NSSME | THE NATIONAL SURVEY OF SCIENCE & MATHEMATICS EDUCATION

Highlights From the 2018 NSSME+

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horizon RESEARCH, INC.

Disclaimer

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Additional Information

More details and products from the 2018 NSSME+, as well as previous iterations of the study, can be found at: http://horizon-research.com/NSSME/

INTRODUCTION

In 2018, the National Science Foundation supported the sixth in a series of surveys through a grant to Horizon Research, Inc. (HRI). The first survey was conducted in 1977 as part of a major assessment of science and mathematics education and consisted of a comprehensive review of the literature; case studies of 11 districts throughout the United States; and a national survey of teachers, principals, and district and state personnel. A second survey of teachers and principals was conducted in 1985–86 to identify trends since 1977. A third survey was conducted in 1993, a fourth in 2000, and a fifth in 2012. This series of studies has been known as the National Survey of Science and Mathematics Education (NSSME).

The 2018 iteration of the study included an emphasis on computer science, particularly at the high school level, which is increasingly prominent in discussions about K–12 science, technology, engineering, and mathematics (STEM) education and college and career readiness. The 2018 NSSME+ (the plus symbol reflecting the additional focus) 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. The research questions addressed by the study are:

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

The 2018 NSSME+ is based on a national probability sample of schools and science, mathematics, and computer science teachers in grades K–12 in the 50 states and the District of Columbia. The sample was designed to yield national estimates of course offerings and enrollment, teacher background preparation, textbook usage, instructional techniques, and availability and use of facilities and equipment. Every eligible school and teacher in the target population had a known, positive probability of being sampled. Details on the survey sample design, as well as data collection and analysis procedures, are included in the *Report of the 2018 NSSME+*.[1]

[1] Banilower, E. R., Smith, P. S., Malzahn, K. A., Plumley, C. L., Gordon, E. M., & Hayes, M. L. (2018). *Report of the 2018 NSSME+*. Chapel Hill, NC: Horizon Research, Inc. Retrieved from http://horizon-research.com/NSSME/2018-nssme/research-products/reports/technical-report

The purpose of this report is to highlight some of the major findings from the 2018 NSSME+. These findings are generally presented by subject (science, mathematics, and computer science) and/or grade range (elementary, middle, and high),[2] and are based on data from individual questionnaire items and composite variables.[3] Survey data are also reported by six 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 prior achievers, mostly average prior achievers/a mixture of levels, or mostly high prior achievers.
- ***Percentage of students from race/ethnicity groups historically underrepresented in STEM in the class***—classes were classified into 1 of 4 categories based on the percentage of students in the class identified as being from race/ethnicity groups historically underrepresented in STEM (i.e., American Indian or Alaskan Native, Black, Hispanic or Latino, or Native Hawaiian or Other Pacific Islander, multiracial).
- ***Percentage 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).
- ***Region***—schools were classified as belonging to 1 of 4 census regions: Midwest (IA, IL, IN, KA, MI, MN, MO, ND, NE, OH, SD, WI), Northeast (CT, MA, ME, NH, NJ, NY, PA, RI, VT), South (AL, AR, DC, DE, FL, GA, KY, LA, MD, MS, NC, SC, TN, VA, WV), or West (AK, AZ, CA, CO, HI, ID, MT, MN, NV, OK, OR, TX, WA, WY).

[2] The computer science teacher questionnaire was administered only to high school teachers; thus, results from this survey are shown only for high school. In addition, because of the smaller sample size, it was not possible to matrix sample items on this questionnaire, and some questions asked of science and mathematics teachers could not be asked of computer science teachers in order to keep response burden reasonable.

[3] 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, mathematics, or computer science education.

Teacher Background and Beliefs

A well-prepared teaching force is essential for an effective education system. This section provides data about the nation's science, mathematics, and computer science teachers, including their course backgrounds, beliefs about teaching and learning, and perceptions of preparedness.

Teachers' Backgrounds

If teachers are to help students learn science, mathematics, and computer science 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. In terms of degrees, teachers were asked to indicate if their degrees are in the fields in which they teach, i.e., science teachers with a degree in science, engineering, or science education; mathematics teachers with a degree in mathematics or mathematics education; and computer science teachers with a degree in computer engineering, computer science, information science, or computer science education. As can be seen in Figure 1, the large majority of high school science and mathematics teachers have a degree in their field (91 percent and 79 percent, respectively). In contrast, only 25 percent of high school computer science teachers have a degree in their teaching field. About half of middle school science and mathematics teachers, and only three percent of elementary teachers, have a degree in their field of teaching.

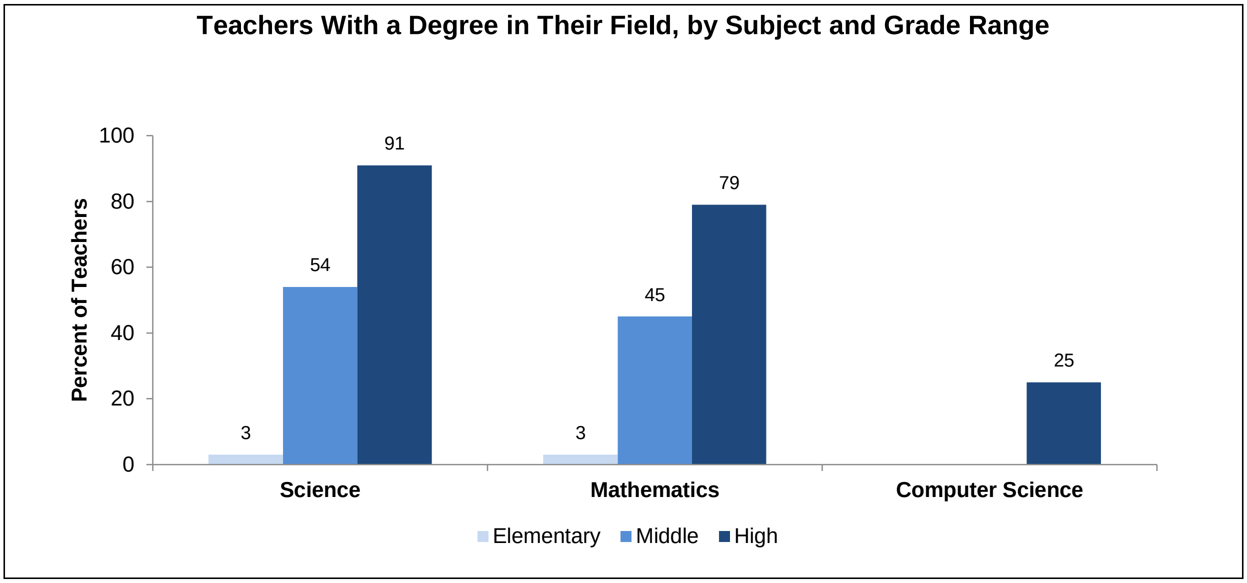


Figure 1

The National Science Teachers Association (NSTA) has recommended that elementary science teachers be prepared to teach life science, physical science, and Earth science.[4] However, only about one-third of elementary science teachers have at least one college course in each of these areas, and approximately another third have courses in only 2 of the 3 areas. For middle grades general/integrated science teachers, NSTA suggests coursework in both chemistry and physics,

[4] National Science Teachers Association. (2012). NSTA science content analysis form: Elementary science specialists or middle school science teachers. Arlington, VA: NSTA.

as well as in the life and Earth sciences. Yet, fewer than half have at least one course in each of these areas.

At the high school level, biology teachers tend to have particularly strong content backgrounds. Nearly 90 percent have either a degree or at least three advanced courses in their discipline, compared to 70 percent of chemistry teachers and 51 percent of physics teachers (see Figure 2). Only about a third of both Earth science and environmental science teachers have substantial background in their subjects.

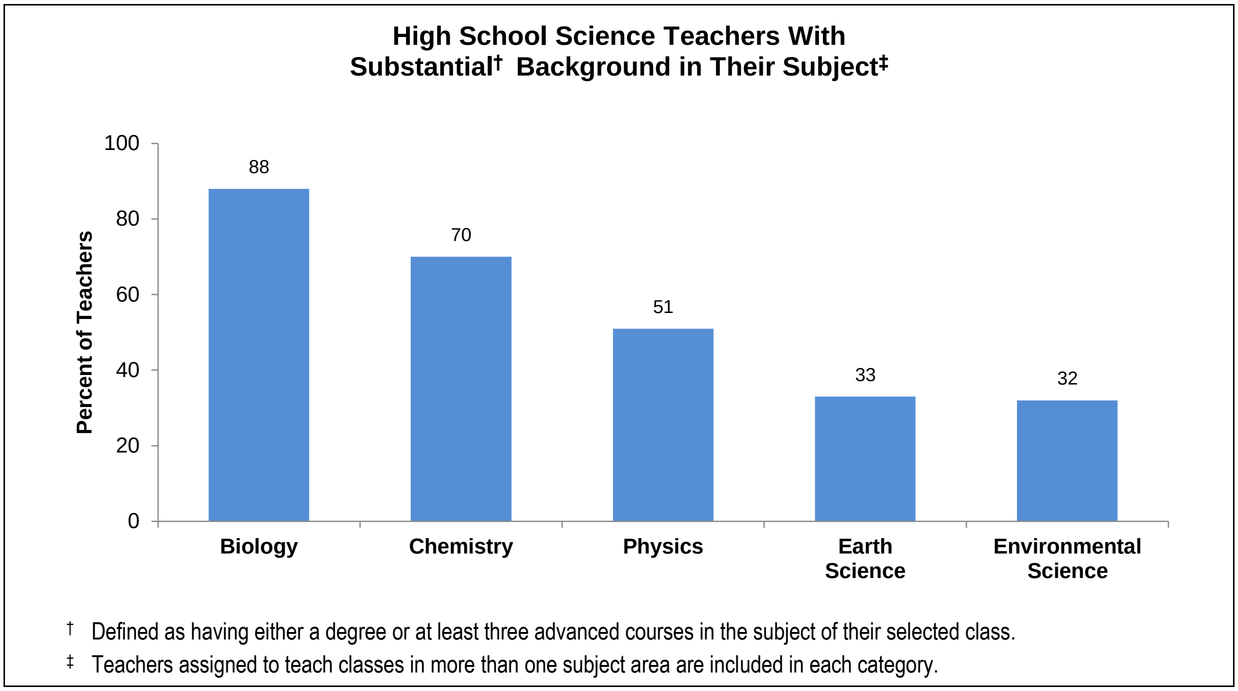


Figure 2

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.[5] However, only seven percent of elementary mathematics teachers have had courses in each of these five areas. The majority of elementary mathematics teachers (53 percent) have had coursework in only one or two of the recommended areas.

NCTM recommends more extensive coursework for middle grades mathematics teachers, including courses in number theory, algebra, geometry, probability, statistics, and calculus.[6] About a fifth of middle school mathematics teachers have had coursework in all six of these areas, and another 37 percent have had coursework in four or five of the areas. The recommendation for high school teachers is similar to middle school, but adds discrete

[5] National Council of Teachers of Mathematics. (2012). NCTM CAEP mathematics content for elementary mathematics specialist. Reston, VA: NCTM.

[6] National Council of Teachers of Mathematics. (2012). NCTM CAEP mathematics content for middle grades. Reston, VA: NCTM.

mathematics.[7] Approximately three-quarters of high school teachers have taken courses in at least 5 of these 7 areas.

Figure 3 displays the percentage of middle and high school mathematics teachers who took courses in some of the specific areas recommended by NCTM (calculus, statistics, and probability). Substantially fewer middle grades teachers have had coursework in these courses than high school teachers.

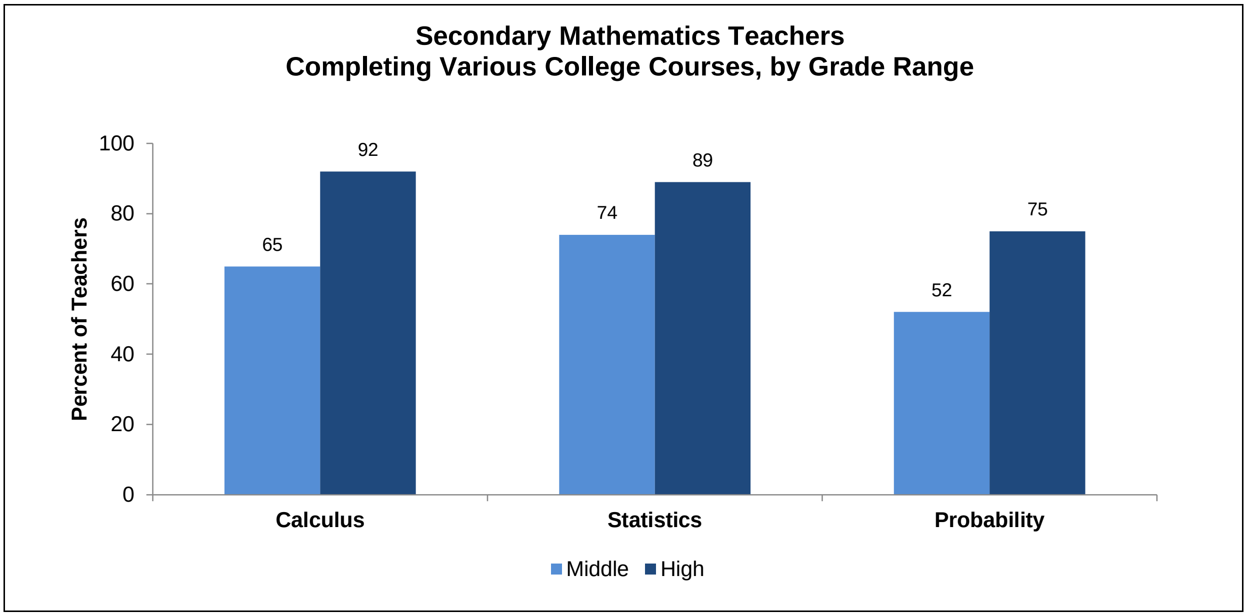


Figure 3

The Computer Science Teachers Association (CSTA) has published recommendations for computer science teacher certification,[8] and the International Society for Technology in Education (ISTE) has published standards for computer science educators.[9] Taken together, they suggest computer science teachers have coursework in the following four areas: programming, algorithms, data structures, and some element of computer systems or networks. About a half of high school computer science teachers have taken coursework in at least 3 of the 4 recommended areas, while 13 percent have not taken courses in any of the areas (see Figure 4).

[7] National Council of Teachers of Mathematics. (2012). NCTM CAEP mathematics content for secondary. Reston, VA: NCTM.

[8] Ericson, B., Armoni, M., Gal-Ezer, J., Seehorn, D., Stephenson, C., & Trees, F. (2008). Ensuring exemplary teaching in an essential discipline. Addressing the crisis in computer science teacher certification. *Final Report of the CSTA Teacher Certification Task Force. ACM*.

[9] International Society for Technology in Education. (2011). *Standards for computer science educators.* Retrieved from https://www.iste.org/standards.

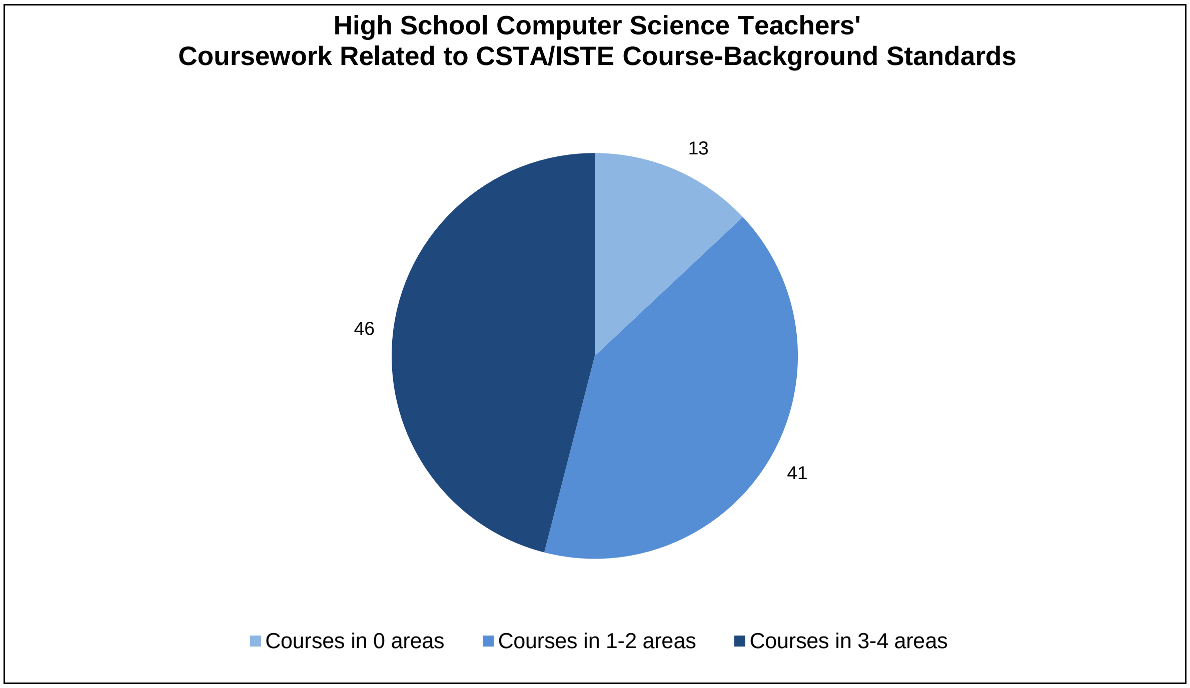


Figure 4

Teachers' Pedagogical Beliefs

When asked about their beliefs regarding teaching and learning, more than 90 percent of science teachers in each grade range agree with elements of effective science instruction derived from cognitive research. These include:

- Teachers should ask students to support their conclusions about a science concept with evidence;
- Students learn best when instruction is connected to their everyday lives;
- Students should learn science by doing science; and
- Most class periods should provide opportunities for students to apply scientific ideas to real-world contexts.

However, more than half indicate that laboratory activities should be used primarily to reinforce ideas that the students have already learned, and roughly one-third agree that teachers should explain an idea to students before having them consider evidence for that idea. Furthermore, despite recommendations that students develop understanding of concepts first and learn the scientific language later, two-thirds of high school science teachers and more than three-quarters of elementary 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 94 percent of teachers in each grade range agree that:

- Teachers should ask students to justify their mathematical thinking;

- Students should learn mathematics by doing mathematics; and
- Most class periods should provide opportunities for students to share their thinking and reasoning.

However, about one-third agree that teachers should explain ideas to students before they investigate those ideas. From 43 to 53 percent, depending on grade range, agree that hands-on activities/manipulatives should be used primarily to reinforce ideas the students have already learned, although research points to their use for helping students develop their initial understanding of key concepts. Even larger proportions of mathematics teachers, around 80 percent across grade levels, believe that students should be given definitions of new vocabulary at the beginning of instruction on a mathematical idea.

