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# Is There Really a Shortage of Mathematics and Science Teachers?

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**Keywords**

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**Comments**

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# **Dr. Richard Ingersoll: Is There Really a Shortage of Mathematics and Science Teachers?**



## **Is There Really a Shortage of Mathematics and Science Teachers?**

**Richard M. Ingersoll  
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Well as Diane was saying, I do research on teacher supply/demand and quality issues, and have been for the last decade. And this morning, I'm going to talk a bit about what I've found about really what's behind this crisis that we've been hearing so, so much about, the teacher shortage crisis.

Well, as we've been told many, many times, we have this teacher shortage. It's particular bad in some fields like math and science and special ed. The arguments go like this: "We have an increase in student enrollments going on. We have an increase in teacher retirements going on. These two large scale demographic trends are colliding. Schools simply don't have sufficient numbers of candidates out there of recruits, of hires to fill all their positions."

And so hence-- and often this is left unsaid-- but the bottom line of course is that students' school performance will decline, that we have a teacher quantity problem. The anecdote, the responses seem very straightforward. We have a shortage of qualified people, particularly in fields like math/science. Let's bring more people into the teaching occupation. Let's enhance recruitment.

And so we have dozens and dozens of very interesting initiatives, federal level, state level, district level, school level. We have Troops To Teachers to entice people from other-- from military to come in. We have other sorts of mid-career transfer kinds of programs. We have some districts who are recruiting overseas. Most of our states now have alternative certification programs that make it easier to get into the teaching occupation. We have places like Massachusetts that made national news with these large signing bonuses as recruitment strategies. There's schools in districts that have mortgage assistance and student loan forgiveness, dozens and dozens of programs, very different, some more costly than others. They all have in common this basic idea, this basic assumption that we have a teacher shortage. And the way to deal with-- cure this problem is to bring more people into the teaching occupation.

Well I've come to the conclusion after looking at the data over the last decade that unfortunately, none of these things are going to work. They may be very worthwhile things to do, but they simply are not going to solve the problem. In many cases, they might even make the problem worse. In any event, many of them involve large expenditures of money.

I've come to the conclusion that if we really want to understand these staffing problems that plague schools-- and historically, there's nothing new about these staffing problems—that we need to stop looking at these large external demographic trends and start looking a little more closely at what's going on in schools and districts. That's where these problems lie. If we do that, I've come to the conclusion that the conventional wisdom on teacher shortages is really a case of a wrong diagnosis and a wrong series of prescriptions.



## The Source of Data:

### The Schools and Staffing Survey with the Teacher Follow-up Survey

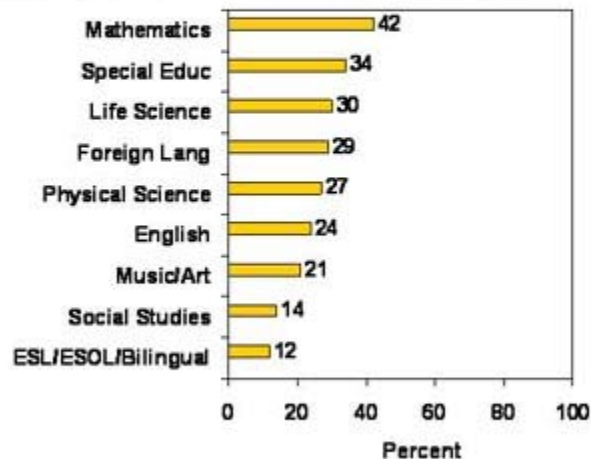
- **Conducted by the Census Bureau for the U.S. Department of Education**
- **4 Cycles: 1987-1989, 1990-1992  
1993-1995, 1999-2001**
- **The largest source of information available on teachers:**
  - Sample: 55,000 teachers  
12,000 schools**
  - Representing all 50 states**

First, a quick word about my data. I use national data from the U.S. Department of Education collected by The Census Bureau, the schools and staffing survey. This is the largest source of information on teachers really in the world. It's a very, very large survey, over 55,000 teachers. I mean, think of that in a sense. Remember now – Gallup and various pollsters, with a couple thousand phone calls, can predict a presidential election down to a margin of error, one or two percentage points either way. Here we have a sample, 55,000 teachers, private, public, charter schools across the whole nation.

