an AMERICAN IMPERATIVE

Transforming the Recruitment, Retention, and Renewal

of Our Nation's Mathematics and Science Teaching Workforce

BHEF BUSINESS-HIGHER EDUCATION FORUM™

Creating Solutions. Inspiring Action.

About BHEF

The Business-Higher Education Forum (BHEF) is an organization of Fortune 500 CEOs, college and university presidents, and foundation leaders working to advance innovative solutions to our nation's education challenges in order to enhance U.S. competitiveness. BHEF currently is pursuing two major initiatives—one focused on college/work readiness and success, and a second promoting America's leadership in science, technology, engineering, and mathematics.

Founded in 1978, BHEF brings together a coalition of corporate, academic and foundation members to influence public policy and inspire other corporate, academic and foundation leaders to act. BHEF members develop, adopt and promote best practices and strategic approaches among corporate, education and foundation leaders, nationally and locally. They also advocate for policy changes at the federal, state and local levels.

Additionally, BHEF conducts research to identify strategies and policy reforms that the organization and its members advance directly and in conjunction with other organizations. Most recently, BHEF has examined the need for enhanced recruitment, retention, and renewal of the nation's mathematics and science teaching workforce. The results of this research are summarized in this report, "An American Imperative: Transforming the Recruitment, Retention, and Renewal of Our Nation's Mathematics and Science Teaching Workforce."

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Preface

While the U.S. economy today is robust, productive, and remarkably innovative, it faces important competitive challenges. American business and educational leaders know that to remain competitive at home and abroad, it is essential not only to transform the way we work—but also the way we educate and prepare future generations of Americans, especially those students who come from poor and historically disadvantaged backgrounds.

From our perspectives in business and higher education, we are deeply concerned by the shortfalls we see in America's ability to remain competitive in the fields of science, technology, engineering, and mathematics, or STEM. These areas are cornerstones, fundamental to our ability to develop the skill sets and knowledge that will keep the United States intellectually vibrant and economically competitive. In particular, we believe that there is more that we can do—and that we *must* do—to transform teaching and improve student learning and interest in these vitally important disciplines.

To address these challenges, the Business-Higher Education Forum recently launched a broad initiative to secure America's leadership in the STEM areas. Our goal is to develop a comprehensive and systemic nationwide strategy to double the number of college graduates with degrees in critical STEM disciplines by 2015. We believe that American businesses must be active, engaged leaders in this work—for the sake of our companies and our country. We believe that American colleges and universities must also be leaders in this work, given the core educational mission of developing human and intellectual capital.

Our report suggests actions that diverse stakeholders can take to effect change, and outlines specific roles and strategies—from high-impact policy decisions to program ideas tailored to local schools.

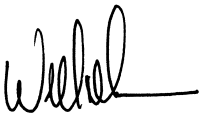
"An American Imperative" details a comprehensive set of recommendations that will serve as the foundation for transforming STEM education in the United States. Recognizing the innate and vital connection between top-caliber teachers, student interest, and achievement, we believe it imperative to focus on improving both the quality and the number of mathematics and science teachers. Our recommendations span three crucial areas—teacher recruitment, retention, and renewal. Our report suggests actions that diverse stakeholders can take to effect change, and outlines specific roles and strategies—from high-impact policy decisions to program ideas tailored to local schools.

Our report builds on the legacy of a number of influential national reports that drew attention to the critical need to strengthen teaching as a means to improve student learning, including the National Commission on Teaching & America's Future's path-breaking report "What Matters Most: Teaching for America's Future," the Glenn Commission's report "Before It's Too Late," and the Teaching Commission—headed by retired IBM CEO Louis V. Gerstner, Jr.—which issued two major reports that called for comprehensive reforms that would elevate teaching to a "true profession."

If the United States is to graduate students empowered with the skills and expertise that the country will need to meet the competitive challenges of the 21st Century, we must act decisively today to recruit, retain, and renew exceptional mathematics and science teachers. We have an abundance of good ideas, and an emerging consensus on the importance of the STEM challenge. What we need now are leaders—individuals and organizations—who share this vision for transforming teaching and learning in science and mathematics, and who are ready to commit to help make it happen.

"An American Imperative" describes a way forward, an opportunity for transformational change that we believe can empower future generations of Americans and contribute significantly to the future prosperity of our nation. We hope you will share our belief that the investment we make now will have an equally important return. We ask you to consider partnering with us, and many others, in this important mission.

Warren J. Baker
President
California Polytechnic State University



William H. Swanson
Chairman and CEO
Raytheon Company

Co-Chairs, Securing America's Leadership in Science, Technology, Engineering and Mathematics

Executive Summary

American students today have limited interest in studying mathematics and science, and academic achievement in these two foundational disciplines is demonstrably low. This bleak reality poses an acute challenge to our ability to keep American society intellectually vibrant and to ensure that our economy is globally competitive. It is a national imperative, therefore, that we improve achievement by all students in mathematics and science and attract more individuals into science, technology, engineering, and mathematics (STEM) careers. Accomplishing these crucial goals will require nothing short of transformational change in our nation's educational system and, in particular, our mathematics and science teaching workforce.

This transformation must focus on two fundamental issues—the quality of the teaching workforce and the growing shortfall of teachers. Research has established that the quality of P–12 mathematics and science teaching is the single most important factor in improving student performance in these disciplines. In addition, the Business-Higher Education Forum (BHEF) has projected that our nation will need more than 280,000 new mathematics and science teachers by 2015. This shortage is particularly acute in classrooms that serve our nation's poorest students.

"An American Imperative: Transforming the Recruitment, Retention, and Renewal of Our Nation's Mathematic and Science Workforce" provides a comprehensive action plan to address these fundamental issues and ensure that every child has a teacher with the content expertise, pedagogical mastery, and professional support necessary to develop the skills they will need to succeed in a dynamic global economy and society.

Three Key Components: Recruitment, Retention, and Renewal

BHEF's plan to elevate the status of the teaching profession focuses on transforming three key components that contribute to a robust, world-class teaching workforce, including:

- **RECRUITMENT**, including teacher enlistment strategies, preparation programs, and licensure.
- **RETENTION**, encompassing strategies and programs to keep new teachers in the classroom and retain experienced teachers.
- **RENEWAL**, a focus on teacher professional development, license renewal, and assessment of teacher quality and student outcomes.

The recommendations in "An American Imperative" are the result of a major BHEF initiative, "Securing America's Leadership in Science, Technology, Engineering and Mathematics (STEM)" that has as its goal the doubling of the number of college students with degrees in STEM fields.

Recommendations to Strengthen our Nation's Mathematics and Science Teaching Workforce

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

- Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.
- Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.
- Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

- Develop and implement research-based induction programs for all new mathematics and science teachers.
- Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

- Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.
- Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.
- Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.

Our ideas for improving the nation's supply of highly qualified mathematics and science teachers are comprehensive, integrated systemically into the whole of the educational enterprise, and aligned among diverse partners who hold a stake in improving student interest and achievement in mathematics and science. They are comprehensive in the sense that they address recruitment, retention, and renewal in a holistic, rather than piecemeal, manner. They are systemically integrated to address the core components of an education system (student content standards, curricula, student assessments, and accountability) and are applied across both P–12 and higher education to ensure an approach that embraces the whole of P–16 education.

Stakeholder Roles

To ensure a coordinated reform effort, the recommendations lead to suggested roles for five key stakeholder groups—federal government, state governments, school districts, higher education, and business and foundations. The roles we propose for the various stakeholders reflect the diversity of strengths among them. For example:

- The federal government should play a leading role in bolstering research efforts to identify and disseminate promising practices and to support programs that are effective in increasing student achievement in mathematics and science.
- State governments need to establish more coherent statewide policies as well as coordinate the efforts of other stakeholders.
- School districts must establish district-wide policies that are suited to local needs and conditions, yet aligned with federal and state guidelines.
- Higher education activities should focus on investing in and strengthening teacher preparation and professional development programs in mathematics and science, and on research that can lead to new insights into effective teaching and learning methods.
- Business and foundations need to publicly champion policies and support effective programs.

Because we want to offer stakeholders a robust plan for action, we have identified more than 100 detailed ways in which they can contribute. These recommendations are contained in this report, which can also be found at http://www.bhef.com. Many of our ideas build on existing interventions or policy proposals and will no doubt be familiar to many readers. For example, we call for differential pay to attract and retain highly qualified mathematics and science teachers and strongly advocate for sustained, research-based induction programs for all new mathematics and science teachers. Other recommendations, however, propose new and innovative solutions. For instance, BHEF calls for teacher recruitment programs that target promising students as early as middle school. And we call for the creation of a new school-based administration role, the vice principal for academic affairs, to lead the vitally important work of providing systemic support for new teachers, helping experienced teachers master classroom instruction skills, and helping all educators develop and implement curricula.

A Time for Action

"An American Imperative" presents a comprehensive plan for transforming the recruitment, retention, and renewal of America's mathematics and science teacher workforce. It addresses a complex set of issues and speaks to a wide range of relevant audiences. At the same time, its recommendations are strategically targeted to have practical value—and maximum impact—in the field. If these recommendations are to have real and lasting impact, however, we must ensure that stakeholders have a plan of action to fund, implement, test, improve, and sustain the proposed set of reforms.

While this report offers roles for the five key stakeholder groups identified above—and we consider each group's full participation to be imperative—BHEF believes it is especially critical for the business community and higher education to become more actively engaged in efforts to improve teaching in mathematics and science. That engagement might take any of a number of forms.

Business executives often assume leadership roles within their state or region and, as a result, are uniquely positioned to have significant impact on the development and adoption of policies in their states, school districts, and schools. Companies should also expand opportunities to bring mathematics and science teachers into the corporate setting to see how knowledge from their disciplines is applied in business and industry, and to help them become more involved with other practitioners in their fields. Regardless of the approach, however, business should provide strong leadership in this important work, bringing more of its expertise and applying more of its resources to the effort to improve mathematics and science teaching.

Similarly, higher education must also provide leadership in this endeavor. Institutions of higher education must raise the priority of developing highly qualified mathematics and science teachers to a more prominent role in their missions. They need to critically evaluate their mathematics and science teacher preparation and professional development programs to strengthen and expand their role in producing a highly qualified teaching workforce. In addition, higher education should expand research on curriculum, instructional methods, and student learning in mathematics and science, and share the results with teachers and policymakers to achieve maximum impact. Finally, higher education leaders should redouble their collaboration with their P–12 colleagues and respond to school districts' specific needs.

BHEF believes it is especially critical for the business community to become more actively engaged in efforts to improve teaching in mathematics and science.

In short, we believe that the time has come for business and university leaders, in concert with partner stakeholders, to collectively work as strong advocates to create and sustain a mathematics and science teaching workforce of the highest possible quality. A synchronized response at both the national and local levels is essential. Specifically, we suggest that such an approach should start with four coordinated actions:

- Establish a national consortium among key stakeholders that would elevate the status of the teaching profession and promote teacher recruitment, retention, and renewal. The consortium would share information and coordinate activities, launch a national public information campaign to raise awareness about the critical need for teachers and opportunities for career growth, and champion promising initiatives.
- Advocate for new and expanded federal policies that address teacher recruitment, retention, and renewal, including key provisions in the Higher Education Act, the No Child Left Behind Act, and National Science Foundation appropriations.
- Encourage each state to conduct a thorough and detailed assessment of teacher recruitment, retention, and renewal to guide state policy. States should project short- and long-term demand for highly qualified mathematics and science teachers and closely analyze teacher retention.
- Participate in and expand state and regional P–16 education councils to include a stronger focus on teacher recruitment, retention, and renewal, and on coordinating reform efforts among stakeholders.

Working together, we can help invest teachers with the skills and confidence they need to inspire a new generation of students—students who will embrace the power of mathematics and science and have the skills they need to attain consistently high levels of academic achievement in these fields. In these ways, we will help build a workforce and a citizenry fully capable of meeting the challenges of the 21st Century. This effort is vital to the continued success of our nation. The time for action is *now*.

Introduction

THE 8TH-GRADE GEOMETRY CLASS LOOKED FAMILIAR, but this year there was something new. Over the summer, the teacher, a 17-year veteran certified in secondary mathematics, had learned a wholly new approach to teaching geometry. Eschewing the usual textbook march through a series of theorems, the new approach used computer software to help students explore broad questions and ideas about geometry.

For a year, the 13 girls and 3 boys in the class explored characteristics of geometric objects, formulating hypotheses for which they generated multiple justifications, or proofs. Students posted their hypotheses on large pieces of paper taped to the classroom's walls. The teacher reported that the students "posed hypotheses I had never encountered before," adding that "when they asked me if they were correct, I found myself *frequently* saying 'I don't know. Let's find out.'" Together teacher and students used a toolkit of general problem-solving strategies to investigate their questions.

Confirmation about the value and validity of the teacher's approach came when the students took the state's annual geometry examination. The students were surprised at the simplistic level of the questions—as one asked, "Is that all they want us to know?" The test asked some questions that the students had not explored in class, but that did not matter. They simply used their toolkit of problem-solving skills to generate answers. When the test results were reported to the school, every student had excelled.

