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Widening the Gap: Unequal Distribution of Resources for K–12 Science Instruction

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Abstract: Inequalities in educational opportunity are well documented. Regardless of the nature of the disadvantage—low income, underrepresented minority status, or prior achievement—students from backgrounds associated with a given disadvantage have less access to educational opportunities. In this article, we use data from the 2012 National Survey of Science and Mathematics Education to explore how resources are allocated for science instruction specifically. We focus on how three kinds of resources—well-prepared teachers, material resources, and instruction itself—are allocated to classes that are homogeneously grouped by prior achievement level. Regardless of the resource, we find that classes of students with low prior achievement (as perceived by their teachers) have less access. Some of the differences are striking, particularly

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regarding access to material resources, while others are more subtle. There is also evidence that some policies do not impact teachers equally. For example, time allowed for teacher professional development is perceived differently by teachers in terms of its impact depending on the achievement level of students in the class. The study supports the assertion that what is known about ability grouping in general applies in science instruction specifically. When students with low prior achievement are grouped together, their classes have less access to critical resources for science learning opportunities, potentially widening the gap between them and their higher-achieving peers.
Keywords: science; education; instructional resources; equity; under-represented minority students; teacher quality

Ampliando la brecha: La desigualdad en la distribución de los recursos para la enseñanza de las ciencias en los niveles K-12
Resumen: Las desigualdades en las oportunidades educativas están bien documentadas. Independientemente de la naturaleza de la desventaja -- baja renta, condición de minoría subrepresentada, o de logros anteriores-- estudiantes asociados con alguna condición de desventaja tienen menos acceso a oportunidades educativas. En este artículo, utilizamos datos de la Encuesta Nacional de Ciencia y Educación Matemática de 2012 para explorar cómo se asignan los recursos para la enseñanza de las ciencias. Nos centramos en cómo tres tipos de recursos -maestros bien preparados, recursos materiales, y la instrucción en sí, se asignan a las clases que se agrupan homogéneamente por nivel de logro anterior. Independientemente del recurso, nos encontramos con que las clases de estudiantes con bajo rendimiento previo (según la percepción de sus maestros) tienen menos acceso. Algunas de las diferencias son sorprendentes, sobre todo con respecto al acceso a los recursos materiales, mientras que otras son más sutiles. También hay evidencia de que algunas políticas no afectan a los docentes por igual. Por ejemplo, el tiempo permitido para el desarrollo profesional de los docentes que se percibe de manera diferente por los profesores en términos de su impacto en función del nivel de logro de los estudiantes en la clase. El estudio apoya la afirmación de que lo que se sabe acerca de la capacidad de agrupación en general se aplica en la enseñanza de la ciencia en particular. Cuando los estudiantes con bajo rendimiento son agrupados, sus clases tienen menos acceso a los recursos críticos para ampliar las oportunidades de aprendizaje de ciencias, lo que podría incrementar la brecha entre ellos y sus compañeros de mayores logros educativos.
Palabras clave: ciencia; educación; recursos didácticos; equidad; estudiantes de minorías subrepresentadas; calidad docente

Ampliando a brecha: A desigualdade na distribuição de recursos para a educação científica nos níveis K-12
Resumo: As desigualdades de oportunidades educacionais estão bem documentadas. Independentemente da natureza da desvantagem - baixa renda, status de minoria sub-representada ou resultados anteriores - estudantes associados a uma condição de desvantagem têm menos acesso a oportunidades educacionais. Neste artigo, usamos dados da Pesquisa Nacional de Ciência e Educação Matemática de 2012 para explorar a forma como os recursos são alocados para a educação científica. Nós nos concentramos em três tipos de- recursos --professores bem preparados, recursos materiais, e da própria instrução, e como são atribuídos a classes agrupados por nível de resultados anteriores. Independentemente da aplicação, verificamos que as turmas de alunos com baixo

aproveitamento anterior (pela percepção dos professores) têm menos acesso. Algumas das diferenças são marcantes, especialmente no que diz respeito ao acesso a recursos materiais, enquanto outros são mais sutis. Há também evidências de que algumas políticas não afetam docentes da mesma maneira. Por exemplo, o tempo permitido para o desenvolvimento profissional de professores é percebido de forma diferente pelos professores em termos do seu impacto sobre o nível de desempenho do aluno na sala de aula. O estudo apoia o que se sabe geralmente sobre as politicas de agrupamento aplicado no ensino da ciência em particular. Quando os alunos de baixo desempenho são agrupados, suas aulas têm menos acesso a recursos essenciais para aumentar as oportunidades de aprendizagem das ciências, o que poderia aumentar a distância entre eles e os seus pares mais alto nível de instrução.
Palavras-chave: ciência; educação; recursos educacionais; equidade; estudantes de minorias sub-representadas; qualidade do ensino

Introduction[1]

In 2012, the National Science Foundation supported the fifth in a series of national surveys of science and mathematics education 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, consisting 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 (Weiss, 1978). A second survey of teachers and principals was conducted in 1985–86 (Weiss, 1987), a third in 1993 (Weiss, Matti, & Smith, 1994), and a fourth in 2000 (Weiss, Banilower, McMahon, & Smith, 2001).

The 2012 National Survey 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 the study. Among the study's research questions, we investigated how resources for science education, including well-prepared teachers and material resources, are distributed among schools in different types of communities and with differing socioeconomic levels. In this article, we explore the distribution of resources among classes of students with varying levels of prior academic achievement. We found that this lens brought into focus previously undetected disparities, complementing the extensive literature on education inequities related to socioeconomic status and race/ethnicity.

Background

As early as 1966, the Coleman report (Coleman et al., 1966) suggested that resources for instruction, including teacher quality, facilities, and curriculum, have differential impacts on the achievement of White and Black students. Over time, this body of research expanded to include examination of the distribution of educational resources by gender and poverty level (Clotfelter,

[1] This article 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.

Ladd, Vigdor, & Wheeler, 2006; Owen, 1972; Peng & Hill, 1995; Reimers, 2000), as well as the effects of unequal resources on diverse student groups (Betts, Reuben, & Danenberg, 2000; Mayer, 2001). In addition, research has focused on inequalities within various disciplines, notably in STEM[2] education (Oakes, Ormseth, Bell, & Camp, 1990; Raudenbush, Fotiu, & Cheong, 1998; Secada, Fennema, & Byrd, 1995).

Among the factors affecting students' science education experience, research suggests that teacher quality is prominent. Studies have shown that teacher content knowledge can directly influence student learning (Bolyard & Moyer-Packenham, 2008; Druva & Anderson, 1983; Monk, 1994). If teachers are to help students deepen their understanding of science concepts, they must also be prepared to carry out basic components of science instruction, including implementing curriculum materials and monitoring student understanding (Black & Wiliam, 1998; Hunter, 1982). In addition, teachers across grade levels must be equipped to teach science content to diverse groups of learners (Tomlinson et al., 2003), utilizing teaching practices that afford equal opportunities for quality science education (Brand, Glasson, & Green, 2006). Noting the prevalence of inequity in science education, Calabrese Barton and Upadhyay (2010) call for "social justice pedagogy," an educational philosophy intended to provide more equitable access to learning opportunities, especially for students who are denied privileges in science education that typically lead to science learning and the pursuit of science careers.

Research also suggests that well-prepared teachers typically teach in suburban schools (Lankford, Loeb, & Wyckoff, 2002; National Center for Education Statistics, 2012), while urban and rural schools are more likely to be staffed by beginning teachers and teachers with weaker science backgrounds (Barton, 2007; Oliver, 2007). Similar disparities are evident in the distribution of well-prepared teachers among schools grouped by percentage of students eligible for free or reduced-price lunch (FRL) (Zumwalt & Craig, 2005). In addition, schools with lower percentages of students from race/ethnic groups historically underrepresented in STEM[3] (hereafter referred to as "underrepresented minority students" or "URM students") typically have higher percentages of well-prepared teachers than schools with higher percentages of these students (Darling-Hammond, 2004, 2006; Lu, Shen, & Poppink, 2007). It is important to note the interrelationships among school setting, student poverty levels, and student body racial/ethnic makeup (Hochschild, 2003; Oakes et al., 1990). For example, urban schools tend to have high populations of underrepresented minority students and students who qualify for FRL.

Access to material resources, including school facilities (e.g., laboratory space), science curriculum materials, and equipment/supplies (e.g., microscopes, chemicals, thermometers), also shapes science learning opportunities. However, schools in urban and rural settings tend to have fewer resources than schools in suburban settings (Oakes et al., 1990; Roscigno, Tomaskovic-Devey, & Crowley, 2006). Also, schools with a high percentage of students qualifying for FRL or a high percentage of underrepresented minority students have tended to have fewer material resources (Hewson, Kahle, Scantlebury, & Davies, 2001; Lee, Maerten-Rivera, Buxton, Penfield, & Secada, 2009; Spillane, Diamond, Walker, Halverson, & Jita, 2001).

Science instruction itself, including instructional time and course offerings, can also be thought of as a resource to which students have varying degrees of access. Urban and rural schools

[2] STEM stands for science, technology, engineering, and mathematics.

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

historically have fewer science course offerings than suburban schools (Coley, 1999). Similarly, higher-poverty schools tend to have fewer science course offerings than more affluent schools (Gollub, Bertenthal, Labov, & Curtis, 2002). Schools with low percentages of underrepresented minority students have tended to offer more advanced science courses (e.g., Advanced Placement) than schools with higher percentages of these students (Gamoran, 1987).

Within courses, science instruction is largely shaped by teachers' instructional objectives and goals. Current reform efforts have highlighted, among other goals, the importance of developing students' conceptual understanding and skills in the practices of science (NGSS Lead States, 2013). Furthermore, there is an increased emphasis on science instruction that both engages students in authentic science experiences (Flemming, 2013; Jones, Childers, Stevens, & Whitley, 2012) and incorporates elements of instructional technology (Dani & Koenig, 2008; Songer, 2007). However, studies have shown that teachers in urban schools tend to have more constraints on science instructional time, and tend to employ primarily traditional science teaching methods (Barton, 2007). Teachers in high-poverty schools tend to use fewer reform-oriented science teaching methods (Supovitz & Turner, 2000) and more traditional teaching practices, associating high-poverty schools with a "pedagogy of poverty" (Haberman, 1991).

In this study, we explore the distribution of resources for science education using a different lens—composition of science classes in terms of the prior achievement level of students. We find that when science classes are grouped homogeneously by prior achievement, classes of lower-achieving students have less access to an array of resources, potentially widening the gap between these students and their higher-achieving peers.

Method

Sample Design

The 2012 National Survey was based on a national probability sample of science and mathematics schools and 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 nation had a known, positive probability of being drawn into the sample.

The sampling frame for the school sample was constructed from the Common Core of Data and Private School Survey databases—programs of the U.S. Department of Education's National Center for Education Statistics—which include school name and address and information about the school needed for stratification and sample selection. The sampling frame for the teacher sample was constructed from lists provided by sampled schools, identifying current teachers and the specific science and mathematics subjects they were teaching.

The study design included obtaining in-depth information from each teacher about his/her background and preparation for teaching, and curriculum and instruction in a single randomly selected class. Most elementary teachers were described by their principals as teaching in self-contained classrooms; i.e., they were responsible for teaching all academic subjects to a single group of students. Each of these teachers was randomly assigned to one of two groups—science or mathematics—and received a questionnaire specific to that subject. Most secondary teachers in the sample taught several classes of a single subject; some taught both science and mathematics. For each these teachers, one class was randomly selected as the focus of the teacher's responses.