Also importantly we have a number of cycles. This survey's really been done a number of times since the late 1980s. That's very important for my purposes, because I want to kind of look at these trends and problems over time.

Well, what do these data tell us? First, the data tell us that in some respects, the conventional wisdom is indeed correct. Student enrollments have been going up, really since the mid-1980s. Teacher retirements are also going up. The demand for teachers is increasing. In any given year, most schools in fact are hiring. And most importantly, the data tell us that, indeed, there are large numbers of schools out there that have difficulties filling all their positions with qualified teachers.

## Percent Secondary Schools with Difficulties Filling their Teaching Vacancies, by Field.



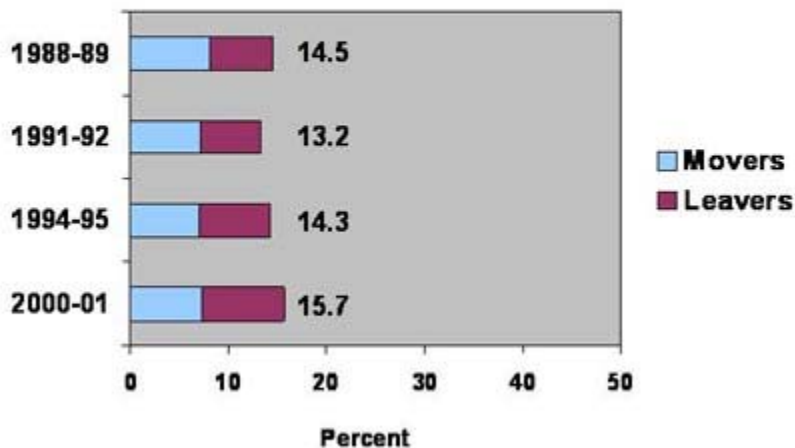
Source: Ingersoll, R. 2003. Is There Really a Teacher Shortage? Consortium for Policy Research in Education, University of Pennsylvania. [http://www.cpre.upenn.edu/faculty/ingersoll/research/Shortage\\_RM-03-2003.pdf](http://www.cpre.upenn.edu/faculty/ingersoll/research/Shortage_RM-03-2003.pdf)

Here's a slide just illustrating some of this. We see that mathematics and science, as we suspect, are amongst those fields where a large proportion of schools tell us that they've had some difficulties, from moderate to severe difficulties, filling their teaching vacancies in those fields with qualified people.

So yes – we do have staffing problems. We do have difficulties in many of our schools, although note that in no field is it the majority of schools in any given year have these difficulties. But nevertheless, it's not small potatoes. We do have problems out there. But after that point, I find that conventional wisdom and data start to diverge. The data tell us that most of the demand for new teachers, most of the hiring that goes on at the beginning of any given school year actually has very little to do with either student enrollment increases or teacher retirement increases.

Most of the demand, most of the hiring, you know, before September, late August or whatever, really is simply to replace people that left several months before. Most of those who left their jobs several months before, at the end of the prior school year, didn't do so because of gray hair and retirement. That's been exaggerated.

## Percent Annual Teacher Turnover, by Year



Source: Ingersoll, R. 2003. *Is There Really a Teacher Shortage?* Consortium for Policy Research in Education, University of Pennsylvania, [http://www.cape.upenn.edu/faculty\\_research/shortage-RMS-09-2003.pdf](http://www.cape.upenn.edu/faculty_research/shortage-RMS-09-2003.pdf)

What are the turnover, the separation, the quit rates in teaching? Here's a slide that shows over time here. This shows us the annual average rates of teacher turnover, over the last decade and a half or so. Interestingly enough, they're fairly stable. They haven't changed a great deal of time. They hover around 15% of the teaching force per year moves out of, or leaves out of their school or leaves the teaching occupation.

Now I need to draw your attention to an unusual thing I've done here. Notice that there's two portions of the bar. There's the dark part, the red part, what I call leavers. These are people who have left the teaching occupation altogether. They've gone to do something else, including retire, become a professor, become a banker, raise babies.

