

What Is the Impact of Decline in Science Instructional Time in Elementary School?

Time for Elementary Instruction Has Declined, and Less Time for Science Is Correlated with Lower Scores on NAEP

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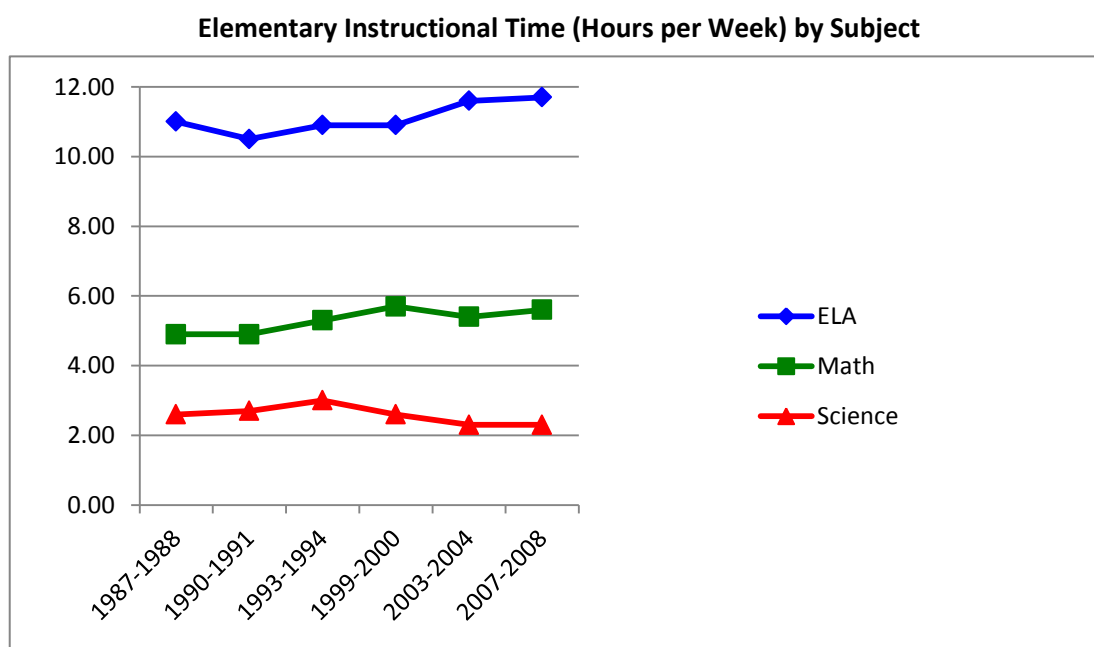
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Executive Summary

Key Finding 1. Instructional time for science in the elementary grades has dropped to an average of 2.3 hours per week, the lowest level since 1988.

National trends analysis shows a decline in time for elementary science instruction, and there is wide variability across the states in the average class time spent on science education. NAEP data for grade 4 classrooms show several states averaging over 3.5 hours per week in science instruction (45 minutes per day) while other states are averaging only 2 hours per week (25 minutes per day).

At a time when proficiency in science is more important than ever, the average time students spend learning science in the elementary grades is declining. Through the late 1980s and 1990s, time spent on both science and mathematics had been increasing until shortly before passage of the No Child Left Behind (NCLB) law in 2001, currently referred to by its more formal title, the Education and Secondary Education Act (ESEA). Since then, instructional time for math has increased modestly and held steady, time for English language arts (ELA) has increased substantially, and time for science has dropped to an average of 2.3 hours per week, the lowest level since 1988, as shown below.



Source: SASS Public School Teacher Survey. Standard errors for average hours by subject and year vary from 0.03 to 0.10. http://nces.ed.gov/surveys/sass/tables/sass0708_005_t1n.asp

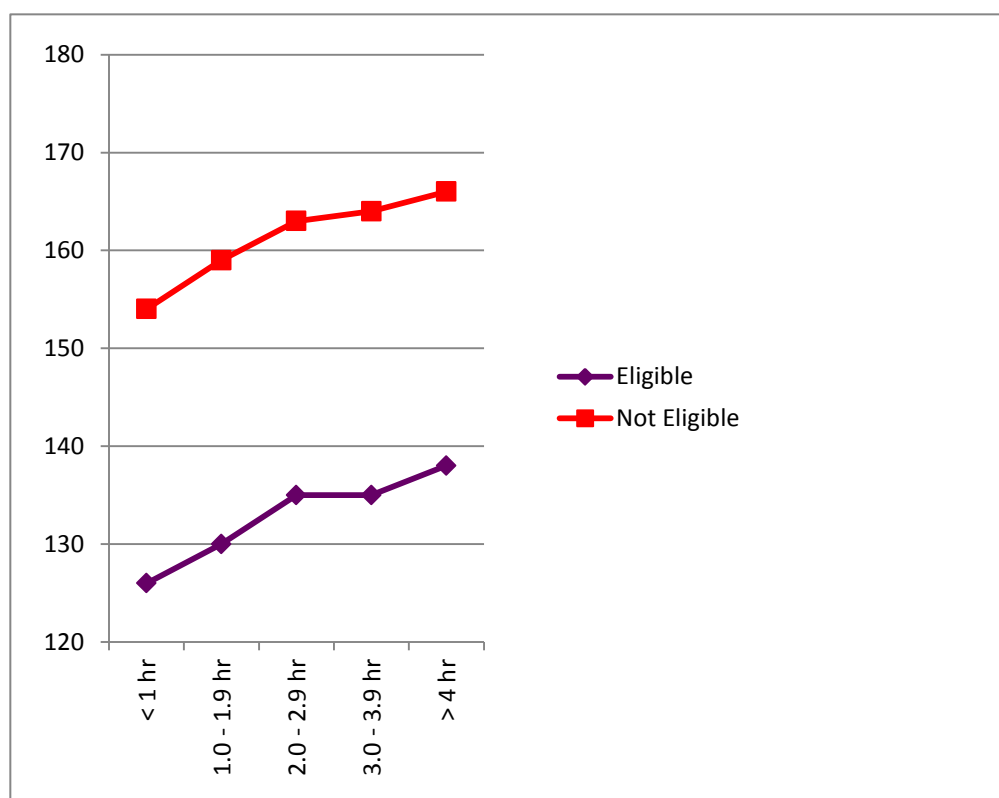
Key Finding 2. Aggregated national and state data indicate that less time for science is correlated with lower scores, accounting for approximately 12 points on the NAEP Science Scale at grade 4.

