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Do We Produce Enough Mathematics and Science Teachers?

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Do We Produce Enough Mathematics and Science Teachers?

Abstract

For years, we've been told that we don't produce enough math and science teachers. Increasing teacher retirements and increasing student enrollments, we're told, have forced many school systems to lower standards to fill teaching openings, leading to high levels of underqualified teachers and, in turn, to lower student performance. Numerous high-profile reports have directly tied mathematics and science teacher shortages to a host of education and social problems, including the inability to meet student achievement goals, low U.S. performance compared to other nations, the minority achievement gap, poor national economic competitiveness, and even threats to national security.

Disciplines

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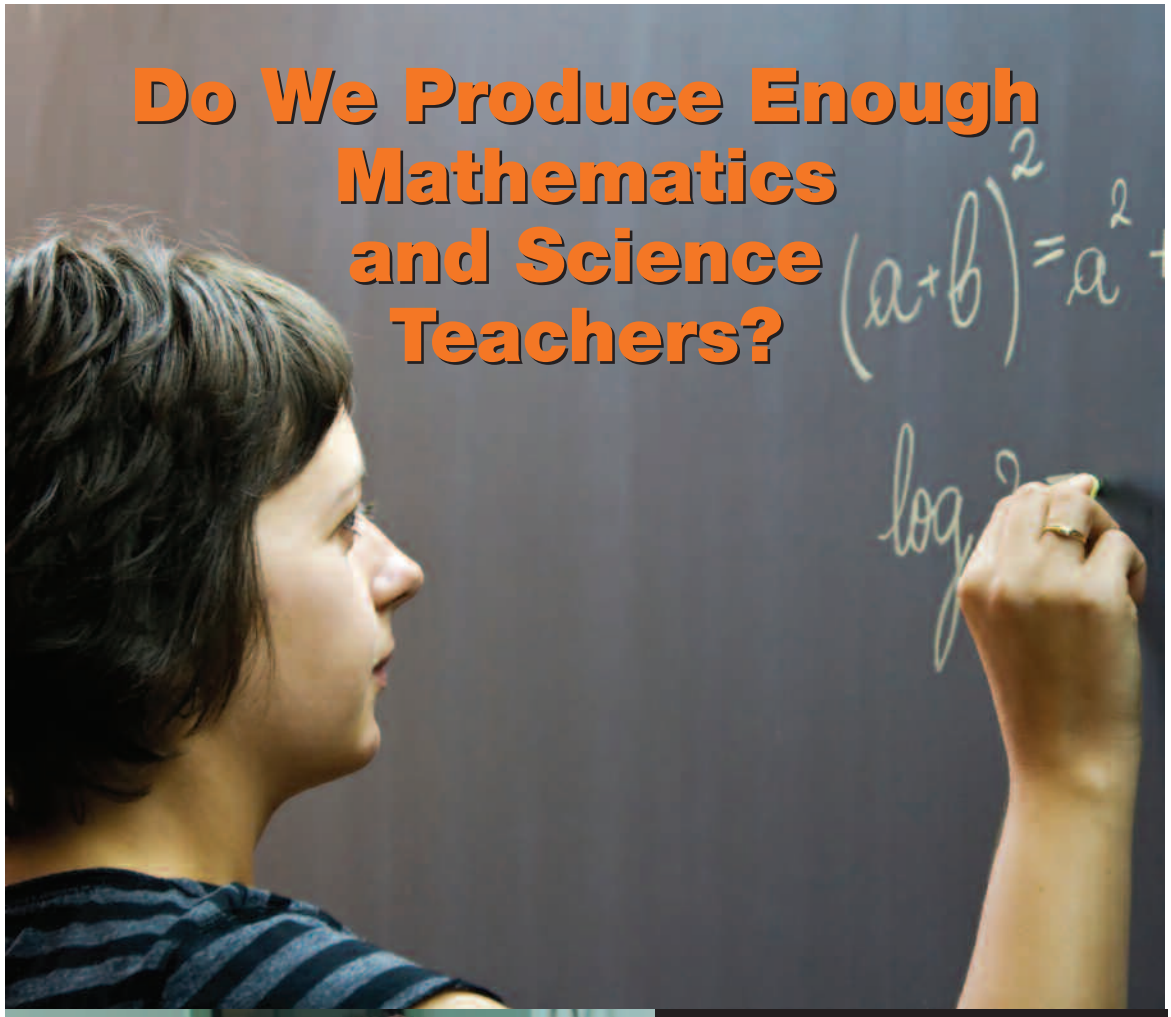

Over the past two decades, efforts to recruit new math and science teachers have been very successful, but retaining them has not.

