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Differential Pay for Math and Science Teachers

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POLICY BRIEF

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Executive Summary

Of the various proposals under discussion for improving public education, some of the most hotly debated have been those designed to reform teacher compensation. This Brief addresses differential compensation designed to attract and retain effective mathematics and science teachers; it accomplishes this through a focus on approaches that integrate performance-based reforms into an ongoing wage enhancement.

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It is vital that the U.S. increase student achievement in science and mathematics to the level attained by high-performing nations, such as Finland, Korea, Japan and Estonia. Doing so would result in increased U.S. economic growth of approximately 2/3 of a percentage point each year.

Teachers are critical to attaining world-class levels of performance in mathematics and science. A growing body of research has documented a wide range in the effectiveness of individual teachers with respect to raising student achievement. The current compensation system rewards traditional teacher qualifications that have been demonstrated as unrelated to raising achievement, including whether a teacher possesses a general

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education certificate, an advanced degree, or years of experience after the first 2-3. Some of the difference in teacher effectiveness has been explained by prior academic success (e.g., SAT or ACT scores) and whether a science or mathematics teacher has a major in the field. Even for mathematics or science teachers with these qualifications, there remains a substantial range in effectiveness.

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A substantial proportion of high school and middle school mathematics and science teachers do not possess a major in their field or in a related field, including, for example, approximately 43% of middle school mathematics teachers. In addition, teachers with higher SAT scores tend to leave teaching, while those with lower SAT scores tend to remain.

One of the causes of this shortage in well-qualified science and mathematics teachers appears to be a "wage gap" between salaries in the private sector and those of teachers in public education. Depending on the calculation, the gap in wages for those with a science or mathematics degree has been estimated to be between $5,000 and $24,000 in the tenth year after college. Yet, wages are only one of the influences on the recruitment and retention of science and mathematics teachers. As one part of a broader strategy to raise science and mathematics achievement, we recommend that policymakers explore an initial wage enhancement of approximately $3,000 to $5,000, followed by a review to determine if any further additions are necessary.

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Due to the wide variation in teacher effectiveness, we also recommend that the wage differential be performance-based as well as focused on student achievement gains. An increasing body of evidence indicates that performance-based compensation can raise student achievement. A performance-based approach is more likely to encourage the best teachers to remain, while perhaps also encouraging the least effective to seek more productive employment elsewhere.

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Several elements should be addressed in the design of such plans: a) incentives for both group performance and individual performance; b) the involvement of all relevant teachers, including those for whom no gain scores are available from a state assessment; c) in calculating test score gains, reliance on sophisticated "value added models" (VAM) rather than simpler, less-accurate calculations; d) use of a high, fixed criterion for growth in determining individual awards, instead of just rewarding the highest performers (enabling more teachers to succeed over time).

However, without other complementary strategies to improve math and science achievement, these amounts will likely prove insufficient. Such broader strategies include: reducing barriers to entry for qualified candidates by improving alternative certification programs; professional development in research-validated methods for classroom management (which addresses a key cause of attrition), and; reforming K-8 math standards and curriculum materials to make them more focused on core skills and less repetitive.

Introduction

Salaries and benefits devoted to instruction typically form the largest part of school district operating budgets.[1] Among the multitude of proposals for improving public education, some of the most hotly debated are those to fundamentally reform teacher compensation systems. While the overwhelming majority of America's educators are still paid much the same way as they have been for nearly a century, bold and far-reaching reforms are now receiving a respectful hearing in many states as well as at the national level. In fact, an unprecedented number of communities and states are putting into effect, in some cases even taking to scale, changes in compensation that question fundamental premises of the standard model. A key area of focus for many of these reforms is the compensation of teachers of science and mathematics.

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The traditional compensation system starts all teachers in a school district at essentially the same salary, then adds increments based on graduate degrees as well as annual raises based on years of experience. First used in 1921 in Denver and Des Moines, this model was implemented to assure "…pay equity, professionalism, and employee satisfaction across grade levels, political wards, districts, and disciplines and to displace prior pay systems negotiated between individual teachers and local school boards".[2]

The new compensation reforms generally fall into two categories:

Differential compensation is usually based on the market principle—that pay should be flexible rather than uniform, varying based on the amount necessary to recruit and retain staff with harder-to-find qualifications or for more challenging assignments. Teachers with a college major or subject credential in science or mathematics are examples of the former, while schools serving primarily disadvantaged students are representative of the latter. Differential compensation can also involve differentiated roles for educators within the school environment, such as master teachers that accept additional responsibilities for coaching other teachers.

