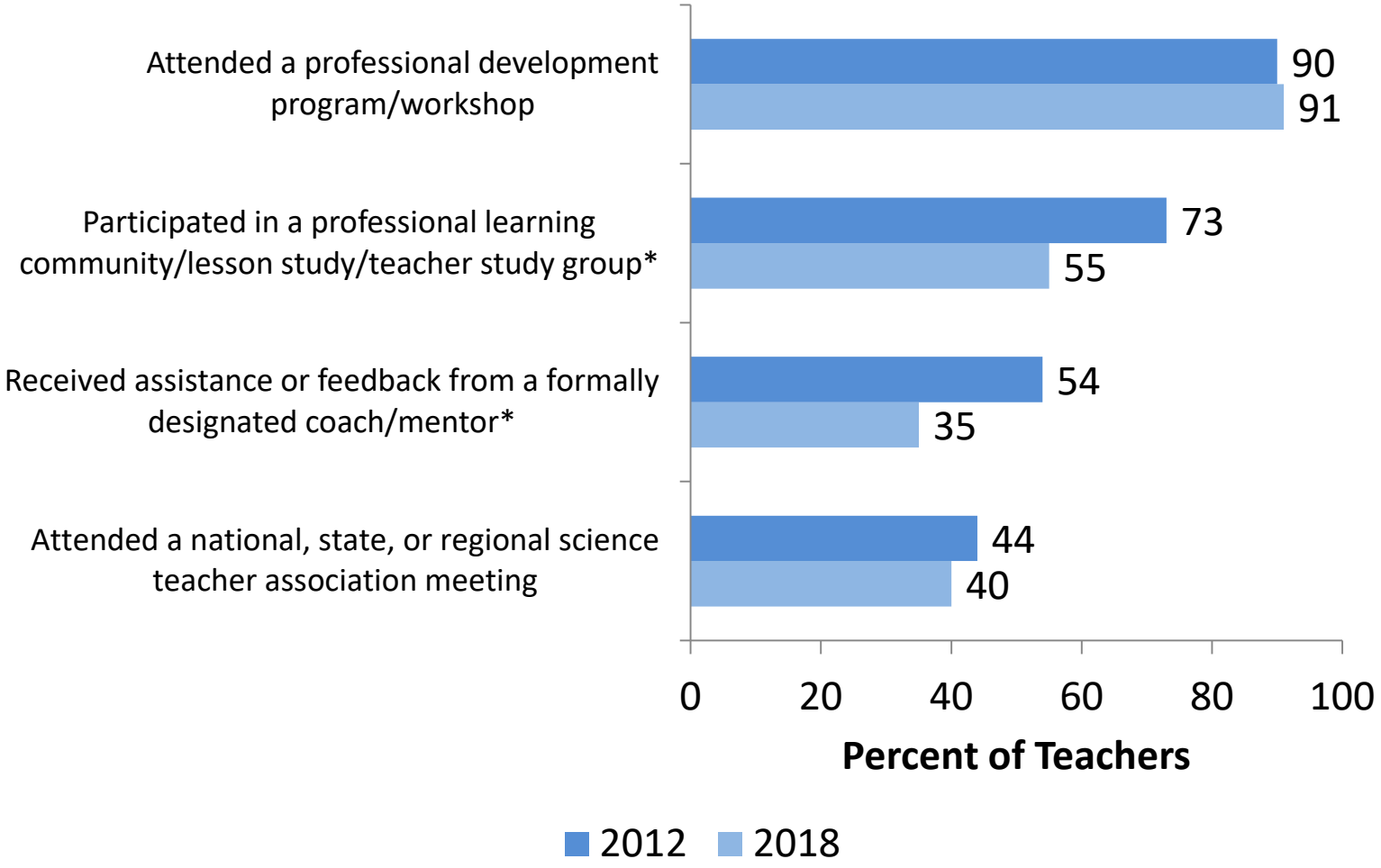
Amount of PD in Previous Three Years: High School Science Teachers



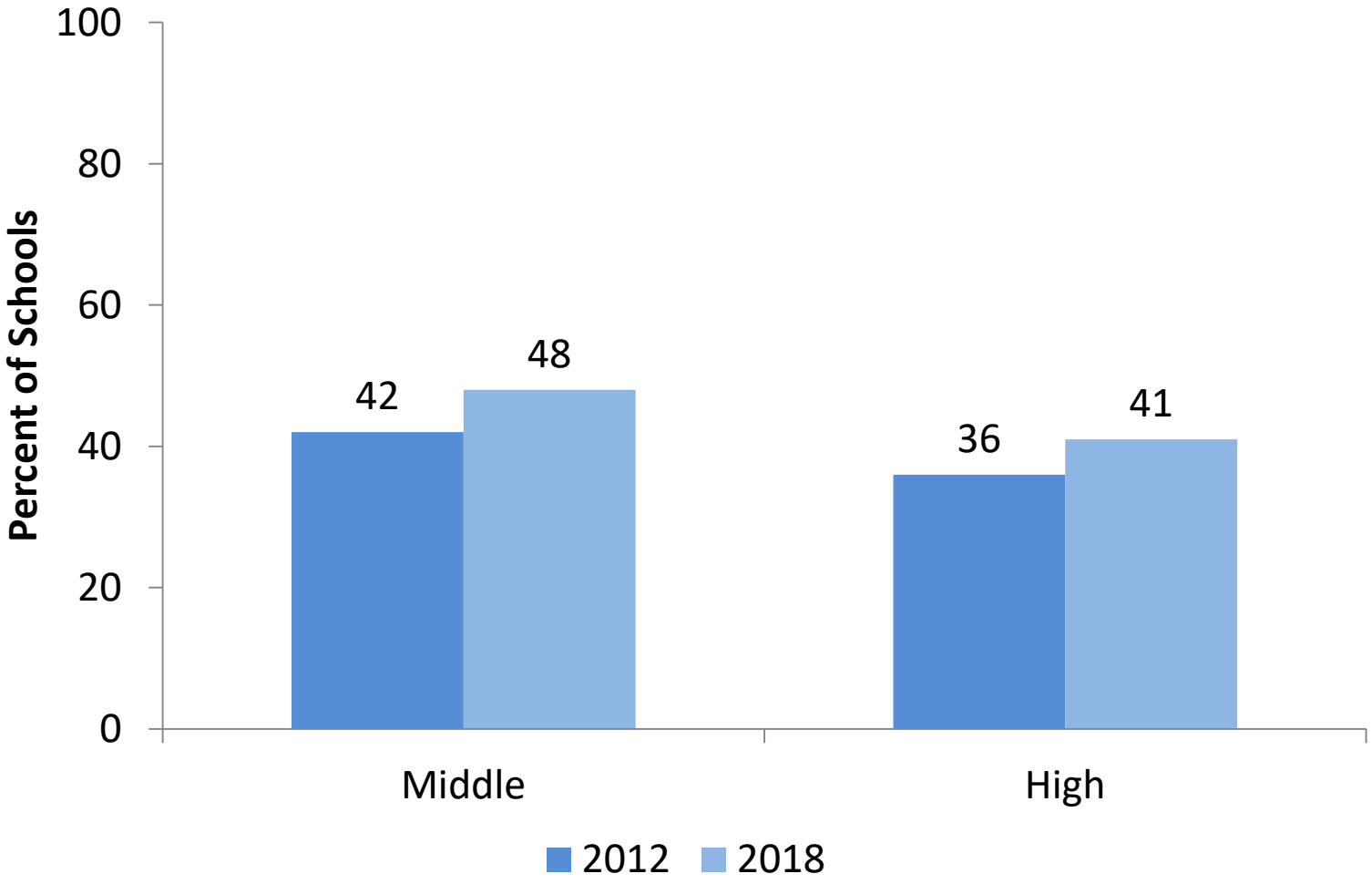
Types of PD in Previous Three Years: Middle School Science Teachers



Types of PD in Previous Three Years: High School Science Teachers



PD Workshops Offered Locally in Previous Three Years

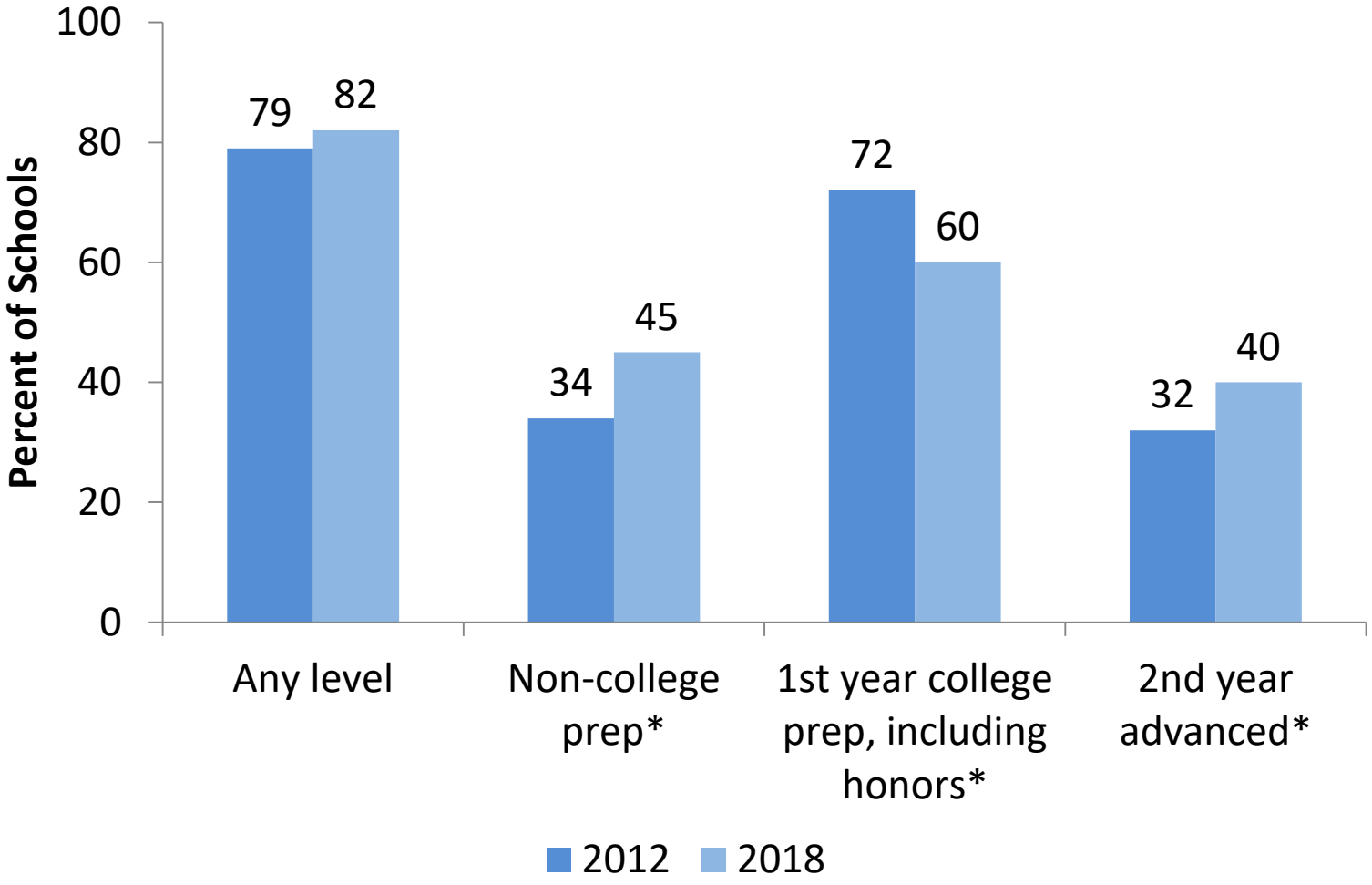


Science Courses

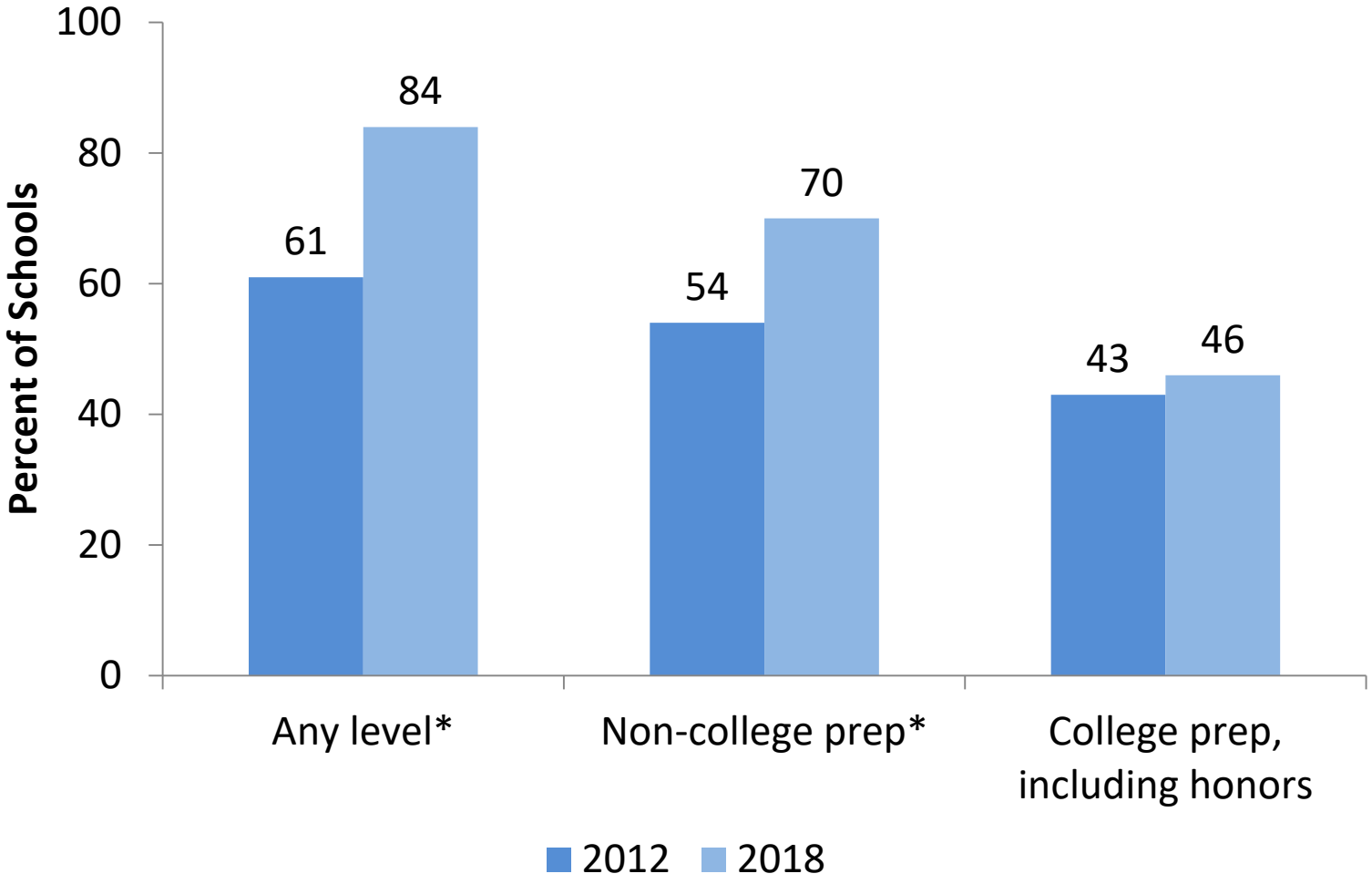
In 2018, schools were more likely than in 2012 to offer non-college prep courses and advanced courses in several science disciplines.

High schools were much more likely in 2018 to offer engineering courses, including non-college prep, college prep, and advanced courses.

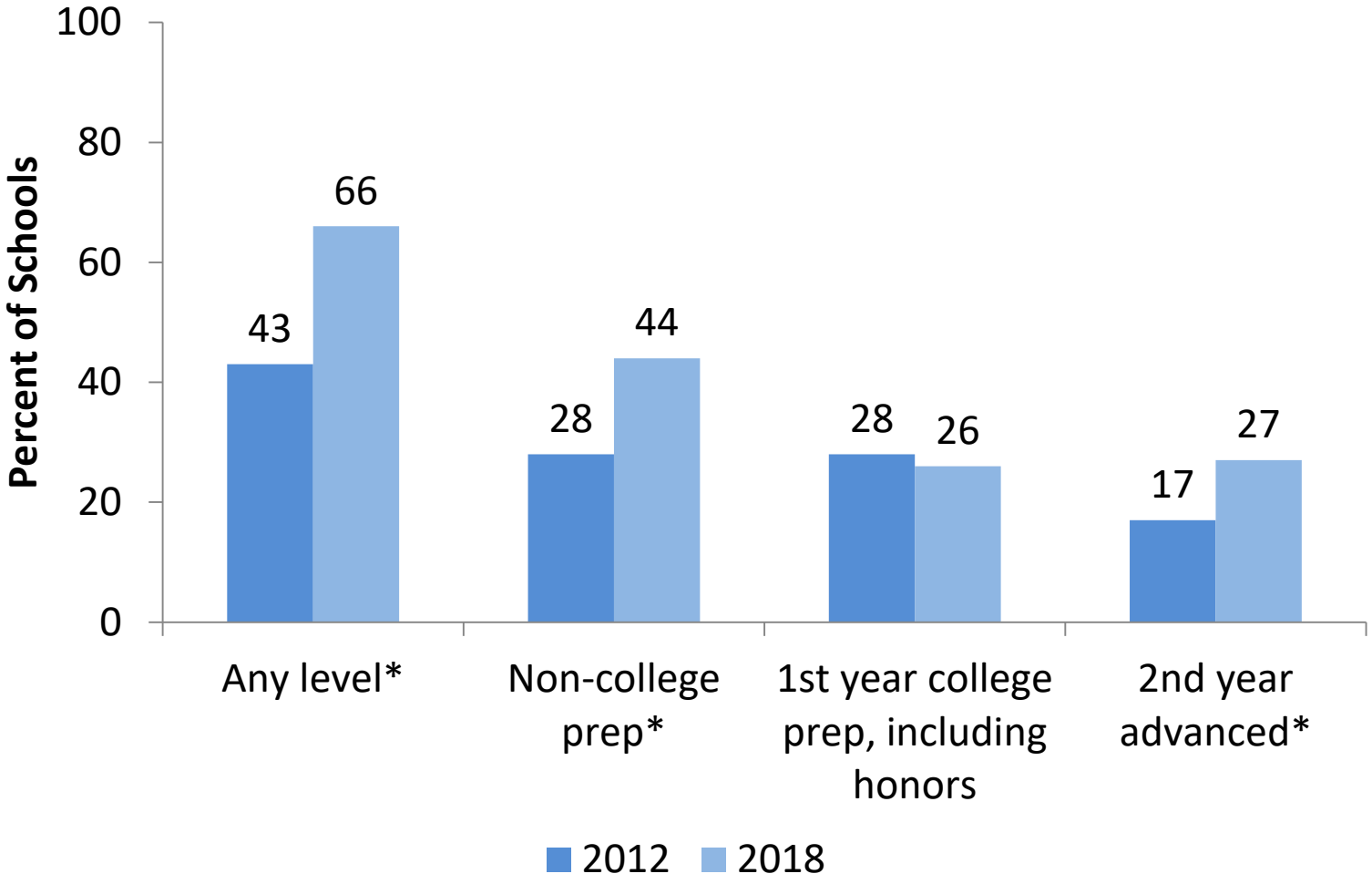
High Schools Offering Physics Courses



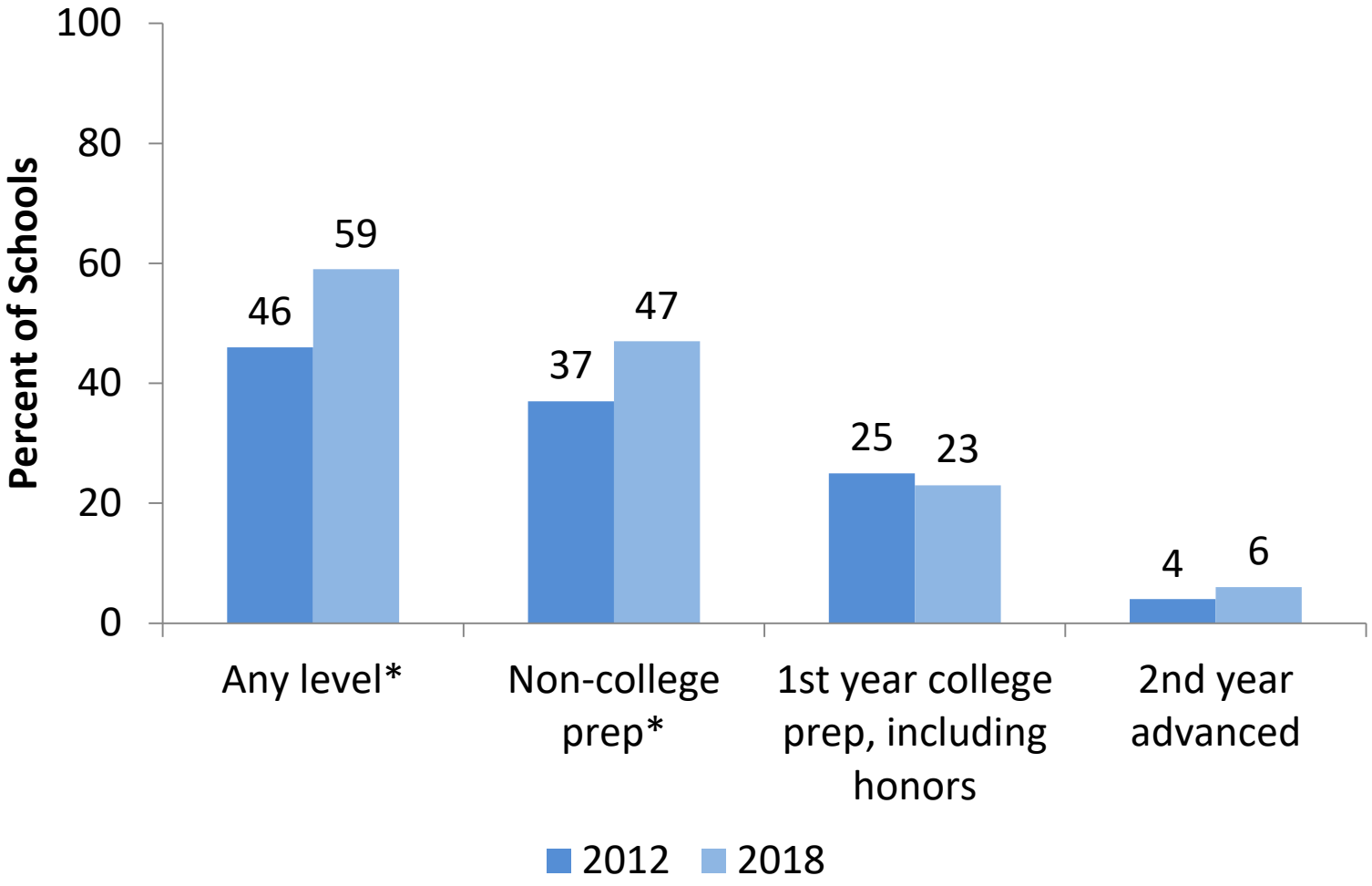
High Schools Offering Coordinated/ Integrated/Interdisciplinary Science Courses



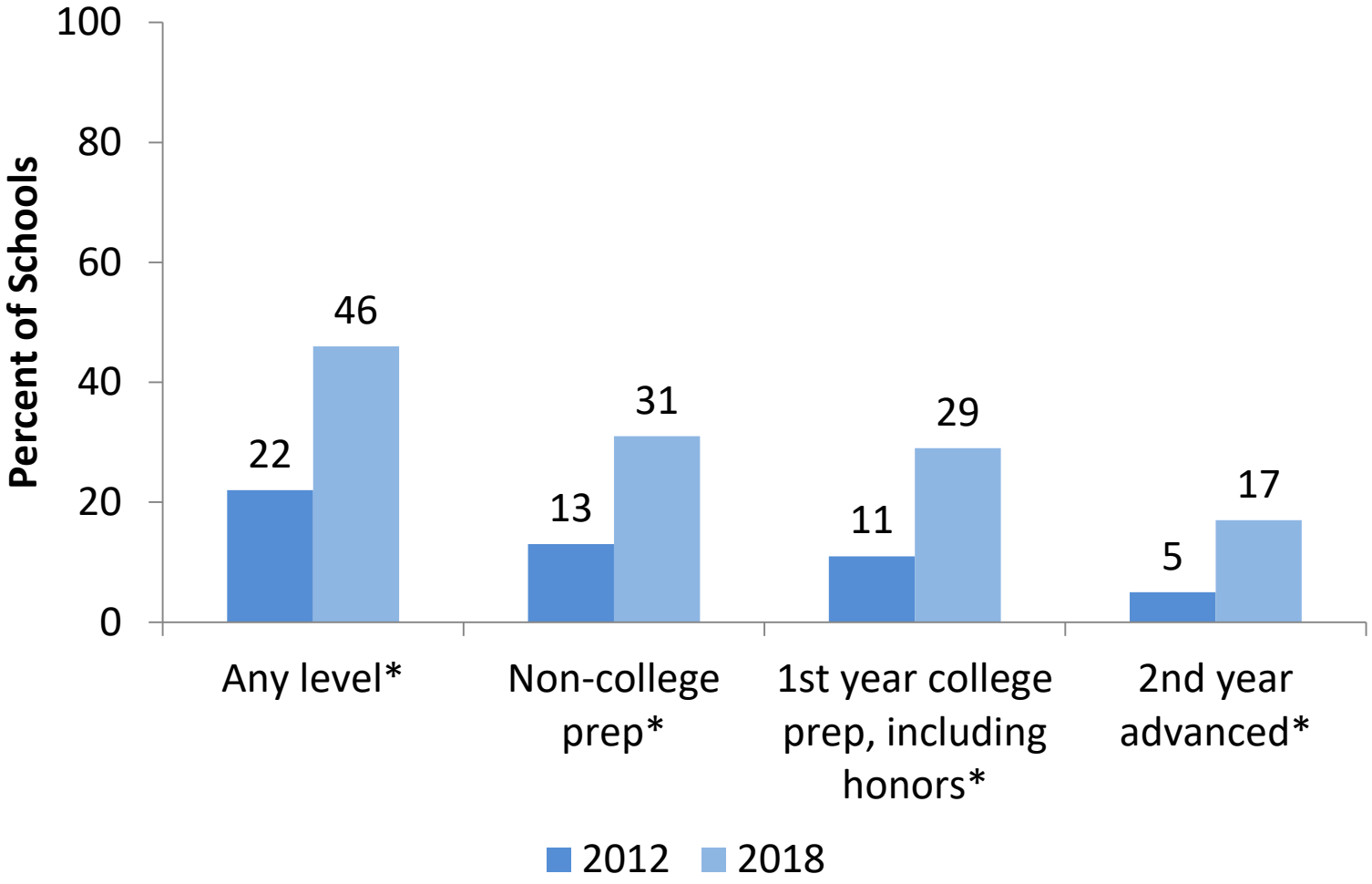
High Schools Offering Environmental Science/Ecology Courses



High Schools Offering Earth/Space Science Courses



High Schools Offering Engineering Courses

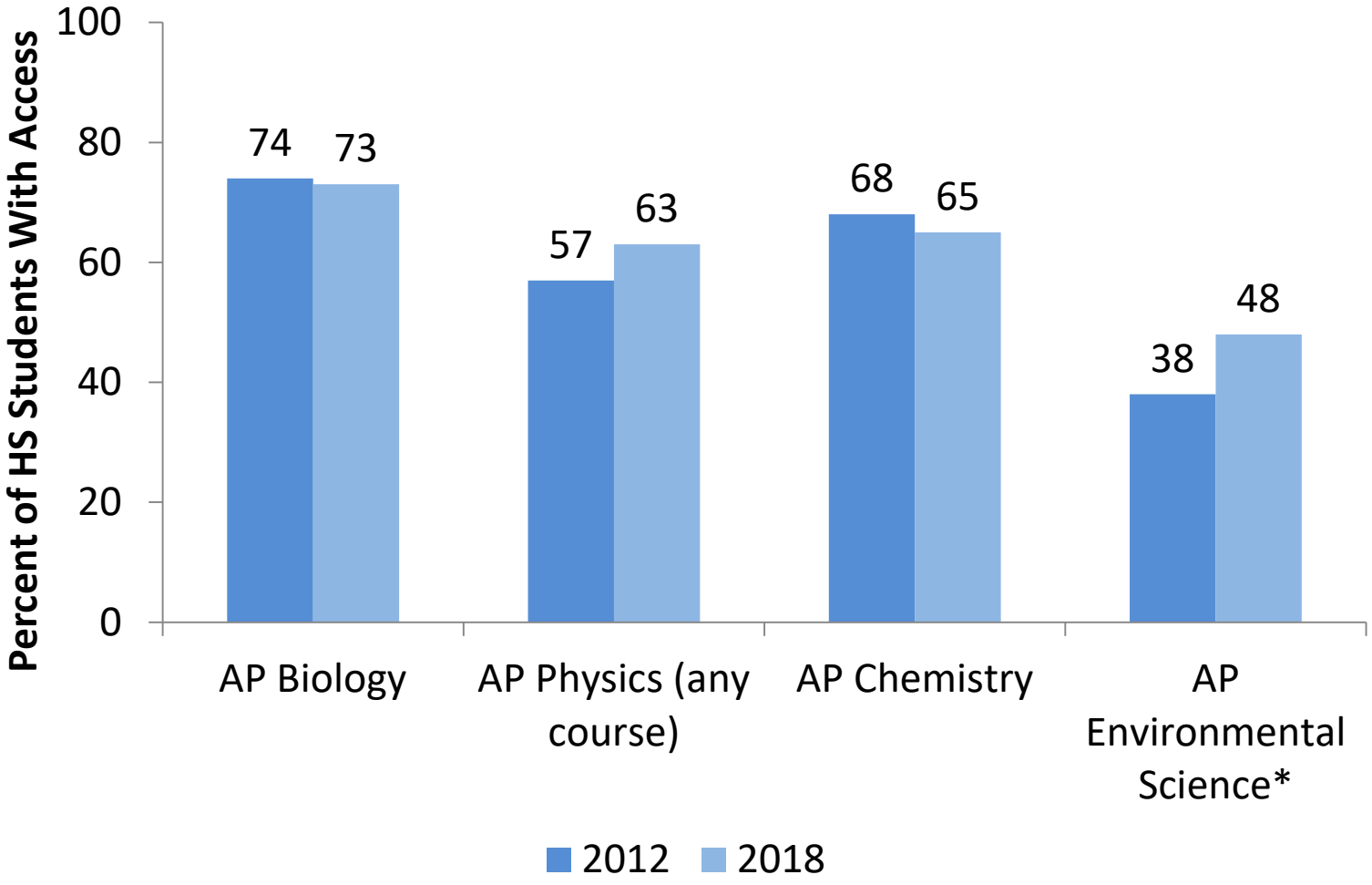


Access to AP and Special Opportunities

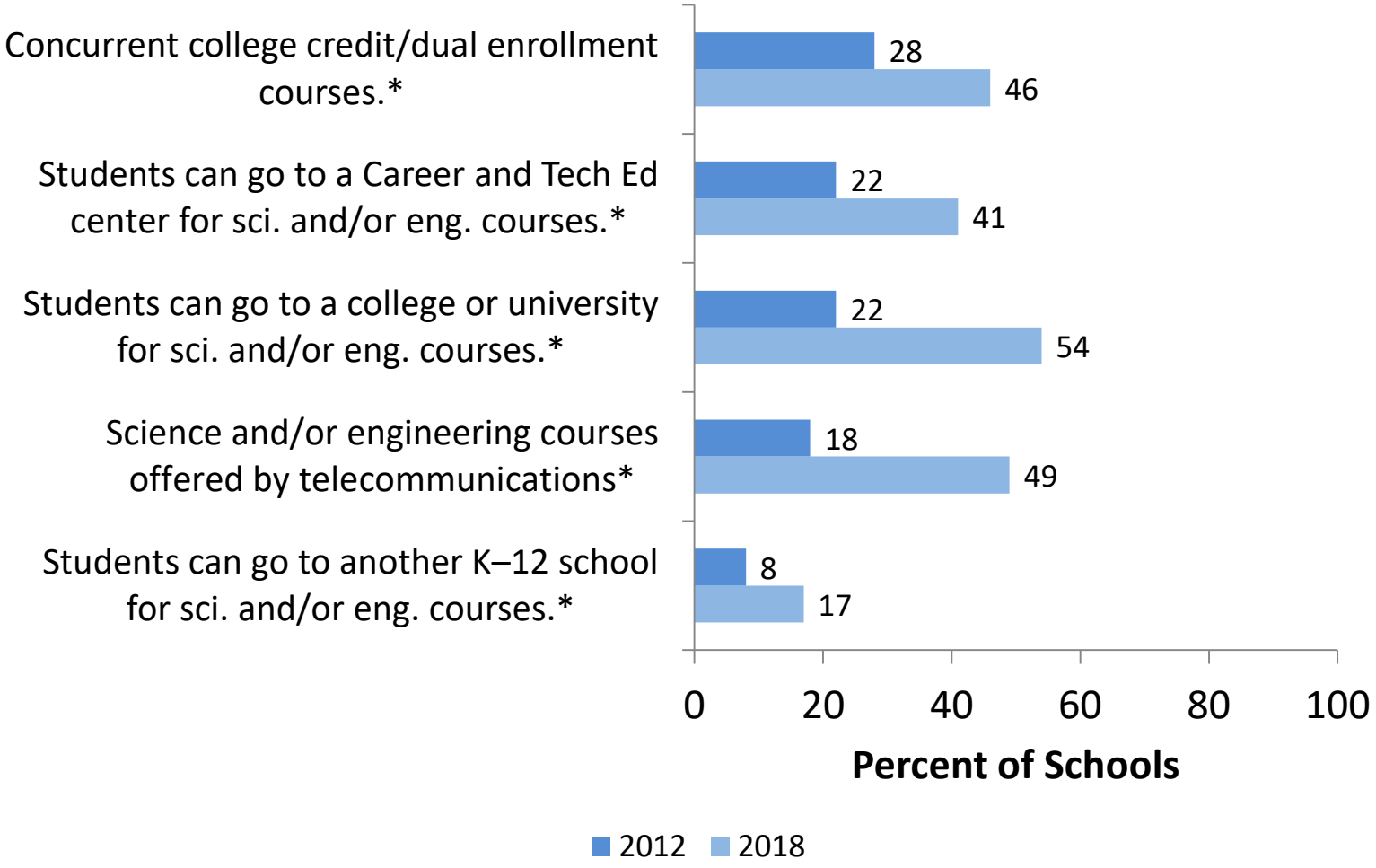
With the exception of access to AP Environmental Science (which increased), student access to AP courses did not change from 2012 to 2018.

Several special opportunities to take science/ engineering courses (e.g., dual enrollment, courses by telecommunications) became much more common in 2018.

Access to AP Courses



Science Programs Offered at High Schools

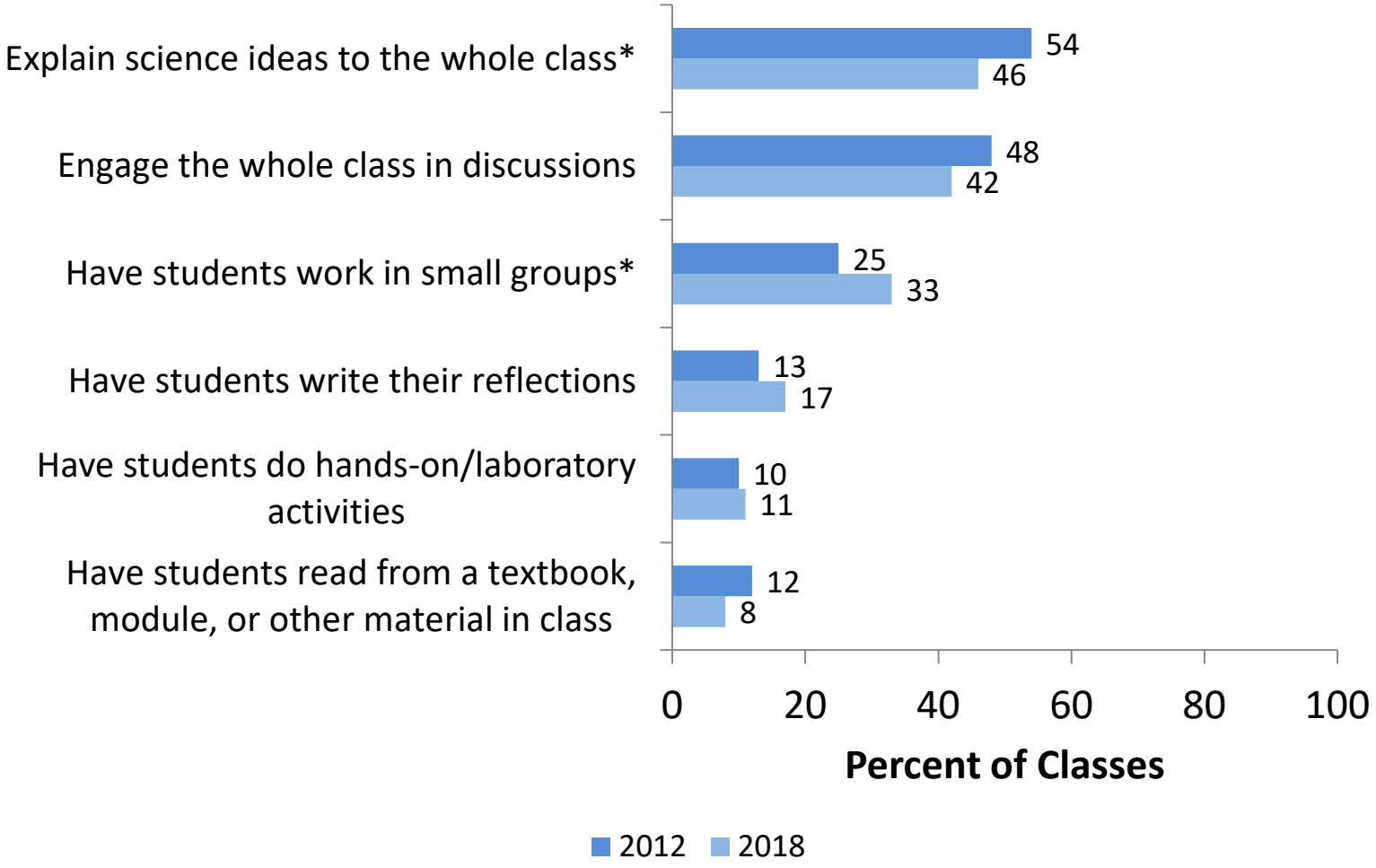


Science Instruction

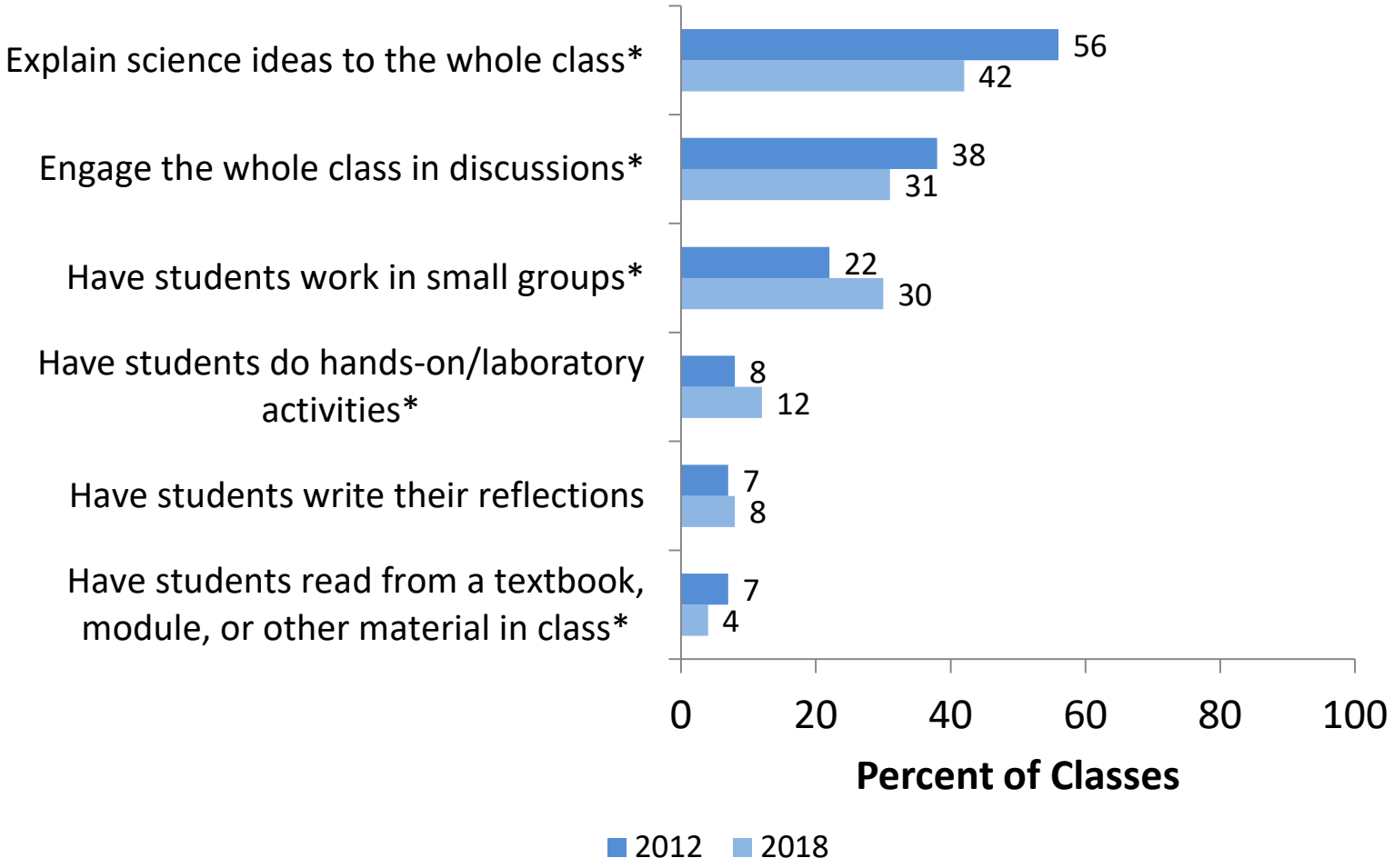
Between 2012 and 2018, there was little change in science class activities in middle and high schools, with some exceptions, including:

- The likelihood of explaining a science idea to the whole class decreased.
- The likelihood of students working in small groups increased.