Instruments

The study included both school- and teacher-level questionnaires. Preliminary drafts of these questionnaires were sent to a number of professional organizations for review, including the National Science Teachers Association (NSTA), the National Education Association (NEA), the Council of State Supervisors of Science (CSSS), and the American Federation of Teachers (AFT), the National Catholic Education Association (NCEA). The survey instruments were revised based on feedback from the reviewers, field tested, and revised again. The field testing included cognitive interviews (Desimone & Le Floch, 2004) to help ensure questionnaire items were being interpreted as intended.

The school-level questionnaire asked about such factors as school size, community type, and the percentage of students qualifying for FRL. The teacher questionnaire included questions about the demographic composition of students in a randomly selected class, including the gender and racial/ethnic composition of the class. In addition, teachers were asked to indicate the prior achievement level of students in the class relative to other students in the school (see Figure 1). The questionnaires were administered beginning in February 2012, allowing most teachers ample time to become acquainted with their students.

Which of the following best describes the prior science achievement levels of the students in this class relative to other students in this school?

a) Mostly low achievers
b) Mostly average achievers
c) Mostly high achievers
d) A mixture of levels

Figure 1. Questionnaire Item about Student Prior Achievement

Data Collection

Principals of sampled schools were asked to log onto the study website and designate a school contact person or "school coordinator." An incentive system was developed to encourage school and teacher participation. School coordinators were offered an honorarium of up to $200 for reminding teachers to finish the survey, monitoring teacher completion, and responding to school-level questionnaires. Teachers were offered a $25 honorarium for completing the teacher questionnaire. Survey invitation letters including a link to the online questionnaire were mailed to teachers. In addition to the incentives described, phone calls and emails to school coordinators were used to encourage non-respondents to complete the questionnaires. The final teacher response rate was 77%.

Data Analysis and Findings

All analyses discussed in this article were conducted using weighting to account for the complex sample design.[4] Through cross-tabulations, the perceived prior achievement level of students in science classes was used to examine the distribution of educational resources. *Any difference among groups discussed in this article is statistically significant at the p<0.05 level.*

As can be seen in Figure 2, at the elementary level (grades K–5), 45% of science classes are heterogeneous in prior achievement, with most of the remaining classes composed of primarily average prior-achieving students. The pattern or grouping in middle grades (6–8) is quite similar. The data indicate that ability grouping is far more common at the high school level (grades 9–12). It is important to note that although only 10–14% of science classes are composed of students perceived by their teachers as mostly low achieving, with roughly 50 million K–12 students in the nation, this percentage corresponds to several million children.

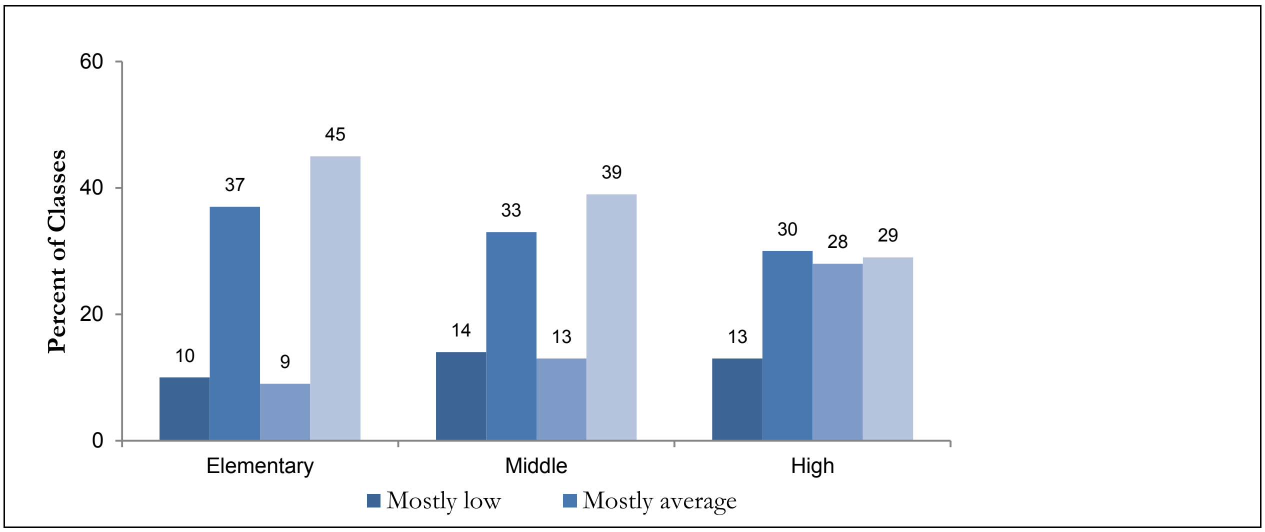

Figure 2. Prior-Achievement Grouping in Science Classes, by Grade Range

In addition, certain groups of students are more likely to be perceived by their teachers as low achieving. In classes composed of students teachers describe as mostly low achieving, 58% of students are male, compared to 49% in mostly high-achieving classes (see Table 1). More striking is the finding that underrepresented minority students are substantially *overrepresented* in classes with mostly low-achieving students (55%), compared to classes with mostly high-achieving students (23%).

[4] Detailed information about weighting is included in the technical report for the study (Banilower et al., 2013), available online at http://www.horizon-research.com/2012nssme/research-products/reports/technical-report/.

Table 1
Student Demographics of Science Classes, by Prior Achievement Level

	Classes with Mostly Low Achievers		Classes with Mostly Average Achievers		Classes with Mostly High Achievers		Classes with a Mixture of Levels	
	%	SE	%	SE	%	SE	%	SE
Sex								
Female	42	(1.5)	47	(0.6)	51	(1.1)	48	(0.5)
Male	58	(1.5)	53	(0.6)	49	(1.1)	52	(0.5)
Race/Ethnicity								
Students from URM groups	55	(3.1)	36	(1.2)	23	(1.3)	36	(1.7)
Asian	2	(0.4)	3	(0.2)	9	(1.2)	4	(0.3)
American Indian/Alaskan Native	1	(0.5)	1	(0.2)	1	(0.3)	1	(0.3)
Black or African-American	24	(3.1)	14	(1.0)	8	(0.8)	14	(1.0)
Hispanic or Latino	25	(2.4)	17	(1.1)	11	(1.1)	17	(1.4)
Native Hawaiian/Other Pacific Islander	1	(0.6)	1	(0.2)	0	(0.1)	1	(0.2)
White	43	(3.1)	60	(1.2)	67	(1.7)	60	(1.7)
Two or more races	4	(0.7)	4	(0.9)	3	(0.4)	4	(0.3)

Access to Well-Prepared Teachers

In this section, we report on the distribution of well-prepared teachers among science classes by students' prior achievement level. The 2012 National Survey asked teachers a series of items about their feelings of preparedness to: (1) teach diverse learners, (2) encourage students' interest in science, (3) implement instruction in a particular unit, and (4) teach science content. Teachers responded on a scale from 1 (not adequately prepared) to 4 (very well prepared). Based on the results of a factor analysis, these items were combined into four teacher preparedness composite variables,[5] shown in Figure 3 with the items that each composite includes and the composite reliability. An individual's composite variable score was calculated by summing the responses to the individual items and then dividing by the total points possible. Composite scores could range from 0 to 100 points. A respondent who marked the lowest point on every item in a composite received a score of 0, and someone who marked the highest point on every item received a score of 100.

[5] For a full description of the composite variables, please see the technical report for the study (Banilower et al., 2013), available online at http://www.horizon-research.com/2012nssme/research-products/reports/technical-report/.

Perceptions of Preparedness to Teach Students from Diverse Backgrounds (Cronbach's Alpha = 0.80)

1. Plan instruction so students at different levels of achievement can increase their understanding of the ideas targeted in each activity
2. Teach science to students who have learning disabilities
3. Teach science to students who have physical disabilities
4. Teach science to English-language learners
5. Provide enrichment experiences for gifted students

Perceptions of Preparedness to Encourage Students' Interest in Science/Engineering (Cronbach's Alpha = 0.92)

1. Encourage students' interest in science and/or engineering
2. Encourage participation of females in science and/or engineering
3. Encourage participation of racial or ethnic minorities in science and/or engineering
4. Encourage participation of students from low socioeconomic backgrounds in science and/or engineering

Perceptions of Preparedness to Implement Instruction in a Particular Unit (Cronbach's Alpha = 0.88)

1. Anticipate difficulties that students will have with particular science ideas and procedures in this unit
2. Find out what students thought or already knew about the key science ideas
3. Implement the science textbook/module to be used during this unit
4. Monitor student understanding during this unit
5. Assess student understanding at the conclusion of this unit

For the *Perceptions of Preparedness to Teach Science Content*† composite, teachers were asked to rate how well prepared they felt to teach the science content aligned with their randomly selected class *(Cronbach's Alpha coefficients for the six composites ranged from 0.83 to 0.95)*. For example, Earth science teachers were asked about their preparedness to teach about:

1. Earth's features and physical processes
2. The solar system and the universe
3. Climate and weather

Figure 3. Teacher Preparedness Composite Variable Definitions

† Perceptions of Preparedness to Teach Science Content score was computed only for non-self-contained classes.

As can be seen in Figure 4, classes of mostly low-achieving students are less likely than classes of mostly high-achieving students to have teachers who feel well prepared to teach science content. This gap is evident in schools overall as well in schools with a high proportion of students eligible for FRL (means of 84 and 74 for classes of mostly high- and low-achieving students, respectively; see Appendix Table A-1). This finding supports a common perception that "the best teachers get the best students," regardless of the school—a perception that is supported by numerous studies (e.g., Goldhaber, Lavery, & Theobald, 2015). It also suggests that low-achieving students must overcome still another obstacle— inadequately prepared teachers—if they are to close the gap with their higher-achieving peers.