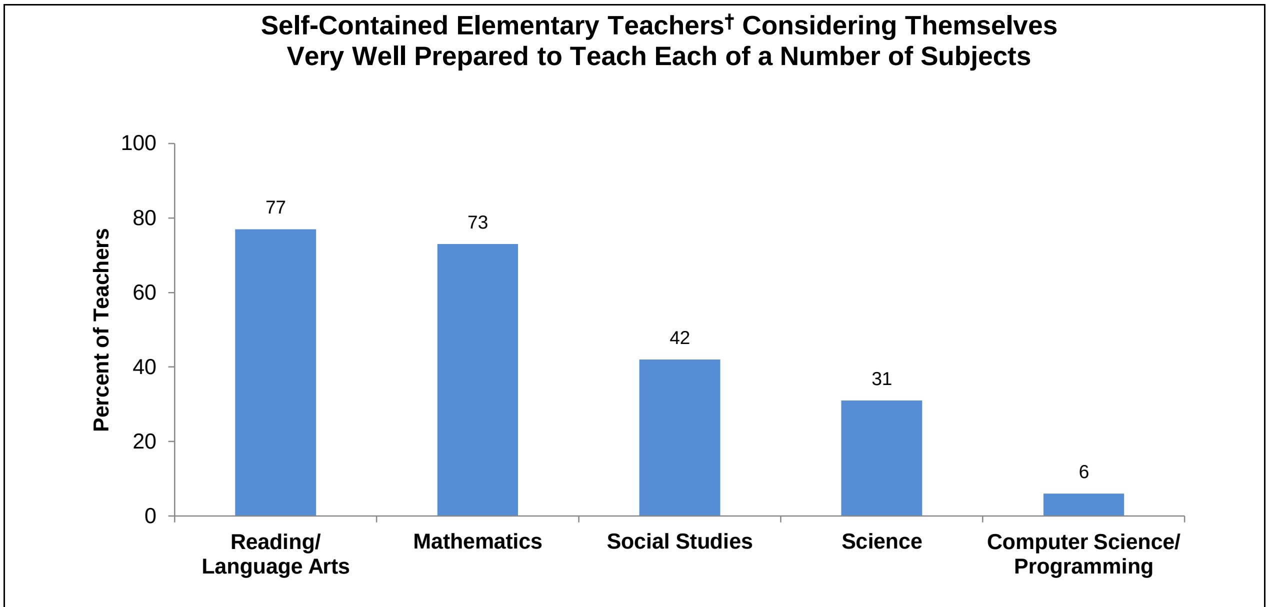
Computer science teachers' views are similar, with at least 90 percent agreeing with the following statements related to effective instruction:

- Students should learn computer science by doing computer science;
- Students learn best when instruction is connected to their everyday lives;
- Teachers should ask students to justify their solutions to computational problems; and
- Most class periods should provide opportunities for students to share their thinking and reasoning.

Like science and mathematics teachers, the majority of high school computer science teachers also hold beliefs aligned with more traditional instruction. For example, 3 out of 4 believe students should be provided with definitions for new vocabulary at the beginning of instruction on a computer science idea, and nearly that many agree that hands-on/manipulative/ programming activities should be used primarily to reinforce computer science ideas that students have already learned.

Teachers' Perceptions of Preparedness

Elementary teachers are typically assigned to teach multiple subjects to a single group of students (i.e., in a self-contained classroom). However, as can be seen in Figure 5, these teachers do not feel equally well prepared to teach the various subjects. Although 73 percent of elementary teachers of self-contained classes feel very well prepared to teach mathematics—slightly lower than the 77 percent for reading/language arts—only 31 percent feel very well prepared to teach science. Far fewer (6 percent) feel very well prepared to teach computer science/programming.



† Includes only teachers assigned to teach multiple subjects to a single class of students in grades K–6.

Figure 5

Figure 6 displays elementary teachers' feelings of preparedness to teach topics within science. Although the vast majority do not feel very well prepared to teach any of the science disciplines, elementary 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.

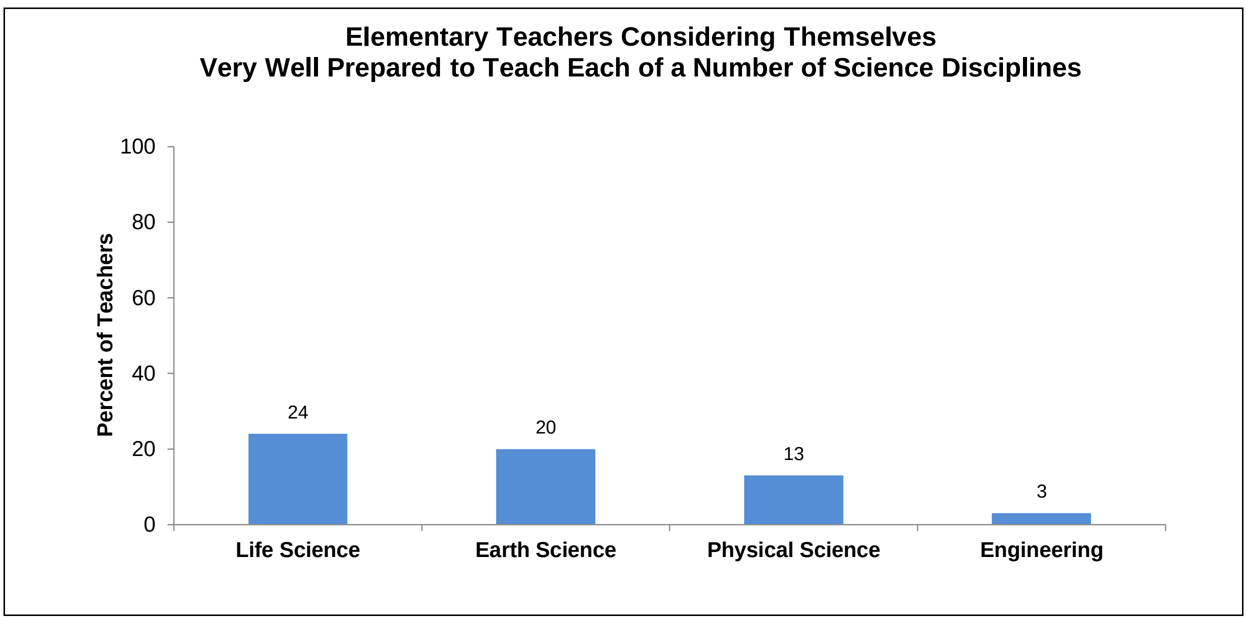


Figure 6

Middle and high school science teachers were shown a list of topics based on the subject of a randomly selected class and asked how well prepared they felt to teach each of those topics at the grade levels they teach. High school science teachers are more likely than their middle grades counterparts to feel very well prepared to teach topics within each discipline.

Figure 7 displays teachers' mean scores for the composite variable[10] Perceptions of Content Preparedness,[11] which was defined based on the content of the targeted class. The mean scores indicate that elementary teachers generally do not feel well prepared to teach science. In addition, high school science teachers feel better prepared to teach science than their middle school counterparts.

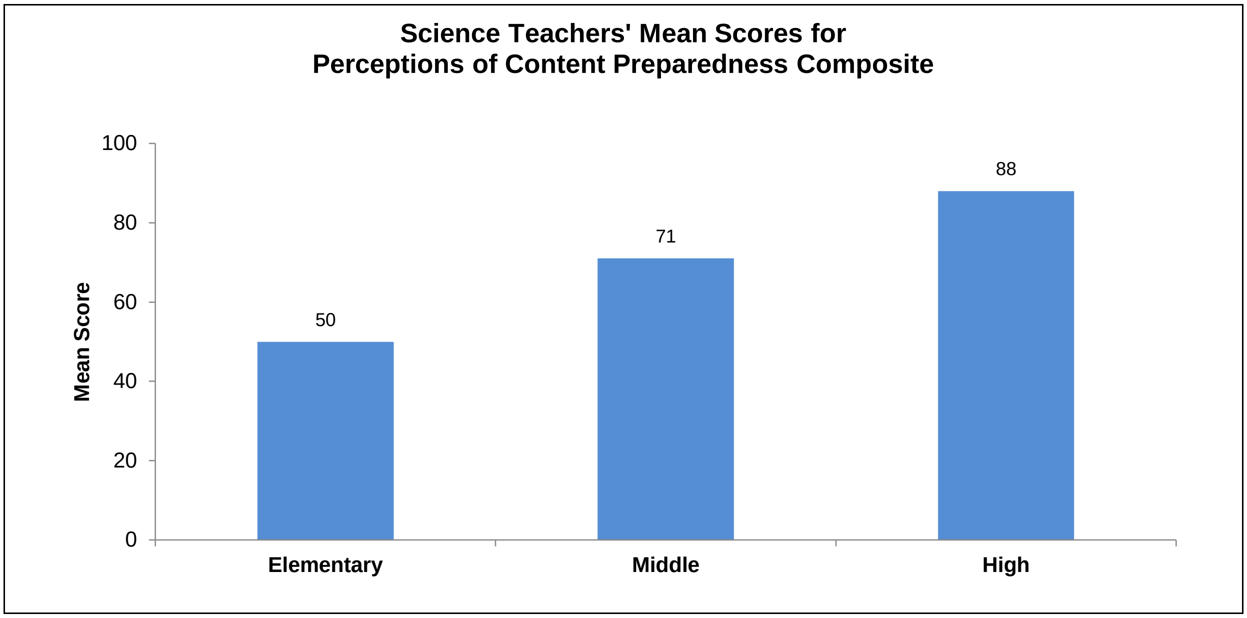


Figure 7

In mathematics, the majority of elementary teachers feel 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 8).

[10] To facilitate the reporting of large amounts of survey data, and because individual questionnaire items are potentially unreliable, HRI used factor analysis to identify survey questions that could be combined into "composites." Each composite represents an important construct related to science, mathematics, or computer science education.

[11] Composite definitions for these and other composites in this report can be found in the *Report of the 2018 NSSME+*.

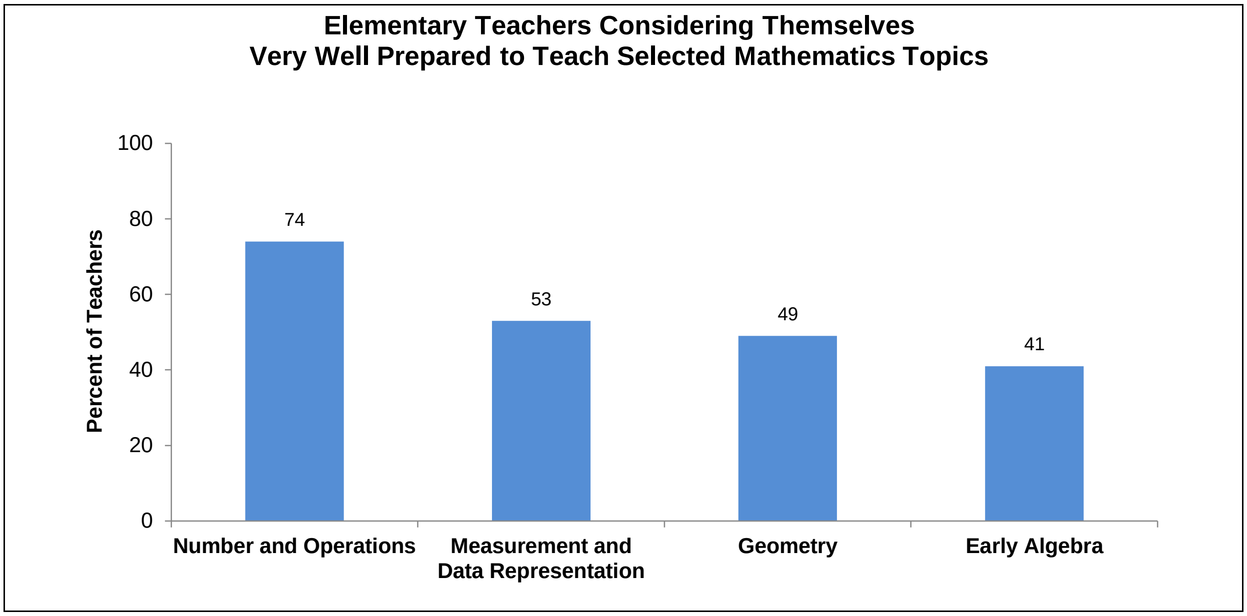


Figure 8

Middle and high school mathematics teachers are most likely to feel very well prepared to teach the number system and operations as well as algebraic thinking, and far less likely to feel that level of preparedness for discrete mathematics. High school mathematics teachers are substantially more likely than middle school teachers to feel very well prepared to teach many topics, such as functions and modeling. However, in the case of statistics and probability, middle grades teachers are more likely than high school teachers to feel very well prepared.

Figure 9 shows mathematics teachers' scores on the Perceptions of Content Preparedness composite. Similar to science teachers, high school mathematics teachers feel better prepared than middle school mathematics teachers. Elementary teachers feel as prepared to teach mathematics as do middle school mathematics teachers, and substantively more prepared in mathematics than they do in science.

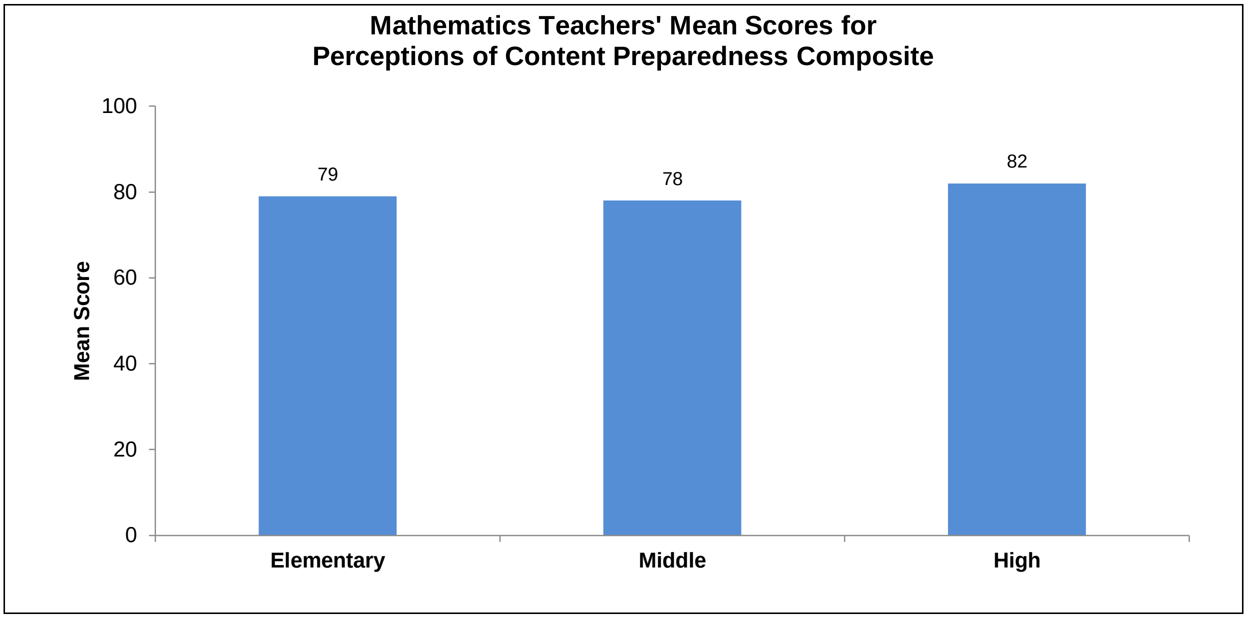


Figure 9

High school computer science teachers were also asked about their preparedness to teach each of a number of topics related to computing and programming. As can be seen in Figure 10, fewer than half consider themselves very well prepared in any of the topics, though they are more likely to feel well prepared to teach about algorithms and programming than about networks and the Internet (47 vs. 23 percent, respectively).

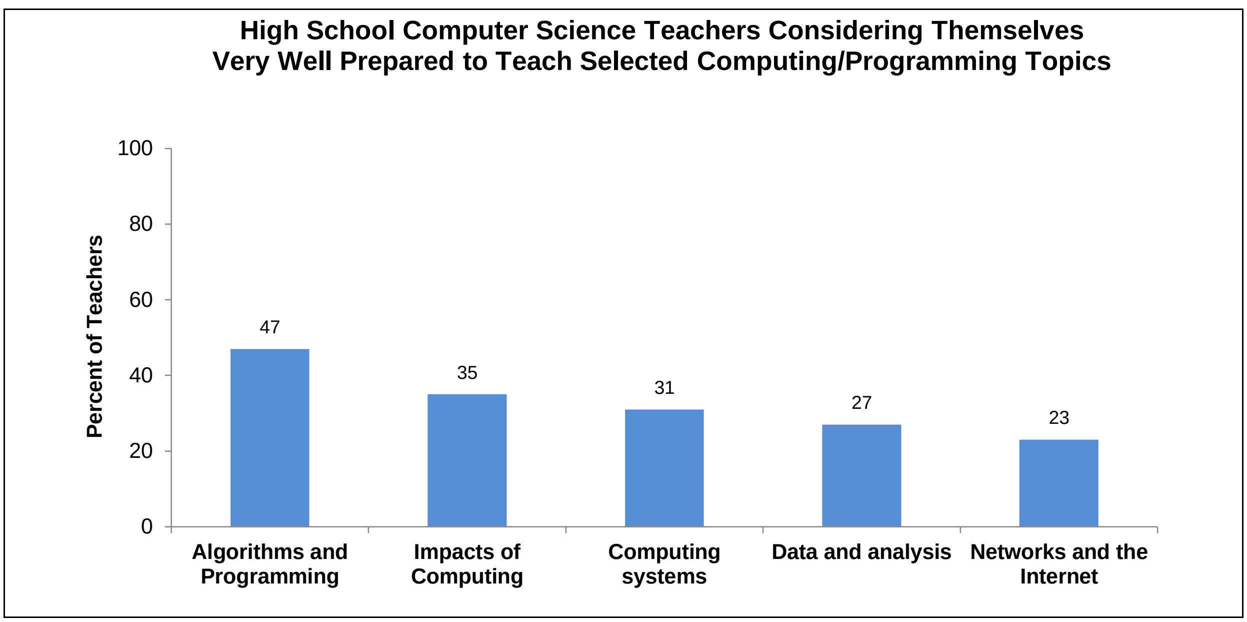


Figure 10

Distribution of Well-Prepared Teachers

Analyses were conducted to examine how teachers are distributed among schools—for example, whether teachers with the least experience are concentrated in high-poverty schools (i.e., schools with high proportions of students eligible for free/reduced-price lunch). The 2018 NSSME+ found that well-prepared science teachers are not equitably distributed among classes and schools. As can be seen in Figure 11, science classes categorized as consisting of mostly high prior achievers are more likely than those categorized as mostly low prior achievers to be taught by teachers who feel well prepared to teach science content, implement pedagogies (e.g., develop students' abilities to do science, encourage students' interest in science and/or engineering), and implement instruction in a particular unit. Although the same pattern appears in teachers' perceptions of preparedness to teach engineering content, the difference between classes of mostly high prior achievers and mostly low prior achievers is not statistically significant.