Middle School Class Activities: All or Almost All Lessons



High School Class Activities: All or Almost All Lessons



Adequacy of Resources

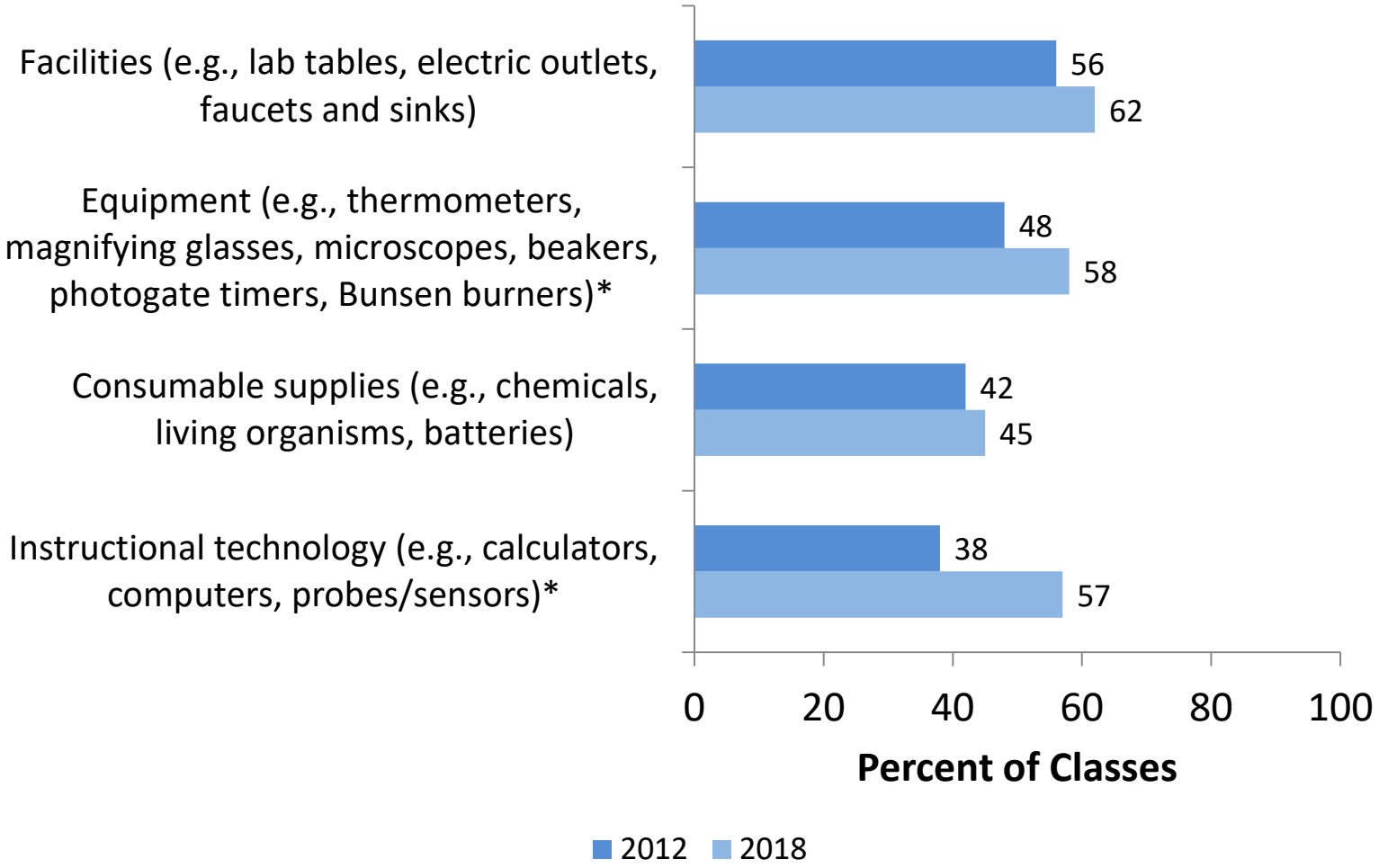
In 2018, middle school science teachers were more likely than in 2012 to view some resources as adequate:

- Equipment (e.g., thermometers, microscopes, beakers, Bunsen burners)
- Instructional technology (e.g., calculators, computers, probes/sensors)

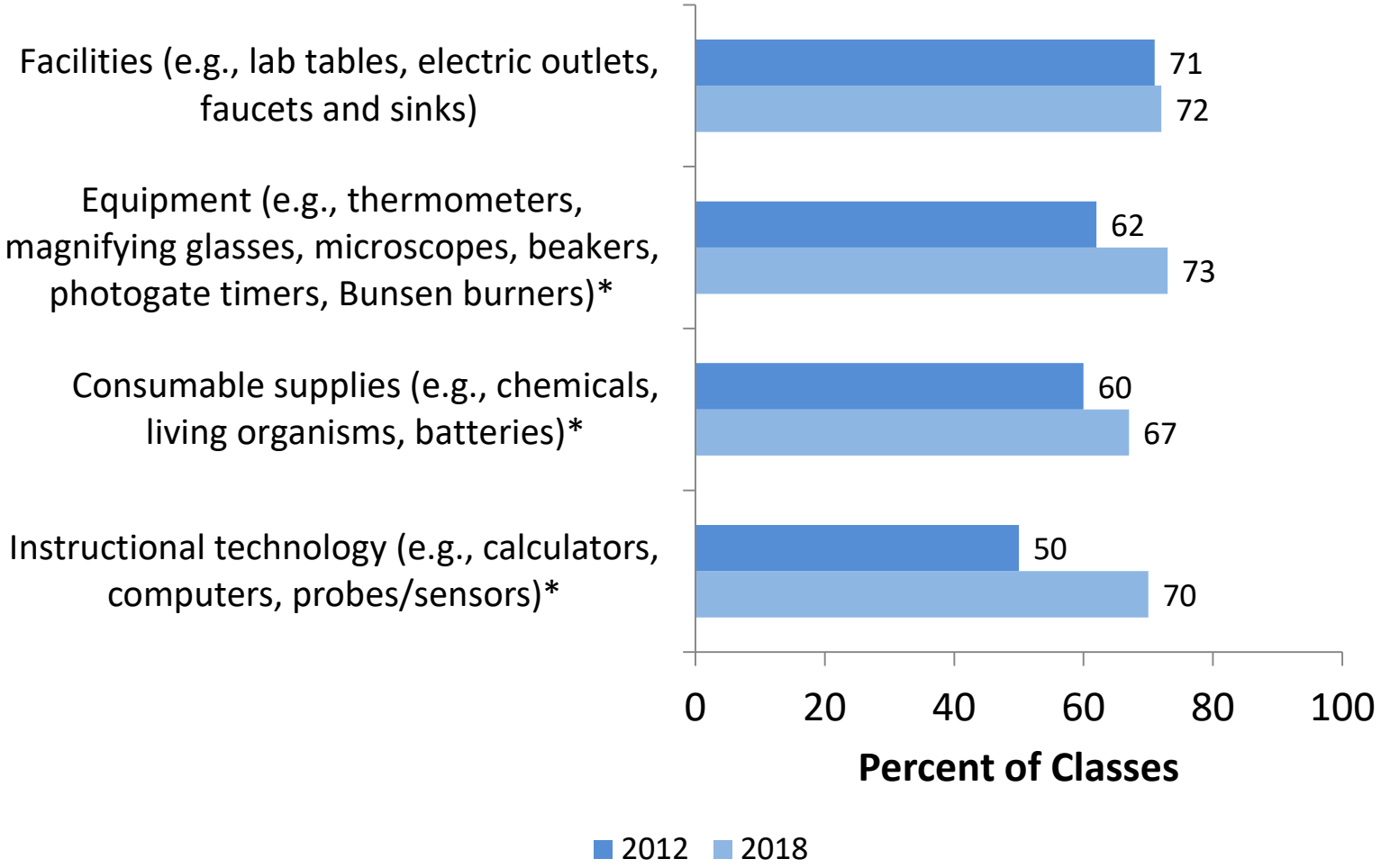
In 2018, high school science teachers were more likely than in 2012 to view some resources as adequate:

- Equipment
- Consumable supplies
- Instructional technology

Classes in Which Teachers Feel Various Resources are Adequate: Middle School



Classes in Which Teachers Feel Various Resources are Adequate: High School



Conclusions

The 2018 NSSME+ data point to several positive trends in secondary science, including:

- Increases in course taking and degrees earned among teachers
- Increased opportunities for students to take science courses by special means
- Less lecture and more group work
- More resources

The data also point to continued problem areas, including:

- Lack of diversity in teaching force
- Inadequate professional learning opportunities and participation

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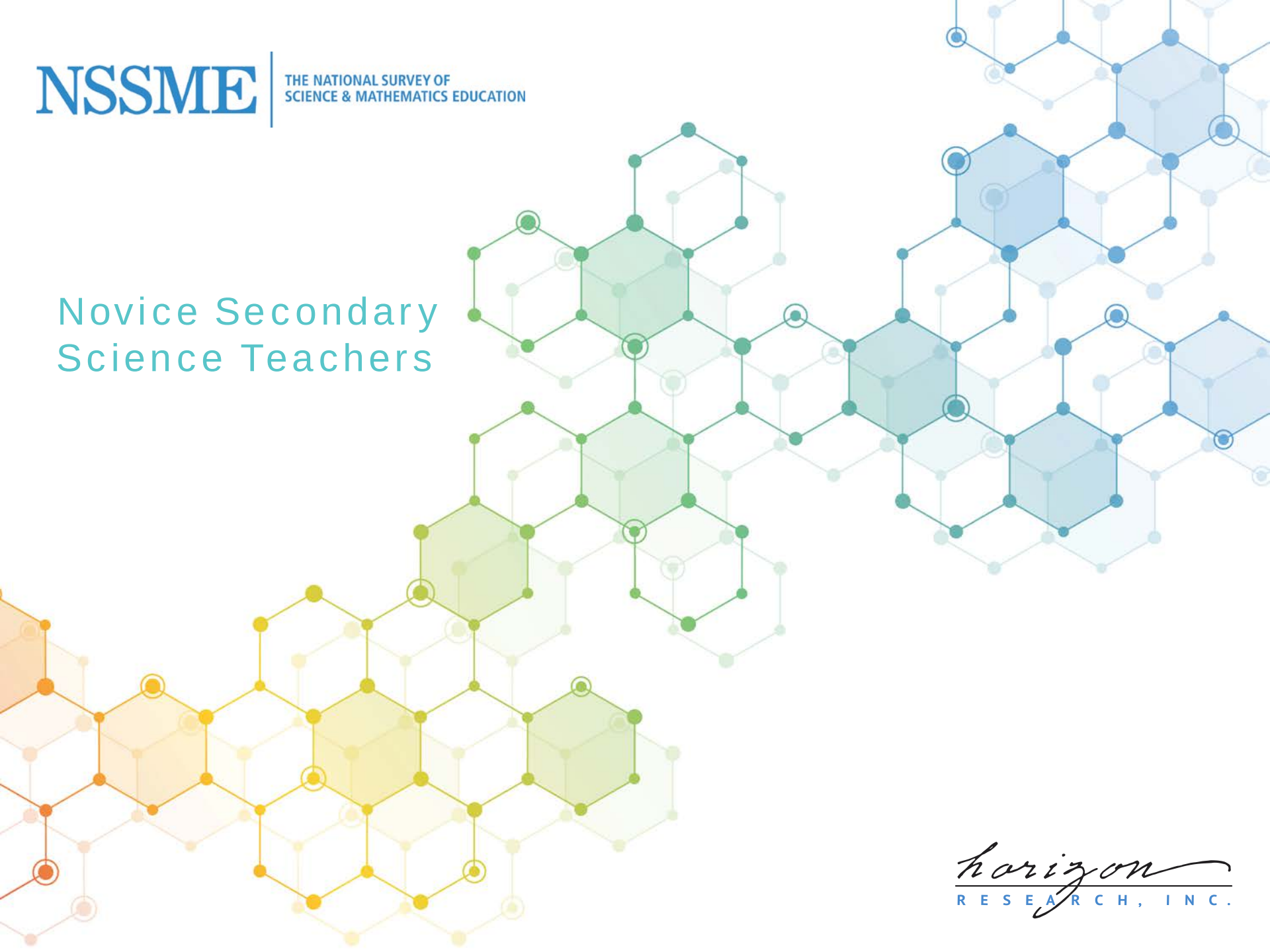
Novice Secondary Science Teachers



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Teacher Characteristics

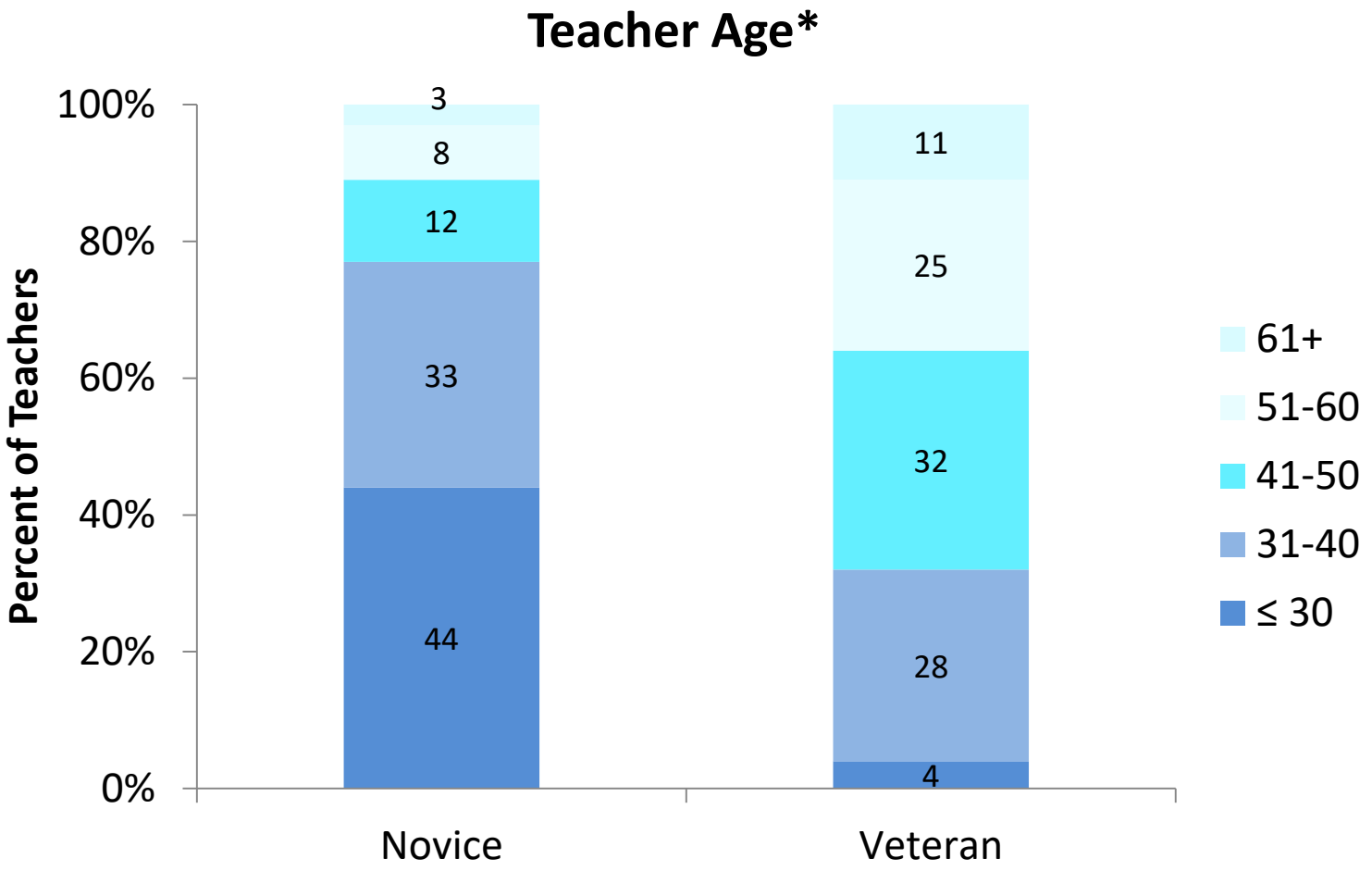
The 2018 NSSME+ collected data on:

- Sex
- Race/ethnicity
- Age
- School Contexts
- Content background (certification, degrees and coursework)
- Beliefs
- Preparedness

Characteristics of the Middle School Teaching Force

	Percent of Teachers	
	Novice	**Veteran**
Sex		
Female	68	73
Male	32	25
Race/Ethnicity		
White	89	92
Black or African-American	11	7
Hispanic or Latino	8	6
Asian	2	1
American Indian/Alaskan Native	2	2
Native Hawaiian/Other Pacific Islander	1	0

Characteristics of the Middle School Teaching Force



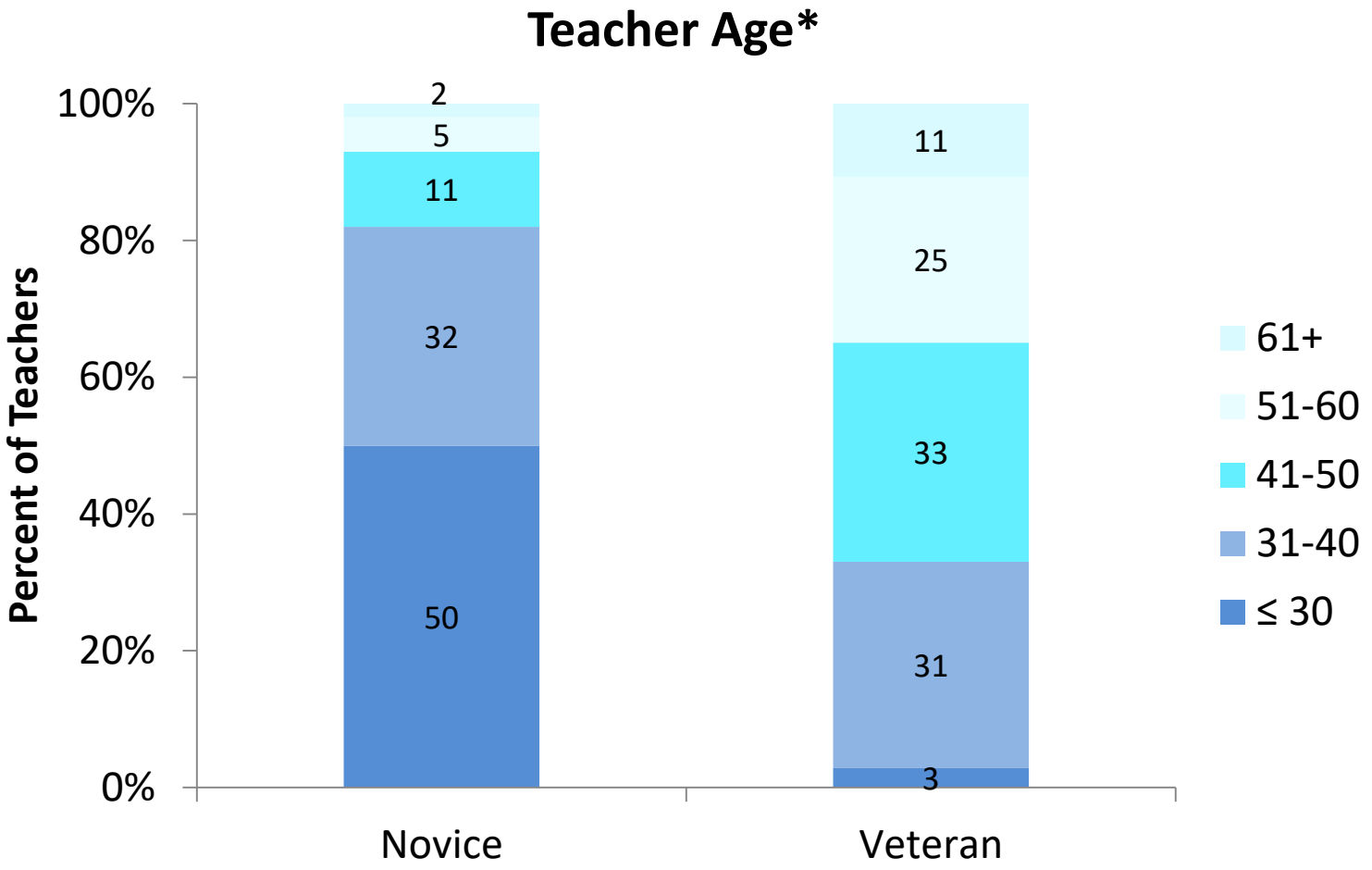
Middle School Contexts

	Percent of Teachers	
	Novice	**Veteran**
School Type		
Catholic	8	6
Non-Catholic Private	5	7
Public	88	87
Community Type		
Rural	31	24
Suburban	47	49
Urban	23	27

Characteristics of the High School Teaching Force

	Percent of Teachers	
	Novice	**Veteran**
Sex		
Female	58	56
Male	42	44
Race/Ethnicity		
White	87	93
Black or African-American	6	4
Hispanic or Latino	11	5
Asian	7	4
American Indian/Alaskan Native	2	2
Native Hawaiian/Other Pacific Islander	0	0

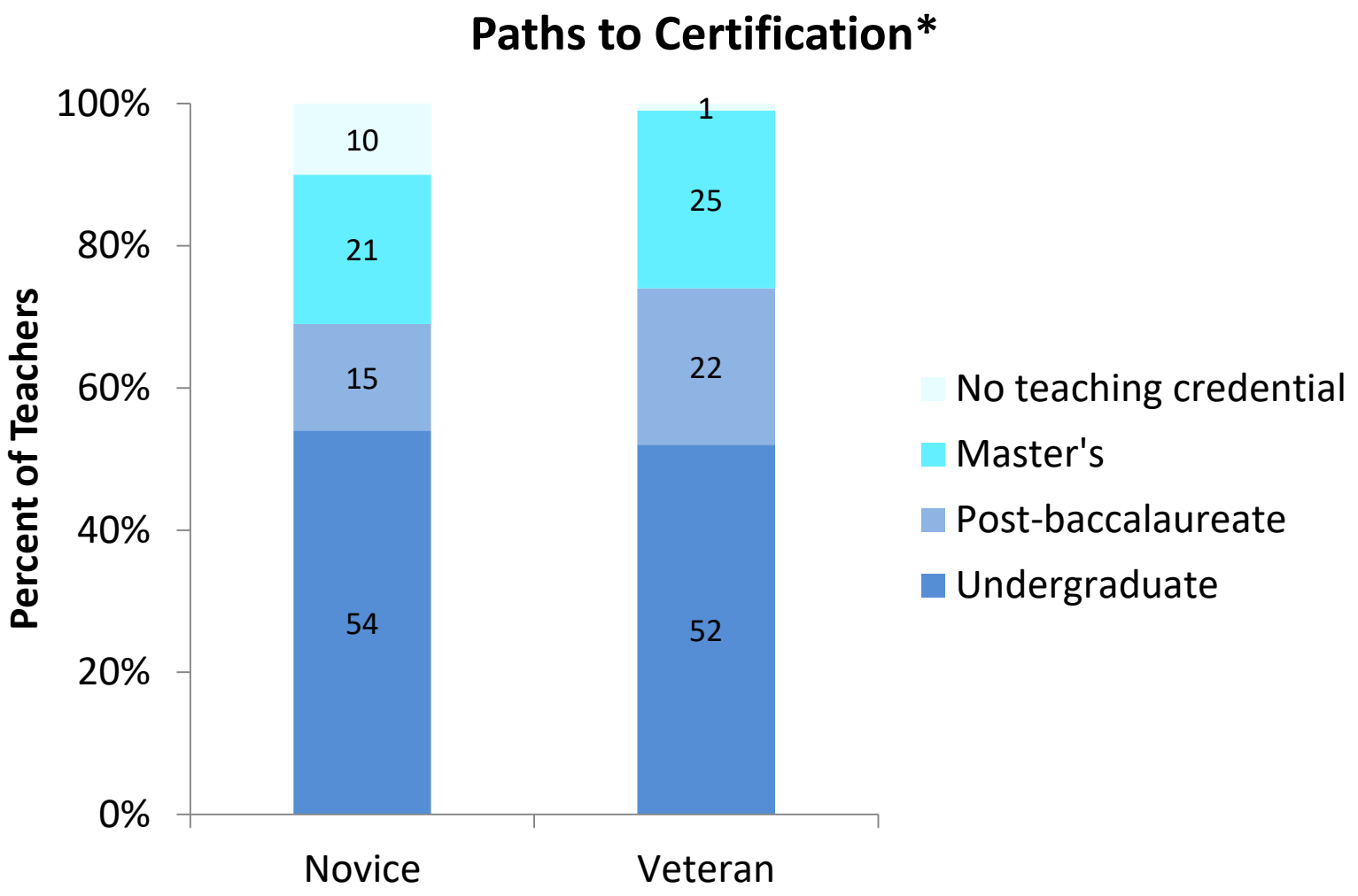
Characteristics of the High School Teaching Force



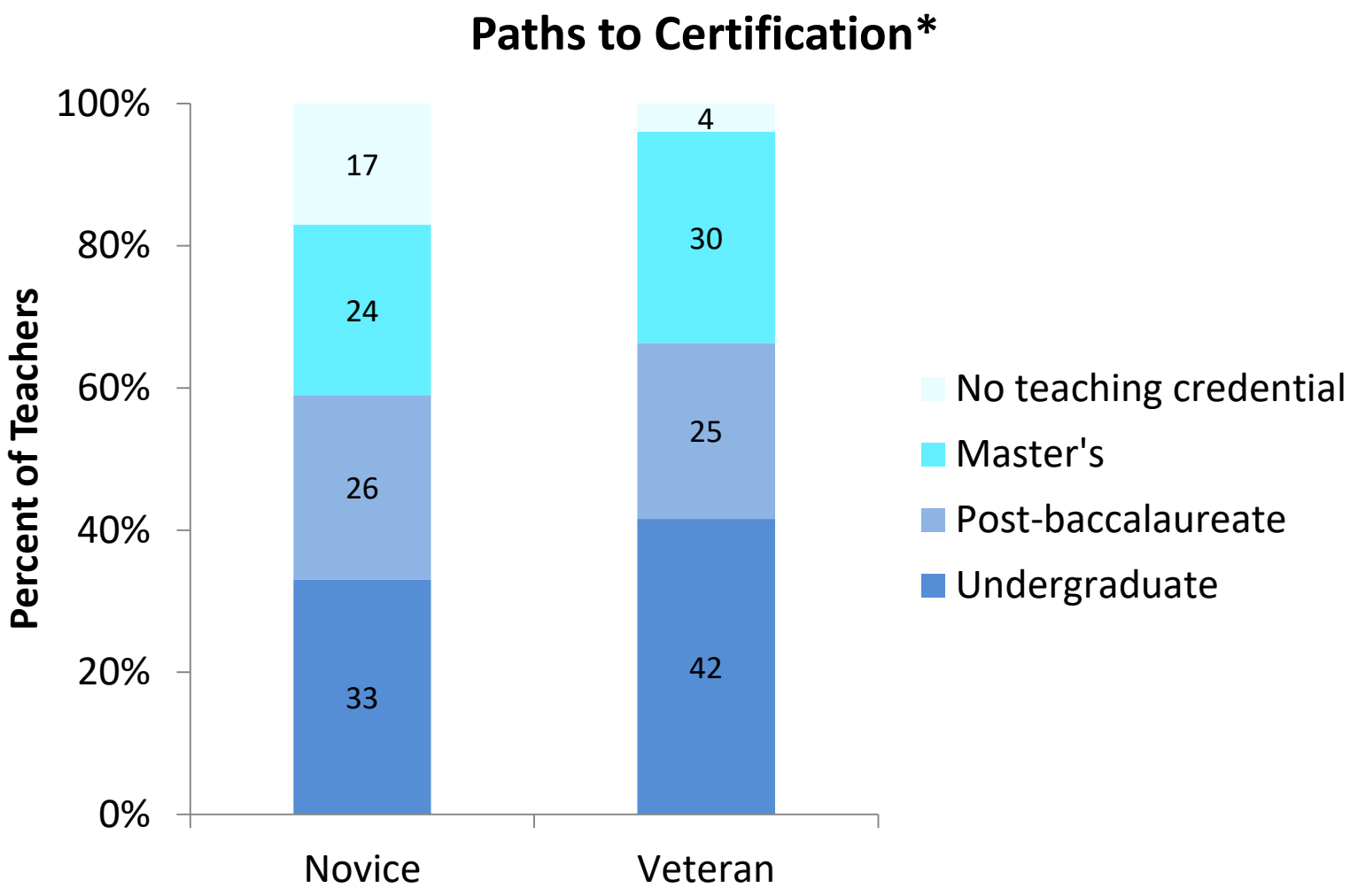
High School Contexts

	Percent of Teachers	
	Novice	**Veteran**
School Type	6	9
Catholic	7	6
Non-Catholic Private	86	85
Public		
Community Type		
Rural	22	26
Suburban	42	49
Urban	36	26