And then there's the blue part, the movers. These are people that have moved from one school to another. Combining these two is an unusual choice for a researcher. I've somewhat gone against the grain. Traditionally, people that do research on teacher turnover, teacher quits, teacher attrition, et cetera, really ignore the blue part, the cross-school movers.

The argument is straightforward. The logic, the rationale makes sense in a way. Look – if a teacher moves from one building to another, they're still in the system. They're not a net loss. So hence, they don't really contribute to shortages. We don't really want to count them. They don't really count. Makes perfect sense of course from a larger, systemic viewpoint.

This gets us to, what we call the level of analysis issue. Because yes, those who move from one building to another don't really count at a systemic level. But of course on the

ground, at the level of the school or the district, they make a great deal of difference. If you're the principal, it doesn't really matter whether that teacher quitting at the end of the year is getting out of teaching altogether or whether they're going to another school 15 minutes down the road. They're part of your staffing problem. And they make a great deal of difference from sort of a managerial and an organizational level of analysis.

And so there's really good reasons to count them in here. Of course you can see it makes a difference. If I'd taken out the blue portion of the bar, the overall amount of teacher flows out of schools would appear half of what it really is. So it makes a difference.

Also, there's something else to remember that's often forgotten when it comes to the teaching occupation. It's large. Teaching is one of the largest occupations in the nation, over three million teachers. There's over twice as many teachers as nurses, five times as many teachers as other professors or lawyers. This is a very large group.

You know, it's interesting. My whole life I've been hearing about how we're going to replace the teacher with, when I was a kid it was television education. Now it's i-learning and e-learning and long-distance and technology, et cetera. And maybe. But somehow, it's still remained what we call a very labor-dependent industry. Somehow, particularly at elementary and secondary level, you still need that body, that person in front of the students. We haven't really figured out how to replace them to automated in a sense.

And so it's a very large occupation. And you combine that with the fact of these levels, relatively high levels of annual turnover, and you end up with a situation, a scenario that we describe as a revolving door.



### Numbers of US Teachers in Transition Before and After 1999-2000 School Year





Teaching is an occupation with a large amount of flows in, between, and out of buildings every year. I've tried to capture that in this slide.

So the red arrow on the left, that's the beginning of the '99/2000 school year. These are the most recent national data we have. We see something over half a million people came into buildings they hadn't been in the year before, in elementary and secondary education.

Then we see just, say, nine or ten months later, a slightly larger number note, the yellow arrow there, leaving buildings. So the data tell us then, in any given 12-month, or in this 12-month period, we have over a million teachers in job transition, moving in, between, or out of schools, almost a third of a large occupation to begin with. Those of us who study occupations and industries and organizations in general, this is what we call a revolving door. There's a great deal of movement, flux, job transition in this "industry," quote/unquote.

Now, there's no assumption here that all this flow, all this turnover, attrition is bad. Turns out the whole subject of employee turnover is a very important topic in schools of business, particularly management departments. There's a great deal of concern over employee turnover, for very good reasons, the bottom line. And there's some general consensus amongst the people who study this, you know, turnover in the insurance industry or banking or law or whatever that the good firm, the effective organization both promotes and benefits from some employee turnover. There's some people that really should move on to other pastures, et cetera. You want some fresh blood to come in, et cetera. You want some employee turnover. It's not all bad.

On the other hand, there's a general consensus that high levels of employee turnover are not cost-free at all. In fact, I have colleagues who get fancy consulting contracts to figure out, to quantify just what is the cost of employee turnover in the insurance industry, that management wants to know. They understand it's not cost-free, and they want to know what those costs are.

Interestingly enough however, in the education industry, until the recent effort in Texas, as far as I can see, no one has ever tried to quantify and figure out the costs of a relatively high turnover rate of teachers in this "industry," quote/unquote, almost as if the assumption was it was cost-free.