Performance-based compensation rewards the attainment of targeted results, or behavior that is helpful in achieving the desired results. Results often include student achievement growth and, at the high school level, a higher graduation rate; additional targeted results may include such things as increased parent satisfaction and a safer, more focused school culture. Other measures of teacher performance, such as enhanced observations of classroom teaching by school administrators and the acquisition of knowledge and skills relevant to improving student achievement, may also be useful when considering performance-based systems.

Reforms of both types share the same fundamental premise that compensation should be aligned with important organizational goals—that you "get what you pay for" and, therefore, should make sure that you pay for what you want. If schools need to attract candidates with hard-to-find skills or to meet challenging goals, compensation should reflect that. Until fairly recently, these two types of reforms were considered quite separate strategies; they might be complementary, but they involved different reforms. Increasingly, however, there is an appreciation for the value of reforms that integrate elements from both categories.

For example, the federal Teacher Incentive Fund (TIF) created by Congress in 2006 to disburse nearly $100 million in grants[3] to support teacher compensation reforms included the following competitive priority in a request for proposals (emphasis added):

> Provide differentiated levels of compensation to *recruit or retain effective* teachers … (as measured by student achievement gains) … in hard-to-staff subject areas such as math and science (5 points).[4]

The TIF, which funds many state and district reform initiatives, is encouraging differential pay reforms that address not only initial *recruitment* of teachers in mathematics and science, but also their *retention*. In doing so, the TIF is also encouraging that differentiated compensation focus on high-performing teachers in the shortage areas, those deemed *effective* according to measures of academic achievement growth. Similarly, a recent publication offering advice to policymakers also recommends focusing differential pay for mathematics and science teachers solely on those determined to be "effective."[5]

Compensation reform ...though critical, is just one element of a comprehensive strategy needed to effectively and efficiently increase student learning in math and science.

This Brief is divided in three sections and will supply support for an approach to teacher compensation that integrates differential pay for hard to staff subjects, specifically math and science, with performance-based measures. The first section provides policymakers with essential background information connected to compensation reform for math and science teachers: 1) summary of important recent research on the need to significantly increase the mathematics and science achievement of U.S. students; 2) impact of teachers and teacher qualifications on raising mathematics and science achievement; 3) a review of the "earnings-gap" between teaching and the private sector for those with a degree in the sciences or mathematics. The second section discusses the current range of options to approach differential compensation, the range of options for performance-based compensation, and the issues policymakers will need to address when implementing any type of compensation reform. The third section will address teacher compensation reform as part of a broader context of reform of science and mathematics education. We will make the case that compensation reform, though critical, is just one element of a comprehensive strategy needed to effectively and efficiently increase student learning in math and science.

I. Background

A. U.S. Mathematics and Science Achievement in a Global Context

Since the release of A Nation At Risk report in 1983[6], employers and economists have argued for the importance of enhancing the skills of American students in mathematics and science. National Education Goals adopted by the nation's governors and President George H. W. Bush in 1989, later codified into federal law by Goals 2000 in 1994, adopted as a goal that U.S. students would lead the world in mathematics and science by 2000.[7]

Since the 1960's, several international studies of student achievement in mathematics and science have documented the relatively mediocre performance of U.S. students when compared to students from other developed countries. The most recent international comparison—the Programme for International Student Assessment (PISA)—was conducted in 2003.[8]

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Unfortunately, the U.S. did not meet the goal of leading the world in mathematics and science by 2000 and our students have never reached the top tier of international performance. U.S. students remained stuck near the middle of the pack among developed countries and, in fact, slipped a bit when compared to their peers. The continuing emphasis on students performing as well as those from high-scoring nations, however, is not just an issue of national pride.