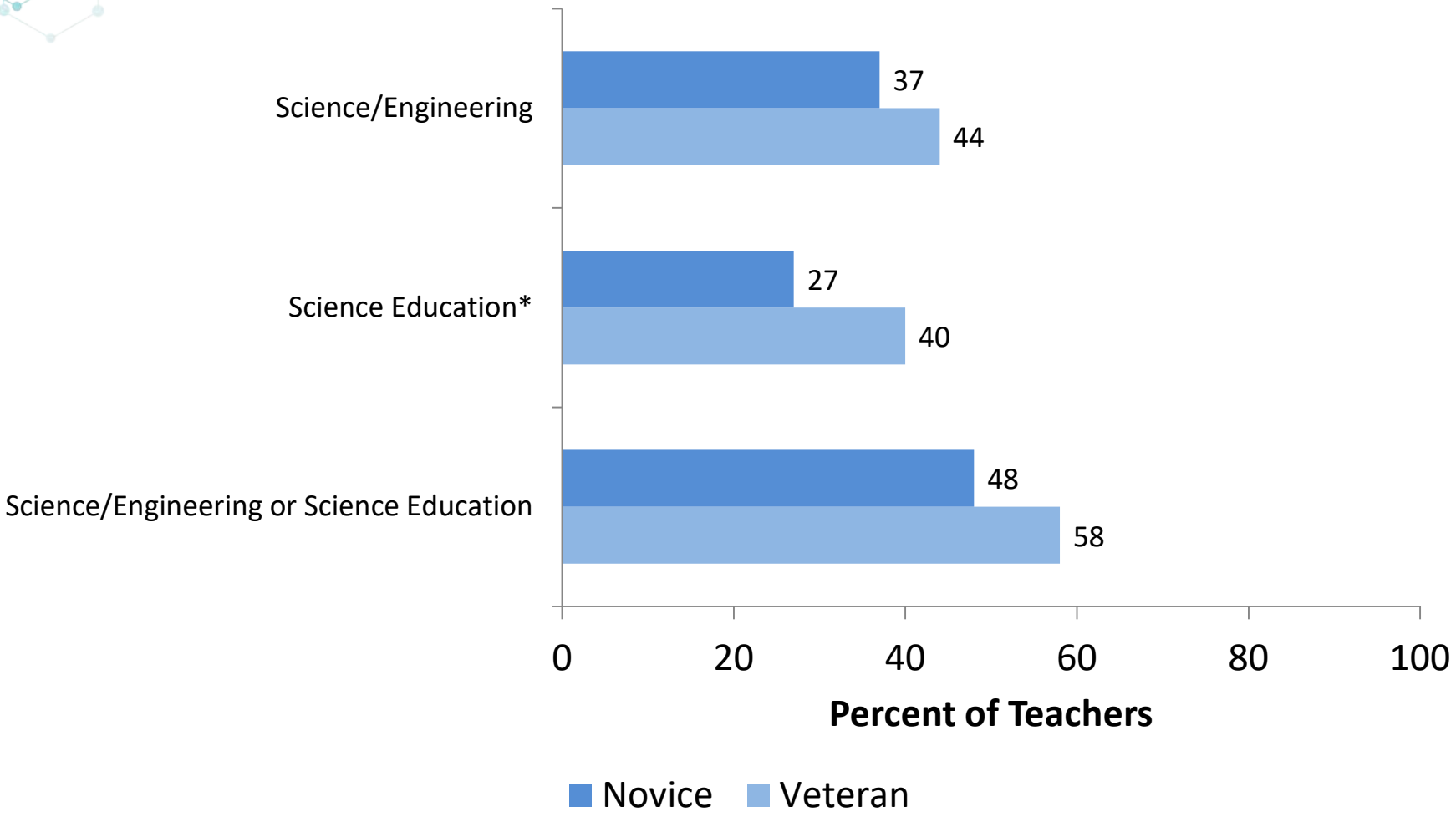
Middle School Teacher Certification



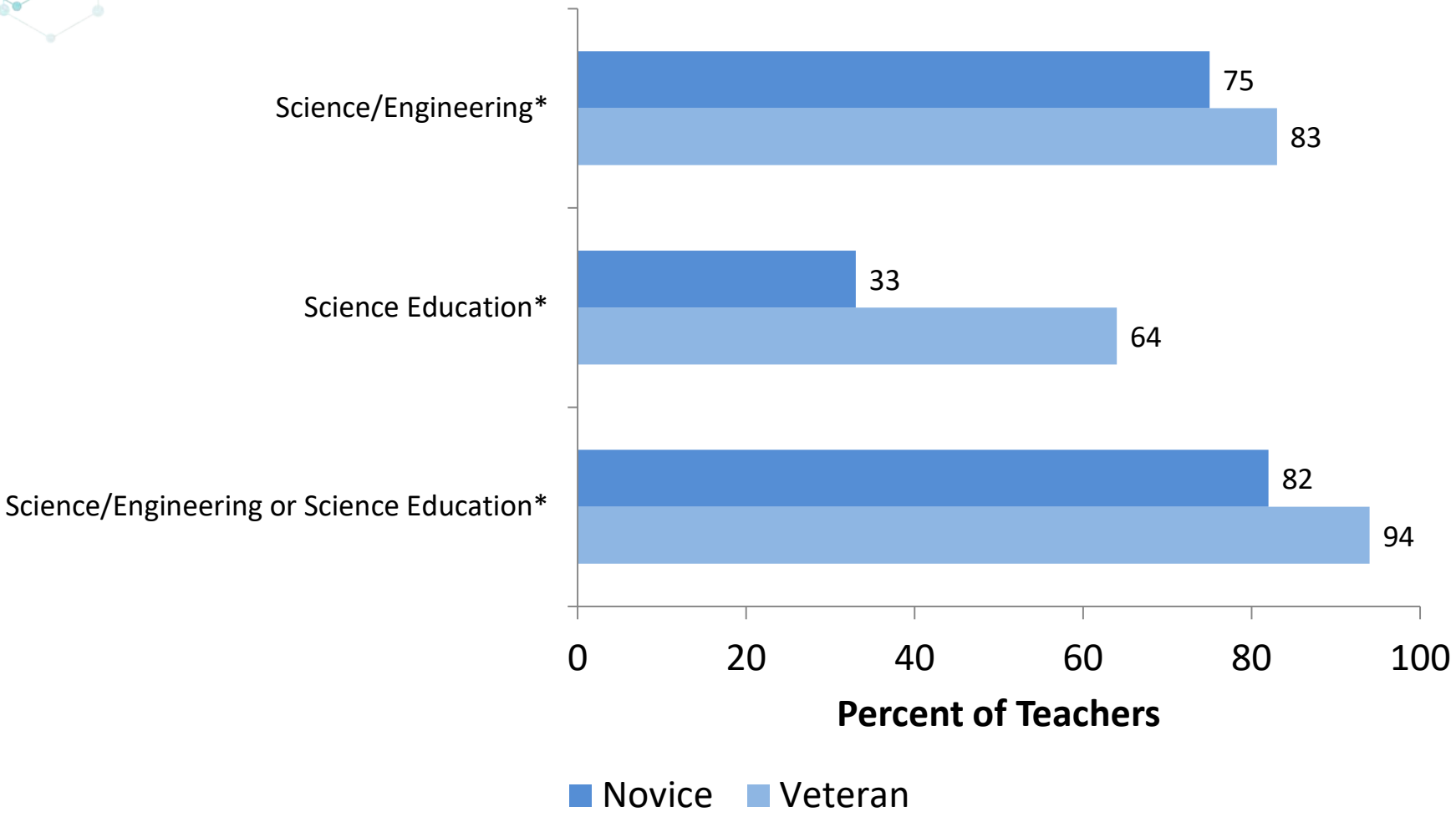
High School Teacher Certification



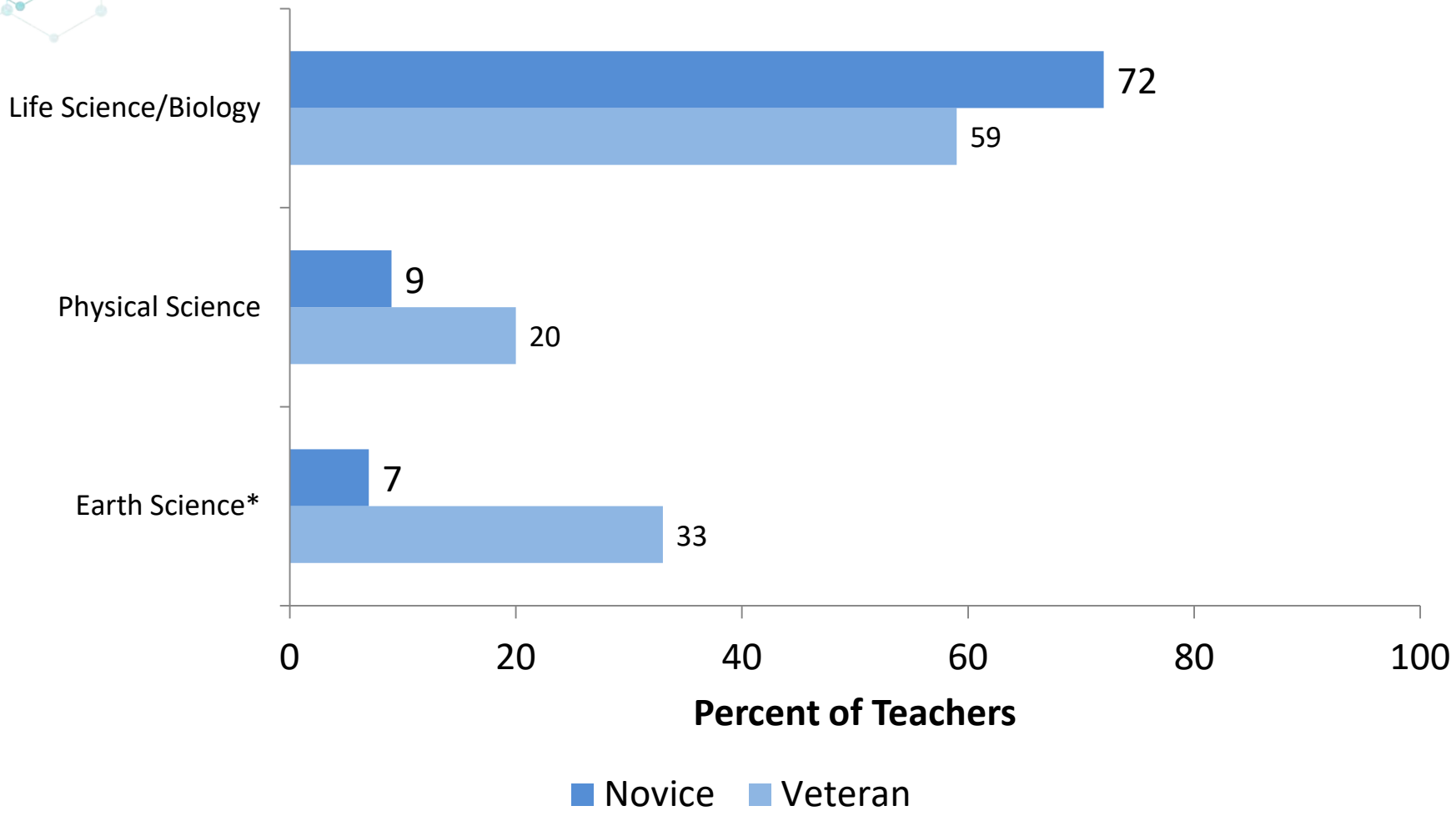
Middle School Teacher Degrees



High School Teacher Degrees



Middle School Substantial Background



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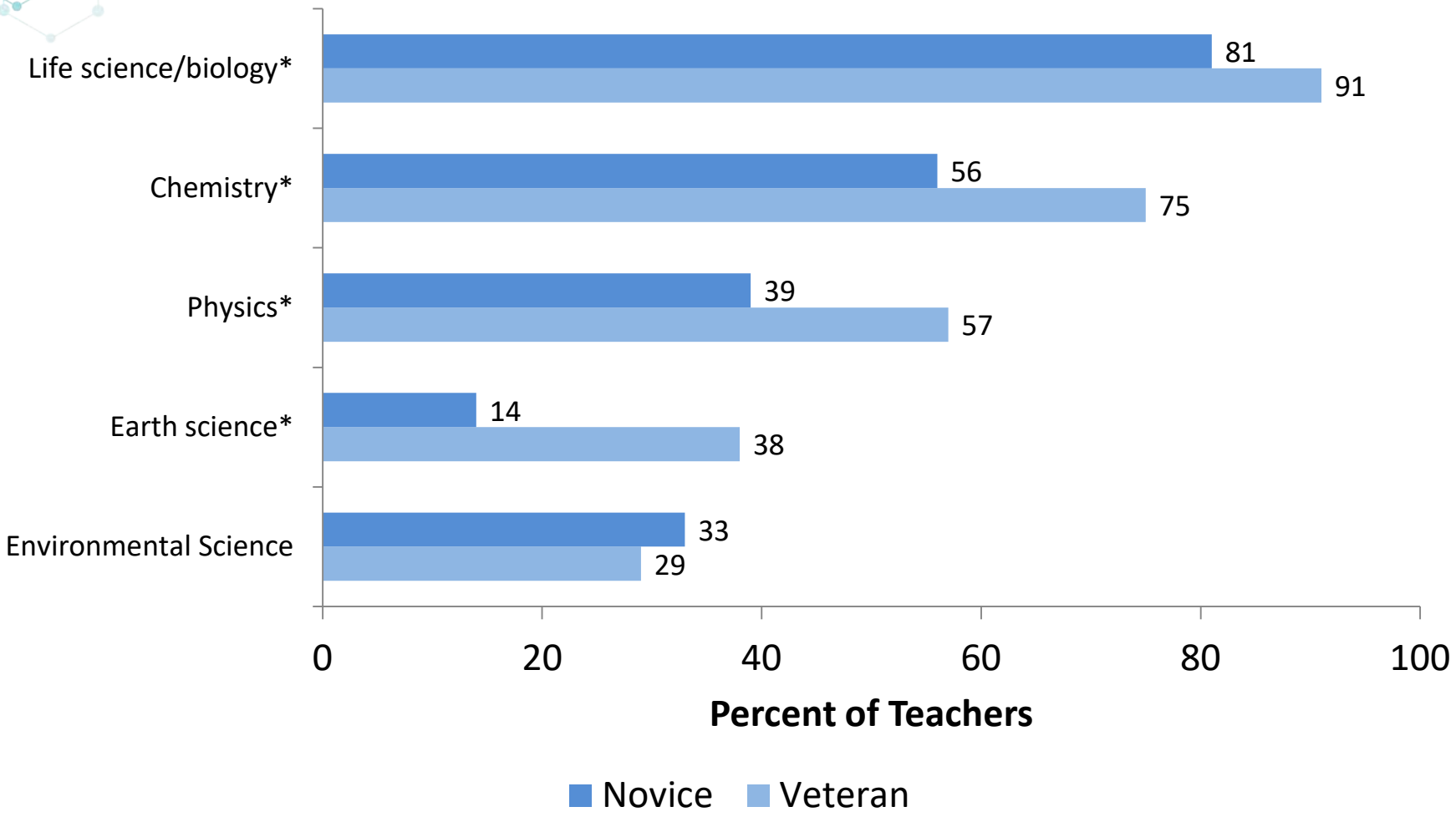
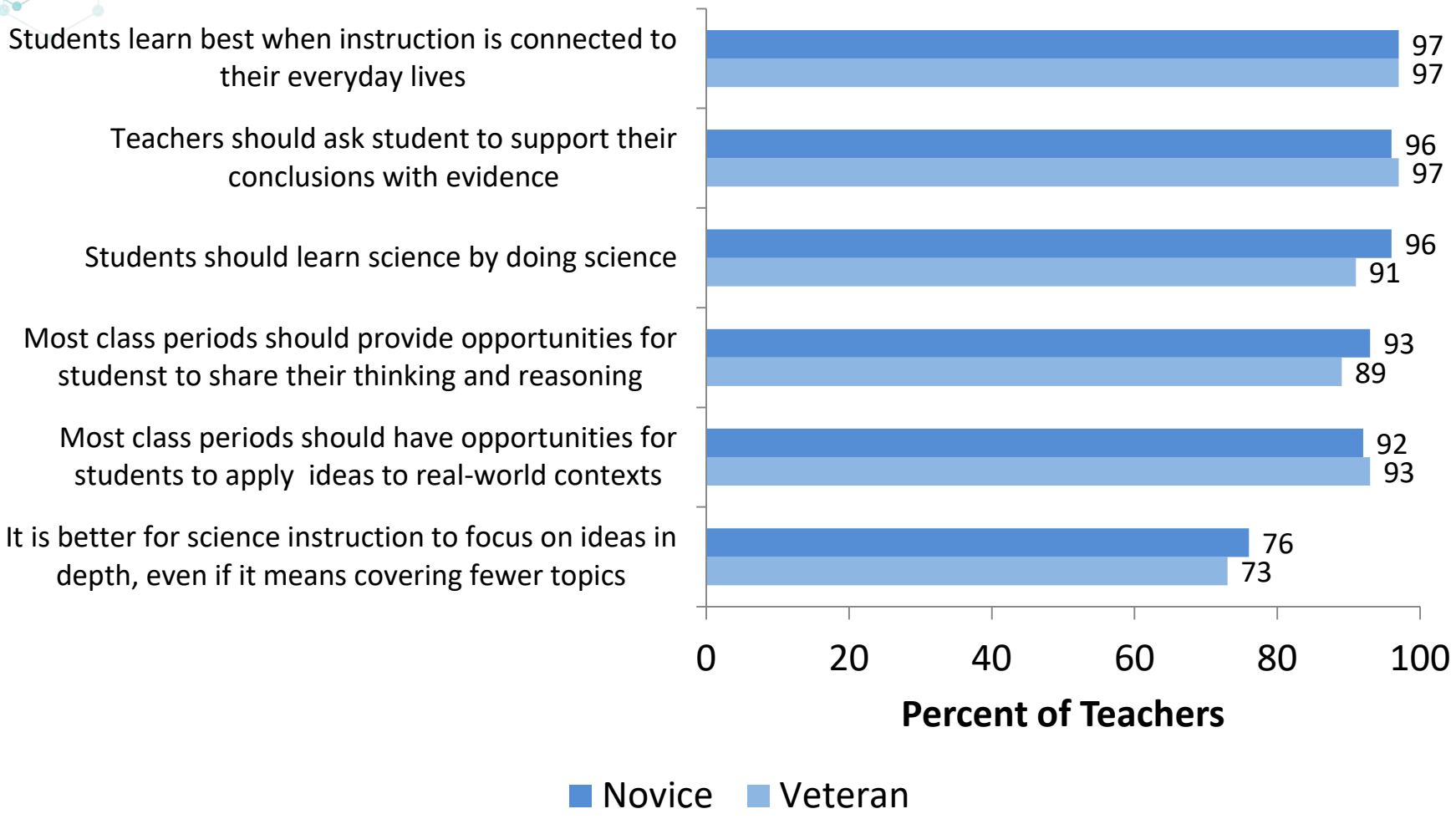
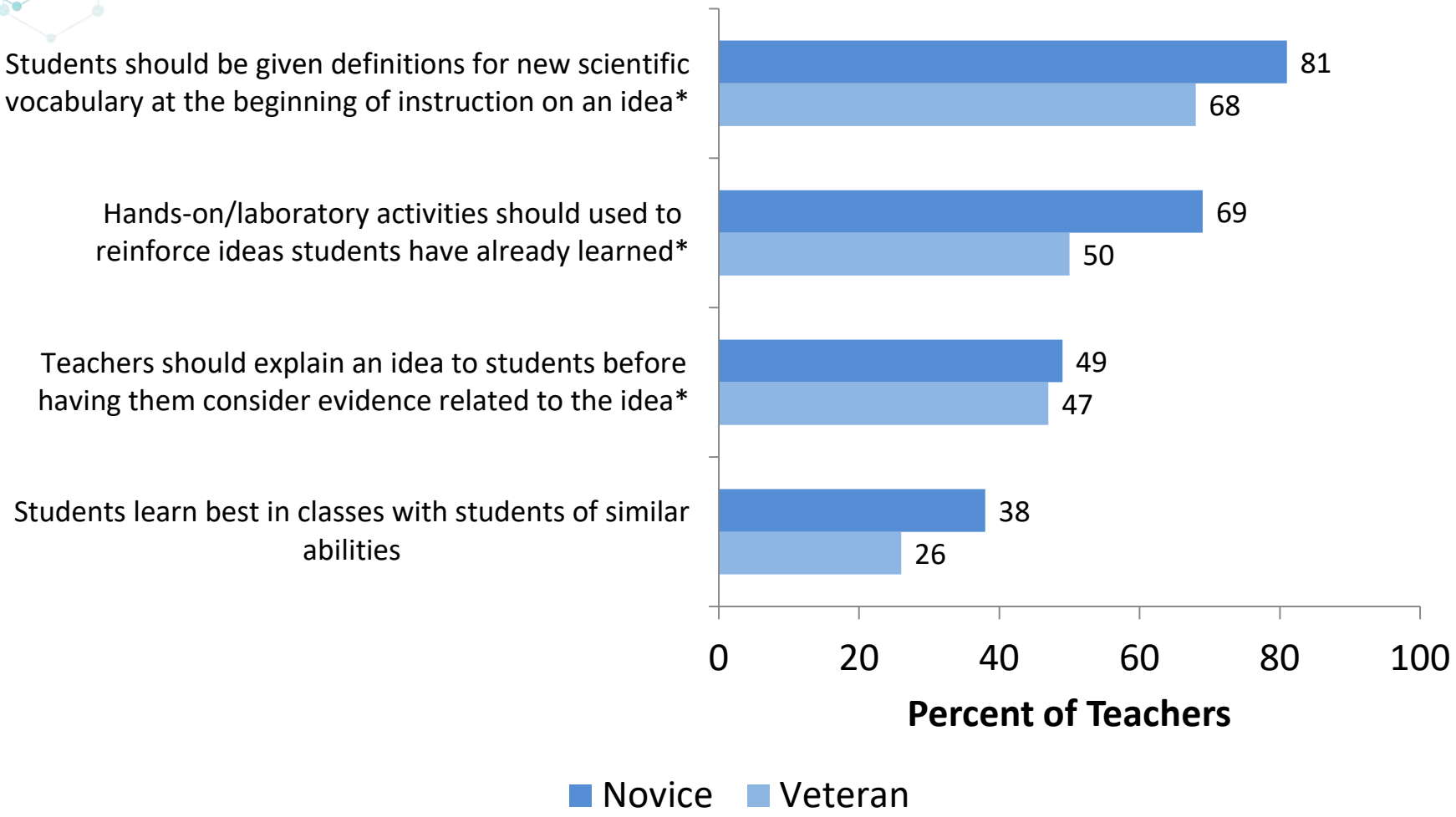


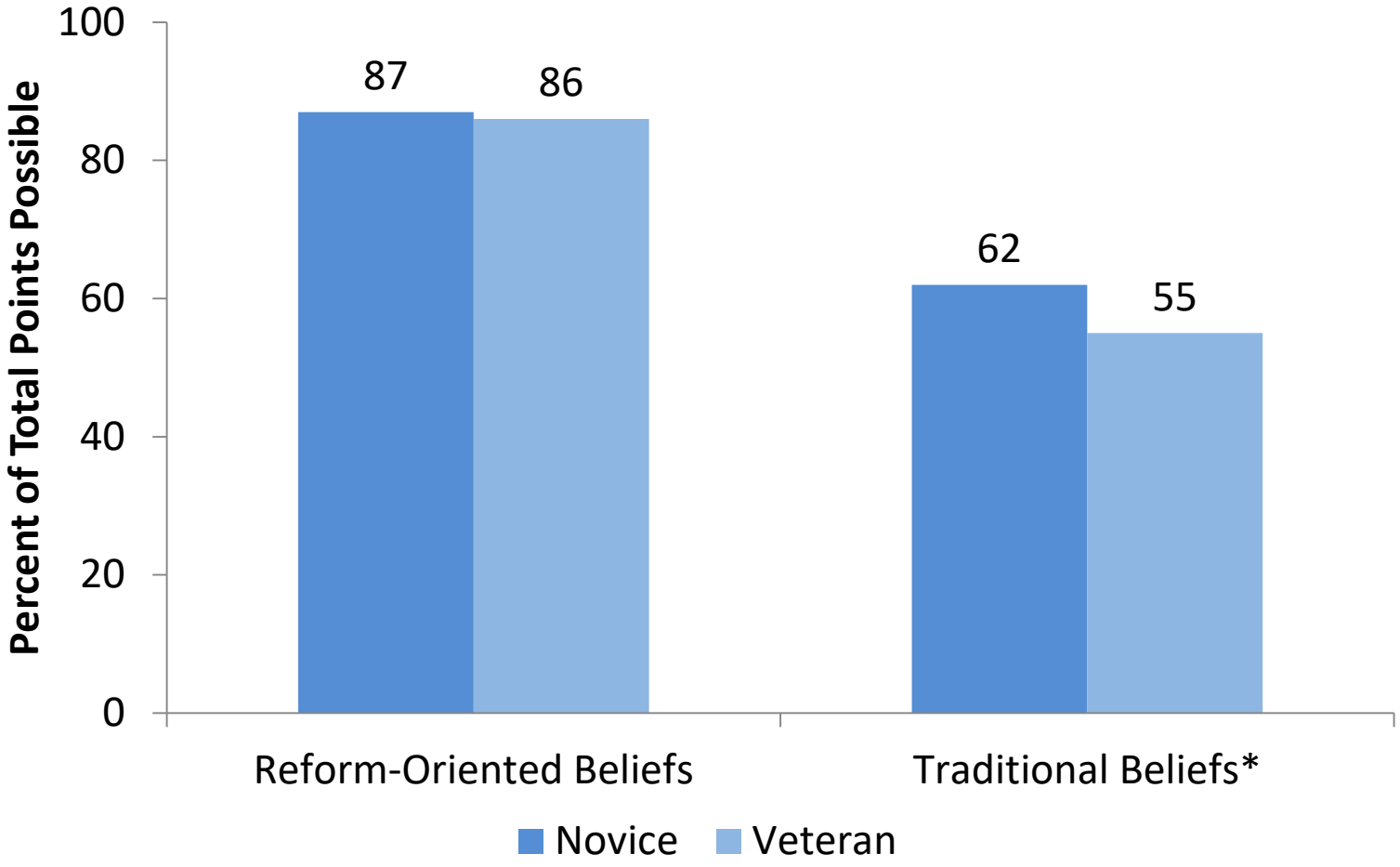
Middle School Teachers Agreeing With Various Reform-Oriented Teaching Beliefs



Middle School Teachers Agreeing With Various Traditional Teaching Beliefs



Middle School Teacher Beliefs Composites About Teaching and Learning



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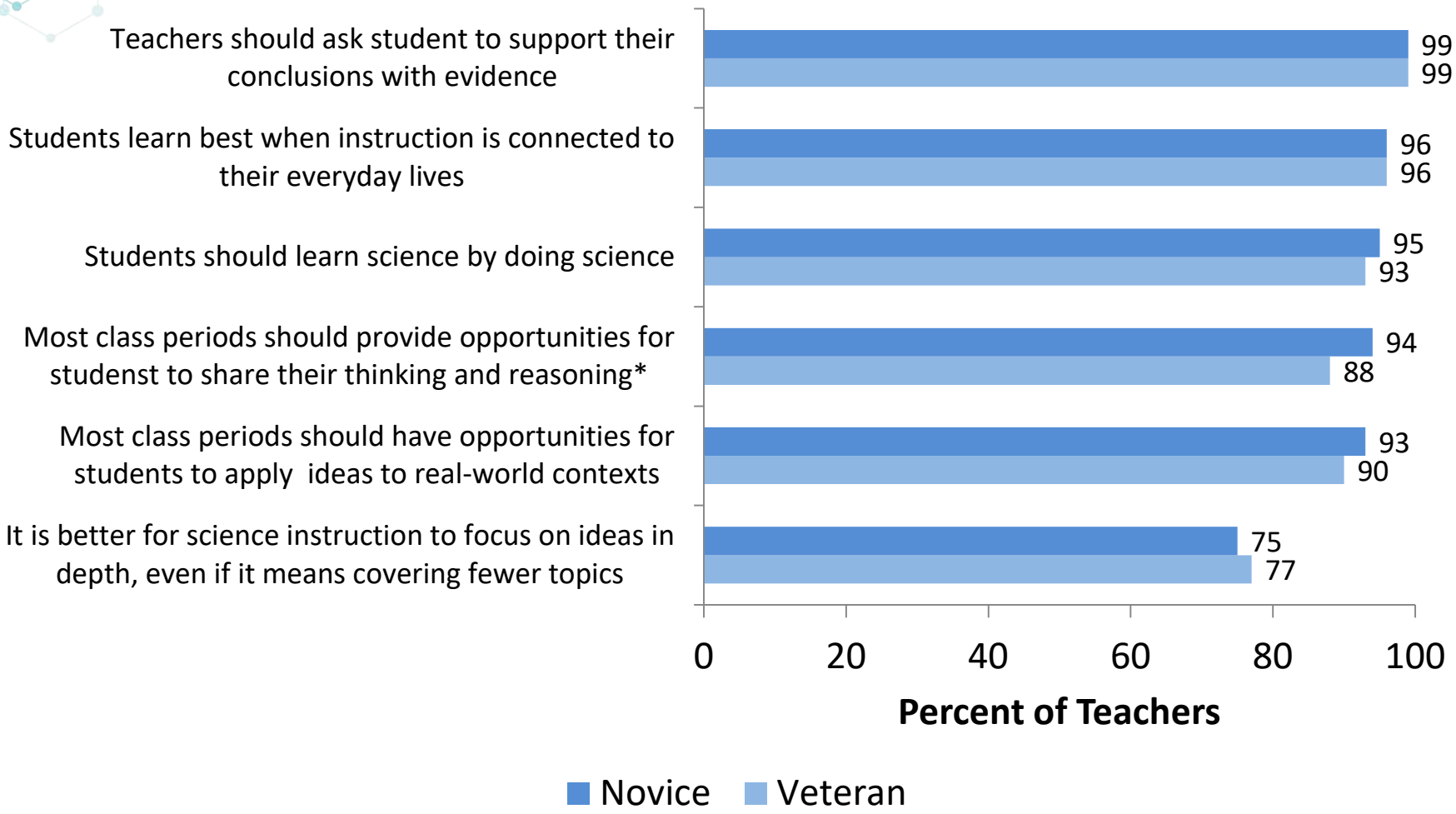

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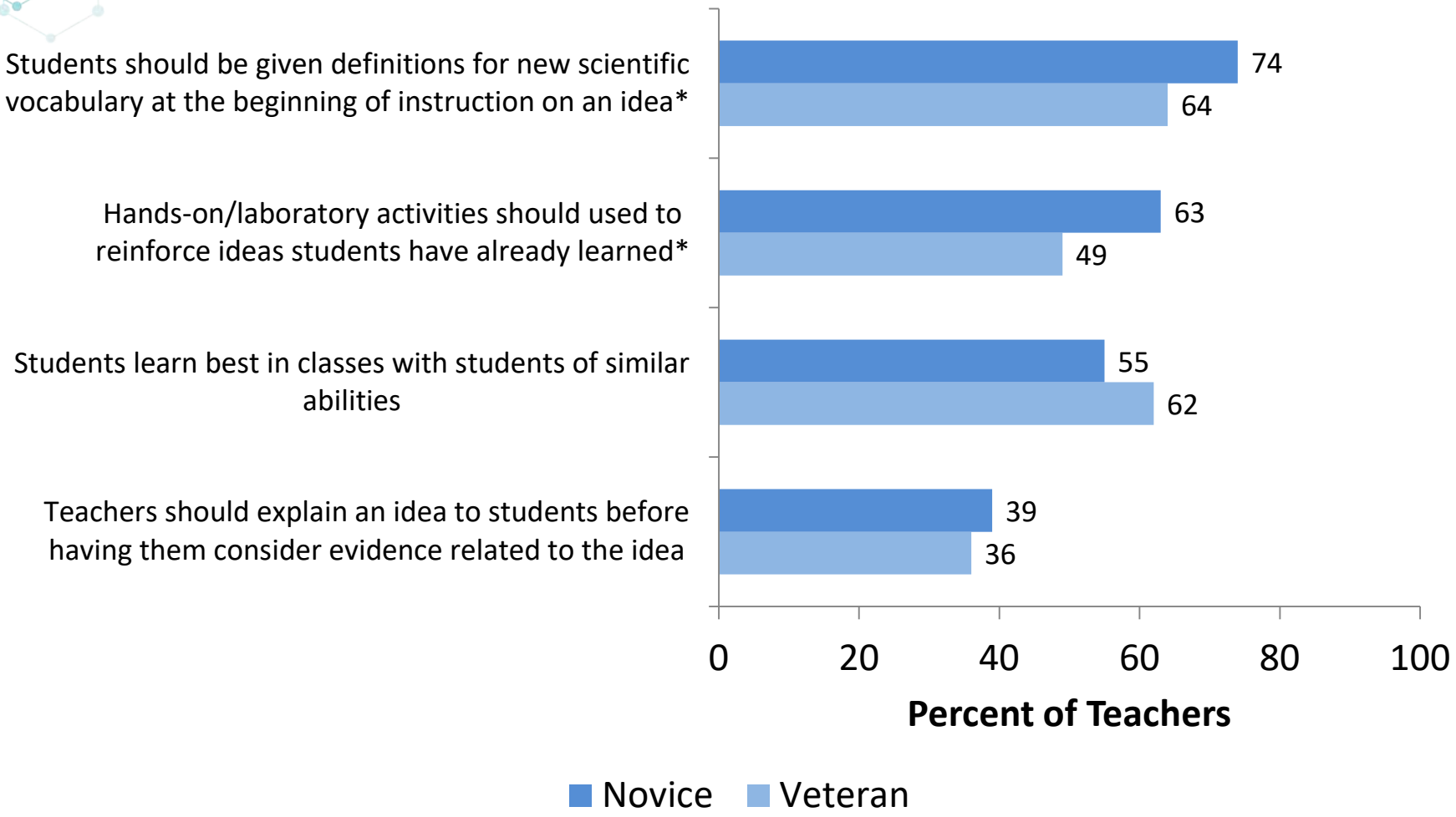
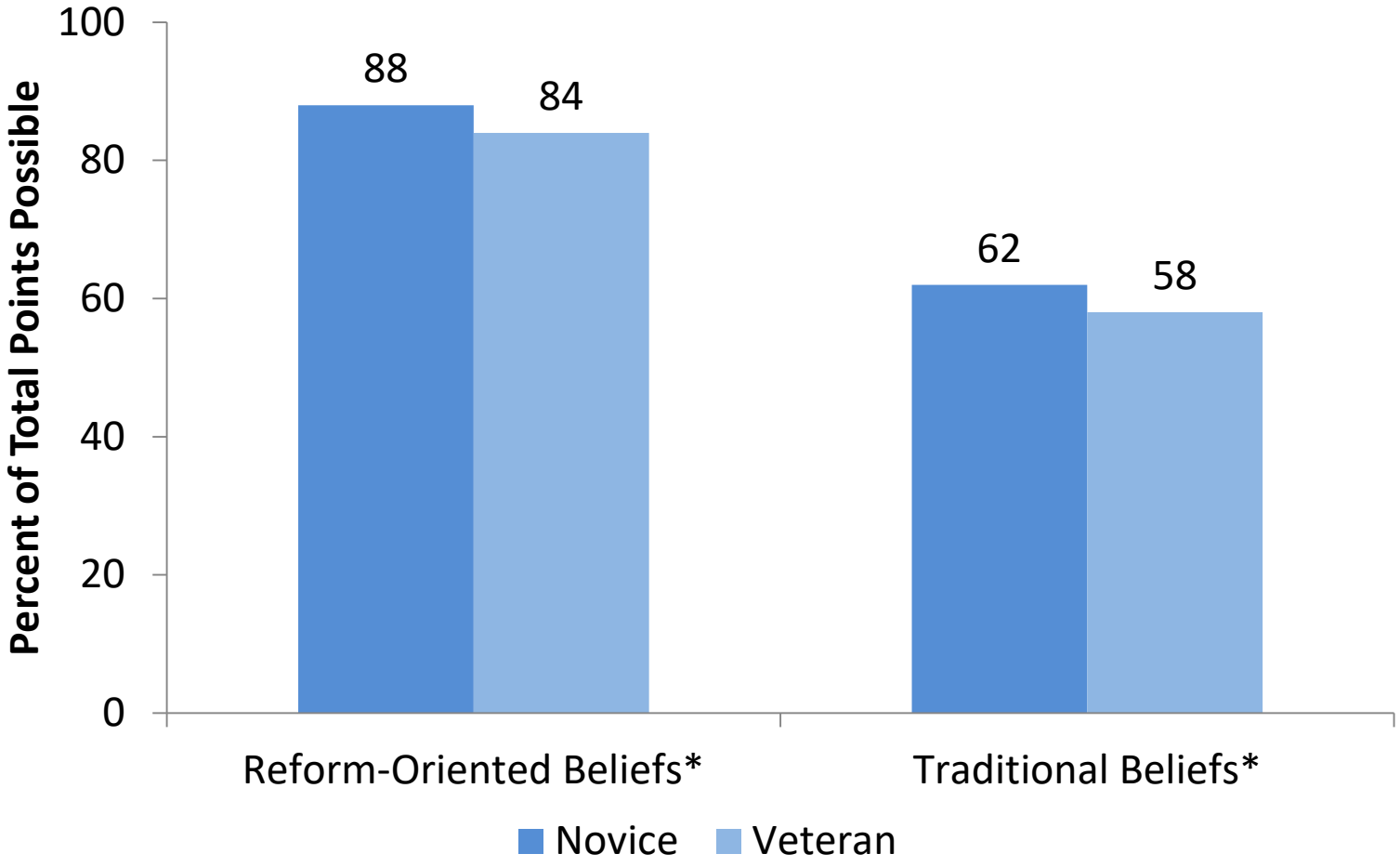
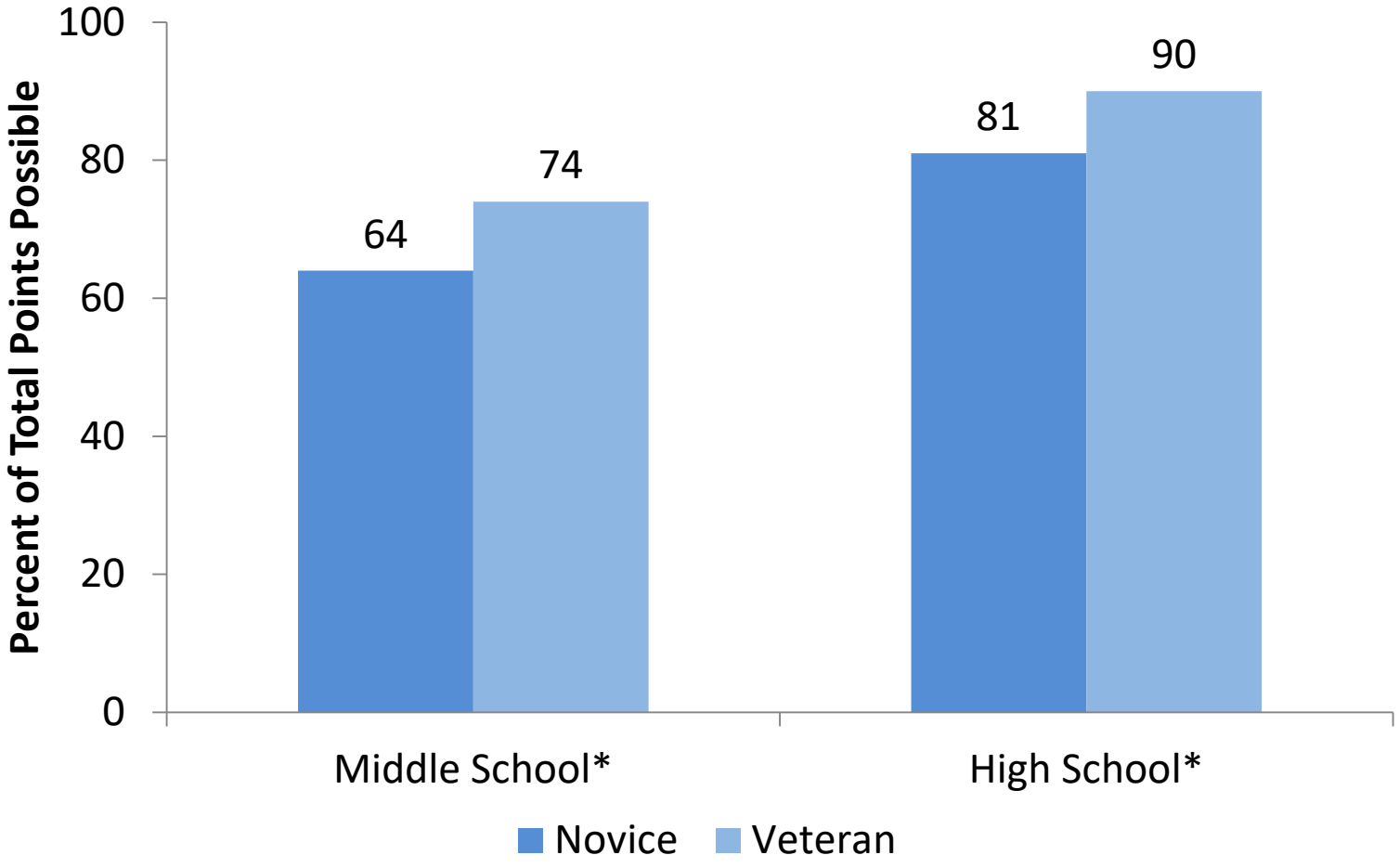


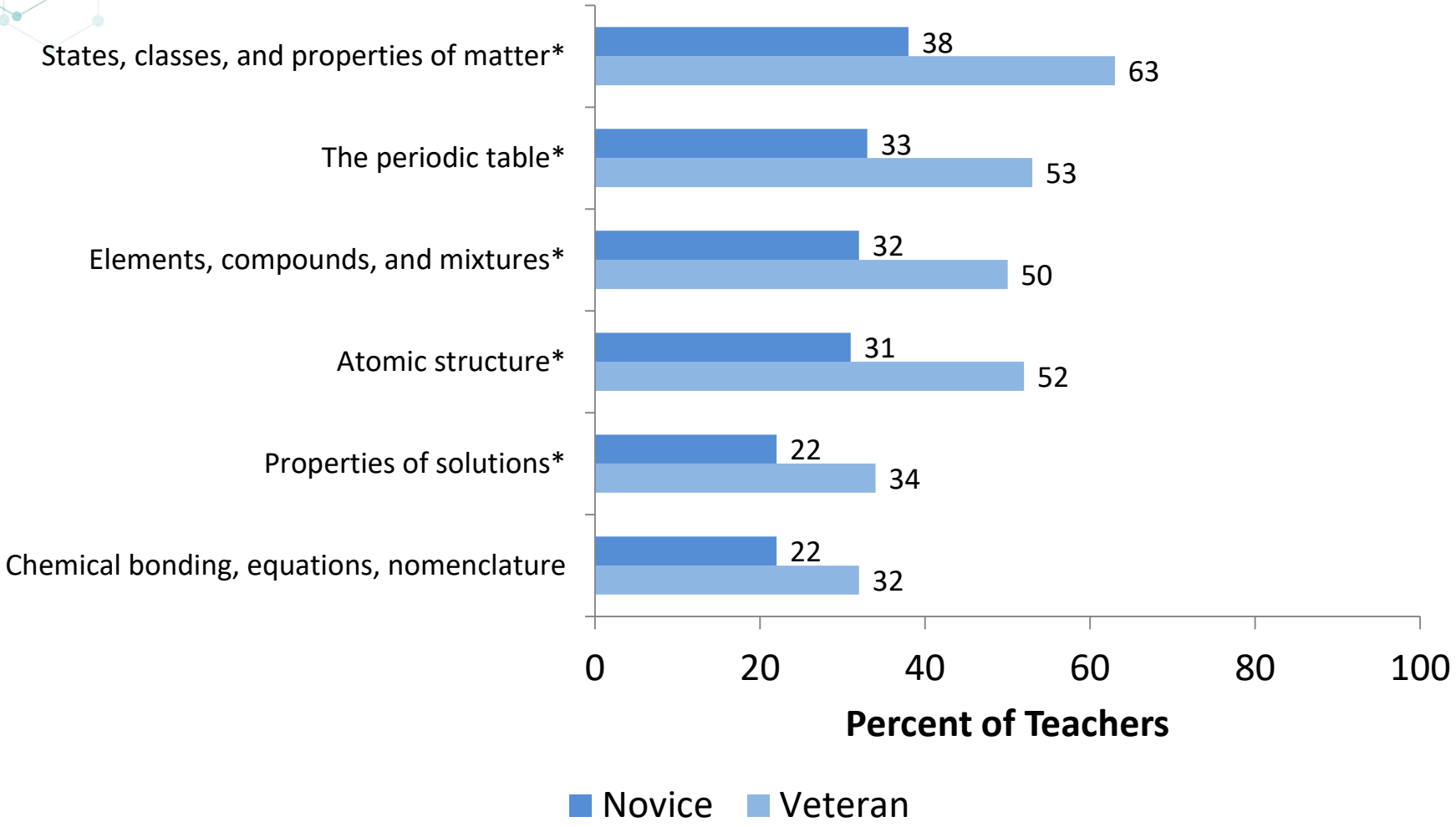
High School Teacher Beliefs Composites About Teaching and Learning



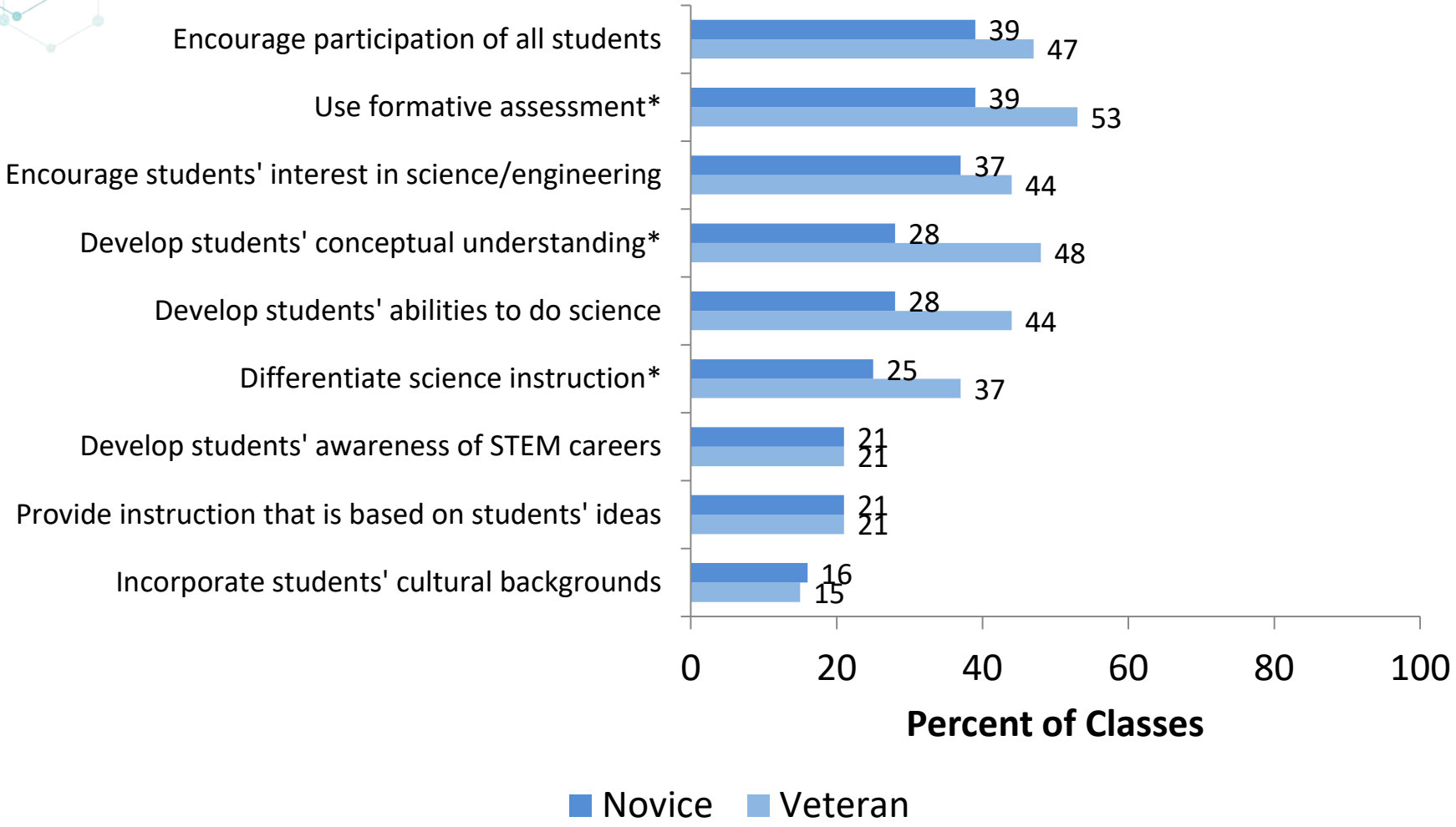
Secondary Teacher Perceptions of Content Preparedness Composites



Middle School Teachers Feeling Very Well Prepared to Teach Chemistry Topics



Middle School Teachers Feeling Very Well Prepared for Instructional Tasks



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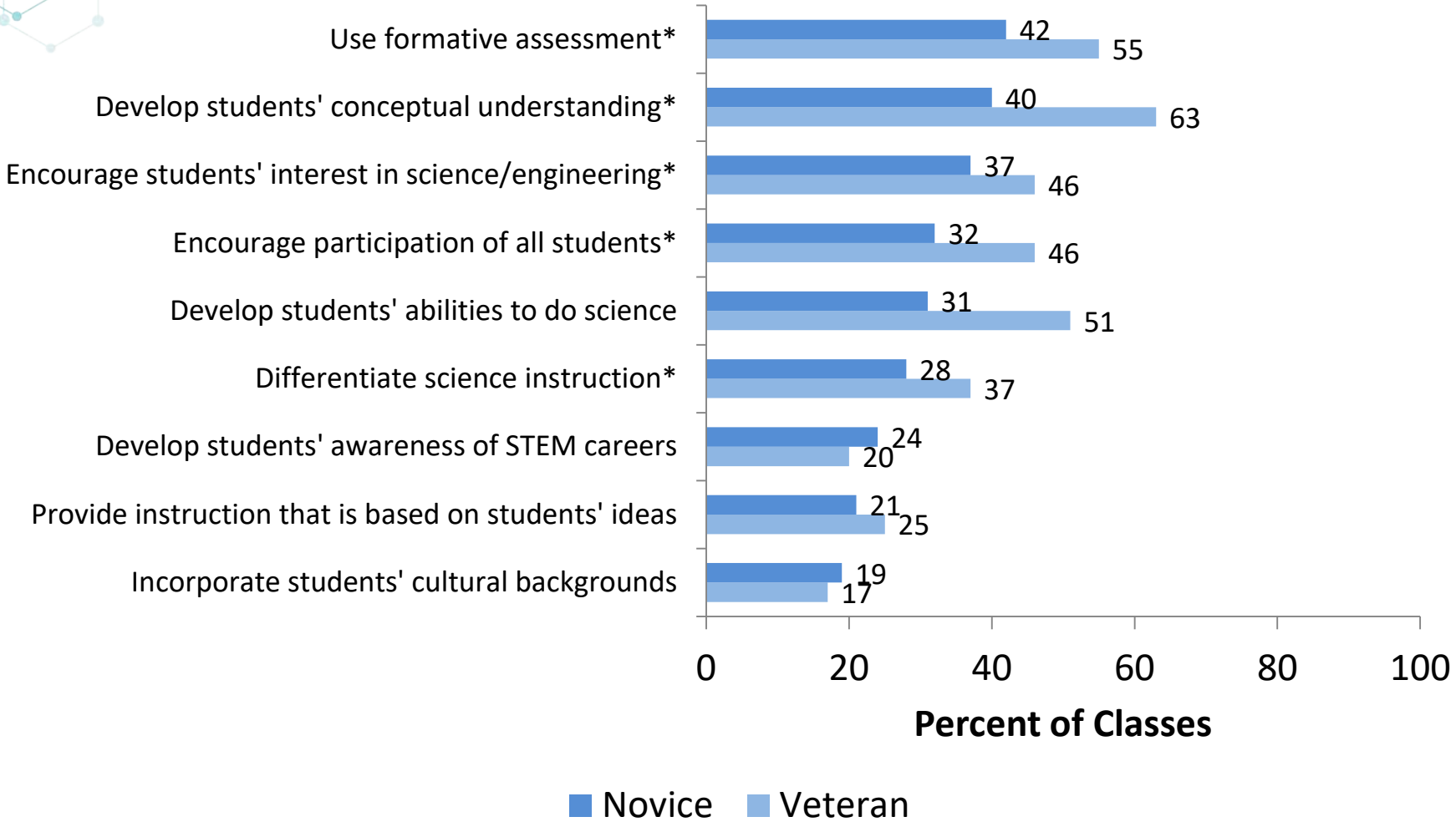
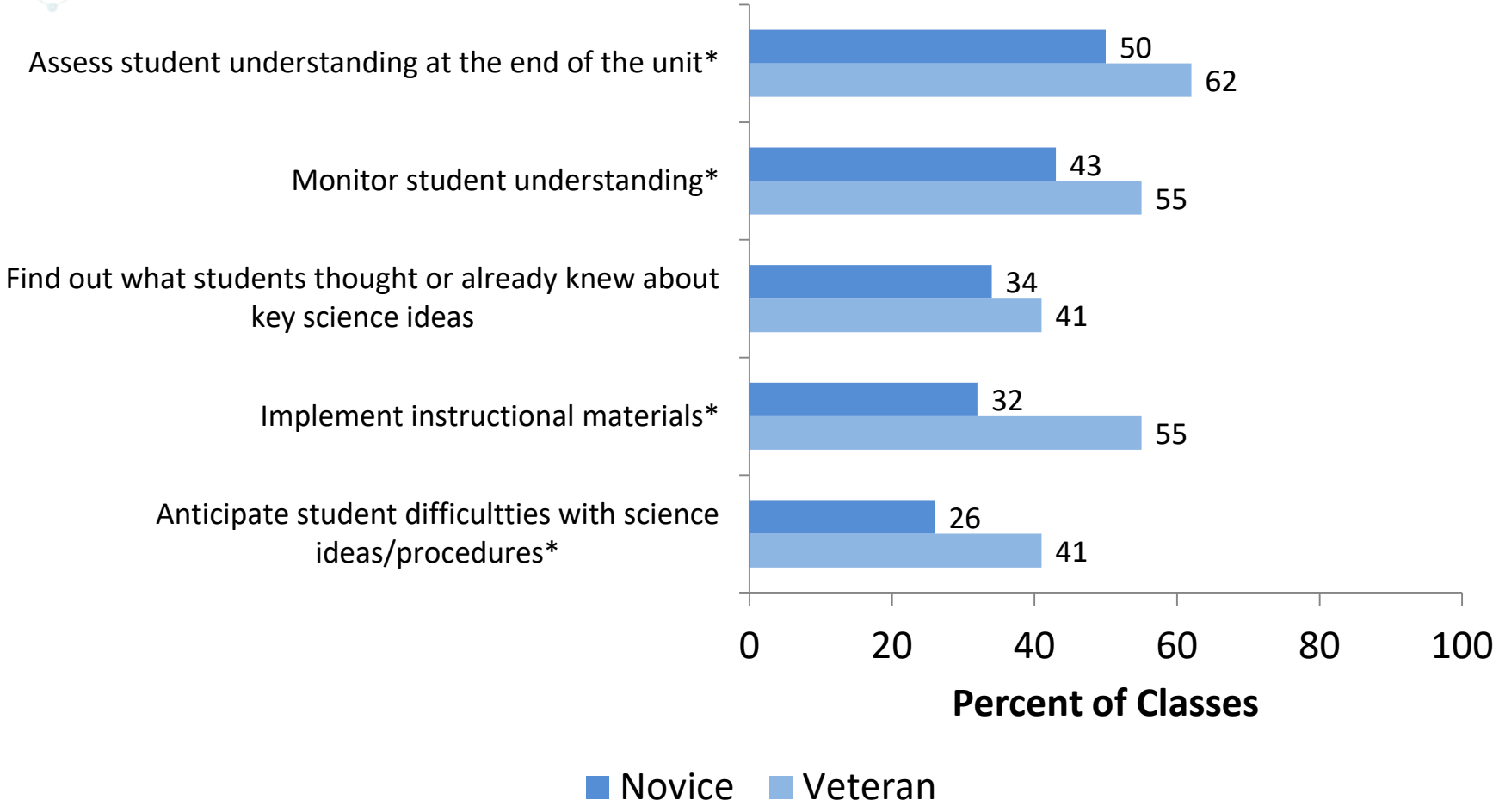
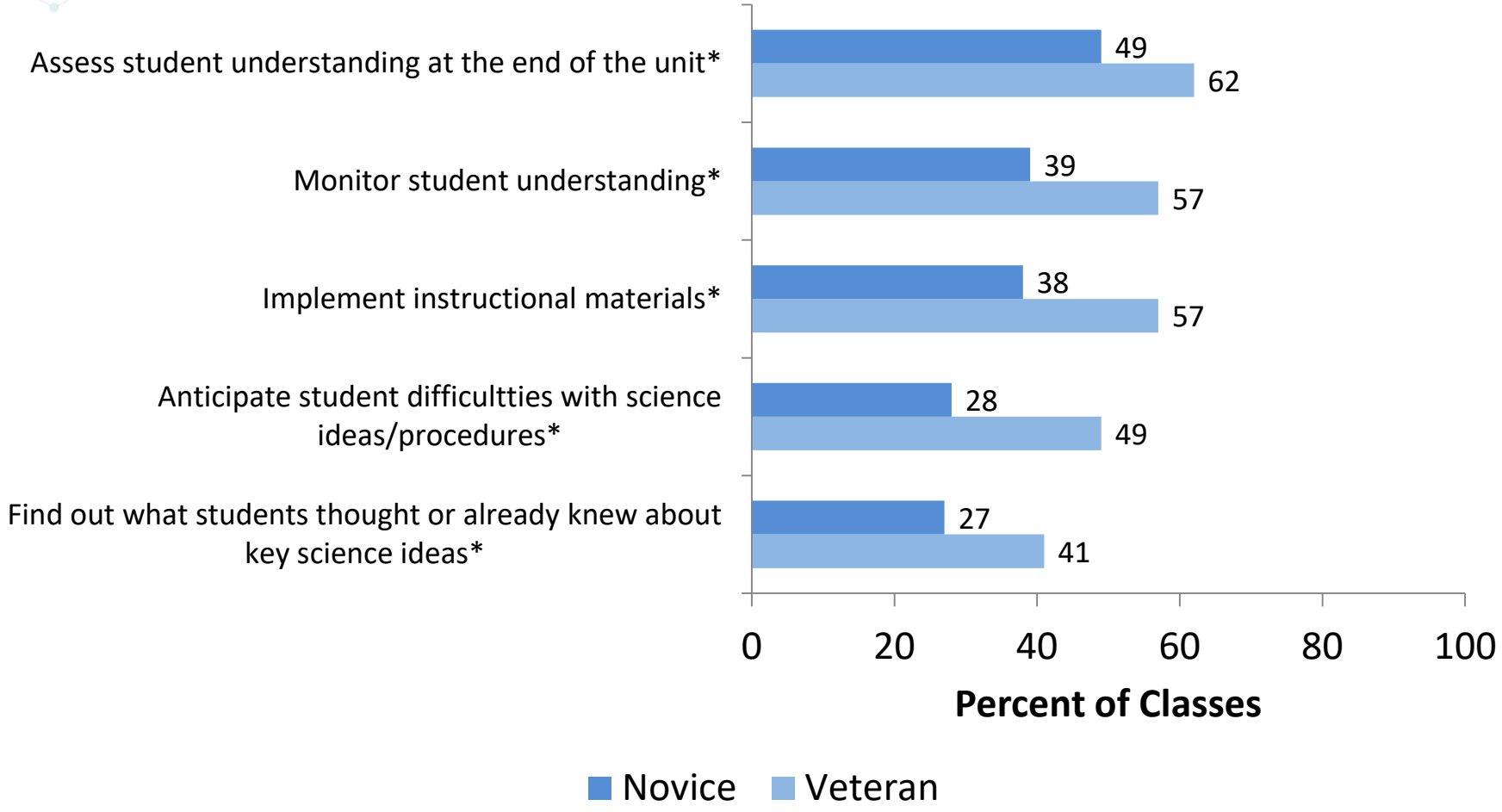