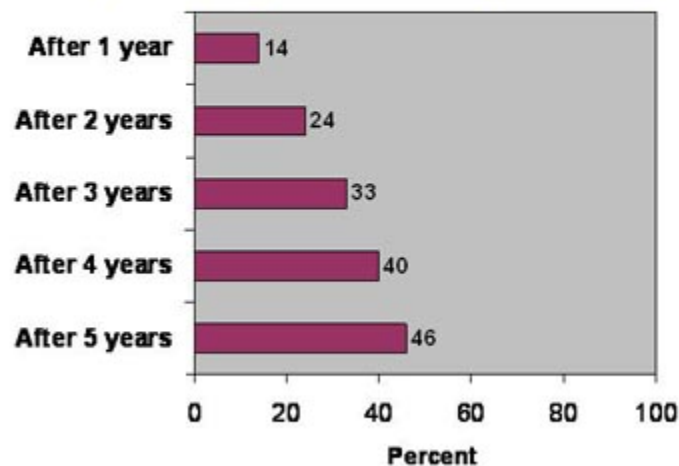
And you can imagine also just the wide range of costs and consequences of having high level of employee turnover, teacher turnover in this case. There's the stuff that's maybe more easily quantified, just the costs of recruiting and replacing and inducting and training people. There's those costs. But there's also maybe the soft, less easily quantified, but perhaps even more consequential costs. I mean, think of what a high-- Think of a building that loses 25% of their people, year in and year out.

I mean, think of the impact that has on students and teachers and the ability to offer a coherent program, et cetera. I mean, this is an area where, in my own bias here, we

desperately need research. What's important to recognize are these costs and perhaps also benefits. Because as you might imagine, the rate at which the revolving door revolves varies dramatically amongst different types of teachers, amongst different types of schools.

There's one segment of the workforce at which the rate is very, very high. And that's beginners. I've tried to capture that in this slide. So I'm not counting the movers here.

### Beginning Teacher Attrition (Cumulative Percent Teachers Having Left Teaching Occupation, by Years of Experience)



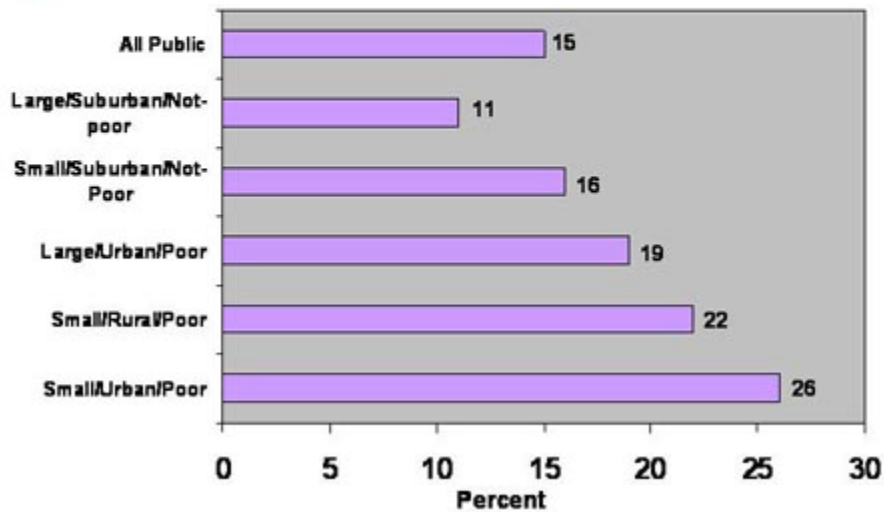
Source: Ingersoll, R. 2003. *Is There Really a Teacher Shortage?* Consortium for Policy Research in Education, University of Pennsylvania, [http://www.cpre.upenn.edu/faculty\\_research/shortage-FRM-09-2003.pdf](http://www.cpre.upenn.edu/faculty_research/shortage-FRM-09-2003.pdf)

There's one segment of the workforce at which the rate is very, very high. And that's beginners. I've tried to capture that in this slide. So I'm not counting the movers here.

I'm not counting those who have gone from one building to another. I'm simply counting the leavers. We see here that, after one year of all those who come into teaching in a given year, after one year, you've lost somewhere around 14%. After two years, you've lost about a quarter. They're gone from the occupation. After three years, about a third, after four years, you've lost something around 40% to 50% of those who came into the teaching occupation. Very dramatic.

And note here, this has nothing to do with gray hair and retirement. These are the newcomers. So we have an occupation that's losing almost half of its newcomers within five years. Quite a revolving door.