A new study that emphasizes the impact of student skills in science and mathematics on U.S. economic growth has reinforced the urgency of improving our student achievement.[9] By analyzing the economic growth measured by Gross Domestic Product (GDP) of 50 countries that participated in the international studies of mathematics and science achievement from the 1960s to the present day, economist Eric Hanushek and his colleagues were able to determine the impact of student skills in these subject areas; the result is quite large, up to 2/3 of a percentage point of GDP growth each year. Further, it appears that this is due both to the skills of top-scoring students (future "rocket scientists") as well as the general competence of everyone else. To provide a sense of the magnitude of the potential benefit to the U.S. economy, the study notes:

> But had [U.S. students matched the performance of those in top-scoring nations] by 2000, our results suggest that GDP would by 2015 be 4.5 percent greater than in the absence of any such gains. That 4.5 percent increment in GDP is equal to the total the U.S. currently spends on K-12 education…In words, had that money effectively raised cognitive skills…the economic returns to the country would probably have been enough to cover the entire cost of education in 2015 and after.[10]

In middle school mathematics, approximately 43% of teachers have neither a major in their subject nor in a related field.

B. Impact of Teachers & Teacher Qualifications on Achievement

Beginning with the work of value added assessment pioneer Bill Sanders in the 1990s, and continuing with a broader group of researchers to the present day, a substantial body of research has documented the impact of individual teachers, as well as their qualifications, on raising student achievement.[11] Conducted independently by a diverse range of investigators, this "teacher effects" research found that quite a few of the commonly held assumptions about the importance of certain teacher qualifications simply do not hold up under careful scrutiny. The following appear to have no impact on raising student achievement: 1) whether or not a teacher holds a general education certification; 2) advanced degrees beyond a Bachelors; 3) years of experience teaching after the first two to three.[12] Yet, the traditional licensing and compensation system still relies on precisely these factors in determining who should teach and what should be rewarded!

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While the teacher effects research disproved many of the conventional assumptions about what mattered for teacher quality, researchers also discovered that student growth was less dependent on "student demographic factors". That is, teachers were enormously varied in their effectiveness at raising student achievement. Some teachers were highly effective, while others were highly ineffective. The effect on students receiving instruction from teachers of either type was found to be profound. For example, one study monitored two similar groups of 3rd grade students, both functioning near the national norm; one started at the 55th percentile (Group 1), while the second started at the 57th percentile (Group 2). Group 1 received instruction from three effective teachers and ended up at the 76th percentile. Group 2 received instruction from three ineffective teachers and ended up at the 27th percentile. After just three years, the difference in the effectiveness of the teachers had resulted in a performance gap of almost 50 percentile points, even though the two groups had started at approximately the same level.[13]

Precisely what teacher characteristics would produce these huge differences? The evidence that subject area content knowledge matters, strongest for middle and high school science and mathematics, has led to increased attention to recruiting and retaining teachers who have majored in those subjects (if possible, from candidates with high test scores or who attended selective colleges). Data from the 2008 National Science Foundation's annual Science and

Engineering Indicator report provides a view of the extent of the problem. In high school mathematics, approximately 11% of teachers do not have a major either in mathematics or in a related field, while over 15% of those teaching low-income students do not. In middle school physical science, approximately 29% of teachers do not have either a major in their subject or a major in a related field. In middle school mathematics, approximately 43% of teachers have neither a major in their subject nor in a related field.[14]

...the teachers that tend to remain in teaching also tend to be disproportionately those with lower levels of prior academic success.

Further, the teachers that tend to remain in teaching also tend to be disproportionately those with lower levels of prior academic success. One study that analyzed a large group of teachers entering the profession in 1994 found that while they started with an average SAT score of 967, by 2003, the average SAT score of those who had remained was 929.[15] Teachers with higher SAT scores left teaching at higher rates than those with lower SAT scores.

C. Earnings Gap Between Private Sector and Teaching

Does money matter? While high earnings may not be the primary goal for many teachers, teachers do respond to financial incentives.[16] For college graduates with a major in science or mathematics, a career in teaching provides lower compensation than a typical career in the private sector. While there is some dispute regarding its size, most observers agree that—especially after several years in teaching—there develops a significant gap between the wages of science and mathematics teachers and those with science or mathematics majors in the private sector. One analyst calculated the gap ten years after college using two different methodologies, with one method yielding a difference of approximately $5,000-$6,000 and the other yielding a difference of approximately $24,000. In both cases, the difference was quite small in the early years soon after college.[17] Since signing bonuses or other short term incentives do little to address the wage gap in later years, when it becomes most substantial, policymakers should consider differential pay models that provide for an ongoing wage adjustment.

