



**2012 NATIONAL SURVEY OF
SCIENCE AND MATHEMATICS EDUCATION**

HIGHLIGHTS REPORT

OCTOBER 2013

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CHAPEL HILL, NC**

Disclaimer

The *2012 National Survey of Science and Mathematics Education: Highlights Report* was prepared with support from the National Science Foundation under grant number DRL-1008228. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Suggested Citation

Horizon Research, Inc. (2013). *2012 National survey of science and mathematics education: Highlights Report*. Chapel Hill, NC: Author.

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INTRODUCTION

The 2012 National Survey of Science and Mathematics Education was designed to provide up-to-date information and to identify trends in the areas of teacher background and experience, curriculum and instruction, and the availability and use of instructional resources. A total of 7,752 science and mathematics teachers in schools across the United States participated in this survey. The research questions addressed are:

1. To what extent do science and mathematics instruction and ongoing assessment mirror current understanding of learning?
2. What influences teachers' decisions about content and pedagogy?
3. What are the characteristics of the science/mathematics teaching force in terms of race, gender, age, content background, beliefs about teaching and learning, and perceptions of preparedness?
4. What are the most commonly used textbooks/programs, and how are they used?
5. What formal and informal opportunities do science/mathematics teachers have for ongoing development of their knowledge and skills?
6. How are resources for science/mathematics education, including well-prepared teachers and course offerings, distributed among schools in different types of communities and different socioeconomic levels?

The 2012 National Survey is based on a national probability sample of schools and science and mathematics teachers in grades K–12 in the 50 states and the District of Columbia. The sample was designed to allow national estimates of science and mathematics course offerings and enrollment; teacher background preparation; textbook usage; instructional techniques; and availability and use of science and mathematics facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being drawn into the sample. Details on the survey sample design, as well as data collection and analysis procedures, are included in the *Report of the 2012 National Survey of Science and Mathematics Education*.¹

The purpose of this report is to highlight some of the major findings from the 2012 National Survey. These findings are generally presented by subject (science or mathematics) and/or grade range (elementary, middle, and high), and are based on data from individual questionnaire items

¹ Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn, K. A., Campbell, K. M., & Weis, A. M. (2013). *Report of the 2012 national survey of science and mathematics education*. Chapel Hill, NC: Horizon Research, Inc. Online: <http://www.horizon-research.com/2012nssme/research-products/reports/technical-report/>

and composite variables.² Survey data are also reported according to five factors historically associated with differences in students' educational opportunities:

- ***Prior achievement level of the class***—based on teacher-provided information, classes were coded into 1 of 3 categories: mostly low achievers, mostly average achievers/a mixture of levels, or mostly high achievers.
- ***Percent of students historically underrepresented in STEM³ in the class***—classes were assigned to quartiles based on the percentage of historically underrepresented students enrolled.
- ***Percent of students in the school eligible for free/reduced-price lunch (FRL)***—each school was classified into 1 of 4 categories based on the proportion of students eligible for FRL. Defining common categories across grades K–12 would have been misleading, because students tend to select out of the FRL program as they advance in grade due to perceived social stigma. Therefore, the categories were defined as quartiles within groups of schools serving the same grades (e.g., schools with grades K–5, schools with grades 6–8).
- ***School size***—schools were classified into 1 of 4 categories based on the number of students served in the school. Like FRL, the categories were defined as quartiles within groups of schools serving the same grades (e.g., schools with grades K–5, schools with grades 6–8).
- ***Community type***—each sample school was classified as belonging to 1 of 3 types of communities: Urban (central city); Suburban (area surrounding a central city, but still located within the counties constituting a Metropolitan Statistical Area); or Rural (area outside any Metropolitan Statistical Area).

This report is organized into six major topical areas: (1) Teacher Background and Beliefs; (2) Science and Mathematics Professional Development; (3) Science and Mathematics Courses; (4) Instructional Decision Making, Objectives, and Activities; (5) Instructional Resources; and (6) Factors Affecting Instruction.

² To facilitate the reporting of large amounts of survey data, and because individual questionnaire items are potentially unreliable, factor analysis was used to identify survey questions that could be combined into “composites.” Composite variables, which are more reliable than individual survey items, were computed to have a minimum possible value of 0 and a maximum possible value of 100. Each composite represents an important construct related to science or mathematics education.

³ Includes students identifying themselves as American Indian or Alaskan Native, Black, Hispanic or Latino, or Native Hawaiian or Other Pacific Islander.

FINDINGS

Teacher Background and Beliefs

Teachers' Backgrounds

If teachers are to help students learn science and mathematics content, they must themselves have a firm understanding of the important ideas in the discipline. Because direct measures of teachers' content knowledge were not feasible in this study, a number of proxy measures were used, including teachers' degrees and course-taking patterns. As can be seen in Figure 1, 82 percent of high school science teachers have a degree in science, engineering, or science education, compared to 41 percent of middle grades science teachers and just 5 percent of elementary school teachers. A similar pattern is evident for mathematics teachers (see Figure 2).

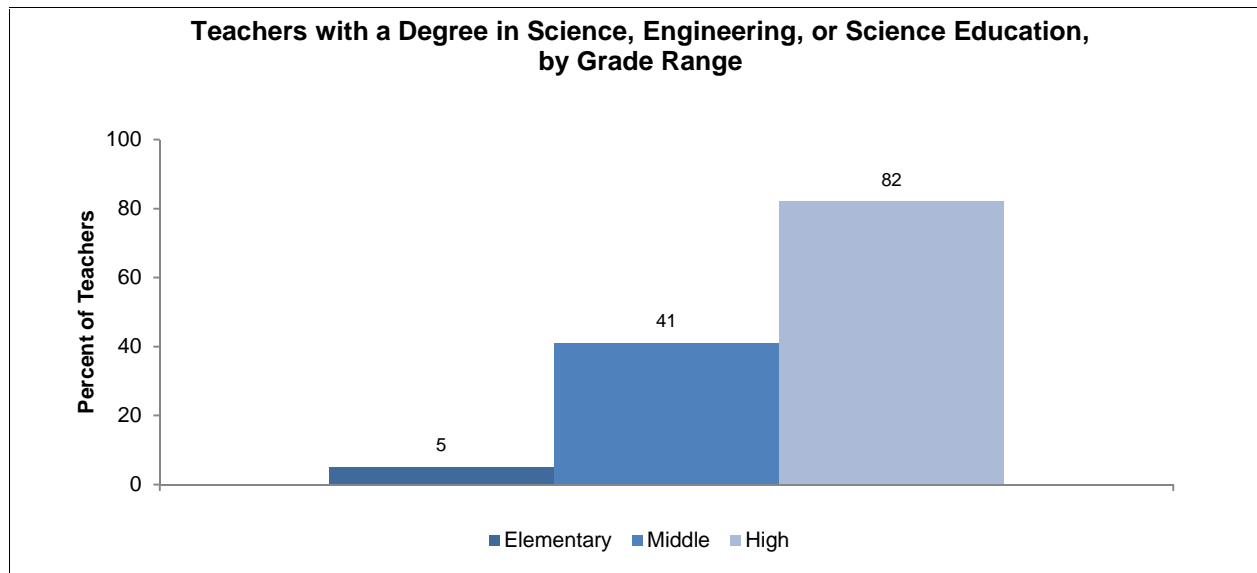


Figure 1

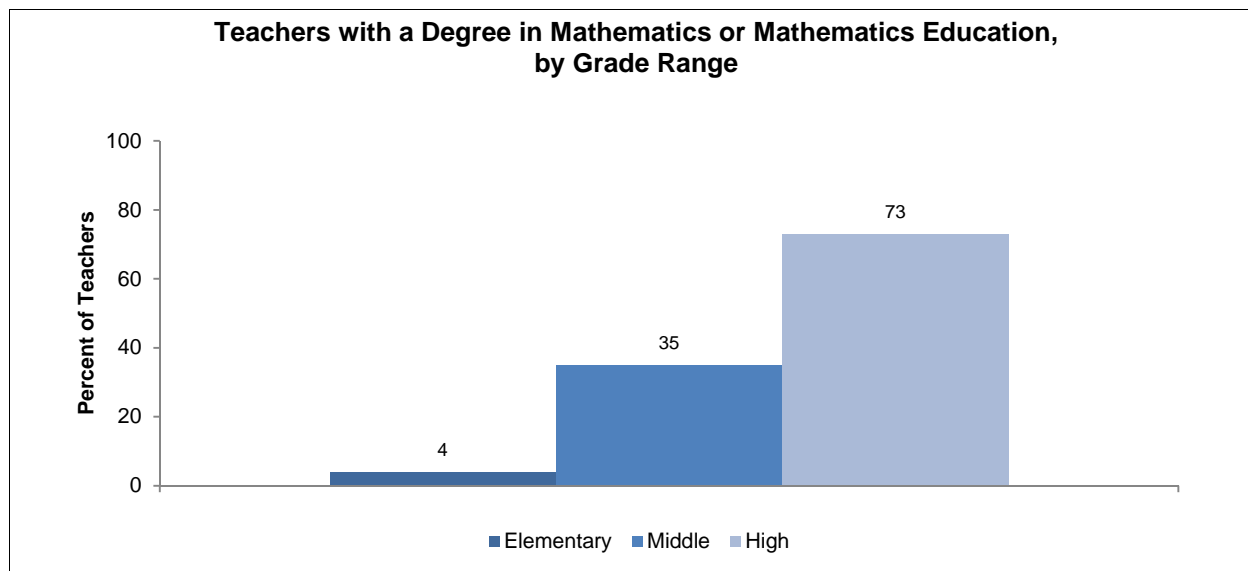


Figure 2

The National Science Teachers Association (NSTA) has recommended that elementary science teachers be prepared to teach life science, physical science, and Earth science. However, only about one-third of elementary science teachers have at least one college course in each of these areas. For middle grades teachers, NSTA suggests coursework in both chemistry and physics, as well as in the life and Earth sciences. Yet, fewer than half of middle grades teachers who teach general/integrated science have at least one course in each of these areas.

At the high school level, biology teachers tend to have particularly strong content backgrounds. Ninety percent have either a degree or at least three advanced courses in their discipline, compared to 68 percent of chemistry teachers and 56 percent of physics teachers (see Figure 3).