This true story shows that good teaching makes a difference and several key features made this possible. The teacher was highly innovative, enthusiastic about experimenting with new teaching practices, took chances, and was confident enough to learn along with the students. It also demonstrates the positive effects of applying professional development training specifically to the curriculum. The teacher's success was further aided by a professional development instructor, who provided weekly advice and classroom observation. In addition, the teacher received critical support from her principal and other teachers in implementing the pedagogical experiment.

A mathematics teacher from Bryan, Texas provided this anecdote.

Supporting transformational change of this nature across the spectrum of mathematics and science education is fundamentally what this report is all about. In the pages that follow, the Business-Higher Education Forum (BHEF) outlines a series of recommendations and our rationale for the reforms we propose. After presenting the recommendations, the report then proposes specific roles that each of five stakeholder groups—federal government, state governments, school districts, higher education, and business and foundations—must embrace in order to ensure successful implementation of the recommendations. The next section describes promising strategies that illustrate actions being taken by stakeholders to improve the recruitment, retention, and renewal of mathematics and science teachers. "An American Imperative" concludes with a call to leaders in all the stakeholder groups, especially business and higher education, to begin advancing a synchronized response at both the national and local levels.

The Teacher Quality and Quantity Problem

At a time when there is increasing worldwide demand for highly skilled workers, U.S. students are losing ground to their international counterparts in mathematics and science performance. These trends are of great concern to many stakeholders, in that they threaten America's preeminence in the global economy, its national security, and the social and economic well-being of its citizens.[1-9] In particular, there is an alarming shortage in our nation's supply of highly qualified[a] mathematics and science teachers, particularly in those classrooms that serve our nation's poorest and neediest students. This shortage is the result of two related facts: too few of our nation's best and brightest enter mathematics and science teaching; and of those who do enter these fields, too many leave the profession early in their careers.

Research has established that the quality of P–12 mathematics and science teaching is the single most important factor in improving student mathematics and science achievement.[10-13] It follows, therefore, that P–12 education reform initiatives should include a strong focus on improving teacher quality and ensuring a robust supply of teachers in critical fields. Because interventions related to the number and quality of teachers affects other major components

> The quality of P–12 mathematics and science teaching is the single most important factor in improving student mathematics and science achievement.

of the education system, such as student content standards, curricula, student assessments, and accountability, it is imperative that policy and programmatic changes be coordinated and implemented comprehensively across the P–16 education system. A holistic approach to reform is better than piecemeal patches.

Nationally there are simply not enough highly skilled mathematics and science teachers entering the profession or committing to long-term careers. The 2005 Business-Higher Education Forum report "A Commitment to America's Future" found that the United States will need more than 280,000 new mathematics and science teachers by 2015.[14]

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These shortages are most apparent in high-minority and high-poverty classrooms, where students are less likely to be taught by a teacher who is well prepared in the subject area. In 2002, 72% of high-minority middle school mathematics classes were taught by teachers who had not majored or minored in mathematics, compared with 55% of low-minority classes. A similar pattern was observed in high schools, where there was a 33% to 23% differential between high- and low-minority mathematic classes.[15]

Additionally, there is a critical shortage of minority teachers. The dearth of qualified minority teachers has been cited as one of the factors contributing to the problem of low achievement of minority students.[16] The shortage of minority teachers is outpacing the overall mathematics and science teacher shortage. In 2003, 42% of public school students were from minority groups—yet only 16% of the teachers were minorities.[17]

[a] For the purpose of this paper, BHEF accepts the criteria of the *No Child Left Behind* Act of 2001 (NCLB) for determining a highly qualified teacher. According to NCLB, a highly qualified teacher has (1) attained a bachelor's degree or better in the subject taught; (2) obtained full state teacher certification; and (3) demonstrated knowledge in the subjects taught.

The staffing problem in mathematics and science is not limited to the recruitment of new teachers. Research has shown that the problem of attracting highly qualified candidates into the mathematics and science teaching workforce is overshadowed by the difficulty of retaining experienced teachers.[18] Approximately half of all teachers leave within 5 years of entering the profession. Similar to the trends of teacher shortages, the rate of attrition is 50% higher in poor schools versus wealthy ones. Replacing teachers requires a much more significant, costly, and time-consuming investment than retaining them.[19] The cost of teacher attrition goes beyond dollars as well, leading to a loss of teacher quality and student achievement.[20]

In response to the shortage of highly qualified mathematics and science teachers, almost all states and many school districts are defining and implementing policies and programs that address the three factors that contribute to a robust teacher workforce: recruitment, retention, and renewal. This paper specifically concentrates on these focus areas. BHEF recognizes that programs and policies to strengthen recruitment, retention, and renewal are important investments in the essential process of securing the quality and quantity of teachers necessary to improve the mathematics and science achievement of all students.

Efforts Converging on a Solution

A number of key national reports have served to draw attention to the critical nature of teaching and suggested ways to strengthen the profession as a means to improve student learning. In 1996, the National Commission on Teaching & America's Future's path-breaking report "What Matters Most: Teaching for America's Future," drew attention to the importance of teachers in closing the achievement gap and helped to galvanize policy action.[21] In 2000, the National Commission on Science and Mathematics Teaching for the 21st Century, headed by John Glenn, issued a major and well-respected report that argued that "the future well-being of our nation and people depends not just on how well we educate our children generally, but on how well we educate them in mathematics and science."[22] That report also argued that "the most powerful instrument for change, and therefore the place to begin, lies at the very core of education—with teaching itself." Meanwhile, the Teaching Commission, headed by retired IBM CEO Louis V. Gerstner, Jr., issued major reports in 2004 and 2006 that called for comprehensive reforms that would elevate teaching to a "true profession."[23-24]

The last few years have seen a convergence of similar opinion from key leaders in government, higher education, business, and foundations regarding the importance of improving mathematics and science teaching.[25-35] During this time, educational researchers also have made significant advances in identifying those characteristics of teacher education, induction programs for beginning teachers, and ongoing professional development that produce successful mathematics and science teachers. The knowledge base created by this research, coupled with the recent successes by educational stakeholders in implementing teacher-related policies and programs, provide invaluable, proven tools to help us increase the number of highly qualified mathematics and science teachers.

The last few years have seen a convergence of similar opinion from key leaders in government, higher education, business and foundations regarding the importance of improving mathematics and science teaching.

Currently, stakeholder interventions range from high-impact legislative initiatives that address quality and teacher quantity at the national or state level to more locally targeted strategies that aim to recruit and retain qualified teachers in high-need schools.

- Spurred by major reports, Congress introduced legislation to support improved teacher preparation, professional development, and recruitment incentives, but much of this legislation has been sporadic and piecemeal, and the overall effect has fallen far short of enacting a national strategy.
- To overcome their respective shortages of mathematics and science teachers, many states have convened task forces to study the problem, and are working toward reforms in pay structures and working conditions. For example, the Kentucky Council on Postsecondary Education and the California Council on Science and Technology have developed statewide action plans to address these issues.
- School districts are implementing a wide array of new programs, such as housing subsidies for teachers working in high-need schools and the creation of district-wide professional learning communities.
- Higher education institutions are beginning to overhaul their teacher preparation programs to improve mathematics and science content and pedagogy; one popular approach is to bundle a science, technology, engineering and mathematics (STEM) major with a teacher license.
- The corporate community and philanthropic foundations have supported a wide range of school improvement activities, including large-scale initiatives aimed at promoting teacher recruitment and retention, strengthening teacher education and professional development, and recently, establishing statewide education data systems.

There is great power in this unique confluence of expanded interest, leadership, and action in the public and private sectors. The combination of legislative change, reforms launched within school districts and higher education, and investment in and support of teaching by business and foundations creates just the kind of momentum that is needed to help advance genuine, systemic change. We need to be assertive now, to build on that momentum and capitalize on this outstanding opportunity to transform teaching and improve student learning in mathematics and science. From legislators and educators to grant makers and the corporate sector, many partners need to drive reform in teaching and learning in mathematics and science.

It is in this context—in which a powerful confluence of partners has an opportunity to effect meaningful change—that BHEF proposes a set of recommendations that address the national shortage of highly qualified P–12 mathematics and science teachers. Our recommendations focus on three key areas: recruitment, retention, and renewal. Our ideas are based on programmatic models and existing research-based evidence. Our proposals identify policies and actions appropriate to each of five key stakeholder groups: federal government, state governments, school districts, higher education, and business and foundations.

Recommendations

to Strengthen the Mathematics and Science Teaching Workforce

BHEF's recommendations address three key factors that contribute to a robust mathematics and science teacher workforce: recruitment, retention, and renewal.

- **RECRUITMENT,** including teacher enlistment strategies, preparation programs, and licensure.
- **RETENTION,** encompassing strategies and programs to keep new teachers in the classroom and retain experienced teachers.
- **RENEWAL,** focusing on teacher professional development, license renewal, and assessment of teacher quality and student outcomes.

Our core recommendations are as follows:

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

- Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.
- Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.
- Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

- Develop and implement research-based induction programs for all new mathematics and science teachers.
- Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

- Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.
- Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.
- Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.

BHEF's recommendations for improving the nation's supply of highly qualified mathematics and science teachers are comprehensive, aligned among diverse partners who hold a stake in this endeavor, and integrated systemically into the whole of the educational enterprise.

They are comprehensive in the sense that they address three core components that contribute to a robust teacher workforce—recruitment, retention, and renewal—and in the way they address them in a holistic, rather than piecemeal, manner. We believe that reform efforts in mathematics and science education must address these components simultaneously to ensure that they have the most effective impact on the supply of highly qualified P–12 teachers.

BHEF's recommendations for improving the nation's supply of highly qualified mathematics and science teachers are comprehensive, aligned, and integrated systemically.

The design of the recommendations also recognizes the need to align and coordinate the unique and necessary contributions of five major groups of education stakeholders: federal government, state government, school districts, higher education, and business and foundations.

Additionally, the recommendations are systemically integrated in that they are interdependent with other key components of the educational system—such as student content standards, curricula, student assessments, and accountability—and in that they are applied across both P–12 and higher education.

We will now examine recommendations in each area in detail.

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

- Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.
- Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.
- Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

The shortage of highly qualified mathematics and science teachers is a national phenomenon with significant local repercussions, particularly in urban and rural districts. This shortage has forced states and school districts to expand their recruitment efforts for qualified teachers—with some seeking candidates from as far away as the Philippines, Germany, Turkey, Nigeria, and India.[36] Additionally, states and school districts seeking teachers must compete with government and private industry for the dwindling number of higher education graduates with mathematics and science degrees.

Starting salaries for mathematics and science teachers have failed to keep pace with occupations requiring a similar educational background.[37-40] Teacher pay, in adjusted dollars, has declined since the 1970s, making the career less attractive to potential candidates. Adjusting for the cost of living over the past decade, the annual mean salary of classroom teachers has declined by 1.9%.[41]

In addition to low salaries, five other trends contribute to the widening gap between the demand for and supply of mathematics and science teachers:

- The nation's teaching force is aging; a national survey indicates that 34% of current public high school teachers expect to be retired by 2010.[42]
- More teachers are leaving the field than are entering it, and teacher turnover rates are highest in mathematics and science.[43]
- The size of the school-aged population is expected to increase by 10% in the next two decades.[44]
- A greater number of students are taking more mathematics and science courses because states are increasing mathematics and science requirements for graduation.[45]
- Women no longer provide the captive teacher labor pool that they were prior to 1980.[46]

To mitigate the effects of these trends, we should make significant changes in our approach to teacher recruitment. We should target potential teachers as early as Grade 6, and nurture them throughout the P–16 pipeline. We should broaden the scope of our recruiting, and work to reach a much larger pool of potential candidates, especially minorities. We should sweeten the financial and professional incentives we offer to attract qualified candidates to P–12 mathematics and science teaching, including scholarships, fellowships, assistantships, signing bonuses, differential pay, loan forgiveness, housing subsidies, stipends, and relocation costs.

Starting salaries for mathematics and science teachers have failed to keep pace with occupations requiring a similar educational background.

We should also bring more STEM professionals into the classroom through efforts that target practitioners outside teaching who seek to change careers or find a new challenge after retirement. According to the National Center for Alternative Certification, alternative routes to teacher licensure have grown dramatically over the past 20 years. Between 2004 and 2005 the number of individuals that entered teaching alternative route programs increased from 39,000 to 50,000. In 2006, 48 states and the District of Columbia had alternative licensure programs in place. [47]

Teacher recruitment programs should be supported by strong mathematics and science teacher *preparation* programs. The divergent and, often, low quality of such programs has been well-documented, with calls for reform from both within the academy and from outside groups. [48-52]

Structures to ensure the regular and ongoing review of teacher preparation programs should be broadened to ensure that they include every institution that is involved in preparing mathematics and science teachers—including community colleges, which represent a significant pathway to teaching careers.

Teacher preparation programs should begin with a baccalaureate degree in the content area in which the teacher intends to specialize. In the case of college-based teacher preparation, the degree programs should be focused on subject-matter content and age-appropriate pedagogical skills and instructional materials, should build on the evolving research regarding how students learn, and should be aligned with the state's P–12 mathematics and science content standards.