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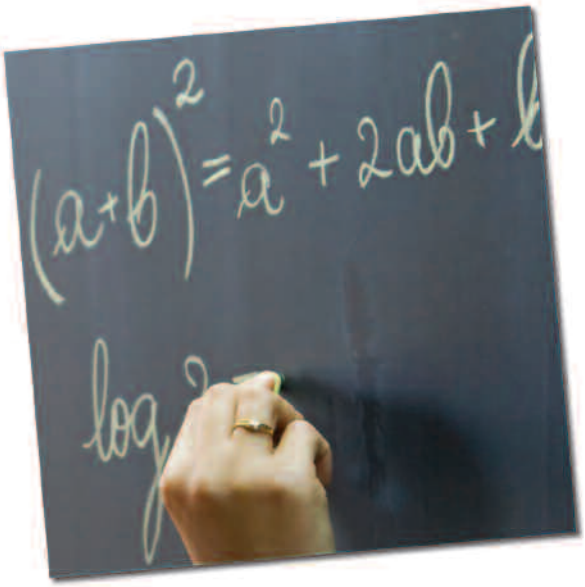
By Richard M. Ingersoll

For years, we've been told that we don't produce enough math and science teachers. Increasing teacher retirements and increasing student enrollments, we're told, have forced many school systems to lower standards to fill teaching openings, leading to high levels of underqualified teachers and, in turn, to lower student performance. Numerous high-profile reports have directly tied mathematics and science teacher shortages to a host of education and social problems, including the inability to meet student achievement goals, low U.S. performance compared to other nations, the minority achievement gap, poor national economic competitiveness, and even threats to national security.

The antidotes have been straightforward: Reformers, legislators, and school officials have implemented a wide range of initiatives designed to recruit able candidates into teaching and to increase the supply of qualified math and science teachers. But, after several decades, we seem to have made little progress. Why?

Despite the long-standing prominence of this issue, there has been surprisingly little empirical research on math and science teacher supply, demand, and shortages. Although it has been widely assumed that student enrollments and teacher retirements have far outstripped the production of new math and science teachers, there do not appear to be any studies that test this claim with data.



Our nation does produce enough qualified math and science teachers to cover both student enrollment and teacher retirement increases.

Several years ago, I set out to use the best national data available to answer these questions. Together with my research assistants, David Perda, Lisa Merrill, and Henry May, I analyzed two decades of data from several national surveys conducted by the U.S. Department of Education. I sought the answer to five questions:

- What has happened to the demand and need for math and science teachers?
- What are the main sources of new hires?
- Has the new supply been sufficient to cover increases in student enrollments and increases in teacher retirements?
- How many schools have trouble finding qualified candidates to fill their math and science job openings? and
- Does the problem vary by state or locale?

Many of our findings contradict conventional wisdom and, no doubt, will be viewed by some as heretical. It became clear that the reasons for these staffing problems are more complex and varied than simply an insufficient production of new teachers (Ingersoll and Perda 2010; Ingersoll and May 2010).

THE DEMAND

Beginning in the mid-1980s and continuing to the present, elementary and secondary student enrollments in the United States have grown steadily. Over the same period, high school graduation course requirements increased in the core academic subjects, especially in math and science. This led, in turn, to a dramatic rise in the number of students taking math and science courses over the past two decades. Math course enrollments grew by 69%, and science course enrollments grew by 60%. In addition, during this period, the number of teacher retirements increased by a striking 141%. All of these factors led to a large jump in the demand for new math and science teachers, and we would expect worsening shortages.

THE SOURCES

Unlike other nations, the United States produces new teachers through large numbers of accessible, widely dispersed teacher-preparation programs — an average of 25 per state — usually in departments or colleges of education. But, despite the large number of teacher-preparation programs, the traditional "pipeline" of college students with freshly completed education degrees is, surprisingly, a relatively minor source of new teachers. It constitutes less than a quarter of new math and science teacher hires in any given year. A larger source is those entering teaching with noneducation degrees in math or in one of the sciences, such as biology or chemistry. An even larger source of new hires is what is called the "reserve pool," primarily former teachers who left teaching to return later (see Figure 1). This array of sources and their relative proportions has not greatly changed over the past two decades. To evaluate whether the new supply of teachers is sufficient requires counting all of these sources of new hires, which is something analysts have often failed to do.