Data from the 2009 fourth grade NAEP Science assessment includes information on both student achievement and information from teachers and schools on a number of variables, including time spent

on science instruction, teacher preparation, frequency of hands-on science instruction, and student demographics. A variety of educational and societal factors explain differences in student achievement scores in science. This paper looks closely at one key factor controlled by schools and teachers – time on science instruction.

States' averages vary widely in class time spent on science, with average hours per week ranging from 1.9 hours per week in Oregon to 3.8 hours per week in Kentucky. Analysis of data on instructional time indicates that time on science is correlated with student performance. States also vary widely in the percent of students who are receiving free or reduced-price lunch, a proxy measure for low income. The figure below shows that low-income students eligible for free or reduced-price lunch who receive more than three hours science instruction per week score 12 points higher on NAEP 4th grade science than students receiving less than one hour per week. However, there is still a 28-point achievement gap between low-income students and other students, as shown below.

**4th Grade NAEP Science Scores,
By Hours per Week Spent on Science and Student Eligibility for Free or Reduced-Price Lunch**



Source: NAEP Data Explorer, <http://nces.ed.gov/nationsreportcard/naepdata/>

Standard error on achievement statistic = ± 3 points.

The results of our analysis of trends in class time for elementary science in public schools are especially troubling given recent research that indicates that students who ultimately decide to take advanced science classes in high school, and major in high-demand science, technology, engineering and

mathematics (STEM) fields in postsecondary education, tend to get hooked on STEM and make their choices as early as middle school. The findings also are particularly relevant as both the federal government and the business community step up their efforts to increase science proficiency and advanced STEM learning, and as Congress considers possible changes in the ESEA law.

Introduction

Current U.S. education policy discussions are focused on how to advance the quality and effectiveness of science and mathematics education for all students. New reports from the National Research Council (NRC) (2012) and National Governors Association (NGA) (2011) call attention to possible strategies for increasing the participation and preparation of more students in the science, technology, engineering and mathematics (STEM) fields. Two primary issues are summarized in these reports:

First, there is a high demand for U.S. high school graduates who are prepared to enter careers requiring STEM knowledge (President's Council of Advisers on Science and Technology, 2012). By 2018, there will be more than 2.8 million job openings for STEM workers; 92 percent of these jobs will require at least some postsecondary education (Carnevale, Smith & Stroll, 2010).

Second, results from the TIMSS and PISA international studies indicate that average U.S. student performance on science and math assessments do not compare favorably with results for students in leading industrialized nations (OECD, 2010; Provasnik, Gonzales & Miller, 2009). For the past several years, the U.S. Congress has been debating reauthorization of the Elementary and Secondary Education Act (ESEA) and examining the effects of its 2001 reauthorization as No Child Left Behind (NCLB). The NCLB law requires state testing and accountability reporting for reading and math at each grade 3 through 8 and one high school grade. Science must be tested at three grades but science scores are not included in school accountability annual progress determinations. One question under close consideration is the effect of accountability requirements under NCLB as well as under prior state and federal accountability policies. The NRC report recommends changes in the current law to reinforce the role of science education in schools (2011, p. 21). The National Science Teachers Association (NSTA) has advocated for increased time in the school curriculum as a key ingredient to improving science education and student outcomes, especially in the elementary grades (NSTA, 2002; see webpage for current position statement, www.nsta.org).

Additionally, greater emphasis is expected on science education in the near future. Twenty-six states have joined with the NRC, NSTA, the American Association for the Advancement of Science, and Achieve in leading the development of Next Generation Science Standards. Draft standards, which are based on

the *Framework for K–12 Science Education* developed and published by NRC (2012), were released May 11 of this year, and a final version will be out in early 2013.

The elementary and middle school years could well be the best time to capture students' interest in and motivation to pursue postsecondary STEM learning. A review of some 150 key studies of children's attitudes toward science found that their interests in science tend to decline from age 11 onwards (Osborne, 2003). In a recent survey of college students, meanwhile, nearly four in five STEM majors (78 percent) said they decided to study STEM in high school or earlier—and one in five (21 percent) said they made their decisions in middle school or earlier (Harris Interactive, 2011).