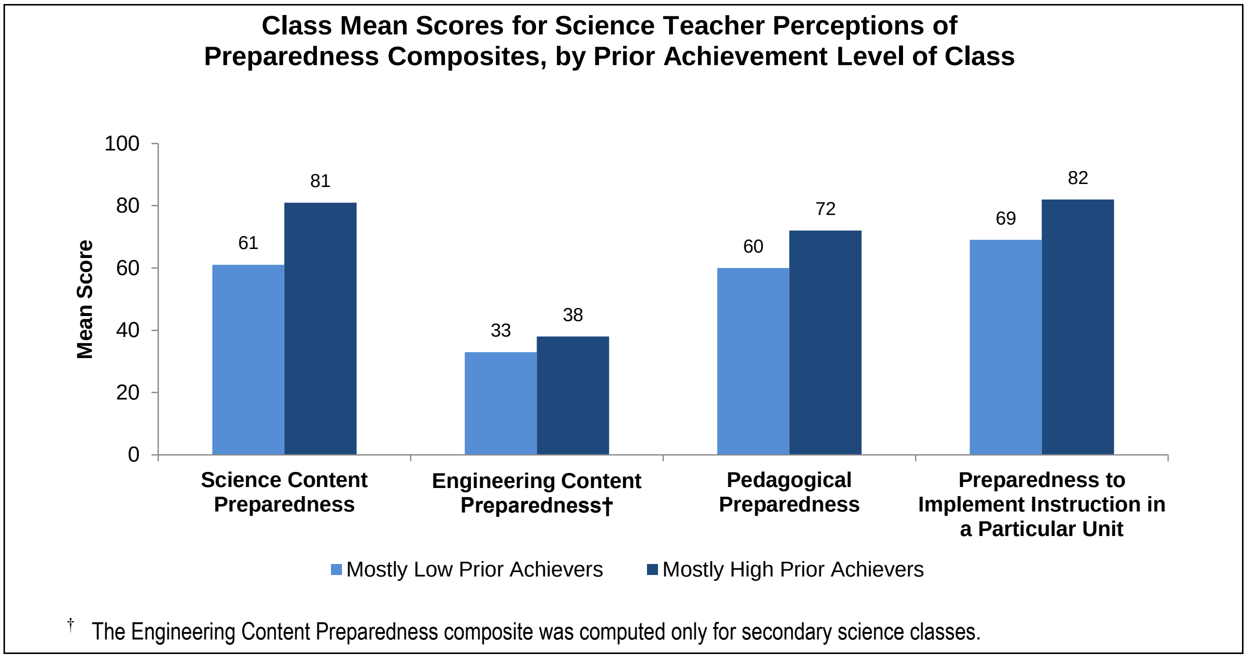


Figure 11

Science classes of mostly high-prior-achieving students are also more likely than classes consisting of mostly low-prior-achieving students 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.

In mathematics, classes of mostly high prior achievers are significantly more likely than those that include mostly low prior achievers to be taught by teachers who feel well prepared in mathematics content and to implement instruction in a particular unit, although the contrast is not as dramatic as in science (see Figure 12).

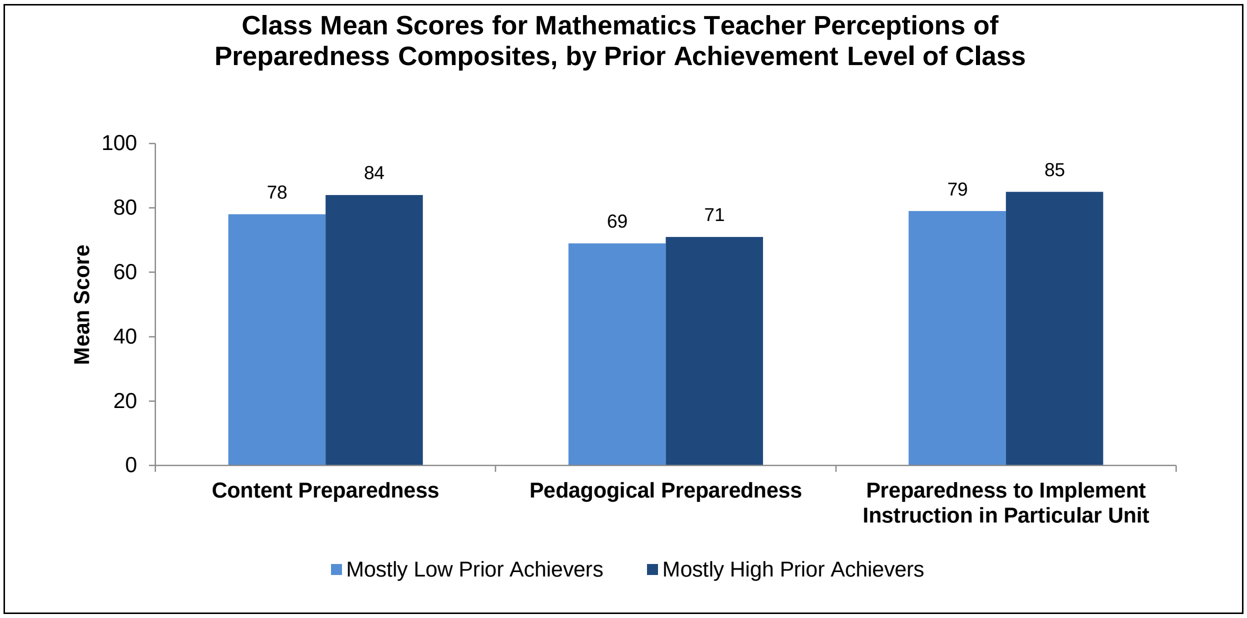


Figure 12

No high school computer science classes in the sample were made up of mostly low-prior-achieving students, so it is not possible to examine the three composites by prior achievement level of the class. However, a majority of computer science classes in high-poverty schools are taught by those with only 0–2 years of experience teaching the subject.

Science, Mathematics, and Computer Science Professional Development

Science, mathematics, and computer science 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/computer science content. The 2018 NSSME+ collected data on teachers' participation in professional activities, such as workshops and teacher induction programs provided by schools and districts.

Teacher Professional Development

Figure 13 displays the percentage of teachers who participated in more than 35 hours of subject-focused professional development in the last three years. Although roughly 80 percent or more of middle and high school science teachers, and over half of elementary teachers, have participated in science-focused professional development in the last three years, only about one-third of secondary teachers and just 5 percent of elementary teachers have had more than 35 hours of professional development in that time period. Similarly, 80–90 percent of mathematics teachers, depending on grade level, have participated in mathematics-focused professional development in the last three years. However, just over one-third of secondary teachers and only 13 percent of elementary teachers have had more than 35 hours of professional development in that time period. In contrast, over half of high school computer science teachers participated in this amount of professional development related to computer science or computer science teaching. This finding most likely reflects the recent national emphasis on computer science in STEM education and the push to develop students' computational thinking skills. In addition, as only a quarter of computer science teachers have a degree in their field, it is likely that they have had to participate in professional development in order to teach the subject.

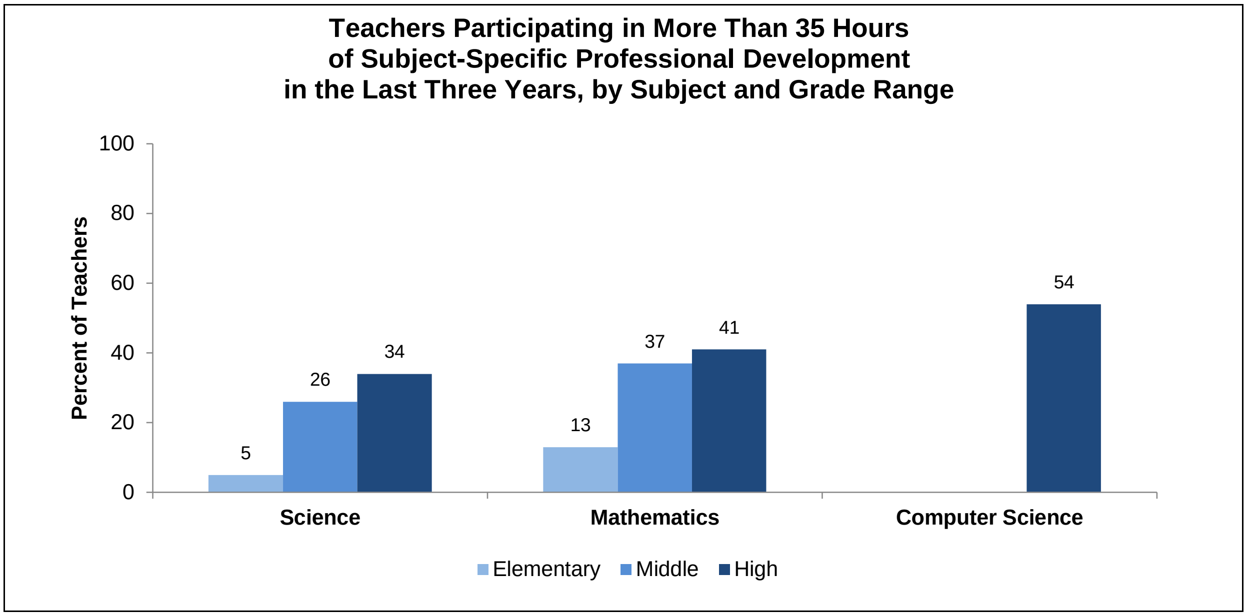


Figure 13

For each subject/grade-range combination, workshops are by far the most prevalent professional development activity, with roughly 90 percent of teachers indicating they had attended a program/workshop related to their discipline.

There are several agreed upon elements of effective professional development, including having teachers work with colleagues who face similar challenges, engaging teachers in investigations, and examining student work/classroom artifacts. Teachers who had participated in professional development in the last three years were asked a series of questions about the nature of their experiences. Responses to these items describing the characteristics of professional development experiences were combined into a single composite variable called Extent Professional Development Aligns with Elements of Effective Professional Development. As can be seen in Figure 14, the mean scores on this composite are similar across subject/grade-range categories, except for elementary science, where scores are lower than the other subject/grade-range combinations.

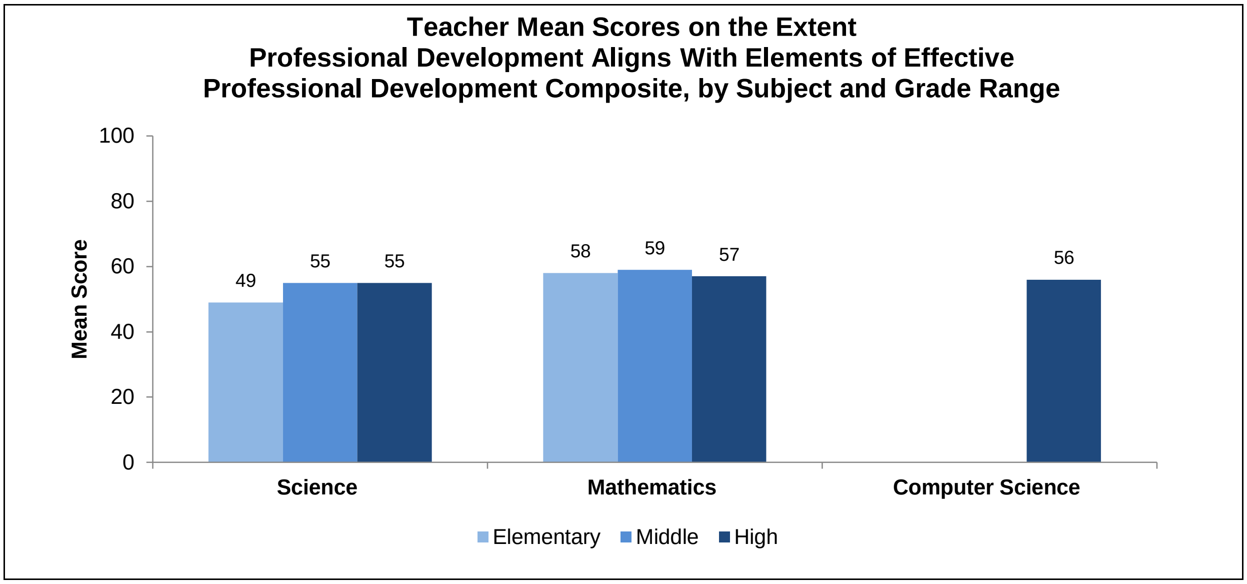


Figure 14

Teachers were also asked to rate the extent to which their professional development experiences in the last three years emphasized student-centered instruction, including monitoring student understanding, finding out what students think or already know before instruction on a topic, and incorporating students' cultural backgrounds into instruction. The items were combined into a composite variable titled Extent Professional Development Supports Student-Centered Instruction. As can be seen in Figure 15, professional development for elementary mathematics is more likely than professional development for elementary science to support student-centered instruction. Interestingly, in science, professional development for middle and high school teachers gives more emphasis to student-centered instruction than professional development for elementary teachers, but in mathematics, professional development for elementary teachers is more likely to have this focus compared to what high school mathematics teachers experience. Lastly, the mean score for high school computer science teachers is significantly higher than the mean scores for both science and mathematics high school teachers.

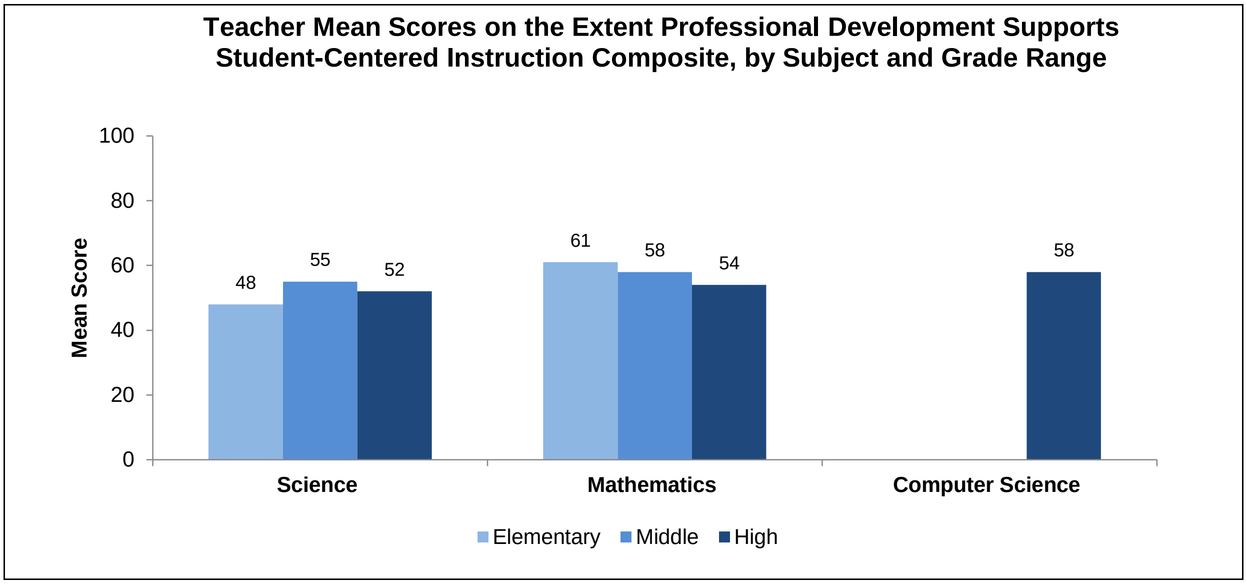


Figure 15

Teacher Induction Programs

Formal induction programs provide critical support and guidance for beginning teachers and show promise for having a positive impact on teacher retention, instructional practices, and student achievement in schools.[12] However, the effectiveness of these programs greatly depends on their length and the nature of the supports offered to teachers.

Roughly 70 percent of schools across the grade bands offer formal teacher induction programs. About a third of schools have programs that last one year or less, and about a fourth of schools have programs that last two years. It is rare for schools to have an induction program of three years or more. Of schools that do offer induction programs, a majority of them are developed and implemented by either the district or the school.

Across grade bands, the types of supports provided as part of a formal induction program are relatively similar. The most predominant supports for beginning teachers, offered by 74 percent or more of schools at any grade level, are a meeting to orient them to school policies and practices, formally assigned school-based mentors, and professional development opportunities on teaching their subject. Elementary and middle schools are more likely than high schools to offer common planning time with experienced teachers who teach the same subject or grade level (76, 68, and 52 percent, respectively). In contrast, high schools are more likely than middle or elementary schools to provide release time for beginning teachers to attend national, state, or local conferences (51, 38, and 33 percent, respectively).

Distribution of Professional Development

Equity factors are related to the extent to which science, mathematics, and computer science classes with different demographic characteristics—in particular prior achievement level of the class and proportion of students from race/ethnicity groups historically underrepresented in

[12] Ingersoll, R., & Strong, M. (2011). *The impact of induction and mentoring programs for beginning teachers: A critical review of the research.* Retrieved from https://repository.upenn.edu/gse_pubs/127.

STEM—have access to teachers with substantive professional development experiences. For example, science classes composed of mostly low prior achievers are less likely than classes of high prior achievers to be taught by teachers who have participated in: (1) a substantial amount of professional development, (2) professional learning experiences aligned with characteristics of effective professional development, and (3) professional development that supports student-centered instruction. In mathematics, classes with mostly low prior achievers and students from race/ethnicity groups historically underrepresented in STEM have an advantage over their counterparts when it comes to having access to teachers with a large amount of professional development and experiences aligned with effective practices.