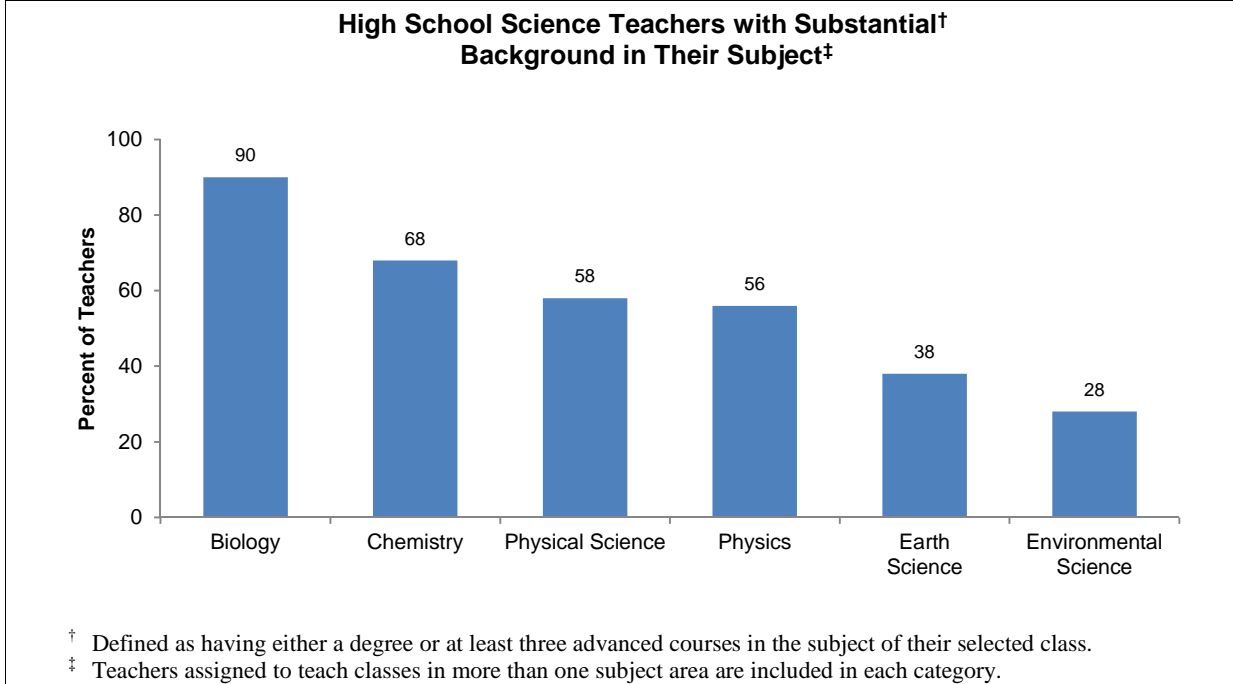


Figure 3

In mathematics, the National Council of Teachers of Mathematics (NCTM) has recommended that elementary teachers take college coursework in a number of different areas, including number and operations, algebra, geometry, probability, and statistics. However, only 10 percent of elementary mathematics teachers have had courses in each of these five areas.

At the secondary level, the majority of high school teachers have coursework in a number of areas, including calculus, linear algebra, and statistics. Substantially fewer middle grades teachers have had coursework in these same areas (see Figure 4).

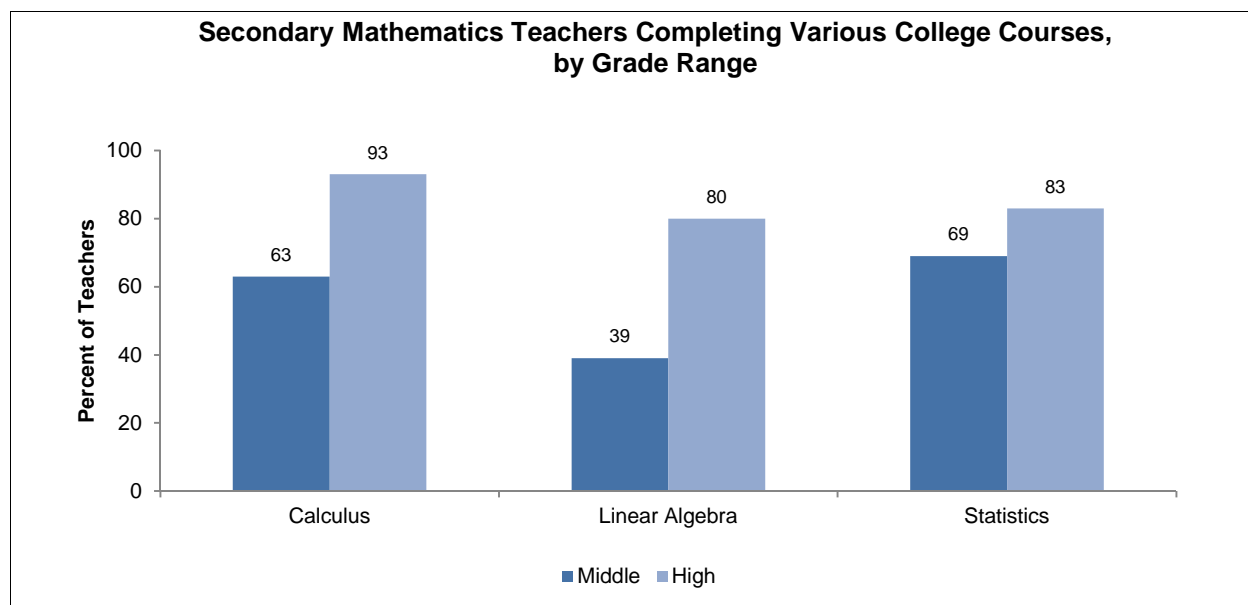


Figure 4

Teachers' Pedagogical Beliefs

When asked about their beliefs regarding teaching and learning in science, more than 85 percent of teachers in each grade range agree with elements of effective science instruction derived from cognitive research. These include:

- Students should be provided with the purpose for a lesson as it begins;
- Most class periods should include review of previously covered material;
- Most class periods should provide students opportunities to share their thinking/reasoning; and
- Most class periods should conclude with a summary of the key ideas addressed in that lesson.

However, roughly 40 percent of science teachers at each grade level agree that teachers should explain an idea to students before having them consider evidence for that idea, and more than half indicate that laboratory activities should be used primarily to reinforce ideas that the students have already learned. Furthermore, despite recommendations that students develop understanding of concepts first and learn the scientific language later, over 70 percent of science teachers indicate that students should be given definitions for new vocabulary at the beginning of instruction on a science idea.

Mathematics teachers' beliefs about effective instruction are also mixed. At least 85 percent of teachers in each grade range agree that students should be provided with the purpose for a lesson as it begins, and that most class periods should:

- Include review;
- Provide students opportunities to share their thinking and reasoning; and
- Conclude with a summary of the key ideas addressed.

However, fewer than half believe that teachers should explain ideas to students before they investigate those ideas. From 39 to 52 percent, depending on grade range, agree that hands-on activities/manipulatives should be used primarily to reinforce ideas the students have already learned, despite recommendations that these be used to help students develop their initial understanding of key concepts. Even larger proportions of mathematics teachers, from 81 percent at the high school level to 90 percent at the elementary level, believe that students should be given definitions of new vocabulary at the beginning of instruction on a mathematical idea.

Teachers’ Perceptions of Preparedness

Elementary teachers are typically assigned to teach multiple subjects to a single group of students. However, these teachers do not feel equally well prepared to teach the various subjects.

Although 77 percent of elementary teachers of self-contained classes feel very well prepared to teach mathematics—slightly lower than the 81 percent for reading/language arts—only 39 percent feel very well prepared to teach science (see Figure 5).

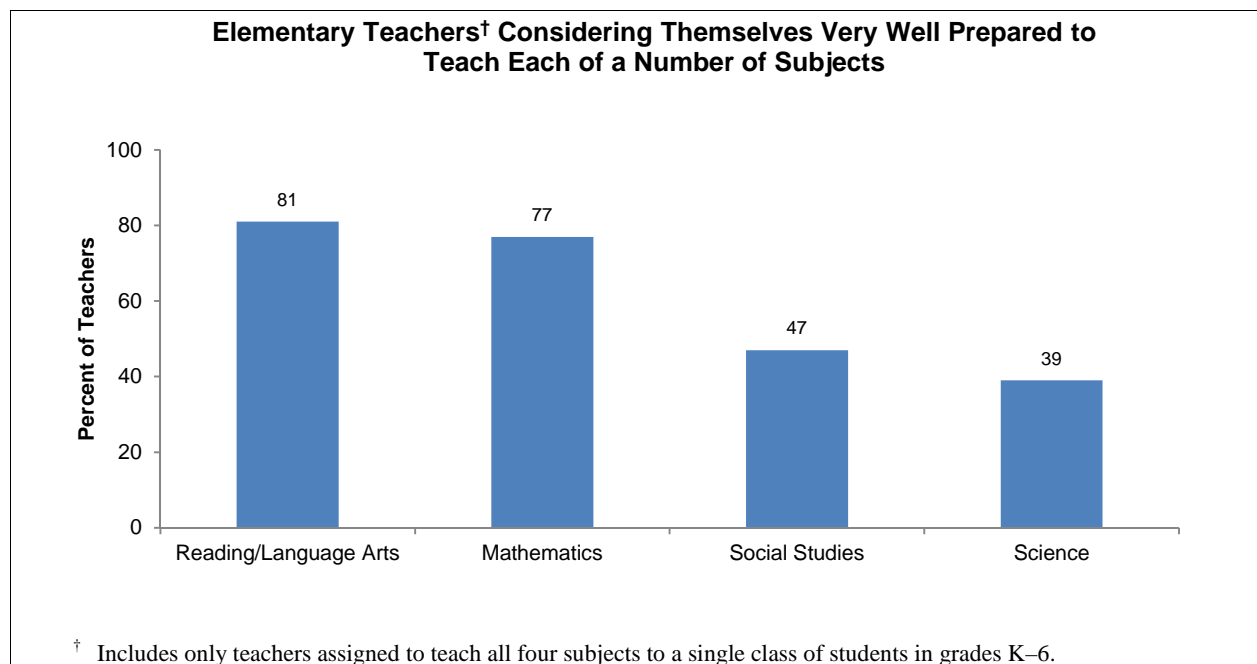


Figure 5

As can be seen in Figure 6, elementary science teachers are more likely to indicate feeling very well prepared to teach life science and Earth science than they are to teach physical science. Engineering stands out as the area where elementary teachers feel least prepared.

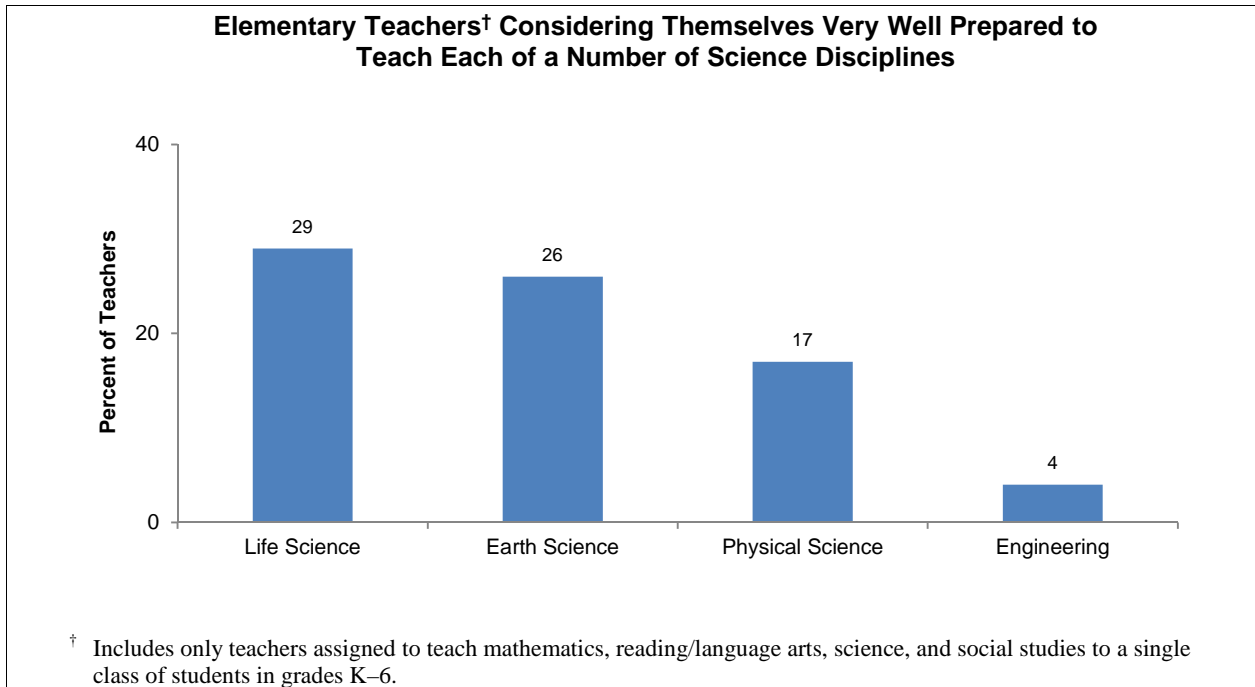


Figure 6

In mathematics, the majority of elementary teachers indicate feeling very well prepared to teach number and operations. Markedly fewer teachers feel very well prepared to teach measurement and data representation, geometry, and early algebra (see Figure 7).

