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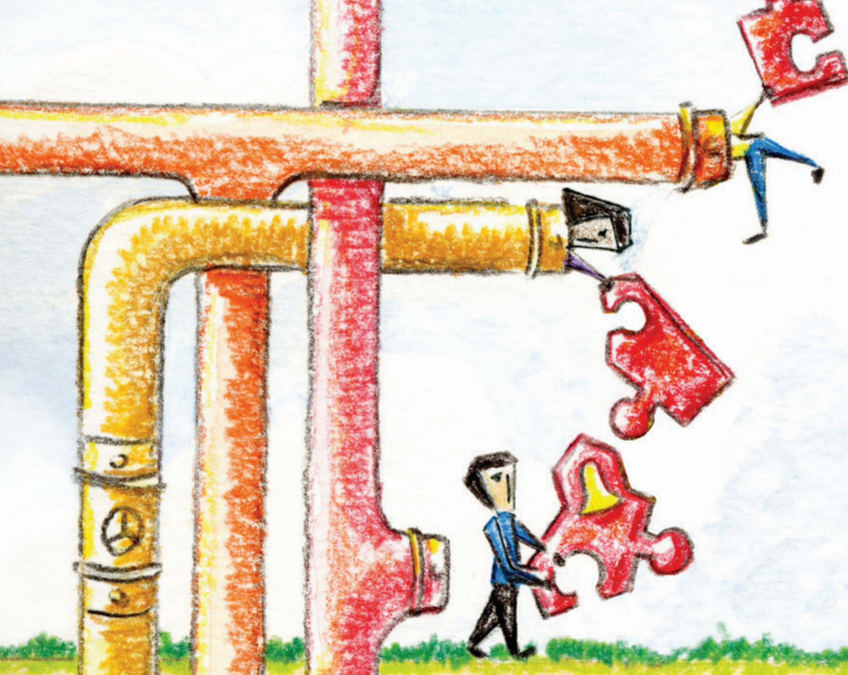
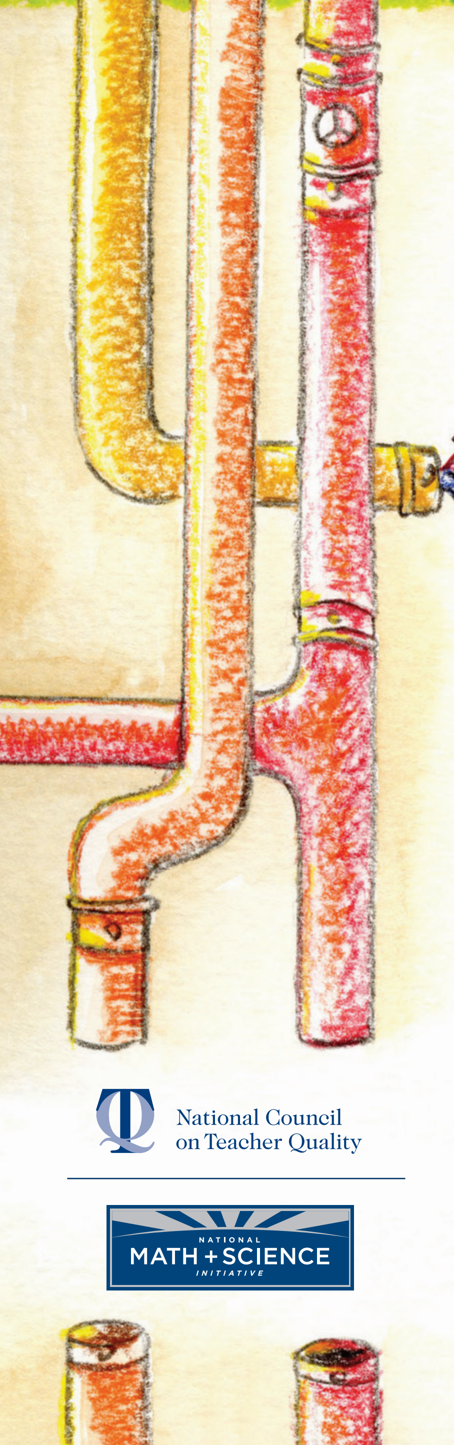


Tackling the STEM crisis:

Five steps your state can take to improve the quality and quantity of its K–12 math and science teachers

State laws and regulations can either help or hinder the ability of school districts to hire effective teachers for STEM (science, technology, engineering and mathematics) subjects. State officials wanting to tackle this critical problem need to begin with a thorough review of relevant policies, asking themselves two questions:

"Are we part of the problem?"
"How do we become part of the solution?"