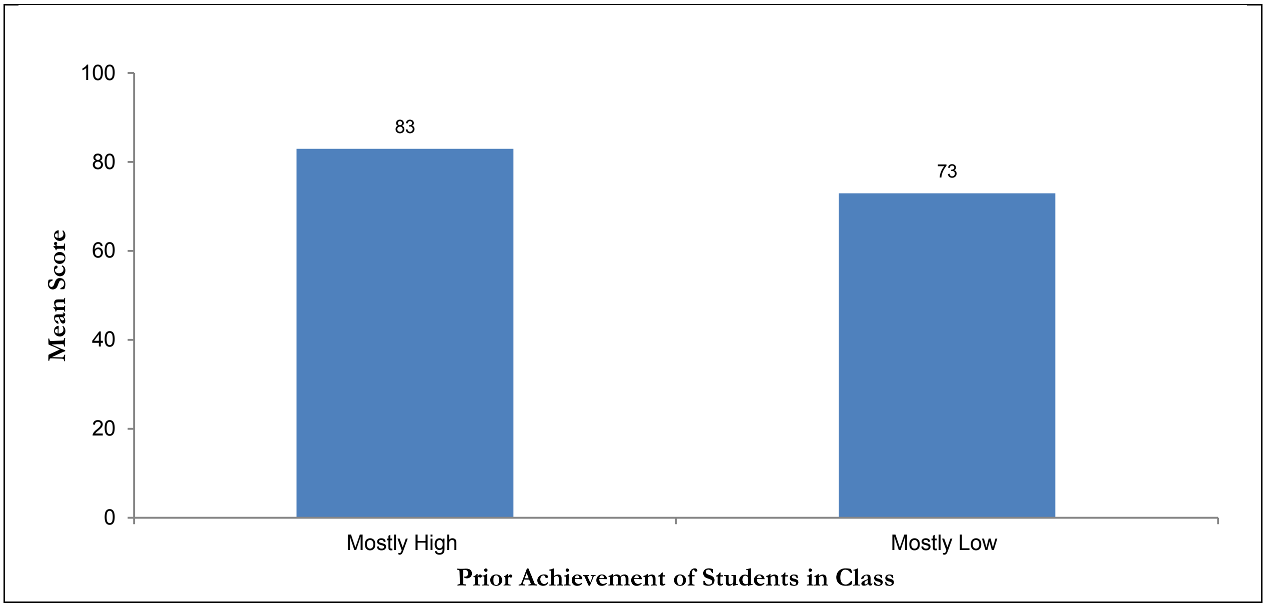

Figure 4. Perceptions of Preparedness to Teach Science Content

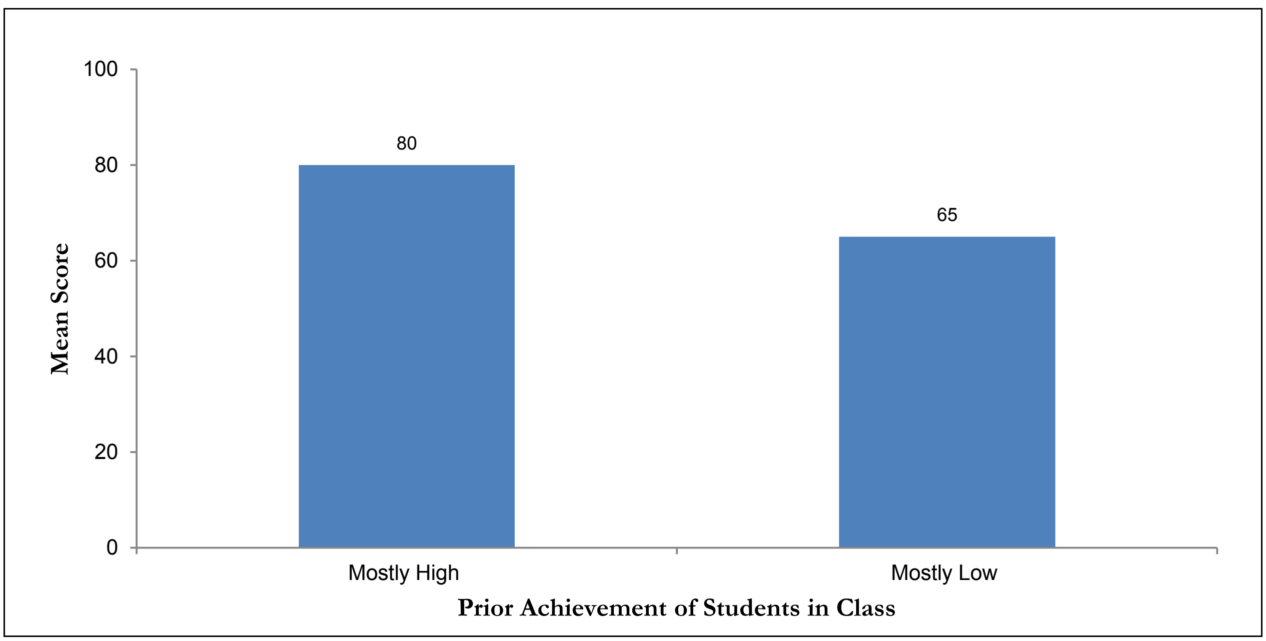

Figure 5. Perceptions of Preparedness to Encourage Students' Interest in Science

There are also disparities in teachers' perceptions of their preparedness to encourage students' interest in science; the mean score for teachers of classes with mostly low-achieving students is substantially lower (15 points) than the mean for classes with mostly high-achieving students (see Figure 5). The gap in the overall composite mean is especially apparent at less affluent schools—i.e., those with a high proportion of students eligible for FRL (means of 86 and 64 for classes of mostly high- and low-achieving students, respectively; see Appendix Table A-2). It is also apparent in urban schools (means of 83 and 64 for classes of mostly high- and low-achieving students, respectively) and suburban schools (means of 79 and 64 for classes of mostly high- and low-achieving students, respectively; see Appendix Table A-2). The disparity is even more pronounced when looking at some of the individual items in this composite. For example, in classes of mostly high-achieving students, 61% of teachers feel very well prepared to encourage the interest of female students, compared to only 37% of teachers in classes of mostly low-achieving students (see Appendix Table A-3). With regard to encouraging the interest of students from racial or ethnic minority backgrounds, the percentages are 52 and 31, respectively (see Appendix Table A-3). It is important to note that these results may be as much about the students as their teachers; that is, high-achieving students may already be interested in science, inflating their teachers' perceptions of their own preparedness. The findings are still disconcerting at best, especially given that classes of low-achieving students are more likely than those of mostly high-achievers to include students from groups that have been historically underrepresented in STEM. In fact, the disparity is evident even in schools with a high proportion of underrepresented minority students (means of 77 and 62 for classes of mostly high- and low-achieving students, respectively; see Appendix Table A-2).

Other composite mean scores, shown in Figures 6 and 7, continue the pattern of low-achieving students having less opportunity than high-achieving students. Classes of mostly low-achieving students are less likely to be taught by teachers who feel prepared to teach diverse learners (e.g., students with physical or learning disabilities, students who are learning English as a second language) and to implement instruction in the science unit they were teaching when they responded to the survey (e.g., to anticipate the difficulties students will have with science concepts in the unit).

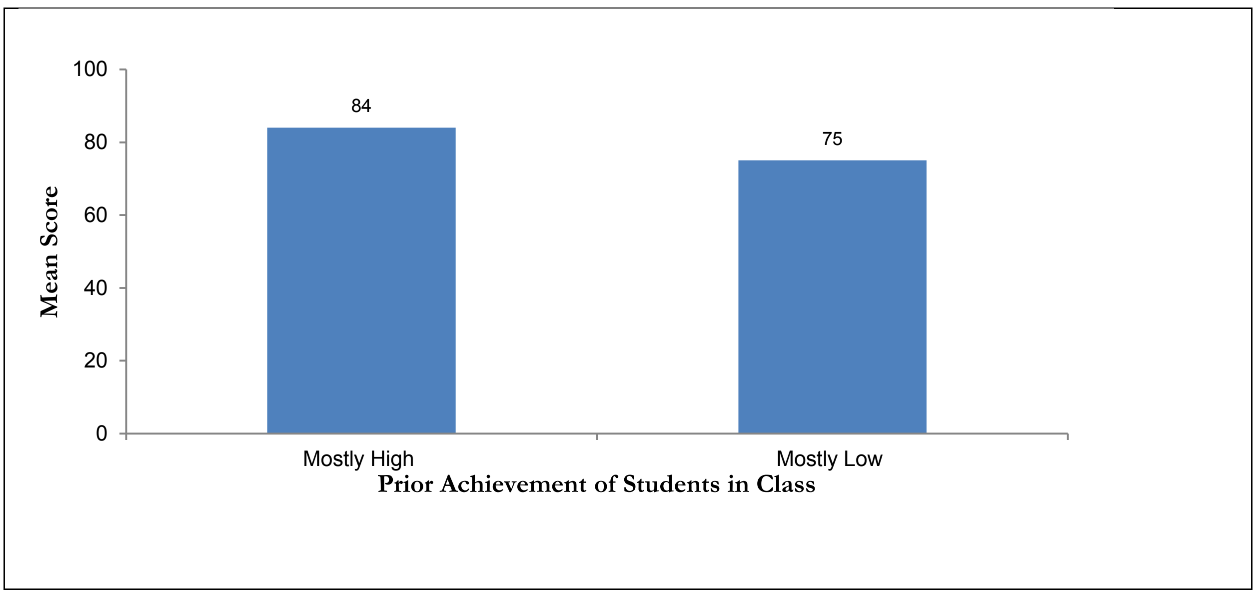

Figure 6. Perceptions of Preparedness to Implement Instruction in a Particular Unit

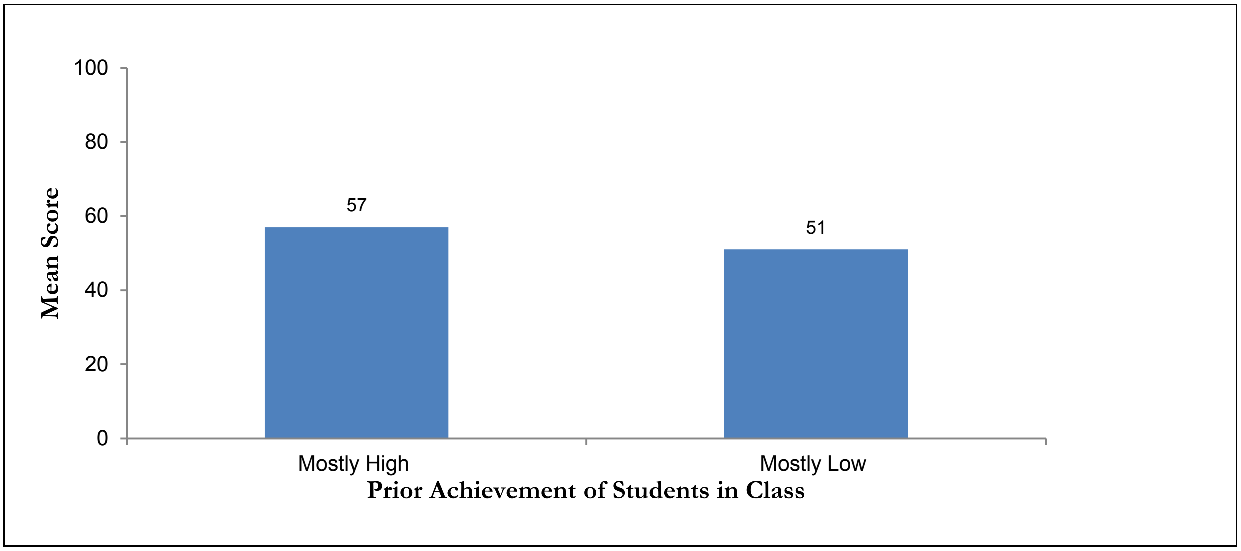

Figure 7. Perceptions of Preparedness to Teach Diverse Learners

Another measure of teacher preparedness is the extent to which teachers have participated in science-specific professional development. The 2012 National Survey asked science teachers to indicate the amount of time they had spent on professional development in science or science teaching in the preceding three years (less than 6 hours, 6–15 hours, 16–35 hours, or more than 35 hours). It is important to note that participation in science-specific professional development is low overall, with less than a third of teachers having substantial participation (more than 35 hours). Still, as shown in Figure 8, science classes of mostly high-achieving students are more likely than those of mostly low-achieving students to be taught by teachers most active in professional development (more than 35 hours) in the preceding three years. This disparity is particularly evident in schools with low proportions of students from underrepresented minority groups (percentages of 31 and 12 for classes of mostly high- and low-achieving students, respectively; see Appendix Table A-8). The data do not suggest an explanation for why the gap in these schools is more than twice as large as in schools overall.

