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REPORT

Preparing Teachers Around the World

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CONTENTS

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Preface

For at least two decades, U.S. policymakers and the public have been concerned about student achievement in mathematics and science. In the 1980s, a series of reports raised concerns about our ability to compete in an increasingly global economy with a population less well prepared than their peers in other countries. Then, the *Repeat of the Third International Mathematics and Science Study at the Eighth Grade* (TIMSS 1999) documented not only the mediocre performance of U.S. students, but also revealed systematic differences in the practices of teachers in this country compared with that of other nations.

More recently, significant attention has been given to policies governing the supply and quality of teachers. Strong debate, together with legislative initiatives, has focused on the need for nationwide standards in licensure testing, the quality of teacher education programs, alternate routes into teaching, academic requirements, induction programs, and hiring and tenure practices. In one way or another, any one of these issues has been viewed as a root cause or possible solution to inadequate teacher quality and consequent student performance.

In *Preparing Teachers Around the World*, ETS researchers Aubrey Wang, Ashaki Coleman, Richard Coley, and Richard Phelps take a systematic look at the kinds of policies and control mechanisms that high-performing countries use to shape the quality of the teaching force. They surveyed the teaching policies of seven countries whose students performed as well or better than students from the United States in mathematics and science. The study is exploratory in nature, and no causal explanations can be made but, nevertheless, the findings suggest certain policy paths that may be more or less likely to bear fruit.

This study makes clear that while there is no one way that the best performing countries manage the teacher pipeline, by and large, they are able to control individuals who enter teacher education programs through more rigorous entry requirements and higher standards. One of the most striking findings is that students in the countries are more likely to have teachers who have training in the subject matter they teach.

The authors present the idea of filters, points in the teacher pipeline where individuals might be forced to exit the profession of teaching. They note that some filters that have come under withering criticism in the United States, such as teacher education programs and tenure, are accepted and universal practices in the comparison countries. Indeed, while some call for the deregulation of teaching as a means of improving the teaching force, every high-performing country in this study employs significant regulatory controls on their teaching force. While the primary regulatory control in the United States is teacher licensure testing, other countries include controls at additional career points.

For more than 50 years, ETS has been involved with efforts to measure and improve teacher quality. We are a strong proponent of high quality, research-based professional development for teachers at all levels (student, beginning, and experienced) and, through studies such as this, we aim to inform policies that will strengthen America's teaching force and improve our nation's schools.

Preparing Teachers Around the World is not meant to be a "best practices" resource, complete with answers and solutions. But, while not definitive, the filter model it describes provides a framework that we can use to study further issues associated with teacher quality. What is most helpful is that the pipeline is viewed as a system rather than a series of discrete steps. This report offers up the possibility that, as a country with local educational decision-making, we can adopt a variety of systems as long as the outcome is a sufficient supply of qualified teachers who can provide America's children with the best education possible.

Drew Gitomer
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Lynn Jenkins was the editor. The cover was designed by Joe Kolodey. Carla Cooper provided desktop publishing. Any errors of fact or omission are those of the authors.

Executive Summary

This report provides an exploratory analysis of teacher education and development policies in a group of countries that participated in the *Repeat of the Third International Mathematics and Science Study at the Eighth Grade* (TIMSS 1999) and scored as well as or higher than the United States in eighth-grade mathematics or science. In addition to the United States, the report provides information on the systems of Australia, England, Hong Kong, Japan, Korea, the Netherlands, and Singapore. While the focus is on eighth-grade mathematics and science teacher education and development policies, most of the issues discussed are also related to teachers of other subjects.

A teacher education and development model, which encompasses the entire "pipeline" from admission to teacher education programs to the award of tenure, was used to guide the data collection and analysis. Based on this model, the report is structured around the following components:

- Control and governance
- Standards for entrance into and exit from teacher education programs
- Characteristics of the education programs for eighth-grade mathematics and science teachers
- Certification requirements
- Availability of advanced certification
- Alternative teacher certification programs
- Hiring and compensation
- In-service and professional development requirements

In addition, the report examines some of the output of these systems in terms of teacher qualifications and teachers' confidence to teach mathematics and science. The final section of the report attempts to draw some conclusions and provide some judgments about the choices that countries make about where along the pipeline they place filters and about the density of the filters applied.