There also are large flows of teaching candidates between states. Analysts have long held that barriers — such as a lack of pension portability and a lack of teacher certification reciprocity — impede the movement of teachers between states, contributing to geographic shortages. There is, no doubt, some truth to this, but despite these impediments, over a quar-

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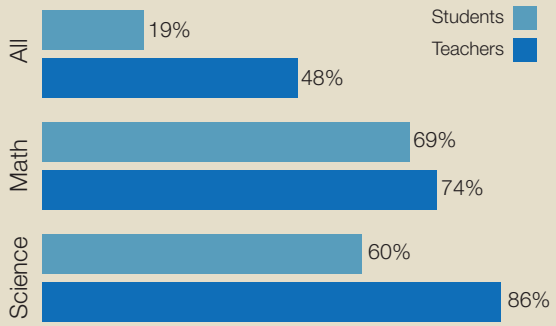
ter of applicants for teaching positions across the nation are out-of-state candidates, with some states far more successful in this regard than others.

IS THE NEW SUPPLY SUFFICIENT?

One way to evaluate whether the math and science teacher supply is sufficient is to test the two claims central to the conventional wisdom that the production of new teachers has not kept pace with: 1) student enrollment increases and 2) teacher retirement increases. In our research, we counted as qualified only those teachers who had a degree in math, in one of the sciences, or in a related field, such as math education. We did not count as qualified those who had passed a subject-area test, held a teaching certificate, or had taught math or science, absent having a degree. This meant that our data probably underestimated the new supply of qualified math and science teachers.

Nevertheless, we found that, despite the increases in high school math and science requirements and in math and science course taking, the employment of qualified math and science teachers has more than kept pace. Teaching has long been one of the largest, if not the largest, occupational groups in the nation, and the data show it is growing even larger. Over the past two decades, the teaching force has increased at a rate over 2½ times that of students while middle and secondary-level class sizes have remained stable (Ingersoll and Merrill 2010). Not all fields have gained equally. While the number of qualified art and music teachers increased by only 19%, the numbers of qualified math teachers ballooned by 74%, and science teachers by 86% (see Figure 2).

FIG. 2
Percent increase in students and qualified employed teachers, by field, from 1987-88 to 2007-08.



Moreover, despite increases in mathematics and science teacher retirements, the new supply of qualified mathematics and science teachers has been more than sufficient to cover those retiring. The new supply of qualified math teachers was over 3½ times the number of qualified math teachers who retired in the same year (Figure 3). The ratio of new supply to retirement was even higher for science. Although there were some limitations in our data on the separate science disciplines, it appears that a similar ratio applied even to physics, long considered the field most prone to shortages.

However, it is also important to determine how many of the newly qualified math and science candidates are really interested in teaching. Research shows that a large portion of newly prepared teachers never teach. Simply because someone has com-

FIG. 1
Percent of math and science teachers newly hired in the school system, by supply source, 2007-08.