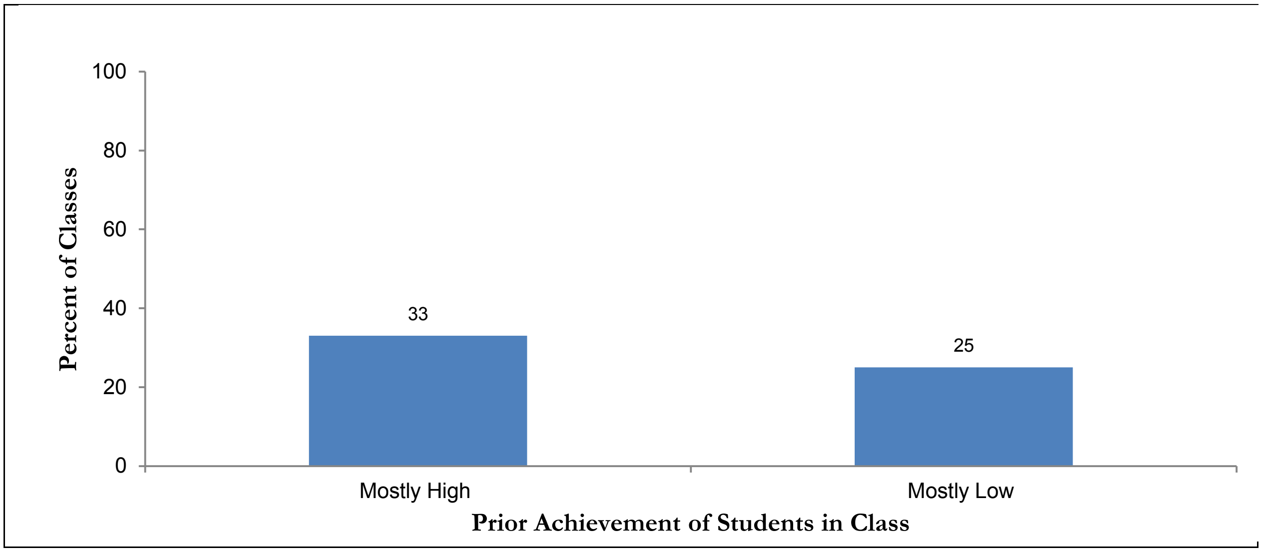

Figure 8. Science Classes Taught by Teachers with More than 35 Hours of Professional Development in the Last Three Years

Taken together, these data strongly suggest that students perceived by their teachers as low achieving have less access to science teachers who are well prepared to encourage students in science, teach diverse learners, and implement science instruction in a given unit. Further, in schools with low percentages of underrepresented minority students, low-achieving students are less likely to be taught by teachers who are very active in professional development.

Access to Material Resources

Science teachers responded to a series of items about the adequacy of their equipment, instructional technology, consumable supplies, and facilities in their randomly selected science class (see Figure 9).

- Science courses may benefit from the availability of particular kinds of equipment (e.g., microscopes, beakers, photogate timers, Bunsen burners). How adequate is the equipment you have available for teaching this science class?
- Science courses may benefit from the availability of particular kinds of instructional technology (e.g., calculators, computers). How adequate is the instructional technology you have available for teaching this science class?
- Science courses may benefit from the availability of particular kinds of consumable supplies (e.g., chemicals, living organisms, batteries). How adequate are the consumable supplies you have available for teaching this science class?
- Science courses may benefit from the availability of particular kinds of facilities (e.g., lab tables, electric outlets, faucets and sinks). How adequate are the facilities you have available for teaching this science class?

Figure 9. Questions about the Adequacy† of Resources for Instruction

† Each question was asked using a 5-point response scale: 1-not adequate, 2, 3-somewhat adequate, 4, 5-adequate.

These items were combined into a composite variable titled *Adequacy of Resources for Science Instruction (Cronbach's Alpha = 0.84).* As can be seen in Figure 10, the mean composite score for science classes composed of mostly low-achieving students was 47 compared to 69 for science classes of mostly high-achieving students, a striking contrast. The difference was evident regardless of the percentage of underrepresented minority students at the school, school location (urban, suburban, rural), or school size (large vs. small); and in some kinds of schools, the gap was more pronounced. For example, in urban schools, the difference is 29 points (see Appendix Table A-9). These data suggest that students who are already at a disadvantage based on their perceived level of prior achievement are in classroom settings that are under resourced for science instruction.

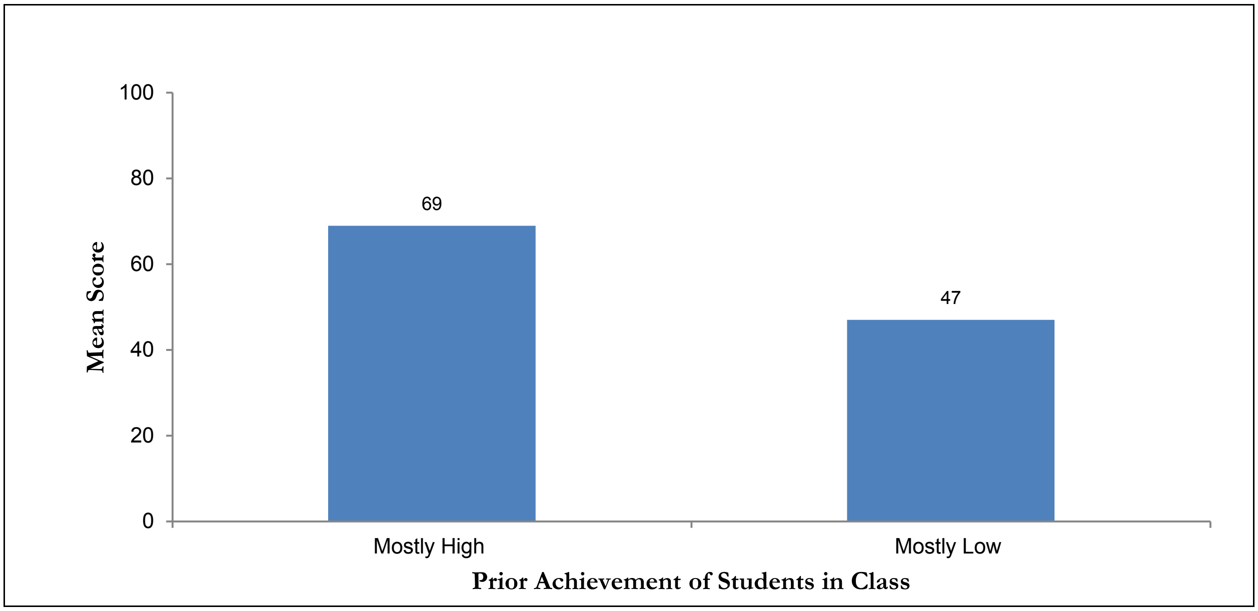

Figure 10. Class Mean Scores on the Adequacy of Resources for Science Instruction Composite

Science teachers were also asked about the availability of various instructional technologies,[6] including microscopes, calculators, and probes (e.g., probes for measuring light intensity or temperature). As can be seen in Figures 11–14, access to these technologies is unequal, with classes of mostly high-achieving students substantially more likely than those of mostly low-achieving students to have access to each. Again, the contrast is striking. Even the least-sophisticated technology—non-graphing calculators—is substantially less available in classes of mostly low-achieving students (61%) compared to those of high-achieving students (79%). And in less affluent schools, the difference is especially noticeable (available in 57% of classes of mostly low-achieving students vs. 85% of classes of mostly high-achieving students; see Appendix Table A-11). More sophisticated technologies, including probes and microscopes, which allow students to gather data firsthand that would be inaccessible otherwise, are also less available to classes of low-achieving students. This disparity calls into question the quality of learning opportunities in these classes. It also suggests that low-achieving students have fewer opportunities to develop competency using these technologies, which may shape subsequent learning opportunities.

[6] Availability was defined as having at least one of the instructional technology in question per small group (4–5 students).