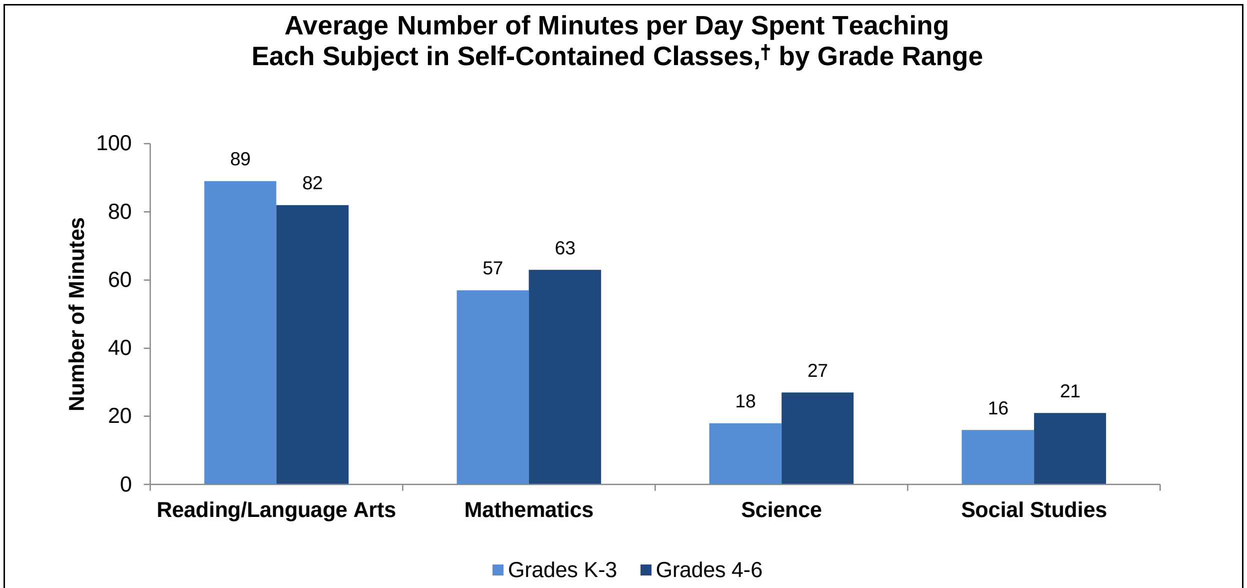
The percentages of schools offering a formal teacher induction program are relatively equally distributed when analyzed by various school-based equity factors, including poverty level, community type, and region. However, it is not surprising that the largest schools are more likely than the smallest schools to have induction programs for beginning teachers.

Science, Mathematics, and Computer Science Courses

The 2018 NSSME+ collected data on science, mathematics, and computer science course offerings in the nation's schools, including time spent on science and mathematics instruction in the elementary grades, availability of science, mathematics, and computer science courses at the secondary level; and composition of classes (e.g., gender, race/ethnicity, and prior achievement levels of students).

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 16). Although mathematics is taught in nearly all classes on most or all school days, science is taught every day of the week, every week of the school year in only 35 percent of grades 4–6 classes and 17 percent of grades K–3 classes.



† Only teachers who indicated they teach reading/language arts, mathematics, science, and social studies to one class of students were included in these analyses.

Figure 16

High School Science, Mathematics, and Computer Science Course Offerings

Figure 17 shows the areas in which high schools offer science courses. Almost all schools with grades 9–12 offer courses in biology/life science and chemistry. Most high schools offer physics courses and coursework in coordinated/integrated science (including physical science). Fewer high schools offer courses in environmental science or Earth/space science than in the other science disciplines. Nearly one-half of high schools offer at least one engineering course.

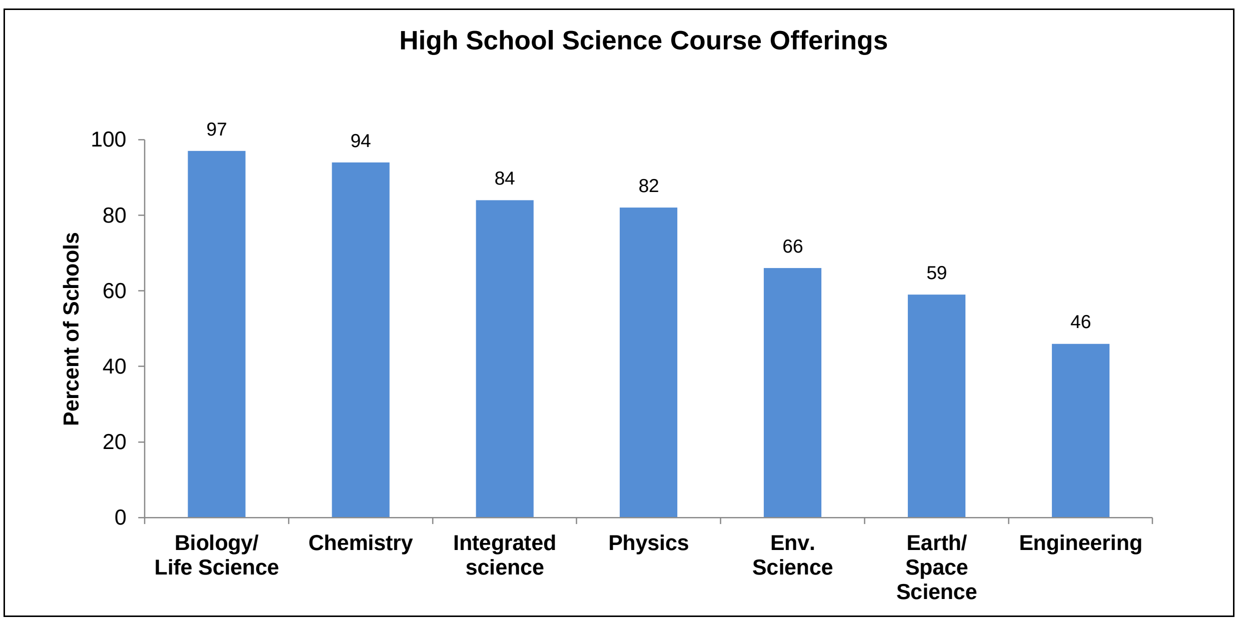


Figure 17

Figure 18 shows the percentage of high schools offering Advanced Placement (AP) science courses in different topics and the percentage of grades 9–12 students in the nation at those schools. Biology is the most commonly offered AP course, available in about 4 in 10 high schools. About the same proportion offer some form of AP Physics, with AP Physics 1 being the most common type. AP Chemistry is offered in roughly 1 in 3 schools and AP Environmental Science in about 1 in 4 high schools. That the percentage of high school students with access to each course is much larger than the percentage of schools offering it indicates that larger schools are more likely than smaller schools to offer AP science courses.

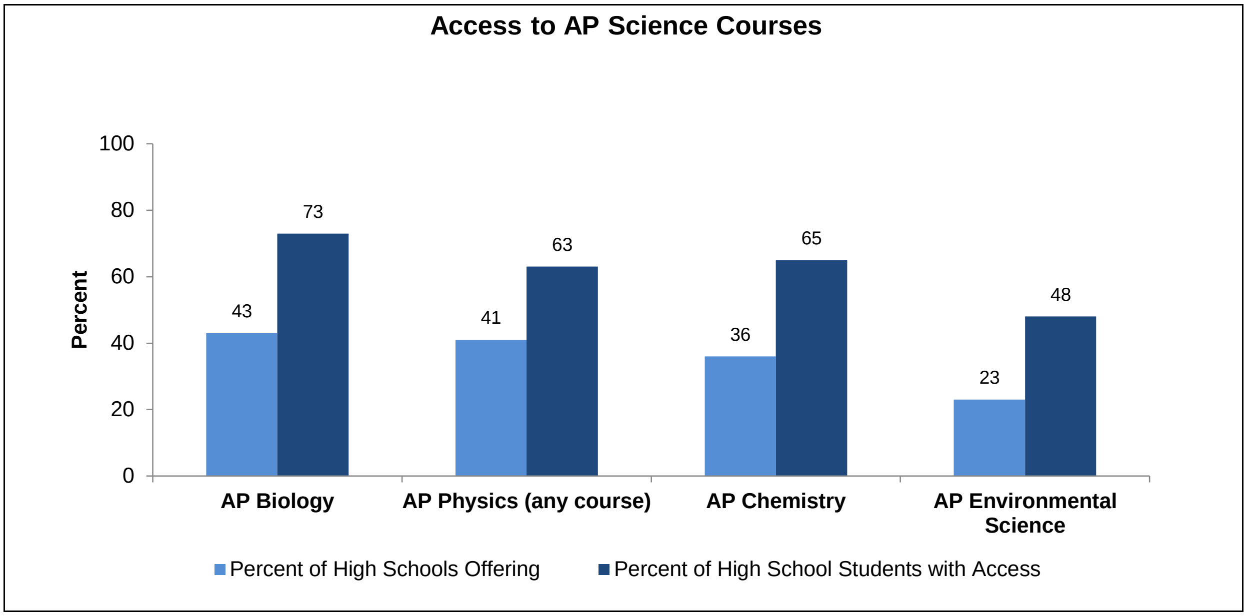


Figure 18

As can be seen in Figure 19, nearly all high schools offer a 1st year formal/college prep mathematics course such as Algebra 1 or Integrated Math 1. The vast majority of high schools also offer a second, third, and fourth year of formal mathematics. Almost three-fourths of high schools offer mathematics courses that might qualify for college credit, such as AP Calculus or AP statistics, and just over that many offer non-college prep courses.

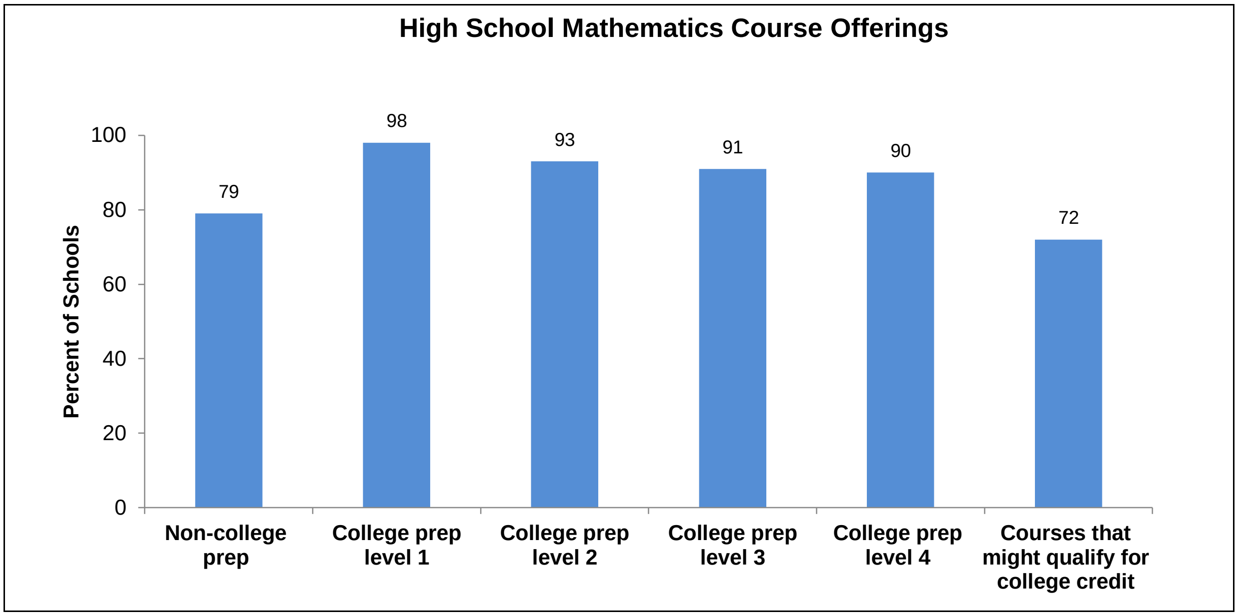


Figure 19

About half of high schools offer AP Calculus, typically AP Calculus AB. AP Calculus BC and AP Statistics are each offered by about one-third of high schools (see Figure 20). As is the case in science, the percentage of grades 9–12 students with access to each course is substantially greater than the percentage of schools offering it, indicating that AP mathematics courses are more likely to be offered in larger schools.

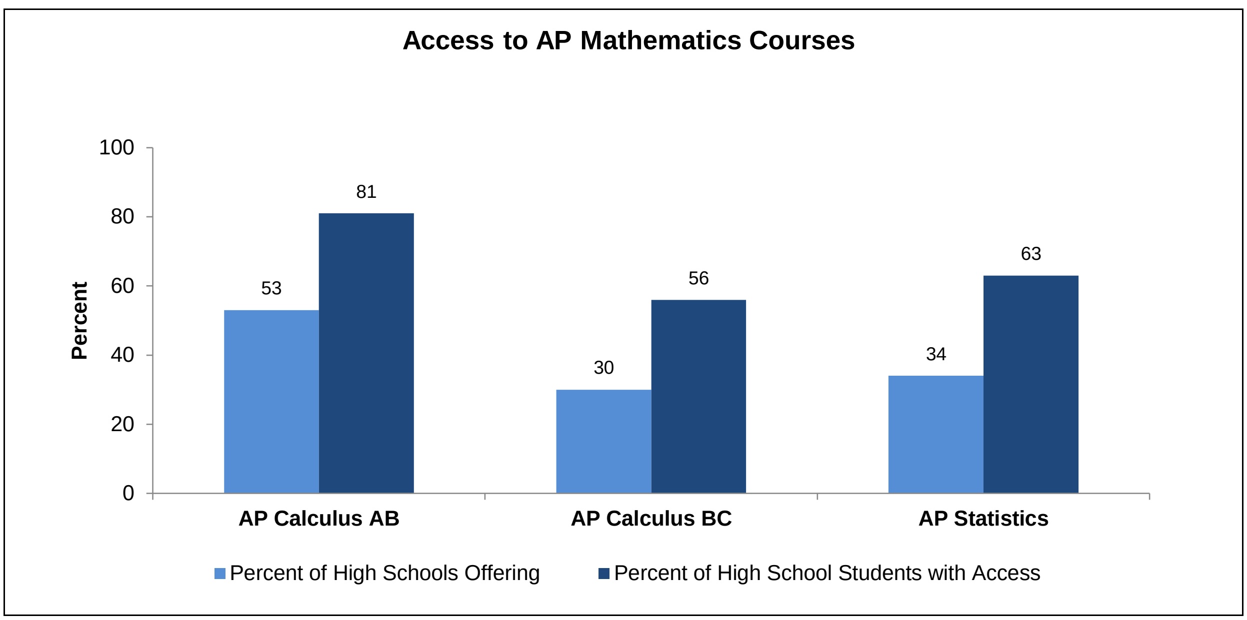


Figure 20

Computer science instruction is offered at only some schools, unlike science and mathematics (see Figure 21). About 1 in 4 elementary schools and 1 in 3 middle schools offer computer programming instruction as part of the regular school day. About half of high schools offer one or more computer courses.

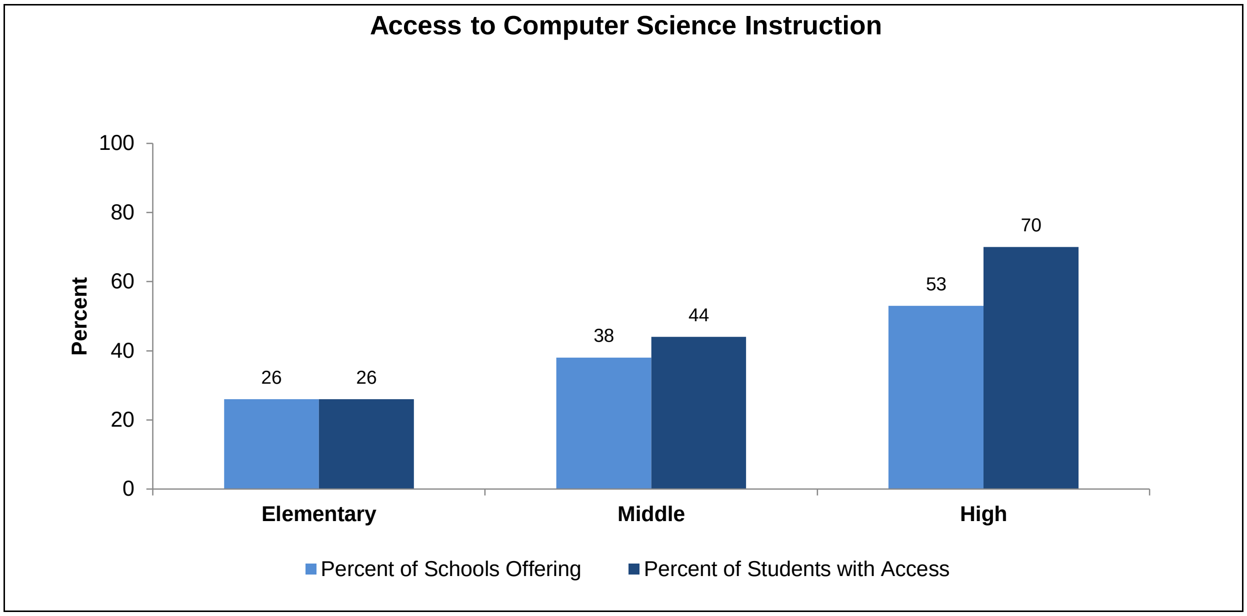


Figure 21

The percentages of schools offering different types of computer science and computer technology courses are shown in Figure 22. Almost half of high schools offer computer technology courses that do not include programming. Introductory high school computer science courses and computer science courses that might qualify for college credit are each offered at about a third of high schools. Specialized computer science courses that require programming as a prerequisite are offered at only about 1 in 5 high schools.

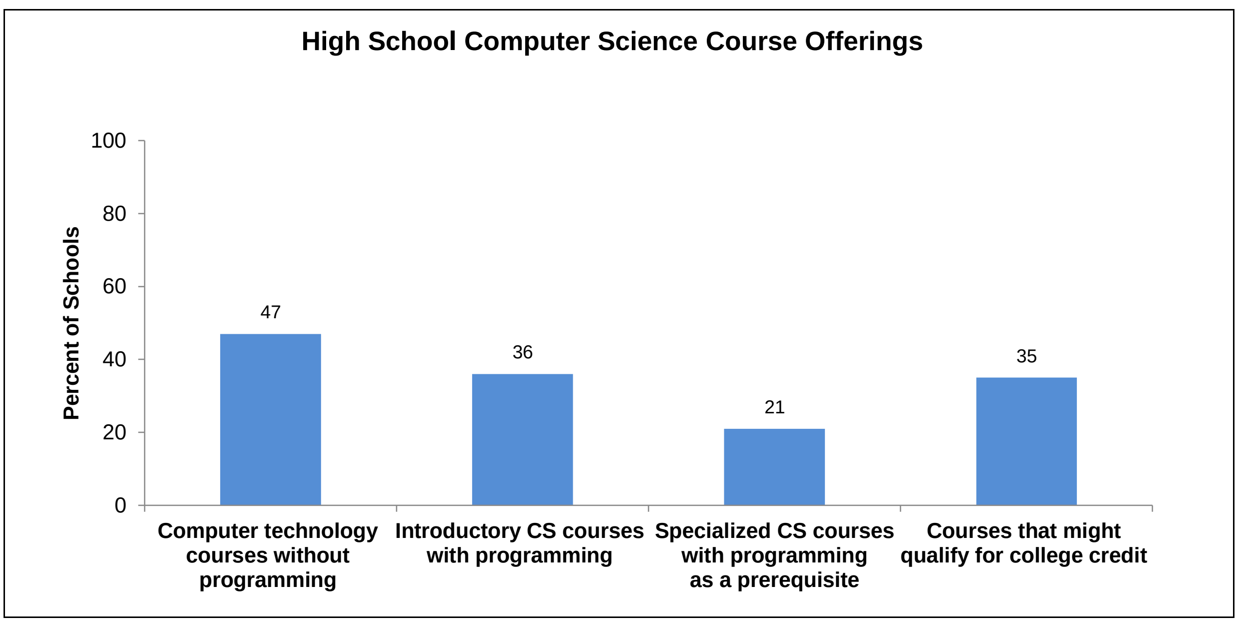


Figure 22

As can be seen in Figure 23, AP Computer Science A and AP Computer Science Principles are offered in about 1 in 6 high schools. Similar to science and mathematics, the percentage of grades 9–12 students with access to each course is substantially greater than the percentage of schools offering it, but is still quite low.