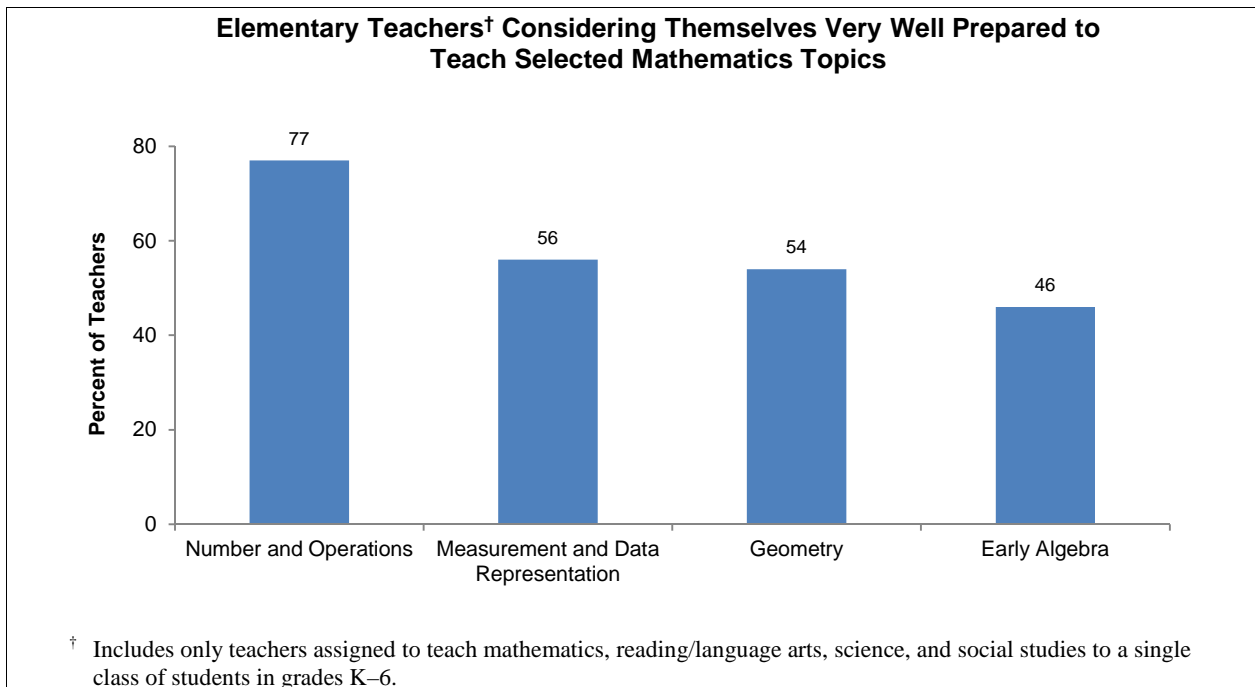


Figure 7

Distribution of Well-Prepared Teachers

The 2012 National Survey found that well-prepared science and mathematics teachers are not necessarily equitably distributed among classes and schools. As can be seen in Figures 8 and 9, science and mathematics classes categorized as consisting of “mostly high achievers” are more likely than those categorized as “mostly low achievers” to be taught by teachers who feel well prepared to teach science/mathematics content, encourage students’ interest in the discipline, and implement instruction in a particular unit.⁴

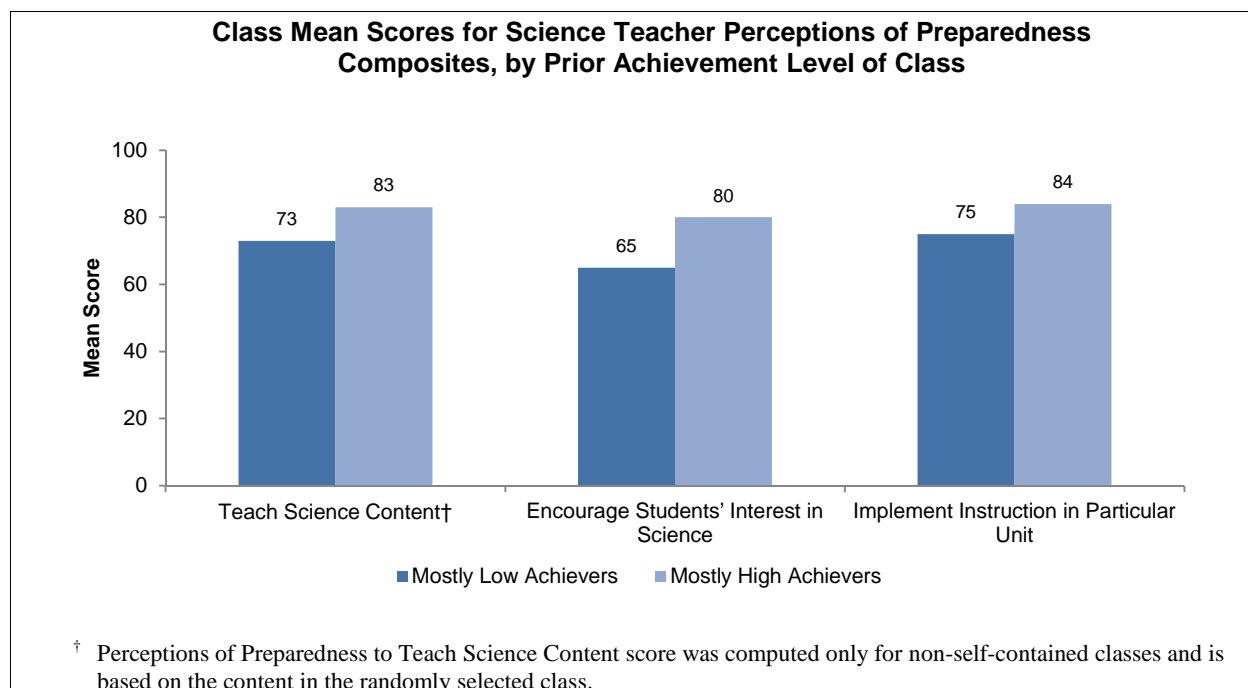


Figure 8

⁴ Composite definitions for these and other composites in this report can be found in the *Report of the 2012 National Survey of Science and Mathematics Education*.

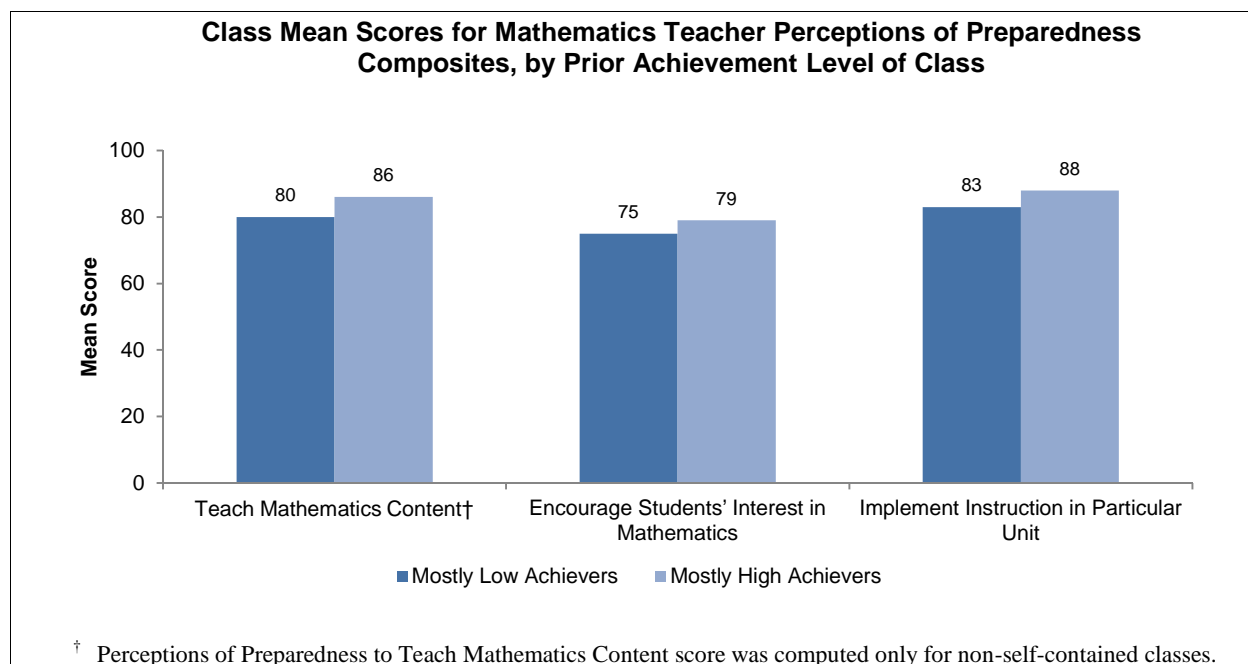


Figure 9

Science classes of mostly high-achieving students are also more likely to be taught by teachers with substantial science backgrounds. Additionally, science classes in schools with high proportions of students eligible for free/reduced-price lunch are more likely than classes in schools with few such students to be taught by relatively inexperienced teachers.

Science and Mathematics Professional Development

Science and mathematics teachers, like all professionals, need opportunities to keep up with advances in their field, including both disciplinary content and how to help their students learn important science/mathematics content. Measures of teachers' continuing education include how recently they participated in professional development and the amount of time spent on professional development.

Although over 80 percent of middle and high school science teachers, and over half of elementary teachers, have participated in science-focused⁵ professional development in the last three years, only about one-third of secondary teachers and just 4 percent of elementary teachers have had more than 35 hours of professional development in that time period (see Figure 10). Similarly, over 85 percent of mathematics teachers at all grade levels have participated in mathematics-focused⁶ professional development in the last three years. However, only about one-third of secondary teachers and just 11 percent of elementary teachers have had more than

⁵ Includes professional development focused on science or science teaching.

⁶ Includes professional development focused on mathematics or mathematics teaching.

35 hours of professional development in that time period (see Figure 10). For each subject/grade-range combination, workshops are by far the most prevalent professional development activity.