Middle School Teachers Feeling Very Well Prepared to Monitor and Address Student Understanding in Most Recent Unit

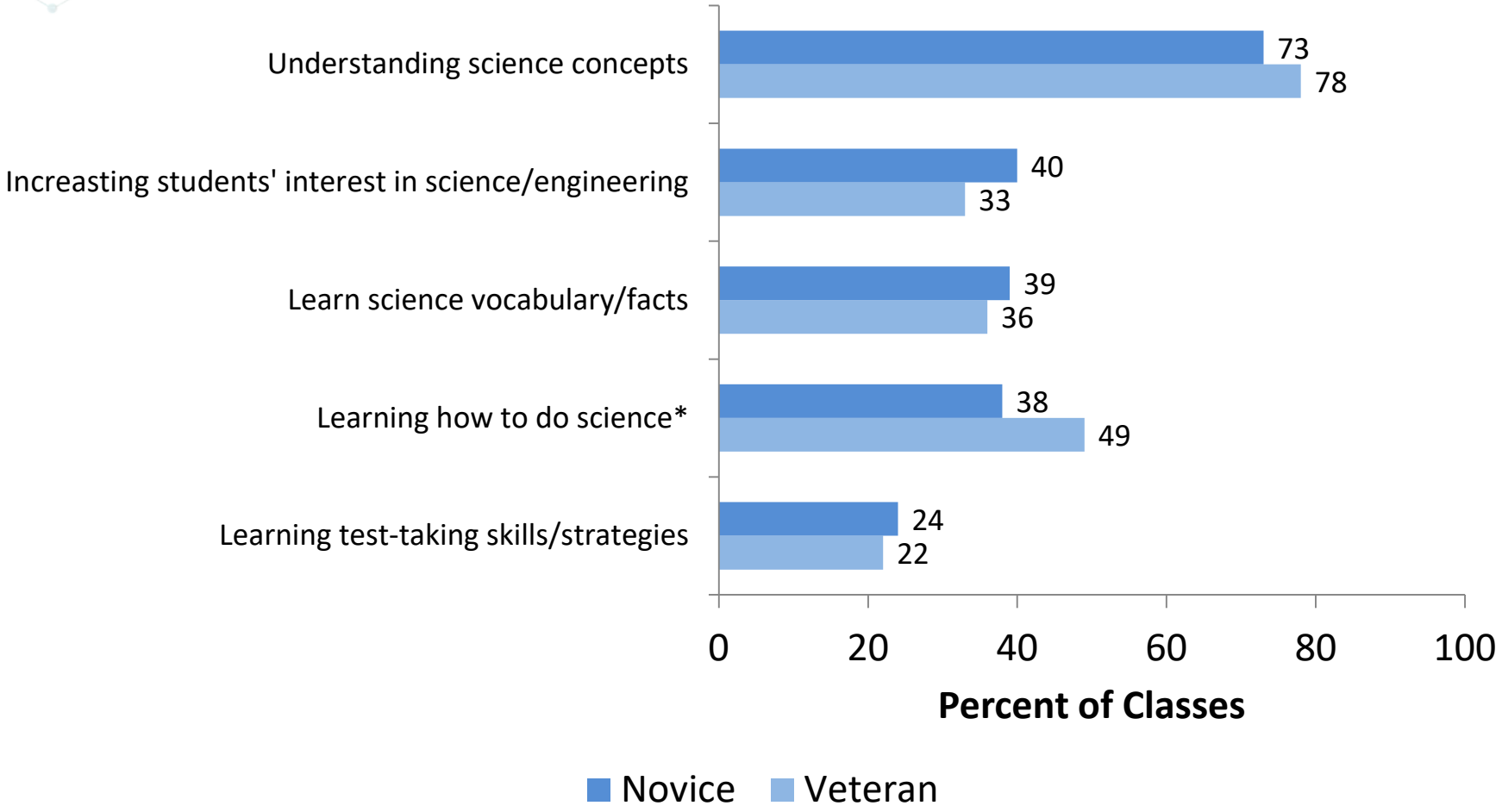


High School Teachers Feeling Very Well Prepared to Monitor and Address Student Understanding in Most Recent Unit

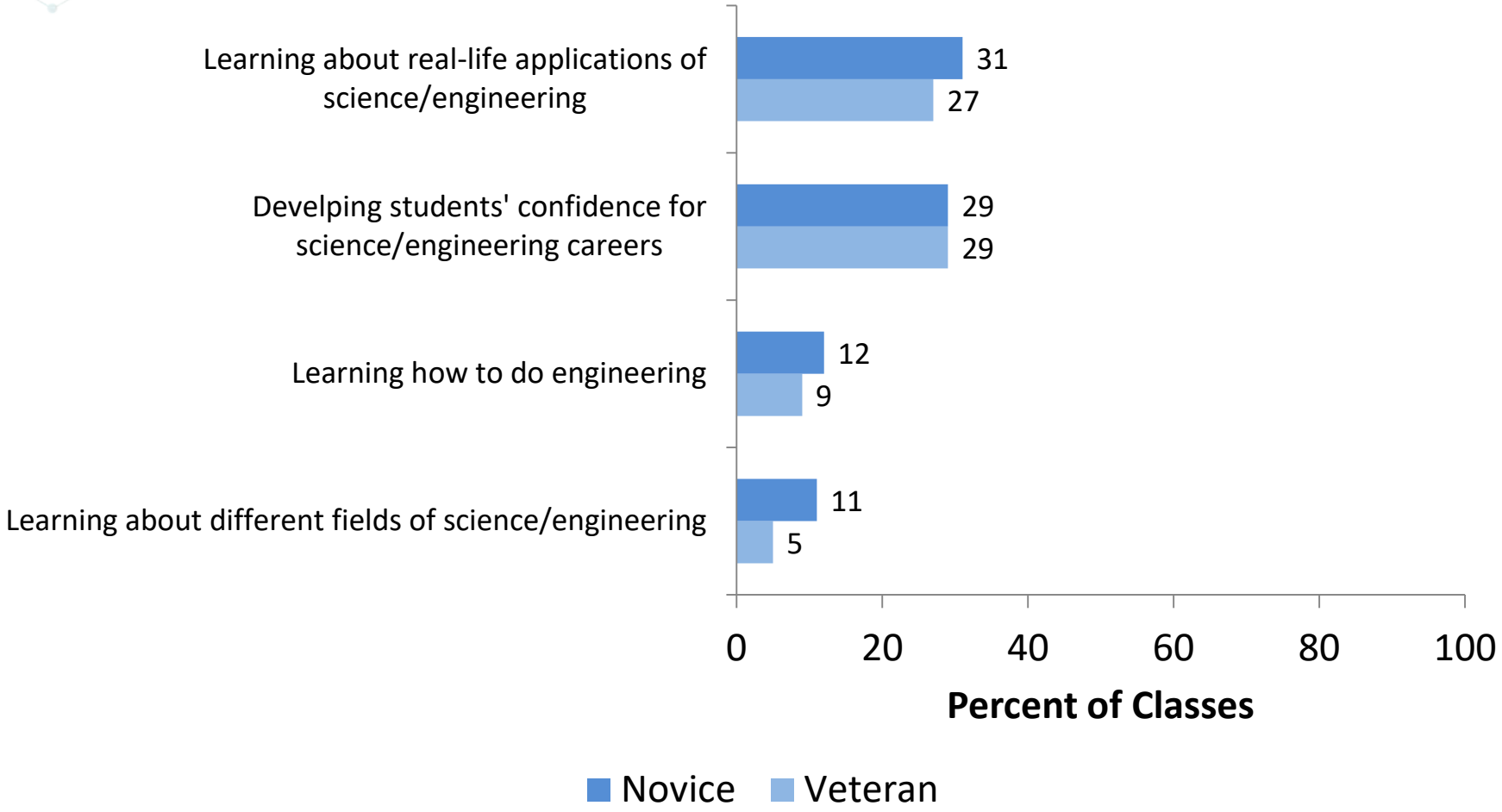


Science Instruction

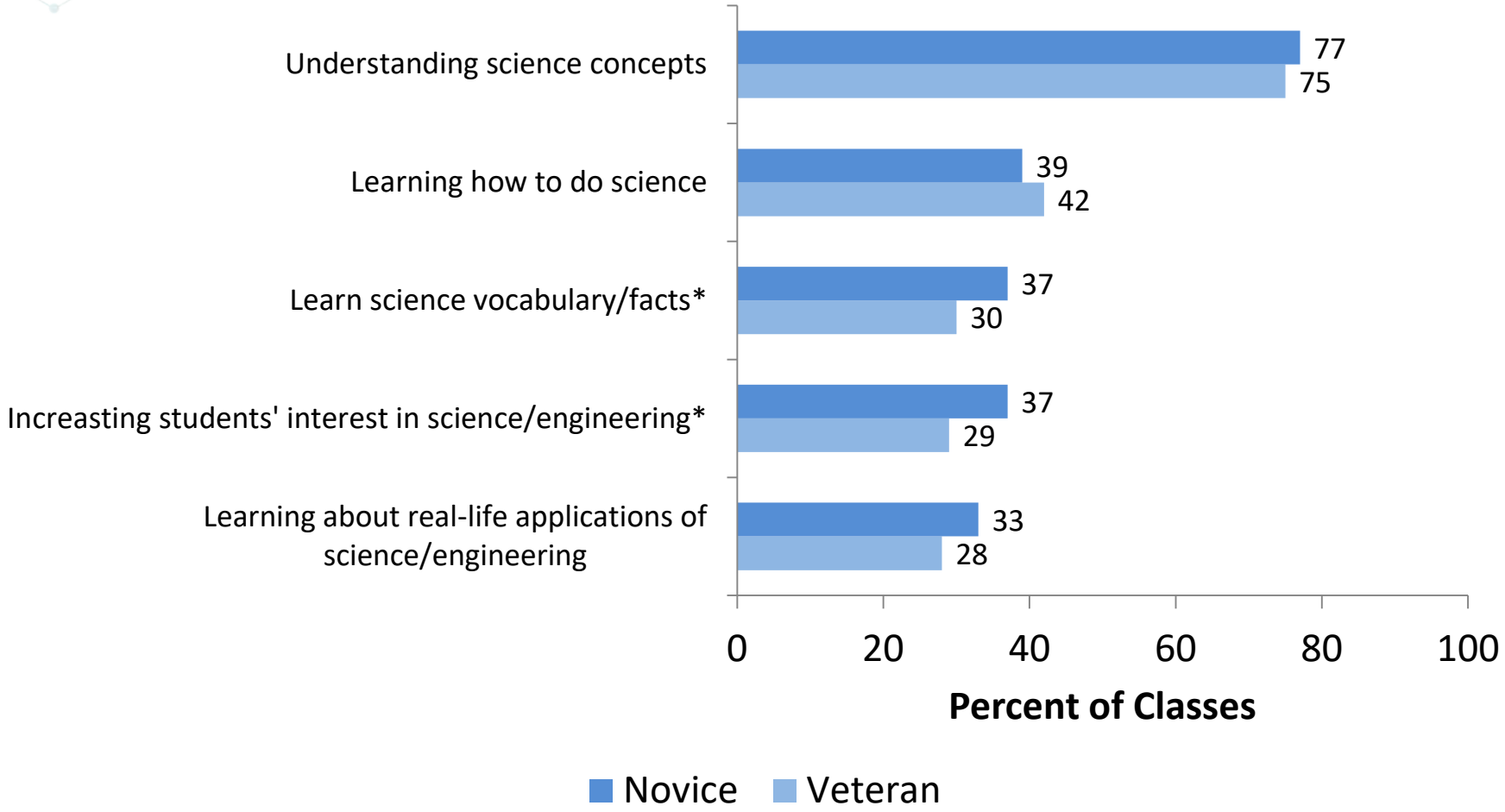
Middle School Classes with Heavy Emphasis on Instructional Objectives



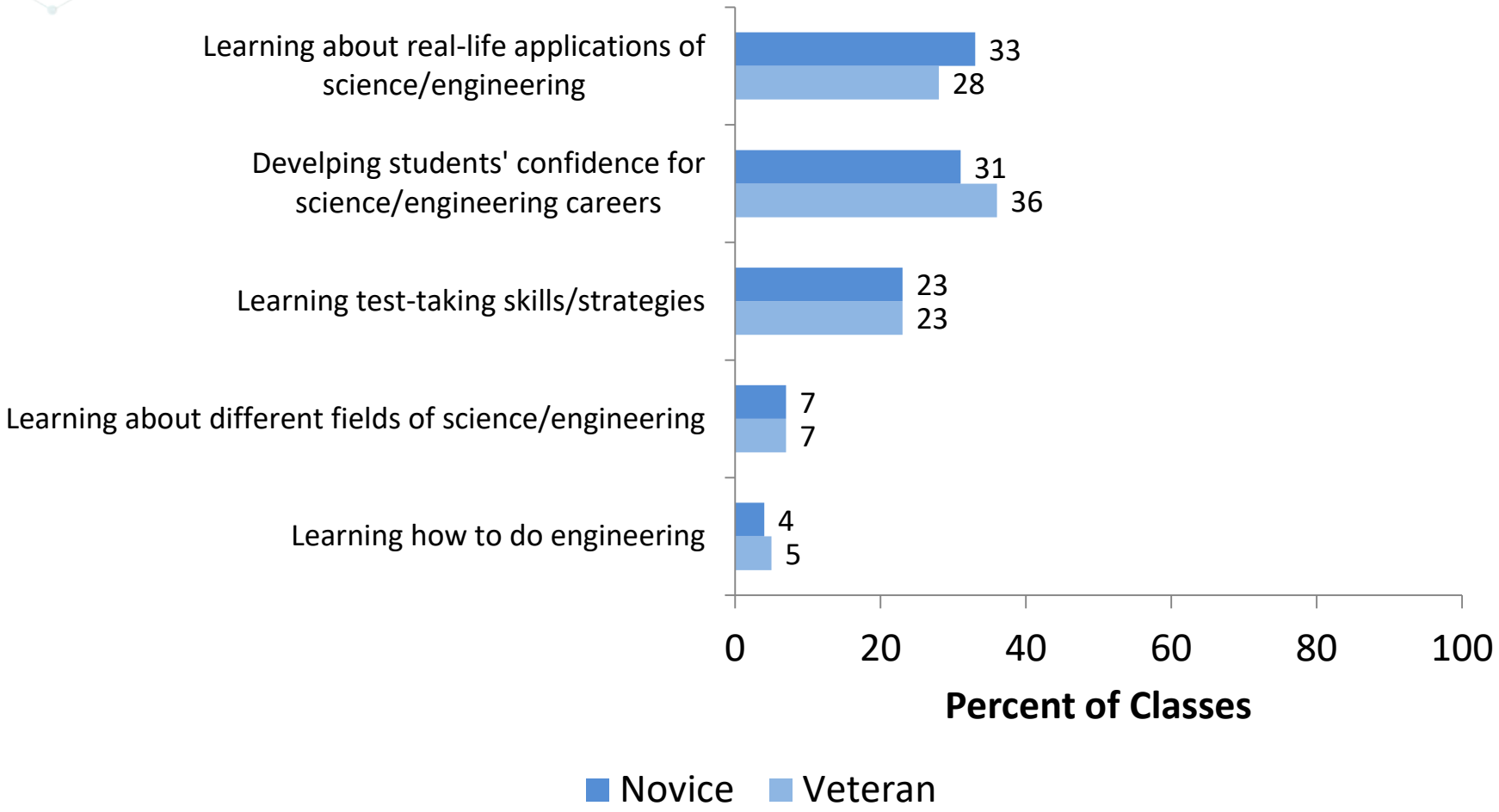
Middle School Classes with Heavy Emphasis on Instructional Objectives



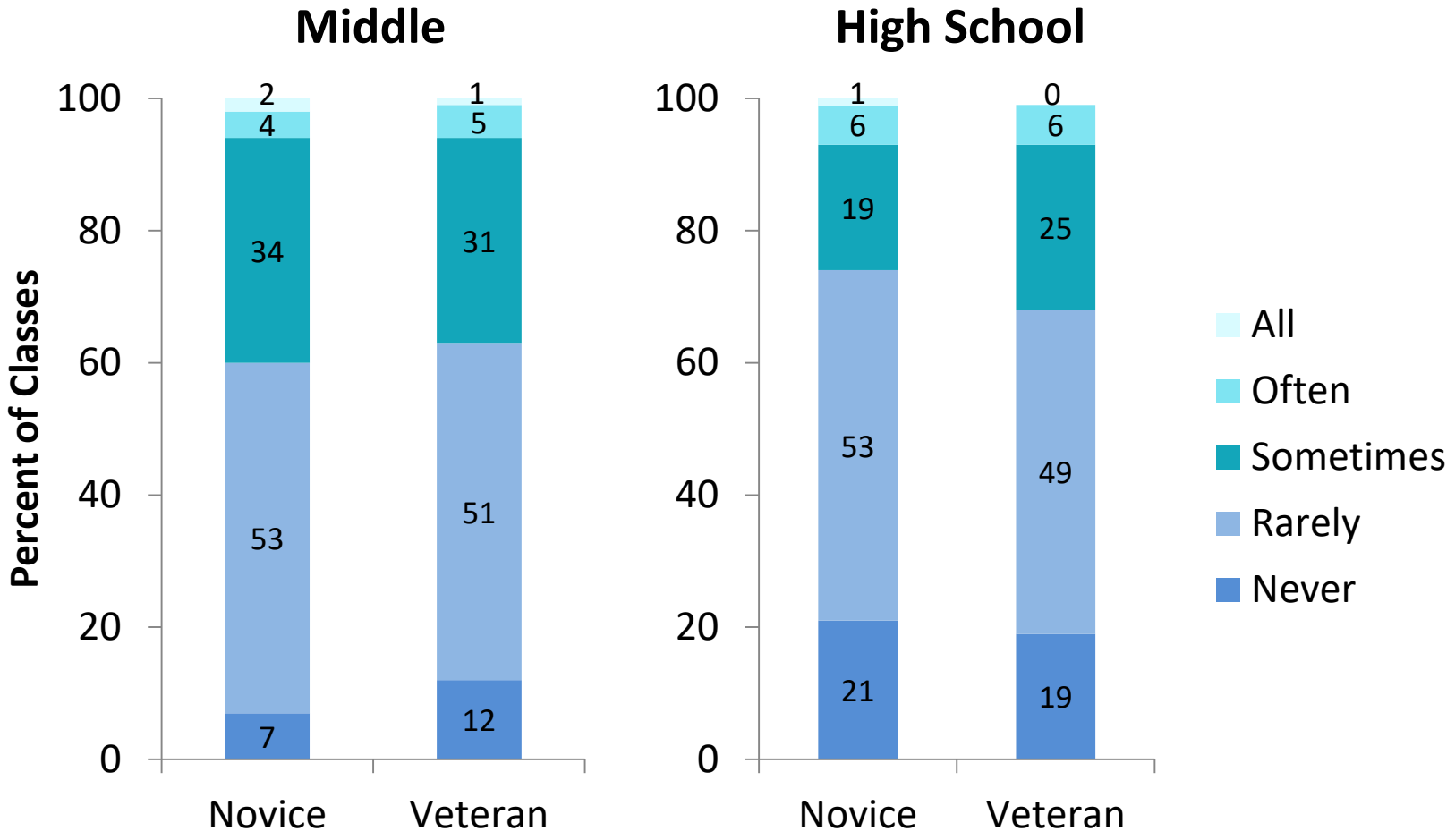
High School Classes with Heavy Emphasis on Instructional Objectives



High School Classes with Heavy Emphasis on Instructional Objectives

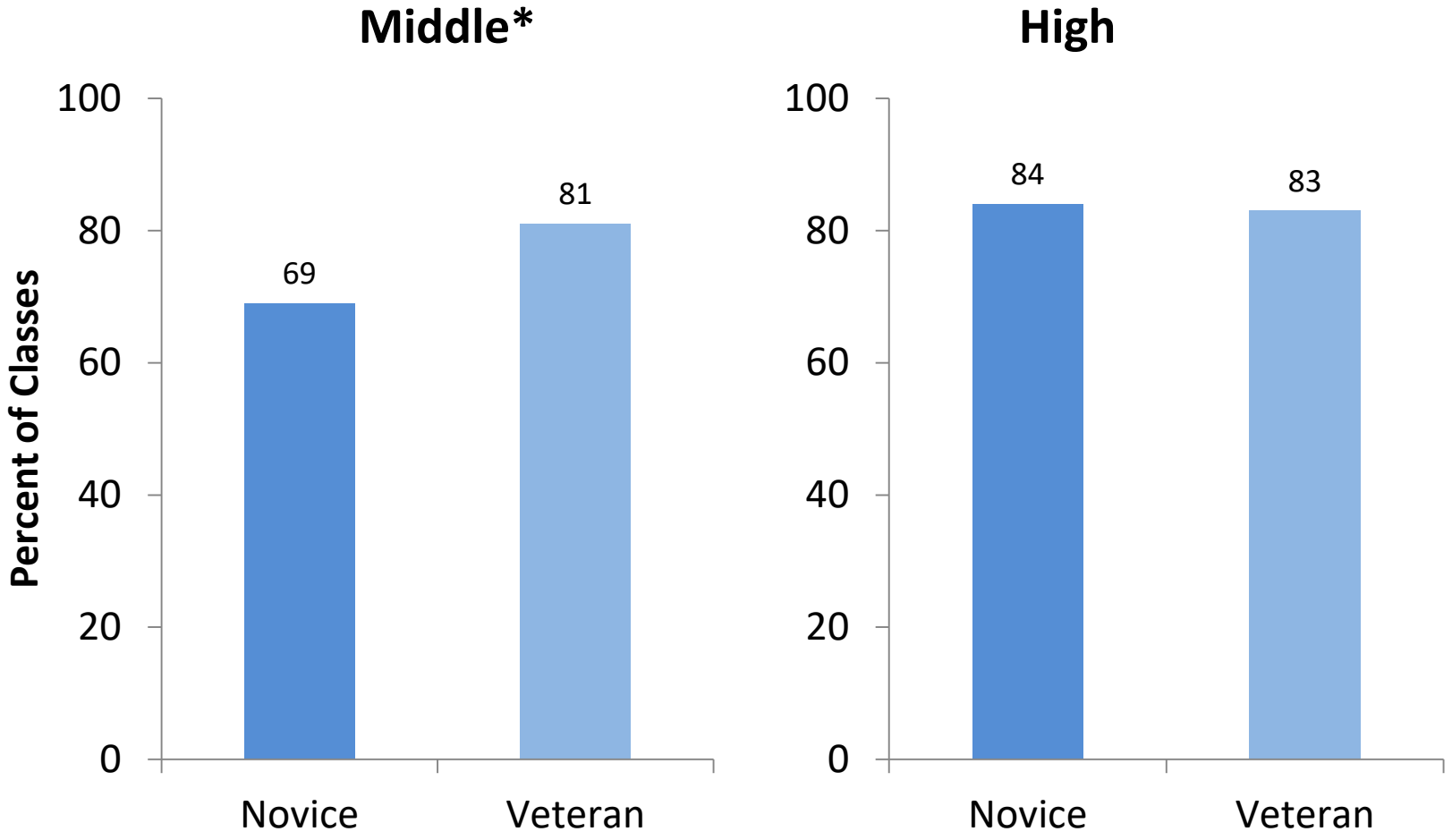


Secondary Teachers Incorporating Engineering into Science Instruction

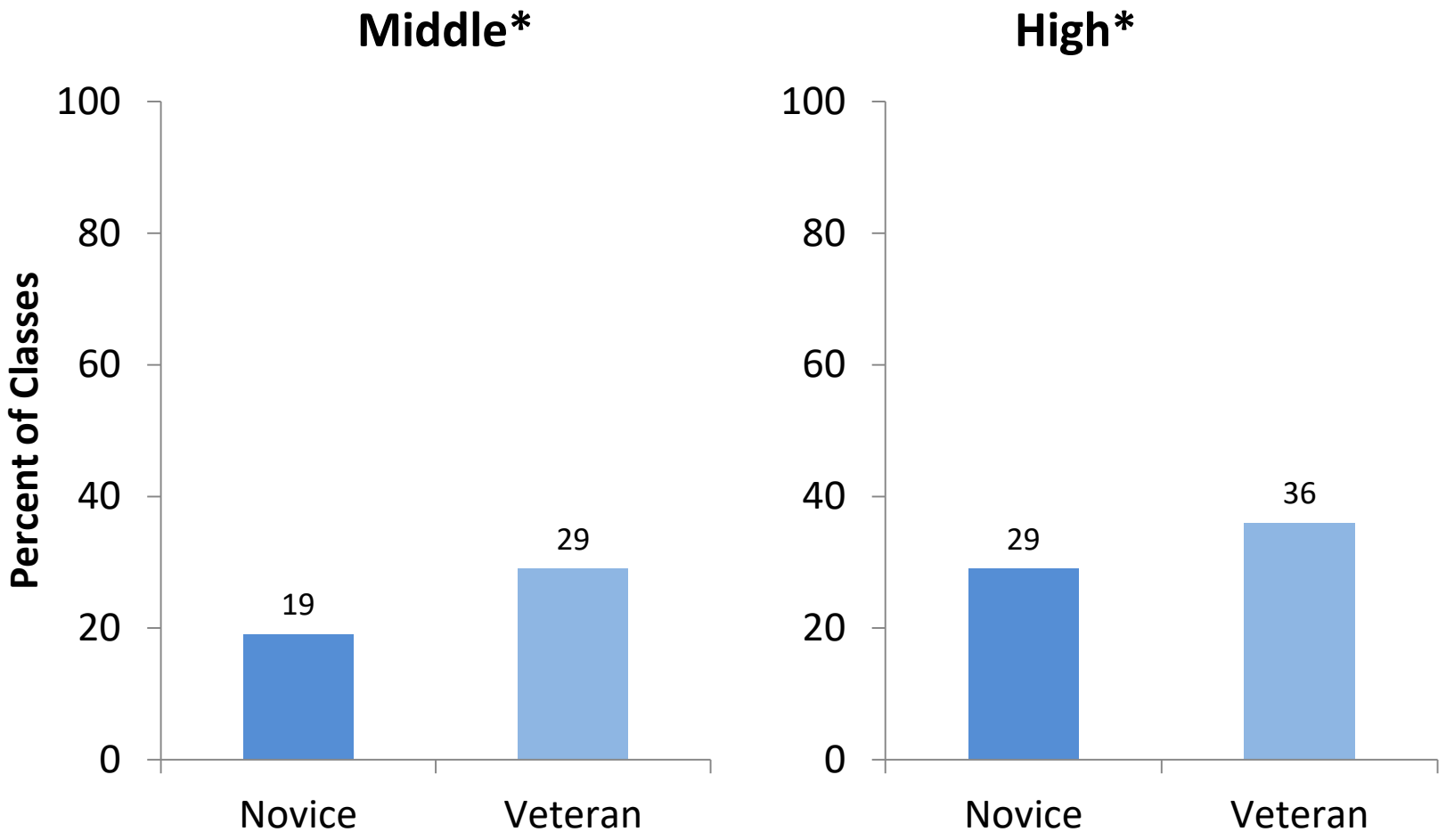


Support for Novice Secondary Teachers

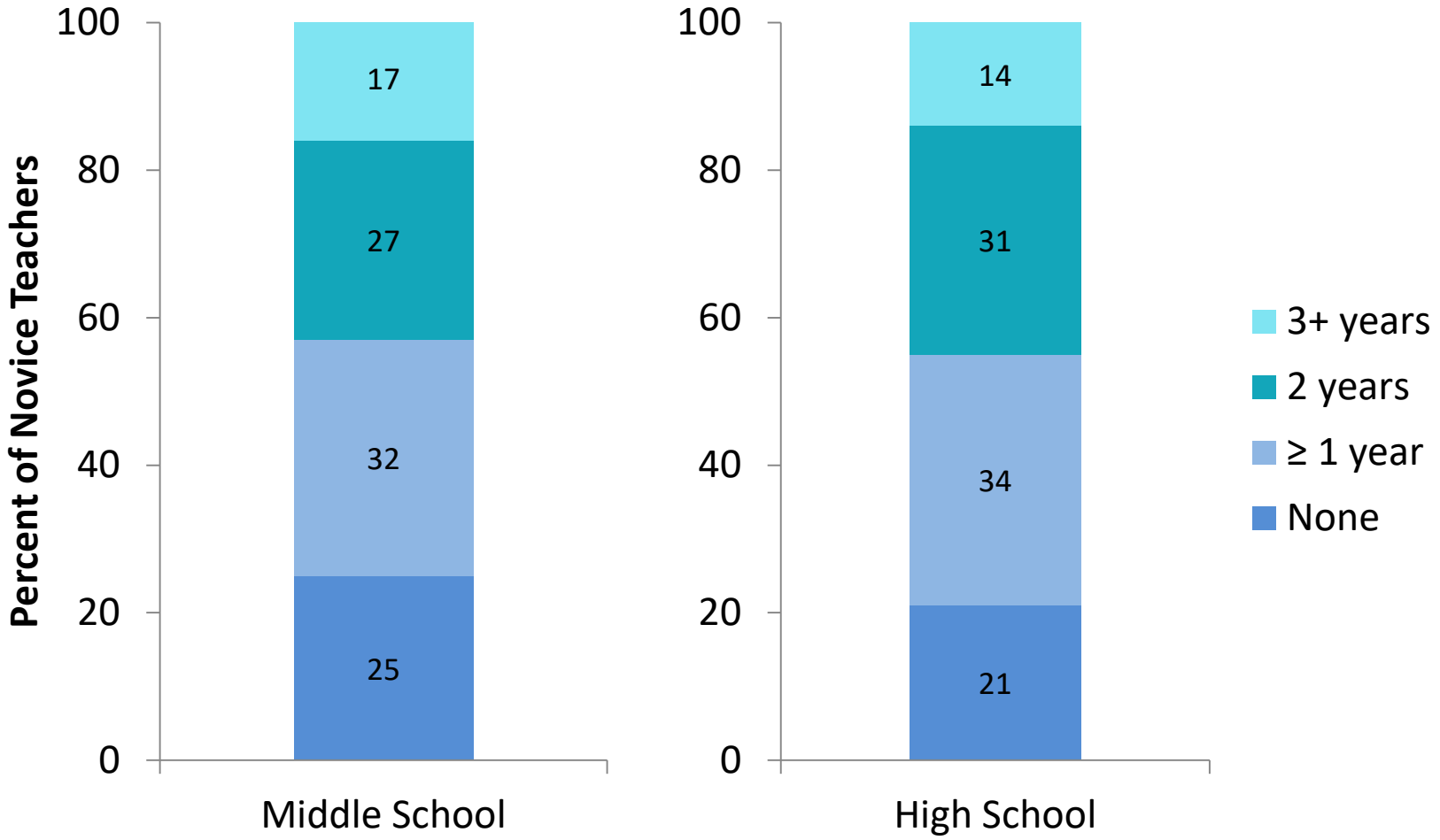
Secondary Teacher Participation in Science PD in Previous Three Years



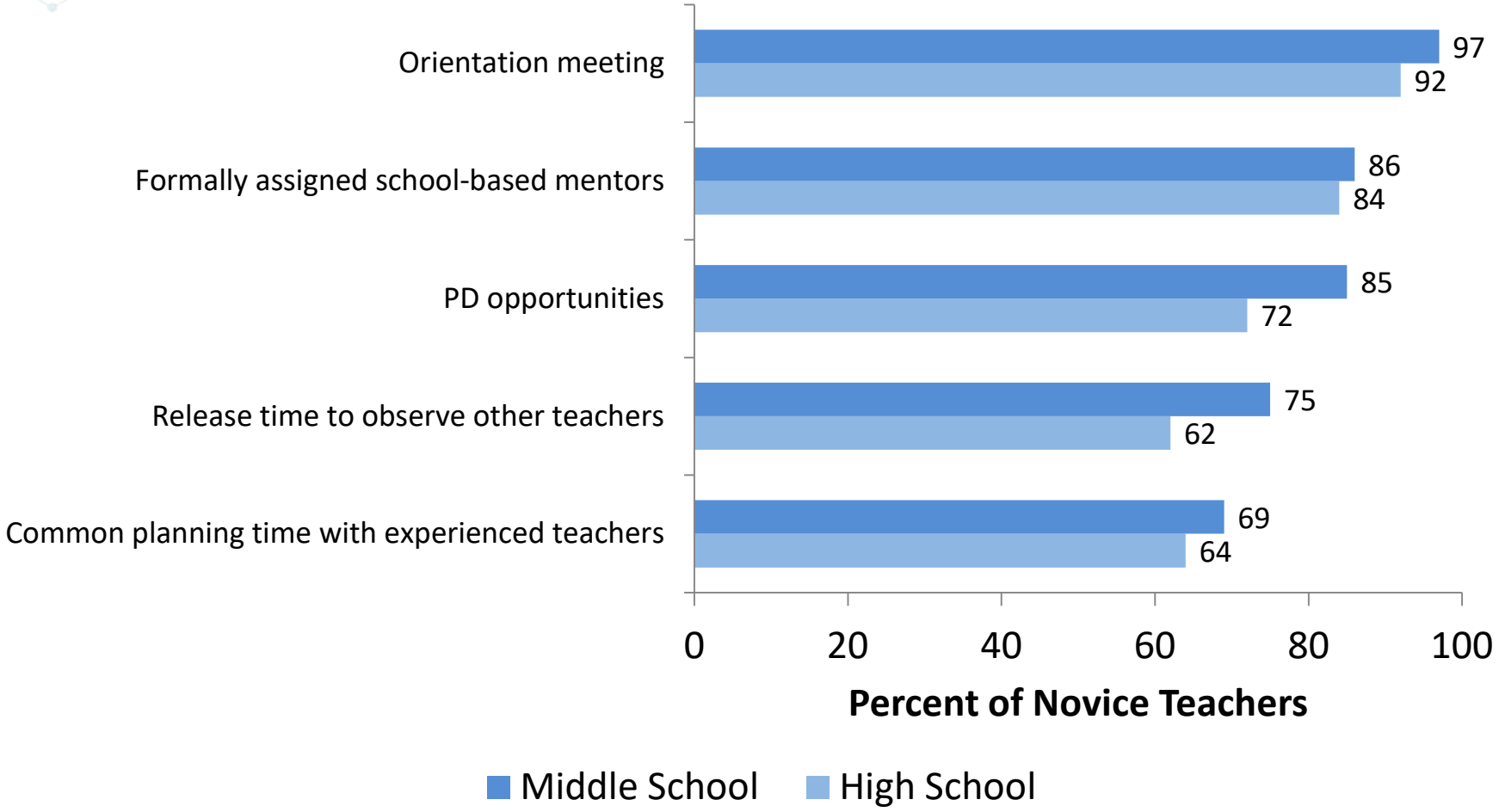
More than 35 hours of Science PD in Previous Three Years



Duration of Formal Induction Programs



Supports Provided as Part of Formal Induction Programs



Takeaways

Some key differences between novices and veterans:

- Content preparedness/background
- Pedagogical preparedness
- Instructional beliefs

Many commonalities which suggest room for professional growth

- PD data suggest teachers are not getting the sustained support they need to “mature” as professionals throughout their teaching careers.

Takeaways

Given the large percentage of novice teachers in schools that offer induction programs, perhaps it is possible to leverage induction program supports:

- School-based mentors might devote time to helping novices increase their science content knowledge or diversify their science teaching practices
- School leaders may strategically choose teachers for novices to observe when they are given release time to do so

NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Factors That Predict the Extent to Which Secondary Teachers' Engage Students in the Science Practices

horizon RESEARCH, INC.