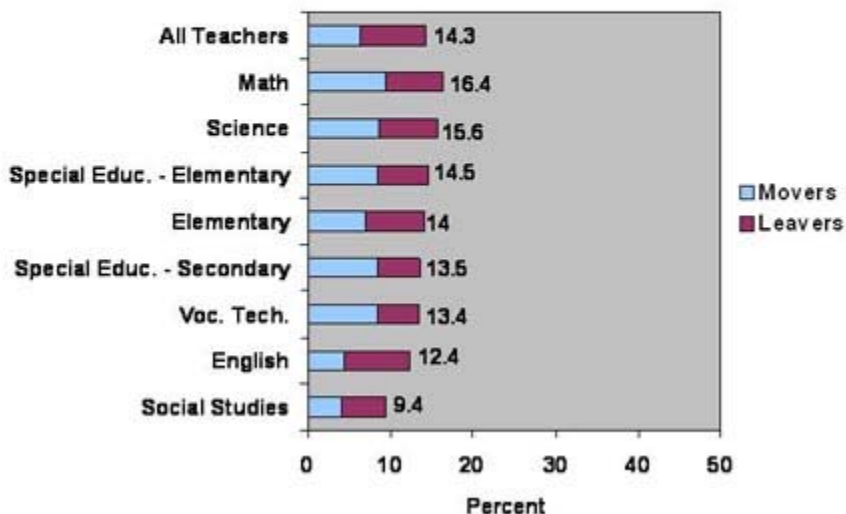
## Percent Annual Public School Teacher Turnover, by Selected School Characteristics



Of course, there's also large school to school differences in teacher turnover. I've illustrated some of those in this slide. This includes both movers and leavers, just to give you kind of the range here, to illustrate. So all the way from large, suburban, not poor schools who have a rate around 10%, all the way up to small, urban, poor schools. Their rate is over double that – wide range of teacher turnover rates across different types of settings.



## Percent Annual Teacher Turnover, by Field



And finally, bringing this back to the topic at hand, there's also differences in types of teachers according to field. I've illustrated that here. We see that, yes, math and science teachers have amongst the higher turnover rates. Special ed is up there also. But the rates of turnover of math teachers is not quite double that of social studies teachers.

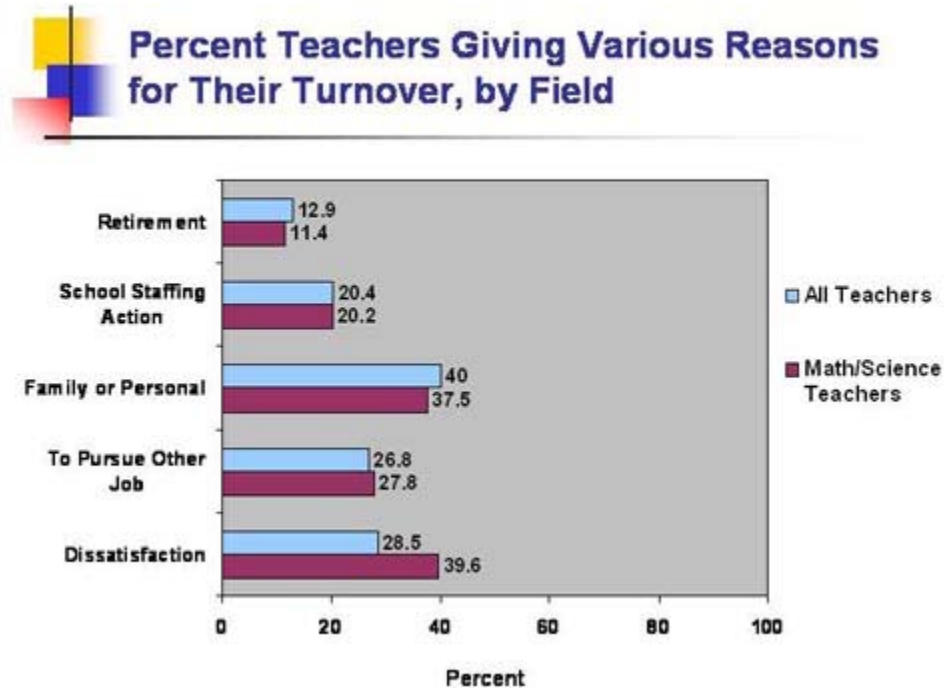
This raises what I think is the really important question, the why question. Why? Why is there so much turnover, quitting, attrition, separation in this occupation, moving between one building and another? More importantly, why is it that some schools have more of it than others, and some fields have more of it than others?