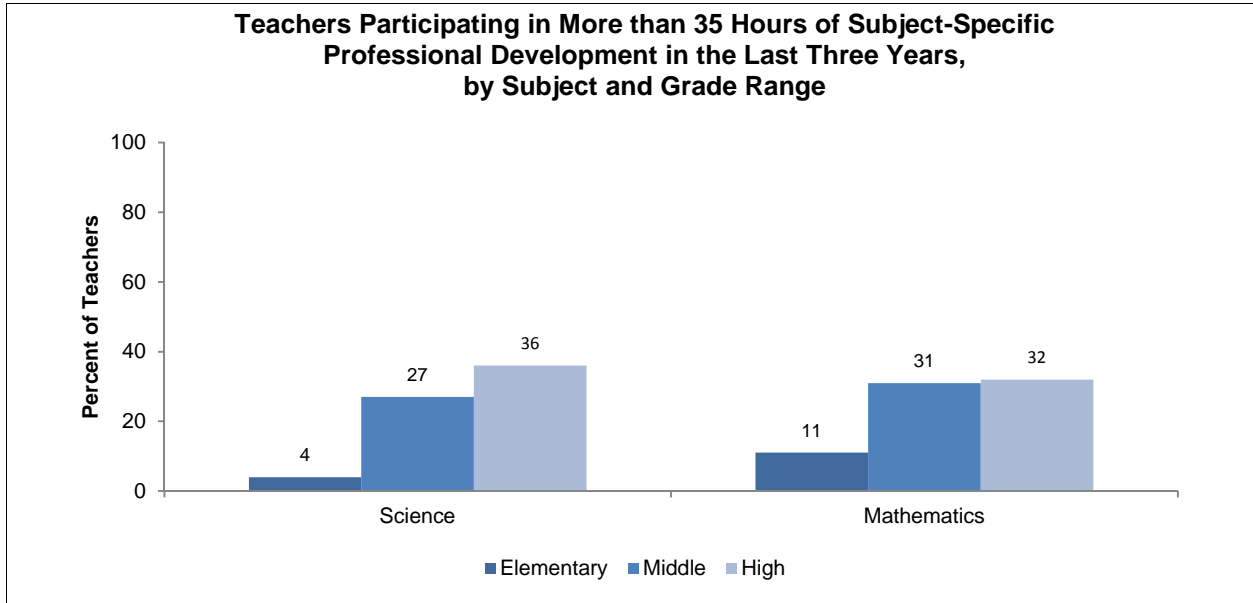


Figure 10

Teacher study groups can be thought of as another a type of professional development. As can be seen in Figure 11, science- and mathematics-focused teacher study groups were each offered in roughly half of secondary schools in the last three years. They were offered in less than half of elementary schools, and were more likely to be offered in mathematics than in science.

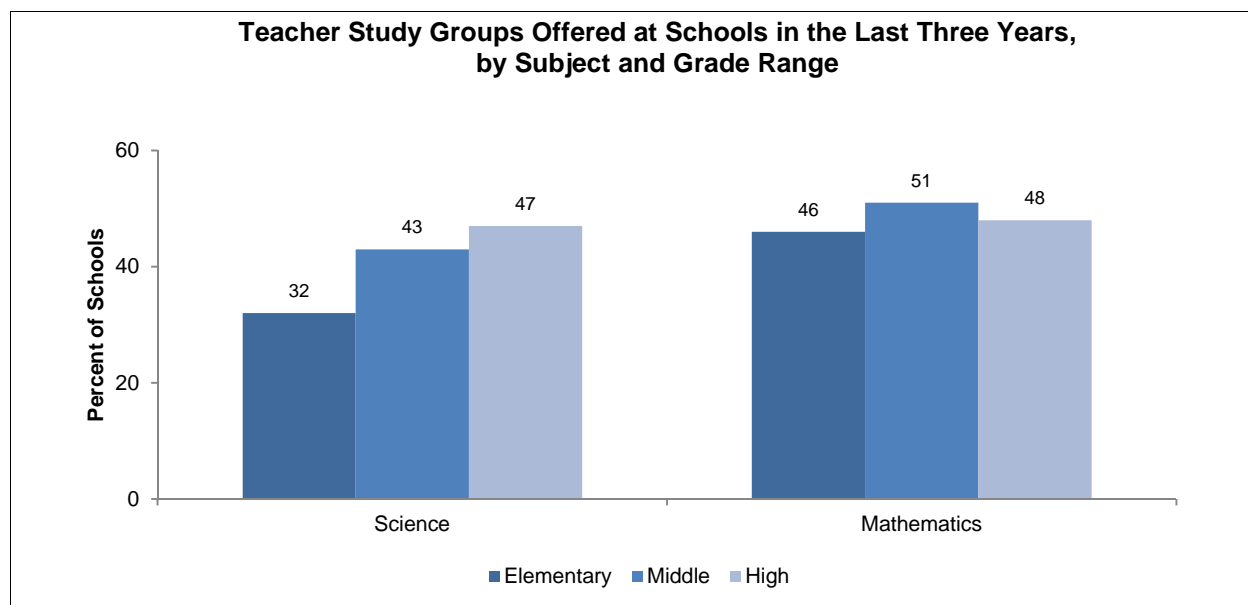


Figure 11

Professional development resources are generally equitably distributed across schools and classrooms, and in some cases even more concentrated among schools and classes serving groups historically underrepresented in STEM. For example, mathematics classes with the highest percentage of historically underrepresented students are more likely than those with the lowest percentage to be taught by teachers who have participated in more than 35 hours of mathematics-related professional development in the last three years. In addition, teachers of science and mathematics classes with a high proportion of historically underrepresented students report a higher focus on student-centered instruction in their professional development/coursework than teachers of classes with relatively few historically underrepresented students. Further, in both science and mathematics, one-on-one coaching is more likely to be offered to teachers in high-poverty schools.

Science and Mathematics Courses

Time Spent on Elementary Science and Mathematics Instruction

The typical elementary school class spends, on average, about 20 minutes a day on science instruction, compared to 60 minutes on mathematics and 90 minutes on reading/language arts (see Figure 12). Although mathematics is taught in nearly all classes on most or all school days, science is rarely taught every day of the week, every week of the school year.

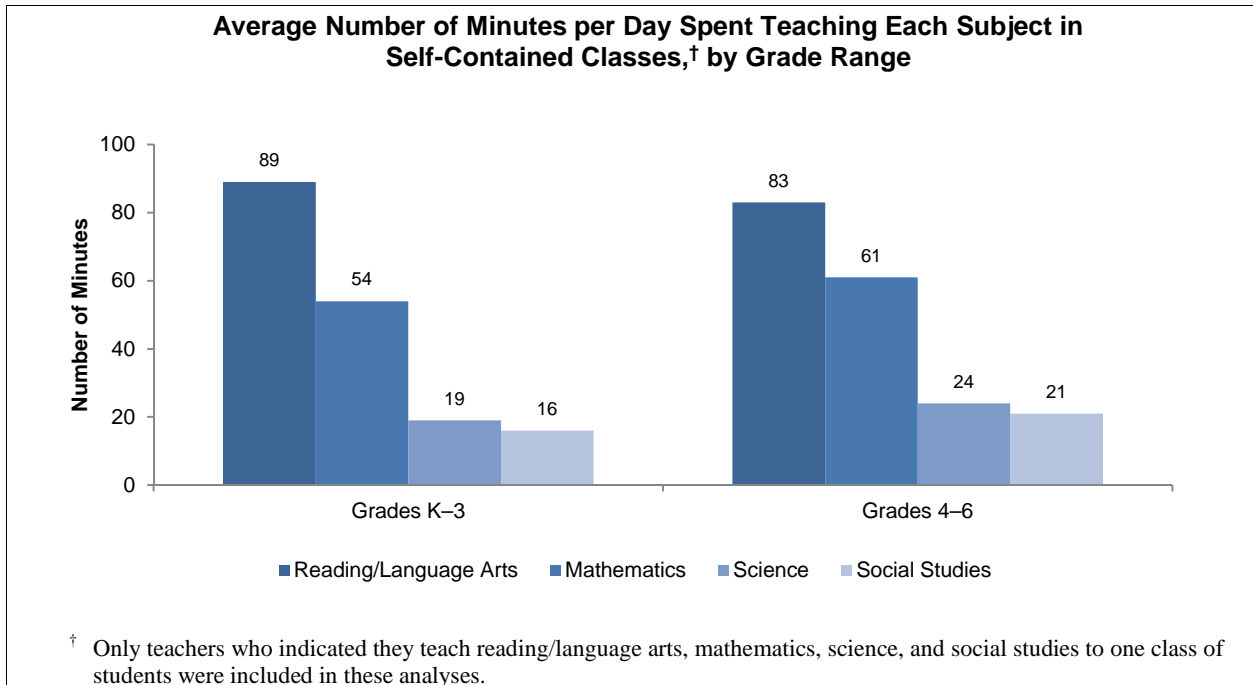


Figure 12

Equitable Access to Science and Mathematics Courses

Across all grade levels and in both subjects, classes with higher percentages of students historically underrepresented in STEM are more likely to be labeled as consisting of “mostly low achievers” than classes with lower percentages of students historically underrepresented in STEM (see Figures 13 and 14). For example, 39 percent of high school mathematics classes with a high percentage of historically underrepresented students are classified as being composed mostly of low achievers, compared to 14 percent of high school mathematics classes with a low percentage of historically underrepresented students.