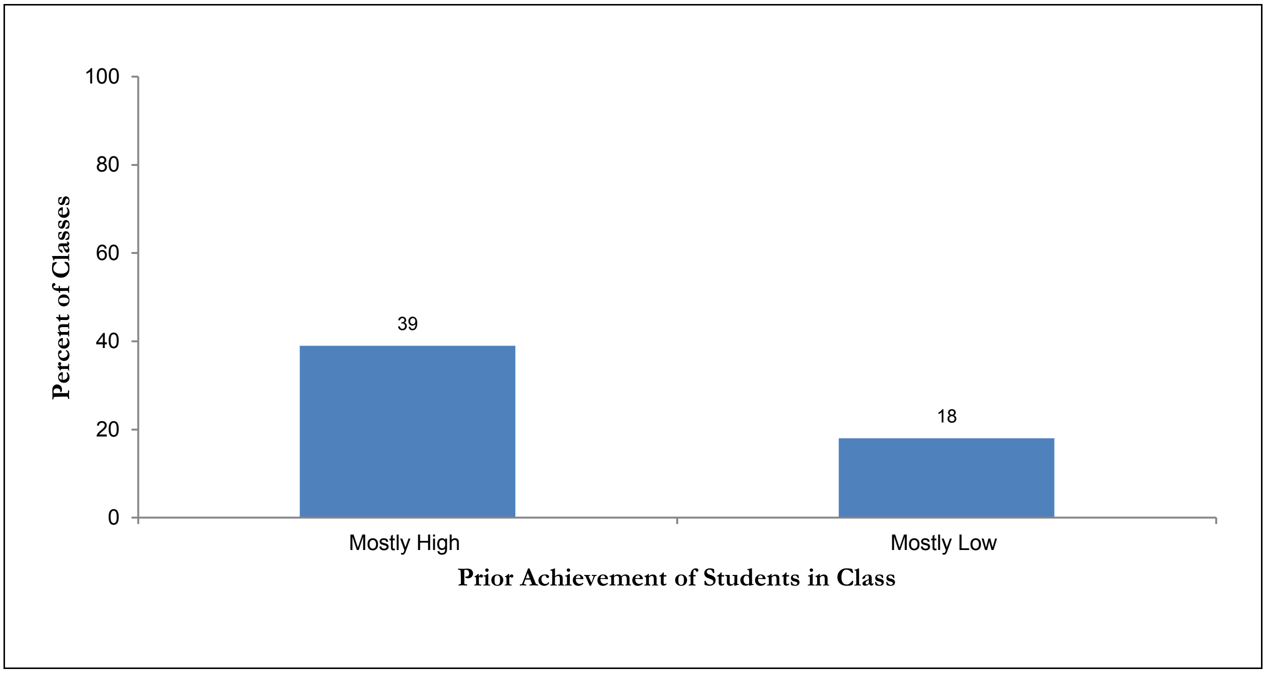

Figure 11. Availability of Graphing Calculators

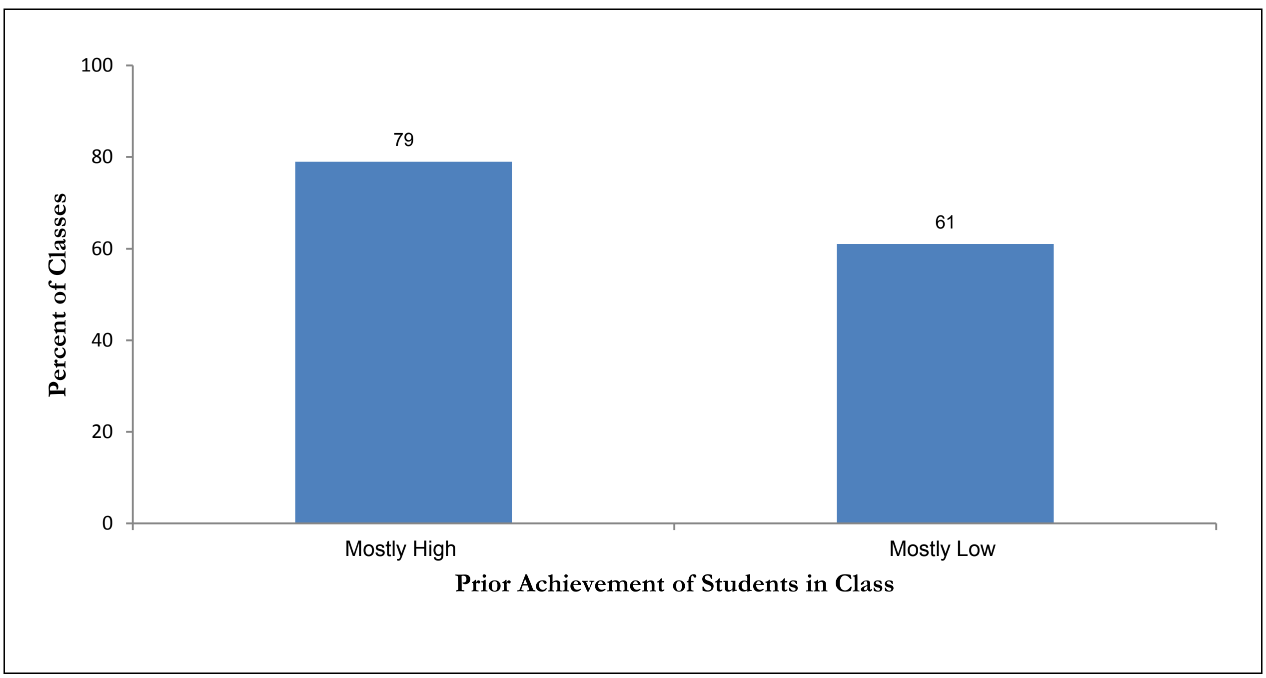

Figure 12. Availability of Non-Graphing Calculators

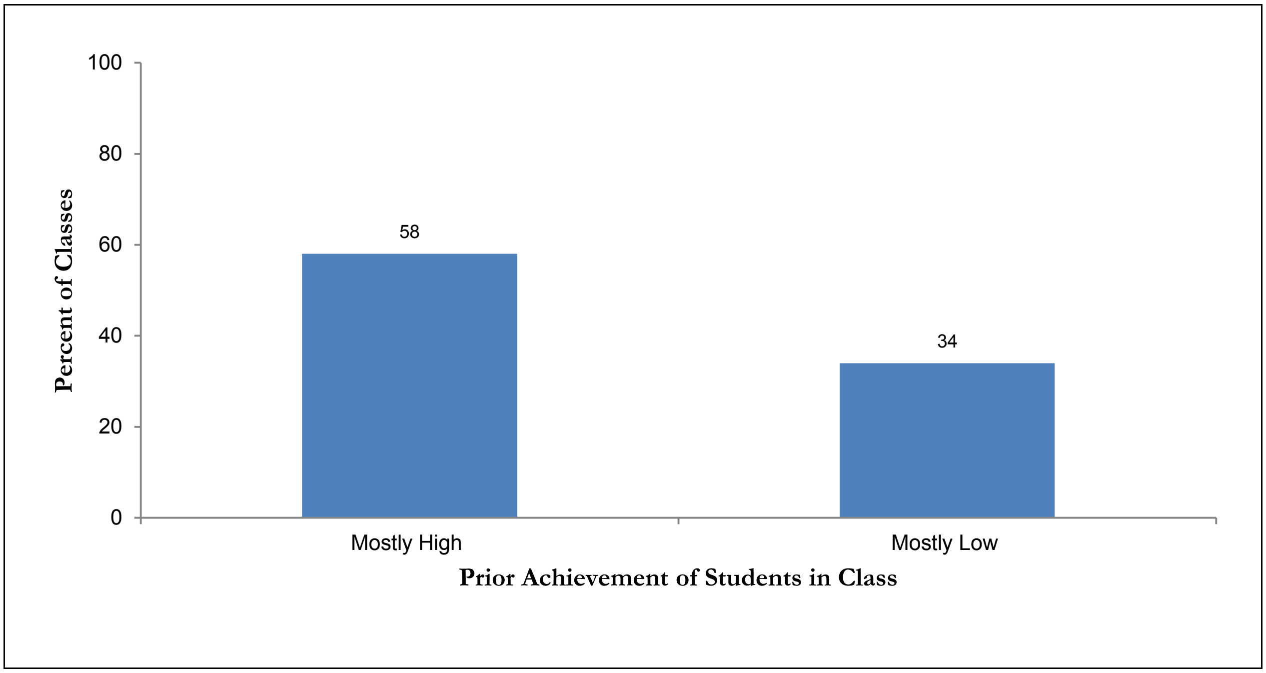

Figure 13. Availability of Probes for Collecting Data

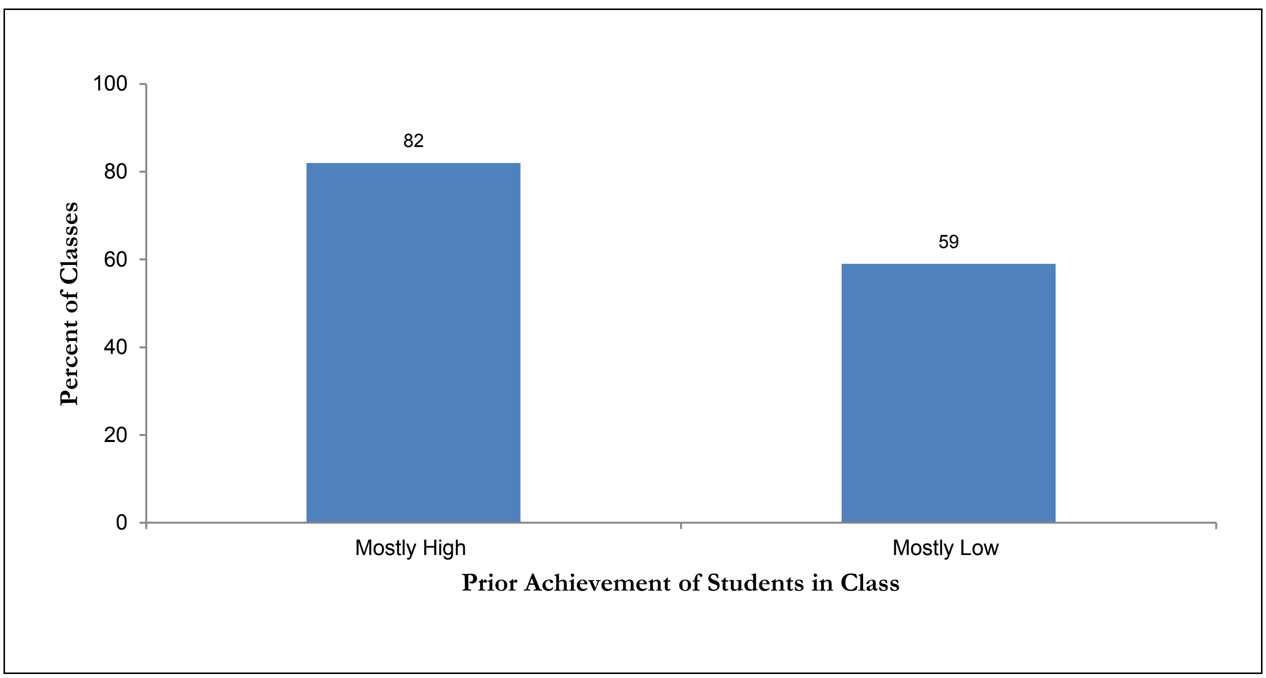

Figure 14. Availability of Microscopes

Access to Science Instruction

Science instruction itself—the objectives teachers emphasize and the practices they employ—can be thought of as another resource to which students have varying degrees of access. The 2012 National Survey provided a list of possible objectives for science instruction and asked teachers how much emphasis each would receive in an entire year of their randomly selected class. Teachers responded using a 4-point scale: 1, no emphasis; 2, minimal emphasis; 3, moderate emphasis; and 4, heavy emphasis. Objectives included:

1. Understanding science concepts;
2. Learning science process skills (e.g., observing, measuring);
3. Learning about real-life applications of science;
4. Increasing students' interest in science; and
5. Preparing for further study in science.

Through exploratory factor analysis, these five items were combined into a composite titled *Reform-oriented Instructional Objectives (Cronbach's Alpha =0.72)*. As can be seen in Figure 15, classes composed of mostly high-achieving students are more likely to experience instruction consistent with reform-oriented instructional objectives. For example, 96% of classes of mostly high-achieving students give moderate or heavy emphasis to preparing for further study in science, compared to 78% of classes of mostly low-achieving students (see Appendix Table A-15).

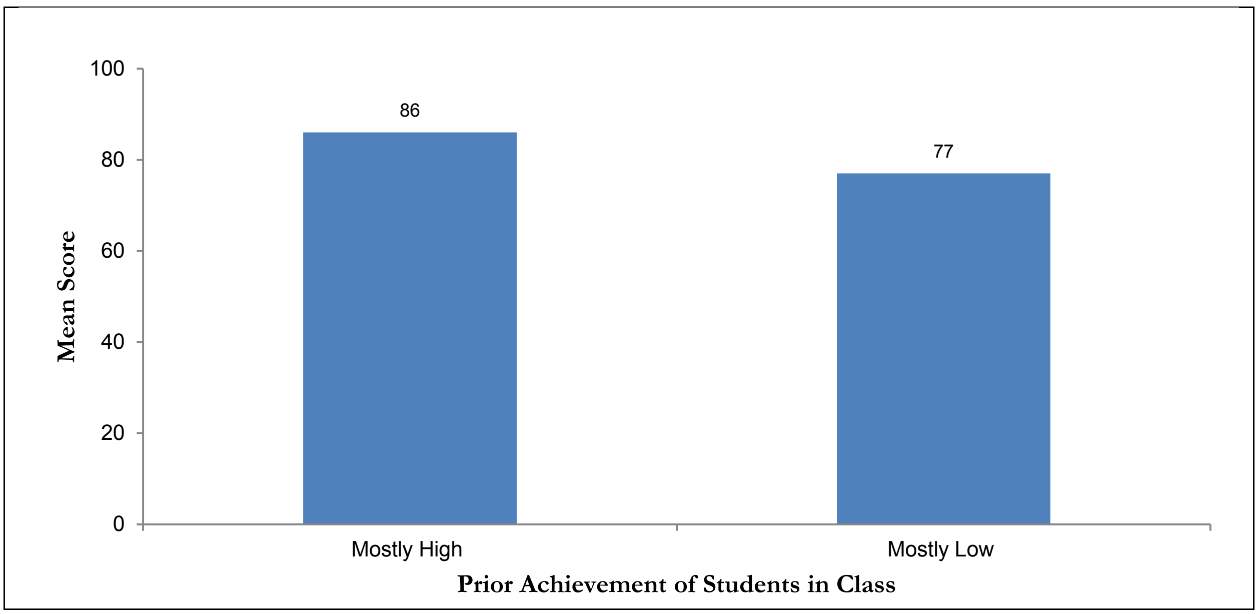

Figure 15. Class Mean Scores on the Reform-Oriented Instructional Objectives Composite

Teachers were also asked about their use of various teaching practices in the randomly selected class. Exploratory factor analysis suggests a composite variable that we titled *Reform-oriented Teaching Practices (Cronbach's Alpha = 0.72)*. The practices in this composite are:

1. Having students work in small groups;
2. Doing hands-on/laboratory activities;
3. Engaging the class in project-based learning (PBL) activities;
4. Having students represent and/or analyze data using tables, charts, or graphs;
5. Requiring students to supply evidence in support of their claims; and

6. Having students write their reflections (e.g., in their journals) in class or for homework

Teachers responded on a 5-point scale: 1, never; 2, a few times a year; 3, once or twice a month; 4, one or twice a week, 5, all or almost all science lessons. Although the difference is quite small, classes of mostly high-achieving students are significantly more likely to incorporate these practices than classes of mostly low-achieving students (see Figure 16). The difference is especially noticeable with regard to the use of hands-on or laboratory activities; 74% of classes with mostly high-achieving students include such activities on at least a weekly basis, compared to 48% of classes with mostly low-achieving students (see Appendix Table A-17).