In particular, we should encourage the development of new programs that are specifically designed to produce specialists in teaching mathematics and science at the elementary level. Similarly, we should expand programs designed to produce the caliber of certified middle school mathematics and science teachers that are needed to teach higher-level mathematics and science courses that are now being offered and required in the middle grades.

In the case of alternative teacher preparation programs, we should ensure that such efforts provide age-appropriate pedagogical skills and knowledge of teaching materials for effective classroom instruction to supplement the content knowledge and real-world experiences that professionals possess.

All teacher preparation programs, whether they are traditional or alternative, must include supervised experience in classroom instruction of students at the level of which the teacher will be certified. In addition, every teacher preparation program should collect and publicly disseminate data on its effectiveness.

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

- Develop and implement research-based induction programs for all new mathematics and science teachers.
- Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

Research has shown that retention of mathematics and science teachers is an even greater problem than recruitment. Staffing classrooms with mathematics and science teachers has been characterized as a "revolving door." Thirty-three percent of all new teachers leave teaching during the first 3 years of their careers; 46% leave in the first 5 years.[53] The annual turnover of mathematics teachers (16.4%) is the highest of all content areas; the rate for science teachers (15.6%) is second-highest.[54] Every school day nearly 1,000 public school teachers leave the

Retention of mathematics and science teachers is an even greater problem than recruitment.

profession and another 1,000 teachers move to other schools. All told, there is an annual attrition of some 394,000 teachers. The cost of this upheaval is estimated at some $4.9 billion annually in the United States, factoring recruiting expenses, signing bonuses, subject-matter stipends, and expenses specific to hard-to-staff schools.[55]

Studies demonstrate that comprehensive induction programs, which typically provide orientation, mentoring, general support, further training, and evaluation, are essential to keeping teachers from leaving the classroom for good. For instance, a comprehensive induction program has been shown to reduce the turnover rate of first-year teachers from 41% to 18%.[56-57] The National Commission on Teaching and America's Future found that 80% to 90% of new teachers who experienced a comprehensive, long-term induction program stay in the field for at least 5 years.[58] Ideally, the process enables novice teachers to stay long enough to develop into high quality professionals who help students meet their maximum level of achievement. From an economic standpoint, induction programs have been shown to produce a significant return on money invested in their operation. One recent study found that comprehensive induction creates a payoff of $1.50 for every $1.00 invested.[59]

Comprehensive induction programs are essential to keeping teachers from leaving the classroom for good.

Despite their proven success, however, comprehensive induction programs are not as prevalent as they should be. All new mathematics and science teachers should be given the opportunity to participate in comprehensive induction programs of at least a 3-year duration. The programs should include mentoring by a veteran teacher in the content area, interaction with a school administrator trained in and dedicated to instructional development, common planning time with other teachers, a reduced course load for at least the first year, help from a teacher's aide, and participation in an external network of teachers engaged in professional development.[60]

Compensation for mathematics and science teachers based on uniform pay scales leads both to recruitment shortfalls and high attrition in these "shortage disciplines," and to inequitable distribution of effective teachers within school districts. While insistence on subject-matter expertise is intended to increase teacher quality, it also increases the career options of the candidates, including opening doors to careers outside teaching that potentially offer higher salaries and better benefits. The teacher pool in mathematics and science continues to shrink as America's "brightest and best" are pulled away to jobs with higher salaries.[61] To be competitive, districts and schools must offer financial incentives, such as higher base salaries for teachers in shortage disciplines like mathematics and science, and, especially, for teachers who teach those disciplines in hard-to-staff and underperforming schools.[62] A large initial salary differential ($10,000) has been shown to reduce the number of teachers leaving a district at the end of their first year by 8%.[63]

Some districts are experimenting with alternative pay systems that recognize and reward excellence in teaching. One such model incorporates a multi-tiered licensure system—a career ladder—whereby teachers gain status and responsibility and receive increases in their base salaries while they hone their craft (see page 45). Each step in the career ladder requires increased pedagogical and content knowledge, classroom experience, appropriate professional development and mentoring activities, and summative evaluations.[64]

To be competitive, districts and schools must offer financial incentives, such as higher base salaries for teachers in shortage disciplines like mathematics and science.

Efforts to retain veteran teachers must address not only insufficient salary, but also the problem of job dissatisfaction, which often results from poor school-based administration support. The condition of work that matters most to many teachers is their teaching assignment. In particular, job satisfaction is greatly influenced by whether or not teachers are assigned to a subject or grade level for which they are prepared. Teachers given out-of-field assignments (33% of secondary mathematics teachers and 20% of science teachers) become frustrated as they struggle to keep ahead of their students, scramble to prepare lessons, and dread the prospect of being put on the spot by students during class.[65] State-mandated testing is playing an increasingly large role in teachers' work lives, especially in low-income, low-performing schools, as teachers feel pressure to concentrate on what is tested to the detriment of other important areas of learning. Teachers report that the volume of paperwork and the increased personal stress associated with high-stakes testing and accountability issues are key factors in their decisions to leave the profession. Studies also show that as school systems focus on testing, teachers are not being provided with the materials and professional development they need to help students achieve new and higher standards. Teachers find themselves in a "curriculum void" created by misalignment of school curricula, state frameworks, and assessment programs.[66]

Given that these conditions are school-based, teacher retention must be addressed at the school level by increasing the school-based administration support given to mathematics and science teachers. However, the workload of existing school-based administrators precludes increasing that support. One solution is the creation of a new administration position, a vice principal for academic affairs, an administration leader responsible for curriculum, instructional practice, and professional development. Research on international programs points, for example, to the value added by "deputy principals" in the schools of New Zealand. These administrators were given a flexible schedule that allowed them to coordinate school-level advance and guidance programs that convened teachers every two weeks during their first 2 years of teaching. The deputy principals

Efforts to retain veteran teachers must address not only insufficient salary, but also the problem of job dissatisfaction, which often results from poor school-based administration support.

facilitated meetings that addressed teacher-identified issues of immediate concern, as well as issues identified by the deputy principals that were scheduled for discussion over the course of the teacher's first year. The deputy principals also conducted classroom observations and led the analysis of lessons delivered by the teachers.[67]

The widespread problem of teacher isolation—a working condition that stands in the way of continuous professional growth—is another leading cause of teacher turnover. In the nation's rural schools, isolation is often a consequence of

physical distances between schools and, hence, between colleagues with similar teaching responsibilities. In urban schools, demanding teaching schedules, large class sizes, and extensive non-teaching duties often preclude opportunities for collaboration. To overcome the obstacle of teacher isolation, we need a greater concerted effort to connect mathematics and science teachers with one another, as well as with STEM professionals outside of teaching. Such an effort can come through wide adoption of the principle of learning communities, also called teacher networks or teacher study groups, in which groups of teachers convene to collectively analyze, reflect on, and solve problems of teaching and learning. These communities can also engage with experts in government, higher education, or industry, and can thus enable teachers to learn from and relate with STEM research and practice.

To overcome the obstacle of teacher isolation, we need a greater concerted effort to connect mathematics and science teachers with one another, as well as with STEM professionals outside of teaching.

The creation and maintenance of learning communities is widely viewed as fundamental to lifelong learning by mathematics and science teachers at all levels.[68-72] Interaction in learning communities promotes the sharing of ideas, the identification and correction of misconceptions, the posing of alternate solutions, and mutual encouragement for all engaged in improving student learning.[73] Learning communities have been shown to encourage and refine the reflective discussion of teaching and learning and to provide an environment in which teachers are comfortable in sharing problems and developing solutions.[74-75]

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

- Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.
- Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.
- Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.

According to a recent study, typical professional development programs fall short of their twin goals of advancing teacher content knowledge and teaching skills and improving student performance. Most professional development opportunities, the study found, are "fragmented, poorly aligned with curricula, and inadequate to meet teachers' needs—particularly acute in mathematics and science—for deeper knowledge of subject matter and understanding of pedagogy." Moreover, the study observed, "often the content of existing professional development programs is unconnected to teachers' daily work, and little follow-up support is offered."[76]

Although research and experience have documented how best to improve teacher professional development programs, efforts to develop and implement professional development programs based on that knowledge are lagging. Research indicates that, to be effective, professional development must be focused on student learning standards, tied to what is happening in local classrooms, sustained over time, and understood and supported by school administrators.[77-78] Comprehensive assessment must be embedded in all professional development programs, another study found, in order to confirm adherence to research-based principles of design and implementation, verify and reinforce desired changes in teaching, and measure improvements in student achievement. [79]

In most states, teacher license renewal depends on input measures, such as hours of professional development activities, rather than on a measure of the teacher's effectiveness. Most renewal programs require that six semester hours of professional development be completed over a period of 5 years.[80] In practice, the time span of a particular professional development activity is less than a week; also, it does not have a major emphasis on content and, hence, is not linked explicitly to student learning expectations, school curricula, or state assessments.[81] Rather than basing license renewal on such measures as hours of non-specific professional development, it should be based on output measures of classroom effectiveness that include classroom observations

Rather than basing license renewal on such measures as hours of non-specific professional development, it should be based on output measures of classroom effectiveness.

(by knowledgeable principals, peers, and other educators—including, perhaps, the vice principal for academic affairs), reviews of student work, parent evaluations, and measures of growth in student performance.[82-83]

Increasingly, states are developing longitudinal data systems to track how students are doing over time. To be successful, these data systems must be comprehensive enough to provide educators, policymakers, and the public with timely, valid, and relevant data necessary to evaluate the effectiveness of programs and policy initiatives. At the same time, measures must be taken to ensure student privacy. The data systems should also have the capability to determine the connection between teacher effectiveness and student learning. For example, a limited number of states can now measure teacher effectiveness by tracking the performance of students taught by each teacher. However, only seven states (Georgia, Hawaii, Louisiana, New Mexico, Ohio, Tennessee, and Utah) can pinpoint which teacher preparation programs produce the graduates whose students have the strongest academic growth.[84] More states must do so.

Additionally, statewide data systems must be expanded to include the gathering, analysis, and system-wide dissemination of information on the entry and exit of qualified mathematics and science teachers. A comprehensive and continuous supply of teacher data is needed to assess the number of qualified teachers currently employed and to predict the need for subject-specific teachers based on both projections of those leaving the workforce (with information on why they leave) and schools' changing instructional demands. Also, the data must measure the effectiveness of traditional and alternative teacher preparation programs in terms of the number of successful alumni they have, and subsequent retention rates in the profession among those alumni. Finally, research is needed to assess the general effectiveness, and cost effectiveness, of state and district recruitment, retention, and renewal programs.

The Role of Stakeholders

in Implementing Recommendations to Transform Recruitment, Retention, and Renewal

In this section, we have identified more than 100 roles that stakeholders can implement in support of the report's overarching recommendations regarding teacher recruitment, retention, and renewal. Each of the five key stakeholder groups—federal government, state government, school districts, higher education, and business and foundations—has an important role in the implementation of the recommendations to improve the quality and quantity of mathematics and science teachers. BHEF recognizes that each stakeholder is uniquely positioned to carry out specific roles in supporting the main recommendations. We also acknowledge that certain strategies might not apply to every stakeholder or in every circumstance. The roles we propose reflect the diversity of strengths among the various stakeholders. For example:

- The federal government should play a leading role in bolstering research efforts to identify and disseminate promising practices and to support programs that are effective in increasing student achievement in mathematics and science.
- State governments need to establish more coherent statewide policies, as well as coordinate the efforts of other stakeholders.
- School districts must establish district-wide policies that are suited to local needs and conditions, yet aligned with federal and state guidelines.
- Higher education activities should focus on investing in and strengthening teacher preparation and professional development programs in mathematics and science, and on research that can lead to new insights into effective teaching and learning methods.
- Business and foundations need to publicly champion policies and support effective programs.

BHEF's strategies for these groups span both policy and programs. While all of the proposed stakeholder roles have the potential to contribute to improving the quality and size of the teaching workforce in the critical fields of mathematics and science, some of the roles BHEF suggests are directed at formulating policy that shapes public debate, brings about substantial and long-lasting changes, and affects the overall direction of efforts to increase the supply of highly qualified mathematics and science teachers. Other suggested roles are directed at effecting change within an organization or at the programmatic level. Depending upon their size and scope, implementation of our proposals will require different degrees of financial investment and human involvement. From the financial perspective, activities may range from underwriting large educational programs to supporting a teacher's summer externship to contributing materials and supplies to a school. Human involvement could range from providing project leadership to supplying volunteers for educational events.

If there is one aspect that all stakeholders should address, it is the critical need to recruit, retain, and renew underrepresented groups into mathematics and science teaching. In addition, we must address the challenges implicit in high-need and low performing schools.

If there is one aspect that all stakeholders should address, it is the critical need to recruit, retain, and renew underrepresented groups into mathematics and science teaching.

The three charts that follow cross-reference BHEF's recommendations according to five stakeholder groups: federal government, state government, school districts, higher education, and business and foundations. The charts are ordered according to the three main recommendations and areas of focus in this paper—teacher recruitment, retention, and renewal. Read across the top horizontal row to find recommendations; read down the left column to find suggested roles for each stakeholder group. To view these proposed roles organized by stakeholder group, please see the appendix (page 56).