STEP 1. Raise standards for what it takes to get into an education school.

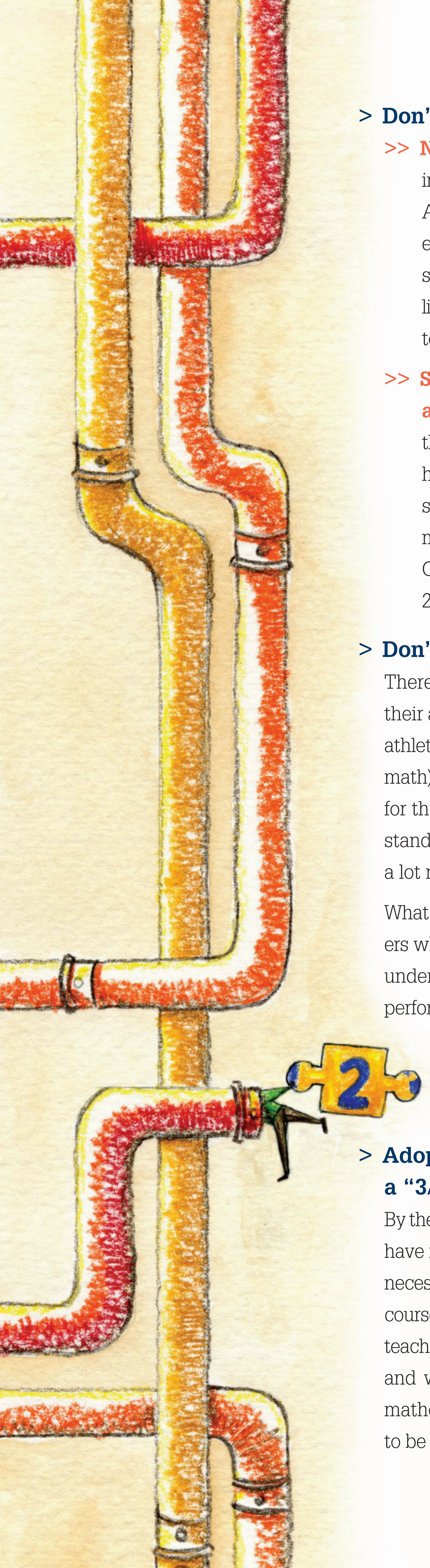
As a nation, the United States makes the teaching profession one of the easiest professions to enter, imposing minimal, if any, academic expectations for aspiring teachers. Accordingly, most of the nation's future teachers come from the bottom third of high school graduates going to college. If we are serious about making sure we stay globally competitive, individuals who were themselves unable to master even high school-level math or science courses should not teach these subjects to the next generation, no matter what level they plan to teach: elementary, middle school or high school.

> Start with a basic skills test.

If your state does not require aspiring teachers to pass a basic skills test (usually the Praxis I) to get into an education school, it should. Even in those states where a basic skills test is already required, the bar for passing this test needs to be raised. The minimum score needed for passing these tests is set far too low; applicants can often pass after getting only about 40 percent of the questions right![1] Since these tests generally assess the knowledge typically acquired in 6th and 7th grade, such low expectations are hard to defend. There is no reason why our future teachers should not be able to meet the same standard we expect of most students when they take a test: a passing grade set at no lower than 60 percent.

National Council on Teacher Quality

NATIONAL MATH + SCIENCE INITIATIVE



> Don't stick with a basic skills test.

- **>> Now, more than ever, elementary teachers need to be good at math.** Teaching elementary math requires much greater competency than is generally presumed. As a condition of admission into an education school, states should require that future elementary teachers demonstrate knowledge of math topics through Algebra II. Basic skills tests (like the Praxis I) don't test these topics, and neither do the elementary licensing tests that states presume are more advanced, such as the Praxis II. Another test, such as the Algebra II test the group Achieve offers, is needed.[2]

- **>> Secondary science and math teacher candidates must be really good at math.** Usually states don't bother testing for teachers' content knowledge until they have finished their undergraduate education; yet these tests assess little beyond high school-level knowledge! Before aspiring teachers even get into an education school, states need to require that institutions have verified that candidates have mastered mathematics through precalculus. Either the Praxis II Mathematics: Content Knowledge test (which includes topics through calculus) or the Math Level 2 SAT Subject Test (which includes topics through precalculus) fits the bill.[3]

> Don't undervalue academic ability.