While many of the components that comprise the pipeline are generally similar across the countries surveyed, we found substantial differences across countries in certain aspects of the teacher education and certification process. Some of these similarities and differences are highlighted below.

Governance

- In contrast to the decentralized systems in the United States and Australia, the other nations surveyed have centralized systems of teacher education and certification, which allow tighter control over the systems.
- While teacher education governance is the responsibility of the states in the United States, there are large, non-governmental, influential accreditation and standard-setting organizations that result in teacher education and certification systems that are more alike than different.

Teacher Education

- There are large differences in the scale of the teacher education enterprise across the countries surveyed. The number of institutions preparing teachers ranges from one in Singapore to about 1,500 in the United States.
- Compared to the United States, screening criteria are more rigorous and are applied earlier in the teacher education and certification pipeline in most of the countries surveyed. Unlike the United States, most of the countries use high school GPA and scores on national exit examinations taken in high school to select students for teacher education programs, including graduate programs. In the United States, the high school record is typically irrelevant to entry into teacher education programs, although it is usually a factor in admission to higher education.

- The structure and content of undergraduate teacher education programs are quite similar across the countries surveyed. These include courses in subject area content, courses in educational theory and pedagogy, and experiences observing and teaching students.

- Exit requirements are similar across the countries surveyed. They typically include completion of an approved program, tests and acceptable grades, and student teaching experience.

- While all countries require student teaching experience as part of the teacher education curriculum, the duration of such programs ranges from three to four weeks in Japan to between 12 and 18 months in the Netherlands.

- Graduate-level teacher education programs in the United States have less stringent and more varied entry requirements for subject content mastery than do those in the other countries surveyed.

Teacher Certification

- In most states in the United States, teachers are awarded an initial teaching certificate after they have completed the course requirements of their teacher education program and have successfully passed the state teacher-licensing exam.

- England is the only country other than the United States that requires a licensure examination in addition to the examinations given by the teacher education institution.

- England and the United States (most states) were the only countries surveyed that require a test for certification *after* the completion of the teacher education program.

- The initial teaching certificate is valid for life in all of the countries except the United States (most states) and Australia, where a specified length of teaching experience serves as the prerequisite for a permanent license.

Hiring, Compensation, and Tenure

- Teacher hiring practices in the United States are characteristic of a decentralized educational system, with hiring done at both the school district and school level. Local schools are also responsible for hiring teachers in Australia, England, Hong Kong, and the Netherlands. Hiring is centralized in Japan and Singapore. Korea hires at the school district level and requires an employment test measuring mastery of subject matter content and pedagogical theory and methods. Singapore requires a test in English-language skills.

- In some countries, decisions about teacher compensation are made at the national level. In others, like the United States, school districts set teacher compensation (for public and charter schools). In Korea and Japan, teacher compensation is also set locally.

- Teacher salaries vary widely across U.S. states and, as in the other countries surveyed, vary with educational attainment and certification levels. Beginning teacher salaries are higher than salaries for similarly educated professionals in Australia, Japan, and Hong Kong, and comparable in Singapore. In England, Korea, and the United States, teachers earn less than other similarly educated professionals.

- Teacher tenure is a practice in all the countries surveyed, although most require a probationary period of some time.

Beginning Teacher Induction

- Teacher induction programs for new teachers in the United States are fragmented due to wide variation in legislation, policy, and type of support available. Such programs are required in England, Singapore, Japan, and Australia. Korea and the Netherlands do not provide support programs for new teachers.

Professional Development

- Professional development for teachers is common and varied across U.S. school districts and is sometimes used for certificate renewal. All countries surveyed provided professional development either through their education ministries or by providing teachers free time or compensation to participate in the offerings of other providers.

Advanced and Alternative Certification

- Advanced certification is voluntary in all of the countries that recognize such certification (of those surveyed, all but the Netherlands and Hong Kong). Such certification generally requires additional course taking and external assessments. In some countries, advanced certification results in additional compensation.

- The United States and England are the only countries surveyed that recognize an "alternative" route to teacher certification.

Teacher Qualifications and Confidence

- Eighth-grade students in the United States and Hong Kong were less likely than students in the other countries surveyed to have teachers with a mathematics or mathematics-education major or a science or science-education major.