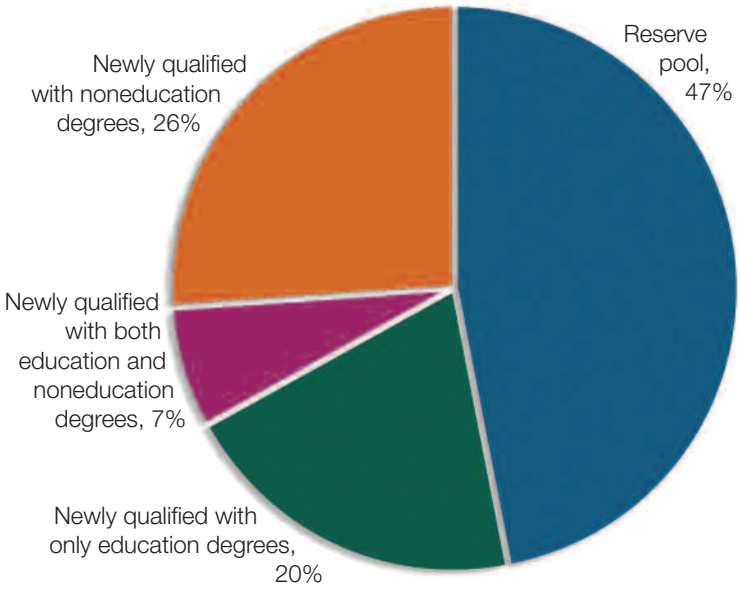
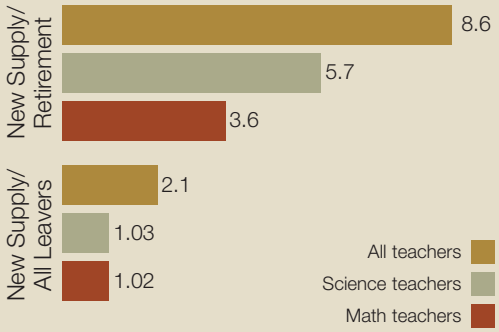


FIG. 3
Ratio of new supply of teachers to retirement and to all leavers, by field.



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pleted a teacher preparation program, and even obtained a teaching license, they may not be part of the "real" supply.

While high rates of pre-employment attrition may be true for such fields as physical education and elementary education, we found that almost all newly qualified math and science teachers in the pipeline, whether with education degrees or with noneducation degrees, were willing to seek teaching jobs and, indeed, had entered teaching within a year of graduating. Very few indicated that they were not interested in becoming teachers.

The largest differences in math and science teacher hiring problems are not between regions or states, but between different schools, even within the same school district.

It is important to recognize that these data do not show that the new supply of math and science teachers is optimum or ideal. That would require first defining desired pupil-teacher ratios, desired class sizes, desired graduation requirements, and so on. What the data do show is that, contrary to conventional wisdom, our nation does produce enough qualified math and science teachers to cover both student enrollment and teacher retirement increases. It appears that over the past two decades, efforts to recruit new math and science teachers have been very successful

CAN SCHOOLS FIND QUALIFIED TEACHERS?

These findings seem to contradict the conventional wisdom. Local school superintendents and principals have long bemoaned the difficulties they face finding qualified math and science teachers. Moreover, the national data show that a significant number of schools each year report serious problems filling their teaching openings. Math and science have been the most severely affected fields. In contrast, very few schools report any trouble in filling their English and social studies teaching positions.

However, math and science hiring difficulties do not affect all schools. In any given year, less than a third of U.S. secondary schools reported serious difficulties in finding qualified math or science teachers. The data show that there has been a persistent minority of schools that are hard to staff, especially for math and science. Why?

AN ALTERNATIVE EXPLANATION

While the new supply is more than sufficient to cover losses due to retirement, this is not the case when we include the losses of teachers before retirement — a figure that is many times larger than retirement and a primary factor behind the need for new hires. In prior research, I found that teacher turnover plays an important, but under-recognized, role in teacher shortages (Ingersoll 2001). Our new research shows that this is especially true for math and science teachers.

Math and science teachers have had about the same annual rates of leaving as other teachers. But the education system does not enjoy a large "cushion" of new mathematics and science teachers as it does for English or social studies teachers. For math and science, there is a much tighter balance between the new supply and the total leaving (Figure 3). Most of the hiring of new mathematics and science teachers at the beginning of a school year is simply to fill spots vacated by math and science teachers who departed at the end of the prior school year. Most of these departures are not the result of a "graying workforce."

Of course, teacher turnover is not necessarily detrimental. Across a range of occupations and industries, job and career changing are normal and common — perhaps increasingly so — and some argue that high levels of employee turnover are a sign of economic opportunity and a dynamic, well-functioning economy. Moreover, management experts argue that effective organizations usually both promote and benefit from some degree of employee turnover by the departure of low-caliber performers and bringing in "new blood" to facilitate innovation.

How does teaching compare to other lines of work? Our data show that teaching has far higher annual turnover than some higher-status or higher-pay occupations (such as lawyers, engineers, architects, professors, pharmacists), about the same turnover as police, but less turnover than some lower-status lines of work (such as correctional officers, childcare workers, secretaries). While there can be benefits to employee turnover, management experts tell us that employee turnover is not cost-free. One such "cost" of teacher turnover is the math and science teacher shortage.