There are education schools in every state that set a lower admission standard for their applicants than what college athletes have to meet. While the NCAA requires an athlete to have a 2.5 high school GPA along with at least an 820 (combined reading and math) on the SAT or 68 (sum of four tests) on the ACT, no such academic standard exists for the teaching profession. Many education schools voluntarily impose an academic standard, but if there is just one institution not doing so (and in most states there are a lot more than one), that is one too many.

What is the right standard? Teacher preparation programs should admit aspiring teachers who were in the top half of college-bound seniors in their high school class. Even under that standard, the United States would still set the bar lower than do other high-performing nations.[4]

STEP 2. Improve the quality of undergraduate preparation.

> Adopt model math course requirements for elementary teachers: a "3/1" sequence.

By the mostly muddled regulations commonly found in state code, it's clear that few states have figured out what math an elementary teacher should know. *Sufficient* preparation necessitates **3 mathematics courses** in order to cover all of the necessary topics. These courses cannot just be any math course, but need to be specific to the needs of elementary teacher candidates (treating topics relating to math foundations, algebra and geometry, and with some statistics). They should also take **1 methods course** for teaching mathematics, hence the 3/1 description of the sequence. Alternatively, candidates need to be allowed to test out of content courses.

> Adopt model science course requirements for elementary teachers that cover all the bases.

Most states have scattershot recommendations for the science elementary teachers need to know, often leaving it up to the future teacher to pick a single area or two of science in which to take coursework. Elementary teacher candidates need to take relevant coursework across *all* primary scientific fields, including physics, chemistry and biology (all with lab) and the earth sciences. Not just any science elective will do: this coursework must pertain to the content elementary teachers need to know.[5] Alternatively, they should be allowed to test out of these courses providing they have sufficient lab experience.

> Put some teeth into elementary licensing tests.

Every state requires teachers to take a set of licensing tests when they finish their preparation. However, most current elementary licensing tests do little to help states create higher standards for teachers. These tests (the most common of which come under the Praxis II umbrella, but some states use their own) only assess content knowledge at superficial levels. Also, these tests usually assess multiple subjects and are scored so that one can do very poorly on the math or science portions and still pass. Since only one new test truly advances higher standards, it is incumbent on states to pressure testing companies to develop better ones.[6]

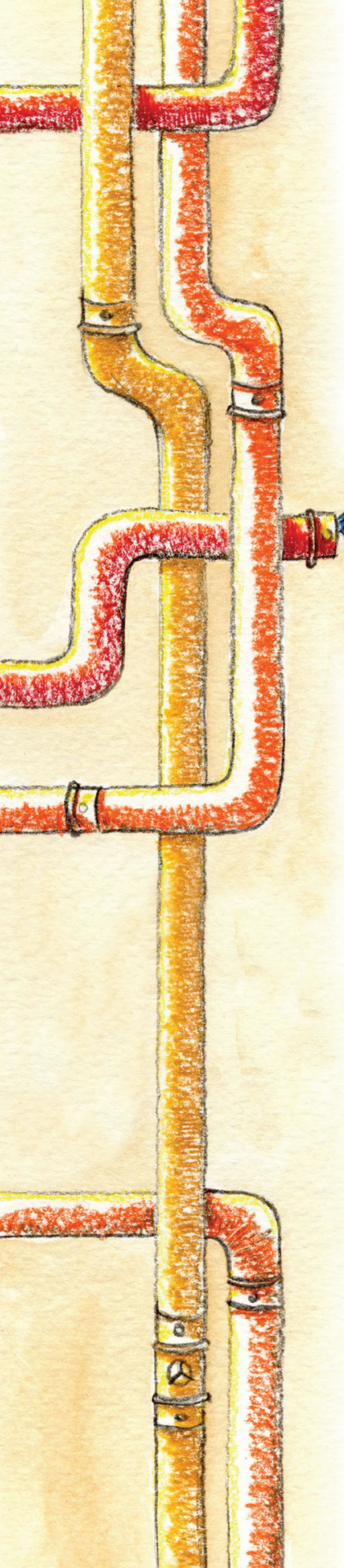
> Ensure that middle school teachers know their content.