A caveat: what may at first appear to be redundancy across stakeholders' roles is, in fact, an effort to ensure the coordination of activities among all stakeholder groups.

The Role of Stakeholders: **RECRUITMENT**

Strengthen teacher recruitment policies in mathematics and science.

RECOMMENDATIONS

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P-12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P-12 students for success in higher education and the workplace.	Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

STAKEHOLDER ROLES

FEDERAL GOVERNMENT	Provide scholarships, research fellowships, teaching assistantships, and awards to attract promising candidates—middle school students through graduate students—into the mathematics and science teaching profession. Provide incentives for recruitment policies and programs, including signing bonuses; differential pay; student loan forgiveness; housing subsidies, loans, and stipends; and relocation costs.	Provide incentives for the development, evaluation, and dissemination of mathematics and science teacher preparation programs. Encourage colleges and universities to align teacher preparation programs with P–12 mathematics and science content standards. Provide incentives for colleges and universities to create a broad range of preprofessional activities, such as creating student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association; offering P–12 field experiences and internships; and sponsoring content-specific pedagogical institutes.	Fund research on standards of effectiveness for alternative mathematics and science licensure programs. Provide incentives to states, school districts, and institutions of higher education for the development, implementation, and evaluation of alternative, research-based mathematics and science teacher licensure programs. Provide incentives, such as tuition assistance and loan forgiveness, to attract STEM professionals currently working outside education to enroll in alternative mathematics and science teacher licensure programs. Establish a national adjunct teacher corps that will prepare qualified STEM professionals to work in classrooms.
STATE GOVERNMENT	Develop a statewide plan that includes policies, programs, and practices to increase the quality and quantity of P–12 mathematics and science teachers. Provide scholarships, research fellowships, teaching assistantships, and awards to attract promising candidates—middle school students through graduate students—into the mathematics and science teaching profession.	Encourage colleges and universities to align teacher preparation programs with mathematics and science P–12 content standards.	Develop/expand and evaluate alternative mathematics and science licensure programs that are based on relevant research and that are designed to attract STEM professionals. Provide incentives to attract STEM professionals currently working outside education to enroll in alternative mathematics and science teacher licensure programs.

Strengthen teacher recruitment policies in mathematics and science.

	RECOMMENDATIONS		
	Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P-12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	**Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P-12 students for success in higher education and the workplace.**	**Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.**
	STAKEHOLDER ROLES		
STATE GOVERNMENT CONTINUED	Provide incentives for recruitment policies and programs, including signing bonuses; differential pay; student loan forgiveness; housing subsidies, loans, and stipends; and relocation costs. Provide incentives to school districts to develop programs that introduce middle and secondary school students to professional mathematics and science education organizations and that engage them in activities to nurture interest in STEM fields, such as mentoring and tutoring.	Provide incentives for colleges and universities to create a broad range of preprofessional activities such as creating student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association; offering P–12 field experiences and internships; and sponsoring content-specific pedagogical institutes.	Invest in programs to strengthen the pedagogical skills of STEM professionals seeking to enter the teaching profession.
SCHOOL DISTRICTS	Develop plans to recruit new teachers and institute recruitment policies and programs, including signing bonuses; differential pay; student loan forgiveness; housing subsidies, loans, and stipends; and relocation costs. Establish programs that introduce middle and secondary school students to professional mathematics and science education organizations and that engage them in activities to nurture interest in STEM fields, such as mentoring and tutoring.	Collaborate with higher education to create a broad range of preprofessional activities, such as P–12 field experiences and internships and content-specific pedagogical institutes.	Develop/expand and evaluate alternative mathematics and science licensure programs that are based on relevant research and that are designed to attract STEM professionals. Create incentives to attract STEM professionals to enroll in alternative mathematics and science teacher licensure programs. Establish programs to strengthen the pedagogical skills of STEM professionals entering the teaching profession.

The Role of Stakeholders: **RECRUITMENT** (CONTINUED)

Strengthen teacher recruitment policies in mathematics and science.

RECOMMENDATIONS

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P-12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.

Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P-12 students for success in higher education and the workplace.

Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

STAKEHOLDER ROLES

HIGHER EDUCATION

Establish goals for increasing the number of graduates qualified to teach mathematics and science.

Provide scholarships, fellowships, and assistantships for recent college graduates with STEM degrees to support their matriculation in graduate programs that lead to a graduate degree in mathematics education or science education.

Develop undergraduate teacher education programs that allow students to earn a STEM degree and obtain licensure as a secondary school teacher.

Develop, evaluate, and disseminate teacher preparation programs that produce elementary school specialists and certified middle school mathematics and science teachers.

Revamp teacher preparation programs based on the programs' graduation and licensure rates, feedback from recent graduates in the field, and requirements to ensure alignment with P–12 mathematics and science content standards.

Assign a higher funding priority to schools of education and recognize and reward arts and science faculty who participate in mathematics and science teacher preparation programs.

Establish a statewide articulation agreement that allows prospective teachers to earn associate's degrees in teaching at local community colleges and then transfer smoothly to four-year institutions.

Create a broad range of preprofessional activities such as creating student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association; offering P–12 field experiences and internships; and sponsoring content-specific pedagogical institutes.

Conduct research to establish standards of effectiveness for alternative licensure programs for STEM professionals.

Develop/expand and evaluate alternative mathematics and science licensure programs that are based on relevant research and that are designed to attract STEM professionals.

Provide scholarships, fellowships, and assistantships for STEM professionals to support their matriculation in graduate programs that lead to a graduate degree in mathematics education or science education.

Establish programs to strengthen the pedagogical skills of STEM professionals entering the teaching profession.

Strengthen teacher recruitment policies in mathematics and science.

RECOMMENDATIONS

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P-12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P-12 students for success in higher education and the workplace.	Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.

STAKEHOLDER ROLES

BUSINESS AND FOUNDATIONS	Fund and support school-, district- and state-level recruitment programs at the middle, secondary, undergraduate, and graduate levels that promote mathematics and science teaching as an attractive profession. Conduct a sustained, professionally designed, multi-media, national campaign to encourage talented students and mathematics and science professionals to commit to a career in mathematics and science teaching. Sponsor programs that introduce middle and secondary school students to professional mathematics and science education organizations and that engage them in activities to nurture interest in STEM fields, such as mentoring and tutoring.	Sponsor both undergraduate teacher education programs at two- and four-year higher education institutions and graduate programs for those seeking a degree in mathematics education or science education. Endow teaching chairs in the departments of mathematics and the sciences to promote collaboration between the colleges of arts and sciences and the college of education. Sponsor student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association.	Support and evaluate existing alternative licensure programs for STEM professionals interested in becoming mathematics and science teachers. Sponsor a graduate program for STEM professionals interested in pursuing a graduate degree in mathematics education or science education. Promote efforts to create a national adjunct teacher corps that will prepare qualified STEM professionals currently working outside of teaching to teach in classrooms on a part-time basis, and provide incentives for employees to participate in the program.

The Role of Stakeholders: **RETENTION**

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

RECOMMENDATIONS	
Develop and implement research-based induction programs for all new mathematics and science teachers.	**Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.**
STAKEHOLDER ROLES	
FEDERAL GOVERNMENT	
Expand support for comprehensive, research-based induction programs. Offer incentives for the development and dissemination of programs to evaluate the effectiveness of comprehensive, research-based induction programs.	Expand summer professional experiences and employment programs for mathematics and science teachers at national laboratories and federal installations involved in STEM-related research and development. Provide incentives to higher education/state department of education partnerships to develop licensure programs for the position of vice principal for academic affairs, a school-level administrative leader who will work with teachers on curriculum, instructional practice, and professional development. Provide loan forgiveness, tax credits, and other financial incentives to mathematics and science teachers. Expand support to upgrade high school laboratory facilities and classroom technology and train teachers to incorporate new technology into their curriculum.
STATE GOVERNMENT	
Develop and disseminate tools to evaluate the effectiveness of comprehensive, research-based induction programs. Establish, evaluate, and report on comprehensive, research-based induction programs.	Establish career ladders for teachers that require increased responsibility, additional training, and appropriate evaluation at each step, while providing an increase in base salary with each career advancement. Establish licensure requirements for the position of vice principal for academic affairs and provide incentives to school districts to create the position in every district school. Work with districts to raise teachers' salaries to levels comparable to those of professions requiring the same level of mathematics and/or science content knowledge. Provide loan forgiveness, tax credits, and other financial incentives to mathematics and science teachers. Encourage districts to create learning communities for mathematics and science teachers.

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

RECOMMENDATIONS

Develop and implement research-based induction programs for all new mathematics and science teachers.

Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

STAKEHOLDER ROLES

SCHOOL DISTRICTS

Establish, evaluate, and report on district-wide, comprehensive, research-based induction programs.

Revamp mathematics and science teachers' compensation by raising starting salaries and offering differentiated pay to teachers for teaching in high-need or low-performing schools.

Establish district policies and programs that address school-based teacher retention issues such as out-of-field teaching assignments, lack of planning time, and inadequate and inappropriate curriculum materials and professional development.

Establish the position of vice principal for academic affairs in every school in the district to provide direct support to teachers.

Work with teachers to design, support, and evaluate school-based professional development programs that address aspects of teacher job dissatisfaction.

Establish learning communities for mathematics and science teachers.

HIGHER EDUCATION

Conduct research and disseminate findings on the effectiveness of comprehensive, research-based induction programs.

Establish, evaluate, and report on comprehensive, research-based induction programs.

Work with state government to develop coursework and curricula that satisfy licensure requirements for the position of vice principal for academic affairs.

Work with school districts and teachers to design, support, and evaluate school-based professional development programs that address aspects of teacher job dissatisfaction.

Provide content-based summer research experiences and other employment opportunities to veteran teachers in order to raise their overall compensation level to that of comparable mathematics and science professionals and to expose them to the broader scientific community.

The Role of Stakeholders: **RETENTION** (CONTINUED)

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

RECOMMENDATIONS	
Develop and implement research-based induction programs for all new mathematics and science teachers.	**Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.**
STAKEHOLDER ROLES	
BUSINESS AND FOUNDATIONS	
Sponsor and support comprehensive, research-based induction programs. Provide content-based summer programs and externships for new teachers that will provide them with practical experiences to broaden their perspective, a better understanding of skill requirements needed in the modern workplace, and connections to professional scientific communities.	Provide content-based summer externships and other employment opportunities to veteran teachers in order to raise their overall compensation level to that of comparable mathematics and science professionals and to expose them to the broader scientific community. Promote P–12 mathematics and science teaching as an attractive and respected profession with special honors and recognition, including monetary awards. Advocate nationally in support of competitive teacher salaries, and take a lead role in seeking solutions (and funding) for problems such as out-of-field teaching, poor administration support, inadequate induction programs, and inappropriate and ineffective professional development. Sponsor and support efforts to upgrade high school laboratory facilities and classroom technology and train teachers to incorporate new technology into their curriculum.

The Role of Stakeholders: **RENEWAL**

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

	RECOMMENDATIONS		
	Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.	**Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.**	**Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.**
	STAKEHOLDER ROLES		
FEDERAL GOVERNMENT	Expand research and dissemination of programs that focus on the teaching and learning of mathematics and science. Increase support for the development, implementation, and evaluation of research-based, comprehensive professional development programs. Provide incentives to businesses, universities, nonprofit organizations, and federal laboratories to develop and support content-based summer externships for P–12 mathematics and science teachers. Provide incentives such as scholarships, fellowships, and assistantships for practicing P–12 mathematics and science teachers to encourage them to pursue graduate degrees in mathematics, science, mathematics education, or science education.	Provide incentives to expand research on, and dissemination of, criteria for determining effective teaching. Offer states and school districts incentives to revamp their teacher license renewal programs to include student performance data that tracks teacher effectiveness over time.	Expand support to states for the initial development of high quality longitudinal data systems and for the expansion and strengthening of existing ones.

The Role of Stakeholders: **RENEWAL** (CONTINUED)

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

	RECOMMENDATIONS		
	Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.	**Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.**	**Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.**
	STAKEHOLDER ROLES		
STATE GOVERNMENT	Establish state policies that require school districts to employ research-based principles for effective design and implementation of professional development. Work with school districts to implement research-based, comprehensive professional development programs that promote teacher collaboration.	Revise state teacher license renewal requirements to include a measure of the teacher's impact on student achievement, classroom observations, reviews of student work, and parent evaluations. Establish licensure standards for teachers of middle school mathematics and science, and for the position of vice principal for academic affairs.	Develop and implement high quality, statewide, longitudinal data systems that track P–12 student performance, graduation rates, and teacher effectiveness; monitor schools of education graduation and licensure rates; and report teacher employment trends. Improve state data analysis and reporting.
SCHOOL DISTRICTS	Provide and evaluate research-based, comprehensive professional development programs that address identified needs of students based on student achievement data or by instructional improvement priorities identified by teachers.	Assess teacher effectiveness using classroom observations, reviews of student work, parent evaluations, and student performance data.	Ensure that all district data collection and reporting procedures are consistent with statewide longitudinal data systems.
HIGHER EDUCATION	Work with the state and school districts to develop research-based, comprehensive professional development programs that focus on grade-appropriate mathematics and science and include activities that demonstrate the real-world relevance of the mathematics and science being taught.	Collaborate with states and school districts on research to determine criteria for effective teaching. Work with the state, school districts, and business to identify the knowledge and skills that are required of mathematics and science teachers to prepare students to transition into higher education or the workforce.	Participate in the design and implementation of statewide, longitudinal data collection systems.