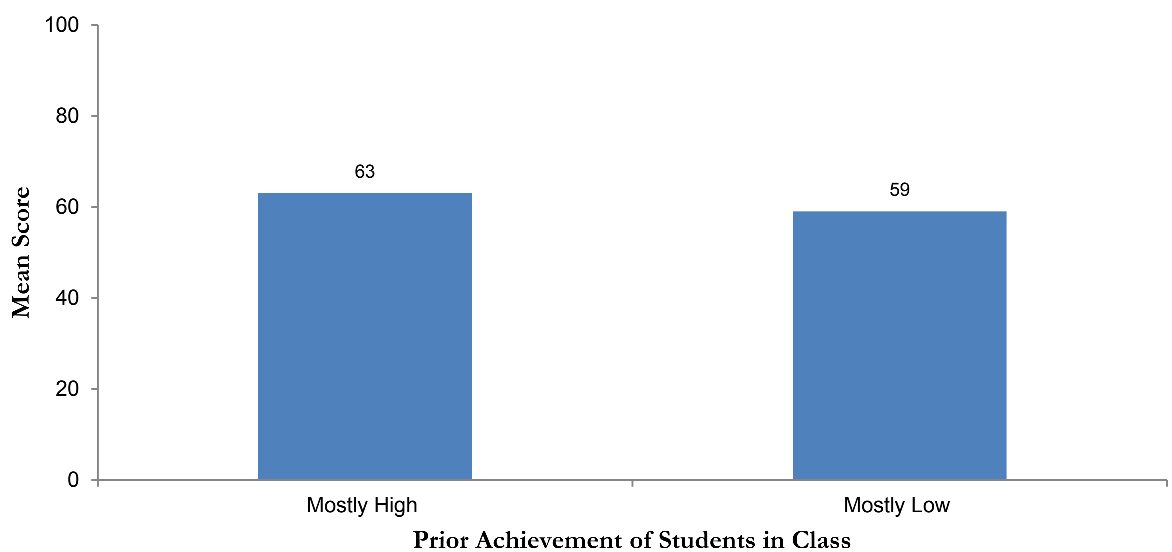

Figure 16. Class Mean Scores on the Use of Reform-Oriented Teaching Practices Composite

Because school and district policies and practices can significantly impact classroom instruction, teachers were asked how various aspects of the climate for science instruction affected teaching in their randomly selected class. The response scale ranged from 1 (inhibits effective instruction) to 5 (promotes effective instruction). Using the results of an exploratory factor analysis, these items were grouped into the three composite variables listed Figure 17.

Extent to Which the Policy Environment Promotes Effective Instruction (Cronbach's Alpha = 0.88)
1. Current state standards
2. District/Diocese curriculum frameworks
3. School/District/Diocese pacing guides
4. State testing/accountability policies
5. District/Diocese testing/accountability policies
6. Textbook/module selection policies
7. Teacher evaluation policies

Extent to Which Stakeholders Promote Effective Instruction (Cronbach's Alpha = 0.84)
1. Students' motivation, interest, and effort in science
2. Parent expectations and involvement
3. Community views on science instruction

Extent to Which School Support Promotes Effective Instruction (Cronbach's Alpha = 0.85)
1. Time for you to plan, individually and with colleagues
2. Time available for your professional development

Figure 17. Climate for Science Instruction Composite Variable Definitions†

† Each question was asked using a 5-point response scale: 1-inhibits effective instruction, 2, 3-neutral or mixed, 4, 5-promotes effective instruction.

As shown in Figures 18–20, classes composed of mostly high-achieving students are more likely than those of mostly low-achieving students to be in supportive instructional environments, with significant differences across all three composite variables. Several aspects of these data are noteworthy. Based on the mean scores, the climate for science instruction is at least neutral, and for the most part somewhat positive, regardless of type of class. That is, all of the mean scores are above 50. Regarding the policy environment, most of the policies the questionnaire asked about apply across all schools in a district or state, but they are perceived as less supportive of science instruction by teachers of classes with mostly low-achieving students. The same can be said for the composite related to school support, which is associated with time for planning and time for professional development. In addition, the gap is wider in certain types of schools. For example, in wealthier schools (those with a relatively small proportion of students who qualify for FRL), the gap is twice as large (26 points; see Appendix Table A-22).

The biggest difference between high- and low-achieving classes (24 points) is in relation to the composite for stakeholders. For example, 69% of teachers of classes with mostly high-achieving students indicated that parent expectations and involvement promote effective science instruction,[7] compared to only 30% of teachers of classes with mostly low-achieving students (see Appendix Table A-21). The gap in the overall composite mean is even more pronounced in small schools (31 points) and rural schools (33 points).

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[7] That is, the teachers gave a rating of 4 or 5 on a 5-point scale from 1, inhibits effective instruction to 5, promotes effective instruction.

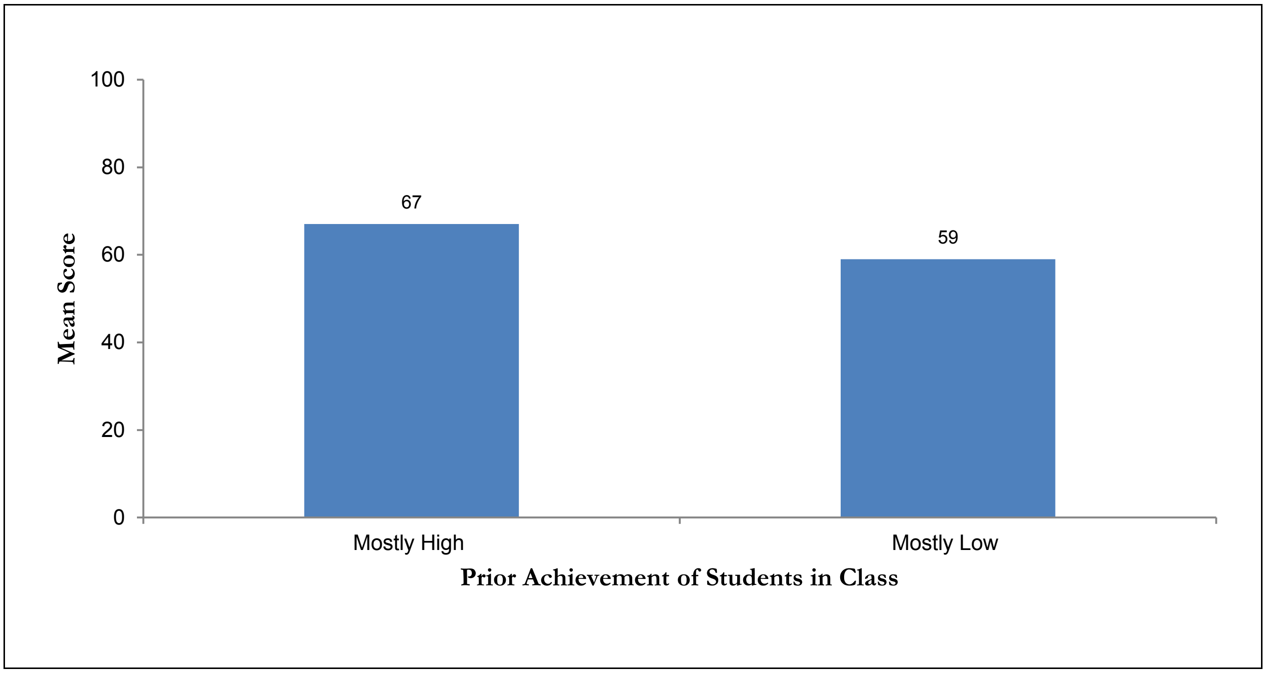

Figure 18. Class Mean Scores on the Effect to which Policy Environment Promotes Effective Instruction Composite

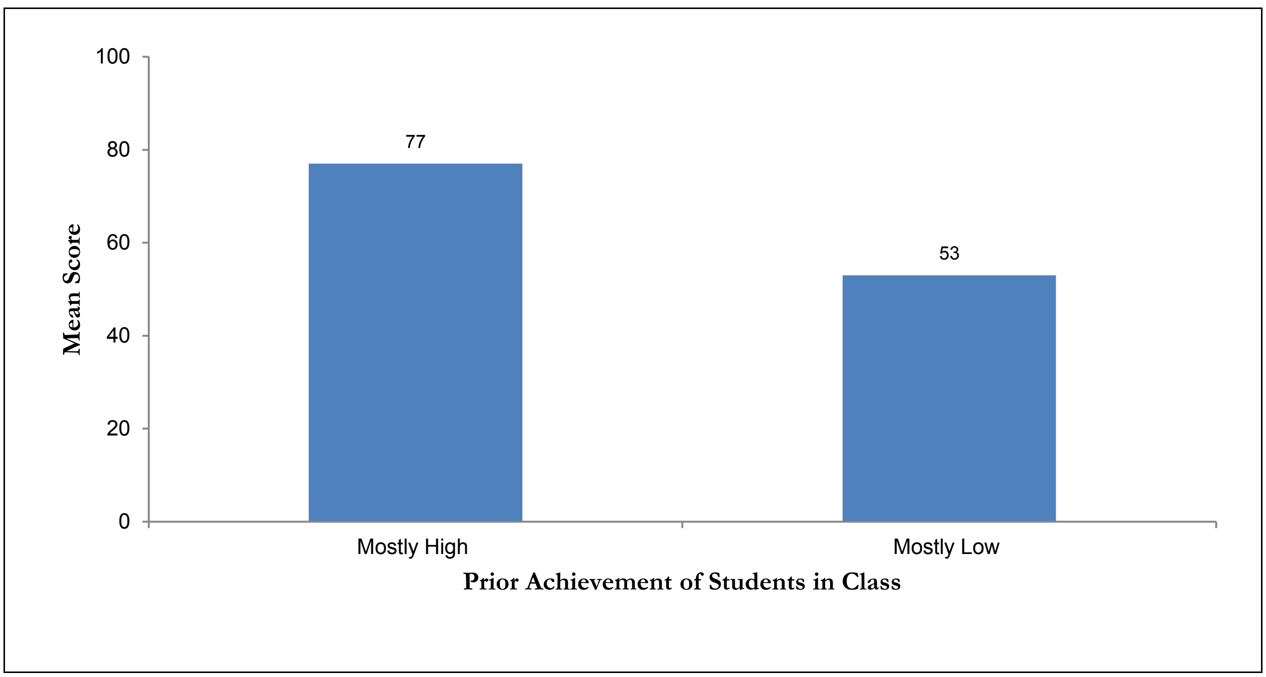

Figure 19. Class Mean Scores on the Extent to which Stakeholders Promote Effective Instruction Composite