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Even if there were a clear consensus on the size of the wage gap, it is not obvious what the proper amount of a pay differential should be. It may not be necessary to entirely eliminate the gap in order to fill the necessary positions with well-qualified candidates. Different researchers have suggested very different amounts. Most actual differentials in school systems have been in the range of $1,000 to $2,000, which appears small relative to the size of the wage gap. One study investigated a pay differential for math, science and special education of $1,800 in North Carolina and found only modest effects.[18] Another study surveyed college sophomores and juniors intending to major in science or mathematics to determine whether they would consider becoming a teacher and, if so, whether different salary levels would impact their decision. Although the implications of this study should be interpreted with caution until it is replicated, it is interesting to note that the researchers found a linear relationship between interest in teaching and higher salary levels. That is, as the prospective teaching salary increased in equal increments, a steadily larger proportion of students who intended to major in math and science indicated they would consider becoming a teacher.[19]

One analyst recommends pay differentials "…of at least $5,000 per teacher per year…".[20] As one part of a broader strategy, our recommendation is that a $5,000 annual differential is the *maximum* that policymakers should consider, at least initially, until they've had an opportunity to evaluate the success of such a differential. While the more common $1,000 to $2,000 differential is usually too low for a significant impact, a differential in the range of $3,000 to $4,000 may well be sufficient, especially if it is implemented in conjunction with other reforms that address the issue at lower cost (these are discussed in section three of this Brief).

II. Compensation Reform for Math and Science Teachers

A. Current Approaches to Differential Pay: Wide Range of Options for Differential Compensation

Differential compensation programs, at both the state and district levels, vary enormously in their design and features. As of January 2008, one review listed sixteen states as having in place policies or initiatives encouraging districts to implement differential pay for targeted teaching-assignment areas, such as science or mathematics. Some of these are quite specific, such as loan forgiveness or a signing incentive.[21] Below are summaries of several programs.

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The Oklahoma Teacher Shortage Employment Incentive Program (TSEIP) is a state-established program administered by the Oklahoma State Regents for Higher Education. It offers reimbursements of student loans or equivalent cash payments to individuals who complete a traditional program of teacher education leading to a degree in math or science education. Participants must also agree to teach in an Oklahoma public school for five years.

Mississippi offers a variety of "Critical Needs Incentives." Among these is Housing Assistance for Teachers (H.A.T.), which offers loans of up to $6,000 and pays closing costs for teachers in critical shortage areas. The obligation is 1 year of service for 1/3 of the amount of the loan.

Brevard Public Schools, Florida, posts critical shortage areas and offers new hires in these areas a bonus of $2,000. The first $1,000 is paid thirty days after the teacher completes a 97-day probationary period and returns for the second semester. The second $1,000 is paid the following September when the teacher is reappointed and returns for the second year. Shortage areas include high school math and science, middle school math, and a wide range of special education positions.

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Some information exists on differential compensation initiatives that were designed to recruit high quality teachers to hard-to-staff schools serving disadvantaged students. Because of the design similarities with programs targeting science and mathematics, a discussion of two such initiatives follows.

In 2000, Chattanooga implemented a differential pay plan to attract some of its best teachers to nine of its lowest performing schools. The teachers were identified in part through data from the Tennessee value added assessment system. Differential incentives included a $5,000 annual bonus, free tuition toward a Master's degree, a $10,000 loan toward a down payment on a house (forgivable if the teacher taught at the school for five years) and $2,000 to every teacher in the school that boosted student tests scores significantly. The Benwood Foundation, a local philanthropic organization, provided funding. The initiative moved significant numbers of high-performing teachers into troubled schools while moving out 100 underperforming teachers. Some positive results have occurred; all nine schools increased the proportion of 3rd graders reading at or above grade level by at least 10 percentage points.[22]

As the prospective teaching salary increased in equal increments, a steadily larger proportion of students who intended to major in math and science indicated they would consider becoming a teacher.