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

	RECOMMENDATIONS		
	Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.	**Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.**	**Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.**
	STAKEHOLDER ROLES		
HIGHER EDUCATION CONTINUED	Research and disseminate information on effective mathematics and science professional development programs. Provide research-based professional development for 2- and 4-year faculty who are participating in teacher preparation and professional development programs.	Develop/expand and evaluate courses for teachers seeking to meet the requirements for license renewal.	
BUSINESS AND FOUNDATIONS	Provide content-based professional experiences for veteran teachers that will provide them with practical experiences to broaden their perspective, a better understanding of skill requirements needed in the modern workplace, and connections to professional scientific communities. Sponsor a graduate program for practicing mathematics and science teachers seeking a master's degree or Ph.D. in mathematics, science, mathematics education, or science education.	Work with the state, school districts, and business to identify the knowledge and skills that are required of mathematics and science teachers to prepare students to transition into higher education or the workforce.	Champion public support for statewide collection, analysis, and reporting of data on educational progress. Share knowledge and expertise with state leaders on data systems and data-driven decision-making.

Promising Strategies

BHEF's recommendations for the transformation of teaching and learning in mathematics and science were informed by a strong body of relevant research and conversations with a wide range of experts. We have also been influenced by examples of existing practices, programs, and strategies that have been shown to contribute to improved teacher recruitment, retention, and renewal. This section of "An American Imperative" summarizes a select array of programmatic ideas that show promise as pathways to advancing goals closely related to those reflected in BHEF's recommendations. There are practicable lessons here for each of the five stakeholder groups.

Each example summarizes a particular strategy, including its goals, targeted audience, activities, and outcomes. The examples also include additional background information, such as an overview of the program's stakeholders.

Our list is not exhaustive, and we recognize that there many other examples not included. We also recognize that many of the programmatic ideas are in early phases of implementation, and have not yet been thoroughly tested and evaluated. Our intent is simply to document a representative sampling of programs that appear to be having a positive effect on the recruitment, retention, and renewal of highly qualified mathematics and science teachers, and in that way to provide ideas and practical suggestions for action.

Promising Strategies: **RECRUITMENT**

UTeach

How can we encourage more college students to become mathematics and science teachers? Educators in Texas have mapped out a way. In 1997, recognizing the dearth of qualified, inspiring mathematics and science teachers in the state, the University of Texas at Austin started a teacher preparation program called UTeach. The program seeks out strong mathematics and science majors and encourages them to pursue careers as teachers—and then prepares them for success in the classroom.

Targeting students from diverse backgrounds, UTeach provides coursework in instruction and content, combined with early field experiences guided by master teachers. Financial incentives help attract and retain students, as does ongoing support—even beyond graduation—in networking, self-assessment, and professional development. The goal is to see that students graduate with both an undergraduate STEM major and a teacher's license.

UTeach measures its success in two important ways. The first is numbers. In its first 10 years, UTeach has graduated 350 future teachers with STEM training, effectively doubling the number of mathematics teachers being licensed and producing as many as six times the number of science teachers. Nearly 90% of graduates either are teaching, planning to teach, or are looking for teaching positions. Of those who graduated in the program's first 4 years, 75% are still teaching.

Another measure of the program's success is the fact that other states have started or are considering programs based on the UTeach model, including a substantial effort in California. UTeach, for example, is the model for the recently announced National Math and Science Initiative, which has inaugural funding of $125 million from ExxonMobil. As one of its programs, the initiative will provide up to $2.4 million over 5 years to up to 10 institutions to replicate the UTeach program on their own campuses. In addition, Congress is pursuing federal legislation that endorses the key components of UTeach.

PROGRAM AT A GLANCE:
UTeach

GOAL: Increase the number and diversity of University of Texas at Austin STEM students entering pre-college mathematics and science teaching.

STRATEGY: Recruit University of Texas STEM undergraduate students into the mathematics and science teaching profession and license STEM degree-holders as teachers.

PARTICIPANTS: The University of Texas at Austin and the Austin Independent School District, with support from the state of Texas, the National Science Foundation, and some 50 individuals, corporations, and foundations.

INFORMATION:
http://uteach.utexas.edu/go/uteachweb/go/uteachweb/

Promising Strategies: **RECRUITMENT** (CONTINUED)

New York City Teaching Fellows

To find new teachers, especially for hard-to-fill slots, New York City maintains a very active Teaching Fellows program, into which it recruits adults from a wide range of fields and backgrounds who want to change their lives by fulfilling a call to teach. The majority of fellows enter the program with little or no teaching experience.

Once they pass an intensive, pre-service summer training program, which includes classroom field work, student achievement framework sessions focused on the practical aspects of teaching, and master's degree coursework, fellows then become classroom teachers. They are assigned a mentor and take part in staff development opportunities in their school community. Fellows also matriculate in a subsidized master's degree program that qualifies them for licensure in their subject area(s). Special immersion programs that lead to mathematics and science licensure are offered to fellows interested in teaching these subjects but who did not major in them.

Since its inception in 2000, 7,500 fellows have been placed in New York City's public schools; more than 600 of them in mathematics and science classrooms. One in 11 of the approximately 78,000 New York City teachers is a Teaching Fellow. In 2006, there were approximately 17,500 applications for the program, with admission being offered to about 3,500. Of the 3,500, about 2,000 accepted a Teaching Fellow position.

PROGRAM AT A GLANCE:

New York City Teaching Fellows

GOAL: Recruit highly qualified people to teach in high-need classrooms and in high-need subject areas, including mathematics and science.

STRATEGY: Recruit mid-career professionals, recent college graduates, and retirees into the teaching profession and provide them with alternative routes to licensure.

PARTICIPANTS: New York City Department of Education, City University of New York, and New York State Department of Education. Program is supported by a combination of city tax levy, state grant, and federal dollars, along with small grants from corporate sponsors.

INFORMATION:
http://www.nyctf.org/about/fellowship.html

Governor's Science and Mathematics Teacher Initiative of the Higher Education Compact of 2004

Leaders in California know that if the state is to remain competitive, its educational institutions need to help students obtain knowledge and skills for work in an economy that is increasingly based on science, engineering and mathematics. That is going to require strong teaching in those fields. Parallel efforts at the University of California (UC) and California State University (CSU) systems are designed to encourage students interested in science, mathematics or engineering to consider teaching as a career.

In a program called California Teach, campuses of the UC system offer a sequence of courses and experiences in which STEM majors can complete an undergraduate STEM degree and receive a preliminary single-subject teaching credential in 4 academic years. The program provides teaching candidates with mentor-supervised field experience in a P–12 classroom, a paid 1-year teaching internship upon graduation, loan forgiveness for graduates who teach mathematics or science for a specified period after graduation, and post-graduation summer activities such as pedagogy-focused institutes and internships in industry settings.

Meanwhile, CSU campuses are piloting a variety of recruitment programs under the system's Mathematics and Science Teacher Initiative. They are pursuing five core strategies: expanding and diversifying the pool of candidates; providing multiple entry points to teaching mathematics and science; delivering instruction to candidates via the Internet; collaborating with community colleges to ensure seamless program articulation as teaching candidates move between institutions; and providing financial support and incentives.

The results so far are promising. The UC program, now on nine campuses of the system, attracted 200 students in its first year. Now in its second year, the CSU program has recruited 730 students on 18 of its campuses.

PROGRAM AT A GLANCE:

Governor's Science and Mathematics Teacher Initiative of the Higher Education Compact of 2004

GOAL: Increase the total number of highly qualified mathematics and science secondary teachers graduated annually by California public universities and colleges from 1,000 to 2,500 by 2010.

STRATEGY: Recruit mathematics and science teaching candidates from several populations, including recent STEM graduates, mid-career changers, high school students, students currently enrolled in community colleges, and students currently enrolled in 4-year colleges. Develop teacher preparation programs, financial incentives, and post-certification activities tailored to each population.

PARTICIPANTS:
State of California, California State University System, University of California System, California Community Colleges, California's independent colleges and universities, P–12 schools, and over a dozen corporations.

INFORMATION:
http://www.calstate.edu/teachered/msti/overviewpg1.shtml

http://www.universityofcalifornia.edu/academics/1000teachers

Promising Strategies: **RECRUITMENT** (CONTINUED)

Teachers for a New Era (TNE)

Talking about the need for "radical change," several of the nation's leading foundations have banded together in an ambitious reform initiative. TNE focuses on teacher education; the program is designed to strengthen K–12 teaching by developing state-of-the-art programs at schools of education. TNE provides a select group of participating institutions with a grant of $5 million over 5 years, which must be matched by the institution.

The program is designed around three broad principles. First, a teacher education program should be guided by a respect for evidence, and by a culture of research, inquiry, and data analysis. Second, faculty across disciplines in the arts and sciences must be fully engaged in the education of prospective teachers. Third, education should be understood as an academically taught clinical practice profession, and include a formal 2-year residency for graduates as they transition into their teaching assignment.

Since the program launched in 2002, 11 institutions have been invited to participate. In 2005, an evaluation by the Rand Corporation found that TNE was likely to be successful in changing institutional culture, increasing awareness of the role of all faculty in preparing teachers, and making teacher education a priority for institutions of higher education (see the full evaluation at http://www.rand.org/pubs/monographs/2006/rand_mg506.sum.pdf). An external evaluation of the national impact of the initiative has begun with support from the Rockefeller Foundation.

PROGRAM AT A GLANCE:
Teachers for a New Era

GOAL: Stimulate construction of excellent teacher education programs at selected colleges and universities.

STRATEGY: Focus on radical change in allocation of resources, academic organization, criteria for evaluating participating faculty, internal accountability measures, and relationships with practicing schools.

PARTICIPANTS:
The Carnegie Corporation of New York, with the Annenberg Foundation, the Ford Foundation, the Rockefeller Foundation, the Nellie Mae Education Foundation, and the Academy for Educational Development.

INFORMATION:
http://www.teachersforanewera.org/

Promising Strategies: **RETENTION**

e-Mentoring for Student Success (eMSS)

Using technology to link new science teachers with experienced mentors and curricular materials, eMSS offers a complete teacher mentoring program that is primarily online. The program provides beginning science teachers with an online curriculum that focuses on science content and pedagogy that is directly applicable to the beginning teacher's classroom. It also offers help from veteran science teacher mentors who are from the novice's state and who teach the same discipline, plus access to other beginning teachers, veteran teachers, and scientists across the nation. Online services are supplemented by face-to-face meetings offered by the districts or contracting affiliate groups. The veteran science teachers, who receive a stipend for their work, attend a 3-week online summer institute for mentors and receive ongoing professional development online throughout the year.

Initiated in 2002 with 5 years of support from the National Science Foundation to mentor new science teachers in two states, eMSS currently is working with over 500 beginning teachers and 350 mentor teachers in 16 states. The program is available to large individual school districts, or to state/regional organizations that partner with school districts on teacher induction and professional development.

Now in its final year of NSF funding, eMSS is transitioning to a per-novice fee-based program that covers the cost of mentor training and stipends as well as the delivery of services to novices. A grant from the Goldman Sachs Foundation will extend eMSS to novice mathematics teachers.

PROGRAM AT A GLANCE:

e-Mentoring for Student Success

GOAL: Increase middle school and high school achievement in science by providing novice science teachers with mentoring via an online learning community.

STRATEGY: Develop and employ Internet-based network technology to provide content-specific and sustained mentoring of novice middle school and high school science teachers. Provide co-mentoring of novices, mentors, and university science and education faculty to improve student learning.

PARTICIPANTS: National Science Teachers Association, New Teacher Center at the University of California Santa Cruz, and Montana State University Bozeman Science/ Math Resource Center.

INFORMATION:
http://emss.nsta.org

Promising Strategies: **RETENTION** (CONTINUED)

National Commission on Teaching and America's Future (NCTAF)/ Georgia State University Induction Project

NCTAF has teamed up with educators in Georgia to provide carefully targeted and tailored support to beginning teachers serving in low-income and high-minority schools around Atlanta. The NCTAF/ Georgia State University Induction Project seeks to improve student achievement in four districts in the Atlanta metropolitan area by enhancing the quality of new teachers entering high-need schools, and by increasing the likelihood that they will stay in their teaching assignments and become skilled teachers.

This approach is designed around the Georgia Framework for Teaching, which defines the knowledge, skills, and other attributes of accomplished teaching and is used by faculty and mentor teachers to observe and support beginning teachers. Three resources that are aligned with the Framework are being developed and tested to determine their usefulness in supporting new teachers:

- Cross-Career Learning Communities provide face-to-face and online support and dialog for pre-service, new, and mentor teachers, as well as university faculty supervisors;
- Building Resources: Induction and Development for Georgia Educators is a peer-reviewed and interactive online resource and mentoring site for teachers; and
- Professional Growth Continuum and Checklist is an observation and self-assessment tool that provides a process for pre-service and beginning teachers to reflect on their knowledge and skills.