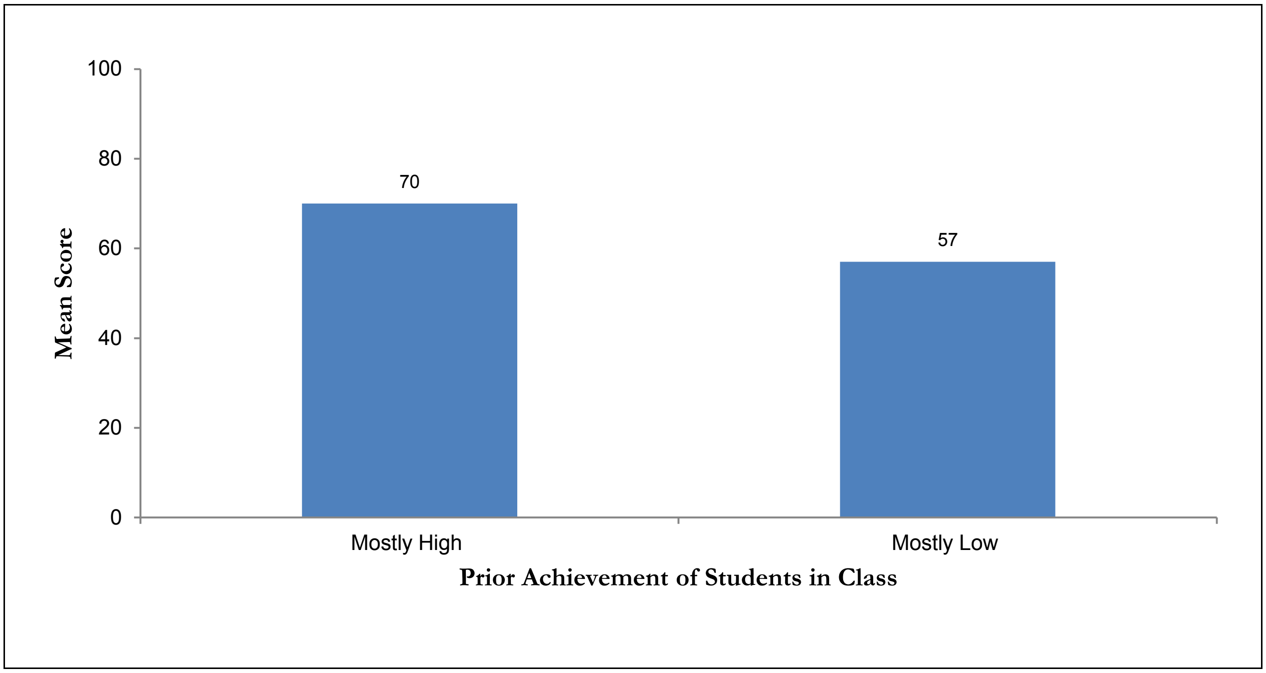

Figure 20. Class Mean Scores on the Extent to which School Support Promotes Effective Instruction Composite

Conclusion

The purpose of this article was to explore how three resources for science education—well-prepared teachers, material resources, and instruction—are allocated among classes of students with varying levels of prior achievement. We acknowledge that the measure of prior achievement (i.e., teacher perception) is imperfect. One potential disadvantage of relying on teacher perceptions of student prior achievement is, of course, that they may be less accurate than objective measures (i.e., test scores). As we noted earlier in the article, this potential threat to validity was mitigated to some extent by the timing of the study, which took place several months into the school year, when teachers had had substantial time to become familiar with their students.

Some researchers suggest that teacher expectations (shaped by their perceptions) can even play a role in creating inequalities, leading to a "self-fulfilling prophecy" in which students perform at levels consistent with teacher expectations (Brophy, 1983; Rosenthal & Jacobson, 1968). Conversely, other researchers suggest that teacher expectations may simply predict student outcomes because these expectations are accurate rather than because they are self-fulfilling (Jussim & Harber, 2005). It is beyond the scope of this article to debate whether, and to what extent, self-fulfilling prophecies affect students in science classrooms. Regardless of how or why students come to be perceived as low achieving, once they are, our data suggest that these students continue to have less access to resources for science instruction, potentially widening the gap between them and their higher-achieving peers.

The prior-achievement lens points to numerous inequities in the allocation of resources for science instruction. In almost all cases, students perceived by their teachers as low-achieving lose out. Not only do low-achieving students come to class with weaker backgrounds (as perceived by their teachers), when placed in classes with students of similar achievement backgrounds they have fewer resources than classes of mostly high-achieving students. This pattern holds true whether the resource is well-prepared teachers (e.g., classes of low-achieving students are less likely to have teachers who consider themselves well prepared to encourage student interest in science), access to instructional resources (e.g., classes of low-achieving students are much less likely to have access to microscopes), or quality of instruction (e.g., classes of mostly low-achieving students are less likely to experience hands-on or laboratory activities).

Arguments against ability grouping abound in the literature (e.g., Hoffer, 1992; Lleras & Rangel, 2009). Data from the 2012 National Survey support the assertion that ability grouping, as currently practiced, further disadvantages many students who are already playing catch up and is likely to widen achievement gaps. Furthermore, low-achievement classes appear to be just as prevalent today as they were almost three decades ago. Data from the 1985–86 National Survey of Science and Mathematics Education (Weiss, 1987) indicated that approximately 10% of elementary school science classes, 17% of middle grades science classes, and 10% of high school science classes were characterized by their teachers as consisting of mostly low-ability[8] students. In 2012, those percentages were hardly changed—10, 14, and 13, respectively.

The implications for students in these classes are profound and wide ranging. In the age of accountability, students perceived as low achieving are too often written off, as schools and teachers focus instead on students who are "on the bubble"—i.e., the students who with a little extra help might make it to the "proficient" category (Booher-Jennings, 2005). Some have recommended that schools should be held accountable for opportunity as well as outcomes (Oakes et al., 1990). Without robust indicators of opportunity and associated consequences, the experiences of students perceived by their teachers as low achieving will continue to be obscured by blunt outcome measures. And the gap between these students and their peers—in both opportunity and outcomes—will continue to grow.

In her widely cited 1990 study, *Multiplying Inequalities: the Effects of Race, Social Class, and Tracking on Opportunities to Learn Mathematics and Science*, Jeannie Oakes wrote:

> The educational system funnels curriculum, resources, instruction, and teachers to students through the schools they attend and the classrooms in which they sit, and this process results in disturbingly different and unequal opportunities to learn—differences that are clearly related to race, social class, community, and the judgments that schools make about students' abilities. (Oakes et al., 1990, p. 102)

Her assessment seems no less true nearly 25 years later. This situation is likely exacerbated by growing income disparity, and will likely require political and societal solutions more broadly than simply making changes within schools.

Recommendations for Future Research

This study highlights a number of disparities in student access to high-quality educational opportunities in the nation's K–12 science classrooms. However, additional research would be helpful to better understand the mechanisms and suggest solutions for these issues. For example, it

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[8] Teachers were asked to characterize students in terms of their ability instead of their prior achievement.

would be beneficial to conduct a similar study using actual student-level prior achievement data rather than teachers' perceptions. Doing so would lend greater confidence to the nature and degree of these gaps.

Another area of research would be to compare data about perceptions of schools, teachers, and science learning opportunities from students, parents, and school and district administrators to allow for a fuller picture of the influences of different stakeholder groups and how they vary by demographic characteristics. Further, these data could be compared to independent observations of science learning opportunities.

Lastly, how gaps in science learning opportunities vary by the nature of teachers' preparation for teaching science would be worth further exploration. In addition to looking at how the nature of how teachers enter the profession (e.g., Bachelor's degree with a teaching credential, a fifth-year credentialing program, an alternative certification route), a more fine-grained categorization of their preparation (e.g., whether their preparation program had a particular emphasis on science education) might provide insight into how teacher preparation and induction programs might be modified.

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Appendix

Table A-1
Composite Mean: Perceptions of Preparedness to Teach Science Content

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	74	(3.45)	84	(2.32)
Low	80	(2.94)	83	(2.25)
Percentage of Underrepresented Minority Students at School				
High	73	(3.76)	81	(3.18)
Low	62	(17.31)	84	(1.91)
School Size				
Large	75	(5.37)	84	(13.97)
Small	58	(13.97)	81	(3.01)
Location of School				
Urban	66	(7.86)	82	(2.13)
Suburban	81	(1.93)	83	(1.19)
Rural*	72	(4.19)	84	(2.12)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-2
Composite Mean: Perceptions of Preparedness to Encourage Students in Science

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	64	(5.73)	86	(3.22)
Low*	69	(4.07)	82	(2.37)
Percentage of Underrepresented Minority Students at School				
High*	62	(5.22)	77	(5.57)
Low	71	(4.95)	78	(3.18)
School Size				
Large*	59	(5.60)	80	(2.70)
Small*	61	(7.13)	80	(3.74)
Location of School				
Urban*	64	(5.21)	83	(1.94)
Suburban*	64	(4.37)	79	(2.15)
Rural	69	(4.19)	78	(3.95)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-3
Teachers Indicating that They Are Very Well Prepared to Encourage Students' Interest in Science/Engineering†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Encourage students' interest in science and/or engineering*	30	(3.78)	60	(3.66)
Encourage participation of females in science and/or engineering*	37	(3.80)	61	(3.87)
Encourage participation of racial or ethnic minorities in science and/or engineering*	31	(3.95)	52	(3.86)
Encourage participation of students from low socioeconomic backgrounds in science and/or engineering*	31	(4.18)	47	(4.14)

† The teachers gave a rating of 4 on a 4-point scale from 1 (not adequately prepared) to 4 (very well prepared).
* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-4
Composite Mean: Perceptions of Preparedness to Implement Instruction in a Particular Unit

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	77	(2.32)	86	(2.32)
Low*	76	(2.83)	87	(1.45)
Percentage of Underrepresented Minority Students at School				
High	76	(1.97)	81	(2.55)
Low*	76	(2.98)	84	(2.02)
School Size				
Large*	75	(1.89)	84	(2.00)
Small	74	(3.13)	81	(2.23)
Location of School				
Urban*	73	(2.48)	82	(2.47)
Suburban*	76	(1.32)	85	(1.27)
Rural	78	(2.31)	83	(1.84)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-5

Teachers Indicating that They Are Very Well Prepared to Implement Instruction in a Particular Unit†

	Low Prior Achievement		**High Prior Achievement**	
	%	SE	%	SE
Anticipate difficulties that students will have with particular science ideas and procedures in this unit*	30	(2.98)	51	(2.60)
Find out what students thought or already knew about the key science ideas*	36	(3.55)	52	(2.77)
Implement the science textbook/module to be used during this unit*	38	(4.39)	56	(3.98)
Monitor student understanding during this unit*	46	(3.78)	65	(2.58)
Assess student understanding at the conclusion of this unit*	50	(3.80)	69	(2.82)

† The teachers gave a rating of 4 on a 4-point scale from 1 (not adequately prepared) to 4 (very well prepared).