DOES THE PROBLEM VARY BY LOCALE?

It does not make sense to talk about overall national shortages or to talk about overall levels of teacher turnover. Looking only at the overall picture masks a big part of the story: Math and science teacher staffing problems vary dramatically by locale.

However, the largest differences in math and science teacher hiring problems are not between regions or states, but between different schools, even within the same school district. Even in the same metropolitan area, in the same year, in the same teacher labor market, and in the same licensure and pension system, some schools have extensive waiting lists of qualified candidates for their teaching job openings while nearby schools have great difficulty finding qualified candidates.

The same holds for turnover. Just one quarter of public schools accounts for almost half of all public school teacher turnover. High-poverty, high-minority, and urban public schools have the highest rates of teachers both moving between schools and leaving teaching. In the case of movers, there is an annual net reshuffling of significant numbers of math and science public school teachers from poor to not-poor schools, from high-minority to low-minority schools, and from urban to suburban schools. Over half of those who move or leave indicate their departures are tied to dissatisfaction with their jobs.

After controlling for the background characteristics of schools and teachers, we found a number of working conditions were strongly related to the turnover of math or science teachers. In particular, schools with fewer student behavioral problems, that allow teachers greater professional autonomy in their classrooms, and that provide better opportunities for teachers to learn and grow as professionals had significantly fewer departures of math or science teachers.

WHAT CAN BE DONE?

The predominant response to the shortage crisis has been recruiting new qualified math and science candidates, and nothing in our research suggests that this is not worthwhile. Indeed, this approach has yielded positive results. In the past two decades, there has been a disproportionately large increase in the employment of qualified math and science teachers.

Producing or recruiting more teachers, by itself, does not directly address a major source of staffing problems: preretirement turnover. For example, President Obama has recently called for the recruitment of 10,000 math and science teachers each year for a decade. But the data show that 33,000 math and science teachers left teaching after the 2008 school year. Of these, only about 10,000 left because of retirement. About twice as many indicated that they left to pursue another career because of dissatisfaction with teaching. Thus, if significant numbers of those recently recruited leave in a few years, the investment is lost, the problem is not solved, and we will have a perennial need to create more recruitment initiatives.

Differences between schools are especially important. In particular, disadvantaged public schools have among the highest rates of math and science turnover. The high rates of math and science teacher turnover in these schools do not appear to be a matter of student and school demographic characteristics per se, but are largely a matter of worse job conditions, such as high levels of student misbehavior, low-quality school leadership, a lack of classroom resources, little faculty input into school decision making, and inadequate opportunity for professional development. Of course, altering any of these working conditions would not be easy. But changing some of these working conditions would be less expensive than many popular school reforms.

Given the current state of our economy, one might ask if anything needs to be done at all. The economic downturn of the past couple of years may already have fixed the math and science shortage. If large layoffs of teachers in many states, coupled with large layoffs of skilled individuals from other occupations, have resulted in a sudden increase in able candidates willing to teach math and science, hard-to-staff schools could decline or even disappear. As new data become available, we plan to examine if this has, in fact, happened. However, the current economic downturn will, at best, provide only a short-term fix. The long-term solution to math and science shortages is not only to increase the quantity of teacher supply, but also to make teaching more attractive in hard-to-staff settings. K

The reasons for staffing problems are more complex and varied than simply an insufficient production of new teachers.

REFERENCES

Ingersoll, Richard M. "Teacher Turnover and Teacher Shortages: An Organizational Analysis." *American Educational Research Journal* 38, no. 3 (2001): 499-534.

Ingersoll, Richard M., and David Perda. "Is the Supply of Mathematics and Science Teachers Sufficient?" *American Educational Research Journal* 47, no. 3 (2010): 563-594. www.gse.upenn.edu/faculty/ingersoll.html.

Ingersoll, Richard M., and Henry May. *The Magnitude, Destinations, and Determinants of Mathematics and Science Teacher Turnover*. Philadelphia, Pa.: University of Pennsylvania, Consortium for Policy Research in Education, 2010. www.gse.upenn.edu/faculty/ingersoll.html.

Ingersoll Richard M., and Lisa Merrill. "Who's Teaching Our Children?" *Educational Leadership* 67, no. 8 (2010): 14-20.