- Overall, students were more likely to have teachers who were highly confident about teaching mathematics than about teaching science. U.S. teachers expressed higher confidence than teachers in the other countries surveyed to teach both mathematics and science.

While the components of the "pipeline" are considered separately above, it may be more useful to view the "pipeline" as a sequence of policies related to the teacher education and development process, from beginning to end. At each part of the pipeline, filters can be placed to control the flow of candidates into teaching. These filters can be dense (or high-stakes) or porous (low-stakes). The summary table on the next page summarizes and characterizes the filters that countries use to control the teacher education and development pipeline (rationales and rubrics for these classifications are provided in the report).

A major finding of this study was the variation among countries with respect to where they choose to place "pipeline filters" where candidates can be screened out from the profession. Most countries (like the Netherlands) "front load" their requirements, emphasizing selection into and exit from teacher education programs. Others (like Japan) also "back load" their requirements, emphasizing rigorous induction programs during a probationary period after which some teachers will not receive permanent posts.

Each country's "pipeline" differs in some important and interesting ways from that of other countries, for reasons ranging from cultural to political to practical. In searching for lessons from other countries, a range of factors limit the transportability of certain features. For example, while countries like Singapore, Hong Kong, and the Netherlands can standardize teacher education programs nationwide with an executive decision, such standardization runs contrary to the politics of education in the United States.

While several countries filter out prospective teachers based on their high school records, casting the die early runs contrary to the American philosophy of ever-open possibilities. Some practices that are common in the United States, like alternative and emergency certification, are much less common in the surveyed countries, and thus, offer no lessons, aside from what policymakers can glean from their conspicuous absence.

Several overall findings may provide lessons for U.S. policymakers.

- Other countries tend to use more filters than the United States;

- Other countries use more high-stakes filters than the United States;

Filters Used Along the Teacher Education and Development Pipeline

	Entry to teacher education program	Evaluation of practical experience requirement	Exit from teacher education program	Certification	Hiring	Evaluation of induction period	Evaluation of professional development	Evaluation of probation period (for tenure)
Australia*	◎	◎	●	◎	○	○	○	◎
England	○	●	○	●	○	○	○	◎
Hong Kong	◎	◎	○	○	○	○	◎	●
Japan	●	●	○	○	◎	◎	●	●
Korea	●	◎	●	○	●	○	●	○
Netherlands	●	●	◎	○	○	○	○	◎
Singapore	●	◎	●	○	◎	◎	○	○
United States*	◎	○	◎	●	○	○	○	○

● High-Stakes ◎ Medium-Stakes ○ Low- or No-Stakes

*Since teacher education and certification are the responsibility of individual states, practices can differ among them.
See Appendix B for the rubrics for the classifications in the table

- In the United States nearly all of the high-stakes filtering is applied before or during initial certification. After that, the filters in place might be considered "pro forma" or low-stakes;

- U.S. policymakers might find it instructive to see how other countries filter teacher candidates at those parts of the pipeline the U.S. system neglects; and

- Efforts to extract lessons from other countries based only upon comparisons of individual segments of the pipeline should be considered inconclusive; conclusive judgments can be derived only after consideration of the entire length (i.e., the entire teacher education and development process).

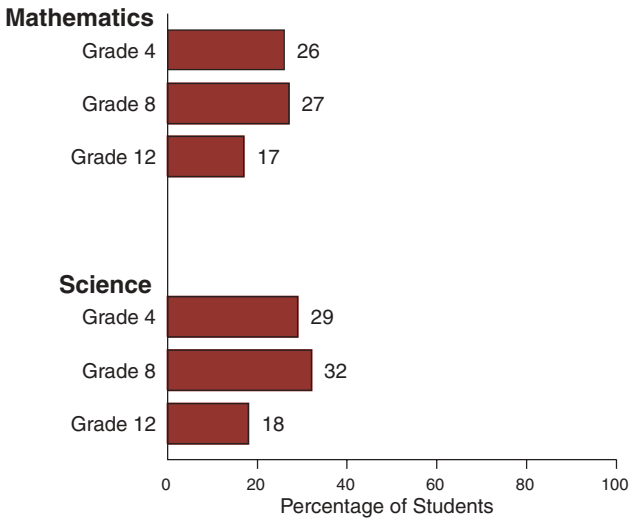
As policymakers and educators in the United States continue to search for effective ways to expand and improve the supply of qualified mathematics and science teachers in the coming years, it will be important to examine the U.S. pipeline closely to determine whether the mechanisms that currently govern the flow of prospective teachers are the proper ones, and whether they are succeeding or failing to achieve their intended goals: to train desirable candidates for the teaching profession and to ensure their success once there.