In 1998, a Massachusetts Initiative for New Teachers (MINT) was established that included a $20,000 signing bonus to recruit high-quality candidates to enter the profession who might not otherwise consider a career in teaching. According to the Massachusetts Department of Education, nearly 4,000 candidates from forty states and eight countries applied for the program.[23] While the program had some successes, critics believed that it stumbled in several respects. A significant number of the recruited teachers felt frustrated by a lack of support at their schools, leading several to quit before completing their four-year commitment. Unfortunately, several induction programs at the participating districts were limited or, in some cases, dysfunctional. The financial payment also did not appear to motivate at least some of the teachers. Instead, many teachers reported valuing the accelerated certification procedure used to enable them to enter teaching.[24] Initially the state fully funded the program for three years. However, amid statewide budget concerns and growing costs, the program was dramatically reduced for subsequent years. Currently, only two districts participate and the future of state funding is unclear. Yet, until recently, the program was still regarded as the largest provider of math and science teachers in the state.

B. Performance-based Compensation

As suggested above, policymakers should consider incorporating an element assessing "effectiveness" in any ongoing differential compensation for mathematics and science teachers. The extraordinarily wide variation in teacher effectiveness encourages focus on retaining only those teachers who are, in fact, capable of increasing student learning. The rationale for performance-based compensation has traditionally been cast in terms of increasing staff motivation. While promoting motivation is important, another, often overlooked, reason for performance-based compensation is that it encourages staff to self-sort according to the targeted outcome. Broader labor market studies find that performance-related compensation systems also achieve their results by attracting and retaining those employees who are good at the targeted activity. Employees who are consistently ineffective will leave the profession to seek out other opportunities, raising the overall quality of the remaining team.[25]

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Much has been learned from well-documented experiences designing and implementing performance based compensation plans. While most pay-for-performance plans have been initiated by school districts, states are becoming increasingly involved. As of January 2008, one survey identified seven state programs supporting pay-for-performance plans of varying types, including Alaska, Arizona, Arkansas, Florida, Minnesota, North Carolina, and Texas.[26] Since then, Utah has also appropriated funds ($20 million) to encourage districts to experiment with pay-for-performance plans.[27]

The design of performance-based compensation plans has varied widely, ranging from plans that reward differentiated roles for teachers (e.g., mentor teacher) to models that reward teachers for increasing their own knowledge and skills to approaches that provide incentives for increased student achievement. It is beyond the scope of this Brief to cover all types of performance-based compensation. Instead, we focus on designs that reward educators for raising student achievement and consider how these might be applied to justify ongoing wage differential for teachers of science and mathematics.

There is a growing body of evaluative research showing generally positive results for approaches that reward educators for increased student achievement. A 2006 review sifted through the available studies and identified 9 evaluations conducted according to rigorous scientific methodology. Though the total number of rigorous evaluations is not large, it found a promising level of consistency in the findings. Of the nine studies, there were unambiguously positive results for seven. Even for the two that were found to have "mixed" results, both significantly improved the behavior that was rewarded; however, the planners for those two initiatives had hoped that other behaviors (which were not rewarded) would also improve. Interestingly, two of the studies were conducted in a manner permitting comparison between the relative impact of group rewards and individual rewards; individual rewards were found to have substantially higher effects than group rewards. Another study used a different assessment for the evaluation than the one used to determine rewards, addressing concerns about narrow "teaching to the test"; it too found positive results on the separate measure.[28]

Policymakers should consider incorporating an element assessing "effectiveness" in any ongoing differential compensation for mathematics and science teachers.

An even more recent 2008 review from the National Mathematics Advisory Panel, summarized in the Report of the Task Group on Teachers and Teacher Education, similarly found consistently positive results. Of the fourteen research studies that met the reviewers' rigorous standards, thirteen identified positive effects from efforts to reward educators for high student performance.[29]

C. Issues for Policy Design

When designing compensation policies that will integrate differential and performance-based pay, it is important policymakers consider four key issues:

1) What type of differential compensation (and how much) will be provided?

Policymakers should decide if the differential portion of the compensation package will provide math and science teachers a one time signing bonus, higher start pay, or other incentives with a cash value, such as housing or low interest loans. For example, an evaluation of the MA MINT program suggested that the cost of the program (i.e. $20,000 per recruit) was too burdensome for the state to maintain given the sheer numbers of people needed to fill the math and science teaching positions.

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2) How are teachers without state standardized test results included in the performance-based system?