About This Study

This paper addresses the question of trends in time spent on science instruction in public schools, and the relationship between instructional time and achievement, using a state comparative analysis. Class time for science instruction is a key indicator of opportunity to learn. Researchers on time and learning have found that class time needs to be allocated regularly during the school day and week, and that instructional time is a key equity issue (for research on time and learning, see Traphagen, 2011; Gettinger, 1985; Karweit, 1983; National Center on Time and Learning, 2010). Time devoted to core academic subjects was a primary focus of the reform recommendations of the National Commission on Excellence in Education report, *A Nation at Risk* (1983). In the ensuing years, almost all states increased core academic subject requirements continuing to the present, with a particular focus on math and science education (Stillman & Blank, 2009). The accountability requirements focused on annual student testing in math and reading, which were broadened to all schools in all states under NCLB, and the current requirement of annual reporting on adequate yearly progress for all students produce strong incentives for schools to focus more instructional time on math and reading, resulting in less time for science, social studies, and other subjects.

Now many educators are asking about the impact of accountability requirements for math and reading on science education. That is, how much time are teachers devoting to science instruction each week? The analysis of data in this paper examines trends over time and variation among states in time spent on science instruction. The paper also addresses differences among student groups. The goal is to increase our understanding of the condition of science education in our schools. Careful data analysis can help leaders and educators determine what is needed to improve student learning in science.

Through analysis of recent representative, comparable data from students and teachers in states, this paper addresses several questions about science education:

1. What is the amount of time spent on science instruction in U.S. elementary schools, and how does the time differ by state? Has time devoted to science education in schools changed over time? Do patterns of time allocation continue in middle schools?
2. Are science class time differences related to student achievement?
3. Is science instructional time related to demographics of the student population?

Data Sources

The two primary data sources for the analysis of science instruction by state are from national surveys conducted through the National Center for Education Statistics of the U.S. Department of Education.

The Schools and Staffing Survey (SASS) provides a measure of time on science instruction and change over time. The most recent survey was conducted in the 2007–08 school year with a representative sample of elementary and secondary public schools and teachers in all 50 states. The same questions were asked of a sample of teachers every four years since the 1987–88 school year. The SASS study design is based on a sample of 800 to 1,200 teachers per state. The SASS data allow for comparison of teaching in science to teaching in other elementary subjects. (Results were accessed from the NCES SASS Public School teacher survey, <http://nces.ed.gov/surveys/sass/>.)

The NAEP 2009 Science assessment was conducted with a representative sample of students in grades 4 and 8 in each participating state (46 states voluntarily participated). In addition to the student assessment, data collection included a survey of teachers, a school-level science program survey and a student survey. The survey responses provide a data source for analyzing several key characteristics of science instruction with results reported at the state and national level. It is important to note that the data provided by the teachers and school concern the same students whose performance is measured by the NAEP assessment.

For this paper, state-level measures based on aggregate 2009 data were selected to address each of the research questions. The possible measures available from NAEP surveys were reviewed through the online NAEP Data Explorer. The NAEP student assessment results can be analyzed in relation to a variety of characteristics of instruction that are reported online.

(<http://nces.ed.gov/nationsreportcard/naepdata/>.)

Key Findings

State-level data from the Schools and Staffing Survey provide a measure of time on science instruction and change over time. Nationally, elementary teachers in grades 1 through 4 in self-contained classrooms spent an average of 2.3 hours per week on science instruction during the 2007–08 school year. The instructional time for science can be compared to 11.7 hours per week on English language

arts (ELA) and reading, 5.6 hours on arithmetic/math and 2.3 hours per week on social studies. Table 1 and Figure 1 provide detail on the national analysis of trends in instructional time per week over the past 20 years. *Time for science instruction in grades 1–4 has declined from an average of 3.0 hours per week in 1993–94 to 2.6 hours in 2000 to 2.3 hours in 2004 and 2008.* The table also shows that, while overall instructional time in elementary grades spent on four core subjects has increased over 20 years, *the percentage of time devoted to science instruction has declined.* This data supports Key Finding 1.

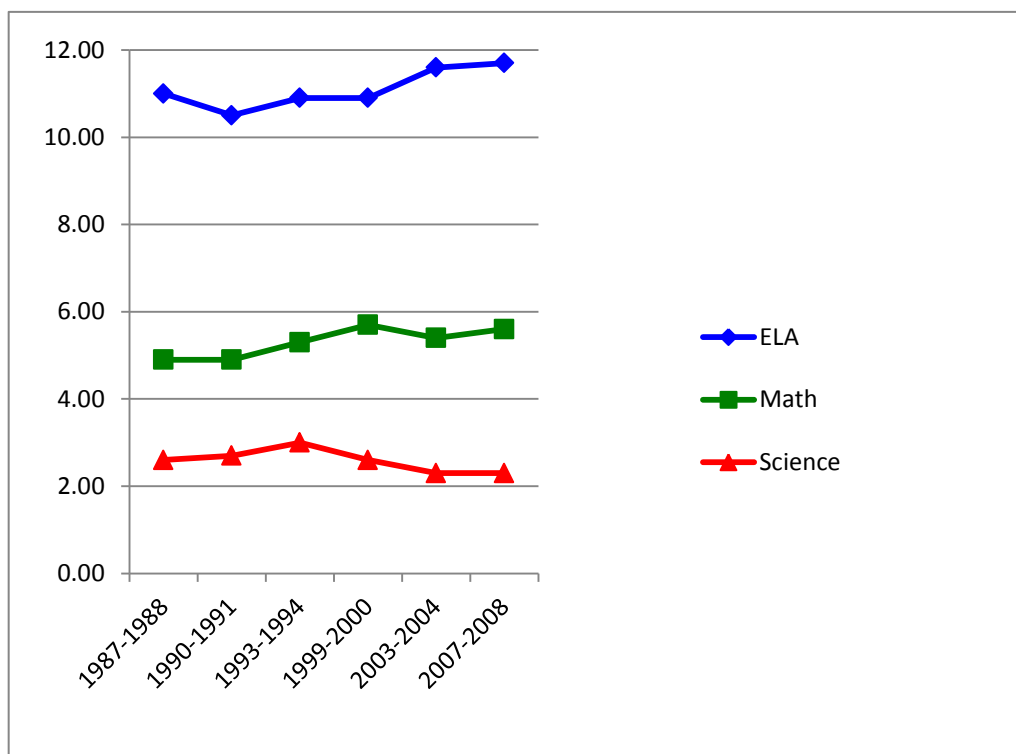
Key Finding. Instructional time for science in the elementary grades has dropped to an average of 2.3 hours per week, the lowest level since 1988.