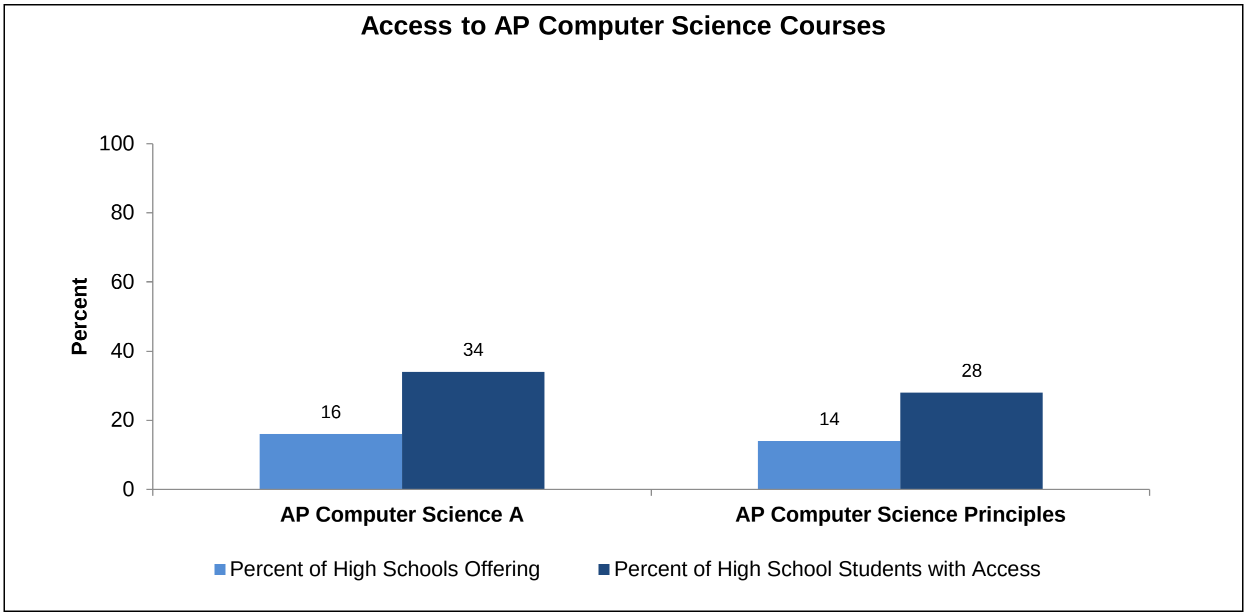


Figure 23

Distribution of Courses

A pattern of decreasing enrollment of students from race/ethnicity groups historically underrepresented in STEM is seen in the class composition data across the progression of high school science courses (see Figure 24). For example, students from these groups make up 43 percent of students in non-college prep science classes and 35 percent of students in 1st year biology classes, compared to only 27 percent in advanced science classes. In terms of gender, high school science courses tend to have classes that are evenly split between male and female students on average. Exceptions are non-college prep classes and 1st year physics classes, which have smaller percentages of female students.

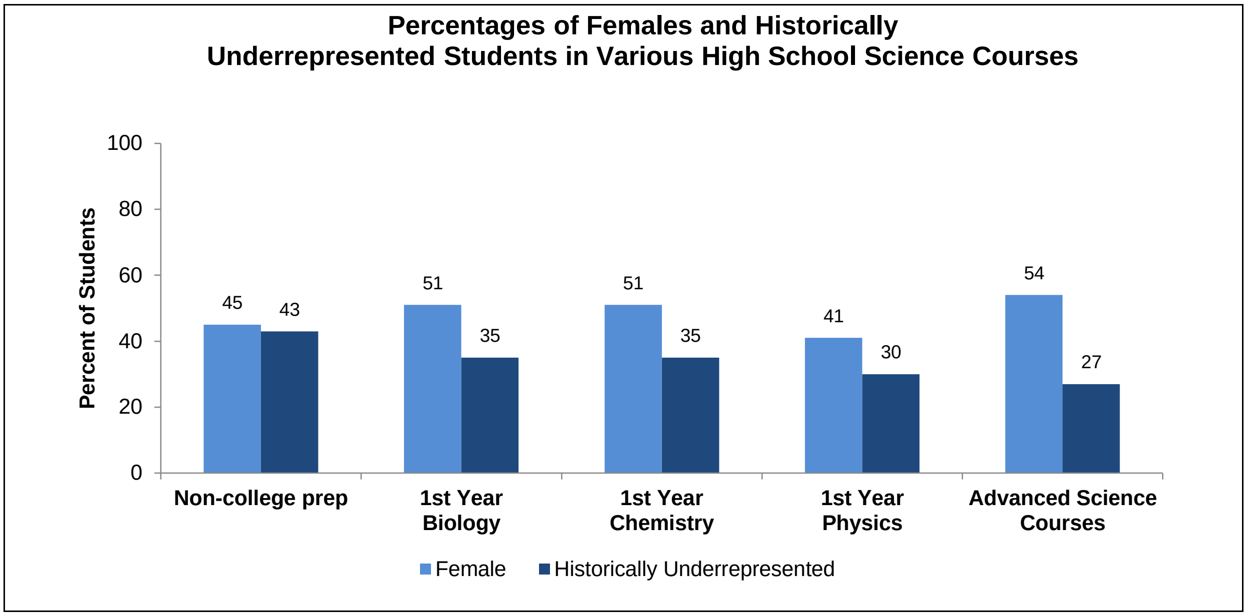


Figure 24

As can be seen in Figure 25, in mathematics again the greatest percentage of students from historically underrepresented race/ethnicity groups are in non-college prep courses (53 percent). Thirty-eight percent of students in formal/college prep level 1 classes are from race/ethnicity groups historically underrepresented in STEM, compared to only 22 percent of students in classes that might qualify for college credit. Females are as likely as males to take all high school mathematics courses except non-college prep courses.

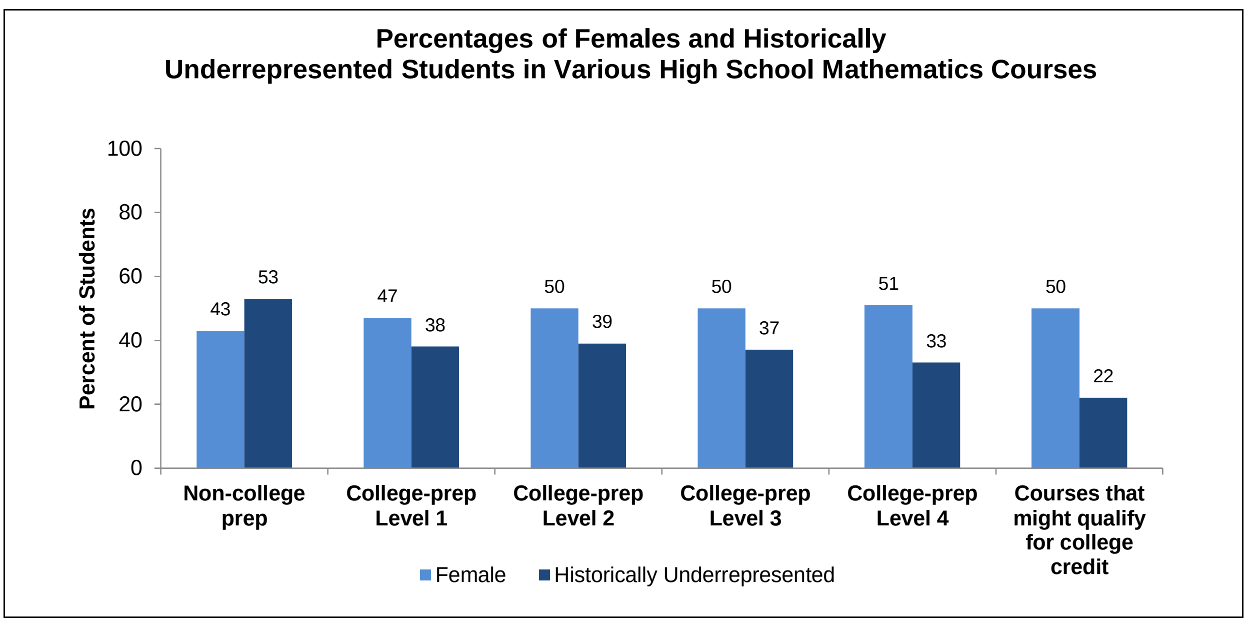


Figure 25

Neither female students nor students from historically underrepresented groups make up much of computer science course enrollment. Thirty percent or fewer of all computer science students are females or students historically underrepresented in STEM (see Figure 26).

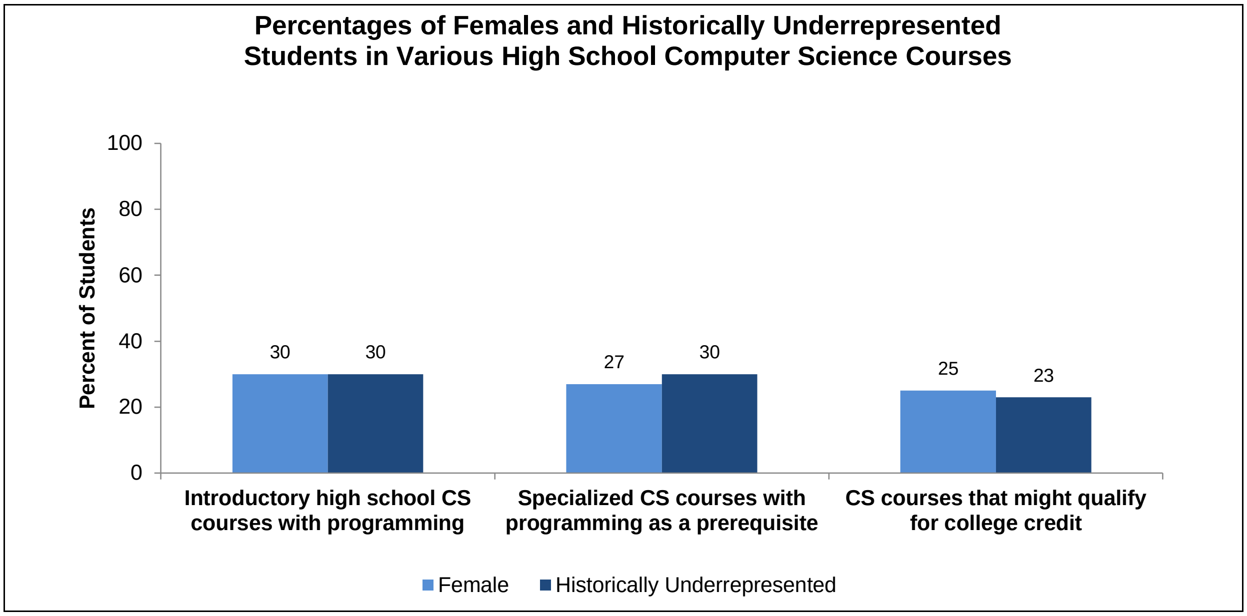


Figure 26

AP courses are less likely to be offered in schools with a high proportion of students eligible for free/reduced-price lunch and more likely to be offered in large schools. AP courses are also more common in suburban and urban schools than in rural schools.

Instructional Decision Making, Objectives, and Activities

The 2018 NSSME+ collected data about teachers' perceptions of their autonomy in making curricular and instructional decisions, as well as their instructional objectives and class activities they use in accomplishing these objectives.

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 27–29, teachers perceive much more control over decisions related to pedagogy than curriculum, especially in science and mathematics classrooms. Additionally, secondary teachers perceive more control in both science and mathematics classes than elementary teachers. Interestingly, high school computer science teachers have higher perceptions of curriculum control than do their science and mathematics counterparts.

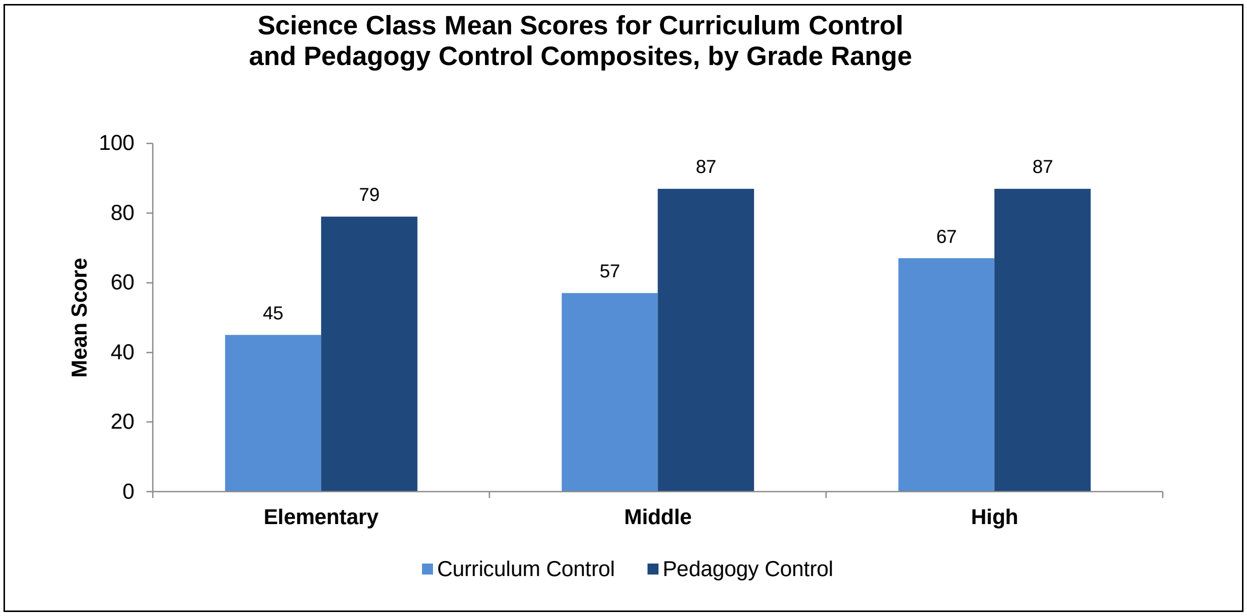


Figure 27

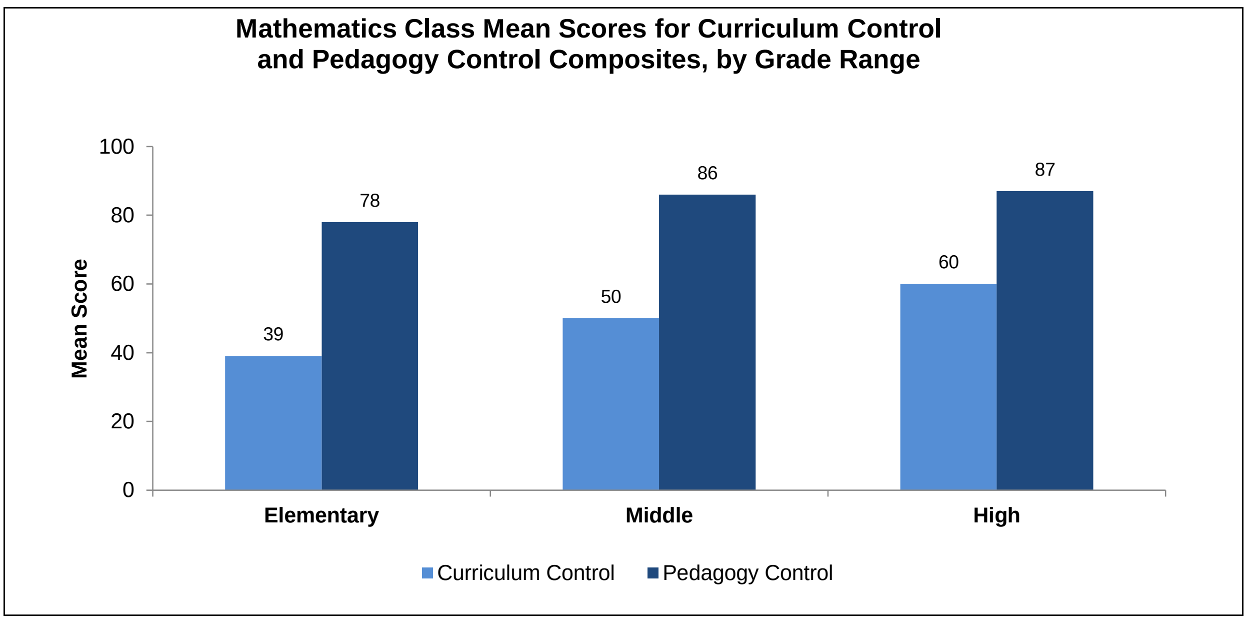


Figure 28

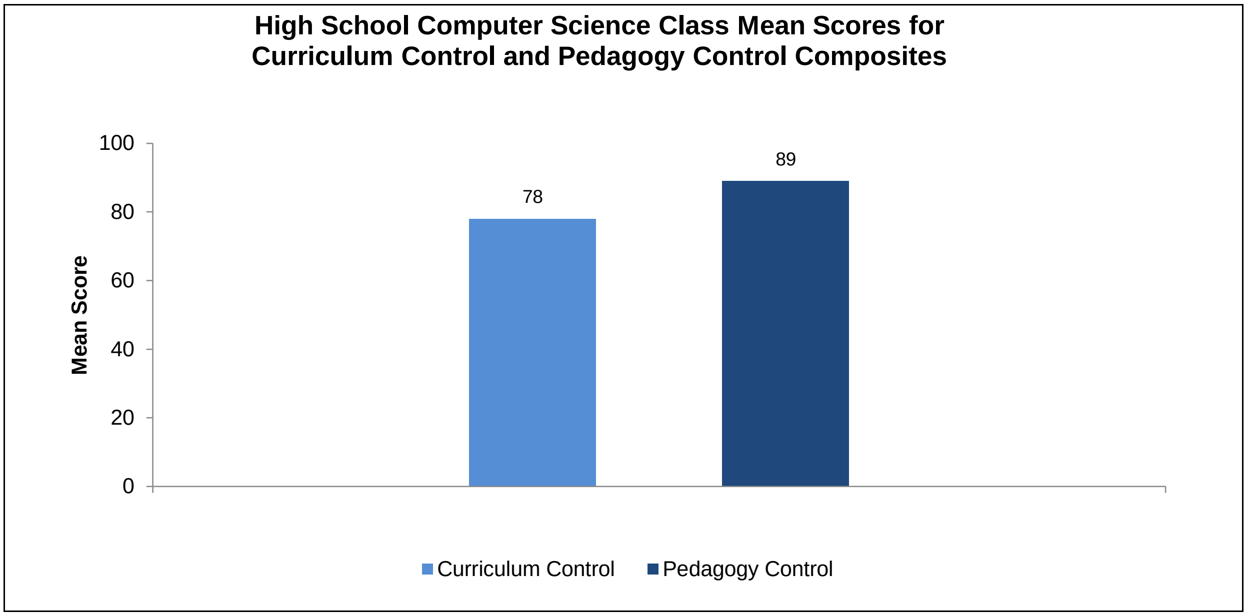


Figure 29

Instructional Objectives

Figure 30 displays class mean scores for all three grade levels and subjects on the reform-oriented instructional objectives composite, which is comprised of objectives such as understanding concepts, increasing student interest in the subject, and learning about real-life applications of the subject. Teachers of classes at all grade levels and subjects are fairly likely to emphasize reform-oriented instructional objectives. However, computer science and mathematics classes are more likely than science classes to emphasize these objectives.