I think this is the important question because if we don't get the diagnosis down, we'll never get the prescriptions right. We have staffing problems. We have a problem. Let's work on the diagnosis, getting that right. And then maybe we can come up with some better prescriptions.

So I've done a lot of looking at different kinds of data and advanced statistical analyses and data from teachers and data from principals over the last number of years, trying to work down on the 'why' question. I'm going to present a few of my findings. These are interesting data. We call them self-report data. It's sort of the concept behind exit interviews that are common in the corporate sector. What better way to find out why your employees are leaving? You ask them.

Now of course there are some validity issues here. Some employees may not feel comfortable speaking frankly about why they just quit the bank, the firm, the school district. In this case, it's an anonymous national survey, confidentiality, privacy,

anonymity has been promised. So we have some confidence in the findings. It also turns out that they're consistent with other kinds of analyses I've done.



So what do the teachers tell us? These are percentage of teachers who give various reasons for their turnover. I've broken them into five categories. I've also broken it down, all teachers versus math/science teachers. The lighter bar is all teachers. This is private, public, and charter. This is the whole workforce. Then the red, the darker bar is the percentage of math/science teachers who give a particular reason why they move from or left their job.

So this is self-reported. This is, when they're asked, why-- The survey tracks them down and asks them, "Why did you move from one building to another," or, "Why did you leave teaching?" Here's the reasons.

I've broken the categories. The first is retirement. This is a very, very interesting finding. We have been told again and again and again that we have this graying hair, teacher retirement crisis. There's no question, the number of teacher retirees is going up. I've been able to track this over time. But it's been completely exaggerated. It's actually a very small portion of the total reasons why people move out of, or leave their building. It's somewhere around 13%, a little less for math/science teachers. So retirement is a factor, but it's not the major reason why teachers are leaving their jobs.

The next category I called school staffing actions. So this is layoffs. This is school closings, school reorganizations, involuntary transfers, cross schools within a district, this kind of category. This is a little more. Around a fifth of those who leave tell us that this is

one of their main reasons. By the way, you'll note that the percentage adds up to more than 100%. Often there's more than one reason you're going to give. Of course, it makes sense. You often have a combination of reasons. In fact, sometimes people might have checked off retirement, but also dissatisfaction, that there's more than one reason, and they checked them all. So school staffing actions accounts for a flow here.

The next one, family or personal, this is, "I moved from or left my teaching job because of health concerns, because I wanted to raise babies, because I needed to care for elderly folks, because my spouse moved to another state and I needed to, family reasons," et cetera. These are really part of life. All occupations and industries are going to have employee turnover for these reasons. Indeed, many argue that these kinds of reasons are increasing. We have a more highly mobile society. And they certainly account for a large proportion of the teacher flows out of buildings, whole series of reasons there.

And again what's interesting is that math/science teachers don't differ a whole lot from other kinds of teachers in the proportions that check that, "One of my main reasons why I moved or left was family or personal." The bottom two sets are the ones that really interest me as a researcher.