It is also important to recognize the factors that affect the attractiveness of teaching as a profession and the tension that can result between the impact of imposing more high-stakes filters along the pipeline and the need to staff the nation's schools adequately.

Introduction

The mathematics and science performance of U.S. students is a perennial concern among educators, education policymakers, and the public. While mathematics scores on the National Assessment of Educational Progress (NAEP) improved between 1990 and 2000 for all three grade levels assessed, only about one-fourth of students reach the *proficient* level, a level that many policymakers assert should be a target for all of our students.[1] In science, the situation is similarly worrisome. NAEP science achievement did not change significantly between 1996 and 2000, and less than one-third of U.S. students reach the *proficient* level in science. Figure 1 shows the percentage of students reaching the *proficient* level in mathematics and science at each grade level assessed by NAEP in 2000.[2]

Figure 1: Percentage of Students at or above the "Proficient" Level in NAEP Mathematics and Science, 2000



Source: National Assessment of Educational Progress.

The performance of U.S. students in mathematics and science not only falls below expected levels; it also lags behind that of students in many other developed countries. Data from the *Repeat of the Third International Mathematics and Science Study* (TIMSS 1999) allow us to see how the mathematics and science performance of U.S. eighth-grade students compares to their international counterparts.

Figure 2 shows the average TIMSS mathematics scores for 38 participating countries in 1999. Although the U.S. score of 502 is higher than the international average of 487, 14 of the 38 countries scored significantly higher than the United States. Singapore, the Republic of Korea, Chinese Taipei, and Hong Kong had the highest average scores, with Singapore's and Korea's significantly higher than all other participating countries, and Chinese Taipei's and Hong Kong's significantly higher than all the rest except Japan. Japan and Flemish Belgium also scored significantly higher than most other countries.[3]

In science, the story is similar, as seen in Figure 3. While the average science score for the United States (515) is higher than the international average (488), 14 of 38 participating countries scored significantly higher than the United States. Chinese Taipei and Singapore had the highest average performance, closely followed by Hungary, Japan, and the Republic of Korea. Other countries that performed well include the Netherlands, Australia, the Czech Republic, and England.[4]