Table 1. Elementary Instructional Time (Hours per Week) 1988 to 2008

	1987-1988	1990-1991	1993-1994	1999-2000	2003-2004	2007-2008
English	11.0	10.5	10.9	10.9	11.6	11.7
Mathematics	4.9	4.9	5.3	5.7	5.4	5.6
Social Studies	2.8	2.9	3.0	2.9	2.5	2.3
Science	2.6	2.7	3.0	2.6	2.3	2.3

Source: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS). "Public Teacher Data File," 1987–88, 1990–91, 1993–94, 1999–2000, and 2003–04, and 2007–08. Standard errors for average hours by subject and year vary from 0.03 to 0.10; For all means and standard error tables, go to http://nces.ed.gov/surveys/sass/tables/sass0708_005_t1n.asp

Figure 1. Trends in Elementary Instructional Time (Hours per Week) by Subject: 1988 to 2008



Source: SASS Public School Teacher Survey, http://nces.ed.gov/surveys/sass/tables/sass0708_005_t1n.asp Table 1 above

Key Finding. Aggregated state-level and national data indicate that less time for elementary science is correlated with lower NAEP science scores.

The NAEP 2009 Science assessment provides a measure of time on science instruction per week reported by grade 4 teachers whose students took the NAEP assessments. In most elementary schools the time spent on each academic subject is the product of several factors, including federal and state policies and standards, district funding and priorities, school leadership, and teacher instructional decisions. The amount of time reported on the NAEP survey by teachers and the average computed from a representative sample of teachers in each state provides one important indicator of the instructional emphasis and attention to science at the elementary level.

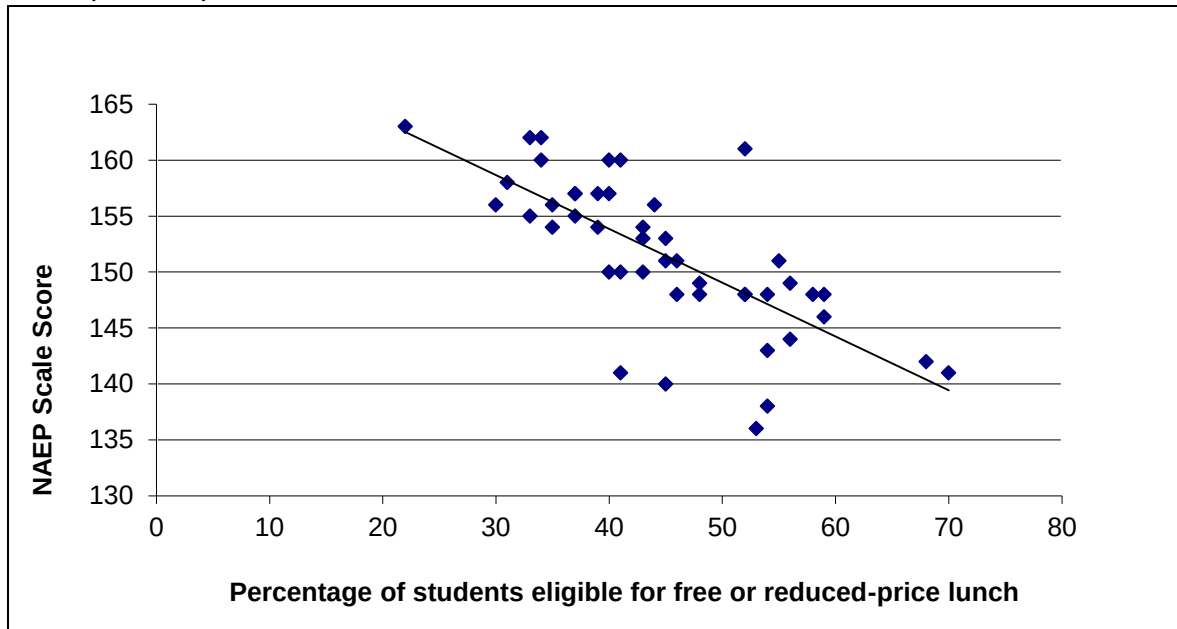
Student performance on the various NAEP assessments is commonly reported in the academic literature and mass media, where the focus is primarily on differences among the states. (Unlike the TIMSS or PISA assessments, NAEP is only conducted within the United States, so comparison with other countries is not currently possible.) So, for example, students in the top performing states, such as New Hampshire, North Dakota, Virginia, and Kentucky, score on average above 160, while the bottom

performing states Mississippi, California, and Arizona score on average below 140. And while there has been much speculation on why these differences occur, there have been few studies that attempt to mine the NAEP data for clues about the possible causes of these differences. The current study provides correlational evidence at the state and national levels. Further studies beyond these correlational findings could be conducted with data at the school, classroom and student levels.