Analytic Approach

The 2018 NSSME+ collected data about the nature of instruction in secondary science classes

Study also collected tons of data about teachers, schools, and instructional resources

This analysis looked at school, class, and teacher characteristics that are associated with instructional practices

Outcomes

Composite variables measuring:

1. Reform-oriented instructional objectives
2. Extent instruction engages students with the practices of science

Reform-Oriented Instructional Objectives

How much emphasis each would receive over the entire course:

1. Understanding science concepts
2. Learning about different fields of science/engineering
3. Learning how to do science (develop scientific questions; design and conduct investigations; analyze data; develop models, explanations, and scientific arguments)
4. Learning how to do engineering (e.g., identify criteria and constraint, design solutions, optimize solutions)
5. Learning about real-life applications of science/engineering
6. Increasing students' interest in science/engineering
7. Developing students' confidence that they can successfully pursue careers in science/engineering

Engagement in Science Practices

How often students are 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

Independent Variables

Schools

- School size
- Community type
- Public vs. private school
- Spending per pupil
- Extent factors are problematic
- Block scheduling (HS only)

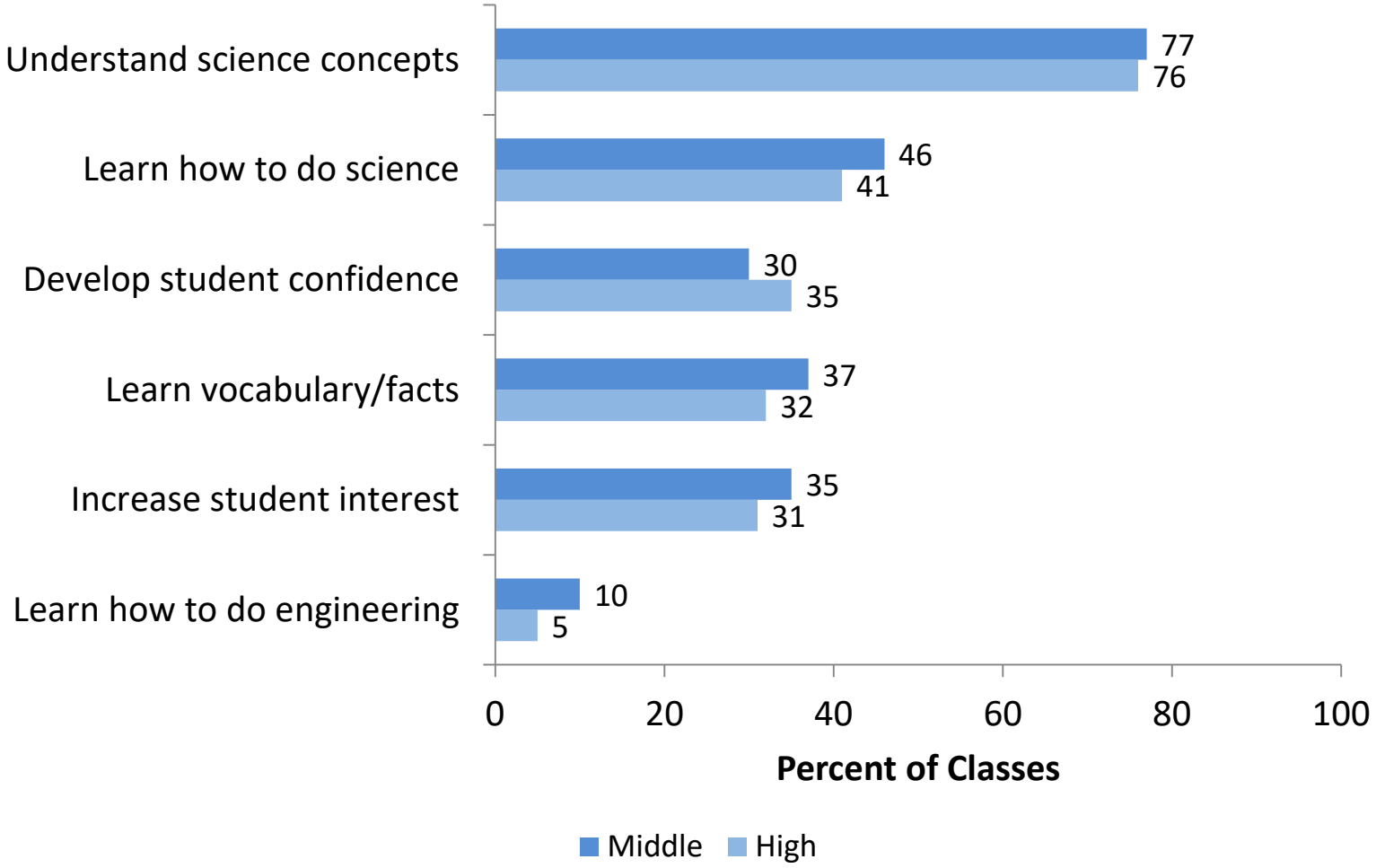
Teachers

- Years of K-12 science teaching experience
- Science-related degree
- Perceptions of preparedness
- Teaching beliefs
- Science-related job before teaching
- Amount of science PD
- Race/sex

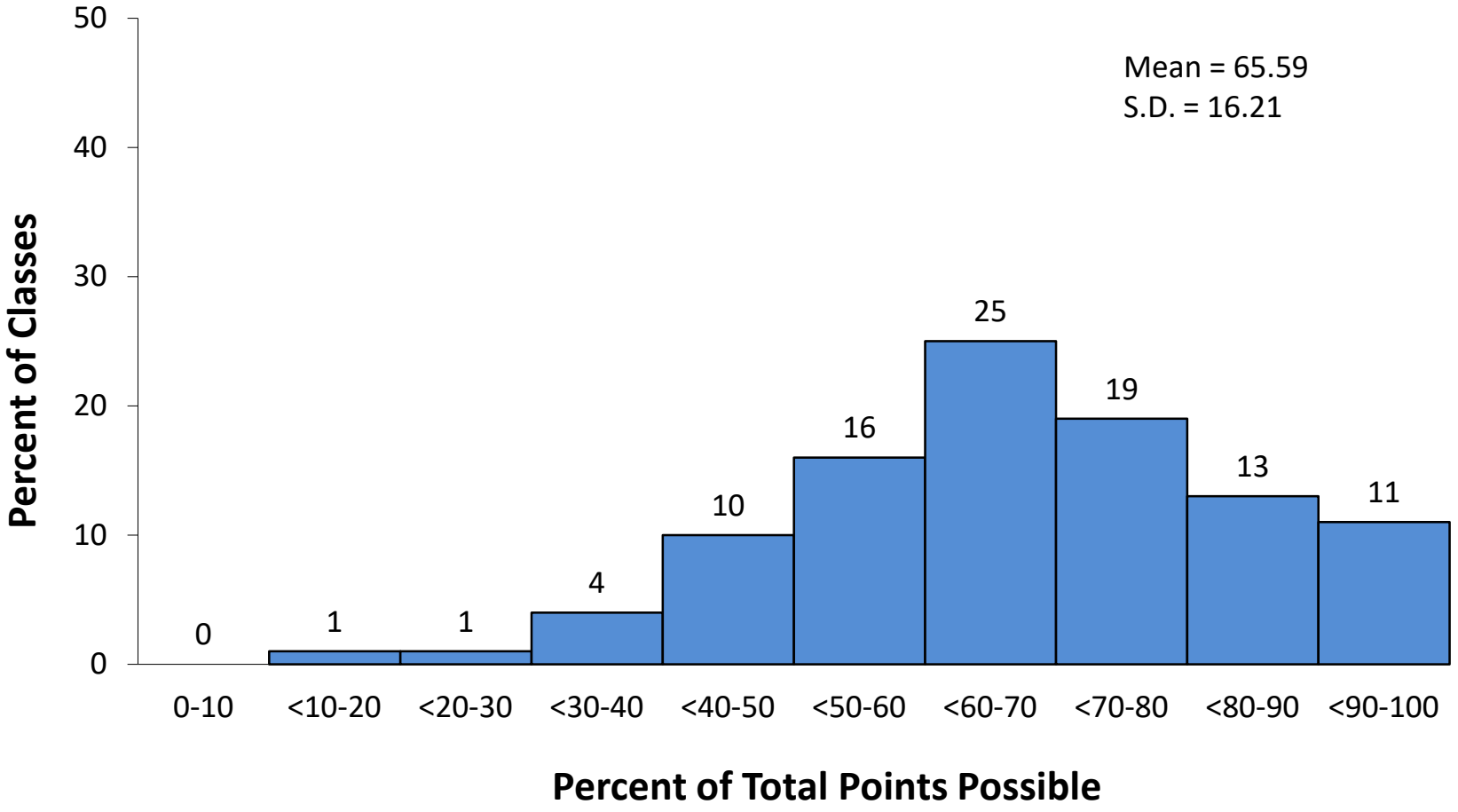
Classes

- Subject matter
- Course level (HS only)
- Prior achievement level of students
- Class size
- Percent of students in class from race/ethnicity groups historically underrepresented in STEM
- Curriculum control
- Pedagogy control
- Number of instructional materials used often
- Adequacy of resources
- Extent effective instruction is promoted

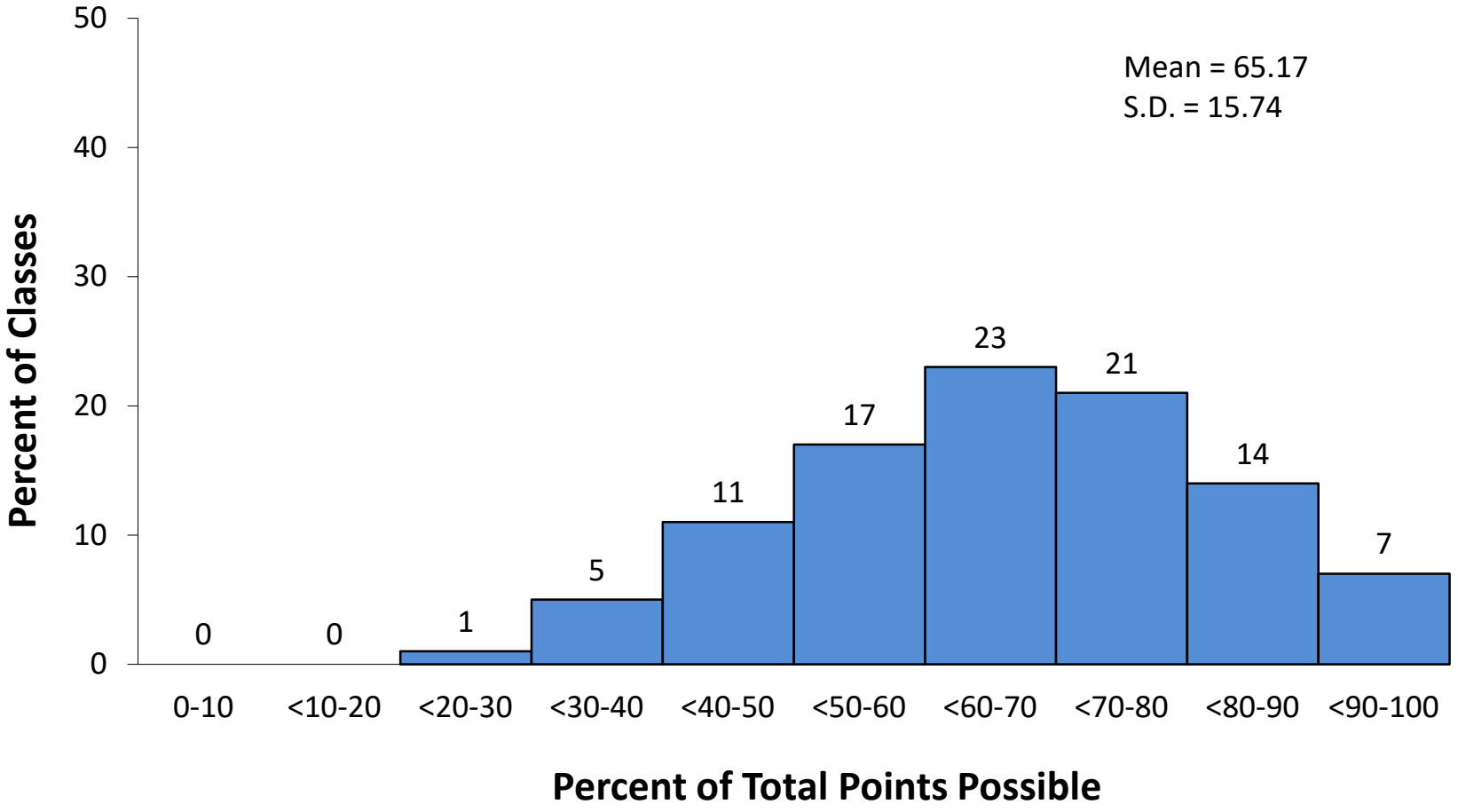
Reform-Oriented Objectives Receiving a Heavy Emphasis



Reform-Oriented Instructional Objectives Composite: Middle School



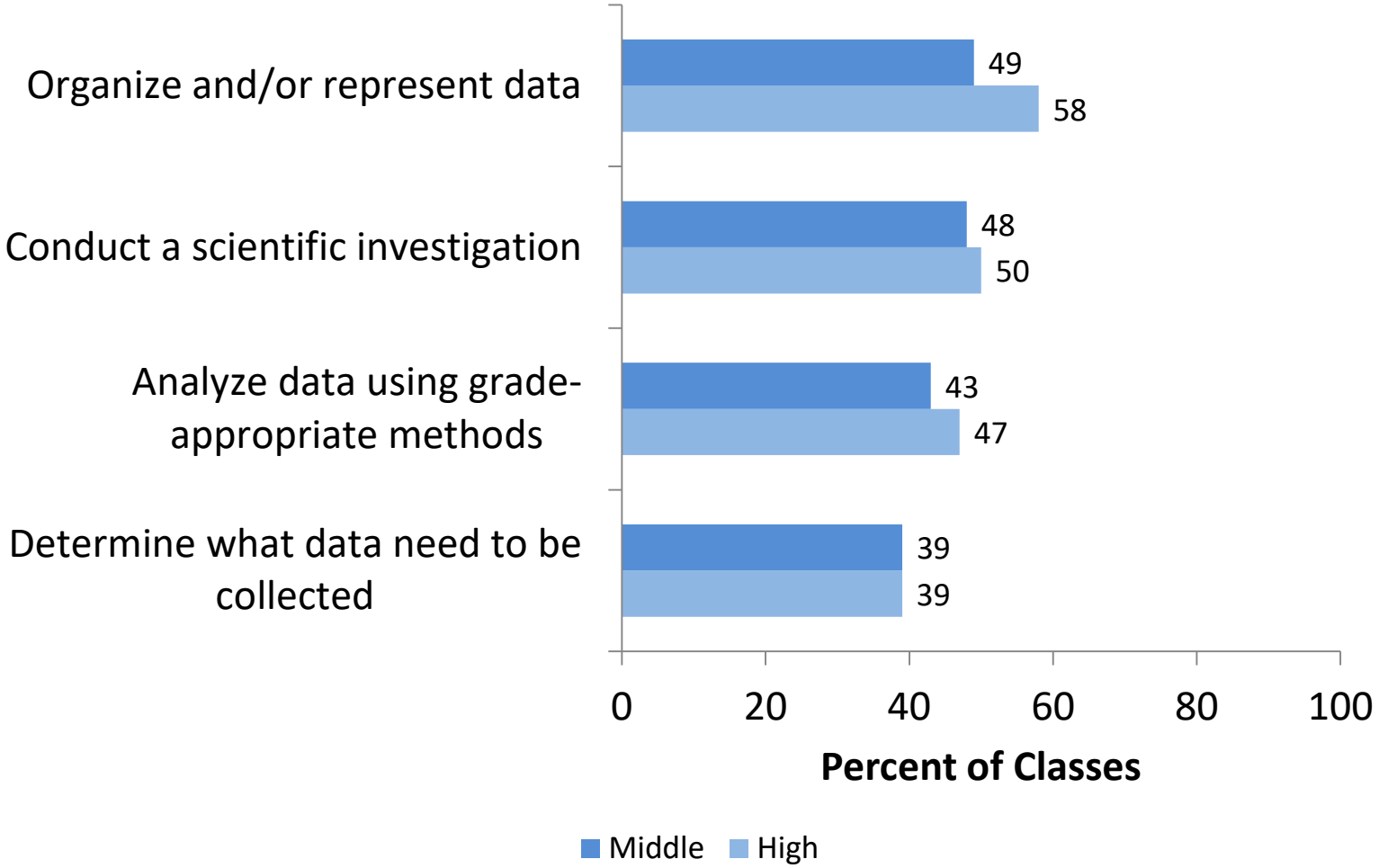
Reform-Oriented Instructional Objectives Composite: High School



Engagement in Science Practices

Students are often engaged in aspects of science related to conducting investigations and analyzing data

Conducting Investigations and Analyzing Data: Weekly

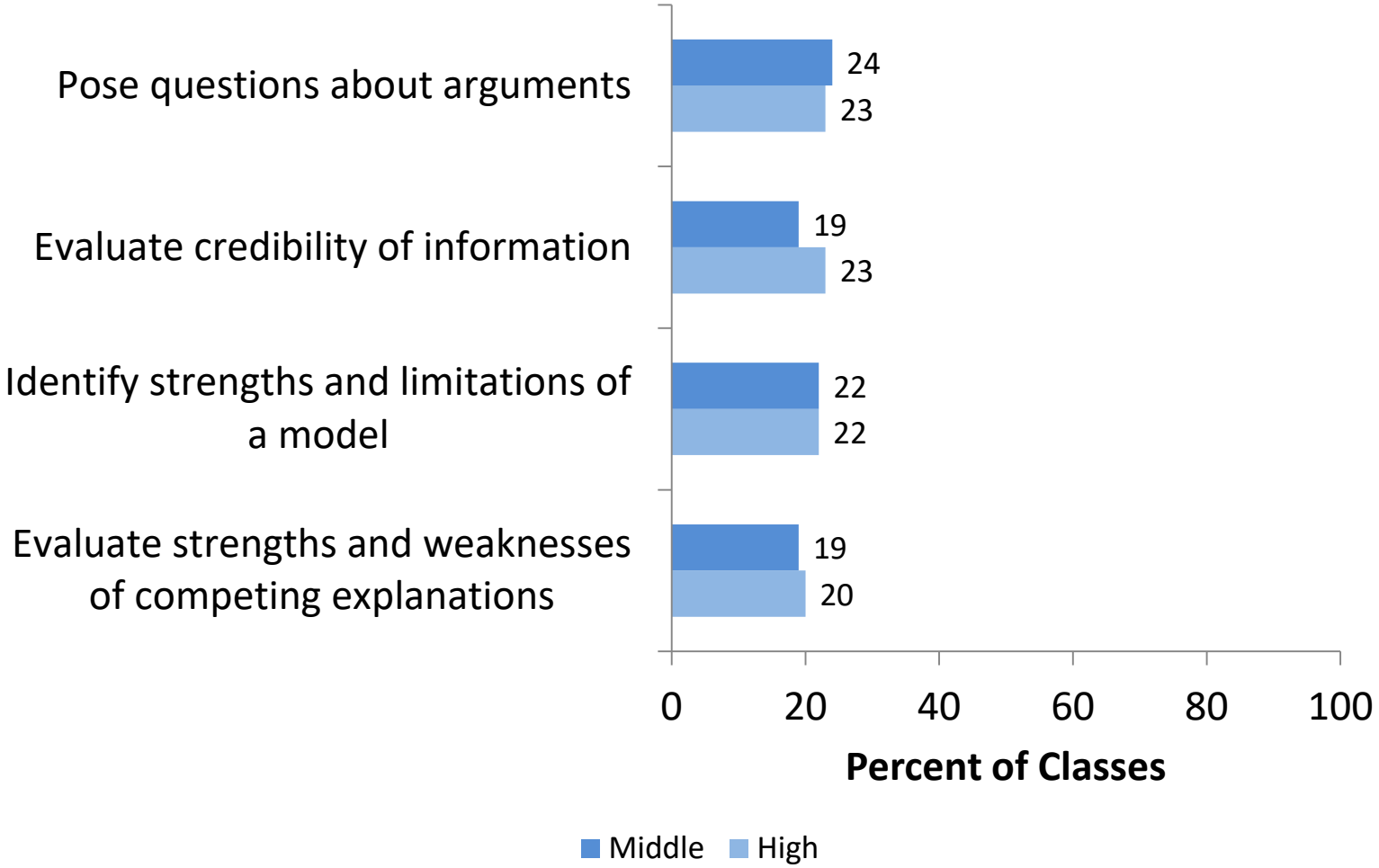


Engagement in Science Practices

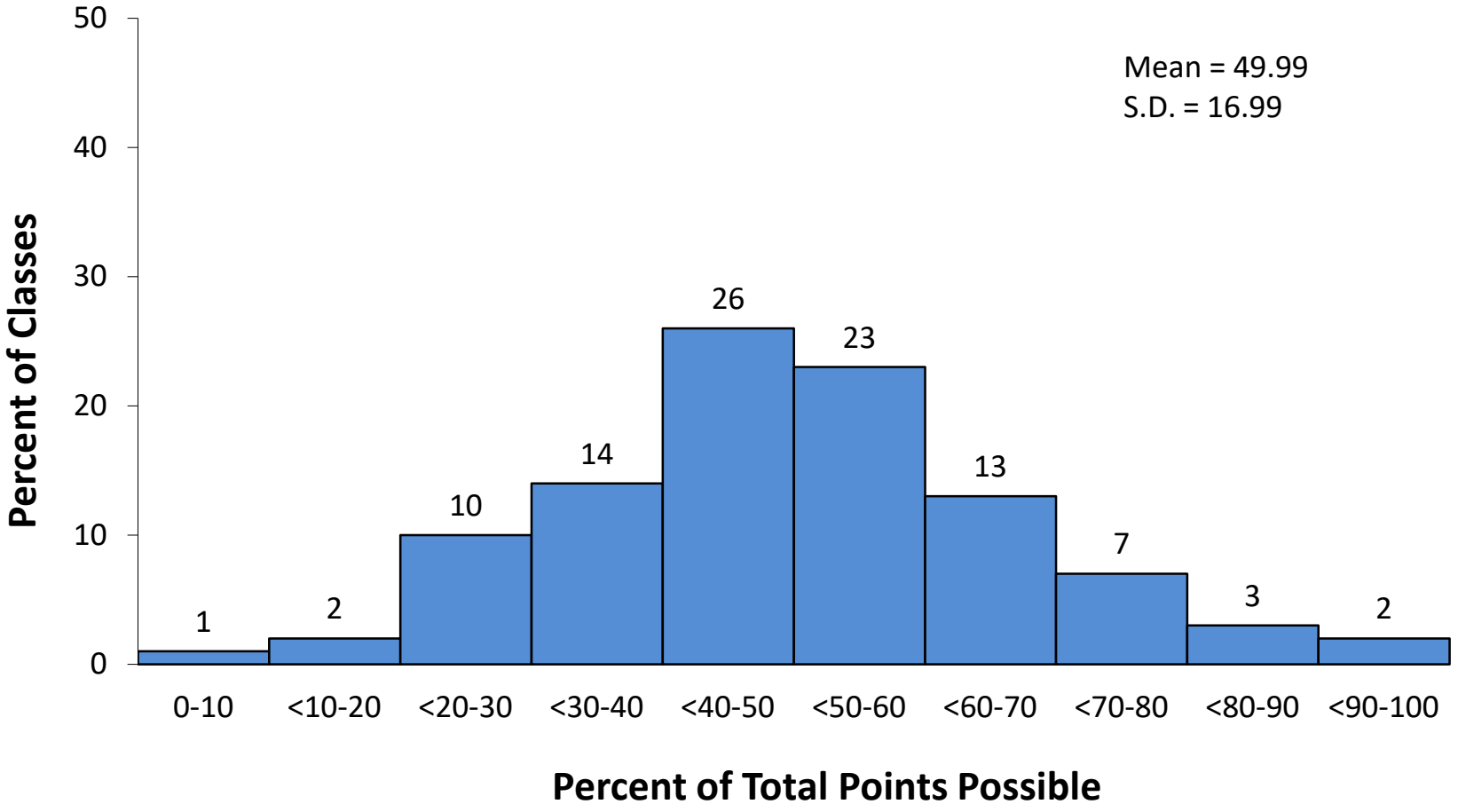
Students are often engaged in aspects of science related to conducting investigations and analyzing data

Students tend to not be engaged very often in aspects of science related to evaluating the strengths/limitations of evidence and the practice of argumentation

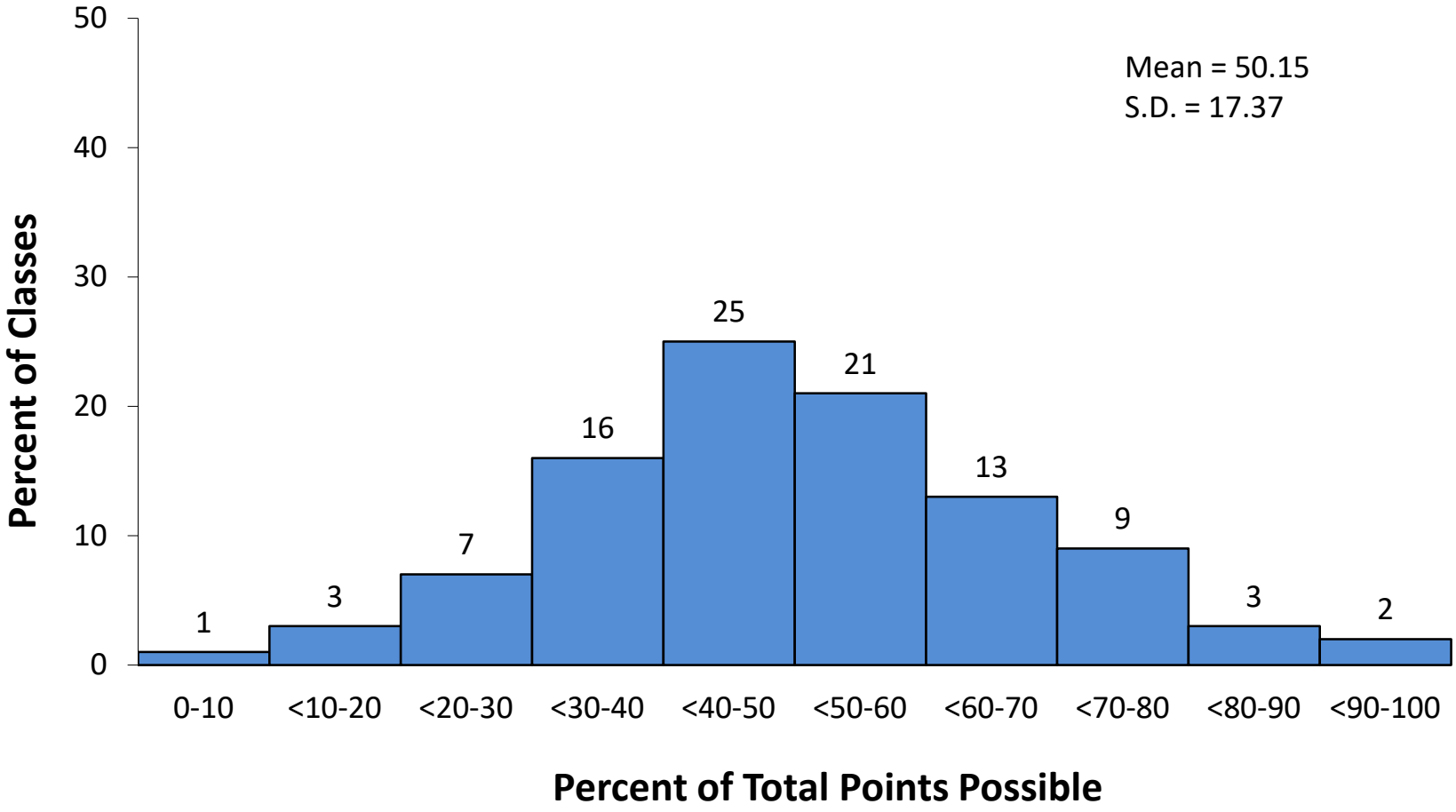
Evaluating Evidence and Arguing: Weekly



Engaging Students in the Practices Science Composite: Middle School



Engaging Students in the Practices Science Composite: High School



School Independent Variables

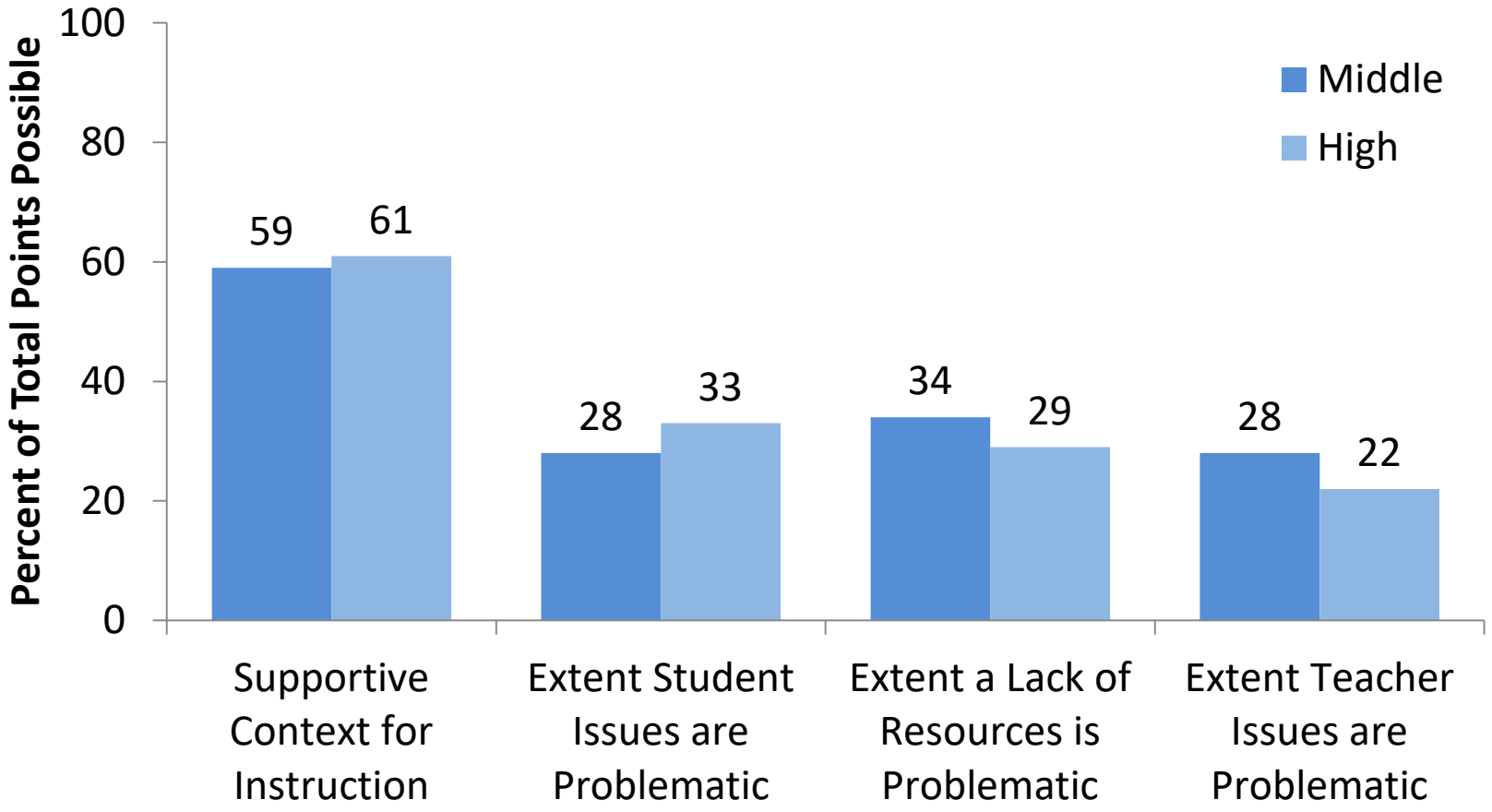
School Independent Variables

	Middle Schools	High Schools
Average Number of Students	460	687
Average Percent FRL	$7.22	$11.62

School Independent Variables

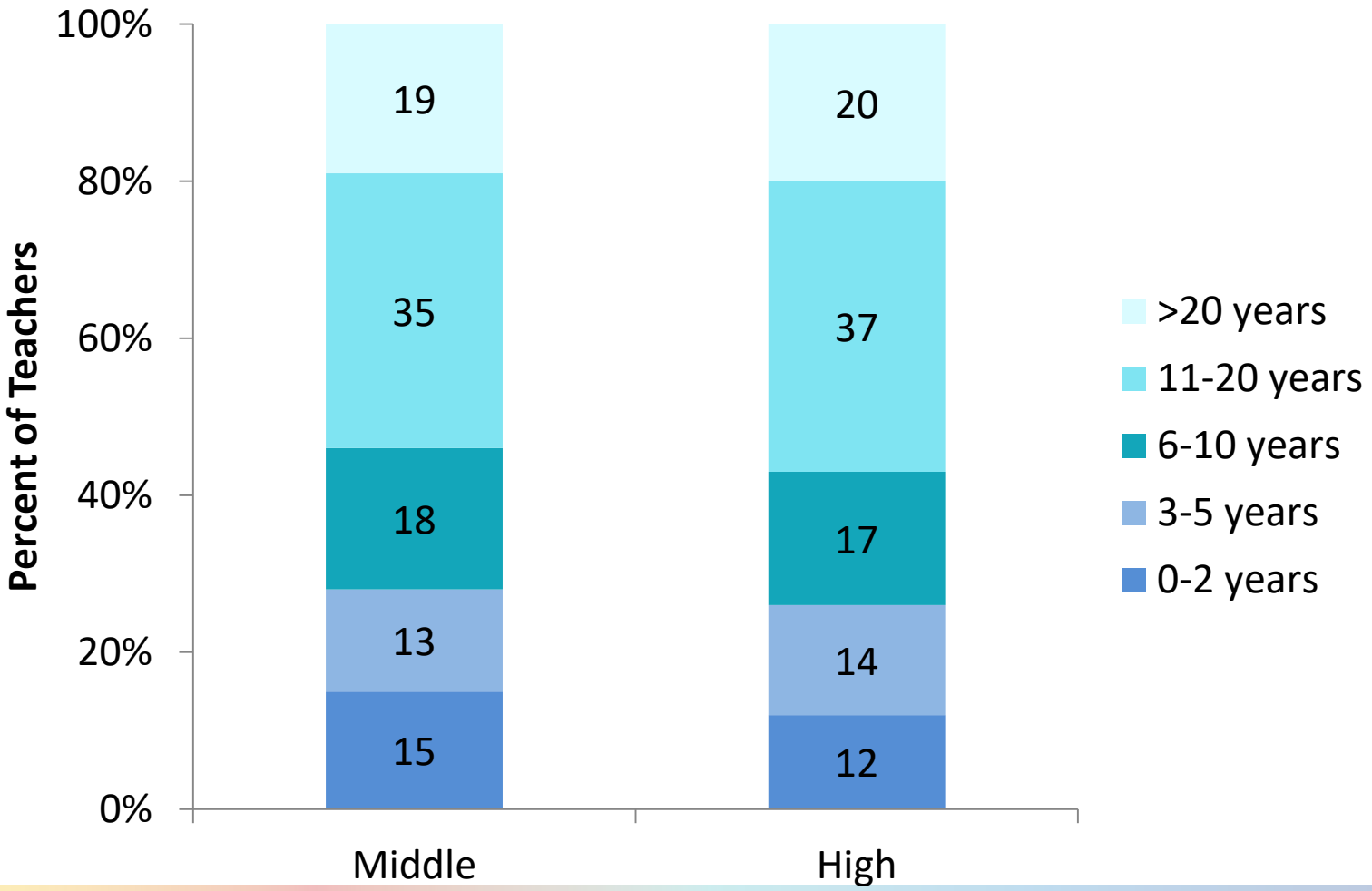
	Percent of Middle Schools	Percent of High Schools
Community Type		
Rural	28	37
Suburban	42	37
Urban	30	26
School Type		
Public	73	81
Private	27	19
Schedule Type		
Block	n/a	33
Traditional	n/a	67

School Mean Scores for Factors Affecting Instruction Composites

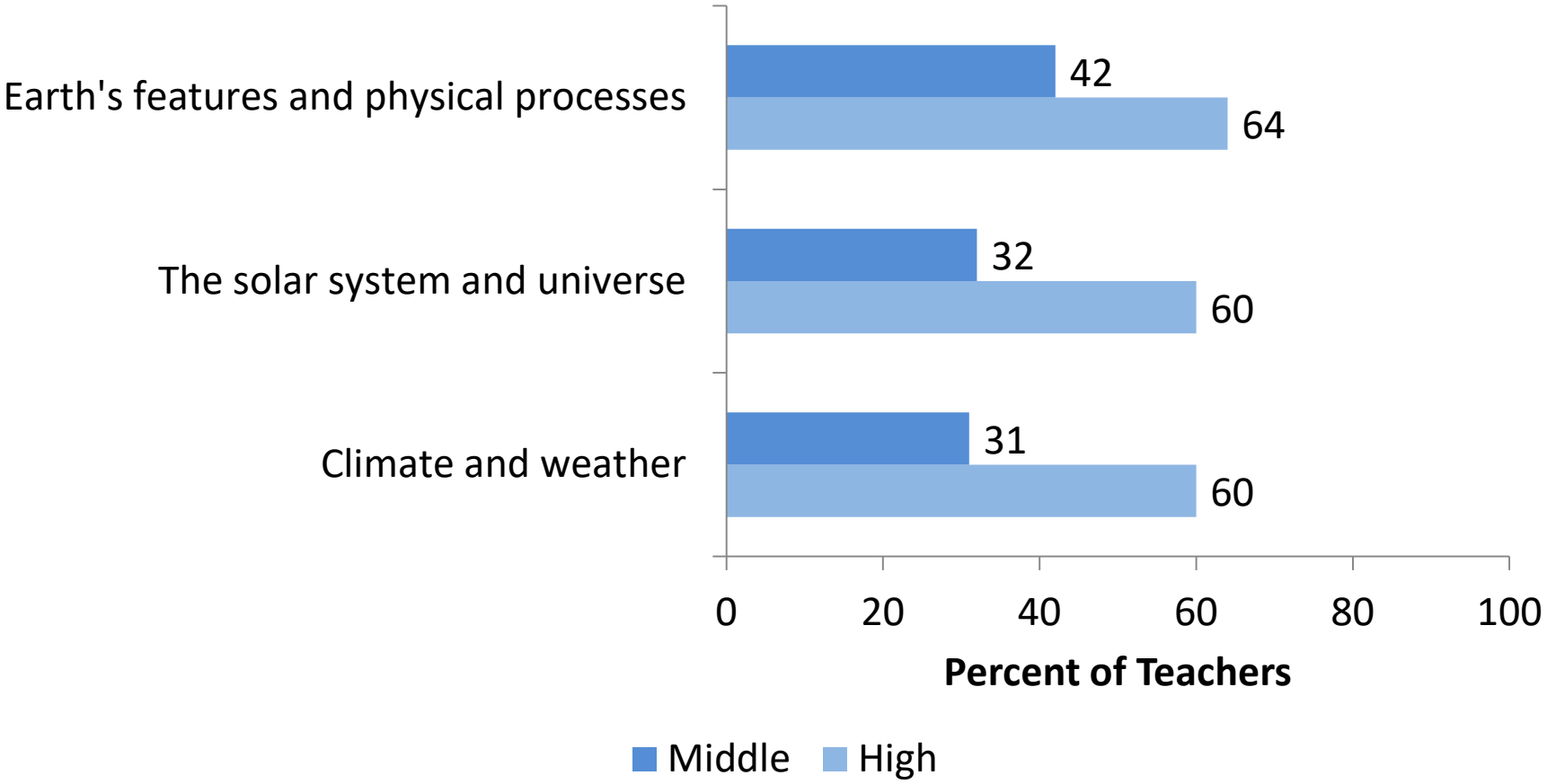


Teacher Independent Variables

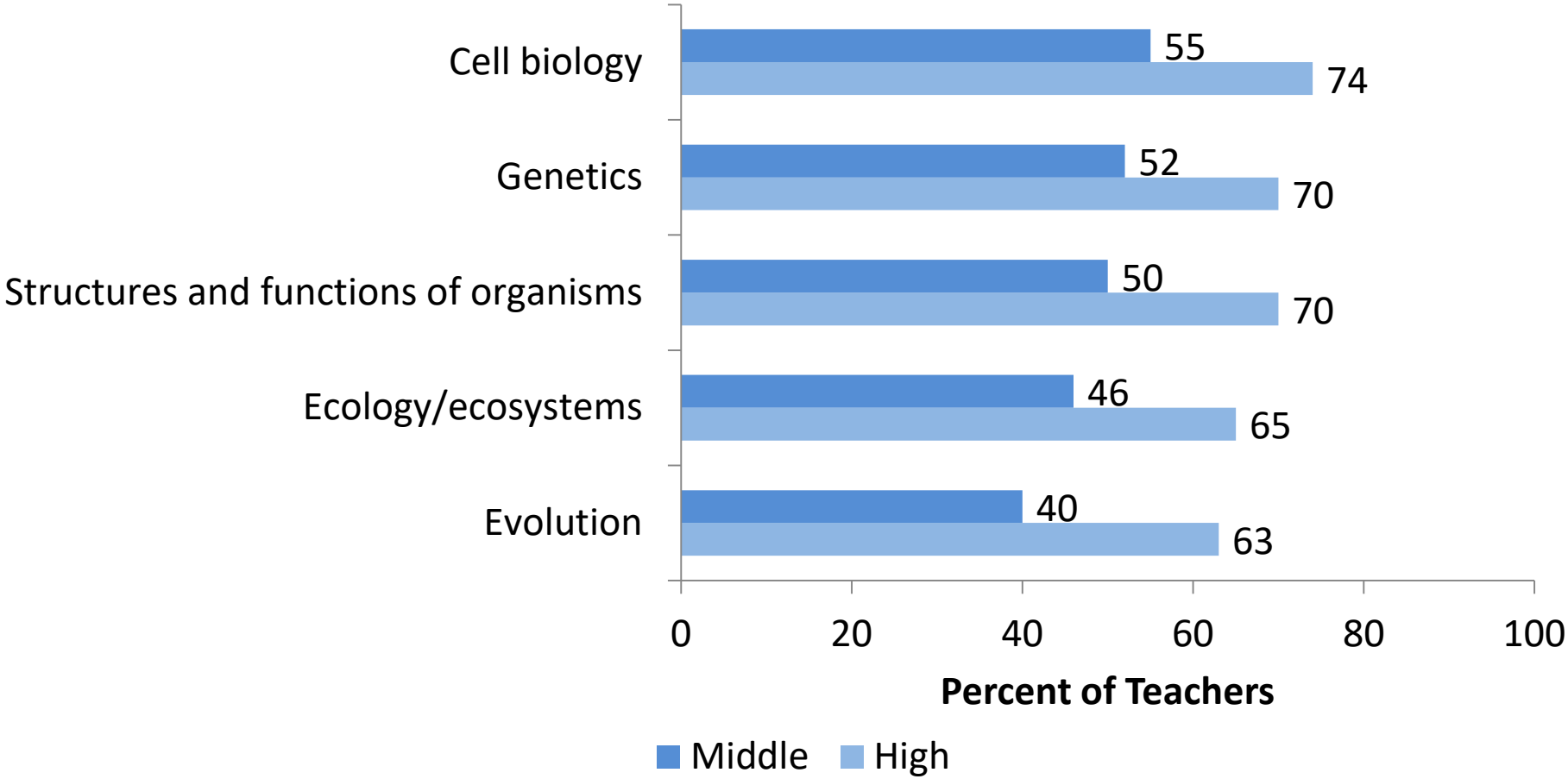
K–12 Science Teaching Experience



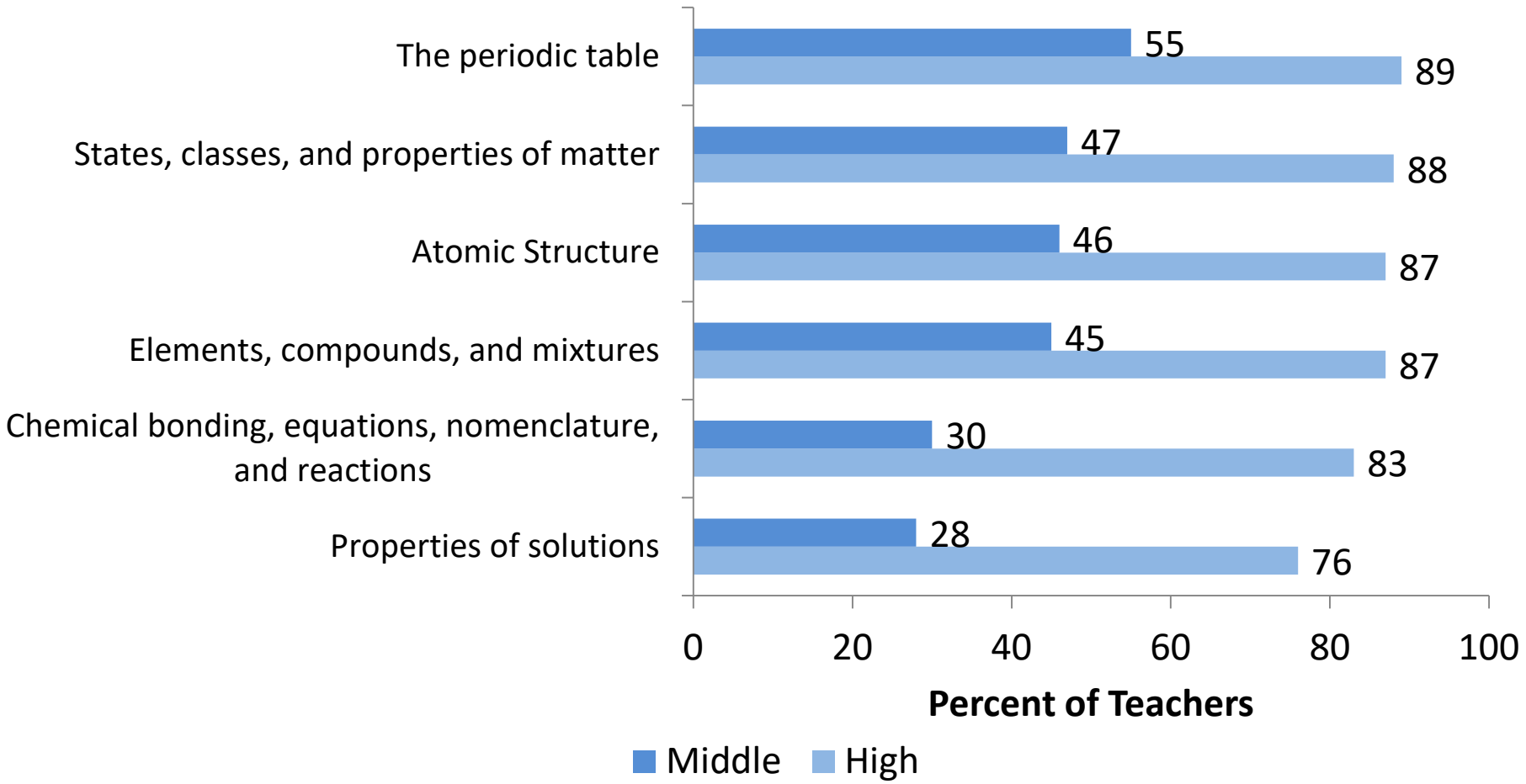
Perceptions of Preparedness: Very Well Prepared to Teach Earth/Space Science Topics