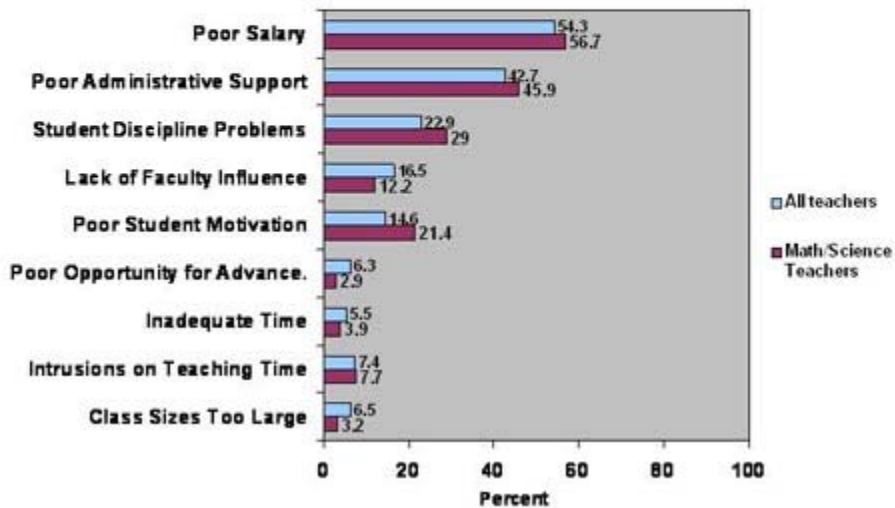
So the fourth set: "I moved from or left my job because I wanted to pursue another job, or another career, or a better kind of employment situation." I see that as kind of the flipside with the last one, which is, "I moved from or left my job because I didn't like it. I was dissatisfied." Now note that those last two, each of them alone far outweighs retirement, you know, the "pursue other job" and the "dissatisfaction." Combining those, those two last sets of reasons, account for over half of the large flows of teachers out of schools every year. And also finally, draw your attention to the fact that math/science teachers are far more likely to say they're dissatisfied. Well, not far more likely. There's about a 10% percentage difference there, that math/science teachers are quite likely to say that dissatisfaction is one of their key reasons why they're leaving, almost 40%.

So then to me, the question that immediately rises is, what's the thing that bothers you the most? What's the source of the dissatisfaction? I can think of hundreds of things that might bother a teacher. We, of course-- I'm a former high school teacher. Of course we have a long history of surveys and studies of teacher job satisfaction and dissatisfaction. There's lots of aspects that teachers do and don't like.

But in this case, are there particular things that dissatisfy them enough that they're going to leave, that they're going to leave that job? The answer is, yes, it's not all over the map. It's quite specific.

There was a long, long list of things teachers could indicate were their source of-- For those who indicated dissatisfaction was the reason they left, then they're asked, "What's your source of dissatisfaction?"

## Percent Teachers Giving Various Reasons for Their Dissatisfaction-Related Turnover, by Field



There's a long, long list of about 25. I've only put the top ones here.

What's interesting is the amount of consensus. I was kind of surprised. I figured that there would be a whole, wide dispersion of reasons. It turns out that there's a relatively finite set of things that bother teachers enough that it dissatisfies them enough to leave. And again, comparing math/science in the red with all teachers in the blue.

Salary is at the top. So we have over 50% of those say that salary and benefits were a major source of dissatisfaction. Now this is a tough one to fix. Because remember, it's a large occupation. Every time you have a politician who sits down and says, "I'm going to raise teachers salaries across the board"-- and this happens all the time-- then they sit down with the accountants and they run the numbers. It's very, very expensive. It turns out, just to raise everybody's salaries just a little is a big ticket item.

I'm not making an argument against raising teacher salaries. But politically, it's difficult. Hence, the attractiveness of not raising everyone's salaries, but raising some -- pay for performance, value-added merit pay. It's far less expensive in a sense. Maybe there's other rationales for it. That's a whole debate. Won't get into it now.

Salaries. Poor administrative support -- now this is several different things I've combined, everything from supplying enough resources -- chalk -- to backing up with discipline problems, to providing induction, mentoring support for those beginning teachers. It turns out, very large proportion of teachers tell us that this is a major source of dissatisfaction.

Student discipline problems. This is another one that a large proportion, a larger proportion of teachers cite. Now, when I give this talk to policymakers, they often say, “Okay, this is a no-brainer. Obviously if there’s a lot of conflict and behavioral problems in the building, it stands to reason some teachers are going to want out of that setting. But really, Dr. Ingersoll, what can you do about this? Isn’t this sort of an unfortunate fact of life for public elementary and secondary teachers now, that we have sort of this decline of respect for authority in our society? We have all this stuff on television and that, yes, it’s unfortunate and it’s bad, but what can you really do about it? Isn’t it just sort of part of the menu that elementary and secondary teachers are going to have to shoulder, unruly students, disrespect?”