This research study explored the 2009 4th grade NAEP assessment results and looked closely at the relationship of key measures of teaching, curriculum and student background to student performance. This analysis focuses on use of state-level, aggregate measures because of the high interest in state-level indicators with NAEP data. Using aggregate measures, however, it is difficult to isolate the effect of each educational measure of interest, such as teacher preparation or types of classroom instructional practices (e.g., hands-on vs. text-driven), from related confounding factors. However, one variable that stood out as the strongest correlate of NAEP performance at the state level was average student income level.

This strong correlation is not reported as a key finding in this study, since it is already well-known as the “achievement gap.” However, given the scatter in the graph of Figure 2, there are clearly other factors at work. Consequently, this study focuses on another key factor correlated with state-level average student performance on the 4th grade NAEP science assessment—classroom instructional time. Our analysis did examine other educational factors in elementary science, including types of instructional practices, curriculum emphasis, and teacher preparation, and time using hands-on science activities did show a positive correlation to NAEP science scores. However, average classroom instructional time was the strongest educational factor related to achievement at the state level, and our reporting focuses on this variable.

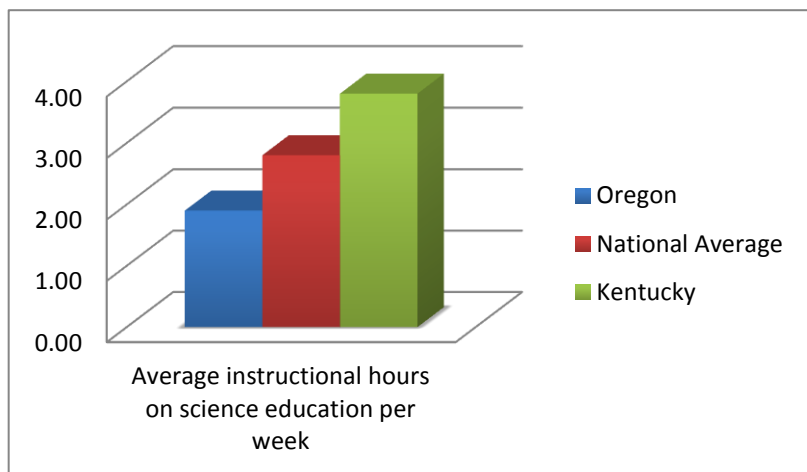
Figure 2. State NAEP Science Score by Percentage of Students Eligible for Free or Reduced-Price Lunch, Grade 4, 2009



Source: NAEP Data Explorer <http://nces.ed.gov/nationsreportcard/naepdata/>

Standard error on achievement scores = ± 3 points

Notice that in Figure 2 a number of states are “outliers.” That is, they are plotted far from the line of best fit. Kentucky, for example, is well to the right of the line with a score of 161. Although it has a relatively high percentage of low-income families (52%), it spends the greatest amount of time on science (3.8 hours/week). Oregon, on the other hand, has fewer low-income families (46%), spends the least amount of time on science (1.9 hours/week), and has an average NAEP Science score of 151.



Source: U.S. Department of Education, NCES, NAEP 2009 Science Assessment.

Figure 3. Science Instructional Time per week: comparing average hours per week at grade 4 in Oregon (the lowest), Kentucky (the highest) and the national average.

Science Instructional Time per week and State NAEP Scores, Grade 4

Data reported by state in Table 2 show that among the 13 states with highest average grade 4 NAEP scores (New Hampshire, 163, to Wisconsin, 157), the average instructional time was more than 3 hours per week. Two states were in the top five states on both measures (Kentucky and Virginia). Thus, there is a pattern across states of more time on science classroom instruction in states with higher student NAEP scores. Considering the variability in use of class instructional time there are exceptions in the state NAEP average scores and relation to instructional time. Among the 13 highest scoring states, five states had less than average time on science instruction in grade 4.

Many factors contribute to student performance, including instructional time. A two-variable plot graph shown in Figure 4 shows the relationship level between state average time allocated to science and the average student achievement of grade 4 students. The plot graph illustrates a positive relationship between these two variables—a state with 2.0 hours per week of science instruction has an average NAEP score of 150; a state with 3.5 hour per week of science instruction has a NAEP average score of 154, and this difference is statistically significant.