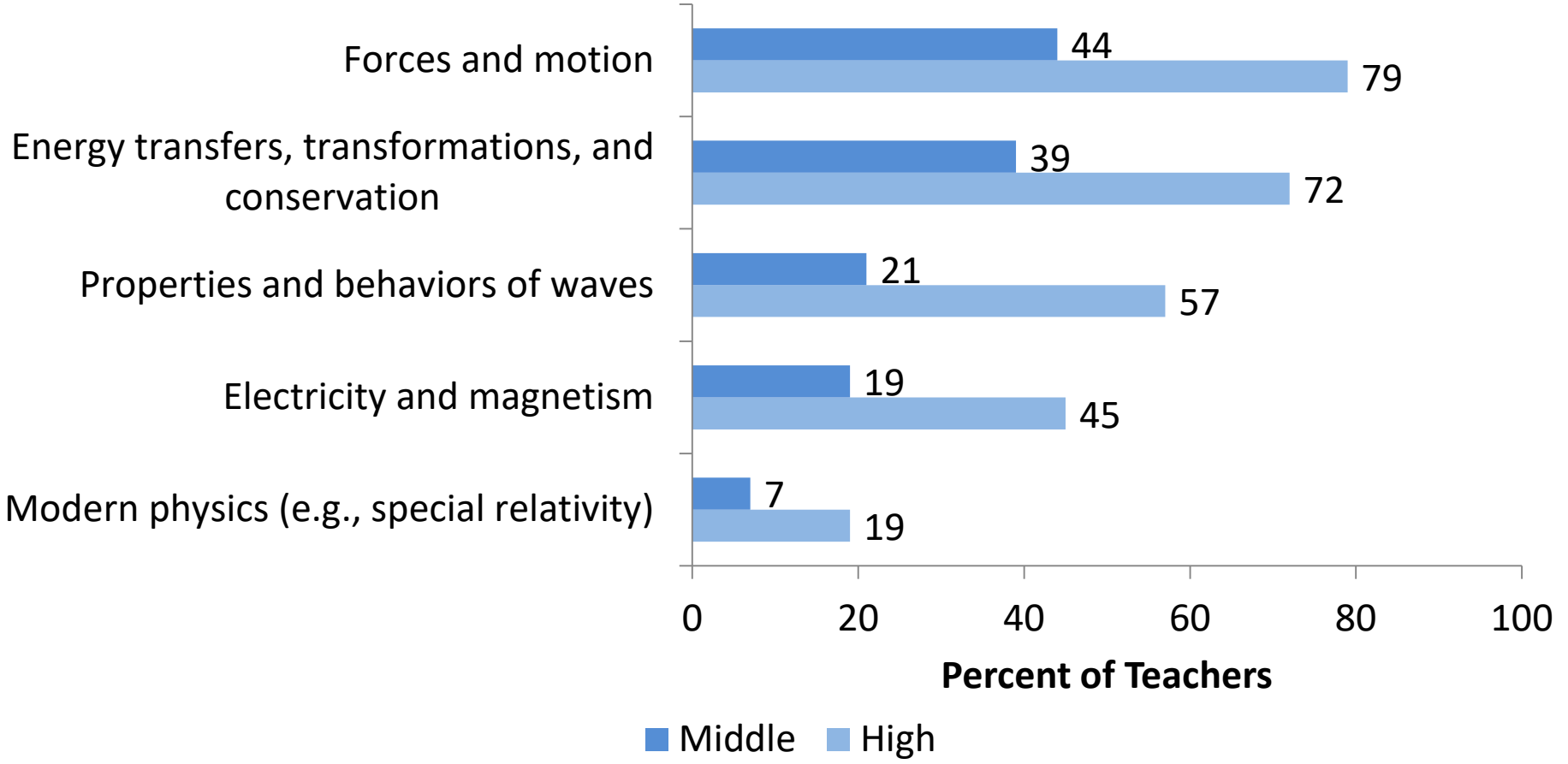
Perceptions of Preparedness: Very Well Prepared to Teach Biology/Life Science Topics



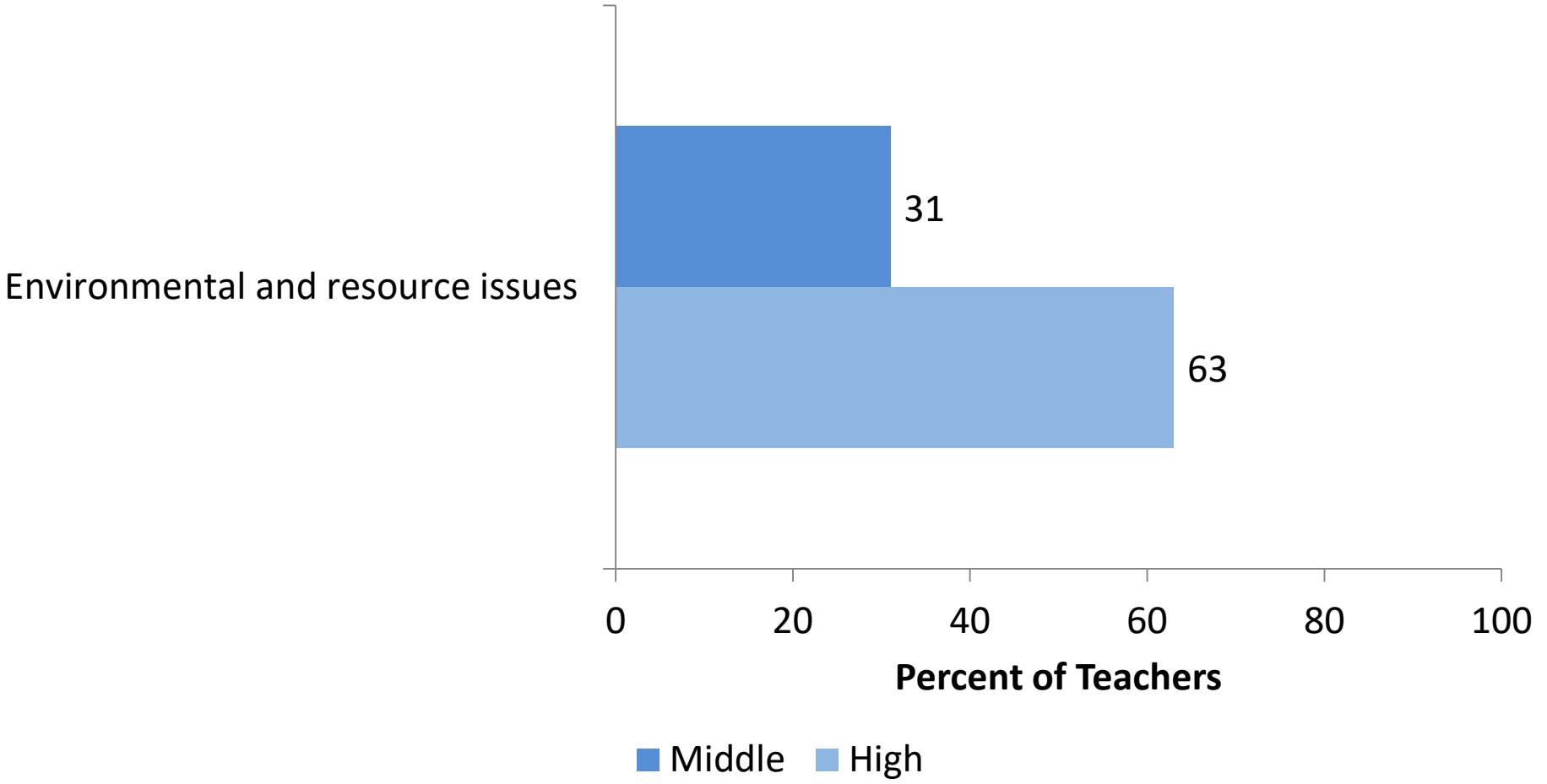
Perceptions of Preparedness: Very Well Prepared to Teach Chemistry Topics



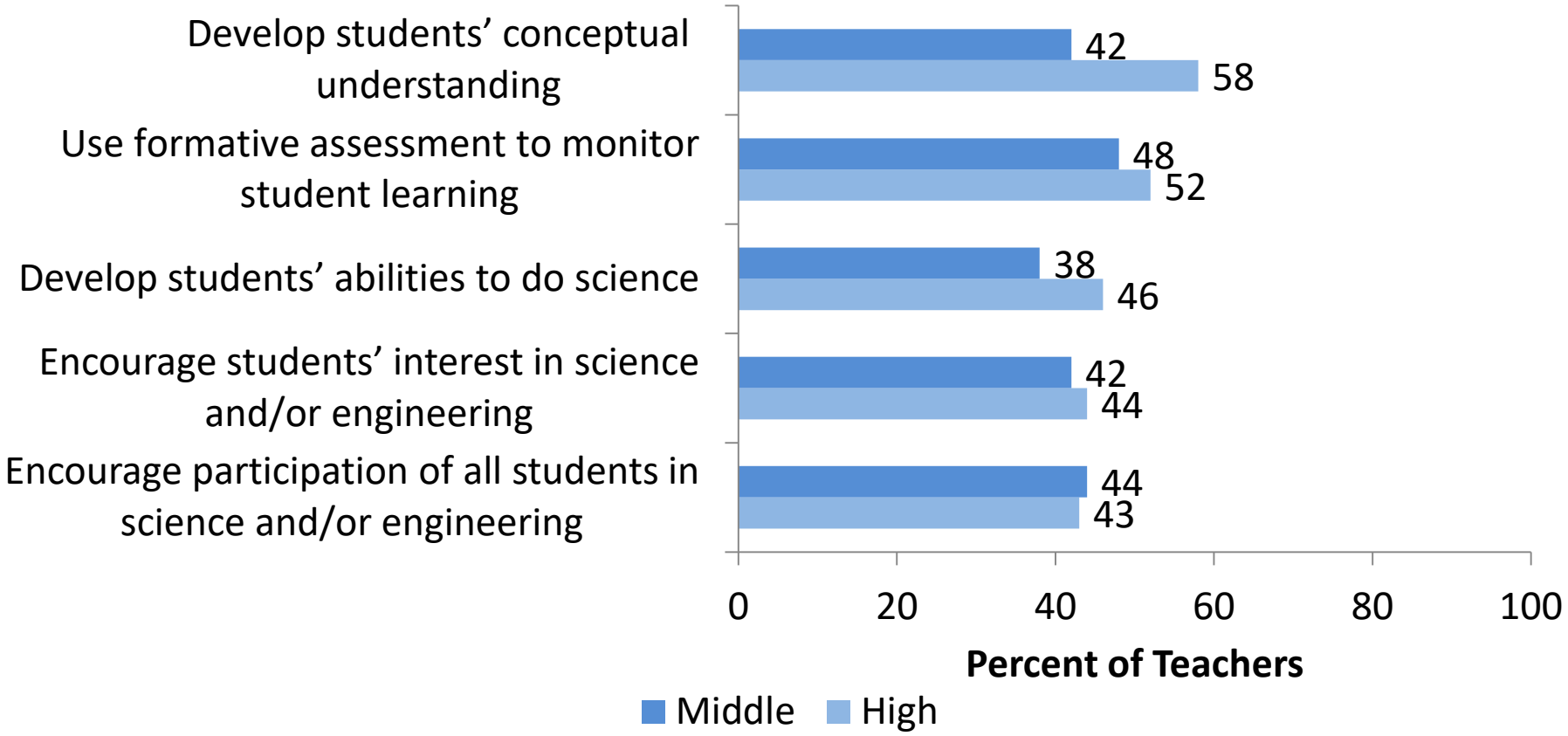
Perceptions of Preparedness: Very Well Prepared to Teach Physics Topics



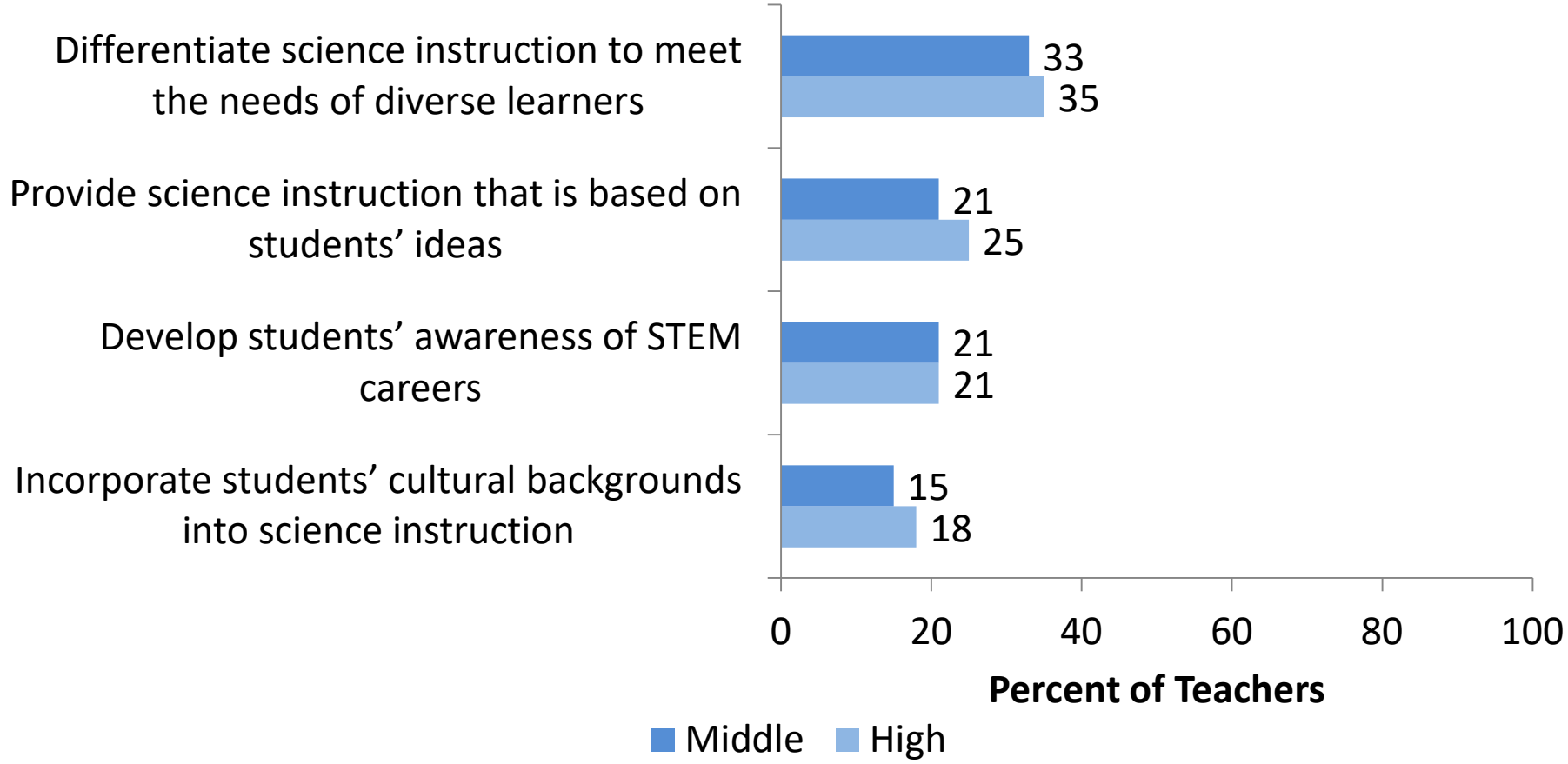
Perceptions of Preparedness: Very Well Prepared to Teach Environmental Science



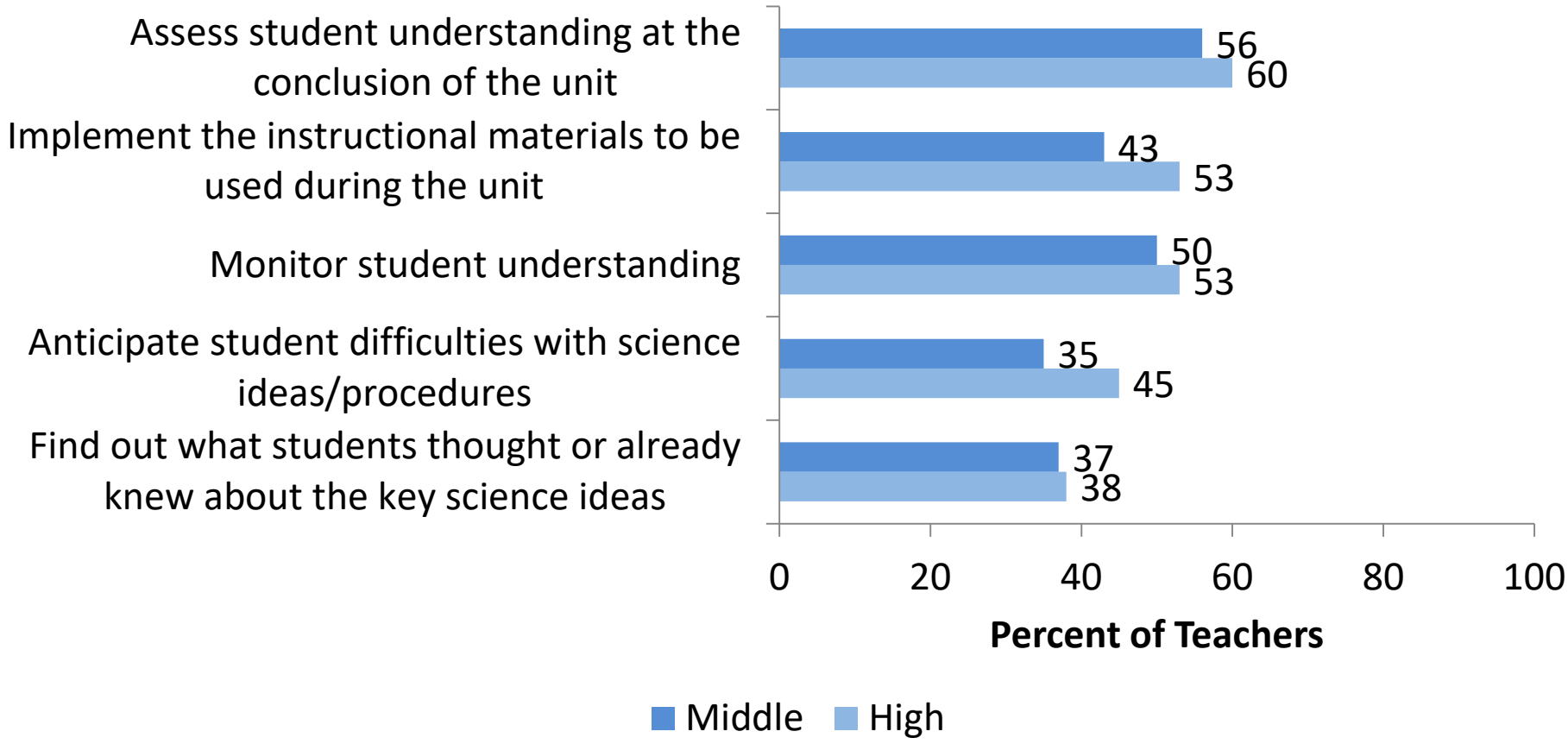
Perceptions of Preparedness: Very Well Prepared to Use Student-Centered Pedagogies



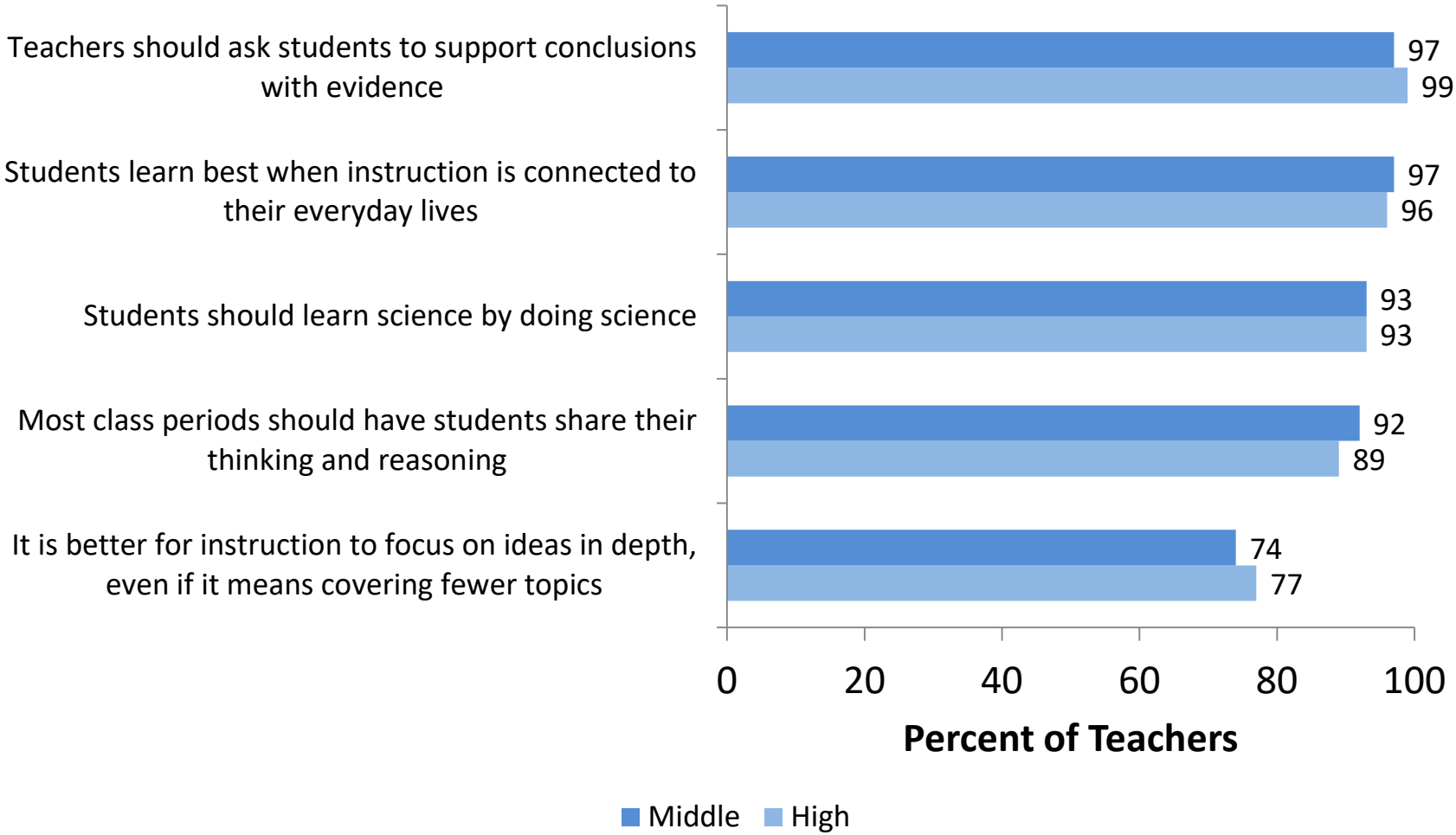
Perceptions of Preparedness: Very Well Prepared to Use Student-Centered Pedagogies



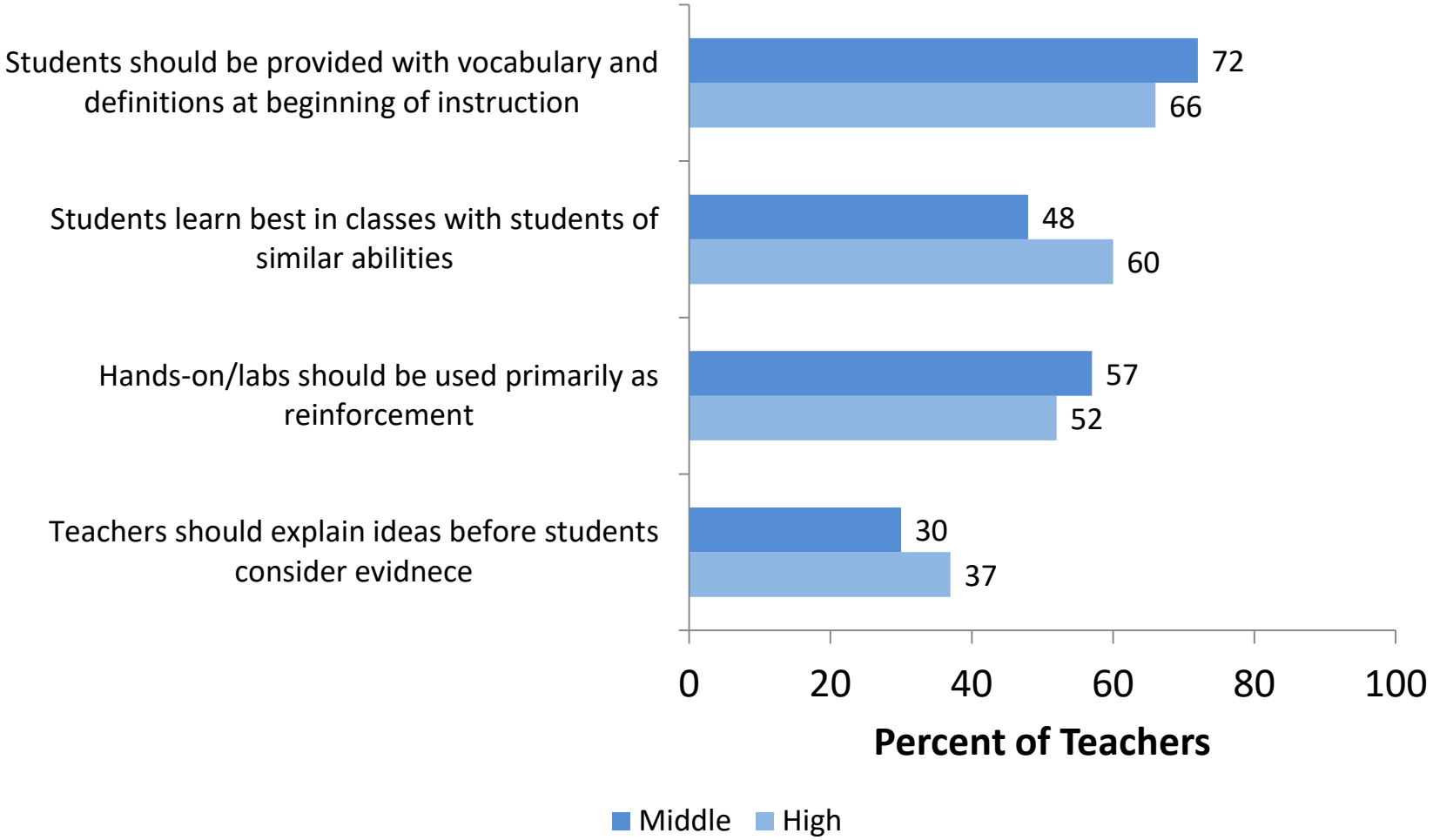
Perceptions of Preparedness: Very Well Prepared for Various Tasks in the Most Recent Unit



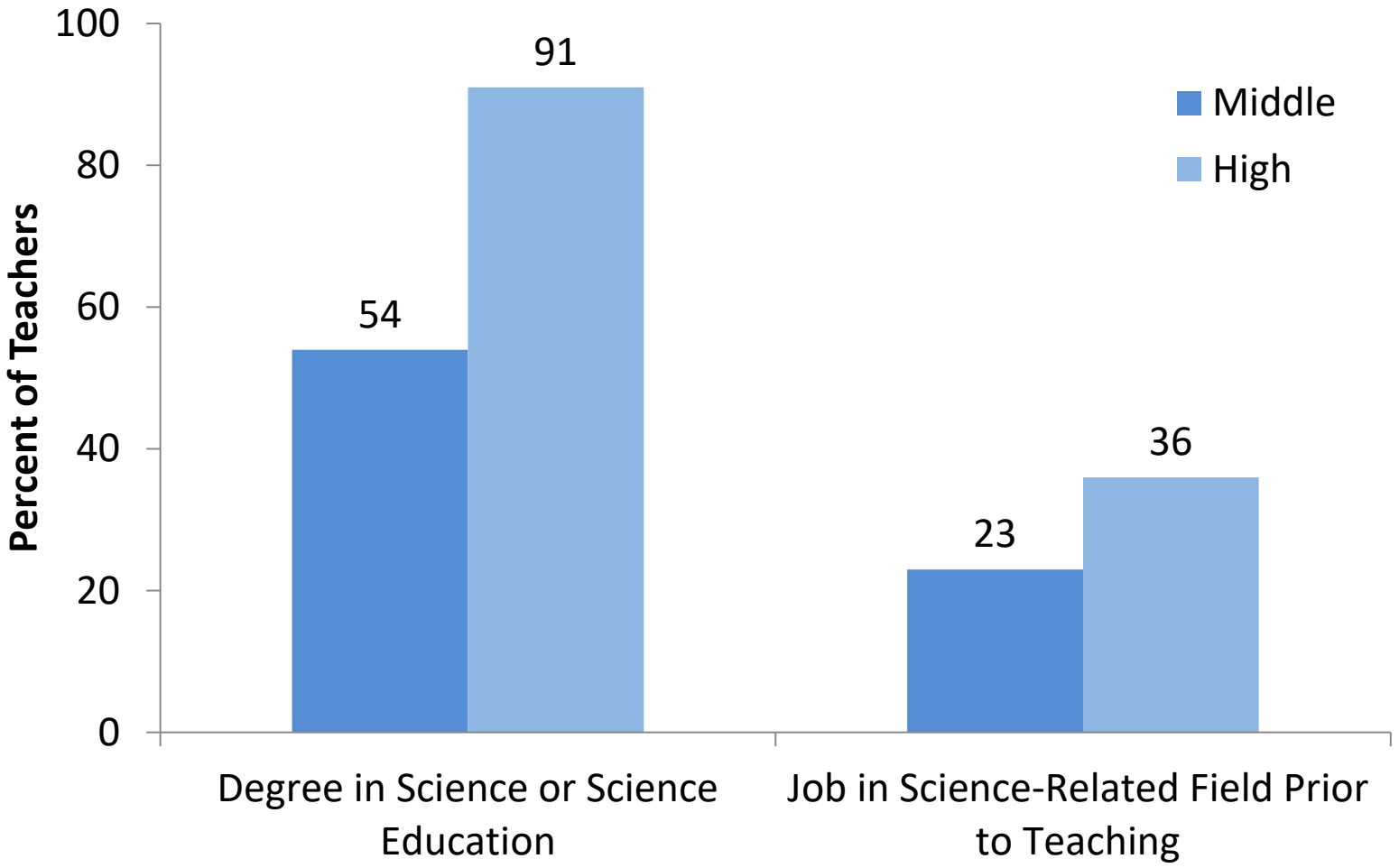
Teachers Agreeing With Various Reform-Oriented Teaching Beliefs



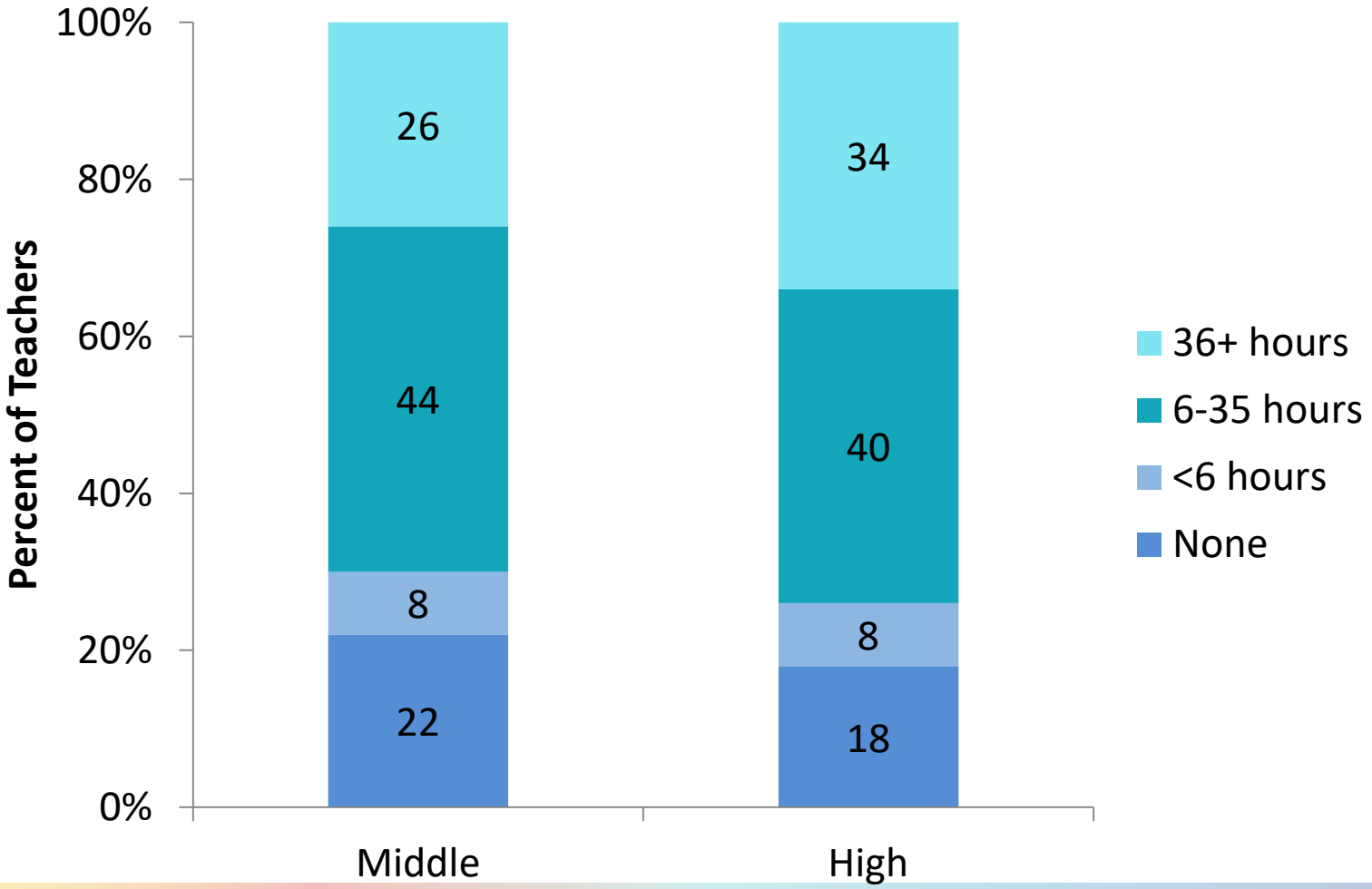
Teachers Agreeing With Various Traditional Teaching Beliefs



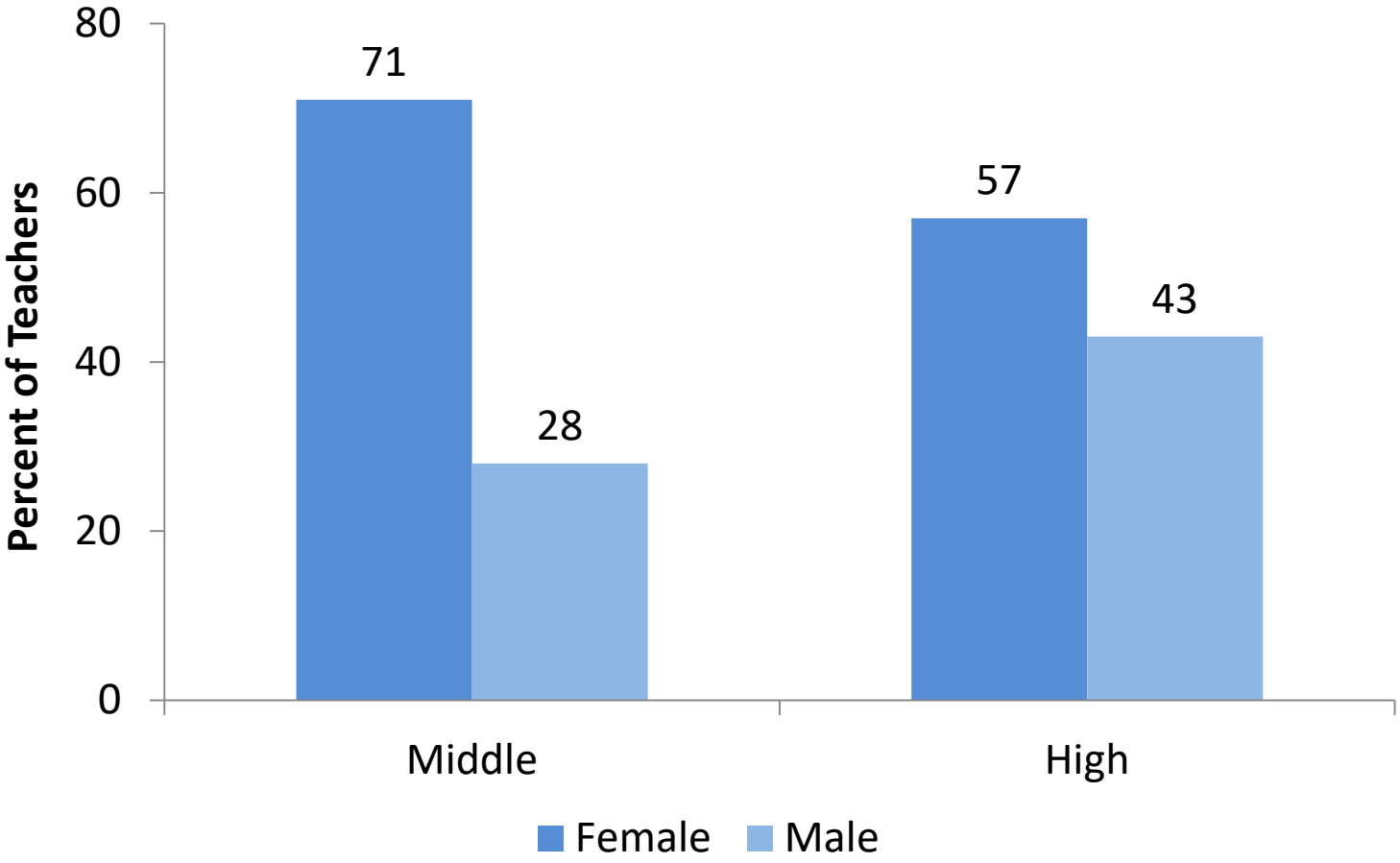
Science Background



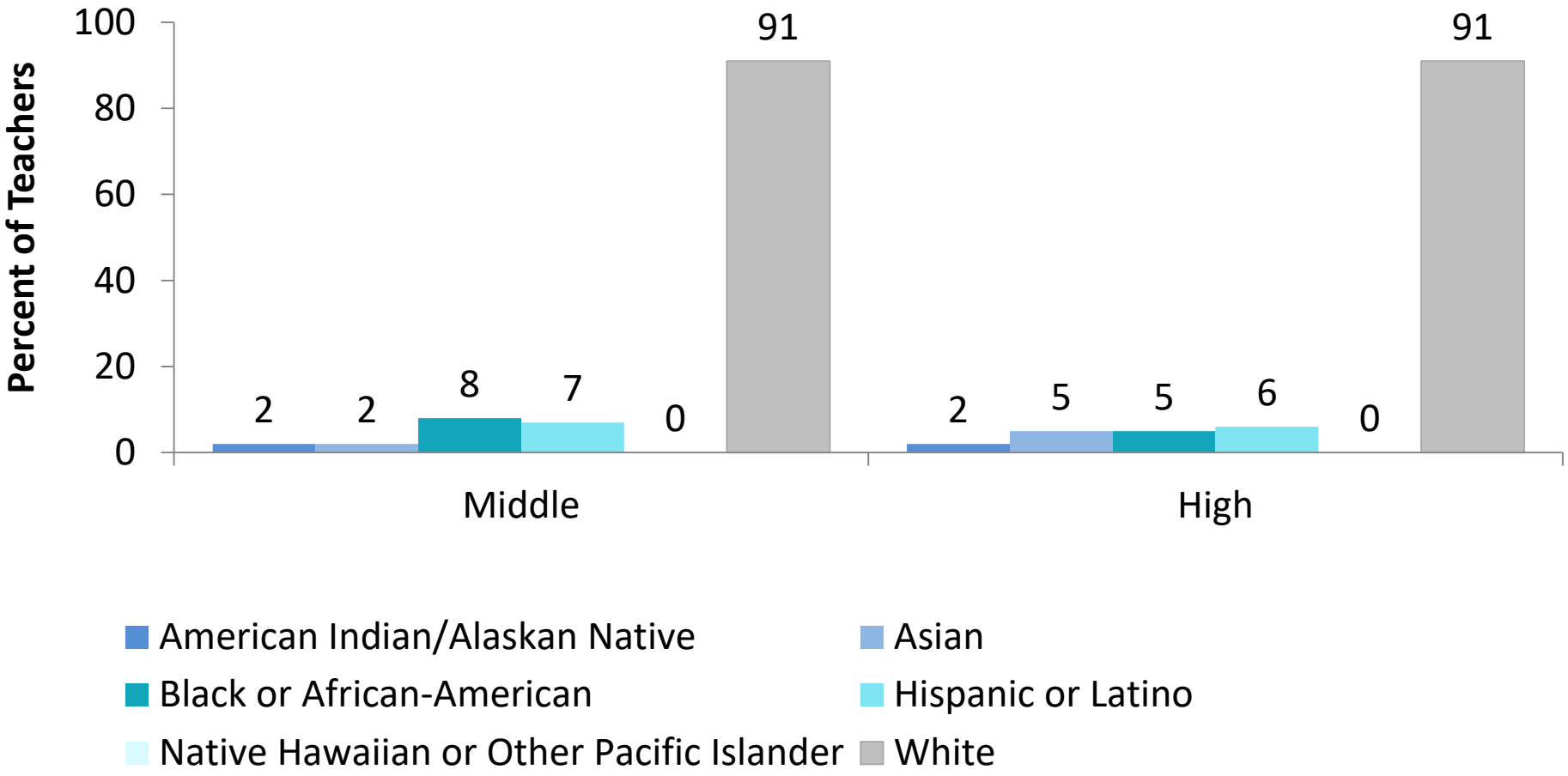
Hours of Science PD in the Previous 3 Years