My answer is, “Well yes, that may all well be true. Things are maybe going down the tube as far as coarseness and rudeness, et cetera. It’s showing up in our teenagers, in our children.” But you know the data shows a very interesting thing. The data tell us that there’s actually very, very large differences between different schools in the amount of student behavioral and discipline problems they have, that some schools have far less of it than other schools. And that poverty by no means is the only factor here, the data tell us.

So that’s interesting. Maybe it’s not just an inevitable thing, that some places do a better job than others. So then the question is, “Well, why is that? How is that? How do they do that?” Maybe it’s a little more optimistic. And it also turns out the data tell us that the buildings that do a better job of coping with their student behavioral issues have significantly less teacher turnover.

Lack of faculty influence. This is the whole issue of, how much input and say do teachers have into the key decisions that affect their jobs? That’s another one where teachers quite often indicate that this is a source of dissatisfaction that led to their turnover.

Now all of these factors are interesting because they’re what we call policy amenable, or actionable. In other words, ostensibly you can do something about them. Let’s just go back to that conventional wisdom. The conventional wisdom is, kind of a demography is destiny kind of argument, that we have these demographic trends. You know, we have student enrollment increases. Well, that’s births. We have teacher retirement increases. Well ultimately, that’s deaths. Births and deaths, they happen.

What can you do about them? Gosh, let’s throw up our hands. We have a teacher shortage. Now look how the data is pointing us a different direction. The problem isn’t so much out there, these inexorable demographic trends that we have no responsibility for. That the problem in many ways is in here, it’s in schools. It’s in how they’re organized and run and managed and set up.

So let’s just go back to that conventional wisdom. Conventional wisdom tells us we have these teacher shortages, and it’s these births and deaths – or not quite. That we have all



these interesting recruitment strategies to fix them, you know, dozens of interesting things. They might be very worthwhile. But they're not alone going to fix the problem.

In other words, the problems isn't so much shortages, entirely shortages, or primarily shortages in the sense that we're producing too few new teachers. Rather, we're losing too many teachers long before retirement. In plain terms, we can recruit hundreds of thousands of new people in this occupation. But if we lose 40% to 50% within five years-- recall that earlier slide-- where are we?

The image that always comes to my mind is pouring water in the bucket with holes in the bottom. You just keep pouring and pouring and pouring, just to stay even. So how do we plug some of those holes in the bucket?

This is what I've been working on, sort of the last couple years, is to pick up from these things and look more closely. I recently got a grant from the Teacher Professional Continuum Program at NSF to hone in specifically on math/science teachers, what about schools, you know, those actionable things, drive retention and turnover? I don't have time in this setting to talk about it. There's a breakout group later where I'm going to present some of those findings.

I look at things, like, does induction/mentoring for new teachers work? Does it do anything? Does it improve the retention of beginning teachers? It's interesting what I've found. Another thing is this issue of lack of faculty influence. Well the brief story, yes, it does make a difference, but it depends what kind of induction and support and mentoring, and how much.

I have another project looking at, what about faculty decision making, influence and autonomy? What kinds of effect does that have? Later in the breakout session, I'll present in a little more detail some of those findings from these new projects where I'm trying to bore down in and sort of more unpack the issue of, what can schools and districts do, particularly with math/science teachers, to address the issue of retention and turnover?

So just to finish, what's the bottom line here, or at least the bottom line as I see it, my own conclusion? It's just that the data don't say changing any of these things will be easy. We know they're difficult, of course. Some of those changes are more costly than others, like salaries. Others might be politically difficult, like the issue of student discipline problems.

The data simply say that if we improve some of these school conditions and characteristics, working conditions, that it would do a lot towards slowing down the large flows of teachers out of buildings every year. It would undermine, it would decrease the turnover. That would slow down the relentless need to constantly recruit. It would free up a lot of administrative time, this constant need to bring in more people, you know, sort of do this revolving door. And it would do a lot. It's not necessarily a panacea towards

dealing with these shortages and staffing problems that have plagued this occupation for so long. Thank you.



### **For Further Information**

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- [www.gse.upenn.edu/faculty/ingersoll.html](http://www.gse.upenn.edu/faculty/ingersoll.html)
  
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