>> **Require high standards—but keep regulations flexible.** There is a lot of confusion in states about the content preparation that middle school teachers need. Middle school teachers who intend to teach two subjects should be able to acquire two subject-area *minors*, subsequently passing state licensing tests in order to be deemed highly qualified in both subjects.[7] The two minors could be in two fields of science, or one could be in mathematics and the other in a science. This policy would help schools that have limited staffing options.[8]

>> **Close loopholes.** Almost half of all states still have loopholes which give some middle school teacher candidates the option of earning a less demanding K–8 generalist license.[9] All future middle school teachers—no matter whether they are teaching in a K-8, 6-8 or 7-9 setting—need to earn a middle school license or a subject-area license, grade 7–12. States should require these teachers to pass the middle school subject-area licensing tests in the upper half of all test takers or even have them pass the same licensing tests as high school teachers.

> Read the writing on the wall: traditional education schools cannot provide all the teachers needed.

Sufficient numbers of secondary math and science teachers are unlikely to emerge from traditional teacher preparation programs. These programs are simply not attracting enough candidates in STEM areas. New approaches are needed.



>> **Consider UTeach.** Each state university system could establish at least one UTeach program, a STEM pipeline that is growing in popularity across the nation, or a model just like it.[10] UTeach programs help undergraduate science, math and computer science majors qualify to teach without having to formally enroll in an education school. The flagship UTeach program at the University of Texas at Austin alone has graduated 400 teachers since 2002 and has 470 students currently enrolled.

> **Keep content knowledge the priority for secondary teachers.**

The state needs to work with its teacher preparation programs, helping them to craft a "minor" in teaching that would allow secondary teachers to earn a major in their content area without also having to earn a major in teaching. Having an additional year of professional coursework piled onto the required content major can serve as a big disincentive to a teaching career.

STEP 3. Recognize the need for creative and diverse solutions.

> **Make it easier for practicing teachers from other states to teach in your state.**

Many states require fully certified teachers coming from other states to take additional coursework, either in the content area or in professional studies. Requiring these practicing teachers to pass a test instead of taking a course can be a more tenable—and perhaps more telling—option.[11]

> **Verify that your "alternative certification" route into teaching is bona fide.**

Many states have regulations that require all teachers to have a major in the subject they will be teaching. This emphasis on content knowledge makes sense, except that many potential teachers coming through alternative certification routes have deep subject-matter knowledge in an area not indicated by their undergraduate major. It is unrealistic and unnecessary to expect career switchers and other alternate route candidates to go back to school to complete coursework when they may already know the material. Instead, allow these candidates to demonstrate subject-matter knowledge through a rigorous content test.[12]

> **Recognize the value of part-time teachers.**

>> **Take advantage of the state superintendent's authority to issue "licensing waivers" to individuals, effectively eliminating some of the state's requirements to become a licensed teacher.** Most state school superintendents have such authority. The state superintendent can actively invite districts to take advantage of teaching waivers for the important purpose of allowing part-time instructors to be hired solely to teach advanced courses, such as Advanced Placement chemistry or calculus.[13]

- >> **Customize compensation.** States should encourage districts to provide flexible compensation packages. Such packages could allow part-time instructors to forego the benefits package, and instead receive those benefit resources as pay.[14]

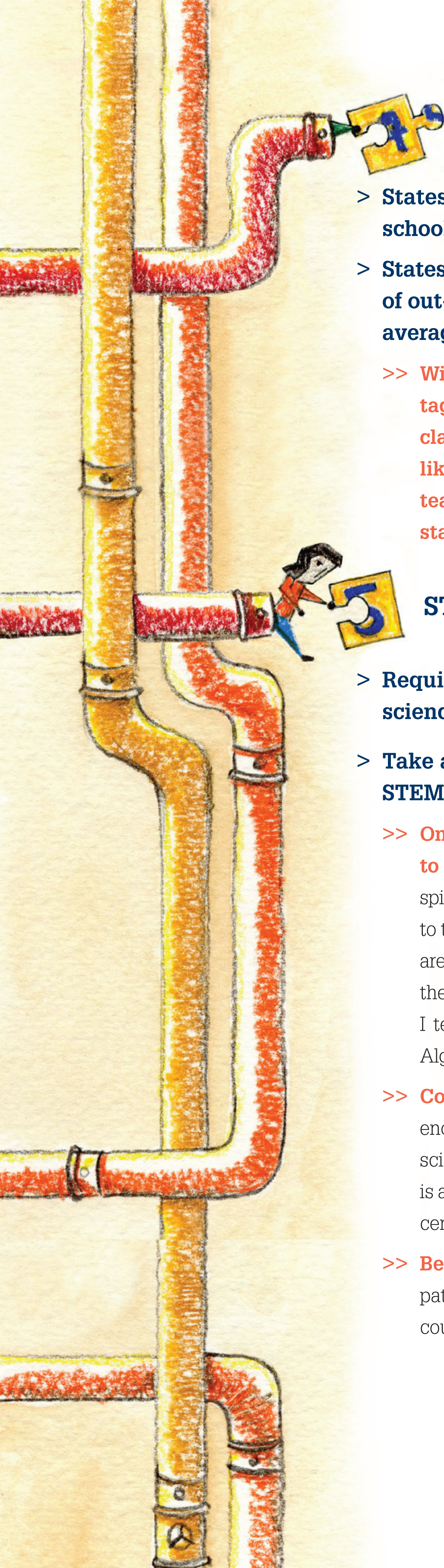
> Sell the profession.