Teacher Characteristics

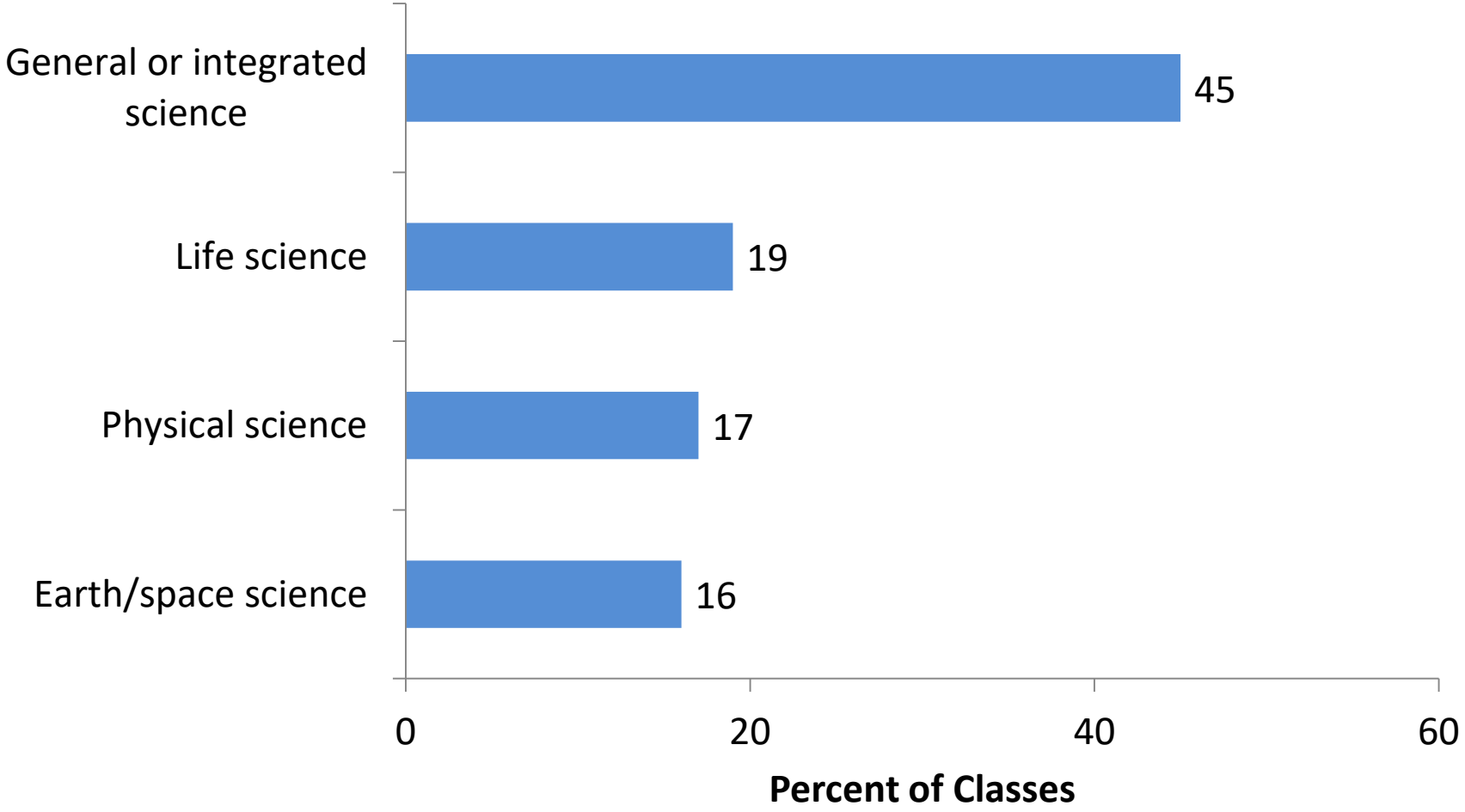


Teacher Race/Ethnicity

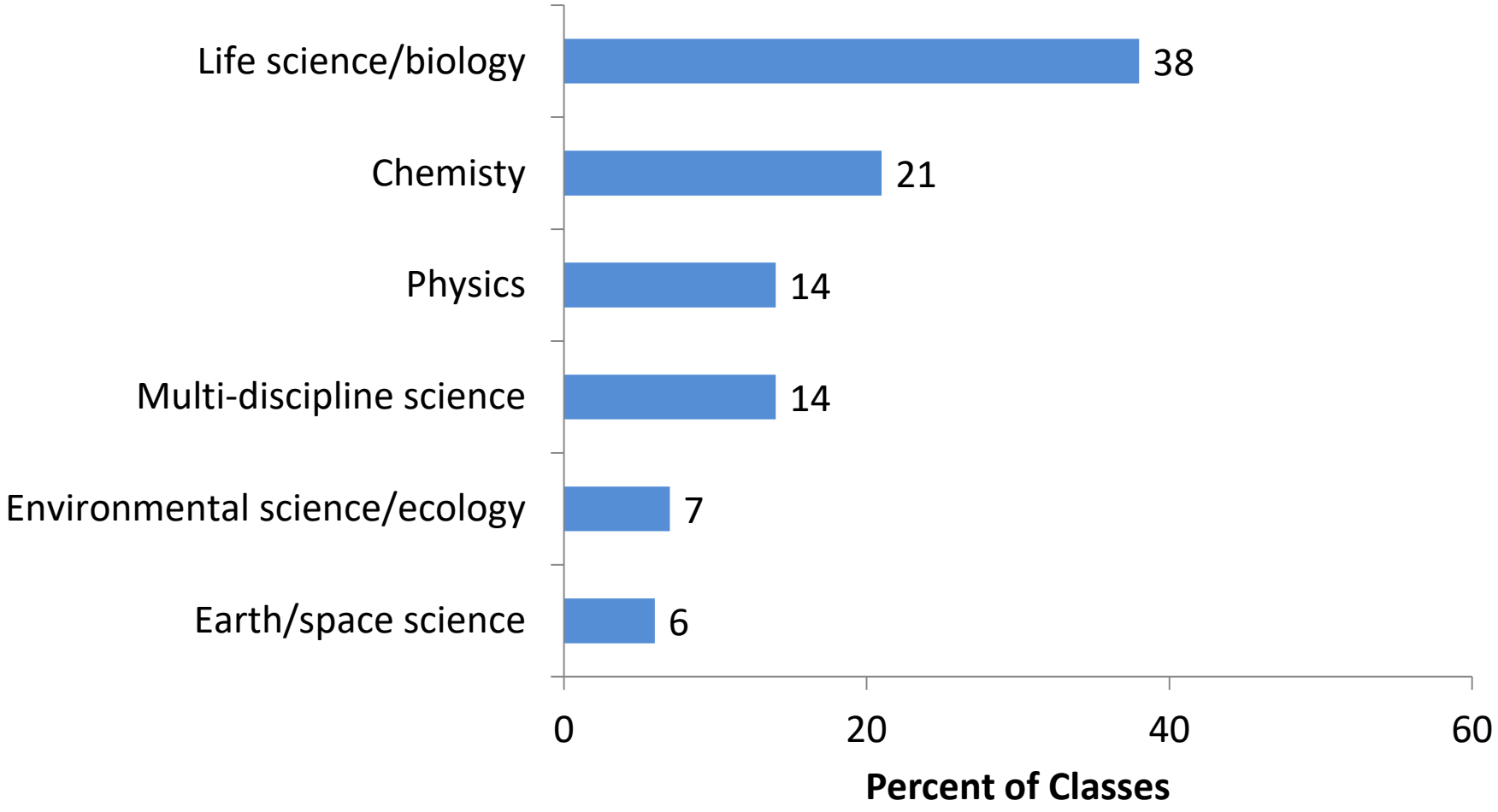


Class Independent Variables

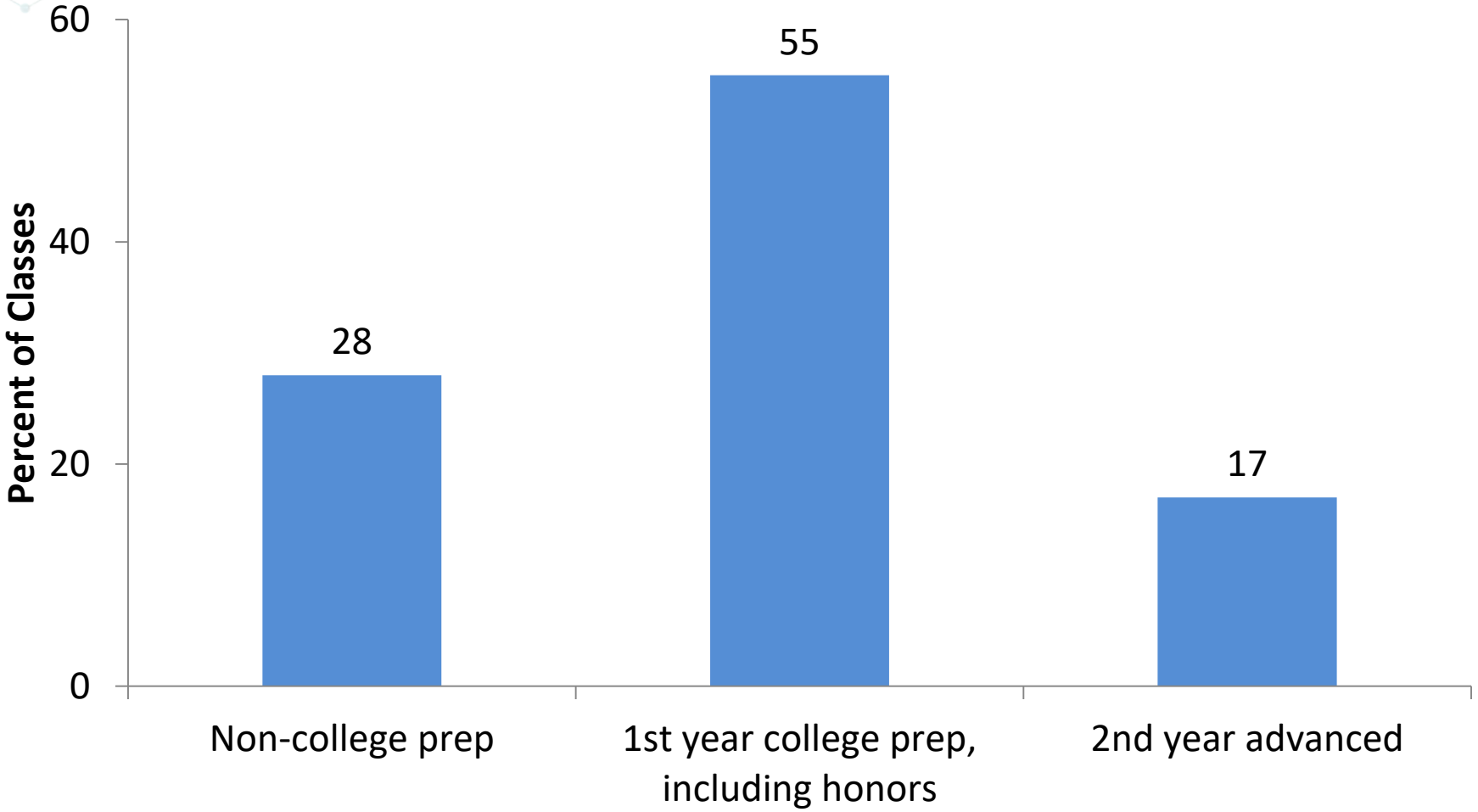
Middle School Course Types



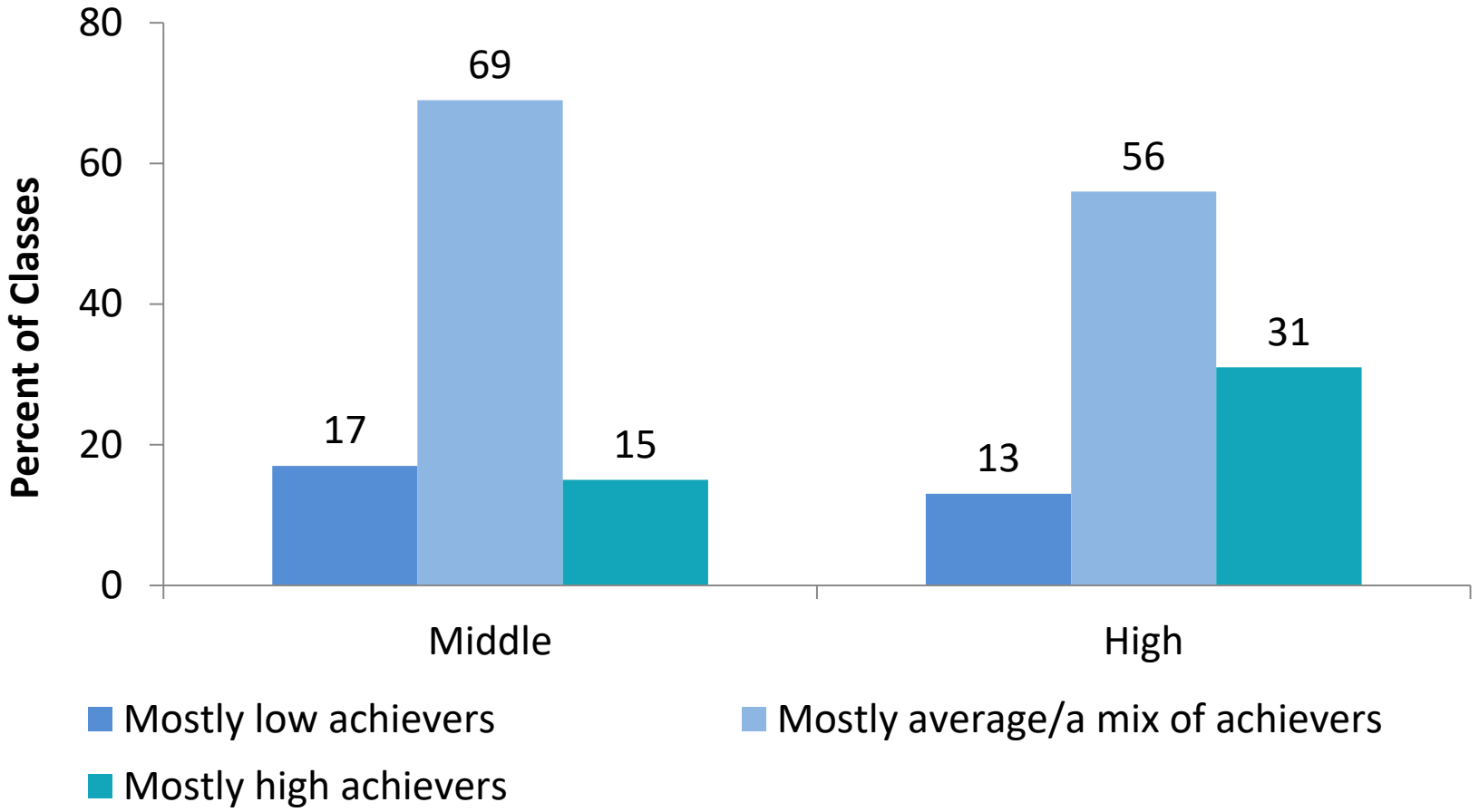
High School Course Types



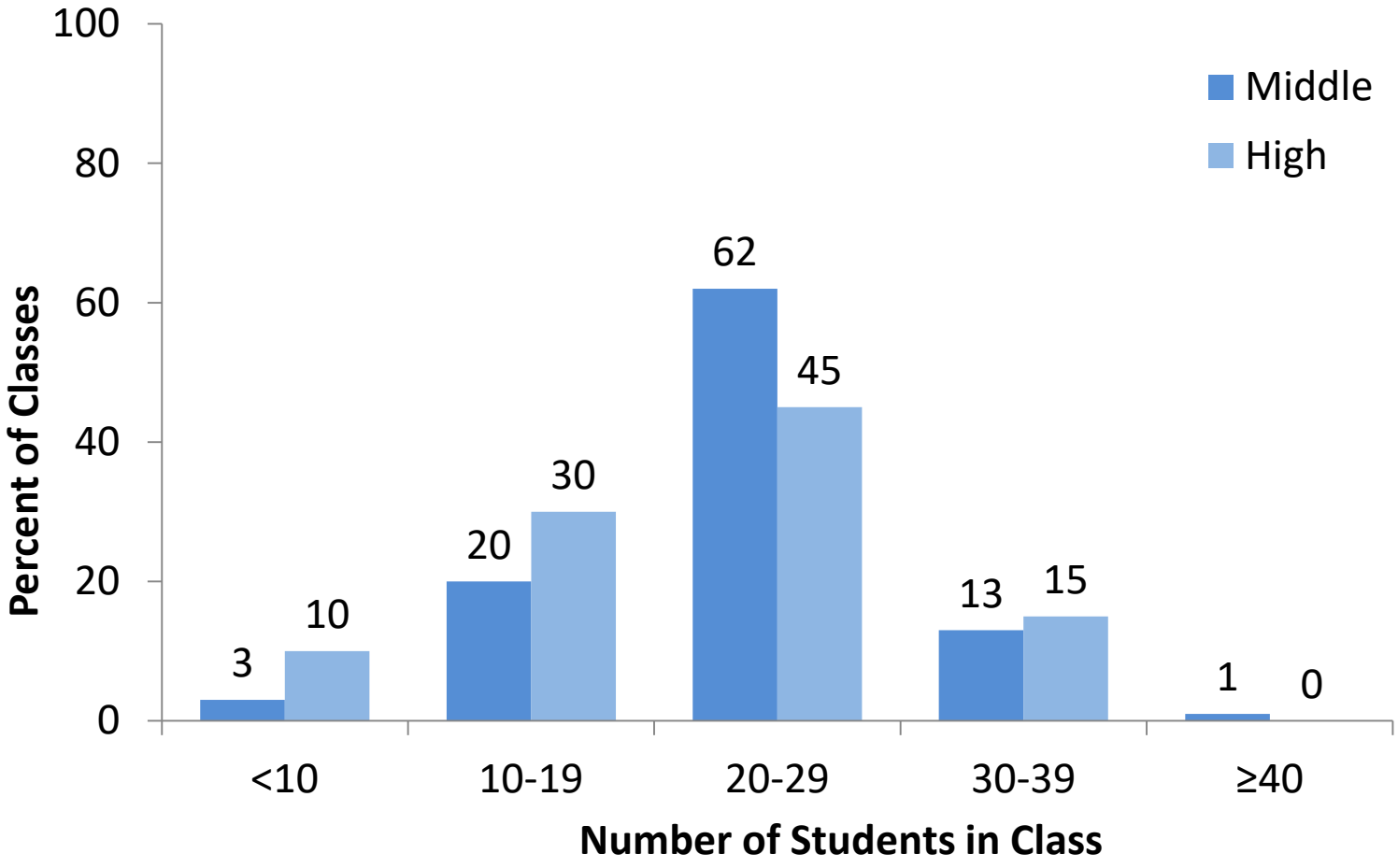
High School Course Levels



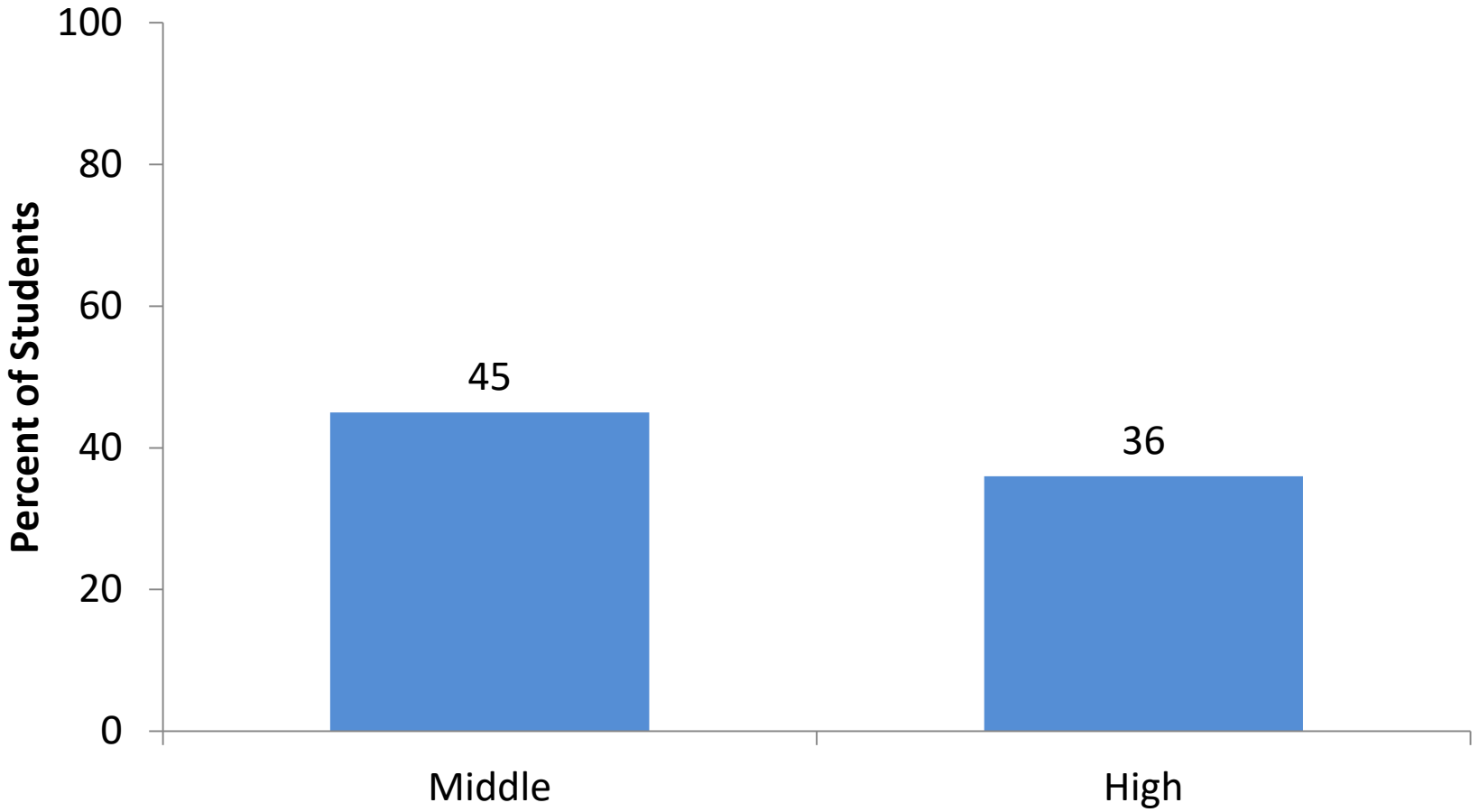
Prior Achievement Grouping in Science Classes



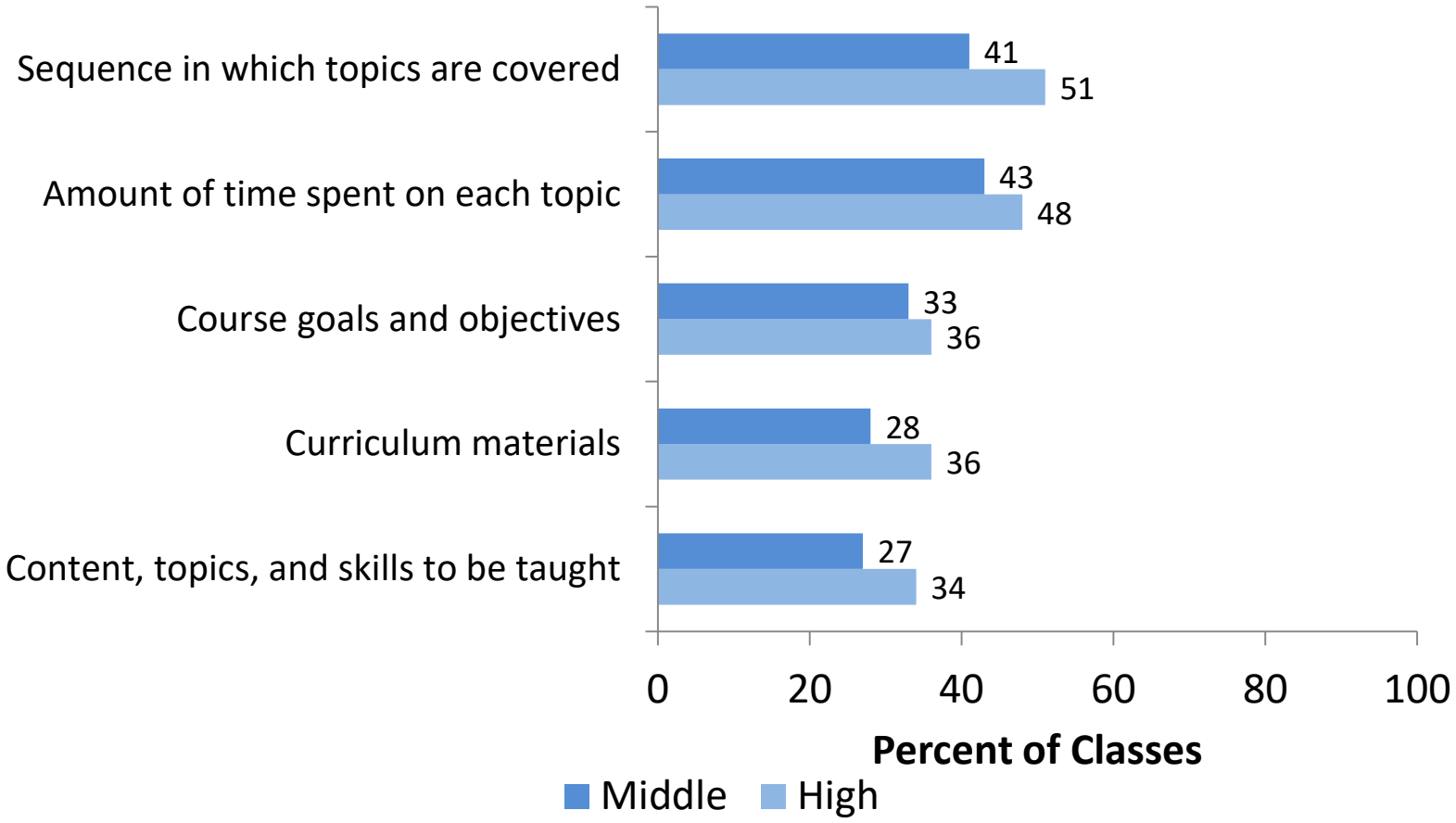
Class Size


100
80
60
40
20
0
Percent of Classes
Middle
High
3
10
20
30
62
45
13
15
1
0
<10
10-19
20-29
30-39
≥40
Number of Students in Class

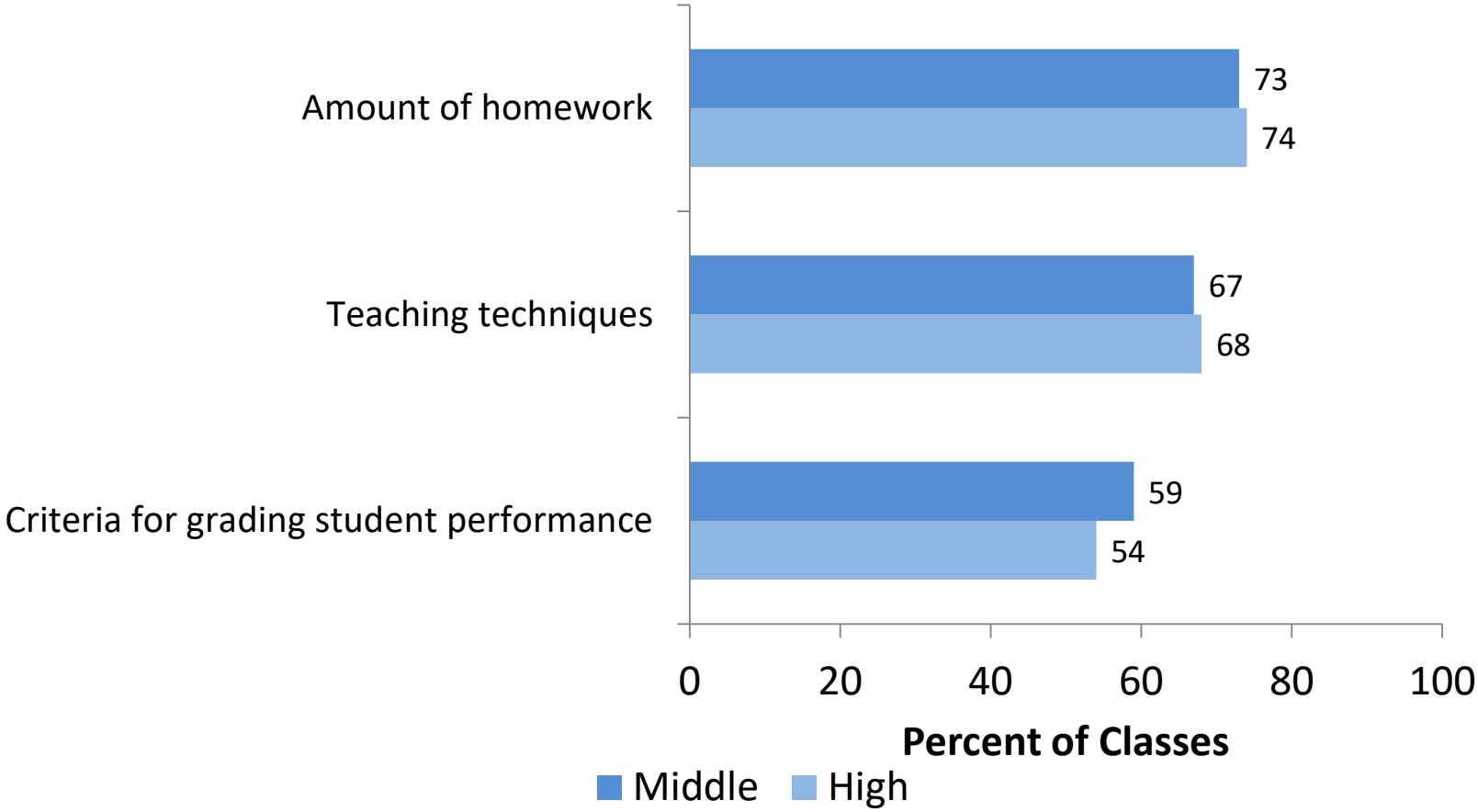
Average Percentage of Historically Underrepresented Students in Class



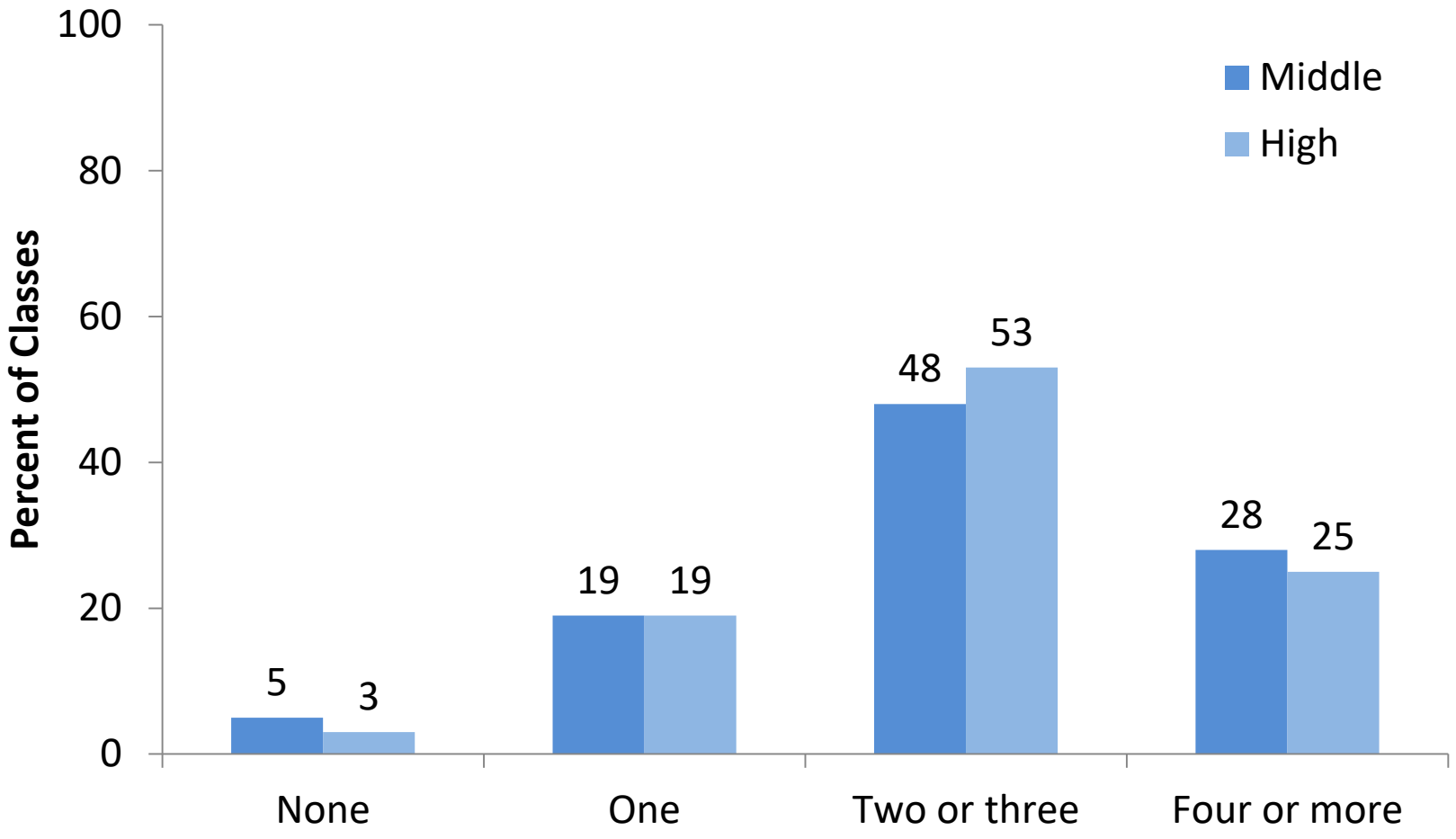
Classes in Which Teachers Feel Strong Control Over Curriculum



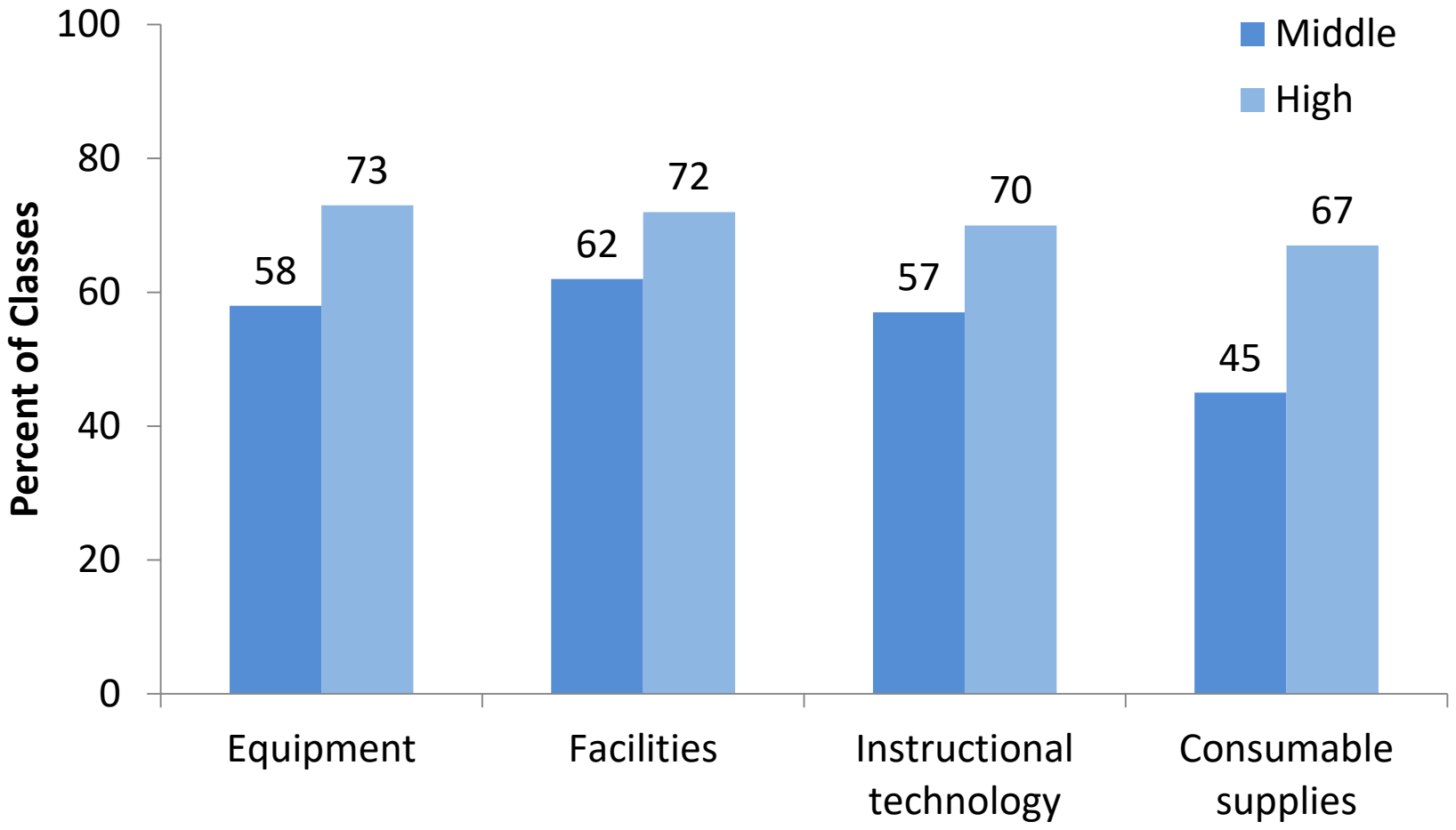
Classes in Which Teachers Feel Strong Control Over Pedagogy



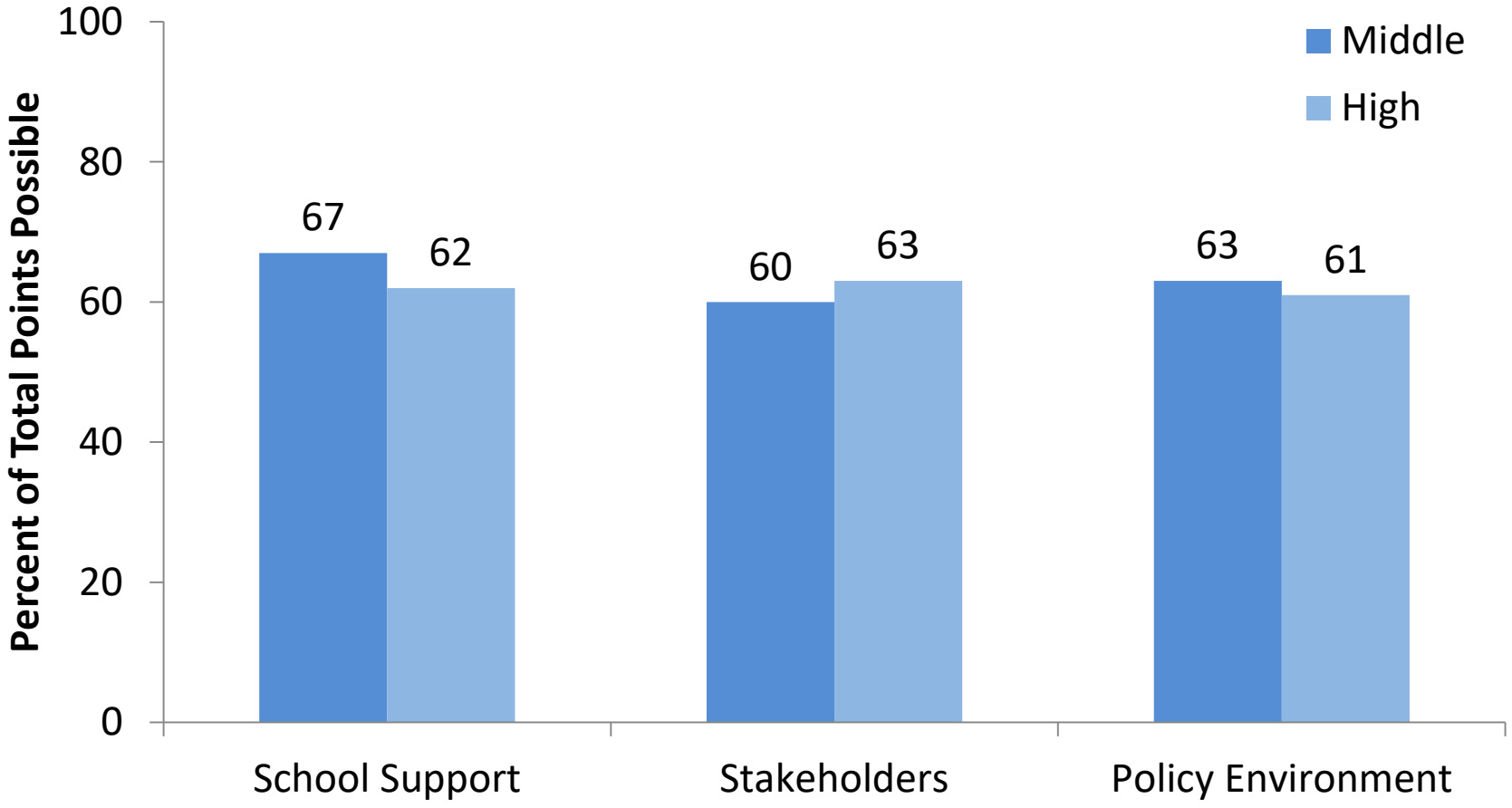
Number of Types of Instructional Materials Used Often