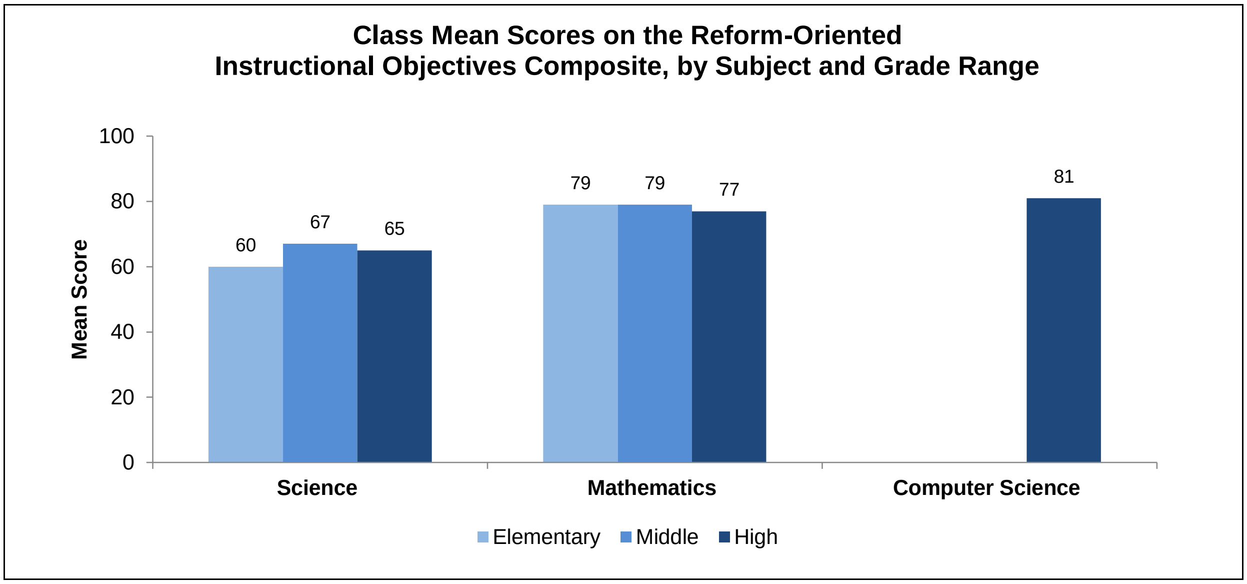


Figure 30

Instructional Activities

As can be seen in Figure 31, lecture and discussion are very common in science instruction. Teachers explaining a science idea to the whole class occurs at least once a week in roughly 90 percent of science classrooms across grade levels. The use of whole class discussion is also prevalent in elementary and middle school classrooms, but is less common in high school classrooms. About half of elementary school classes have students do hands-on/laboratory activities at least once a week, compared about two-thirds of secondary classes.

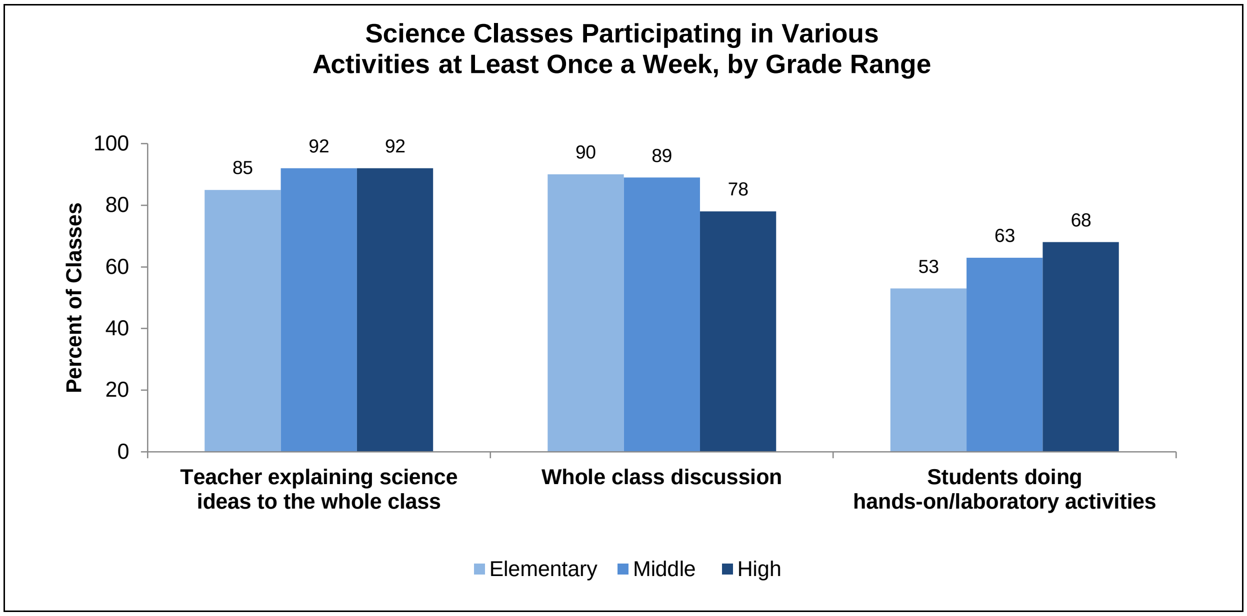


Figure 31

In mathematics, as in science, instruction commonly includes lecture at least once a week (95 percent of classes at each grade level) and whole class discussion (84 percent or more of lessons). A striking difference between elementary and secondary classes is in the use of hands-on/manipulative activities. At the elementary level, students use manipulatives in problem-solving/investigations at least once a week in 78 percent of classes, compared with only 29 percent of middle school mathematics classes and 20 percent of high school mathematics classes (see Figure 32).

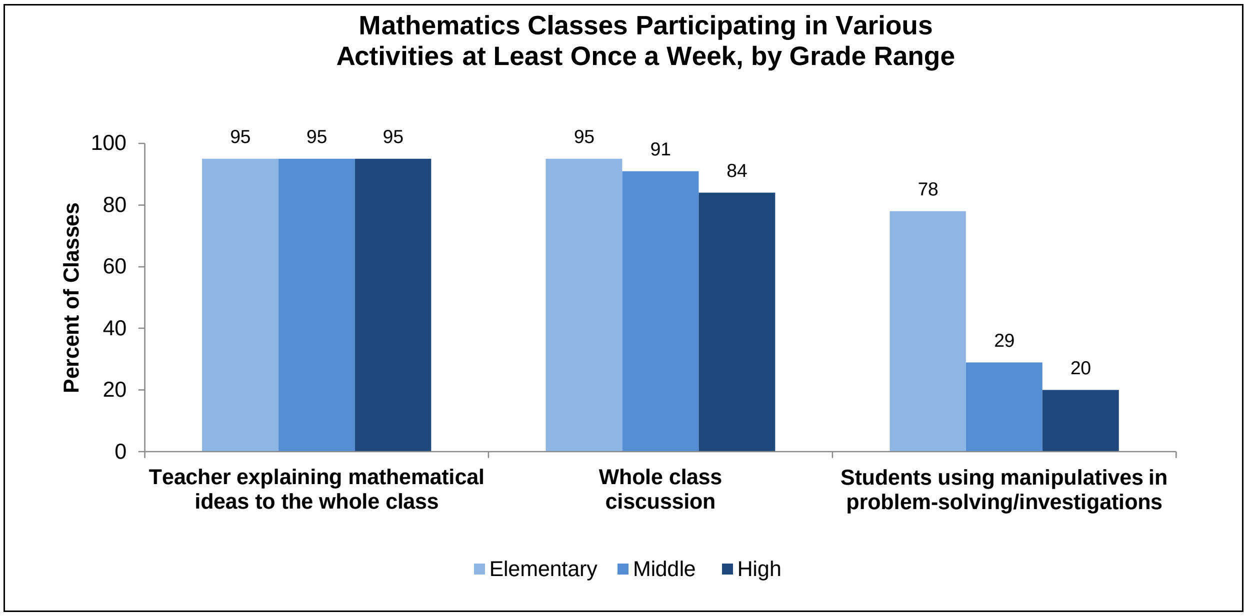


Figure 32

In stark contrast to high school mathematics classes, nearly all high school computer science classes include students doing hands-on activities—in this case, working on programming activities on computers—at least once a week. A large proportion of high school computer science classes also frequently include the teacher explaining ideas and whole class discussions (see Figure 33).

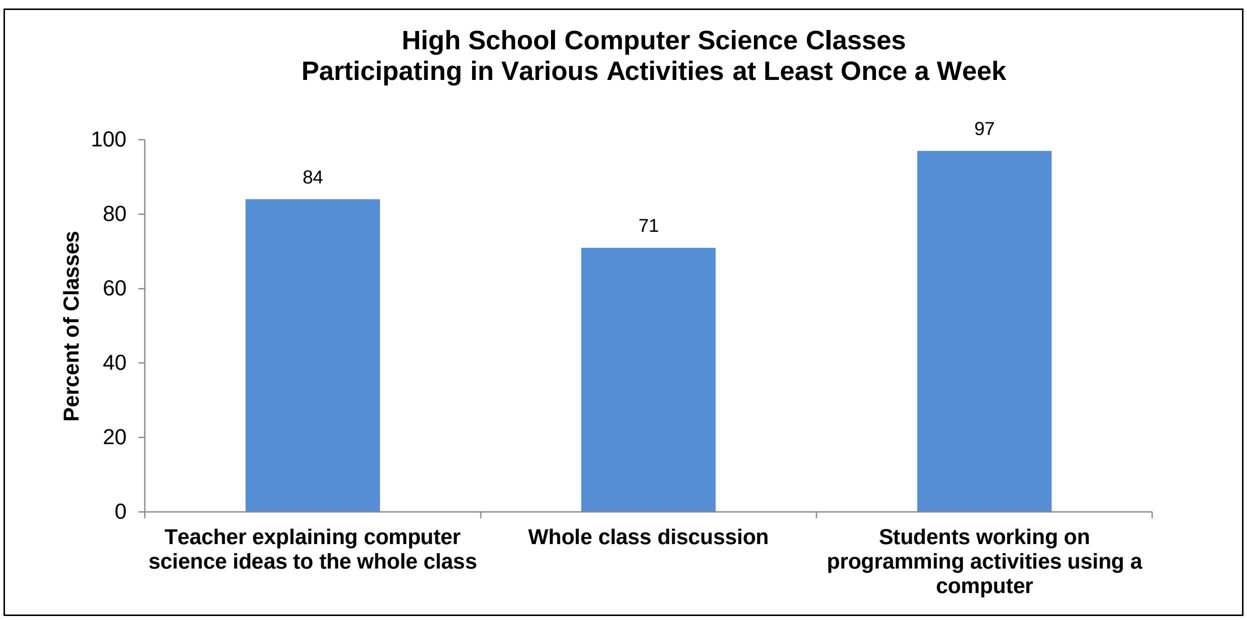


Figure 33

In addition to general instructional activities, teachers were asked about their use of specific practices described in *A Framework for K–12 Science Education, Common Core State Standards—Mathematics,* and the *CSTA K–12 Computer Science Standards*. Such practices include formulating scientific questions, designing and implementing investigations, engaging in argumentation, making sense of problems, critiquing the reasoning of others, developing and using abstractions, and communicating about computing.

In science classes, students often engage in aspects of science related to conducting investigations and analyzing data. For example, about half of middle and high school classes have students organize and represent data, make and support claims with evidence, conduct scientific investigations, and analyze data at least once a week. At the elementary level, about a third of classes engage students in these activities weekly. However, across all grade bands, 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. For example, fewer than a quarter of secondary science classes have students, at least once a week, pose questions about scientific arguments or evaluate the credibility of scientific information. Even fewer elementary classes engage students in these activities weekly, and about a third never do so.

Across all grade levels of mathematics, students are unlikely to be engaged in aspects of mathematics practices on a daily basis; however, they are relatively likely to engage with them at least once a week. For example, in three-quarters or more of classes across the grade bands, students are asked to determine whether their answer makes sense; provide mathematics reasoning to explain, justify, or prove their thinking; develop representations of aspects of problems; and continue working through mathematics problems when they reach points of difficulty, challenge, or error.

In high school computer science, activities related to testing and refining computational artifacts occur most frequently. For example, creating computational artifacts, writing comments within code, considering how to break a program into modules/procedures/objects, and adapting existing code to a new problem occur weekly in 60 percent or more of classes. Aspects of computer science related to end users are less often emphasized. For example, only 30 percent of classes have students create instructions for an end-user explaining a computational artifact on a weekly basis. Similarly, fewer than a quarter of high school computer science classes have students create a computational artifact to be used by someone else or get input on computational products from people with different perspectives at least once a week.

The items for each subject were combined into composites titled Engaging Students in the Practices of Science, Engaging Students in the Practices of Mathematics, and Engaging Students in the Practices of Computer Science. Scores on these composites for each grade level are displayed in Figure 34. The scores on the science practices composite indicate that students are more likely to be engaged in doing science in middle and high school classes than they are in elementary classes and that students engage in this set of practices, on average, just once or twice a month or less. Similarly, the overall score of 56 on the computer science practices composite indicates that, on average, computer science students engage with these practices once or twice a month. The scores on the mathematics practices composite are quite similar across grade bands, and indicate that students in most mathematics classes engage in these practices once or twice a week.

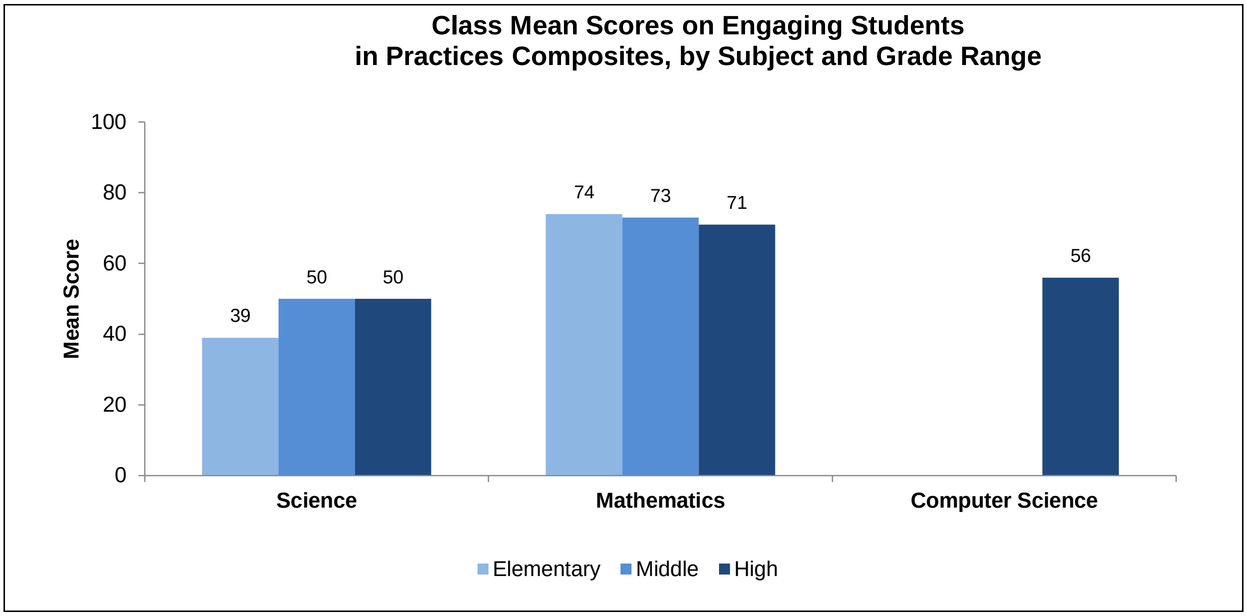


Figure 34

Distribution of Decision Making, Objectives, and Activities

Equity factors, in particular prior achievement level of the class, are related to instruction in science and mathematics. For example, teachers of science classes composed of mostly low prior achievers report having less control over both curriculum and pedagogy than teachers of classes containing mostly high prior achievers (see Figures 35 and 36).