- >> **Many states and large school districts offer good or excellent pensions, as well as retirement health care plans** for teachers entering at age 50 who are willing to work for ten years. States should advertise this fact.
- >> **Give signing bonuses** to STEM teachers, and encourage districts to start them at a higher step on the salary schedule.[15]
- >> **Adopt incentive programs,** such as loan forgiveness and tuition waivers, for out-of-field teachers to obtain full certification while teaching.[16]
- >> **Pay a person's worth.** Many districts have rules that place any new teacher at a fixed step on the salary schedule, often Step 1, regardless of background or teaching experience. Even where districts have built in some leeway on starting salary, the rules are still fairly restrictive. States can encourage districts to exercise more discretion on starting salary, adjusting salary, for example, for relevant prior work experience.[17]

> Give teachers the tools they need to be effective—in other words, a strong curriculum.

- >> **All teachers can do a better job if they are given a better curriculum (along with better standards and tests).** States should enlist the opinion of national experts to review their curriculum or standards.

  For example, states should consider the Singapore Math Method. This elementary curriculum is recommended by many university mathematicians who train elementary teachers and are well versed in K–12 curriculum issues. Used by a country whose students outperform their counterparts worldwide, Singapore Math is available in a fully "Americanized" version meeting California's academic standards, making widespread adoption of the curriculum much easier.[18]
- >> **Link professional development to content.** Teachers complain that most of the professional development they are forced to take isn't much good. States can help districts develop strong in-service math and science training that is systematic, focused on content and taught by knowledgeable professionals.[19]



STEP 4. Send qualified teachers to the schools that most need them.

> **States should offer incentives to get teachers into high-needs schools and to retain such teachers in those schools.**

> **States should not allow school districts to assign a greater number of out-of-field or new teachers to high-needs schools than the district average.**[20]

>> **With knowledgeable and effective teachers, even students who have been tagged as low achievers can meet academic standards. Unfortunately, classes in high-poverty and high-minority secondary schools are more likely to have teachers who simply don't know their subjects, and even teachers who do have the right preparation need some extra support to stay at the top of their game in challenging teaching environments.**

STEP 5. Remember it is the PK-12 system which produces our future STEM teachers.

> **Require that all students take four years of math and three of science for a high school diploma.**[21]

> **Take a hard, objective look at the PK-12 curriculum standards in STEM subjects.**

>> **One mark of good standards in mathematics is that students are prepared to take a genuine Algebra I course, not pretend algebra, by 8th grade.** In spite of state mandates, most school districts are not adequately preparing students to take real Algebra I by 8th grade. State tests reflect this sorry truth, with tests that aren't really testing genuine Algebra I topics. States should have experts compare their current Algebra I test with high quality algebra tests, including the Algebra I test offered by the Educational Testing Service (ETS) or Achieve's upcoming Algebra I test.[22]

>> **Compare your state to other states.** Examining your own state tests isn't enough. States should look at their performance on the 8th grade NAEP math and science tests to see if they are competitive. These are highly reliable tests; if there is a big discrepancy between the state test results and the NAEP, you can be fairly certain that there are problems with your state tests.[23]

>> **Better yet, compare your state to the world.** States should consider participating in the TIMSS math and science assessments taken by students in about 60 countries.[24]

Throughout, check your progress.