Many mathematics teachers and science teachers are in grades without any state-mandated assessments. In mathematics, states typically assess in grades 3-8 and then only once in high school, while in science, most states only assess once in elementary school, once in middle school, and once in high school. In science, even for those grades with state assessment results, inferring the contribution to student learning made by individual teachers (their "value added") is limited by the lack of results from the prior grade for those students. From a measurement standpoint, the ideal solution is for districts to implement their own, curriculum-aligned assessments. If that is not feasible, another option is illustrated by Denver's ProComp pay-for-performance plan. Under ProComp, teachers work with their principals to develop highly specific, measurable growth objectives for student achievement. Some objectives are based on assessments embedded in the curriculum or instructional materials, while others address specific student skills expressed in measurable terms. While some judgment by the principal is ultimately involved in determining whether objectives were met, it is not entirely subjective if the objectives are designed properly and are measurable. Such objectives may even be a good idea for grades in which gains may be measured by state standardized tests in order to provide a more complete picture of student achievement. Thus, for teachers in grades or classes without test score gains, the best solution may be a combination of individual rewards for student achievement growth on measurable learning objectives combined with group rewards for school-wide performance on the state assessment.

Individual rewards were found to have substantially higher effects than group rewards.

3) Which is best? Individual or Group rewards

There has been somewhat less resistance to group rewards in public education than individual awards. Sometimes, concerns about individual awards have been based on fears about the accuracy of measures at the level of the individual. More often, concerns have been expressed that schools benefit from collaboration among teachers, which, it is thought, will be discouraged by individual rewards.

The accuracy of individual teacher results can be addressed successfully if policymakers avoid simplistic calculations and, instead, opt for quality "value added models". These approaches typically rely on results from three years of data associated with an individual teacher (though they can be implemented in just one year, if a school system has prior data).[30] While there is some cost associated with these methodologies, it is not high; the expense will certainly not be a large proportion of the overall cost of a typical performance compensation plan unless the total number of teachers involved is very small. The alternative—simple non-statistical calculations of test scores—results in determinations with a high degree of error, often rewarding individuals who are not effective and failing to reward teachers who are.

With respect to group dynamics, while it is true that productive collaboration among teachers is very useful in schools, fears that individual rewards will discourage collaboration can be addressed. It is not necessary to pit teachers against each other in pay-for-performance plans. Value added calculations have historically been used to identify the most effective teachers (usually 20%-30%), as well as the least effective teachers (again, usually 20%-30%). Well-known value added models in Tennessee and Dallas were implemented in this way. Arguably, using such an approach in the context of pay-for-performance could lead to discouraging teachers from collaboration, since one teacher helping another will make it that much harder for the first teacher to score in the top group. While it should be noted, however, that we could find no actual evidence supporting such an effect, policymakers can address this fear by adopting a high, but fixed, criterion for the student achievement gains that merit reward for any teacher. In addition, policymakers should consider weighting both individual results and group results in determining awards. Inclusion of a component based on group success provides a direct incentive for collaboration. If a fixed criterion for growth is combined with weighting group and individual results, a solution can be designed to allay fears that collaboration among teachers might be discouraged.

4) What performance is good enough? A High, Fixed Growth Standard for Teacher Success

Value added models based on standardized test results, such as state assessments, can work with a fixed criterion and have sometimes been implemented in such a fashion.[31] In such an approach, value added calculations identify the degree of possible error for each teachers' student gain results, and determinations of whether a teacher met the standard are adjusted for this amount. In this model, no teacher helping another reduces his or her chance of success. Over time, if the initiative is successful, more teachers will meet the standard and earn the reward, so this needs to be accounted for in setting the initial standard, as well as budget planning.

Of the fourteen research studies that met the reviewers' rigorous standards, thirteen identified positive effects from efforts to reward educators for high student performance.

If a fixed criterion is to be established for gains, it is a policy judgment how high to set that standard. At a broad conceptual level, this is similar to the policy judgment involved in establishing standards for "proficiency" on state assessments. In the case of establishing a growth standard for teacher success, a carefully designed process should be followed to analyze available prior data and establish a challenging but realistic benchmark.[32] The growth performance of all teachers can be sorted and the impact of multiple proposed standards can be considered. Any such standard should be reviewed after a few years of program implementation.

For teachers in grades or classes without test score gains, the best solution may be a combination of individual rewards for student achievement growth on measurable learning objectives combined with group rewards for school-wide performance on the state assessment.