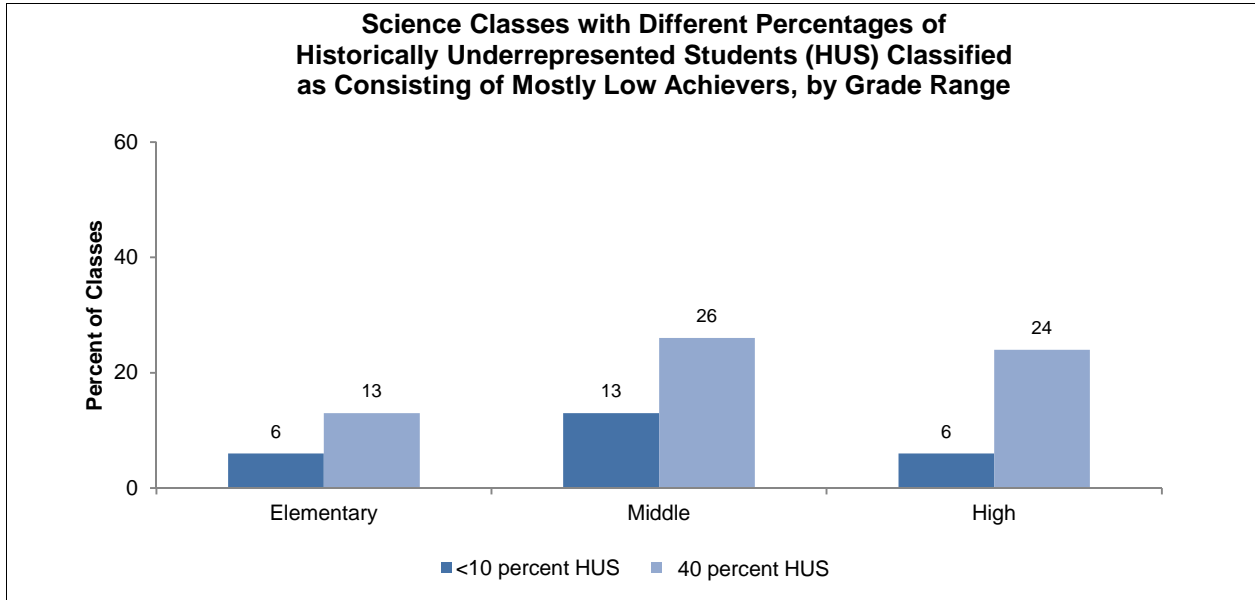


Figure 13

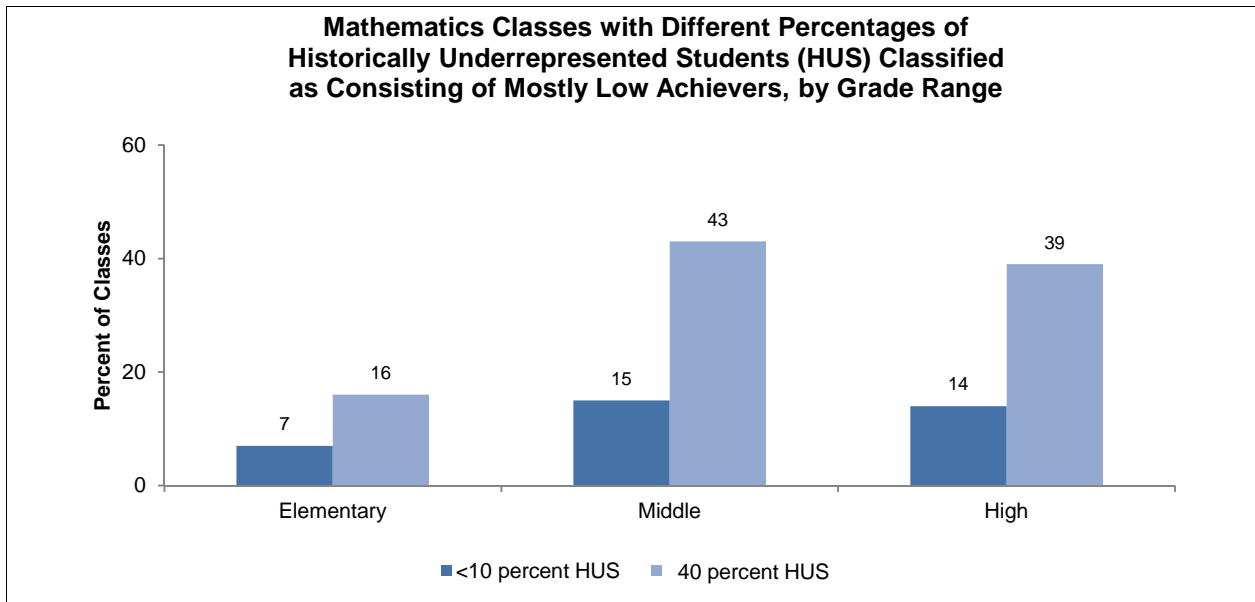


Figure 14

At the high school level, females are just as likely as males to take advanced science and mathematics courses. However, the percentage of students from groups historically underrepresented in STEM trends downward across the progression of science and mathematics courses. As can be seen in Figures 15 and 16, historically underrepresented students make up a higher proportion of students in non-college prep courses than in advanced courses.

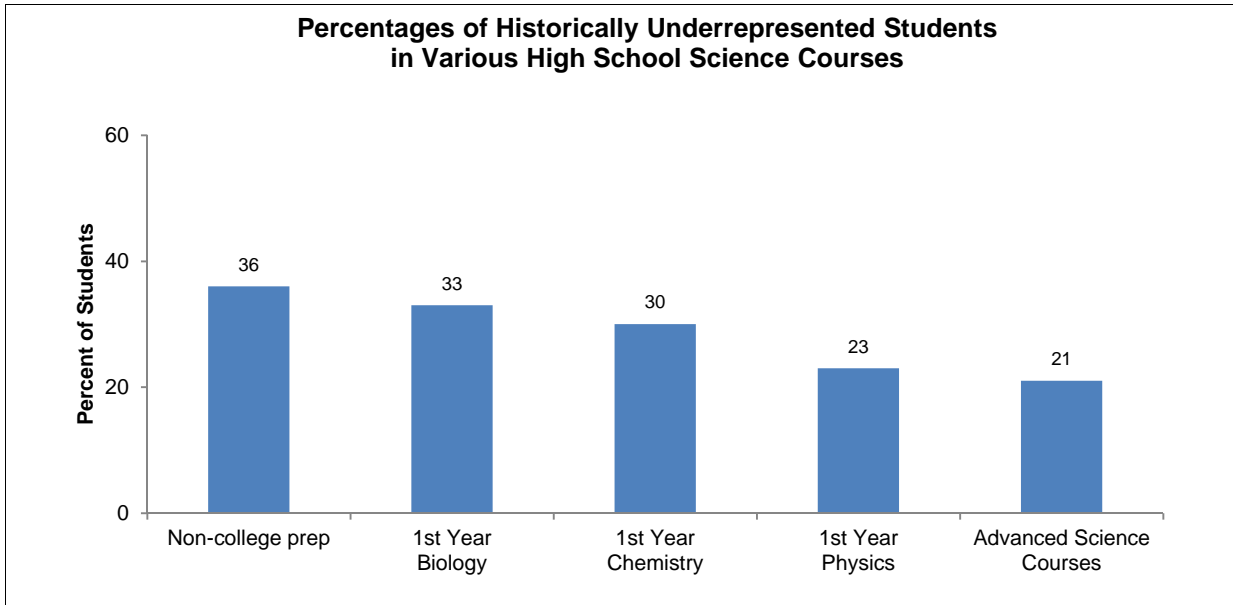


Figure 15

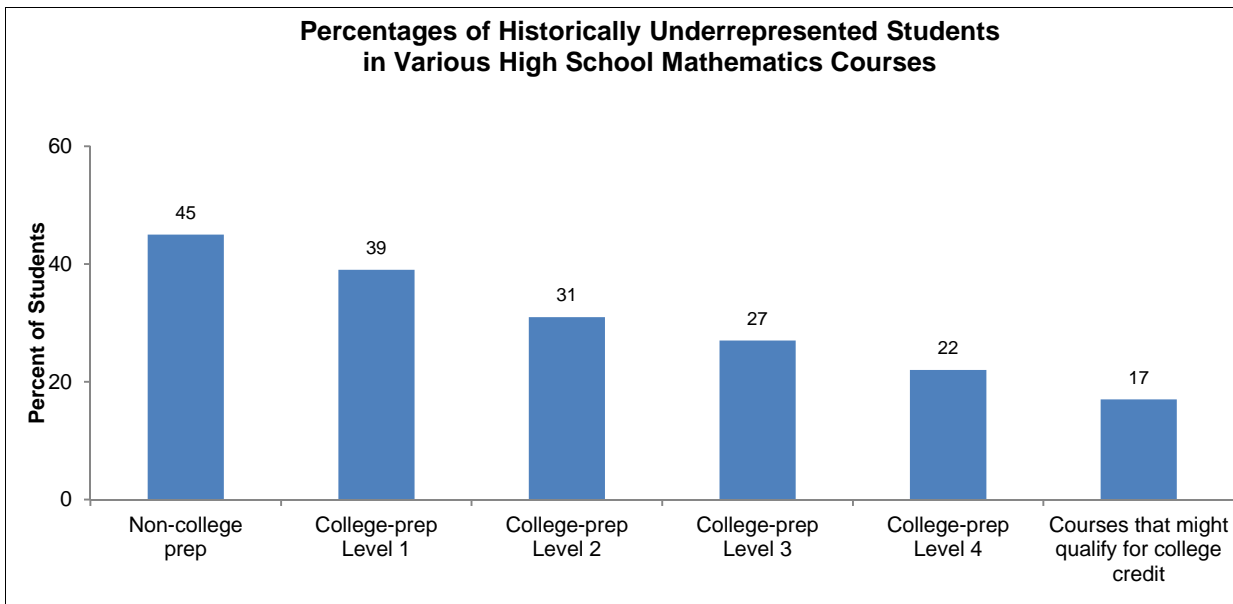


Figure 16

Although Advanced Placement (AP) courses in science and mathematics are offered in about half of high schools, more AP courses are offered in schools that are large and located in suburban and urban areas. In addition, schools with higher proportions of students eligible for free/reduced-price lunch offer fewer AP courses.

Instructional Decision Making, Objectives, and Activities

Instructional Decision Making

Underlying many school reform efforts is the notion that classroom teachers are in the best position to know their students' needs and interests, and therefore should be the ones to make decisions about tailoring instruction to a particular group of students. As can be seen in Figures 17 and 18, science and mathematics teachers perceive much more control over decisions related to pedagogy than curriculum. Additionally, secondary teachers perceive more control in both of these areas than elementary teachers.

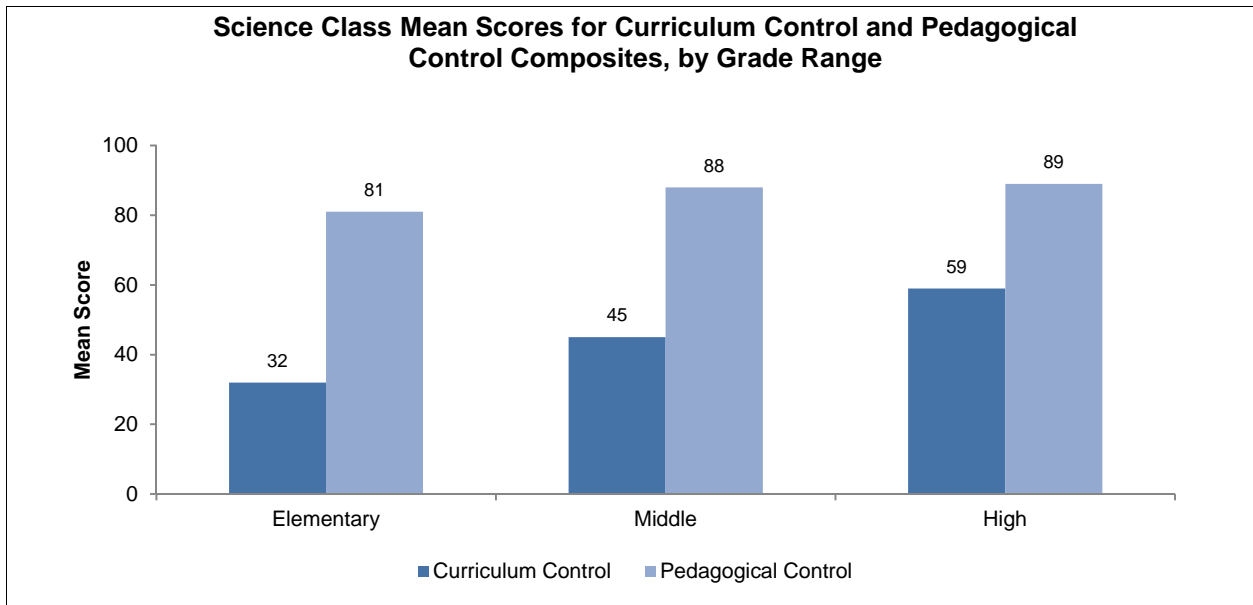


Figure 17

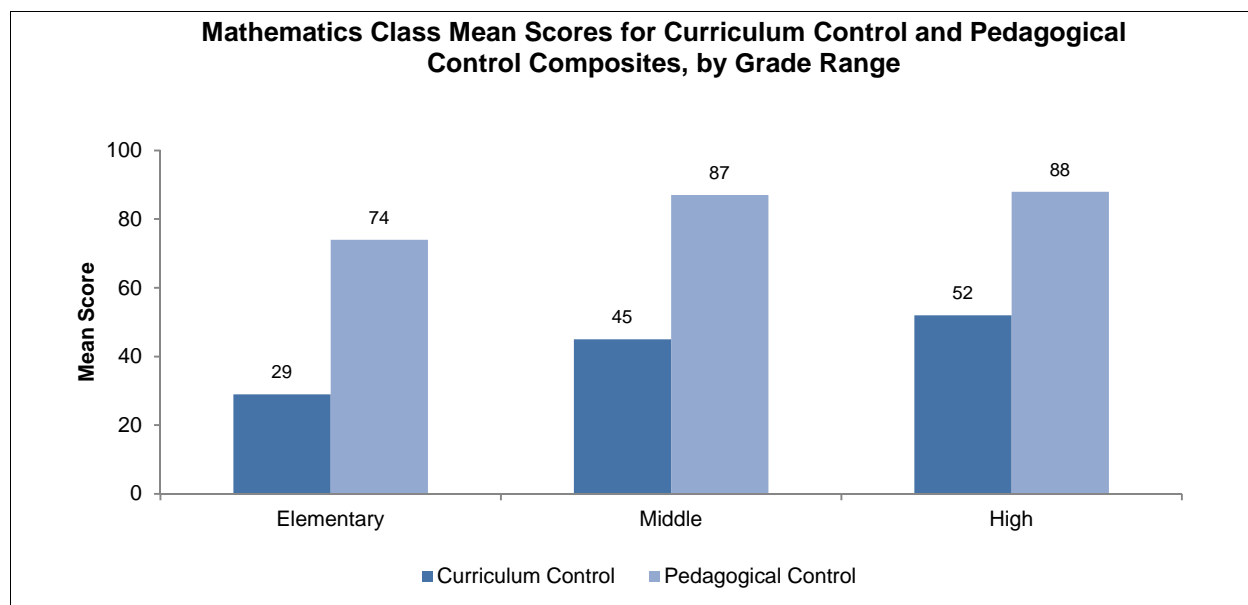


Figure 18

Instructional Objectives

Teachers of classes at all grade levels and in both subjects are fairly likely to emphasize reform-oriented instructional objectives, such as developing understanding of concepts, increasing student interest in the subject, and connecting what students are learning to real-life applications. However, science classes are more likely than mathematics classes to have a heavy emphasis on increasing students' interest in the subject, and in both subjects this objective is emphasized less in high school. In contrast, mathematics classes are more likely than science classes to focus on preparing students for further study in the discipline.