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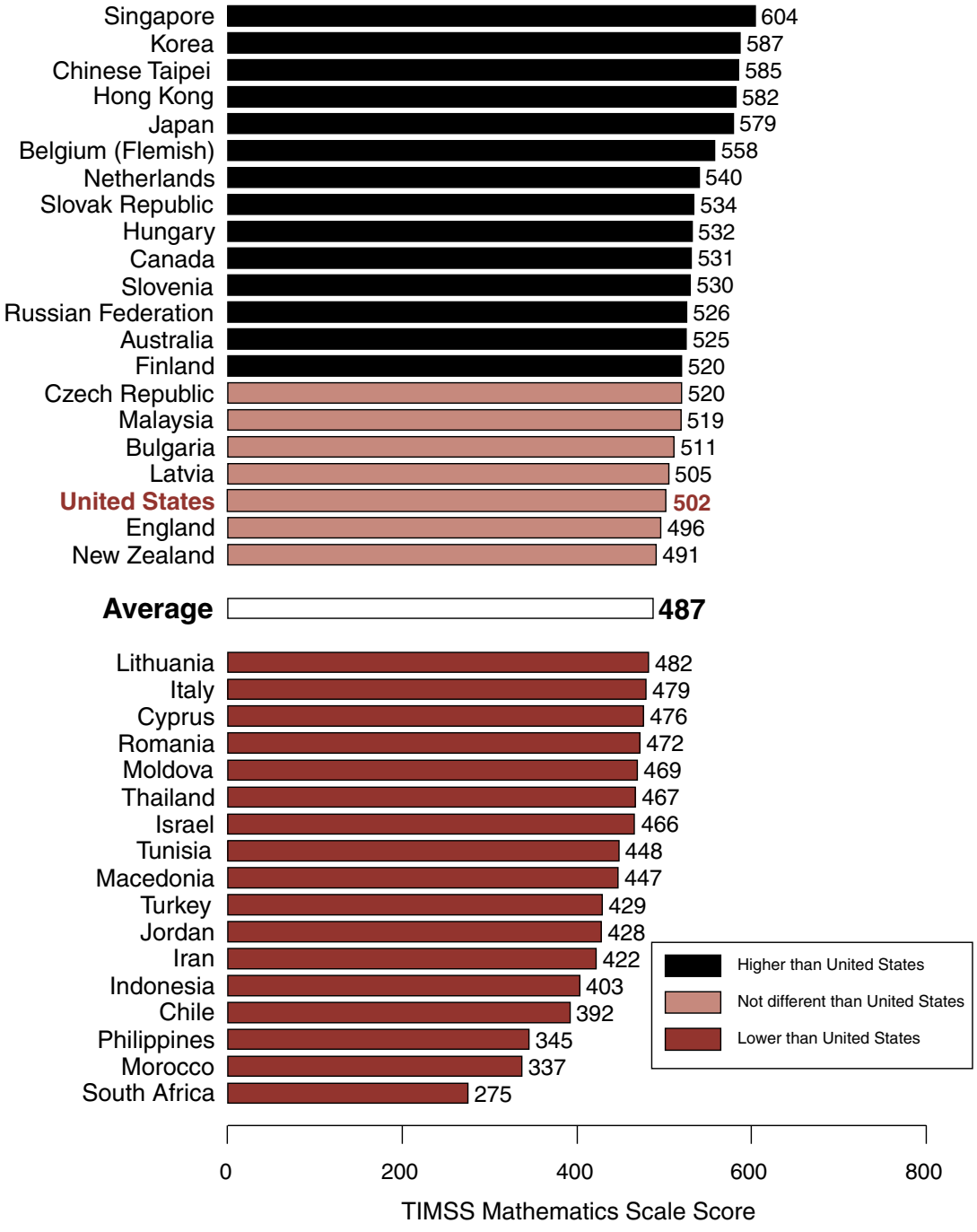
1 NAEP defines *proficient* as follows. "This level represents solid academic performance for each grade assessed. Students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real-world situations, and analytical skills appropriate to the subject matter."

2 U.S. Department of Education. Office of Educational Research and Improvement. National Center for Education Statistics. *The Nation's Report Card: Mathematics 2000*, NCES 2001-517, by J.S. Braswell, A.D. Lutkus, W.S. Grigg, S.L. Santapau, B.S.-H. Tay-Lim, and M.S. Johnson. Washington, DC: 2001.

3 For complete TIMSS mathematics results, see Ina V.S. Mullis et al., *TIMSS 1999 International Mathematics Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade*, The International Study Center, Boston College, Lynch School of Education, December 2000.