The program was first funded in 2005; implementation of its key components is still under way.

PROGRAM AT A GLANCE:

National Commission on Teaching and America's Future/ Georgia State University Induction Project

GOAL: Improve student achievement by enhancing the quality of new teachers entering high-need schools and by increasing the likelihood that they will stay in teaching.

STRATEGY: Provide support to beginning teachers serving in low-income and high-minority schools in four districts in the Atlanta metropolitan area.

PARTICIPANTS: Project partners are NCTAF, Georgia State University, the Board of Regents of the University System of Georgia, the Georgia Systemic Teacher Education Program, and four Atlanta-area school districts. Funded by the Wachovia Foundation.

INFORMATION:
http://nctaf.org/resources/demonstration_projects/

U.S. Department of Energy's Academies Creating Teacher Scientists (ACTS)

Based at the U.S. Department of Energy (DOE), ACTS seeks to create a cadre of mathematics and science teachers who have both highly developed content knowledge and scientific research experience, and who can serve as education leaders and agents of positive change in their local and regional teaching communities. The ACTS program (formerly known as Laboratory Science Teacher Professional Development) draws on the wealth of mentoring talent at the DOE laboratories to guide and enrich teachers' understanding of the scientific and technological world. Through ACTS, teachers will establish long-term relationships with mentor scientists and teaching colleagues—experts who will continue to support them when they have returned to their classrooms.

ACTS includes two programs. "Teachers as Research Associates" is designed for teachers seeking an independent research project with a mentor scientist. "Teachers as Investigators" is designed to update teachers' skills and knowledge of research methods, scientific instruments, laboratory technology and how scientists work and think.

Teachers spend 4 to 8 weeks at a participating National Lab for three consecutive summers; receive an $800/week stipend, travel and living expenses, and a mini-grant to purchase classroom supplies; participate in professional teacher-scientists' networks; have access to educational materials, laboratory equipment and National Lab research appropriate for classroom use; and receive support to share their experiences at professional conferences and in professional publications.

Since its establishment in 2004, 100 teachers in seven National Labs have participated in ACTS. Retention rate for the first cohort of teachers over the 3-year period of commitment was 98%. Pending congressional funding, ACTS plans to expand to all 18 National Laboratories, and support some 300 teachers overall.

PROGRAM AT A GLANCE:

U.S. Department of Energy's Academies Creating Teacher Scientists

GOAL: Create a cadre of outstanding mathematics and science teachers.

STRATEGY: Provide P–12 classroom teachers and community college faculty long-term, mentor-intensive professional development through scientific research/immersion opportunities at the National Laboratories.

PARTICIPANTS: Office of Science at the U.S. Department of Energy, and a network of U.S. Department of Energy laboratories.

INFORMATION:
http://www.scied.science.doe.gov/scied/lstpd/about.htm

Promising Strategies: **RETENTION** (CONTINUED)

Guilford County Schools (GCS) Mission Possible

A Greensboro, North Carolina teacher incentive program designed to attract and retain teachers for select schools and to reward teachers for outstanding results, *GCS Mission Possible* offers annual recruitment stipends, performance pay—and much more. The program is a comprehensive support program for teachers in selected schools focusing on high quality staff development and smaller class sizes. The program seeks to establish schools that are professional learning communities, with supportive leaders and collaborative work environments.

In its 3-year pilot phase, the initiative raised $4 million in public-private funding. In that initial phase, GCS was able to offer new teachers one step up on the salary scale, and provided hiring bonuses ($9,000–$10,000) for middle school and high school mathematics teachers with at least 24 semester hours of college mathematics coursework. Other aspects of the program include reduced class sizes; mentoring; project-specific staff development classes; measurement of academic growth of students of participating teachers; and annual salary incentives of up to $14,000 per year.

The program has tough standards: Mission Possible teachers with two consecutives years of negative value-added scores (on state-administered End of Grade or End of Course exams) will be transferred out of the program; Mission Possible principals whose schools do not make Adequate Yearly Progress for three consecutive years will be reassigned or removed.

As of January 2007, Mission Possible had been implemented in 22 Greensboro schools, and 320 educators had received bonuses through the project. A recent grant of $2 million from the U.S. Department of Education will make it possible to add seven more schools during the 2007–08 school year. Guilford County Schools plans to measure the success of the program in terms of teacher retention, teacher quality, and student achievement. If the program is ultimately judged to be successful, it will be expanded statewide.

PROGRAM AT A GLANCE:

Guilford County Schools Mission Possible

GOAL: Increase student academic performance in mathematics in schools that currently are not achieving Adequate Yearly Progress with respect to No Child Left Behind standards.

STRATEGY: Recruit and retain highly qualified mathematics teachers using a combination of mentoring, relevant professional development, differential pay, and performance incentives.

PARTICIPANTS:
GCS of North Carolina, the Weaver Foundation, 25 business members of Action Greensboro, University of North Carolina–Greensboro, and North Carolina A&T State University.

INFORMATION:
http://www.gcsnc.com/mission_possible/index.htm

Promising Strategies: **RENEWAL**

Industry Initiatives for Science and Math Education (IISME) Summer Fellowship Program

In the San Francisco Bay area, educators and industry practitioners have joined forces to transform teaching and learning *and* address the critical need for a highly skilled workforce in mathematics, science and technological fields. The IISME Summer Fellowship Program provides teachers with field experiences and tools they need to adapt their pedagogical practices and change education practices in their schools, all by way of helping students prepare to be lifelong learners, responsible citizens, and productive employees. The IISME industry-education partnership focuses on teachers as the primary agents for effecting meaningful change in mathematics and science education.

The IISME Summer Fellowship Program places San Francisco-area P–16 teachers in all subjects into high-performance work sites for the summer. Teachers complete a project for their sponsors and are paid $7,400 for their work. Teachers also spend time focusing on ways to transfer their summer experience back to their students and colleagues.

The program helps teachers understand the skills and knowledge their students will need in today's workplace. Teachers are placed in a variety of functional areas within a company, including manufacturing, information systems, training and human resources, engineering, programming, software development, finance and statistics, and sales and marketing. They develop plans to transfer their experience to their students and colleagues, are provided opportunities to develop inquiry-based lesson plans to be shared over the Web, and are invited to apply for innovation grants to implement creative ideas to enhance instruction.

Since its inception in 1985, 2,200 fellowships have been awarded to teachers from almost 500 schools in the Bay Area, impacting more than 1.3 million students. In 2006, 57 companies hosted close to 200 teachers. Studies show that IISME fellowships encourage teachers to remain in teaching at twice the rate of their peers and that they promote lasting relationships with their sponsor organization and a network of scientists.

PROGRAM AT A GLANCE:

Industry Initiatives for Science and Math Education Summer Fellowship Program

GOAL: Improve mathematics and science education.

STRATEGY: Seeks to transform teaching and learning through industry-education partnerships that provide teachers with industry- and research-based professional development opportunities.

PARTICIPANTS:
Established by a consortium of San Francisco-area companies in partnership with the Lawrence Hall of Science at the University of California, Berkeley. Programs supported by over 125 corporations, universities, government agencies, foundations, and individuals.

INFORMATION:
http://iisme.org/aboutiisme.cfm

Promising Strategies: **RENEWAL** (CONTINUED)

Project SOAR (Schools' Online Assessment Reports)

In Ohio, Project SOAR supports school districts that are committed to continuous school improvement to enhance teaching and learning. Project SOAR's centerpiece is a secure Web site that educators use to view district, grade, and student-level performance data.Value-added reports in science, social studies, reading, and mathematics provide districts with diagnostic information that can be used to improve teaching and learning practices. Districts are trained to use value-added information to reliably measure students' individual progress, identify at-risk students, and analyze various educational, instructional, and program practices' impact on student achievement.

Support from Project SOAR districts, Ohio's teachers' unions, education associations, educators, and business and community leaders led to legislation that instituted a value-added metric in Ohio's education accountability system in 2007–2008. All Ohio school districts will receive reading and mathematics value-added reports for their students in the 4th and 8th grades. Battelle for Kids and the Ohio Department of Education are leading a comprehensive training program to prepare districts to use and interpret value-added information.

PROGRAM AT A GLANCE:

Project SOAR (Schools' Online Assessment Reports)

GOAL: Provide Ohio school districts with information to assist their efforts in focusing instruction to improve performance and raise student achievement.

STRATEGY: Uses a longitudinal database of student performance data to develop and conduct research and professional development initiatives to improve student achievement.

PARTICIPANTS: Battelle for Kids, with more than 100 Ohio school districts representing more than 30% of Ohio's students in grades 3–8.

INFORMATION:
http://www.battelleforkids.org

Math for America (MfA) Newton Master Teacher Program

Based in New York City, MfA's Newton Master Teacher Program rewards exceptional high school mathematics teachers with a 4-year, $50,000 fellowship to support professional development and leadership opportunities. Master Teachers remain teaching in their schools; participate in monthly seminars focused on mathematics content knowledge and/or pedagogical issues; are partially funded to attend conferences or courses at chosen colleges and universities; and are required to continue teaching in NYC public schools for the duration of the 4-year program. A companion program, the Newton Fellowship Program, recruits and trains mathematically talented individuals to become high school mathematics teachers. Fellows receive a stipend of $90,000 over 5 years; obtain a full tuition scholarship to a master's level teacher preparation program; earn a state teacher license; are employed as a mathematics teacher by the city of New York; and are provided mentoring, coaching, support services, and professional development activities.

MfA's successful programs influenced the introduction of the Math Science Teaching Corps Act in Congress by Senator Charles Schumer (D-N.Y.) and Representative Jim Saxton (R-N.J.); the legislation promotes programs modeled on MfA's initiatives. Since MfA's establishment in 2004, 20 Master Teachers have been selected and 48 Newton Fellows have been placed in New York City public schools. An additional 39 Newton Fellows are receiving master's training and are due to enter the classroom in 2007. MfA recently doubled its financial commitment to $50 million, guaranteeing that 440 highly qualified mathematics teachers will be in New York City public schools before 2011.

PROGRAM AT A GLANCE:

Math for America Newton Master Teacher Program

GOAL: Improve the quality of mathematics education in our country's public schools.

STRATEGY: Provide professional development opportunities to practicing New York City high school mathematics teachers with the intention of developing a replicable model that would be federally financed and implemented nationwide.

PARTICIPANTS: MfA, with support from the Simons Foundation, New York University, Teachers College at Columbia University, Bard College, New York City Department of Education, and over 100 corporations, foundations, and individuals associated with MfA.

INFORMATION:
http://www.mathforamerica.org

Promising Strategies: **RENEWAL** (CONTINUED)

Data Quality Campaign (DQC)

DQC is a national, collaborative effort to encourage and support state policymakers to improve the collection, availability, and use of high quality education data, and implement state longitudinal data systems to improve student achievement.

The program defined 10 essential elements of a longitudinal state data system that aligns P–12 and postsecondary data. Site visits are used to document and report lessons learned as states design and build student-level data systems. DQC also conducts an annual survey to determine states' progress in adopting the 10 essential data system elements and assesses the ability of each state's data system to answer priority questions of policymakers and educators.

DQC found that no state had built a data system with all 10 essential elements by 2005, but that five states (Florida, Georgia, Louisiana, Texas, and Utah) had incorporated nine elements, and that five elements are in place in more than half the states. The data systems in 23 states are capable of determining which schools produce the strongest student academic growth; 17 systems provide data that meets the standard for computing graduation rates as specified in the National Governors Association's Graduation Counts Compact. (See http://www.nga.org/files/pdf/0507gradcompact.pdf.)

PROGRAM AT A GLANCE:
Data Quality Campaign

GOAL: Establish longitudinal education data systems in all 50 states by 2009; increase policymaker and educator understanding of how to use longitudinal data to improve student achievement; and promote data standards and efficient data transfer and exchange.

STRATEGY: Improve the collection, availability and use of high quality education data and implement state longitudinal data systems to improve student achievement.

PARTICIPANTS: National Center for Educational Accountability, with the Bill & Melinda Gates Foundation; the Broad Foundation; 14 managing partner organizations that oversee the goals, direction, and activities of the DQC; and 18 endorsing partner organizations that promote coordination and consensus focused on improving data quality, access, and use.

INFORMATION:
http://www.dataqualitycampaign.org

New Mexico 3-Tiered Licensure System

High quality education in New Mexico depends on attracting and keeping excellent teachers. The state's 3-Tiered Licensure System is designed to ensure teacher quality through accountability and support. The system links licensure levels and salaries to the work teachers accomplish in the classroom, and it encourages and supports ongoing professional development in nine competency levels established by the state. The system applies to teachers in all public schools (including charter schools), who must meet the nine competencies to renew their license renewal and achieve career advancement.