Instructional Activities

As can be seen in Figure 19, lecture and discussion are very common in science instruction. Roughly 90 percent of classes in each grade range include the teacher explaining a science idea to the whole class in their most recent lesson. The use of whole class discussion is also prevalent in elementary lessons, but is less common in middle and high school lessons. About half of elementary and middle school classes include students doing hands-on/laboratory activities in the most recent lesson, compared to about 4 in 10 high school classes.

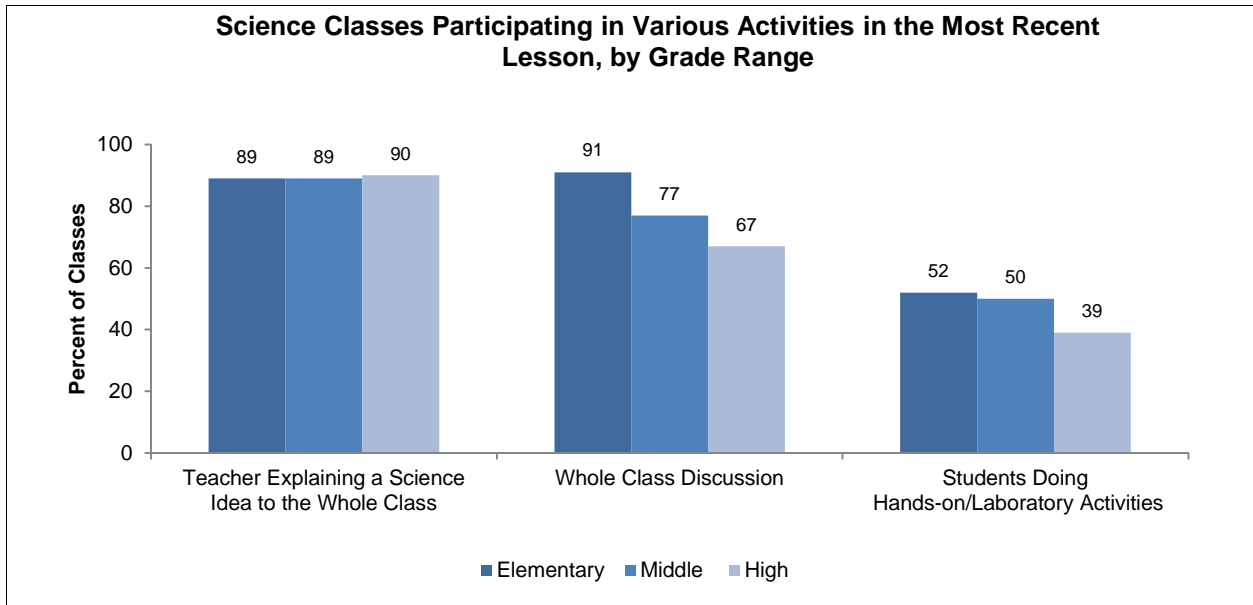


Figure 19

Furthermore, whole class activities; including lectures, explanations, and discussions, comprise the majority of science instructional time across grade levels in the most recent lesson (see Figure 20).

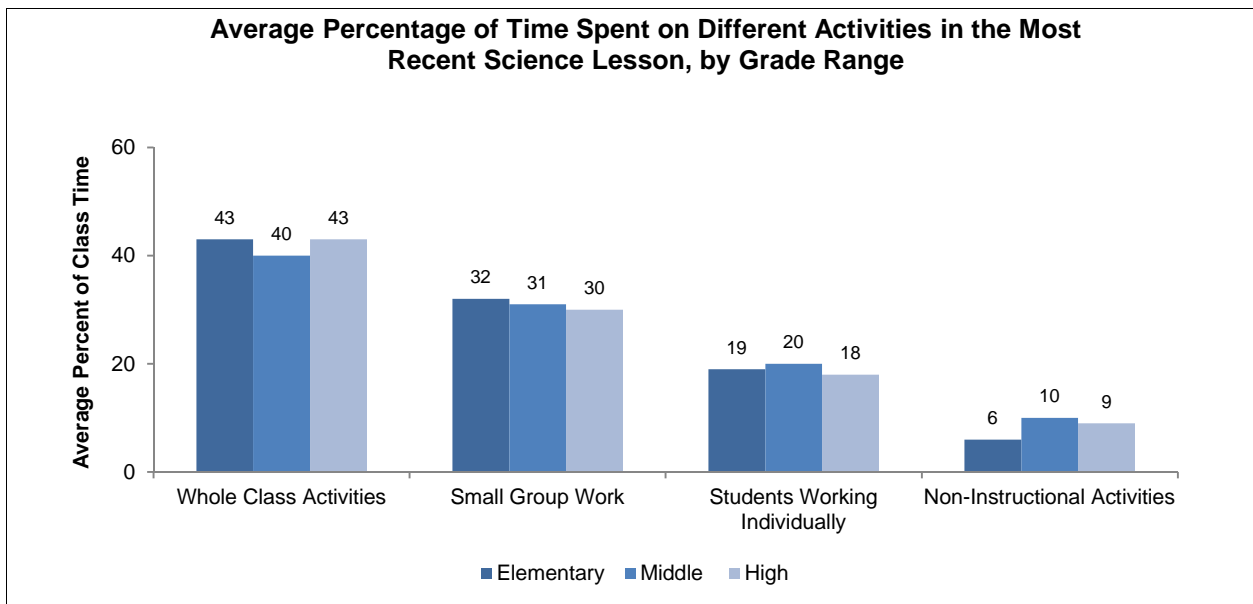


Figure 20

In mathematics, instruction commonly includes lecture (over 90 percent of lessons at each grade level), discussion (75 percent or more of lessons), and students working on textbook/worksheet problems (about 80 percent of lessons). A striking difference between elementary and secondary

classes is in the use of hands-on/manipulative activities. At the elementary level, 77 percent of classes include students doing hands-on/manipulative activities, compared to only 37 percent of middle school mathematics classes and 21 percent of high school mathematics classes (see Figure 21).

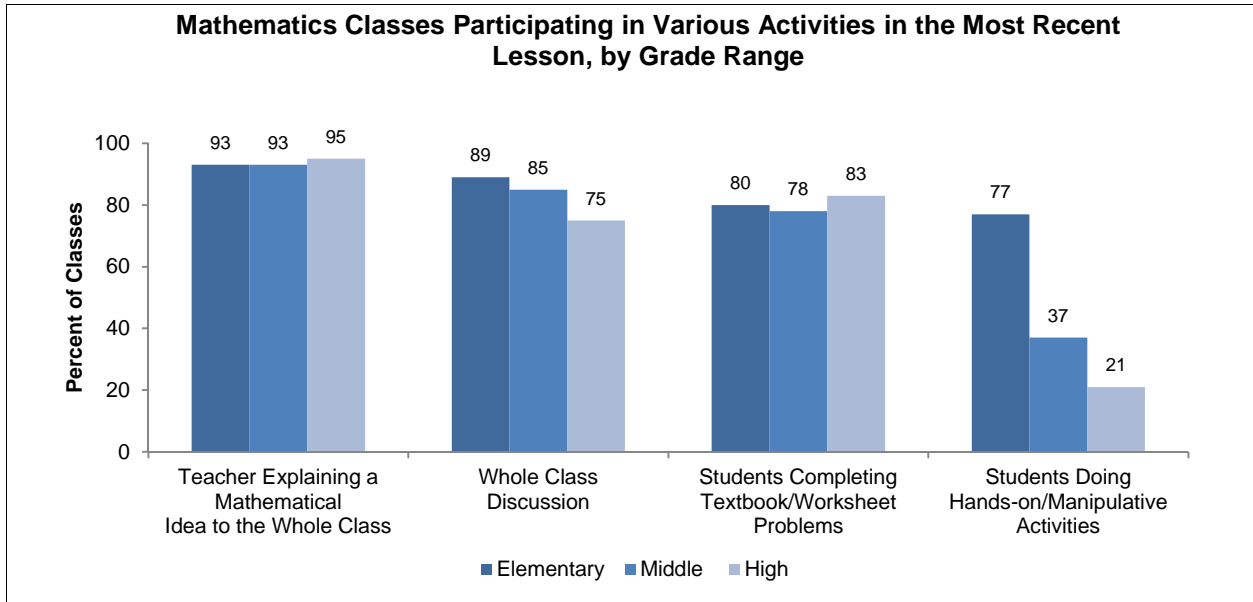


Figure 21

As in science, a substantial amount of mathematics instructional time is spent on whole class activities in the most recent lesson. This is consistent across the grade levels (see Figure 22).