> Use reliable measures such as those listed here to track your progress:

>> NAEP for national comparisons.[25]

>> TIMSS for international comparisons.[26]

>> College remediation rates, including rates of enrollment in credit-bearing coursework that is actually high school coursework in disguise.

1 Virginia has established the highest score needed to pass the mathematics portion of the Praxis I. Its score of 178 means that test takers need to get from 48 to 63 percent of the questions right, depending on the version of the test taken.

2 Find out more about Achieve's Algebra II test: www.achieve.org/AlgebraIITestOverview or the Math Level 1 SAT Subject Test: www.collegeboard.com/student/testing/sat/lc_two/math1c/math1c.html.

3 For more information on these tests, see www.ets.org/Media/Tests/PRAXIS/pdf/0061.pdf or www.collegeboard.com/student/testing/sat/lc_two/math2c/math2c.html.

4 For more information on the selectivity requirements of other nations, see the McKinsey report, How the world's best-performing school systems come out on top: www.mckinsey.com/locations/ukireland/publications/pdf/Education_report.pdf.

5 The Core Knowledge Foundation has developed appropriate syllabi describing the courses elementary teachers need in the sciences: coreknowledge.org/CK/resrcs/syllabusdl.htm.

For an example of a state with good standards across all areas of science, see Virginia's standards for teacher preparation: www.doe.virginia.gov/VDOE/newvdoe/regulation.pdf.

6 A better stand alone mathematics test for teacher licensure is being piloted in Massachusetts: www.doe.mass.edu/mtel/.

7 A prospective middle school teacher preparing to teach two subjects by acquiring two minors can ensure compliance with the "highly qualified teacher" provision of No Child Left Behind by taking two subject area tests.

8 Connecticut combines rigor with flexibility by requiring middle school teachers to complete either a subject-matter major or an interdisciplinary major consisting of 24 credit hours in one subject and 15 in another. Georgia, Louisiana and Mississippi require two minors of middle school teacher candidates and a major for high school teacher candidates.

9 The National Council on Teacher Quality's *State Teacher Policy Yearbook* at www.nctq.org/stpy lists which states have closed up their loopholes.

10 Arizona, California, Colorado, Florida, Kansas, Kentucky, Louisiana and Pennsylvania have recently established UTeach programs at one or more campuses and Texas has continued to add programs.

11 Alabama, Hawaii, Maine and Texas all have sensible policies for granting licensure to teachers already licensed in another state.

12 Sixteen states allow a test to be used in lieu of a major to demonstrate subject-matter knowledge.

13 The Arkansas Department of Education issues one-year permits to experienced professionals to teach one or two classes per semester: www.teacharkansas.org/professional_teaching_permit.html.

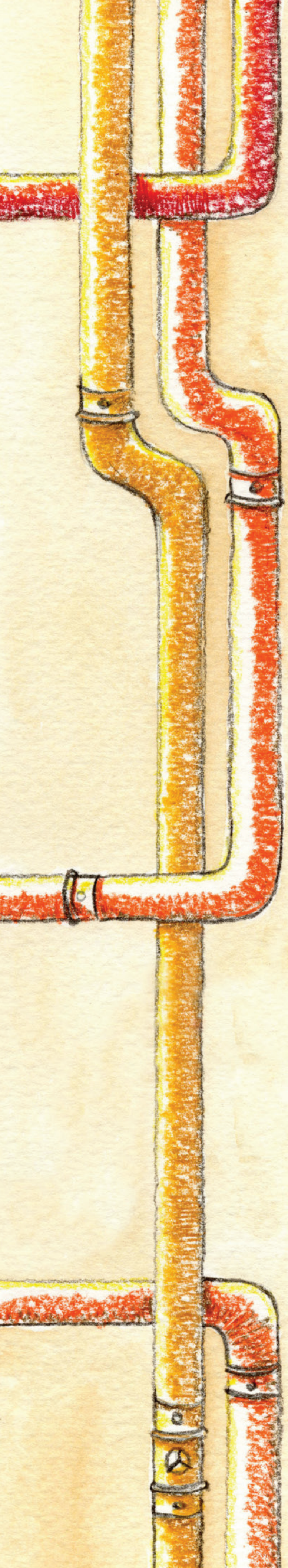
14 A couple of examples: Providence (RI) pays teachers who wish to opt out of the district's health plan. New York City has a separate salary schedule entirely for part-time employees.