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-6

Composite Mean: Perceptions of Preparedness to Teach Diverse Learners

	Low Prior Achievement		**High Prior Achievement**	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	47	(4.20)	57	(4.38)
Low	64	(3.35)	62	(3.26)
Percentage of Underrepresented Minority Students at School				
High	51	(3.50)	57	(4.28)
Low*	37	(4.42)	51	(3.22)
School Size				
Large	48	(5.55)	56	(3.63)
Small	46	(5.96)	59	(3.58)
Location of School				
Urban*	47	(3.95)	59	(2.95)
Suburban	54	(4.08)	59	(2.56)
Rural	51	(4.28)	50	(3.53)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-7

Teachers Indicating that They Are Very Well Prepared to Teach Students from Diverse Backgrounds†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Plan instruction so students at different levels of achievement can increase their understanding of the ideas targeted in each activity*	22	(3.34)	35	(4.12)
Teach science to students who have learning disabilities	18	(2.62)	16	(2.76)
Teach science to students who have physical disabilities	15	(2.29)	12	(2.25)
Teach science to English-language learners	14	(2.70)	15	(2.56)
Provide enrichment experiences for gifted students*	18	(2.91)	39	(3.74)

† The teachers gave a rating of 4 on a 4-point scale from 1 (not adequately prepared) to 4 (very well prepared).

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-8

Composite Mean: Science Classes Taught by Teachers with More than 35 Hours of Professional Development in the Last Three Years

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	31	(4.85)	44	(9.30)
Low	19	(7.21)	28	(3.53)
Percentage of Underrepresented Minority Students at School				
High	30	(4.04)	39	(7.15)
Low*	12	(5.21)	31	(4.08)
School Size				
Large	27	(5.46)	36	(4.24)
Small	14	(4.36)	27	(4.92)
Location of School				
Urban	35	(5.43)	38	(5.69)
Suburban	21	(3.80)	30	(3.24)
Rural	20	(5.07)	33	(5.48)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-9
Composite Mean: Adequacy of Resource for Science Instruction

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	43	(3.52)	67	(4.17)
Low	63	(8.77)	71	(2.28)
Percentage of Underrepresented Minority Students at School				
High*	43	(3.11)	60	(4.35)
Low*	51	(8.77)	71	(2.49)
School Size				
Large*	48	(5.30)	70	(2.82)
Small*	40	(6.60)	70	(2.72)
Location of School				
Urban*	42	(4.98)	71	(2.51)
Suburban*	52	(3.36)	68	(2.43)
Rural*	48	(4.82)	66	(2.47)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-10
Composite Mean: Availability of Graphing Calculators

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	22	(6.66)	30	(7.67)
Low*	9	(7.98)	37	(5.97)
Percentage of Underrepresented Minority Students at School				
High	17	(4.94)	21	(6.81)
Low	38	(15.11)	45	(7.18)
School Size				
Large*	12	(5.54)	34	(6.40)
Small	20	(6.40)	39	(8.40)
Location of School				
Urban	17	(6.57)	27	(5.20)
Suburban*	15	(3.96)	43	(5.08)
Rural	33	(7.70)	49	(8.75)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-11
Composite Mean: Availability of Non-Graphing Calculators

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	57	(6.83)	85	(5.96)
Low	37	(25.23)	75	(5.99)
Percentage of Underrepresented Minority Students at School				
High	56	(7.73)	61	(10.73)
Low	71	(13.23)	78	(5.86)
School Size				
Large*	50	(11.42)	77	(6.75)
Small	65	(15.60)	75	(8.77)
Location of School				
Urban	66	(9.20)	77	(6.25)
Suburban*	55	(9.34)	78	(4.11)
Rural	68	(8.90)	86	(3.97)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-12
Composite Mean: Availability of Probes for Collecting Data

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	28	(7.73)	45	(10.87)
Low	21	(15.86)	66	(7.14)
Percentage of Underrepresented Minority Students at School				
High*	30	(5.71)	62	(10.20)
Low	42	(14.97)	62	(8.55)
School Size				
Large*	22	(7.68)	59	(8.06)
Small*	31	(7.83)	67	(8.58)
Location of School				
Urban	41	(7.95)	50	(8.44)
Suburban*	24	(5.86)	63	(5.70)
Rural	44	(7.93)	60	(9.99)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-13
Composite Mean: Availability of Microscopes

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	56	(9.22)	87	(5.23)
Low	81	(14.48)	79	(5.65)
Percentage of Underrepresented Minority Students at School				
High*	50	(7.34)	79	(8.91)
Low	69	(11.93)	78	(5.09)
School Size				
Large*	53	(12.62)	81	(5.01)
Small*	56	(11.81)	83	(6.77)
Location of School				
Urban*	54	(8.53)	84	(4.67)
Suburban*	58	(8.38)	77	(4.51)
Rural	71	(8.79)	88	(4.34)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-14
Composite Mean: Reform-Oriented Instructional Objectives

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High*	75	(2.34)	87	(1.45)
Low	85	(5.41)	89	(0.98)
Percentage of Underrepresented Minority Students at School				
High*	76	(1.70)	84	(1.73)
Low	73	(7.31)	85	(1.38)
School Size				
Large*	76	(3.62)	87	(1.24)
Small	79	(3.42)	85	(1.12)
Location of School				
Urban*	74	(2.66)	87	(1.03)
Suburban*	78	(2.18)	86	(0.83)
Rural	80	(2.71)	85	(1.23)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-15
Teachers Reporting Moderate or Heavy Emphasis on Reform-Oriented Instructional Objectives†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Understanding science concepts*	94	(1.61)	100	(0.33)
Learning science process skills (e.g., observing, measuring)*	87	(2.07)	93	(1.29)
Learning about real-life applications of science*	89	(2.18)	95	(0.97)
Increasing students' interest in science	93	(1.61)	96	(0.55)
Preparing for further study in science*	78	(2.35)	96	(1.02)

† The teachers gave a rating of 3 or 4 on a 4-point scale from 1 (none) to 4 (heavy emphasis).
* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-16
Composite Mean: Use of Reform-Oriented Teaching Practices

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	60	(1.66)	64	(1.83)
Low*	58	(1.98)	67	(1.42)
Percentage of Underrepresented Minority Students at School				
High	59	(1.75)	62	(2.26)
Low	62	(4.58)	62	(1.37)
School Size				
Large	61	(1.95)	63	(1.48)
Small*	55	(1.73)	61	(2.09)
Location of School				
Urban	61	(2.14)	64	(1.80)
Suburban	59	(1.46)	63	(1.37)
Rural*	56	(1.97)	61	(1.47)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-17
Teachers Including Various Instructional Practices in their Instruction at Least Weekly†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Having students work in small groups*	74	(2.45)	84	(1.80)
Doing hands-on/laboratory activities*	48	(4.22)	74	(2.00)
Engaging the class in project-based learning (PBL) activities	24	(2.65)	26	(2.48)
Having students represent and/or analyze data using tables, charts, or graphs*	47	(3.65)	58	(2.54)
Requiring students to supply evidence in support of their claims*	55	(3.84)	66	(2.49)
Having students write their reflections (e.g., in their journals) in class or for homework*	43	(3.83)	31	(2.72)

† The teachers gave a rating of 4 or 5 on the following scale: 1, never; 2, a few times a year; 3, once or twice a month; 4, once or twice a week; 5, all or almost all science lessons.

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-18
Composite Mean: Extent to which the Policy Environment Promotes Effective Instruction

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	67	(2.60)	66	(4.41)
Low*	56	(3.53)	69	(3.66)
Percentage of Underrepresented Minority Students at School				
High	66	(3.07)	61	(4.46)
Low	54	(13.81)	65	(3.67)
School Size				
Large	66	(4.15)	65	(3.32)
Small	54	(9.90)	65	(4.59)
Location of School				
Urban	63	(4.92)	71	(6.59)
Suburban	60	(3.03)	62	(2.27)
Rural*	55	(7.48)	72	(2.76)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-19
Teachers Indicating that Various Policies Promote Effective Instruction†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Current state standards	56	(5.40)	65	(3.26)
District/Diocese curriculum frameworks*	54	(5.57)	64	(4.21)
School/District/Diocese pacing guides	47	(5.22)	58	(4.51)
State testing/accountability policies	33	(5.20)	38	(5.08)
District/Diocese testing/accountability policies	31	(5.13)	44	(4.80)
Textbook/module selection policies*	38	(5.14)	56	(4.35)
Teacher evaluation policies	47	(5.86)	58	(3.51)

† The teachers gave a rating of 4 or 5 on a 5-point scale from 1 (inhibits effective instruction) to 5 (promotes effective instruction).
* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-20
Composite Mean: Extent to which Stakeholders Promote Effective Instruction

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	57	(2.46)	67	(4.94)
Low*	58	(4.27)	80	(2.41)
Percentage of Underrepresented Minority Students at School				
High*	56	(2.45)	72	(4.47)
Low*	50	(6.30)	72	(2.86)
School Size				
Large*	53	(3.70)	79	(3.18)
Small*	46	(3.98)	77	(3.76)
Location of School				
Urban*	64	(3.28)	82	(2.99)
Suburban*	51	(3.39)	74	(1.98)
Rural*	43	(2.59)	76	(3.17)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-21

Teachers Indicating that Stakeholders Promote Effective Instruction†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Students' motivation, interest, and effort in science*	52	(5.34)	80	(2.73)
Parent expectations and involvement*	30	(4.86)	69	(3.32)
Community views on science instruction*	34	(5:39)	64	(3.78)

† The teachers gave a rating of 4 or 5 on a 5-point scale from 1 (inhibits effective instruction) to 5 (promotes effective instruction).

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-22

Composite Mean: Extent to which School Support Promotes Effective Instruction

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Percentage of Students Qualifying for Free or Reduced-Price Lunch				
High	59	(4.95)	60	(6.45)
Low*	52	(10.51)	78	(2.79)
Percentage of Underrepresented Minority Students at School				
High	58	(5.04)	64	(6.29)
Low	52	(17.80)	68	(2.93)
School Size				
Large	62	(4.92)	70	(4.73)
Small*	43	(9.01)	68	(3.82)
Location of School				
Urban	58	(6.06)	69	(5.98)
Suburban	60	(5.04)	68	(2.93)
Rural*	51	(9.25)	73	(4.15)

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

Table A-23

Teachers Indicating that School Support Promotes Effective Instruction†

	Low Prior Achievement		High Prior Achievement	
	%	SE	%	SE
Time for you to plan, individually and with colleagues*	49	(5.66)	67	(2.98)
Time available for your professional development*	41	(5.30)	59	(3.16)

† The teachers gave a rating of 4 or 5 on a 5-point scale from 1 (inhibits effective instruction) to 5 (promotes effective instruction).

* The difference between means for classes of students with mostly low prior achievement and classes of students with mostly high prior achievement is statistically significant (independent samples t-test; $p < 0.05$).

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