The system also establishes statewide minimum salaries for each tier (Provisional, $30,000; Professional, $40,000; Master, $50,000); all levels require an annual professional development plan and an assessment of professional growth. The state grants a provisional teaching license for graduates of Bachelor of Arts programs who pass state licensure tests. Conditions for a Professional-level license include a master's degree (or National Board certification) and evidence of growth in student performance. A Professional license is renewed every 9 years. Application for a Master Teacher license is optional.

By the end of 2005, the program's first year, 1,085 Provisional teachers had completed annual evaluations (4% were alternatively trained), with a 90% pass rate. Teachers on waivers in high-poverty districts dropped from 16% in 2001 to 4% in 2005. The system is tracking the success rates of novice teachers from nine New Mexico universities that produce 76% of the new hires. A 2005 report from the U.S. Secretary of Education pointed to New Mexico as an example of a state working to improve teacher standards. New Mexico's teacher-quality rating rose from C- to B in 2006, according to a *Quality Counts* survey. As of 2006, 9,500 teachers had advanced to the Professional or Master level.

PROGRAM AT A GLANCE:

New Mexico 3-Tiered Licensure System

GOAL: Recruit and retain excellent teachers.

STRATEGY: Establish a progressive career system in which teachers demonstrate increased competencies and undertake increased duties as they pass through the licensure levels of Provisional Teacher, Professional Teacher, and Master Teacher.

PARTICIPANTS: New Mexico Public Education Department, and the Office of Education Accountability of the New Mexico Department of Finance and Administration.

INFORMATION:
http://www.teachnm.org/overview.html

A Time for Action

"An American Imperative" presents a comprehensive plan for transforming the recruitment, retention, and renewal of America's mathematics and science teacher workforce. It addresses a complex set of issues and speaks to a wide range of relevant audiences. At the same time, its recommendations are strategically targeted to have practical value—and maximum impact—in the field. If these recommendations are to have real and lasting impact, however, we must ensure that stakeholders have a plan of action to fund, implement, test, improve, and sustain the proposed set of reforms.

The effectiveness of our recommendations hinges in large part on action taken by a cohort of five key stakeholder groups—federal government, state governments, school districts, higher education, and business and foundations. If we are to truly transform teaching and learning in mathematics and science, all the key stakeholders need to be actively engaged as advocates for the cause and as agents of change. In particular, though, BHEF calls on leaders in the business community and higher education to motivate, energize, and drive this important work.

We look for strong leadership from these two quarters for a number of reasons. Business leaders are uniquely and powerfully positioned to advance broad and systemic change by virtue of their established relationships with decision makers and policy shapers. They have the ear of influential leaders, and their perspectives command respect. They should provide necessary funds to make change happen, and can influence others to also contribute. It is vitally important, however, that education projects funded by corporations and foundations align and are integrated with ongoing systemwide efforts of states and school districts to improve mathematics and science education. Business should also provide a bridge between mathematics and science practitioners in the classroom and STEM professionals in the field—a partnership that can broaden the perspectives of the former group while drawing meaningfully on the experience of the latter. Overall, the business community can draw on a toolbox of resources—people, dollars, expertise, infrastructure—that help support and drive the kind of change we need.

BHEF calls on leaders in the business community and higher education to motivate, energize, and drive this important work.

Higher education must also play a central leadership role in the changes we have outlined here. The leaders of colleges and universities hold positions that enable them to be strong advocates for reform of teaching and learning in mathematics and science. As role models, individual representatives from higher education, from the faculty to a president or chancellor, can guide young people to consider and pursue careers in STEM fields, including careers in teaching. Colleges and universities must assess how well their teacher education programs are preparing future mathematics and science teachers and make bold changes to strengthen these programs. In addition, higher education must play a key role in reinvigorating mathematics and science

teachers throughout the development and delivery of professional development programming. Higher education also stands to provide strong leadership through research in expanding the knowledge base in mathematics and science curriculum, instructional methods, and effective student learning.

Our recommendations suggest a number of courses of action. Each is important, of course, but their broad scope raises a pertinent question: Where do we start?

By design, we have structured our recommendations in ways that clearly point to intersections where different clusters of stakeholders can find common ground for collaboration. The success of our recommendations will be directly linked to the degree to which they align and integrate with the programs and policies of the stakeholders. A synchronized response at both the national and local levels is imperative.

Specifically, we suggest that the transformation we have targeted in this paper start with four coordinated components:

- Establish a national consortium among key stakeholders that would elevate the status of the teaching profession and promote teacher recruitment, retention, and renewal. The consortium would share information and coordinate activities, launch a national public information campaign to raise awareness about the critical need for teachers and opportunities for career growth, and champion promising initiatives.
- Advocate for new and expanded federal policies that address teacher recruitment, retention, and renewal, including key provisions in the Higher Education Act, the No Child Left Behind Act, and National Science Foundation appropriations.
- Encourage each state to conduct a thorough and detailed assessment of teacher recruitment, retention, and renewal to guide state policy. States should project short- and long-term demand for highly qualified mathematics and science teachers and closely analyze teacher retention.
- Participate in and expand state and regional P–16 education councils to include a stronger focus on teacher recruitment, retention, and renewal and on coordinating reform efforts among stakeholders.

Let us examine the opportunities in each of these areas.

NATIONAL CONSORTIUM. We believe it is time to create a national consortium that would serve a vitally important role as an advocate and clearinghouse in the effort to reform teacher recruitment, retention, and renewal. The consortium should serve as a resource bank, collecting and disseminating strategies designed to strengthen teacher recruitment, retention, and renewal programs. It should also establish pilot partnerships with schools of education, school districts, and organizations to revamp existing teacher preparation programs and develop new models in partnership with STEM departments and faculty. At the same time, the consortium would encourage higher education, corporations, and foundations to invest in teacher professional development activities that have been shown to contribute to increased teacher effectiveness. It would promote research-based induction programs, research assistantships, and externships sponsored by corporations and universities. It would also foster collaboration by business, P–12, and higher education experts in the development, implementation, and training of teachers in data-driven assessment and improvement efforts.

A synchronized response at both the national and local levels is imperative.

We also envision that the consortium would invite key stakeholder organizations to join in a collaborative national public information campaign to promote mathematics and science teaching as an attractive profession and encourage talented students and STEM professionals to pursue careers in these crucial fields.

FEDERAL POLICY. In regard to federal policy, it is important to note that during the 110th Congress of 2007–2008, three critically important pieces of legislation relating to teaching are slated to be reauthorized: the Higher Education Act, the No Child Left Behind Act, and the National Science Foundation. Each of these laws contains programs and provisions that directly impact the recruitment, retention, and renewal of highly qualified mathematics and science teachers. The timing for these reauthorizations presents opportunities to augment these existing laws with ideas articulated throughout this paper.

In order for this to be achieved, business and higher education must convey to Congress and the Administration that a concerted effort is needed to recruit, retain, and renew a highly qualified mathematics and science teaching workforce for our nation. It is essential for corporations and colleges and universities to engage their own Congressional representatives, as well as leadership in both the Senate and House, through personal visits with members and their staff, congressional briefings, and testimony at hearings.

It is also imperative for these groups to communicate and collaborate with P–12 organizations and other groups that will inevitably articulate and pursue similar priorities. Furthermore, advocacy must expand beyond the authorization of programs to include annual appropriations or funding to ensure that successful programs receive sufficient and sustainable funds.

STATE POLICY. Each state should undertake a thorough and detailed self-assessment of its capacity to recruit, retain, and renew a high quality mathematics and science teaching workforce. States should project short- and long-term demand for highly qualified mathematics and science teachers in order to understand how best to meet their current and future needs in this area. This assessment should also examine existing recruitment, retention, and renewal policies and strategies, trends in graduation from teacher preparation programs, and entrance into the teaching profession through alternative routes to certification. The state assessments should closely analyze teacher retention, particularly to determine how many teachers leave the profession within their first 5 years—and why. Additionally, it is important to understand the extent to which mathematics and science teachers are fully qualified to teach their assigned subject area.

Each state should undertake a thorough and detailed self-assessment of its capacity to recruit, retain, and renew a high quality mathematics and science teaching workforce.

California offers one promising model of such an assessment. In March 2007, the California Council on Science and Technology and the Center for the Future of Teaching and Learning issued findings from a critical path analysis that mapped and analyzed existing state strategies to recruit, retain, and renew mathematics and science teachers.[85] The findings revealed that "California's system of science and mathematics teacher development…is not meeting the current or future needs of the state," and that "California lacks a coherent system to consistently produce fully prepared teachers, particularly science and mathematics teachers." Accordingly, the authors issued a well-conceived and detailed set of recommendations tasking various stakeholders to assist with meeting this current and anticipated shortfall. BHEF challenges corporate and academic communities in other states to work with their governors and other leaders to perform a similar assessment of their own state's teacher workforce policies and capacity.

P–16 COUNCILS. Finally, we believe that business and higher education leaders should advocate for and participate in the establishment or expansion of state and regional coordinating councils that include a focus on improving systemic coordination of teacher education reform and recruitment efforts. In the 2005 report "A Commitment to America's Future," BHEF championed establishing or strengthening existing state infrastructures, called "P–16 Councils."[86] Our enthusiasm for this concept is even stronger today. Such councils guide the implementation of policies and programs by coordinating reform efforts among stakeholders across the key components of a state's education system as well as across the different sectors of the education system. As such, P–16 Councils are an extremely valuable tool for executing the overarching recommendations of this report, including the completion of a statewide assessment of teacher workforce needs as mentioned above.

Currently, 30 states are engaged through P–16 Councils in broad-based collaborations of educators, policymakers, and business leaders that seek coordinated and comprehensive solutions to problems that cut across the various educational systems. Issues of teacher quality and quantity headline the goals of almost all of these P–16 Councils. However, many of these collaborations have never proceeded past the planning stages. Others are limited in scope or are merely symbolic, lacking authority to implement change.[87] BHEF urges business and higher education leaders to work collaboratively with the governors of their states to provide leadership in either formalizing or strengthening the authority and charge of these councils.

Conclusion

This report is predicated on the principle that science, technology, engineering, and mathematics are cornerstone disciplines, fundamental to our ability to develop the skill sets and knowledge that will keep the United States intellectually vibrant and economically competitive. It is a *national imperative*, therefore, that we invest in programs and human capital that will strengthen capacity in the United States across the STEM fields. In large part, that investment starts in the pre-college classroom.

We have an opportunity today to take bold steps to ensure that we recruit, retain, and renew an exceptional P–12 teaching workforce in mathematics and science. Working together, we can help teachers develop the skills and confidence they need to inspire a new generation of students—students who will embrace the power of mathematics and science and have the skills they need to attain consistently high levels of academic achievement in these fields. In these ways, we will help build a workforce and a citizenry fully capable of meeting the challenges of the 21st Century. This effort is vital to the continued success of our nation.

This report has documented the issues, and presents an abundance of solutions. Now it is time for the stakeholders to turn these recommendations into reality. We must move quickly to capitalize on the opportunities we have, and to fulfill the imperative of this vitally important challenge. The time for action is *now*.

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Stakeholder Roles for the Recruitment, Retention and Renewal of Mathematics and Science Teachers

FEDERAL GOVERNMENT

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P-12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P-12 students for success in higher education and the workplace.	Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.
ROLES FOR FEDERAL GOVERNMENT		
Provide scholarships, research fellowships, teaching assistantships, and awards to attract promising candidates—middle school students through graduate students—into the mathematics and science teaching profession. Provide incentives for recruitment policies and programs, including signing bonuses; differential pay; student loan forgiveness; housing subsidies, loans, and stipends; and relocation costs.	Provide incentives for the development, evaluation, and dissemination of mathematics and science teacher preparation programs. Encourage colleges and universities to align teacher preparation programs with P–12 mathematics and science content standards. Provide incentives for colleges and universities to create a broad range of pre-professional activities, such as creating student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association; offering P–12 field experiences and internships; and sponsoring content-specific pedagogical institutes.	Fund research on standards of effectiveness for alternative mathematics and science licensure programs. Provide incentives to states, school districts, and institutions of higher education for the development, implementation, and evaluation of alternative, research-based mathematics and science teacher licensure programs. Provide incentives, such as tuition assistance and loan forgiveness, to attract STEM professionals currently working outside education to enroll in alternative mathematics and science teacher licensure programs. Establish a national adjunct teacher corps that will prepare qualified STEM professionals to work in classrooms.

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

Develop and implement research-based induction programs for all new mathematics and science teachers.	Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.
ROLES FOR FEDERAL GOVERNMENT	
Expand support for comprehensive, research-based induction programs. Offer incentives for the development and dissemination of programs to evaluate the effectiveness of comprehensive, research-based induction programs.	Expand summer professional experiences and employment programs for mathematics and science teachers at national laboratories and federal installations involved in STEM-related research and development. Provide incentives to higher education/state department of education partnerships to develop licensure programs for the position of vice principal for academic affairs, a school-level administrative leader who will work with teachers on curriculum, instructional practice, and professional development. Provide loan forgiveness, tax credits, and other financial incentives to mathematics and science teachers. Expand support to upgrade high school laboratory facilities and classroom technology and train teachers to incorporate new technology into their curriculum.