15 For example, Hartford (CT) lets new teachers with a mathematics major start at a higher step on its salary schedule than other beginning teachers.

16 For example, Maryland offers tuition reimbursement for retraining in the areas of mathematics and science and a stipend for alternate route candidates who agree to teach mathematics or science. Further, nine states offer loan forgiveness in shortage subject areas. (See NCTQ's *State Teacher Policy Yearbook* at www.nctq.org/stpy).

17 North Carolina compensates new teachers with relevant prior work experience by awarding them up to one year's credit for every year of full-time work related to their area of licensure and work assignment.

18 Pilot implementation of Singapore Math in Hall County (GA) has been so successful that it is being adopted district-wide. California has approved district use of state funds to purchase the "Americanized" Singapore Math textbooks available at singaporemath.com.



19 See *Professional Learning in the Learning Professions: A Status Report on Teacher Development in the U.S. and Abroad* at www.srnleads.org/resources/publications/pdf/nsdc_profdev_tech_report.pdf.

Also, a number of states have conducted high quality professional development efforts: 1. The Intensive Immersion Institutes in Massachusetts, funded by the state's Department of Elementary and Secondary Education, provide instruction on mathematics content to grade 4–8 teachers (www.edutron.com/Courses/); 2. Minnesota's Math and Science Teacher Academies, funded through SciMathMN, a non-profit education and business coalition advocating for better K-12 STEM instruction (www.scimathmn.org/about.htm); 3. The Vermont Mathematics Initiative (VMI), established a decade ago through joint efforts of the state commissioner of education and the University of Vermont. VMI provides 80 hours of instruction on mathematics content to all elementary teachers in the state (www.emba.uvm.edu/~gross/index_files/Page399.html).

Another good source for professional development training is Reasoning Mind (www.reasoningmind.org/), a promising inservice course for elementary teachers combining on-site and online instruction.

20 For example, Florida makes sure that districts assign first-year teachers, temporarily certified teachers, out-of-field teachers, or teachers with weak ratings at the same rate to affluent schools as to those schools that are either low performing, high minority or high poverty.

21 States requiring all students, not just those heading to college, to take four years of both mathematics and science include: Alabama (www.alsde.edu/html/sections/doc_download.asp?section=54&id=829), Louisiana (www.louisianaschools.net/LDE/uploads/7516.pdf) and Texas (ritter.tea.state.tx.us/rules/tac/chapter074/ch074f.html).

22 For more information about these two tests, see www.ets.org/portal/site/ets/menuitem.435c0b5cc7bd0ae7015d9510c3921509/?vgnextoid=4d7de3b5f64f4010VgnVCM10000022f95190RCRD and www.achieve.org/AlgebraITestOverview.

23 You can do so by going to nces.ed.gov/NATIONSREPORTCARD.

24 Massachusetts and Minnesota performed notably well on the 2007 TIMSS. Massachusetts math and science standards have received high marks and have a proven track record: In the 2007 TIMSS, Massachusetts 4th graders ranked second worldwide in science achievement and third in math, while the state's 8th graders tied for first in science and were sixth in math: www.doe.mass.edu/frameworks/current.html. Minnesota's students also performed well above the national average, with 4th graders ranked fourth worldwide in science and fifth in math, while 8th graders were ranked eighth in science and sixth in math: education.state.mn.us/mde/Academic_Excellence/Academic_Standards/Mathematics/index.html.

For more information on this process, write to the TIMSS International Study Center at Boston College (timss@bc.edu). Monitor new, budget-friendly approaches to doing "small area estimates" of TIMSS scores that may soon be available by contacting Patrick Gonzales at the National Center for Education Statistics, Patrick.Gonzales@ed.gov.

25 See nces.ed.gov/NATIONSREPORTCARD.

26 The administration of TIMSS in the United States is handled by Boston College. Contact: timss@bc.edu.

National Council on Teacher Quality

The **National Council on Teacher Quality** (NCTQ) is a nonpartisan research and advocacy group committed to restructuring the teaching profession, led by the vision that every child deserves effective teachers. NCTQ is available to work with individual states to improve teacher policies. For more information please contact:

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The **National Math and Science Initiative** (NMSI) is working to scale effective STEM programs, including UTeach and the Advanced Placement Training and Incentive Program. NMSI sponsors programs in 14 states. For more information please refer to www.nationalmathandscience.org