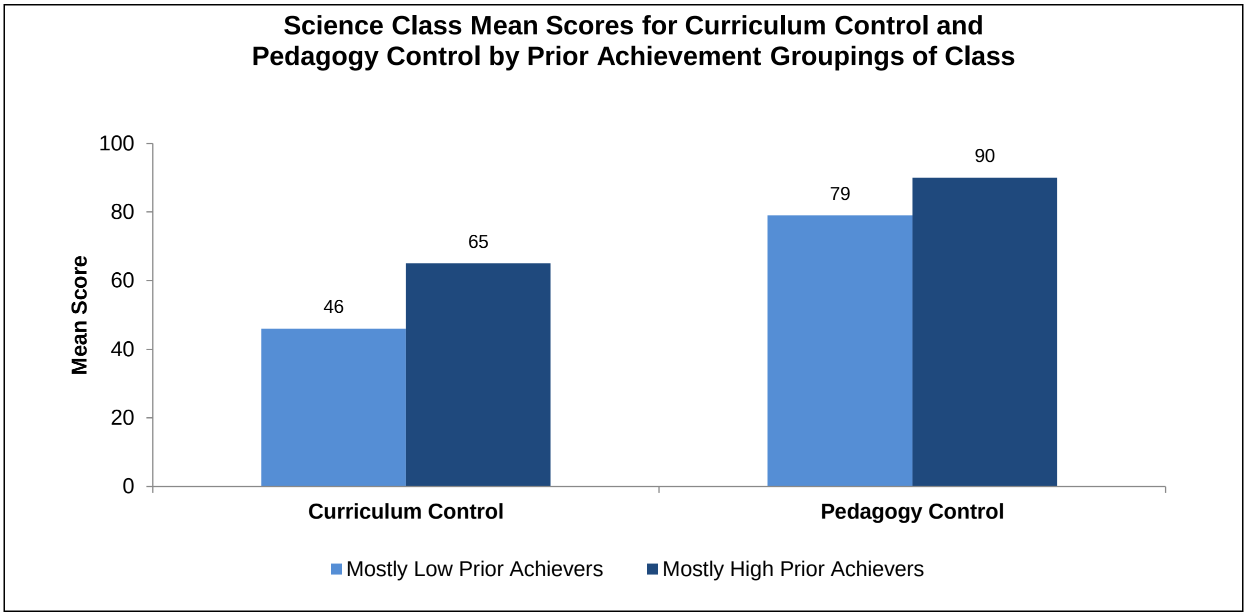


Figure 35

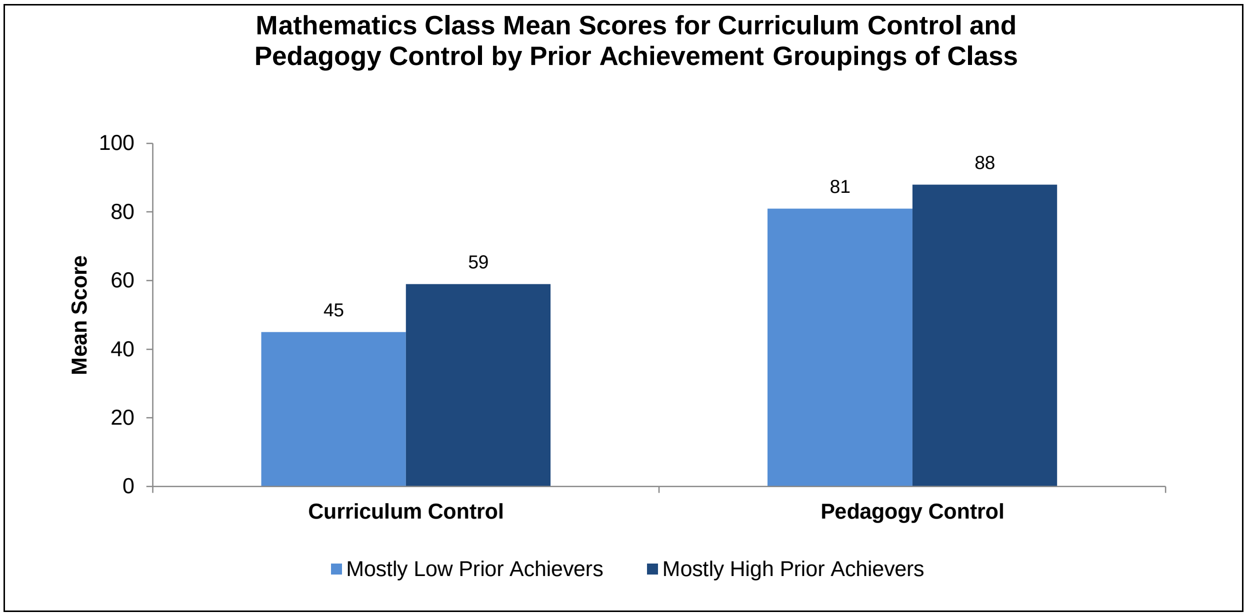


Figure 36

In addition, in both science and mathematics, classes with mostly high-achieving students are more likely to stress reform-oriented objectives than classes consisting of mostly low-achieving students. In high school computer science, the percentage of students in the class from race/ethnicity groups historically underrepresented in STEM is often positively correlated with aspects of instruction considered to be high quality, though even the most diverse computer science classes tend to have relatively few students from these groups.

Instructional Resources

The quality and availability of instructional resources is a major factor in science, mathematics, and computer science teaching. The 2018 NSSME+ included a series of items on textbooks and instructional programs—which ones teachers use and how teachers use them. Program representatives were also asked how much money their schools spent during the most recently completed school year on instructional resources.

Use of Textbooks and Other Instructional Resources

Instructional materials are designated by the district in the majority of science and mathematics classes, particularly at the elementary level (see Figure 37). Overwhelmingly, districts designate commercially published textbooks (in two-thirds of elementary science classes and about 90 percent of middle and high school science classes and all grade levels of mathematics classes). Across both science and mathematics, the same three publishers—Pearson, McGraw-Hill, and Houghton Mifflin Harcourt—dominate, accounting for more than two-thirds of the market at each grade level. In contrast, only about a quarter of high school computer science classes have designated materials, and among them, free, web-based resources are just as common as commercially published materials.

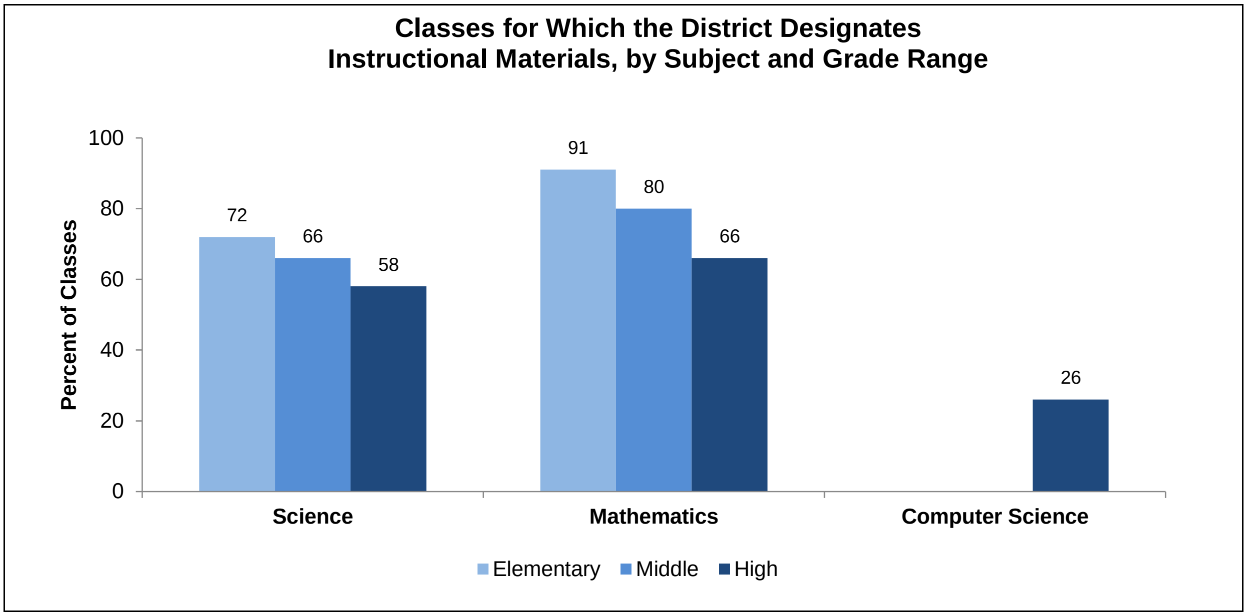


Figure 37

Regardless of whether instructional materials had been designated for their class, teachers were asked how often instruction was based on various types of materials, such as textbooks, units/lessons from free websites, or materials teachers created themselves. In almost half of all elementary science classes, a substantial proportion of teachers use lessons they create themselves and lessons or resources from websites that have a subscription fee or per lesson cost, such as BrainPop and Teachers Pay Teachers, at least once a week. Teacher-created lessons are used weekly in the large majority of middle and high school science classes, and commercially published textbooks are used in about half of secondary science classes at least once a week.

In middle and high school mathematics classes, teacher-created lessons and commercially published textbooks are the most commonly used instructional materials. Textbooks are especially prominent at the elementary level, where three-fourths of classes base instruction on this type of resource at least once a week. Elementary mathematics classes are also much more likely than those at other grade levels to rely on fee-based websites.

In high school computer science, like high school science and mathematics, classes are most likely to be based on teacher-created lessons. However, compared to high school classes in the other subjects, computer science instruction is much less likely to be based on a commercially published textbook and considerably more likely to be based on free websites and online self-paced materials.

Facilities and Equipment

Almost all schools have school-wide Wi-Fi, and the majority have computer labs and laptop/tablet carts available for classes to use. Initiatives in which every student is provided with a computer are found in 35–44 percent of schools. Balances, microscopes, electric outlets, faucets and sinks, and lab tables are available for use in more than 80 percent of middle and high school science classes; their availability is more limited at the elementary level. Almost all high school computer science classes have access to projection devices (e.g., Smartboard, document camera, LCD projector), and more than half have access to robotics equipment. It is interesting to note that only 40 percent of computer science classes have access to probes for collecting data but 81 percent of high school science classes do.

The 2018 NSSME+ also asked science and mathematics program representatives how much money their schools spent during the most recently completed school year on three kinds of resources: non-consumable items/equipment (excluding computers), consumable supplies (e.g., chemicals, graph paper), and software specific to science and mathematics instruction. Per-pupil estimates were generated by dividing these amounts by school enrollment (see Figures 38 and 39). In science, the median per-pupil spending increases sharply from elementary school to high school. In mathematics, median per-pupil spending is substantially higher in elementary schools than in middle and high schools.

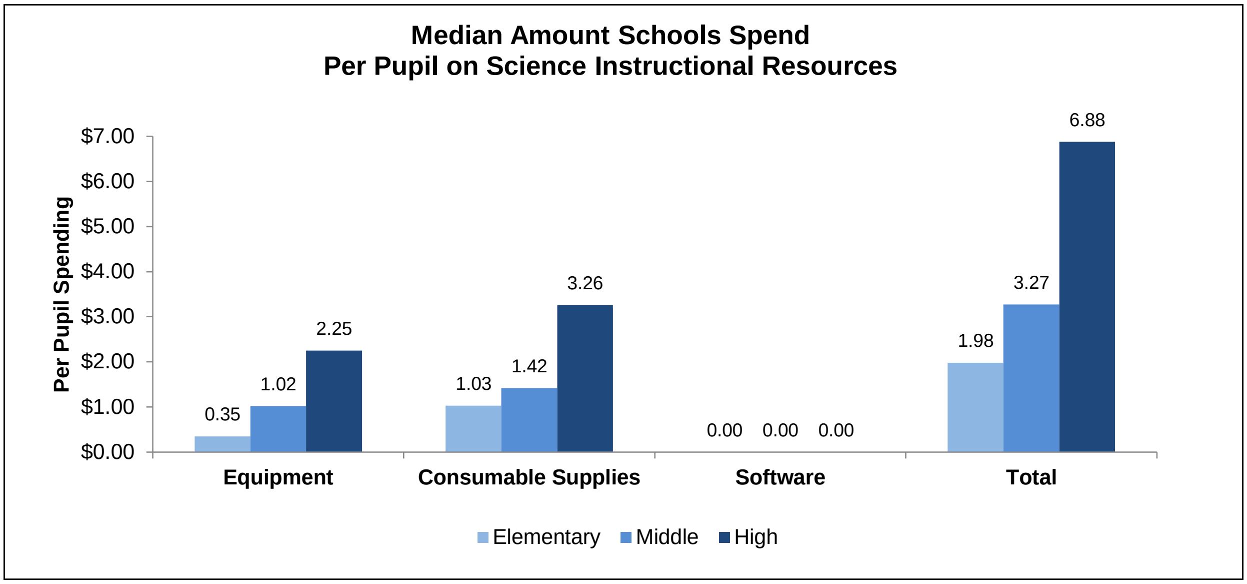


Figure 38

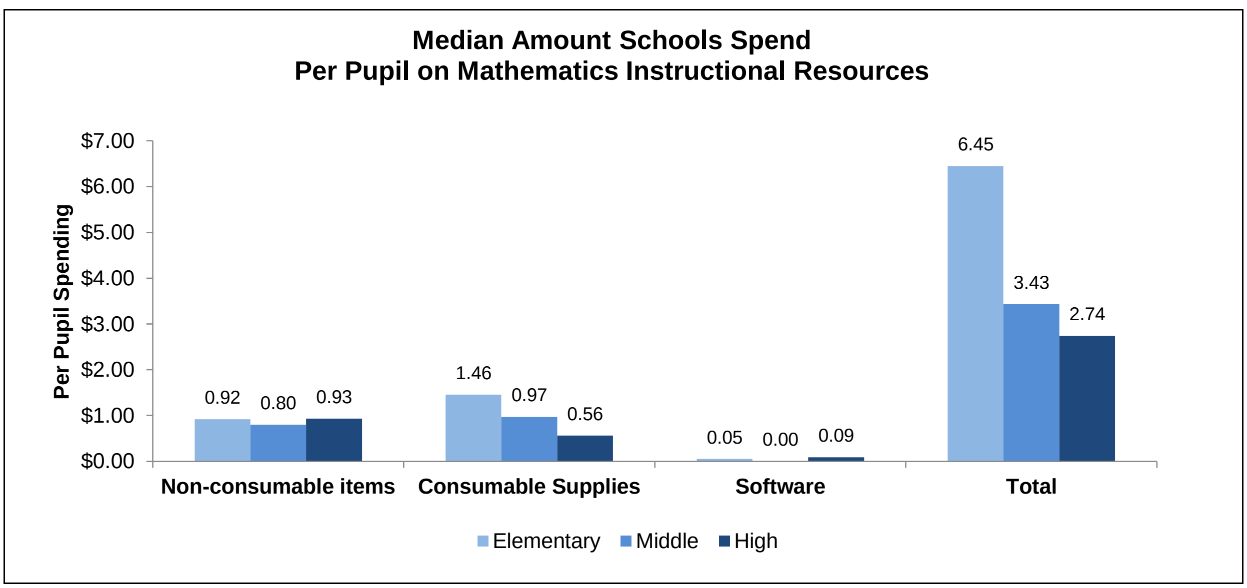


Figure 39

Science and mathematics teachers were asked to rate the adequacy of their available resources (e.g., equipment and facilities in science, measurement tools and manipulatives in mathematics). These items were combined into a composite variable named Adequacy of Resources for Instruction. As shown in Figure 40, perceptions of the adequacy of resources vary substantially by content area in elementary and middle school classrooms but are essentially the same in high school classrooms. This aggregate view appears to reflect the per-pupil spending data reported in this section.

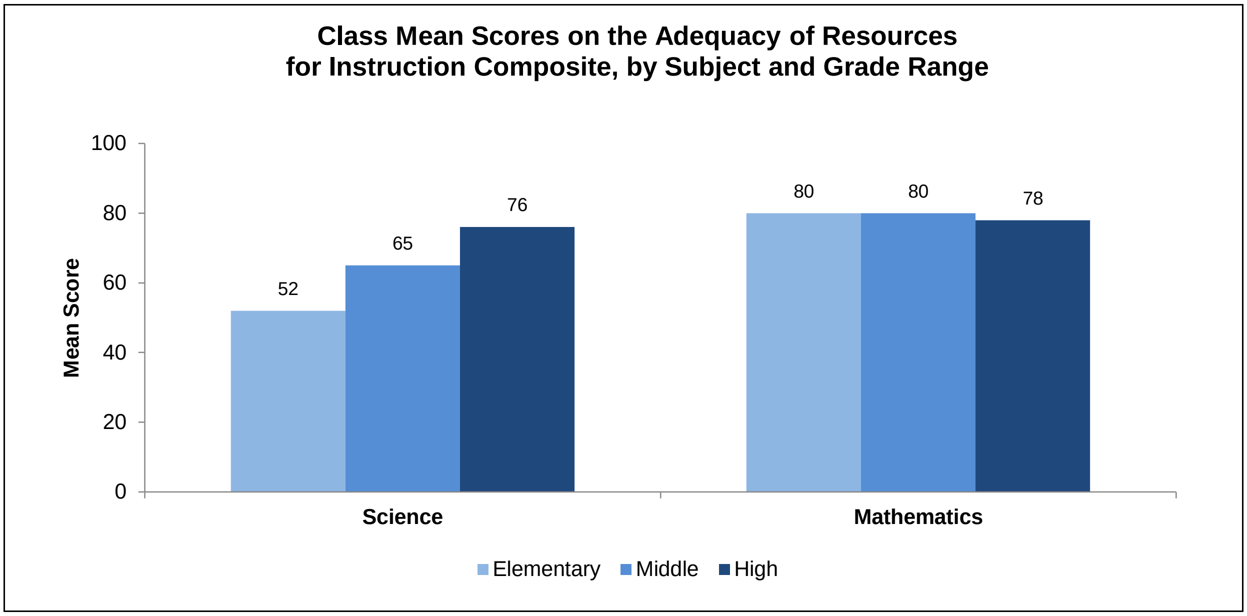


Figure 40

Distribution of Instructional Resources

Expenditures for science and mathematics are not distributed equally across all schools. For example, in science, schools with the lowest percentage of students who are eligible for free/reduced-price lunch spend considerably more per pupil on equipment and supplies than those with the highest percentage. The opposite pattern is true in mathematics (see Figure 41).