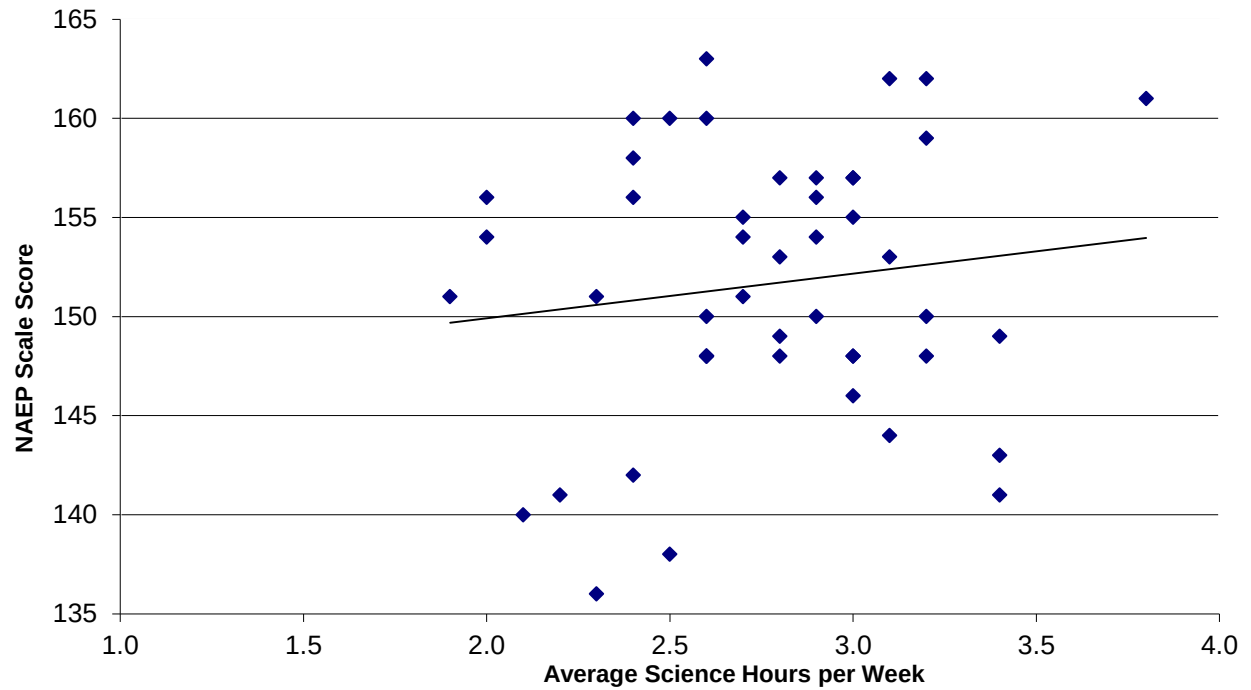
Table 2: Science Grade 4 Instructional Time, State NAEP Score, and Percent Low-Income, 2009

	Avg. Hrs. per week	NAEP Scale Score	% Low-income
New Hampshire	2.6	163	22
North Dakota	3.2	162	33
Virginia	3.1	162	34
Kentucky	3.8	161	52
Maine	2.5	160	40
Massachusetts	2.4	160	34
Montana	2.6	160	41
DoDEA	3.2	159	na
Minnesota	2.4	158	31
Iowa	2.9	157	37
Ohio	3.0	157	40
South Dakota	2.8	157	37
Wisconsin	3.0	157	39
Connecticut	2.4	156	30
Missouri	2.9	156	44
Wyoming	2.0	156	35
Colorado	2.7	155	37
New Jersey	3.0	155	33
Idaho	2.0	154	43
Pennsylvania	2.9	154	39
Utah	2.7	154	35
Delaware	3.1	153	43
Indiana	2.8	153	45
Florida	2.7	151	55
Oregon	1.9	151	46
Washington	2.3	151	45
Maryland	2.9	150	40
Michigan	3.2	150	43
Rhode Island	2.6	150	41
South Carolina	3.4	149	56
National public	2.8	149	48
Illinois	3.0	148	46
New York	2.6	148	52
North Carolina	2.6	148	48
Oklahoma	2.8	148	54
Tennessee	3.0	148	52
Texas	3.2	148	59
West Virginia	2.6	148	58
Arkansas	3.0	146	59
Georgia	3.1	144	56
Alabama	3.4	143	54
New Mexico	2.4	142	68
Louisiana	3.4	141	70
Nevada	2.2	141	41
Hawaii	2.1	140	45
Arizona	2.5	138	54
California	2.3	136	53
Mississippi	3.0	133	69

Source: U.S. Department of Education, NAEP 2009 Science Assessment. Note: Standard errors for state NAEP scores from 1 to 3 points; SE for science hrs/week by state from 0.2 to 0.4 hr.

<http://nces.ed.gov/nationsreportcard/naepdata/>

Figure 4. State NAEP Score by Science Instructional Time, Grade 4, 2009



Source: U.S. Department of Education, NAEP 2009 Science Assessment. Note: Standard errors for state NAEP scores from 1 to 3 points; SE for science hrs/week by state from 0.2 to 0.4 hr. <http://nces.ed.gov/nationsreportcard/naepdata/>

Correlation of Time and Family Income with 4th Grade NAEP Score

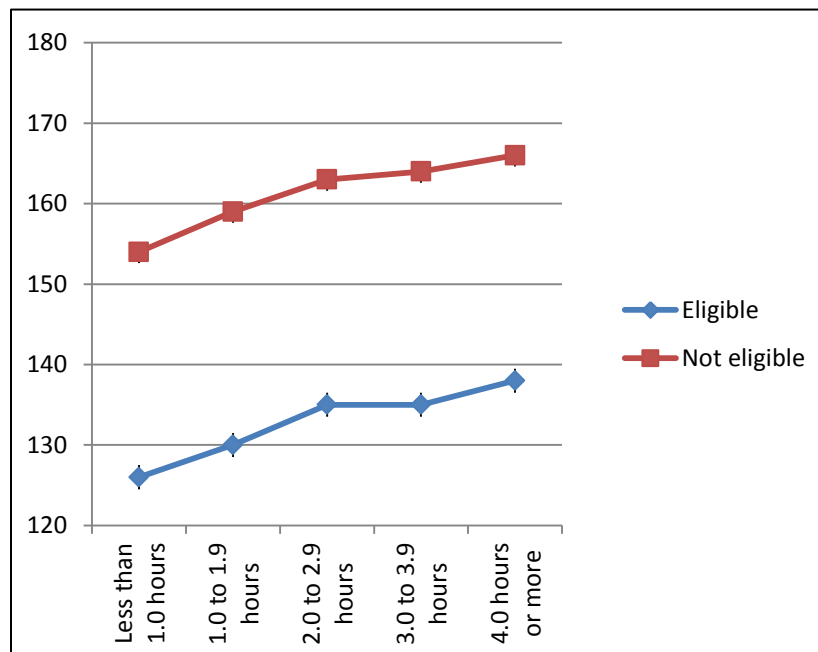
A clear pattern emerges when the 2009 NAEP 4th grade data is analyzed as a nationally aggregated sample by time and percentage of students from low-income families. The results of this analysis are shown below. Within the standard error of the sample, it is clear that more time on science means higher NAEP scores for all students. This set of data supports our second key finding.