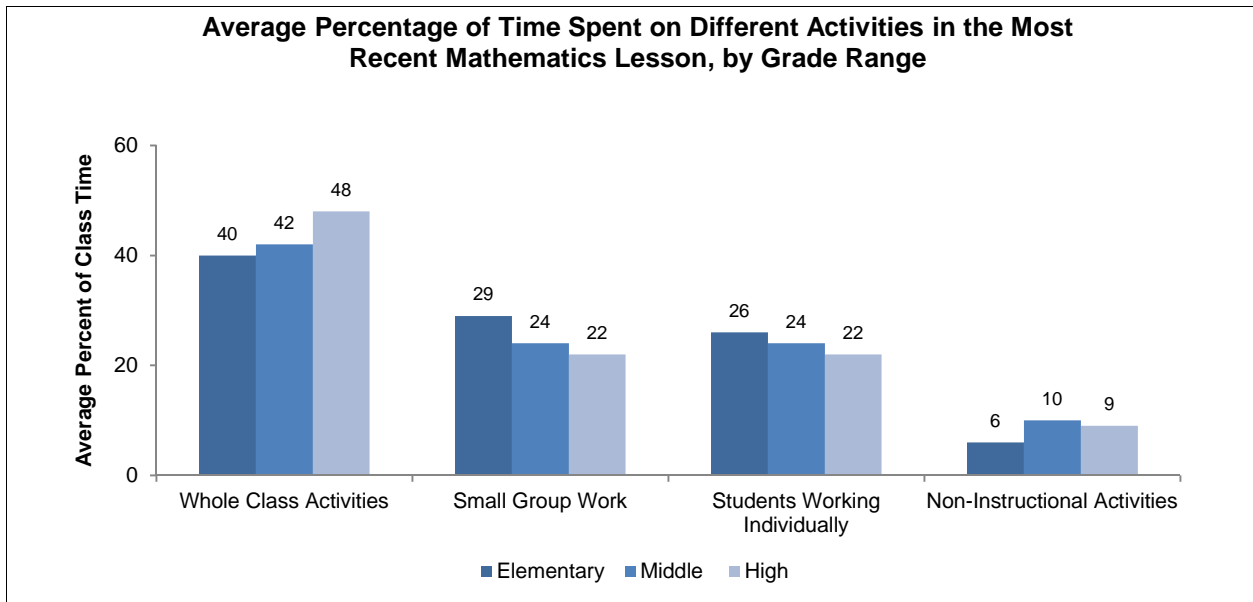


Figure 22

Assessment Practices

Given the increased emphasis on high-stakes assessment, it is not surprising that the frequency of external testing is greater in mathematics classes than in science classes. This difference is particularly striking at the elementary level. As can be seen in Figure 23, 50 percent of classes administer external science assessments at least once a year. In contrast, 91 percent of classes administer external mathematics assessments at least once a year, with 31 percent administering assessments five or more times a year.

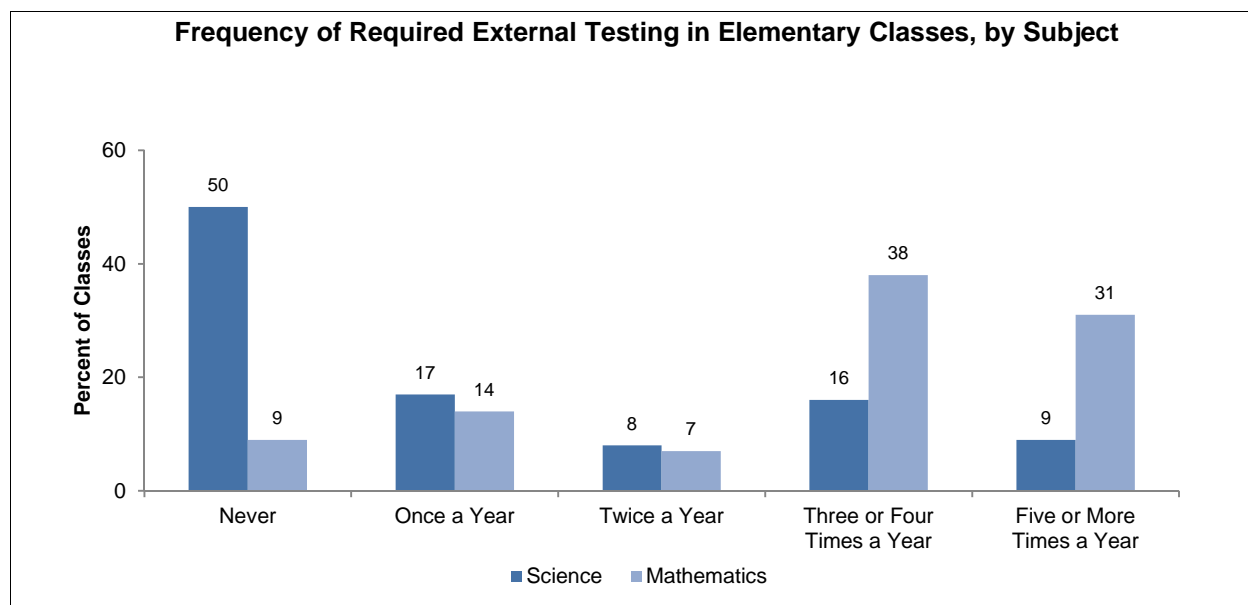


Figure 23

In addition, prior achievement level and socioeconomic status are related to the frequency of external assessment. Science and mathematics classes of mostly low-achieving students are more likely than classes of mostly high-achieving students to take external assessments two or more times per year. Students are also more likely to take external assessments two or more times per year if they are in schools with a high percentage of students eligible for free/reduced-price lunch.

Instructional Resources

More than three-fourths of middle and high school science classes and about two-thirds of elementary science classes use commercially published textbooks/modules. In mathematics, over 80 percent of classes at all grade levels use commercially published textbooks/programs. However, as can be seen in Figure 24, science and mathematics classes across grade levels are quite likely to be using textbooks published in 2006 or earlier. Mathematics classes are more

likely than science classes to use newer textbooks (published after 2006), especially at the elementary level.

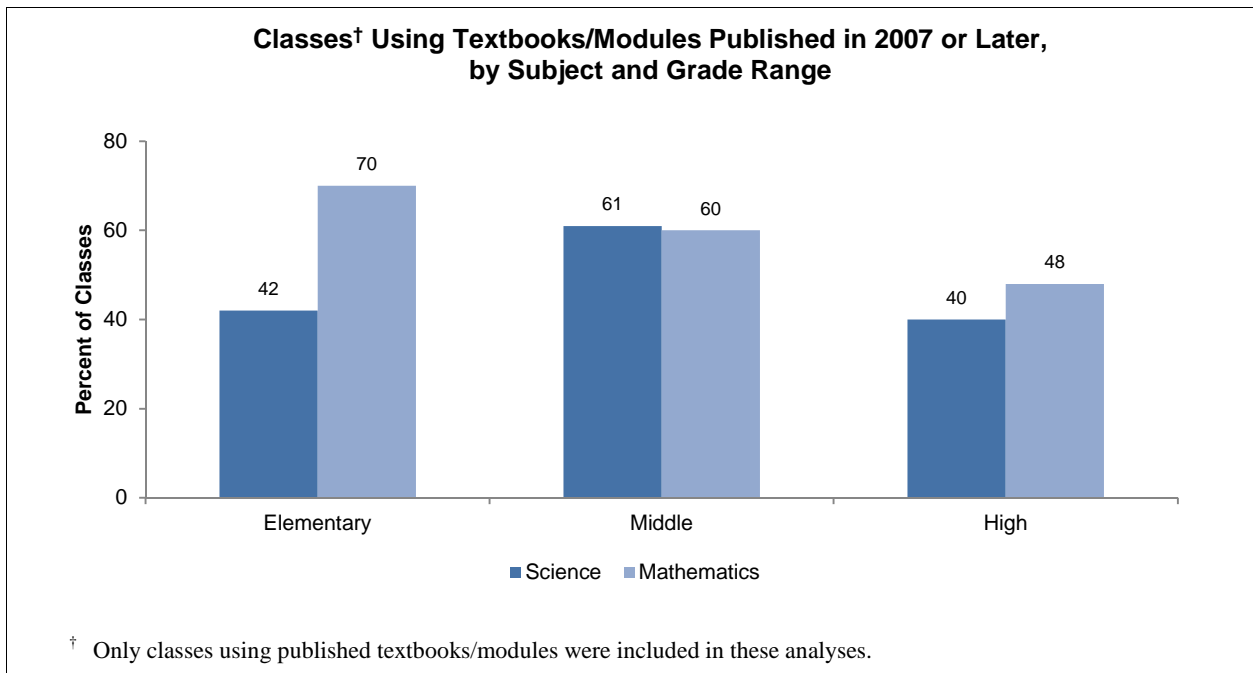


Figure 24

Mathematics classes across grade levels are more likely than science classes to use their textbooks 75 percent or more of the time (See Figure 25). In more than half of science and mathematics classes, teachers report incorporating activities from other sources substantially and more than 40 percent report skipping parts of the materials.

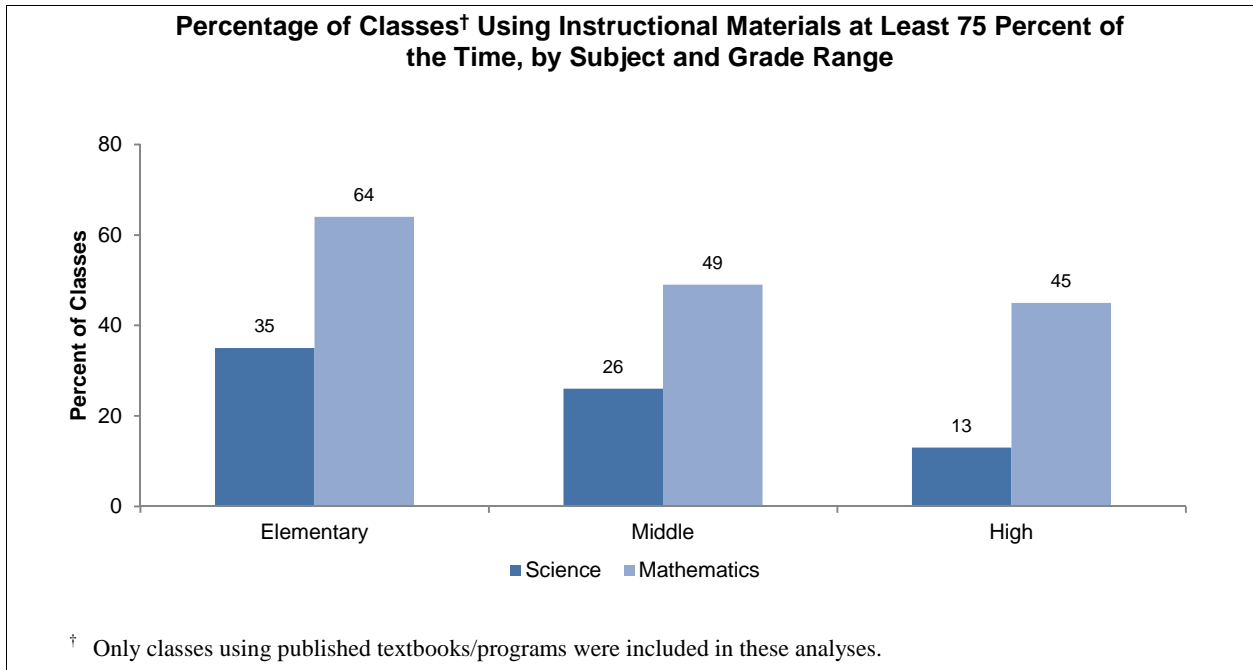


Figure 25

Teachers of high school science classes are much more likely than teachers of elementary science classes to rate their facilities, equipment, consumable supplies, and instructional technologies as adequate. In mathematics, over 80 percent of elementary teachers rate their manipulatives as adequate, compared to substantially lower percentages of middle school (58 percent) and high school (43 percent) teachers.

Equitable Distribution of Instructional Resources

Some instructional resources are not distributed equitably across science and mathematics classes. For example, instructional technologies, including calculators, probes, and microscopes are more likely to be available in science classes of mostly high-achieving students than in classes of mostly low-achieving students (see Figure 26).