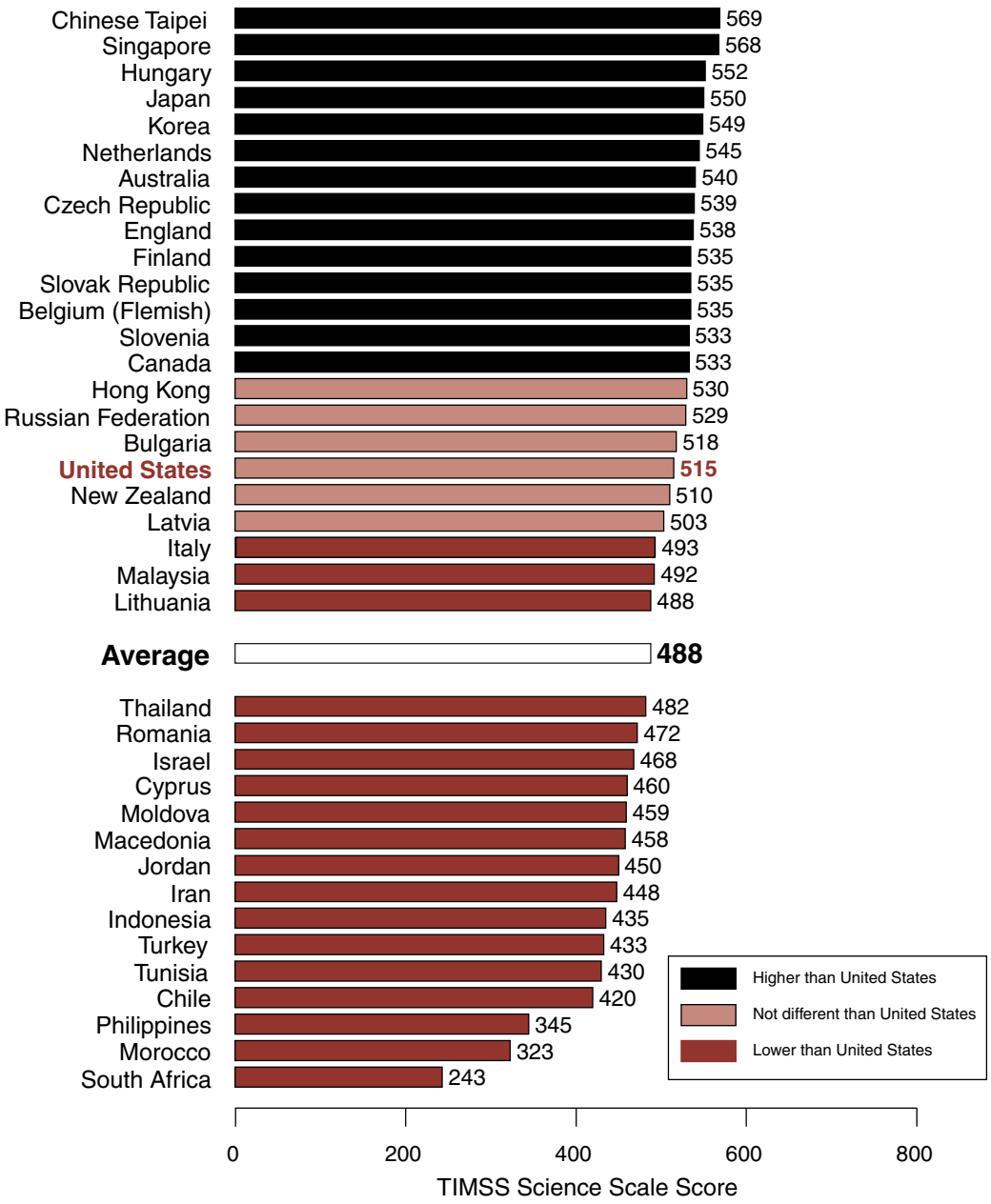
4 For complete TIMSS science results, see Michael O. Martin et al., *TIMSS 1999 International Science Report: Findings from IEA's Repeat of the Third International Mathematics and Science Study at the Eighth Grade*, The International Study Center, Boston College, Lynch School of Education, December 2000.

Figure 2: Average Mathematics Performance of Eighth Graders for 38 Countries Participating in TIMSS, 1999



Source: National Center for Education Statistics, *The Condition of Education 2002*.

Figure 3: Average Science Performance of Eighth Graders for 38 Countries Participating in TIMSS, 1999



Source: National Center for Education Statistics, *The Condition of Education 2002.*

While there has been healthy debate about the reasons the United States does not do better in these international comparisons, there is broad consensus that the quality of teachers is essential to improving performance, not just in mathematics and science, but across the entire elementary and secondary school curriculum.[5]

In fact, increasing the quality of teachers in this country is a key goal of the *No Child Left Behind Act of 2001*, recently passed by the U.S. Congress. According to an ETS report on the law's provisions:

> *States and/or local education agencies will receive funding to reform teacher and principal certification; provide professional development, including mentoring and induction; create alternative routes for entry into the profession; and to recruit and retain highly qualified educators. Funds appropriated for professional development activities, which are authorized in a variety of sections of the bill, have increased for FY '02 by about one-third over FY '01. A series of national activities to strengthen the profession is also authorized to include support for advanced certification or credentialing programs, a national principal recruitment program and a program to improve the skills of early childhood educators.*[6]

Thus, teacher education, certification, and professional development are important to the current education reform movement. The new law requires that all teachers in core academic subjects be highly qualified by the end of the 2005-6 school year. This means that the teachers are fully certified and have an academic background in the subject they teach.

According to a recent report from *Education Week*, the nation has far to go.