Classes in Which Teachers Feel Various Resources are Adequate

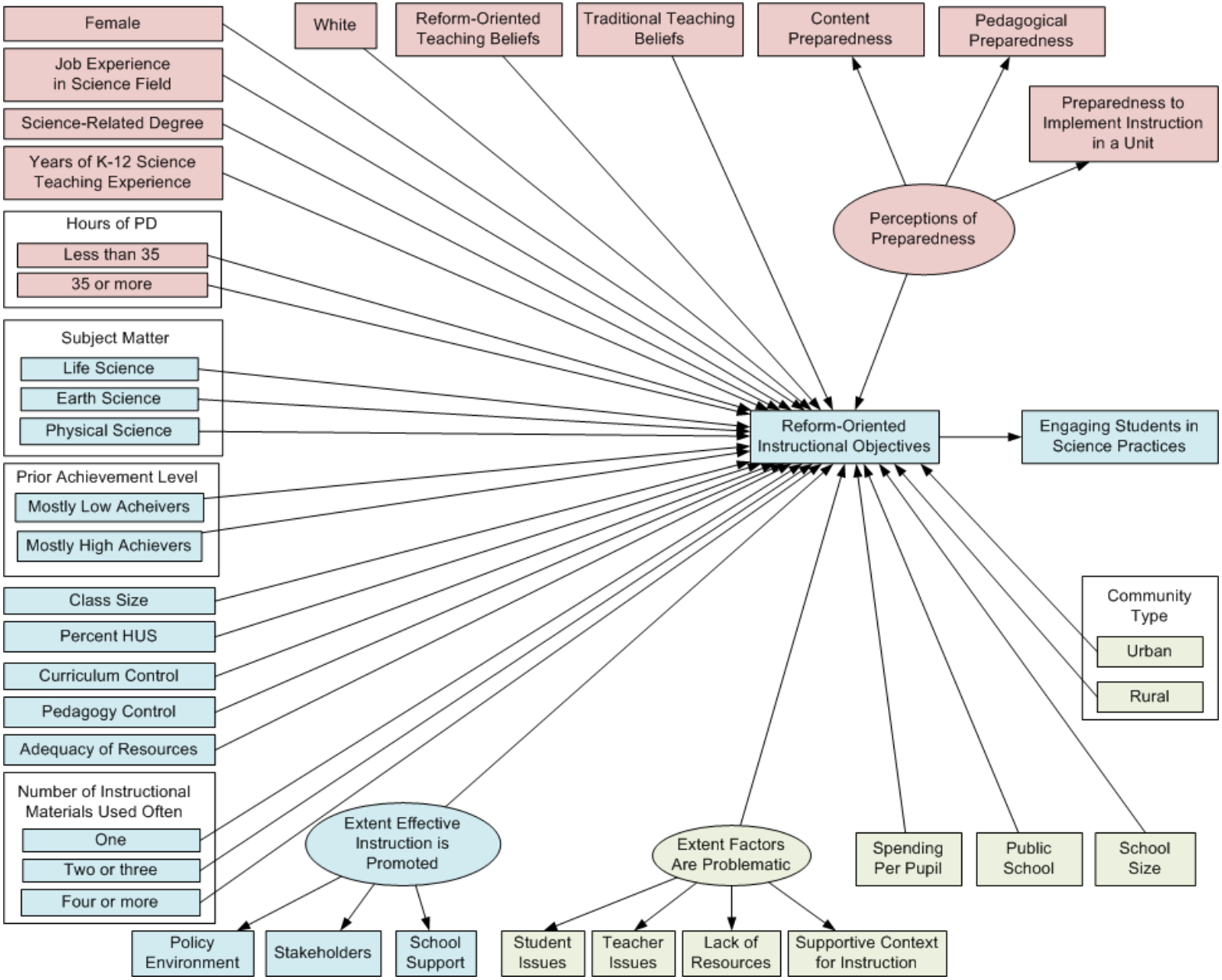


Class Mean Scores for Factors Promoting Effective Instruction Composites

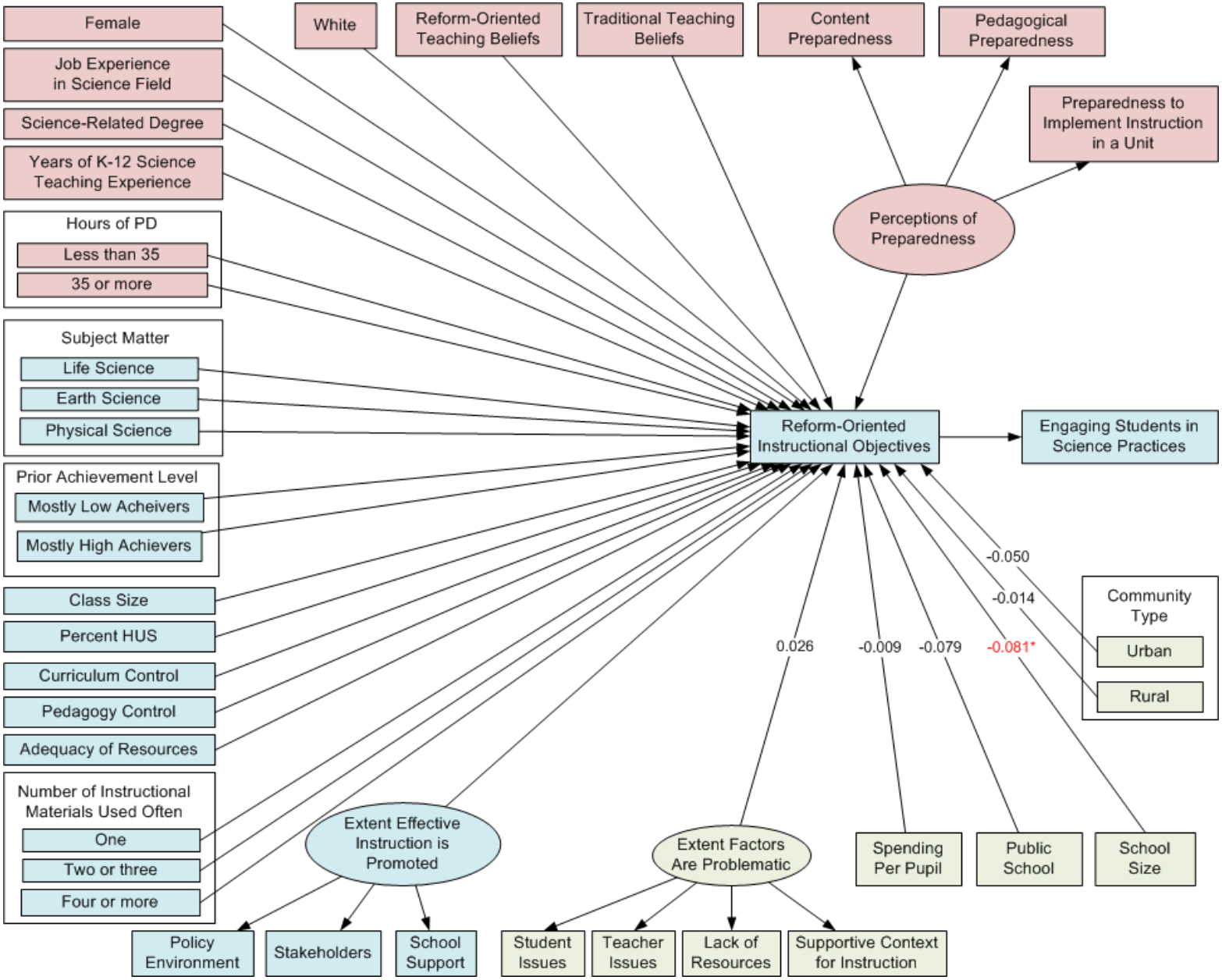


Middle School Path Model

MIDDLE


Female
Job Experience in Science Field
Science-Related Degree
Years of K-12 Science Teaching Experience
Hours of PD
Less than 35
35 or more
Subject Matter
Life Science
Earth Science
Physical Science
Prior Achievement Level
Mostly Low Acheivers
Mostly High Achievers
Class Size
Percent HUS
Curriculum Control
Pedagogy Control
Adequacy of Resources
Number of Instructional Materials Used Often
One
Two or three
Four or more
White
Reform-Oriented Teaching Beliefs
Traditional Teaching Beliefs
Content Preparedness
Pedagogical Preparedness
Preparedness to Implement Instruction in a Unit
Perceptions of Preparedness
Reform-Oriented Instructional Objectives
Engaging Students in Science Practices
Community Type
Urban
Rural
Extent Effective Instruction is Promoted
Extent Factors Are Problematic
Spending Per Pupil
Public School
School Size
Policy Environment
Stakeholders
School Support
Student Issues
Teacher Issues
Lack of Resources
Supportive Context for Instruction

MIDDLE


Female
Job Experience in Science Field
Science-Related Degree
Years of K-12 Science Teaching Experience
Hours of PD
Less than 35
35 or more
Subject Matter
Life Science
Earth Science
Physical Science
Prior Achievement Level
Mostly Low Acheivers
Mostly High Achievers
Class Size
Percent HUS
Curriculum Control
Pedagogy Control
Adequacy of Resources
Number of Instructional Materials Used Often
One
Two or three
Four or more
White
Reform-Oriented Teaching Beliefs
Traditional Teaching Beliefs
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Pedagogical Preparedness
Preparedness to Implement Instruction in a Unit
Perceptions of Preparedness
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-0.050
-0.014
0.026
-0.009
-0.079
-0.081*
Community Type
Urban
Rural
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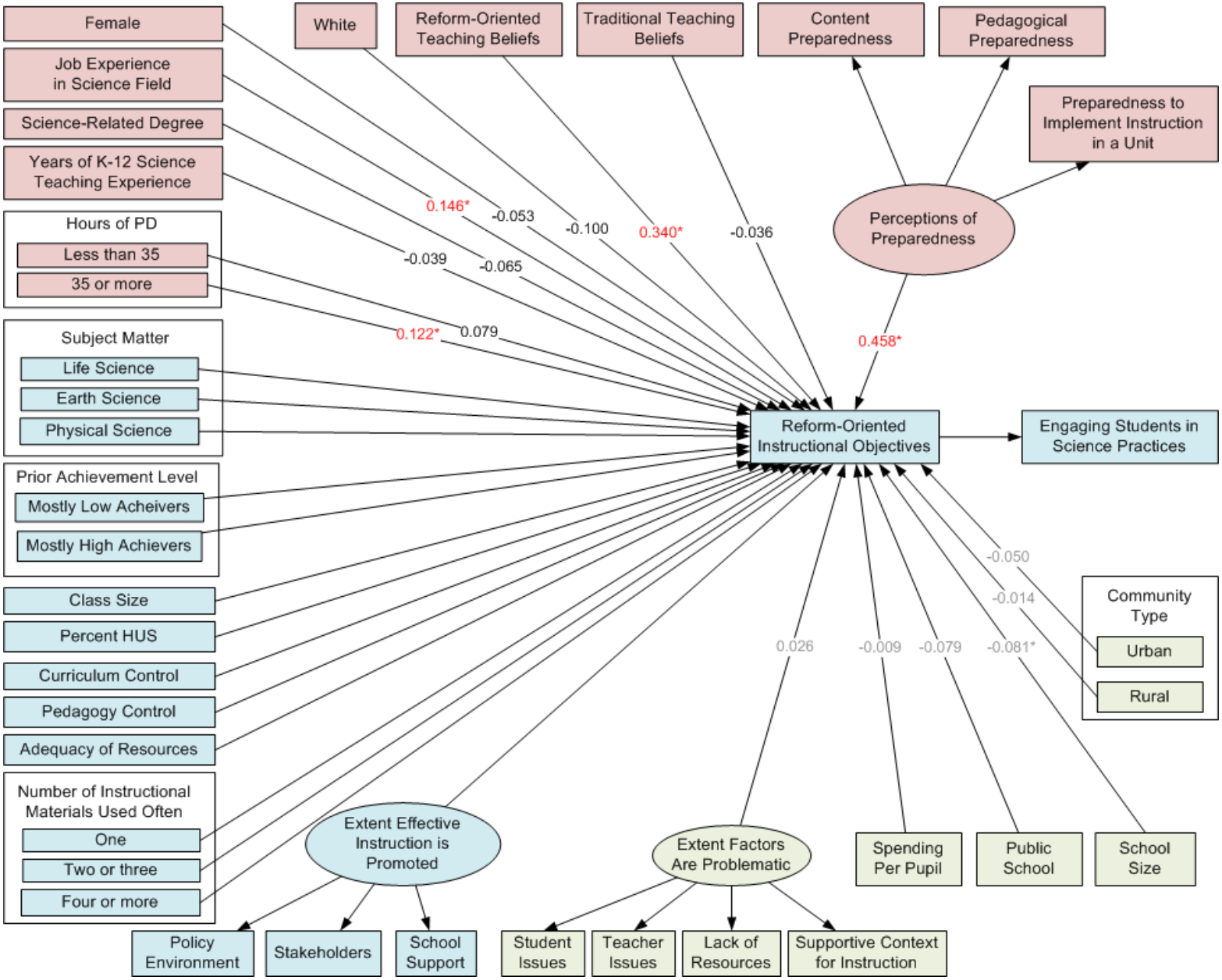
Public School
School Size
Policy Environment
Stakeholders
School Support
Student Issues
Teacher Issues
Lack of Resources
Supportive Context for Instruction

MIDDLE


Female
Job Experience in Science Field
Science-Related Degree
Years of K-12 Science Teaching Experience
Hours of PD
Less than 35
35 or more
Subject Matter
Life Science
Earth Science
Physical Science
Prior Achievement Level
Mostly Low Acheivers
Mostly High Achievers
Class Size
Percent HUS
Curriculum Control
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Adequacy of Resources
Number of Instructional Materials Used Often
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Two or three
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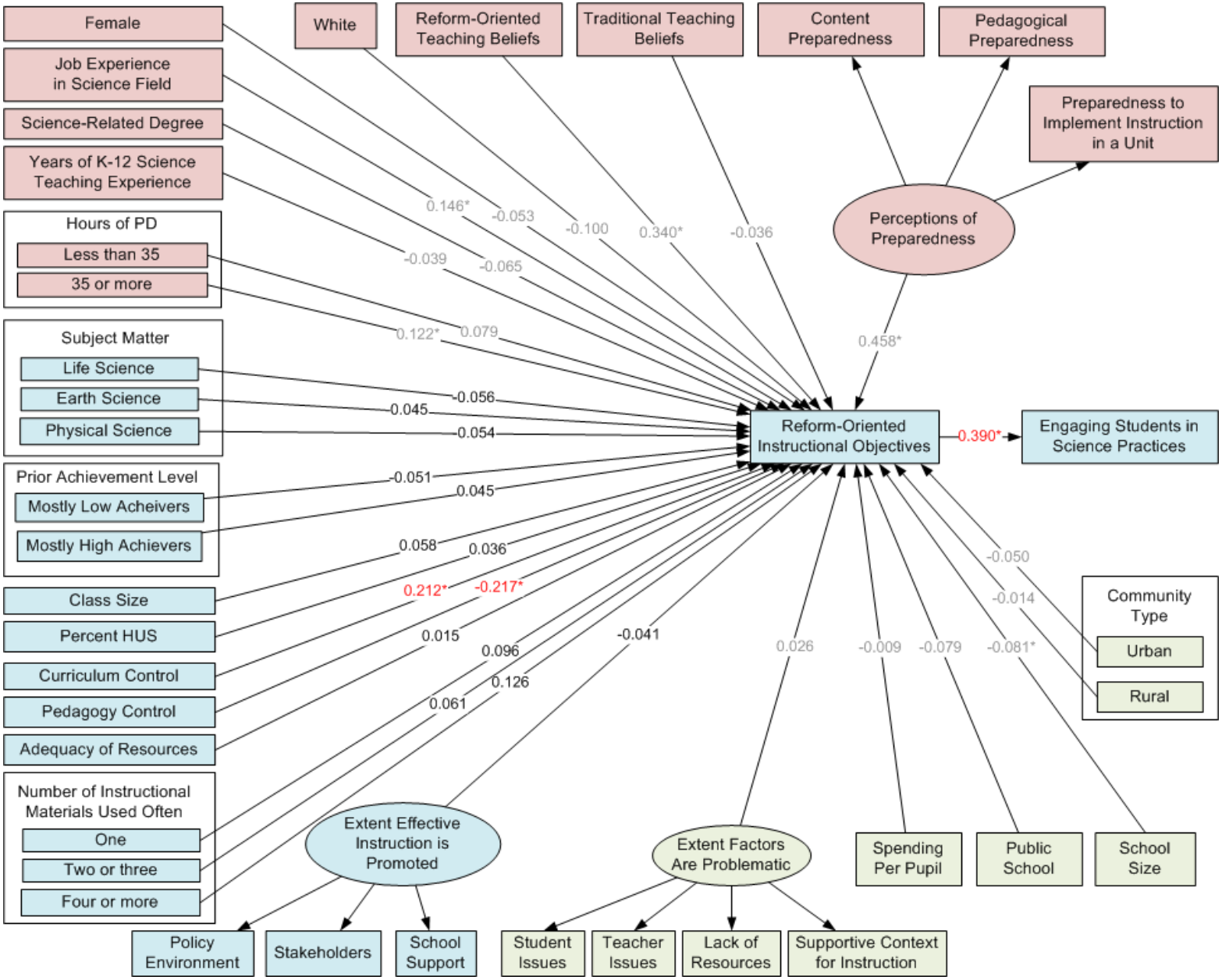
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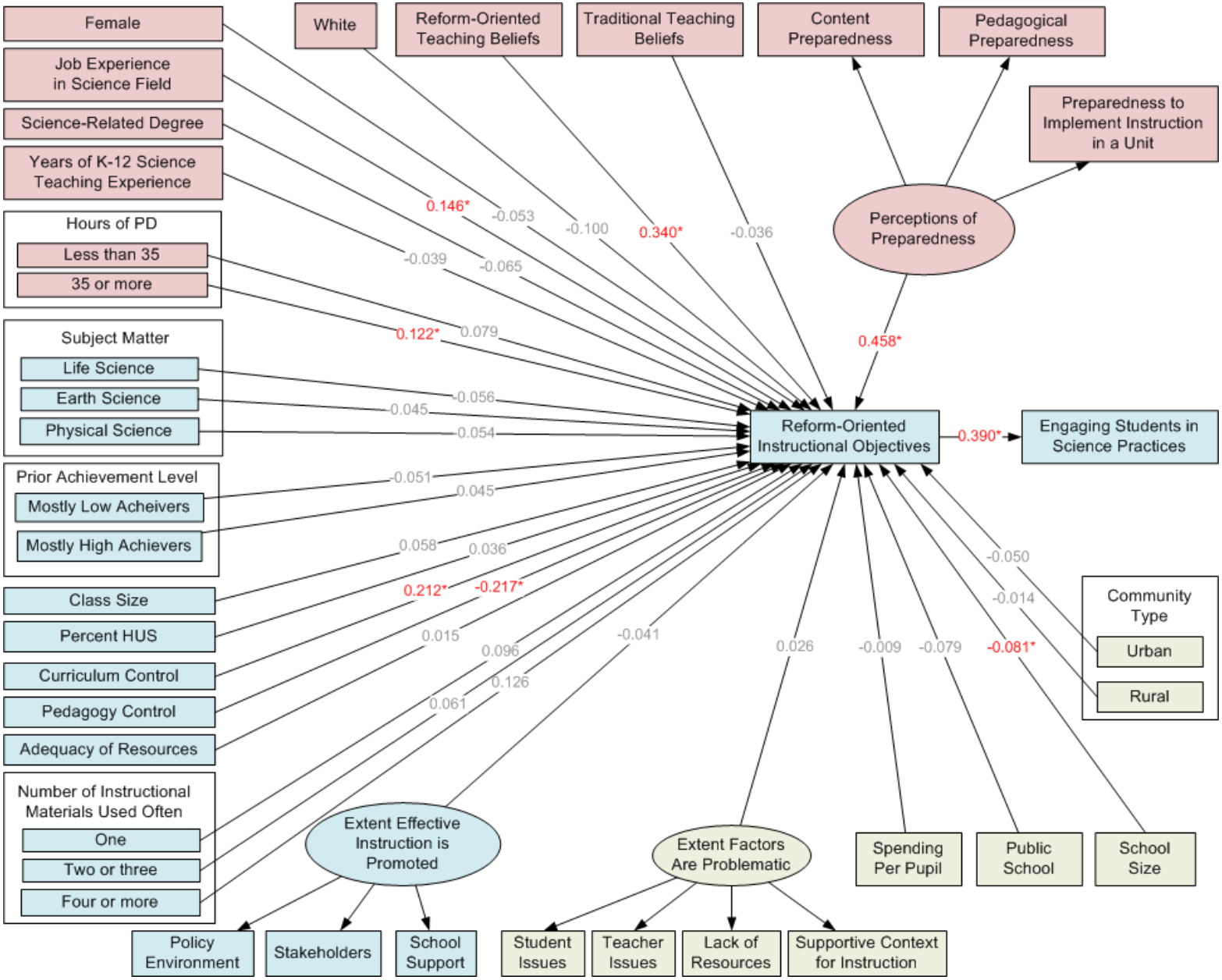
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High School Path Model

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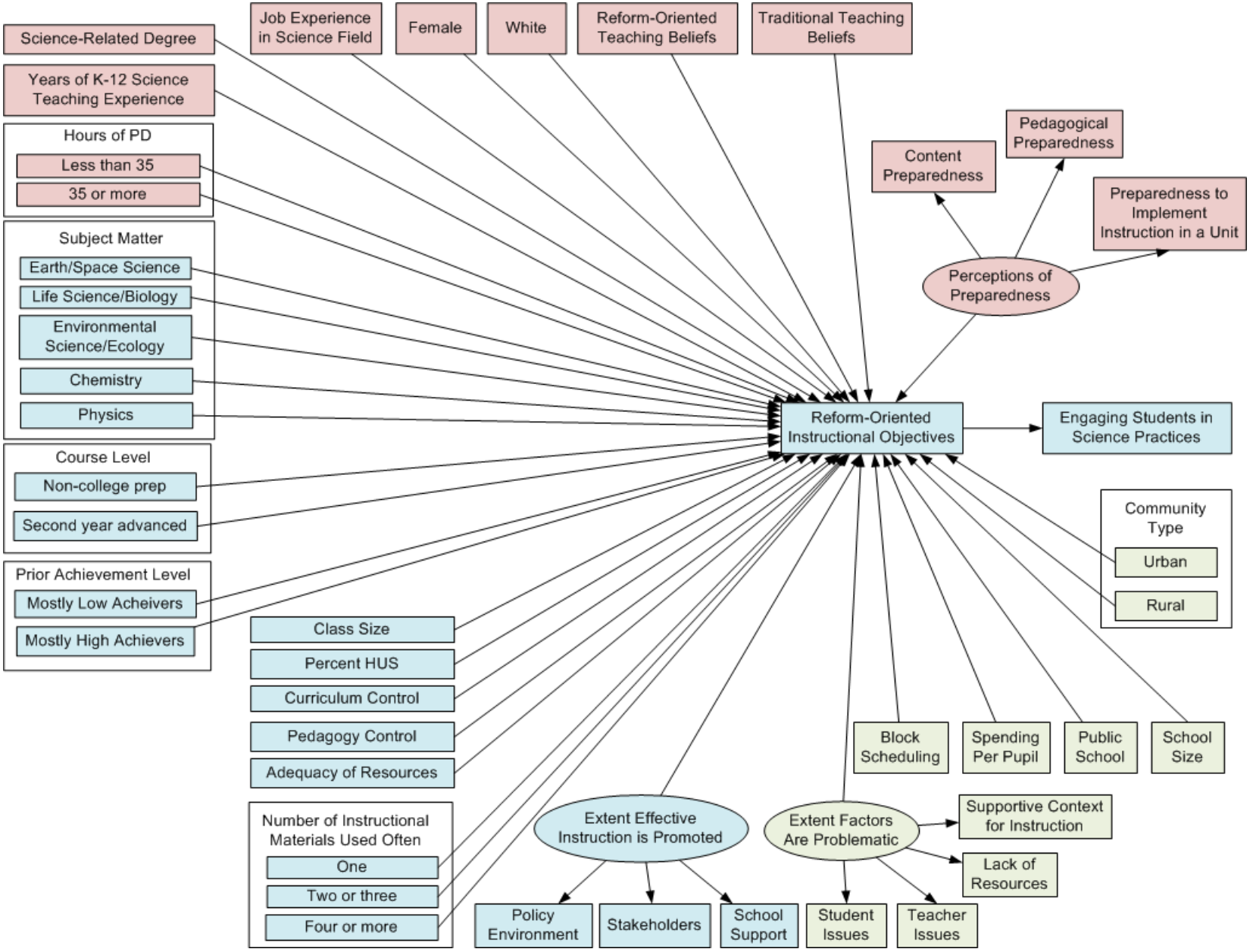
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35 or more
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Life Science/Biology
Environmental Science/Ecology
Chemistry
Physics
Course Level
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Second year advanced
Prior Achievement Level
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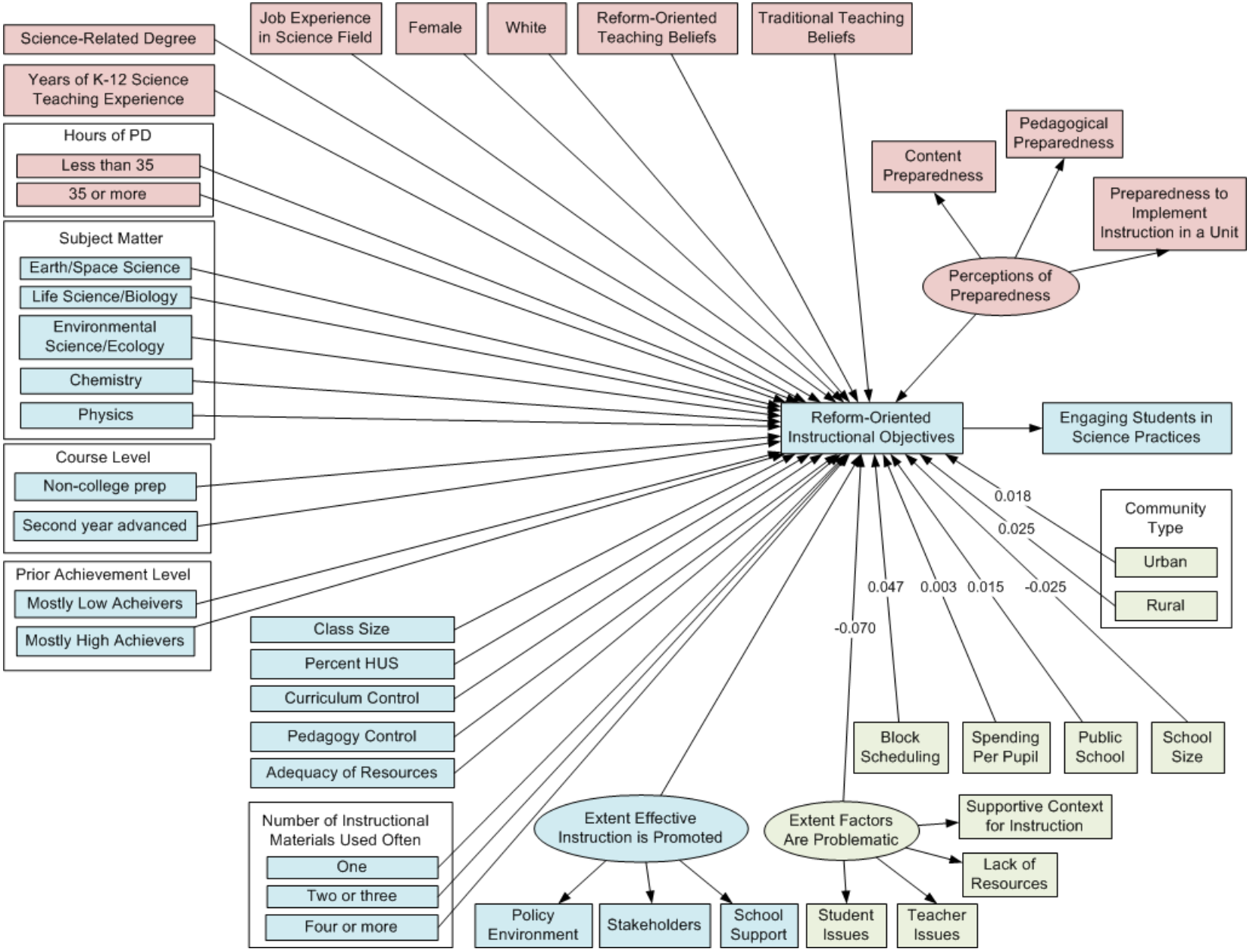
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Class Size
Percent HUS
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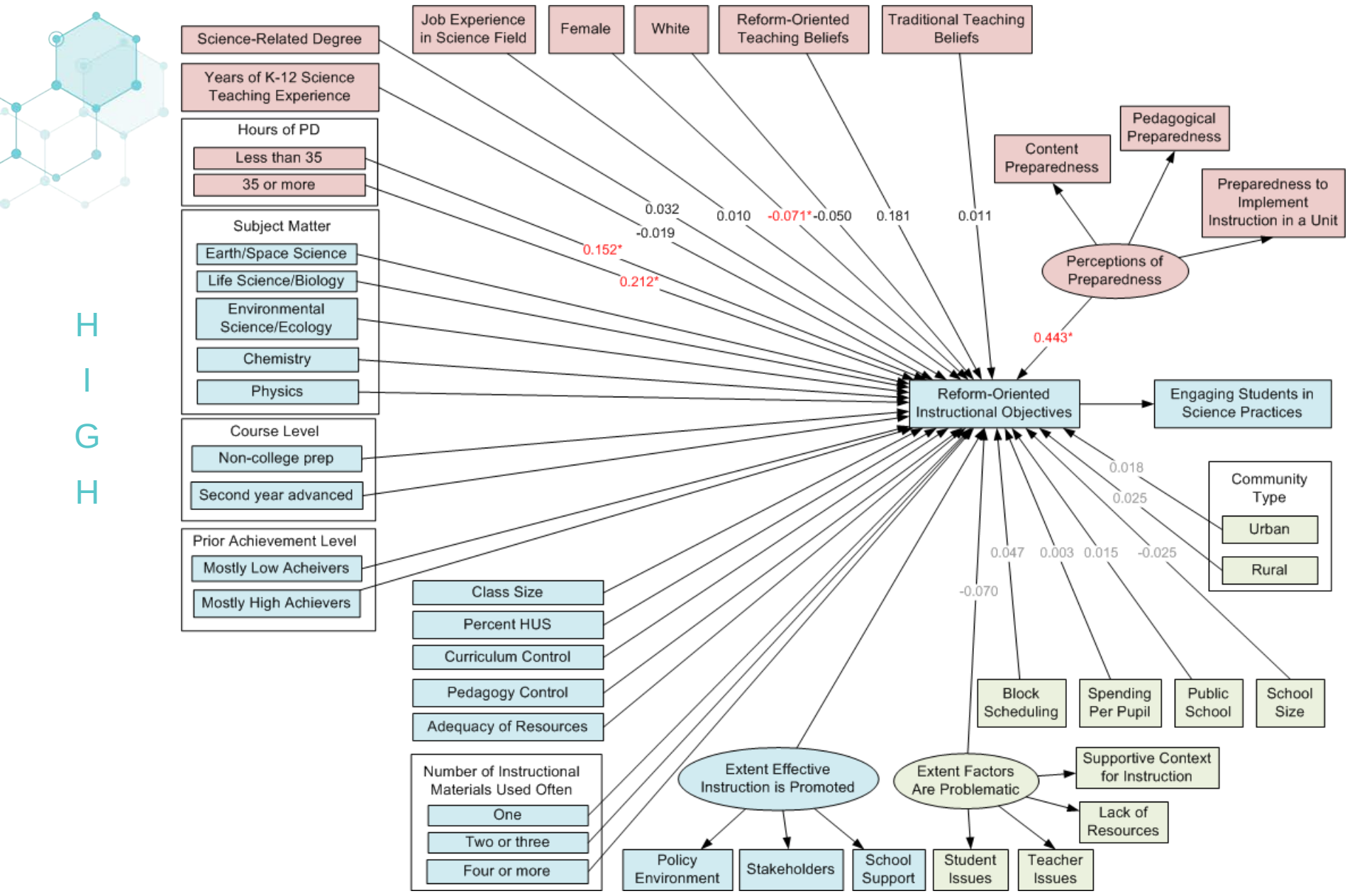
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Perceptions of Preparedness
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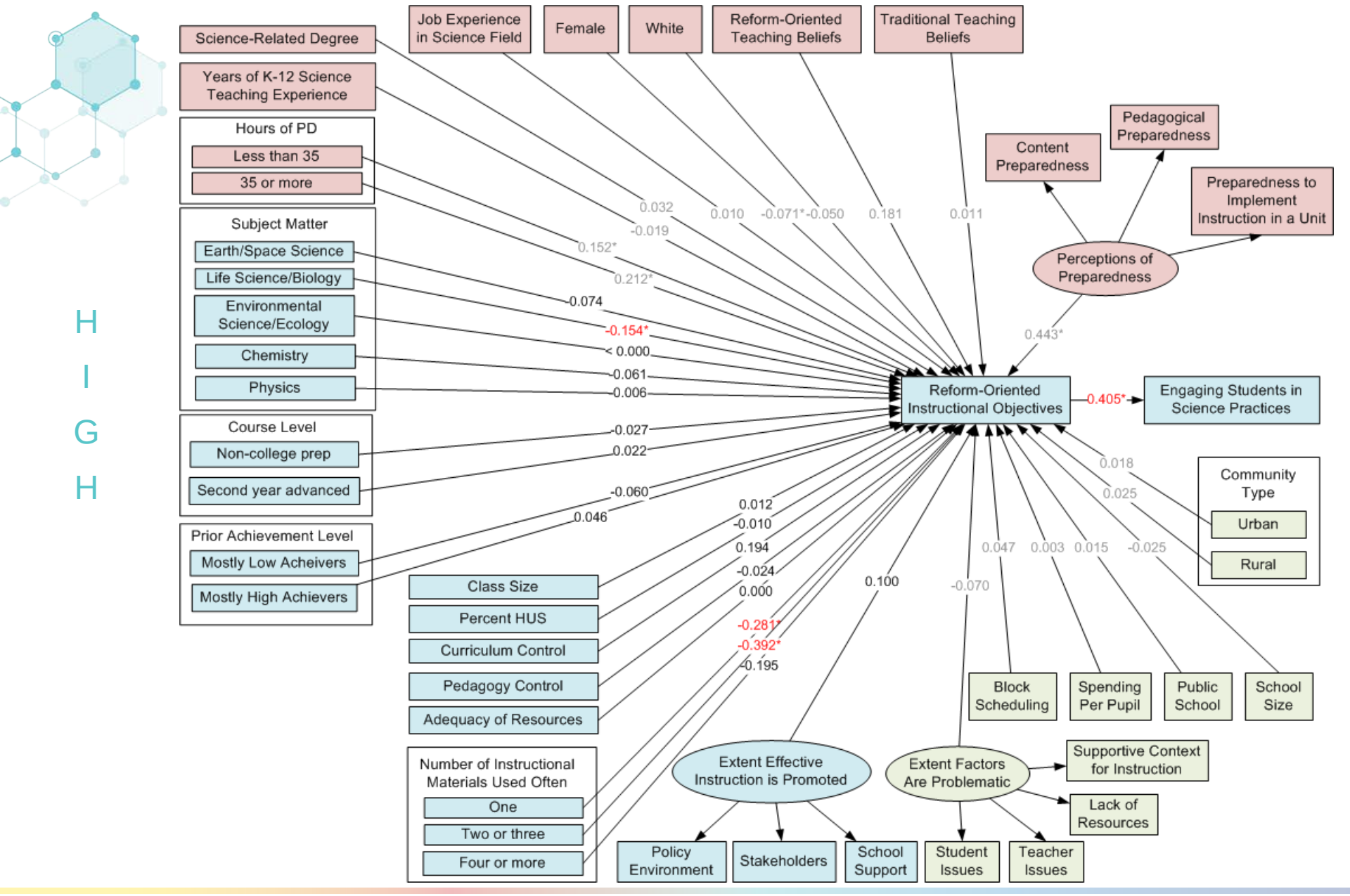
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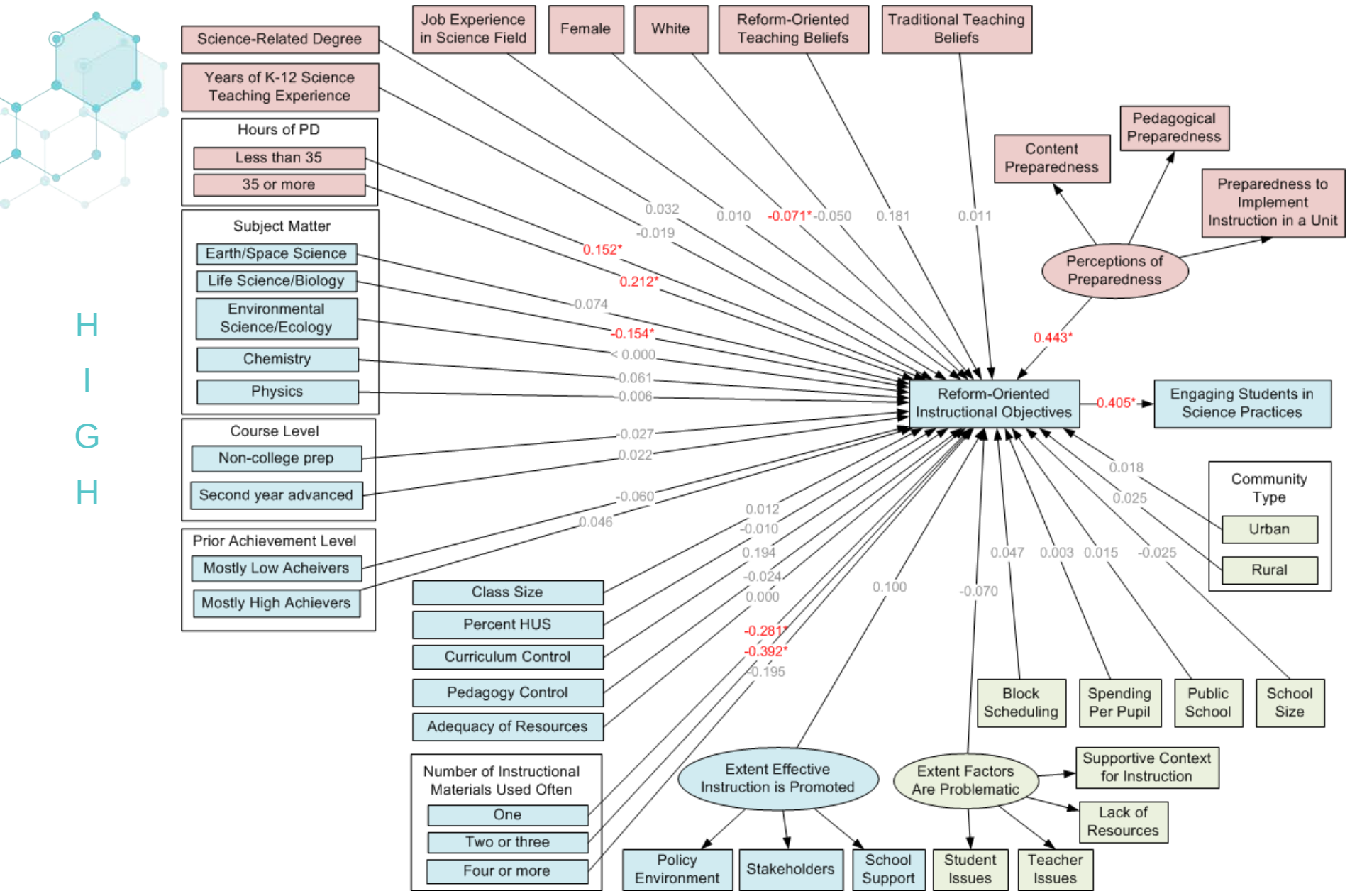
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Total Effects on Student Engagement in Science Practices

	Middle	High
Perceptions of Preparedness	0.370	0.341
Reform-Oriented Teaching Beliefs	0.129	0.188
Amount of Science PD in Previous 3 Years		
Less than 35 hours	---	0.157
35 or more hours	---	0.184
Reform-Oriented Instructional Objectives	0.390	0.405
Curriculum Control	---	0.180
Pedagogy Control	-0.337	-0.121
Number of instructional materials used often (vs. none)		
One	0.090	-0.254
Two or three	0.101	-0.286
Four or more	0.198	-0.064
Adequacy of Resources for Instruction	-0.229	---
Extent Effective Instruction is Promoted	0.380	---