In instances where value added calculations for individual teachers are not possible (e.g., science assessments at only three grades in K-12), fixed criteria can still be set for school-wide performance. Such targets should address improvement, not simply a single performance goal. If the assessment has more than two targets (i.e., proficient/non-proficient), it may also be beneficial to set more than a single improvement target. For example, by setting performance categories for improvement according to the proportion of students achieving an "advanced" level, as well as improvement according to the proportion achieving "proficiency", two targets are established.

III. Improving Pay Only Goes So Far—The Broader Context

Given the goal is to improve student learning by filling teaching positions with quality candidates at the lowest additional cost, policymakers should also consider: a) drastically reforming teacher licensure; b) promoting the use of research-based classroom management strategies; c) revising curricular standards with respect to breadth and depth coverage.

A. Reform teacher licensure requirements

First, reduce or eliminate traditional requirements for licensure and determine if the pool of potential candidates can be expanded using minimal regulations. While states and districts cite the use of alternate certification routes as a way to reduce barriers to entry, many of these programs require the candidate to complete numerous credit hour requirements in the evening or on weekends. These "seat-time" obligations when added to the normal demands of a new teacher, say for a career-changing engineer, may still be too high for some candidates. Policymakers should explore accelerated routes that still maintain quality, such as the American Board for Certification of Teacher Excellence, a federally-sponsored initiative to create a rigorous alternate certification route that places a lighter burden on new teachers. Eliminating regulatory burdens associated with certification assists those interested in entering the profession. Yet, it is also necessary to create the conditions to retain high quality teachers.

B. Use research-based classroom management strategies

A second strategy to complement differential pay would address the reasons why many promising new hires soon leave teaching positions. Non-financial factors contribute to attrition that helps to cause the teacher shortage in science and mathematics. Among the key factors of teacher attrition is student behavior and classroom management.[33] The report by Public Agenda in 2000,"A Sense of Calling", found that teachers believe their preparation programs lack the training needed to manage a classroom, bring classes alive and make sure their students actually learn. In a more recent Public Agenda report, "Teaching Interrupted", teachers admit that their teaching would be a lot more effective if they didn't have to spend so much time dealing with disruptive students. One of the more common reasons cited for leaving the profession or changing schools, especially in schools serving disadvantaged students, is difficulty managing classroom behavior. New hires with high academic credentials appear to be especially vulnerable to the frustrations of classroom management in a challenging environment.[34] New teachers sometimes indicate that they feel that they have been left to "sink or swim" in their new duties (though classroom management is not the only reason for this). While there exists a variety of options for assisting new teachers (e.g., assigning a mentor), one that is sometimes overlooked is to provide focused professional development on research-validated models of behavior management. The research on positive student behavior supports, second only to the depth of the reading research, consists of a robust knowledge base addressing the most effective principles and methods.[35] Some of the better-designed, school-wide programs can assist veterans as well and enable them to focus more on academic instruction.

C. Improve curriculum

In addition to strategies addressing recruitment and retention of mathematics and science teachers, policymakers grappling with the broader question of improving student achievement in those subjects should also consider reforms to local curricula or even state standards. The same international studies that have compared student achievement in different countries have also gone beyond testing to investigate the causes of the different results. One of the most important findings to come out of these analyses identified key differences between the K-8 mathematics curriculum in high-performing countries and the U.S. curriculum. Compared to the math curricula in other nations, the U.S. approach is fragmented, covers far too many topics superficially at each grade level, does not focus on the most essential content, and includes excessive repetition.[36]

If a fixed criterion for growth is combined with weighting group and individual results, a solution can be designed to allay fears that collaboration among teachers might be discouraged.

States and districts interested in improving the effectiveness and coherence of their mathematics standards and curricula can find a wealth of useful information in the Report of the National Mathematics Advisory Panel, especially the "Report of the Task Group on Conceptual Knowledge and Skills."[37] Among the more interesting findings was that even the better mathematics standards developed by U.S. states and teacher professional associations still contain significant design flaws or limitations when compared to the mathematics standards of top-performing nations.[38] In addition, the provided skill-level analyses may be invaluable to reformers interested in using the best sources from around the world to enhance mathematics curricula for high performance.

Endnotes

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