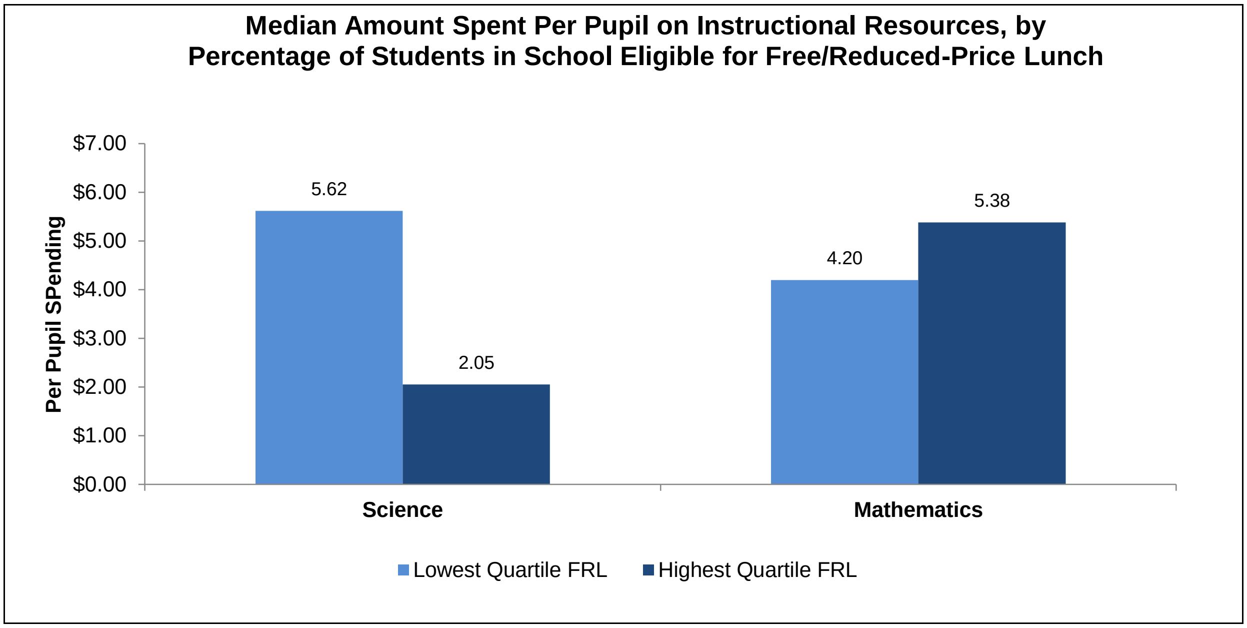


Figure 41

Factors Affecting Instruction

Although the primary focus of the 2018 NSSME+ was on teachers and teaching, the study also collected information on the context of classroom practice. The surveys included items asking about (1) the use of various programs and practices in the school to encourage and support students and (2) the extent various factors promote or inhibit instruction in the school.

School Programs and Practices

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, more than three-quarters of high schools offer after-school help in science and/or engineering, compared to 31 percent of elementary schools. Similarly, more than half of high schools offer science clubs, whereas only 36 percent of elementary schools do. In contrast, programs to enhance students' interest and/or achievement are offered infrequently in mathematics. Mathematics clubs are found in 20–36 percent of schools, depending on grade level, and fewer than 20 percent of all schools participate in local or regional math fairs. Computer science enhancement programs are rare at all grade levels. With the exception of encouraging students to participate in computer science-based summer programs, the majority of all schools do not provide opportunities intended to promote interest and achievement in computer science.

Factors That Promote and Inhibit Instruction

Program representatives were given a list of factors and asked to indicate their influence on science and mathematics instruction. Included in this list were school/district professional development policies and practices and the amount of time provided for teachers to share ideas about instruction. The items were combined into a composite variable in order to look at the effects of the factors on science and mathematics instruction more holistically. As Figure 42 shows, elementary schools generally provide a less supportive context for science instruction than middle or high schools. In addition, elementary and middle schools tend to be more supportive for mathematics teaching than science teaching.

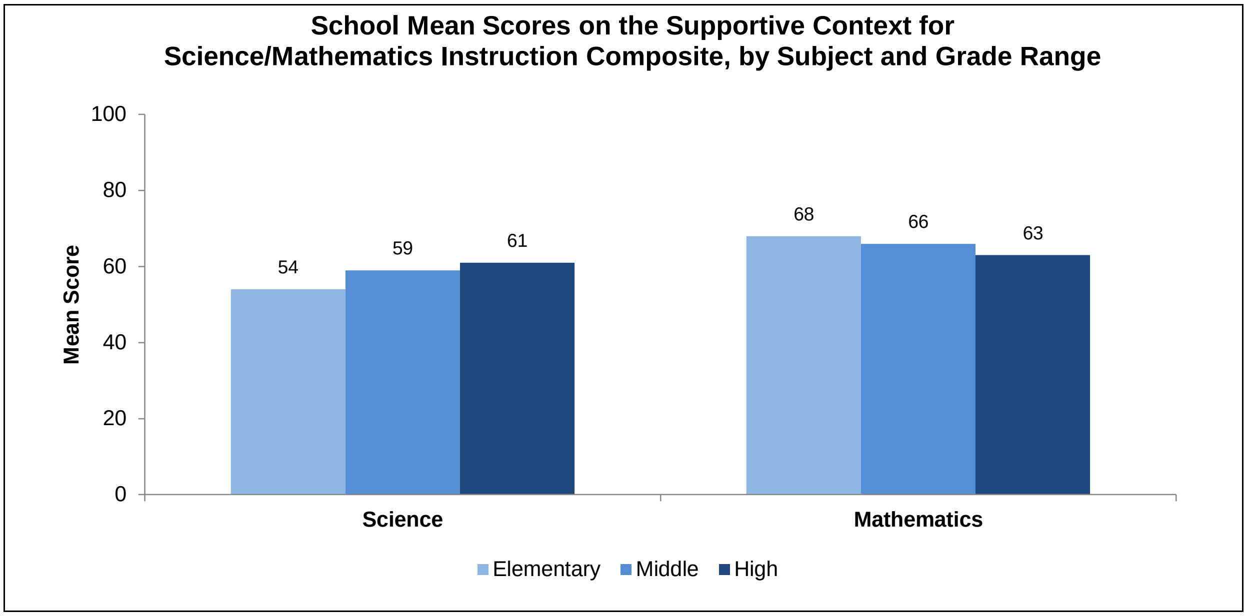


Figure 42

Teachers' opinions about various factors affecting instruction vary by grade level and subject. At the elementary grades, school support, stakeholders, and the policy environment all are seen as promoting effective instruction in mathematics more than in science (see Figure 43). All three factors are about equally supportive in science and mathematics in the middle school grades (see Figure 44). There is no one distinct pattern at the high school level across science, mathematics, and computer science, although school and stakeholder support are generally high in computer science compared with the policy environment (see Figure 45).

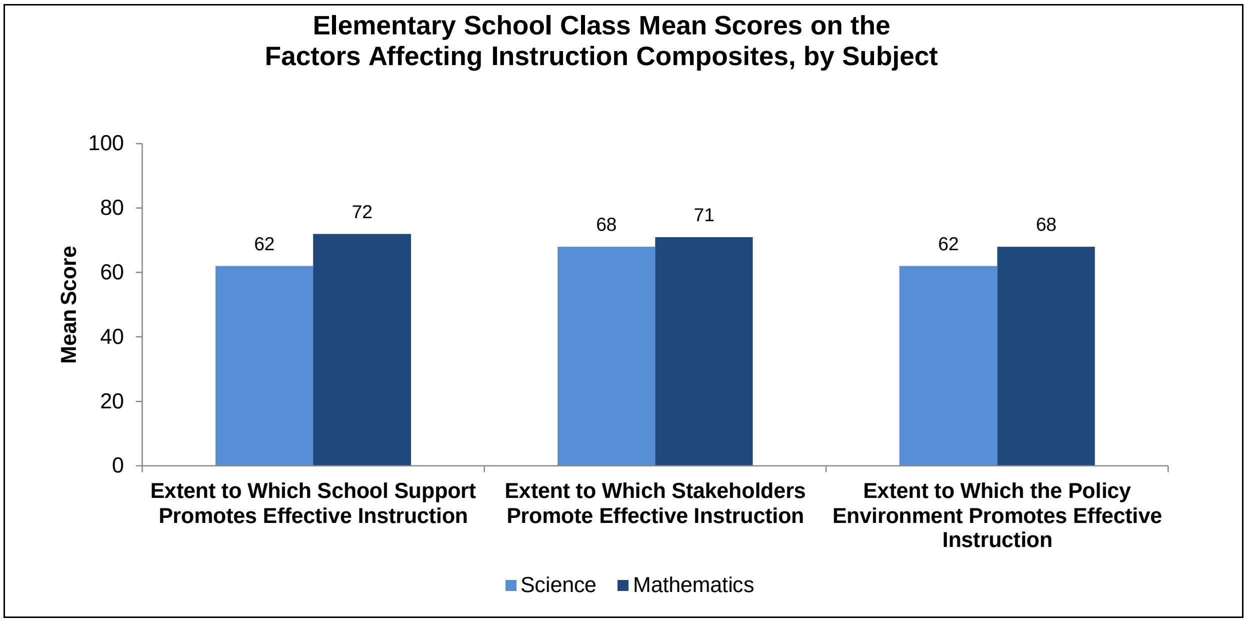


Figure 43

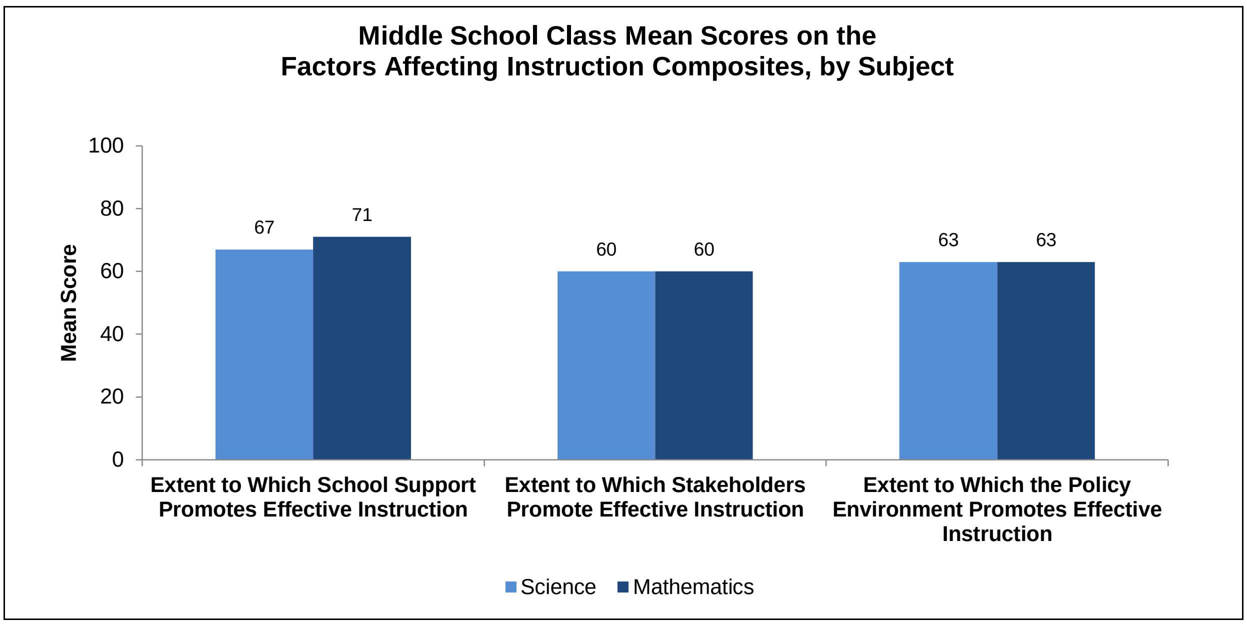


Figure 44

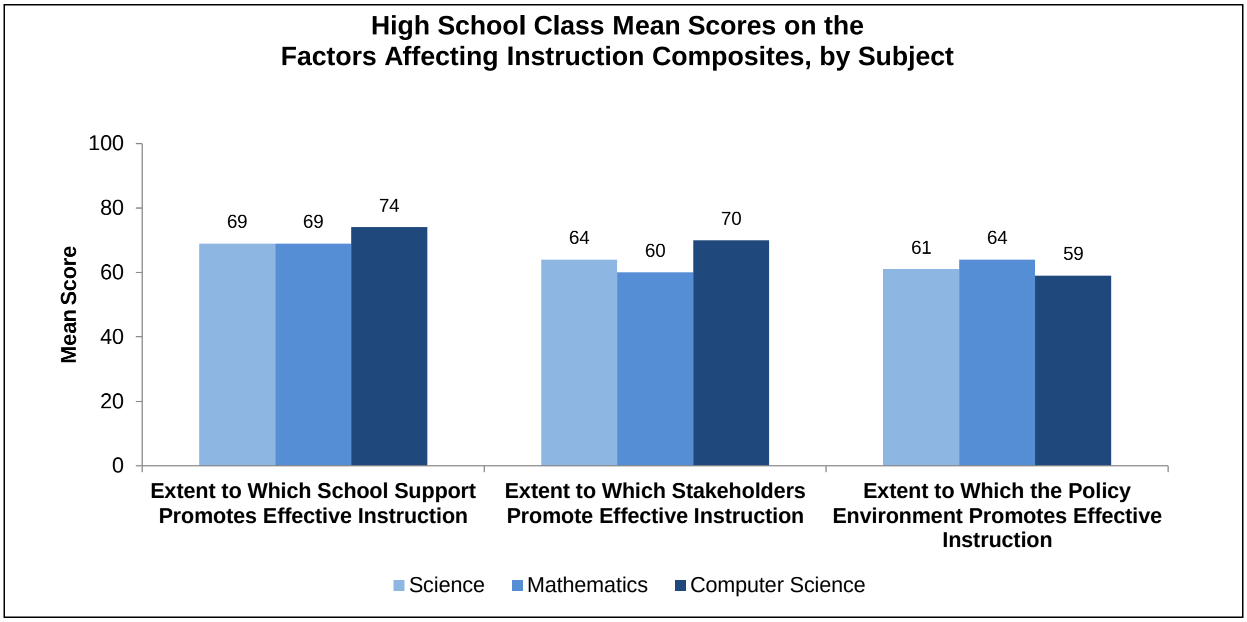


Figure 45

Distribution of Factors Affecting Instruction

Programs to enhance students' interest and/or achievement in science, mathematics, and computer science are not equally distributed across all types of schools. Some differences are particularly evident by percentage of students eligible for free/reduced-price lunch and school size. Large schools are more likely than small schools to offer many of these programs. Results are more varied when looking at these programs by the percentage of students in the school eligible for free/reduced-price lunch. For example, schools with the fewest students eligible for free/reduced-price lunch are more likely to offer content-focused clubs for students (see Figure 46). In contrast, schools in the highest quartile are more likely than schools in the lowest quartile to offer content-focused family nights (see Figure 47).

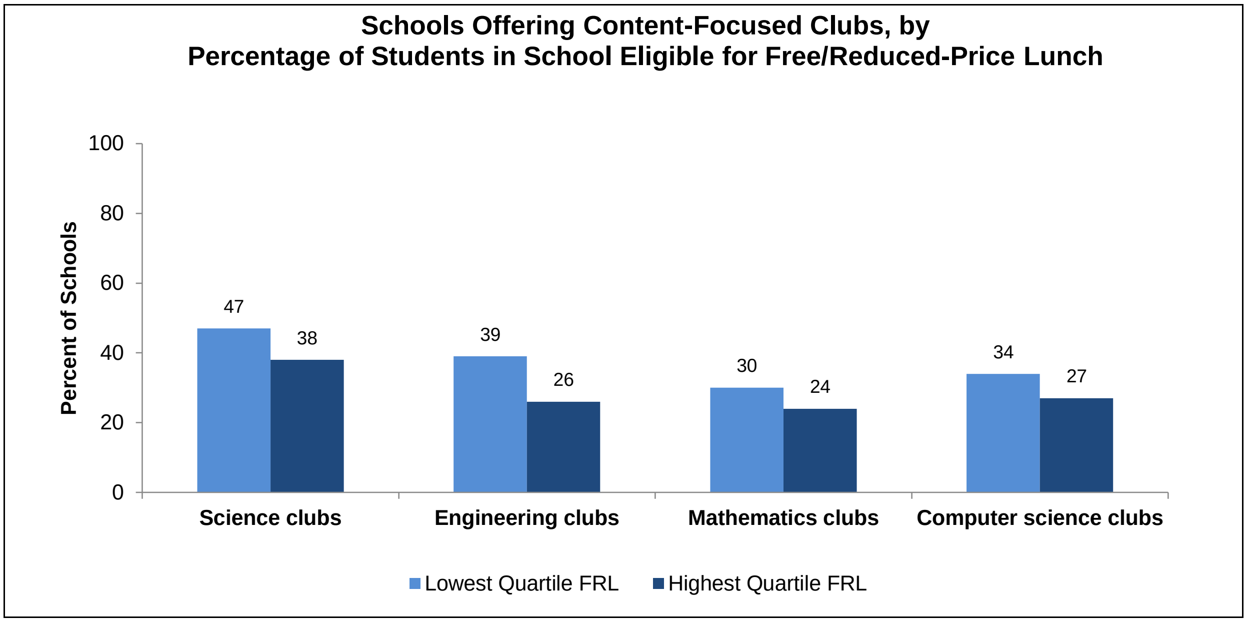


Figure 46

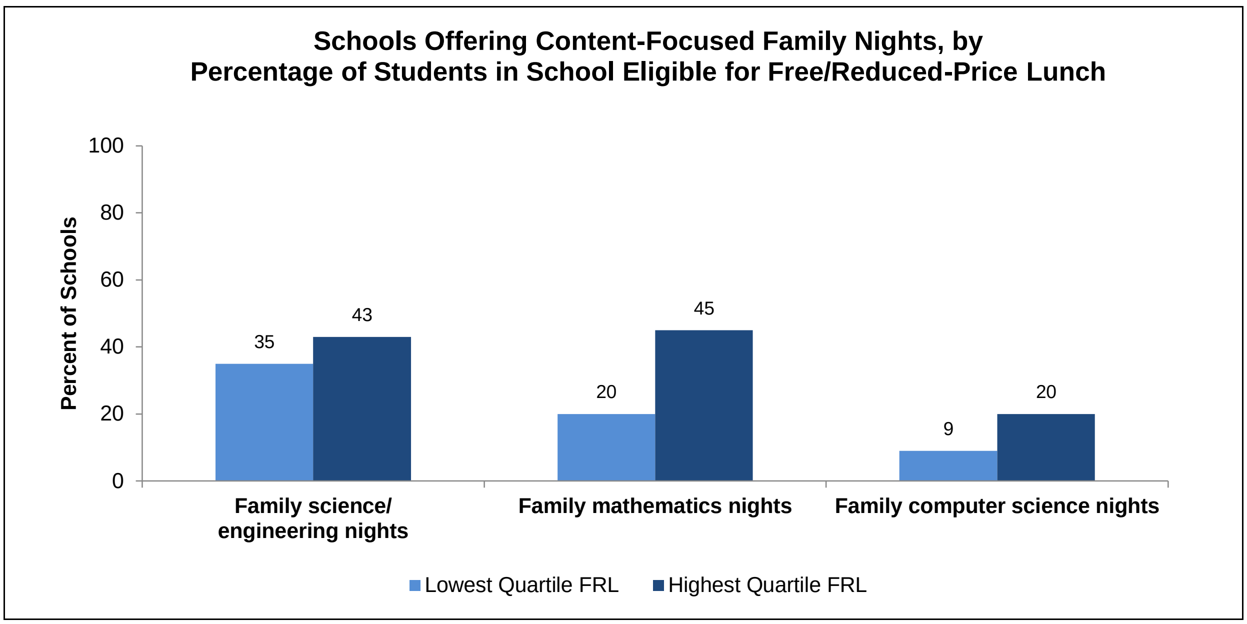


Figure 47