- Almost a quarter of secondary school students (22 percent) take at least one class with a teacher who did not even minor in the subject he or she teaches. In high-poverty secondary schools, 32 percent of students take a class with a teacher who lacks even a minor in the subject.

- About 44 percent of middle school students nationwide, and more than half of students in high-poverty middle schools, take a class with a teacher who hasn't acquired even a minor in the subject.[7]

This confluence of factors casts a renewed focus on teacher education and certification at an especially critical time. Over the next decade, many teachers from the "baby boom" generation will leave the classroom and enter retirement. The National Center for Education Statistics (NCES) estimates that the United States will need 2 million new teachers over the next decade.

This study aims to inform the debate over improving teacher education and certification in eighth-grade mathematics and science in the United States by describing teacher education and certification policies in other developed countries. The following sections describe some of the previous research conducted in this area and then go on to provide information on how we selected the countries and how we gathered the relevant information.

Some Previous Research on International Comparisons

The depth and sophistication of international comparisons of education systems have grown steadily and substantially over the past couple of decades. International student assessments 40 years ago were brief and included less than a dozen countries at one grade level. Now, several dozen countries participate at several grade levels in several different subject areas. Meanwhile, comparisons of national education systems have evolved from descriptive narratives

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5 For a recent, brief summary of the relationship between teacher quality and student achievement, see Dan Goldhaber, "The Mystery of Good Teaching," *Education Next*, Spring 2002. (http://www.educationnext.org/20021/50.html)

6 Educational Testing Service, State and Federal Relations Office, *The No Child Left Behind Act, A Special Report,* Washington, DC, February 2002.

7 Education Week, Quality Counts 2003: "*If I Can't Learn From You*," January 9, 2003.

written according to a standard outline to arrays of measures conforming to negotiated, well-ordered, standardized benchmarks.

Some international education indicators have evolved more quickly than others, however. Perhaps it was most important that topics related to students, such as academic achievement, enrollment, and attainment, and those related to finance, such as revenues, expenditures, and salaries, accumulate the most refined sets of international indicators first. By contrast, international indicators pertaining to teacher education and development remain in the developmental stage.

Some of these first efforts have been very good, however, and deserve noting here. Indeed, our study both benefits from and complements the information accrued in these previous studies of teacher education. Our study is different from the others in three respects:

- we examine a different set of countries—the top performers in the TIMSS;
- we study the entire length of the teacher education and development "pipeline;" and
- our work, for the time being, is the most current and therefore most reflective of rapidly evolving changes in teacher education practices.

Perhaps the first large-scale effort to develop international indicators on classroom teachers was undertaken by the American Federation of Teachers in 1993, under the direction of F. Howard Nelson and Timothy O'Brien.[8] They compared teacher salary levels, salary and benefit structures, and some measures of education requirements and working conditions across 19 industrialized countries, including most of those from our sample.

A couple of years later, David F. Robitaille, one of the key, early organizers of the TIMSS, assembled a compendium of standardized reports from experts in 38 participating countries, including all those included in our study.[9] The standard country report format of the Robitaille collection is oriented toward the TIMSS areas of focus, such as curriculum and instruction, pedagogy, school system structure, and textbooks. Each country expert did include, however, short sections on "Certification of Mathematics and Science Teachers" and "Teacher Profile" (essentially, a demographic description of the teacher population). While brief, these sections were useful to our study as points of comparison, although, in a few instances, the certification system details have changed in the six or seven intervening years.

About the same time David Robitaille was assembling his collection, the APEC Education Forum, of the Asia-Pacific Economic Cooperation organization, sponsored a series of case studies of the teacher induction process in Japan, New Zealand, and Australia's Northern Territory.[10] A summary chapter, based on the results of a survey of APEC member countries, provides some basic comparisons of teacher induction system structures across many countries with diverse education systems. All countries in our own survey group, except for England and the Netherlands, are APEC members.

A similarly structured and detailed companion study was undertaken at the same time by Linda Darling-Hammond and others pertaining to teacher preparation and professional development in APEC countries.[11]

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8 F. Howard Nelson and Timothy O'Brien, *How U.S. Teachers Measure Up Internationally: A Comparative Study of Teacher Pay, Training, and Conditions of Service*, American Federation of Teachers, July 1993.

9 David E. Robitaille (ed.), *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*, Vancouver, Canada: Pacific Education Press, 1997.