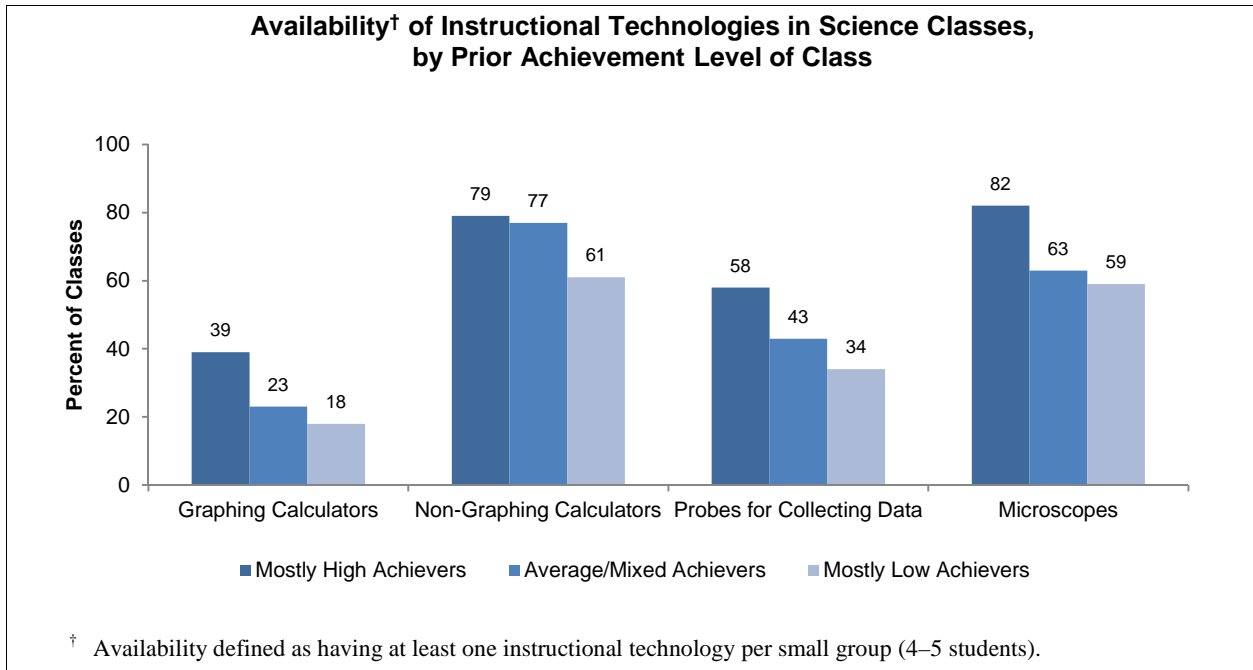


Figure 26

In mathematics, calculators and probes for collecting data are much more likely to be available in classes with the lowest percentages of students historically underrepresented in STEM than classes with the highest percentages (see Figure 27).

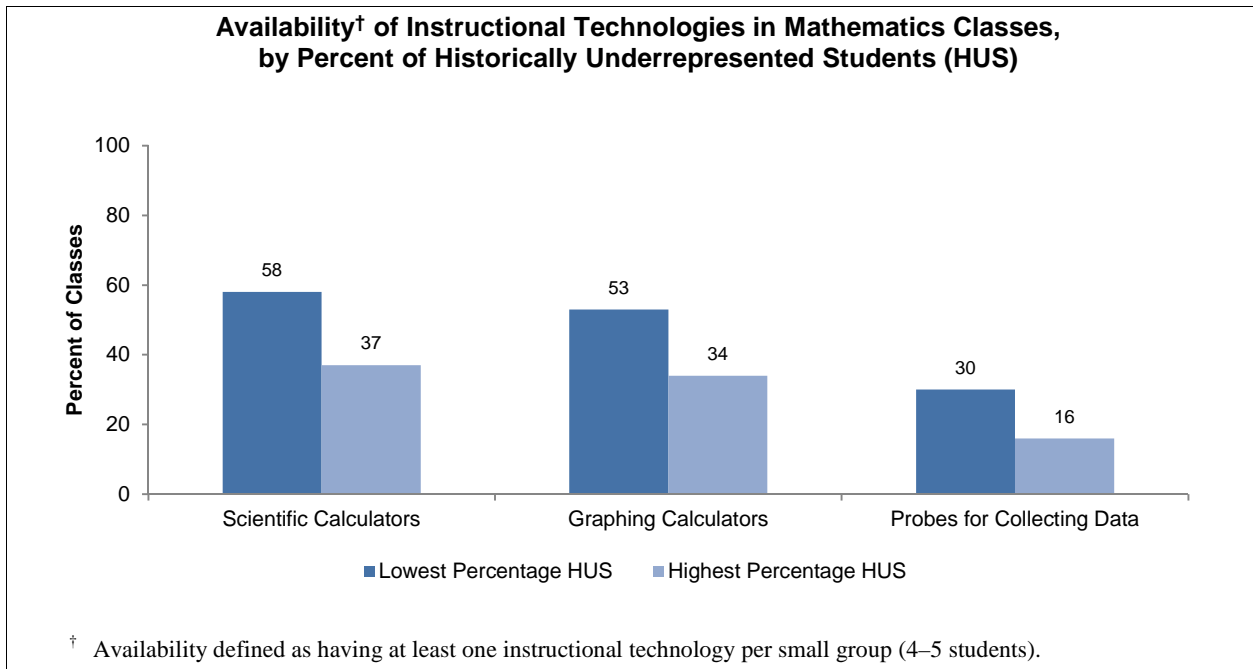


Figure 27

Factors Affecting Instruction

State standards have a major influence on science and mathematics instruction. However, attention to state standards is generally greater in mathematics than in science, perhaps due to greater accountability pressures in mathematics. The difference is especially pronounced in the elementary grades (see Figure 28).

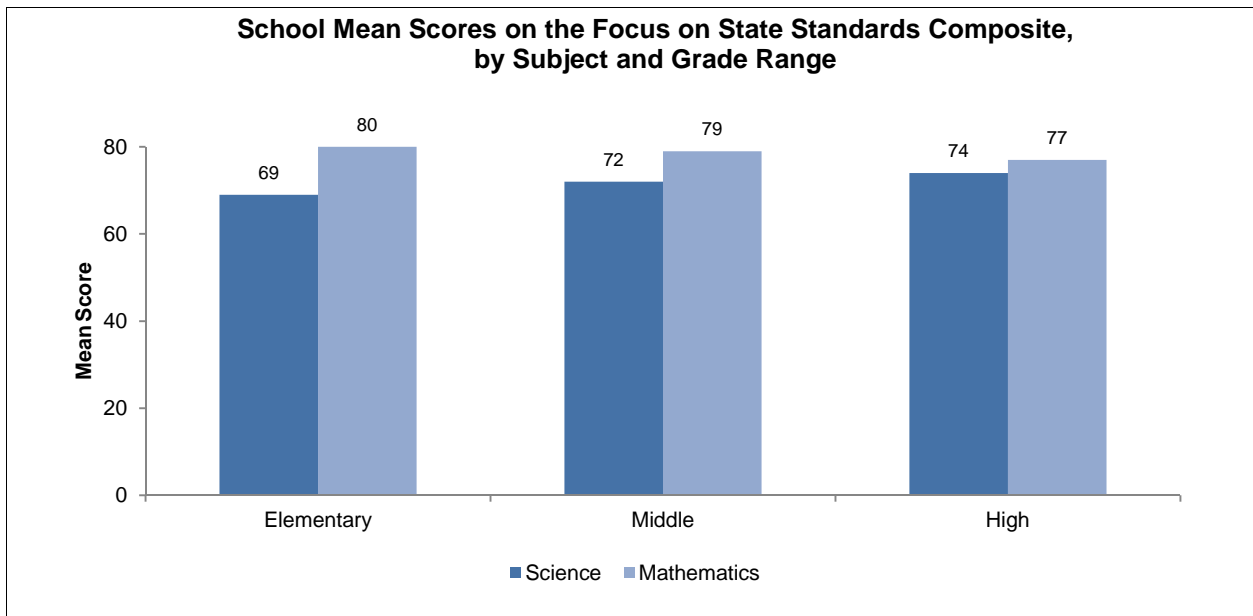


Figure 28

Pull-out instruction, whether for remediation or enrichment, affects students' opportunities to learn science and mathematics content. However, the use of pull-out instruction is much more prevalent for elementary mathematics instruction than elementary science instruction (see Figure 29). The prevalence of these practices, like the focus on state standards, may be due in part to the fact that mathematics is much more likely than science to be tested for accountability purposes.

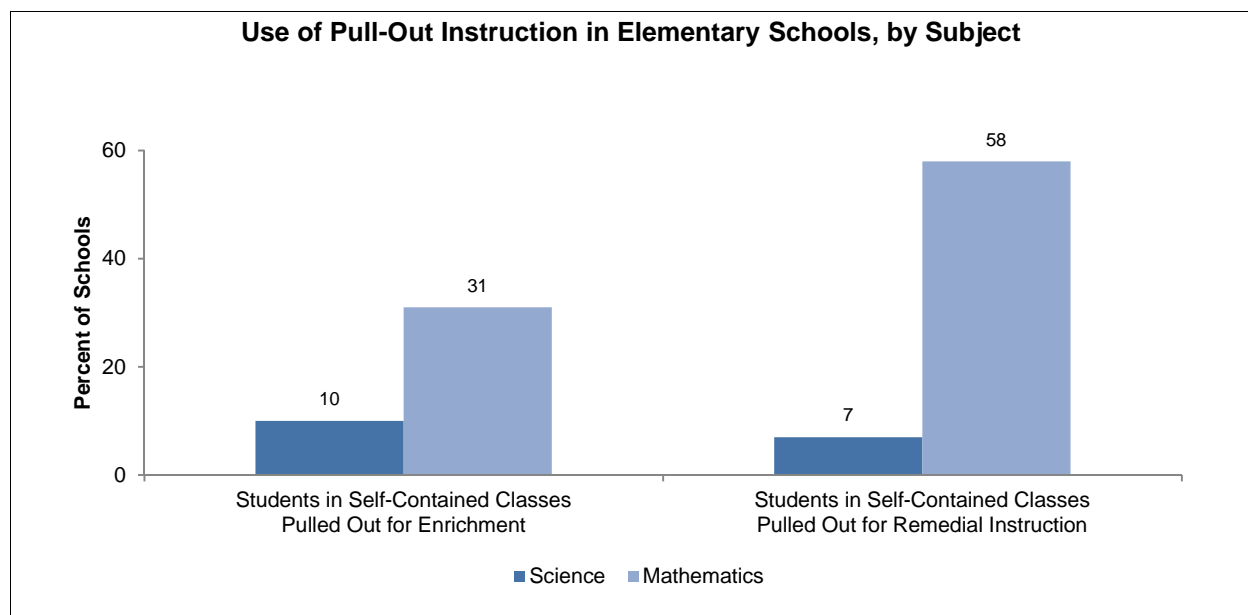


Figure 29

Programs to enhance students’ interest and/or achievement (e.g., clubs, teams, enrichment programs) are relatively common in science, but become more prevalent as grade range increases. For example, almost half of high schools have science clubs, compared to 20 percent of elementary schools. Similarly, 40 percent of high schools have one or more teams participating in science competitions, whereas only 13 percent of elementary schools do. In contrast, programs to enhance students’ interest and/or achievement are offered infrequently in mathematics. Only one-third of high schools have mathematics clubs, and less than a fourth of all schools offer after-school enrichment in mathematics. Furthermore, these programs are not distributed equally across all types of schools, with differences particularly evident by size of school. Disparities exist in the prevalence of family math nights, enrichment programs, discipline-specific clubs, participation in competitions, and participation in science fairs; all of which are more common in larger schools.

In general, the school climate for mathematics instruction seems more supportive than that for science. For example, in 82 percent of schools the importance the school places on the subject promotes effective mathematics instruction compared to 60 percent of schools for science. Similarly, professional development policies and practices, as well as time provided for professional development, are more likely to be viewed as promoting effective mathematics instruction.