Key Finding: Aggregated state-level and national data indicate that less time for science is correlated with lower scores on NAEP Science. In Table 3 and Figure 5 notice that the range of time spent on science and the range of NAEP scores is considerably greater than the ranges of these variables by state. The difference in NAEP scores is 12 points between students receiving less than 1 hour of science instruction and more than 4 hours of instruction per week. This difference in range of time and scores indicates that science instruction in schools varies considerably within states as well as between states.

Table 3. NAEP Score by Science Class Time and Eligibility for Free/Reduced-Price Lunch, Grade 4, 2009

Science Class Time per week	Eligible		Not eligible	
	Avg. scale scores	SE	Avg. scale scores	SE
Less than 1.0 hours	126	(1.4)	154	(1.5)
1.0 to 1.9 hours	130	(1.1)	159	(0.9)
2.0 to 2.9 hours	135	(0.6)	163	(0.5)
3.0 to 3.9 hours	135	(0.6)	164	(0.5)
4.0 hours or more	138	(0.6)	166	(0.6)

Figure 5. NAEP Score by Science Class Time and Eligibility for Free or Reduced-Price Lunch (Data from Table 3)

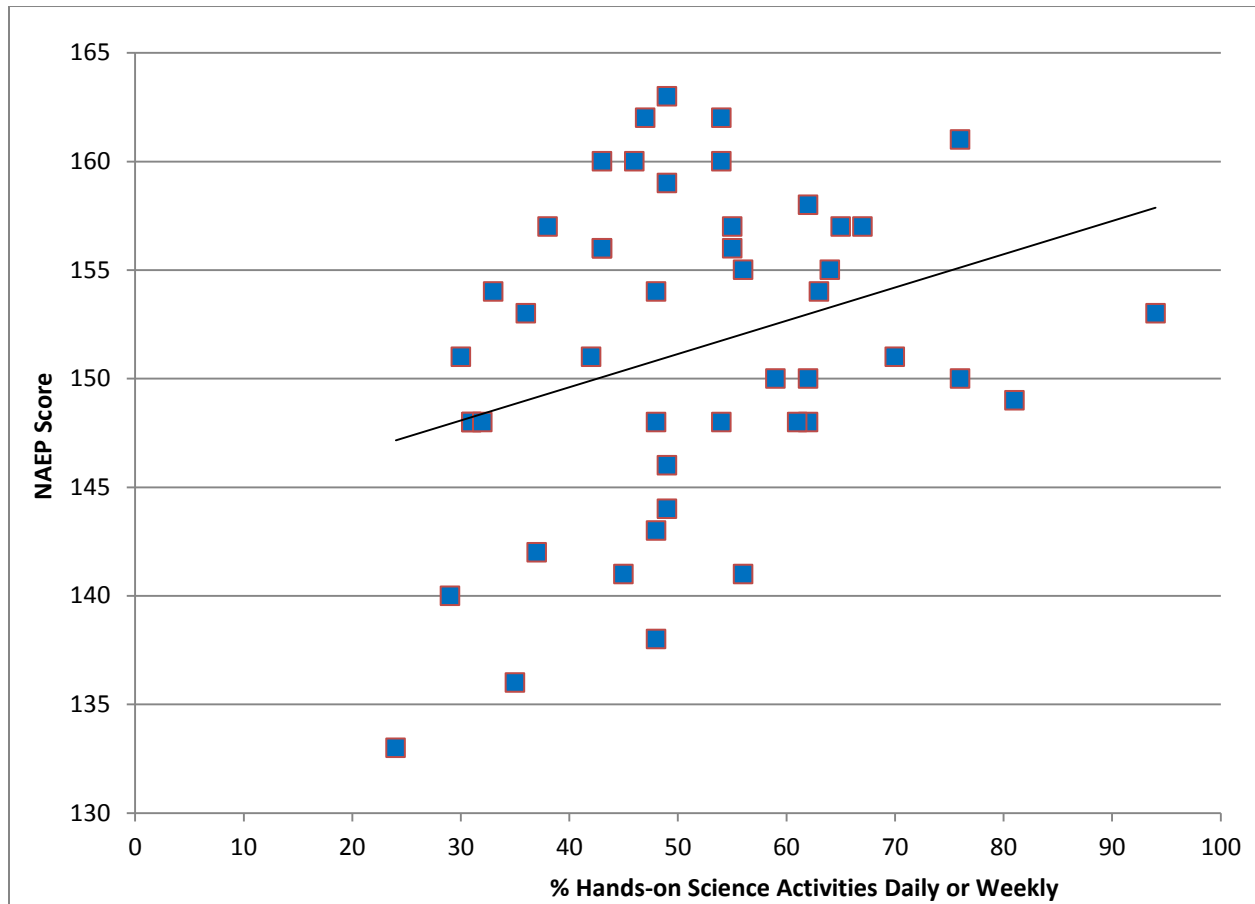


Use of Hands-on Activities in Science Instruction, Grade 4

The NAEP teacher survey includes a number of questions regarding instructional practices with students in classrooms. One type of practice with high interest in the science education community is the use of hands-on activities with students in elementary science instruction (see National Research Council, *Framework for K-12 Science Education*, 2012). The data reported below by state address the question of how time for science instruction is used in elementary classrooms. The state average results reported in Figure 5 and Table 4 show that *hands-on science activities* were reported by teachers as used daily or once or twice a week in over 60 percent of grade 4 classrooms in 12 states. The leading states by percentage of grade 4 teachers reporting hands-on science activities at least once or twice per week were: Delaware--94 percent (including 56% daily use), Iowa--67 percent, Kentucky--76 percent, , Rhode Island--76 percent, and Washington--70 percent. On the other hand, *states with low levels of science hands-on activities* below 35 percent at least weekly were: California, Hawaii, Idaho, Mississippi, Oklahoma, Oregon, Tennessee, and West Virginia. A majority of these states also had teachers report less time per week on science (see Table 2).

Figure 6 shows a two-variable plot graph of hands-on science activities by NAEP score. The relationship between the two measures indicated by the line plot indicates that states with higher NAEP scores have more teachers reporting frequent use of hands-on science activities in class in grade 4.

Figure 6: NAEP State Score by Percentage of Classes with Hands-on Science Activities Daily or Weekly, Grade 4, 2009



Source: U.S. Department of Education, NAEP 2009 Science Assessment

Note: Standard errors for NAEP State scores from 1 to 3 points; SE for % hands-on by state from 1 to 3 %.

Table 4: Hands-on Science Activities in Class and State Scale Score, Grade 4

	% Weekly Hands-on	% Daily Hands-on	NAEP Score
Alabama	34	14	143
Arizona	37	11	138
Arkansas	45	4	146
California	29	6	136
Colorado	42	22	155
Connecticut	43	12	156
Delaware	38	56	153
Florida	40	2	159
Georgia	45	4	151
Hawaii	26	3	144
Idaho	27	6	140
Illinois	40	8	154
Indiana	29	7	148
Iowa	38	29	153
Kentucky	52	24	157
Louisiana	50	6	161
Maine	39	7	141
Maryland	42	20	160
Massachusetts	45	9	150
Michigan	43	16	160
Minnesota	41	21	150
Mississippi	23	1	158
Missouri	34	9	133
Montana	33	10	156
Nevada	36	9	160