FEDERAL GOVERNMENT

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.	Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.	Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.
ROLES FOR FEDERAL GOVERNMENT		
Expand research and dissemination of programs that focus on the teaching and learning of mathematics and science. Increase support for the development, implementation, and evaluation of research-based, comprehensive professional development programs. Provide incentives to businesses, universities, nonprofit organizations, and federal laboratories to develop and support content-based summer externships for P–12 mathematics and science teachers. Provide incentives such as scholarships, fellowships, and assistantships for practicing P–12 mathematics and science teachers to encourage them to pursue graduate degrees in mathematics, science, mathematics education, or science education.	Provide incentives to expand research on, and dissemination of, criteria for determining effective teaching. Offer states and school districts incentives to revamp their teacher license renewal programs to include student performance data that tracks teacher effectiveness over time.	Expand support to states for the initial development of high quality longitudinal data systems and for the expansion and strengthening of existing ones.

Stakeholder Roles for the Recruitment, Retention and Renewal of Mathematics and Science Teachers

STATE GOVERNMENT

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.	Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.
ROLES FOR STATE GOVERNMENT		
Develop a statewide plan that includes policies, programs, and practices to increase the quality and quantity of P–12 mathematics and science teachers. Provide scholarships, research fellowships, teaching assistantships, and awards to attract promising candidates—middle school students through graduate students—into the mathematics and science teaching profession. Provide incentives for recruitment policies and programs, including signing bonuses; differential pay; student loan forgiveness; housing subsidies, loans, and stipends; and relocation costs. Provide incentives to school districts to develop programs that introduce middle and secondary school students to professional mathematics and science education organizations and that engage them in activities to nurture interest in STEM fields, such as mentoring and tutoring.	Encourage colleges and universities to align teacher preparation programs with P–12 mathematics and science content standards. Provide incentives for colleges and universities to create a broad range of preprofessional activities such as creating affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association; offering P–12 field experiences and internships; and sponsoring content-specific pedagogical institutes.	Develop/expand and evaluate alternative mathematics and science licensure programs that are based on relevant research and that are designed to attract STEM professionals. Provide incentives to attract STEM professionals currently working outside education to enroll in alternative mathematics and science teacher licensure programs. Invest in programs to strengthen the pedagogical skills of STEM professionals seeking to enter the teaching profession.

STATE GOVERNMENT

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

Develop and implement research-based induction programs for all new mathematics and science teachers.	Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.
ROLES FOR STATE GOVERNMENT	
Develop and disseminate tools to evaluate the effectiveness of comprehensive, research-based induction programs. Establish, evaluate, and report on comprehensive, research-based induction programs.	Establish career ladders for teachers that require increased responsibility, additional training, and appropriate evaluation at each step, while providing an increase in base salary with each career advancement. Establish licensure requirements for the position of vice principal for academic affairs and provide incentives to school districts to create the position in every district school. Work with districts to raise teachers' salaries to levels comparable to those of professions requiring the same level of mathematics and/or science content knowledge. Encourage districts to create learning communities for mathematics and science teachers.

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.	Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.	Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.
ROLES FOR STATE GOVERNMENT		
Establish state policies that require school districts to employ research-based principles for effective design and implementation of professional development. Work with school districts to implement research-based, comprehensive professional development programs that promote teacher collaboration.	Revise state teacher license renewal requirements to include a measure of the teacher's impact on student achievement, classroom observations, reviews of student work, and parent evaluations. Establish licensure standards for teachers of middle school mathematics and science, and for the position of vice principal for academic affairs.	Develop and implement high quality, statewide, longitudinal data systems that track P–12 student performance, graduation rates, and teacher effectiveness; monitor schools of education graduation and licensure rates; and report teacher employment trends. Improve state data analysis and reporting.

Stakeholder Roles for the Recruitment, Retention and Renewal of Mathematics and Science Teachers

SCHOOL DISTRICTS

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	**Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.**	**Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.**
ROLES FOR SCHOOL DISTRICTS		
Develop plans to recruit new teachers and institute recruitment policies and programs, including signing bonuses; differential pay; student loan forgiveness; housing subsidies, loans, and stipends; and relocation costs. Establish programs that introduce middle and secondary school students to professional mathematics and science education organizations and that engage them in activities to nurture interest in STEM fields, such as mentoring and tutoring.	Collaborate with higher education to create a broad range of preprofessional activities, such as P–12 field experiences and internships and content-specific pedagogical institutes.	Develop/expand and evaluate alternative mathematics and science licensure programs that are based on relevant research and that are designed to attract STEM professionals. Create incentives to attract STEM professionals to enroll in alternative mathematics and science teacher licensure programs. Establish programs to strengthen the pedagogical skills of STEM professionals entering the teaching profession.

SCHOOL DISTRICTS

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

Develop and implement research-based induction programs for all new mathematics and science teachers.

Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

ROLES FOR SCHOOL DISTRICTS

Establish, evaluate, and report on district-wide, comprehensive, research-based induction programs.

Revamp mathematics and science teachers' compensation by raising starting salaries and offering differentiated pay to teachers for teaching in high-need or low-performing schools.

Establish district policies and programs that address school-based teacher retention issues such as out-of-field teaching assignments, lack of planning time, and inadequate and inappropriate curriculum materials and professional development.

Establish the position of vice principal for academic affairs in every school in the district to provide direct support to teachers.

Work with teachers to design, support, and evaluate school-based professional development programs that address aspects of teacher job dissatisfaction.

Establish learning communities for mathematics and science teachers.

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.

Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.

Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.

ROLES FOR SCHOOL DISTRICTS

Provide and evaluate research-based, comprehensive professional development programs that address identified needs of students based on student achievement data or by instructional improvement priorities identified by teachers.

Assess teacher effectiveness using classroom observations, reviews of student work, parent evaluations, and student performance data.

Ensure that all district data collection and reporting procedures are consistent with statewide longitudinal data systems.

Stakeholder Roles for the Recruitment, Retention and Renewal of Mathematics and Science Teachers

HIGHER EDUCATION

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.	Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.
ROLES FOR HIGHER EDUCATION		
Establish goals for increasing the number of graduates qualified to teach mathematics and science. Provide scholarships, fellowships, and assistantships for recent college graduates with STEM degrees to support their matriculation in graduate programs that lead to a graduate degree in mathematics education or science education.	Develop undergraduate teacher education programs that allow students to earn a STEM degree and obtain licensure as a secondary school teacher. Develop, evaluate, and disseminate teacher preparation programs that produce elementary school specialists and certified middle school mathematics and science teachers. Revamp teacher preparation programs based on the programs' graduation and licensure rates, feedback from recent graduates in the field, and requirements to ensure alignment with P–12 mathematics and science content standards. Assign a higher funding priority to schools of education and recognize and reward arts and science faculty who participate in mathematics and science teacher preparation programs. Establish a statewide articulation agreement that allows prospective teachers to earn associate's degrees in teaching at local community colleges and then transfer smoothly to four-year institutions. Create a broad range of preprofessional activities such as creating student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association; offering P–12 field experiences and internships; and sponsoring content-specific pedagogical institutes.	Conduct research to establish standards of effectiveness for alternative licensure programs for STEM professionals. Develop/expand and evaluate alternative mathematics and science licensure programs that are based on relevant research and that are designed to attract STEM professionals. Provide scholarships, fellowships, and assistantships for STEM professionals to support their matriculation in graduate programs that lead to a graduate degree in mathematics education or science education. Establish programs to strengthen the pedagogical skills of STEM professionals entering the teaching profession.

HIGHER EDUCATION

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

Develop and implement research-based induction programs for all new mathematics and science teachers.

Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

ROLES FOR HIGHER EDUCATION

Conduct research and disseminate findings on the effectiveness of comprehensive, research-based induction programs.

Establish, evaluate, and report on comprehensive, research-based induction programs.

Work with state government to develop coursework and curricula that satisfy licensure requirements for the position of vice principal for academic affairs.

Work with school districts and teachers to design, support, and evaluate school-based professional development programs that address aspects of teacher job dissatisfaction.

Provide content-based summer research experiences and other employment opportunities to veteran teachers in order to raise their overall compensation level to that of comparable mathematics and science professionals and to expose them to the broader scientific community.

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.

Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.

Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.

ROLES FOR HIGHER EDUCATION

Work with the state and school districts to develop research-based, comprehensive professional development programs that focus on grade-appropriate mathematics and science and include activities that demonstrate the real-world relevance of the mathematics and science being taught.

Research and disseminate information on effective mathematics and science professional development programs.

Provide research-based professional development for two- and four-year faculty who are participating in teacher preparation and professional development programs.

Collaborate with states and school districts on research to determine criteria for effective teaching.

Work with the state, school districts, and business to identify the knowledge and skills that are required of mathematics and science teachers to prepare students to transition into higher education or the workforce.

Develop/expand and evaluate courses for teachers seeking to meet the requirements for license renewal.

Participate in the design and implementation of statewide, longitudinal data collection systems.

Stakeholder Roles for the Recruitment, Retention and Renewal of Mathematics and Science Teachers

BUSINESS AND FOUNDATIONS

RECRUITMENT

Strengthen teacher recruitment policies in mathematics and science.

Implement a comprehensive package of mathematics and science teacher education recruitment strategies, starting in P–12 and extending through graduate school, that include incentives such as scholarships, signing bonuses, and differential pay.	Strengthen the content and pedagogy of teacher preparation programs to ensure a national mathematics and science teacher workforce capable of preparing P–12 students for success in higher education and the workplace.	Expand strategies to attract talented individuals in STEM-related professions to teaching, and ensure that they are adequately trained for the classroom.
ROLES FOR BUSINESS AND FOUNDATIONS		
Fund and support school-, district-, and state-level recruitment programs at the middle, secondary, undergraduate, and graduate levels that promote mathematics and science teaching as an attractive profession. Conduct a sustained, professionally designed, multi-media, national campaign to encourage talented students and mathematics and science professionals to commit to a career in mathematics and science teaching. Sponsor programs that introduce middle and secondary school students to professional mathematics and science education organizations and that engage them in activities to nurture interest in STEM fields, such as mentoring and tutoring.	Sponsor both undergraduate teacher education programs at two- and four-year higher education institutions and graduate programs for those seeking a degree in mathematics education or science education. Endow teaching chairs in the departments of mathematics and the sciences to promote collaboration between the colleges of arts and sciences and the college of education. Sponsor student affiliate groups of the National Council of Teachers of Mathematics and the National Science Teachers Association.	Support and evaluate existing alternative licensure programs for STEM professionals interested in becoming mathematics and science teachers. Sponsor a graduate program for STEM professionals interested in pursuing a graduate degree in mathematics education or science education. Promote efforts to create a national adjunct teacher corps that will prepare qualified STEM professionals currently working outside of teaching to teach in classrooms on a part-time basis, and provide incentives for employees to participate in the program.

BUSINESS AND FOUNDATIONS

RETENTION

Improve the retention of both new and experienced teachers, and address the causes of teacher dissatisfaction.

Develop and implement research-based induction programs for all new mathematics and science teachers.

Implement comprehensive policies and programs that address the leading causes of teacher job dissatisfaction, including inadequate compensation, lack of administration support, and professional isolation.

ROLES FOR BUSINESS AND FOUNDATIONS

Sponsor and support comprehensive, research-based induction programs.

Provide content-based summer programs and externships for new teachers that will provide them with practical experiences to broaden their perspective, a better understanding of skill requirements needed in the modern workplace, and connections to professional scientific communities.

Provide content-based summer externships and other employment opportunities to veteran teachers in order to raise their overall compensation level to that of comparable mathematics and science professionals and to expose them to the broader scientific community.

Promote P–12 mathematics and science teaching as an attractive and respected profession with special honors and recognition, including monetary awards.

Advocate nationally in support of competitive teacher salaries, and take a lead role in seeking solutions (and funding) for problems such as out-of-field teaching, poor administration support, inadequate induction programs, and inappropriate and ineffective professional development.

Sponsor and support efforts to upgrade high school laboratory facilities and classroom technology and train teachers to incorporate new technology into their curriculum.

RENEWAL

Ensure that all mathematics and science teachers participate in renewal activities that support their effectiveness in the classroom.

Provide ongoing, research-based professional development programs, focused on both content and pedagogy, for all mathematics and science teachers.

Revamp teacher license renewal programs to incorporate measures of teacher effectiveness.

Establish comprehensive statewide data collection systems that track student progress, teacher effectiveness, and employment trends of mathematics and science teachers.

ROLES FOR BUSINESS AND FOUNDATIONS

Provide content-based professional experiences for veteran teachers that will provide them with practical experiences to broaden their perspective, a better understanding of skill requirements needed in the modern workplace, and connections to professional scientific communities.

Sponsor a graduate program for practicing mathematics and science teachers seeking a master's degree or Ph.D. in mathematics, science, mathematics education, or science education.

Work with the state, school districts, and business to identify the knowledge and skills that are required of mathematics and science teachers to prepare students to transition into higher education or the workforce.

Champion public support for statewide collection, analysis, and reporting of data on educational progress.

Share knowledge and expertise with state leaders on data systems and data-driven decision-making.

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