New Hampshire	40	9	141
New Jersey	42	14	163
New Mexico	32	5	155
New York	51	11	142
North Carolina	39	15	148
North Dakota	43	11	148
Ohio	45	10	162
Oklahoma	23	8	157
Oregon	24	6	148
Pennsylvania	40	23	151
Rhode Island	57	19	154
South Carolina	60	21	150
South Dakota	34	4	149
Tennessee	25	6	157
Texas	46	15	148
Utah	42	6	148
Virginia	42	5	154
Washington	51	19	162
West Virginia	25	7	151
Wisconsin	43	22	148
Wyoming	38	5	157
DoDEA	44	5	156

Source: U.S. Department of Education, NAEP 2009 Science Assessment

Note: Standard errors for NAEP State scores from 1 to 3 points; SE for % hands-on by state from 1 to 3 %.

Conclusion

Nationally, the trends-over-time analysis shows that time on elementary science instruction has declined since 1994, despite the increased time spent per week on core academic subjects during the past decade. Elementary science instruction is at the lowest number of hours per week as a national average since trend data on the measure began in 1988. Time spent in classroom instruction in science has declined during the time period of state and federal accountability testing and reporting, and during the past decade when the NCLB requirements were implemented by states, the instructional time on reading and math has gone up while instructional time on science has continued to decline. The state-level analysis of science instructional time shows that wide variation in amount of class time at grade 4 exists among the states, with average time in several states almost twice the time provided in other states. Although the large disparity in NAEP Science scores at the fourth grade level is highly correlated with the “achievement gap,” time on science instruction also contributes to this disparity. The impact on all students, including those from low-income families, is most strikingly illustrated in Table 4 and Figure 4, which show that time on science accounts for approximately 12 points on the 4th grade NAEP science scale.

In summary, the major findings of this study are that:

- Instructional time for science in the elementary grades has dropped to an average of 2.3 hours per week, the lowest level since 1994; and
- Aggregated national and state-level data indicate that less time for science is correlated with lower scores, accounting for approximately 12 points on the 4th grade NAEP Science Scale.
- States with higher average classroom time on science show a pattern of higher NAEP Science scores; additionally, states with higher average classroom time spent on *hands-on science activities* have higher NAEP scores.

At a time when proficiency in science is more important than ever, the findings on overall trends in allocation of classroom time are troubling. The findings of this analysis on science time in elementary classrooms together with the long record of prior research on the importance of adequate instructional time point to time as a key ingredient for improving instruction and student performance. The findings are **not** intended to suggest that time is the only factor in improving teaching and learning in science or performance on NAEP—other variables including teaching practices, curriculum, and teacher preparation also need to be considered. Although a number of factors contribute to students’ performance, the strong correlations found in this study suggest that at the elementary school level, time on science instruction makes a difference—and the national trends over time of increased time and attention on English language arts and mathematics may be contributing to the low level of science performance in our nation.

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