10 Jay Moskowitz and Maria Stephens (eds.), *From Students of Teaching to Teachers of Students: Teacher Induction Around the Pacific Rim*, Washington, DC: APEC Education Forum and the U.S. Department of Education, January 1997.

11 Linda Darling-Hammond and Velma L. Cobb (eds.), *Teacher Preparation and Professional Development in APEC Members: A Comparative Study*, Washington, DC: U.S. Department of Education, 1995.

Also in the mid-1990s, EURYDICE, the research and statistics division of SOCRATES, the European Union's education group, published the results of their survey.[12] The compendium is structured much like the Robitaille collection: country experts were asked to complete sections of the report according to a standardized format, and summary comparison tables are assembled as well. The result is substantial, with considerable detail provided on the topic of in-service training. Of the countries in our own survey group, only England and the Netherlands are European Union members.

In 1997, Dorothy M. Gilford and Mary Rollefson assembled a compendium on professional development, drawing information from sources such as those just mentioned above and responses gathered from relevant survey items posed to teachers in some international surveys, such as the TIMSS, the Computers in Education Study, and the Reading Literacy Study.[13]

More recently, the Milken Family Foundation and the Council for Basic Education (CBE) published a report that assembled responses of experts in the nine countries participating in the CBE's Schools Around the World Project, an ongoing effort in communication and collaboration among teachers on the topic of classroom and homework assignments. As the title implies, the report focuses on aspects of teachers' careers, post-graduation, such as recruitment, reward, retention, and job quality. The nine participating countries were Australia, Czech Republic, France, Germany, Hong Kong, Japan, Portugal, the United Kingdom, and the United States. Australia, Hong Kong, and Japan were also part of our study and, of course, England is part of the United Kingdom.[14]

Richard Phelps compared a group of the top-performing TIMSS countries to a group of their low-performing counterparts according to the number of "quality control" measures, or high-stakes decision points, each education system employed. Most of the quality control measures he counted involved decisions about students, but two involved decisions about teachers: examinations in subject areas required for entry into the profession and the presence or absence of curriculum-based classroom inspections. Phelps' study was similar to this one in that it identified pressure points along the student career pipeline and described various combinations of quality control measures that different countries used.[15]

Still to come is a study by Edward Britton and Senta Raizen of WestEd and others affiliated with the National Center for Improving Science Education and Michigan State University. They are investigating induction experiences in the first years of middle grades mathematics and science teaching in several countries (China [Shanghai], France, New Zealand, and Switzerland).

Of all the studies mentioned above, one examines teacher education or certification, two focus on induction programs, and three look at professional development (inservice training included). One of the aforementioned studies compares the population demographics of practicing teachers and another looks at characteristics of their working lives.

Aside from the fairly incidental and mundane contrasts of selecting a different comparison group and conducting our study at a different time, our study offers one clear and, as it turns out, very instructive point of departure from these other studies—our

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12 EURYDICE European Unit, *In-Service Training of Teachers in the European Union and the EFTA/EEA Countries*, Brussels: EURYDICE, January 1995.

13 Dorothy M. Gilford and Mary Rollefson, *International Comparisons of Inservice Professional Development*, 1997.

14 Carol F. Stoel and Tin-Swe Thant, *Teachers' Professional Lives—A View from Nine Industrialized Countries*, Council for Basic Education and the Milken Family Foundation, Washington, DC: March 18, 2002.

15 Richard P. Phelps, "Benchmarking to the World's Best in Mathematics: Quality Control in Curriculum and Instruction Among the Top Performers in the TIMSS," *Evaluation Review*, Vol. 25, No. 4, August 2001.

study encompasses the entire teacher education and development process, from admission to teacher education programs, through graduation, induction, and certification, to tenure. We put the entire length of the pipeline under examination and comparison. This "pipeline" model is described below.

This study would be most properly classified as an exploratory analysis or development of indicators about the teacher education and certification policies in a selected group of countries. It is not an evaluation of these policies nor an analysis that attempts to relate the policies to other aspects of the education system, like student achievement. Developing valid and reliable indicators is only a first step among several that could support the testing of hypotheses about the relationship, for example, between different teacher development practices and student achievement. Such studies would need to use controls for other factors that might play a role, including family background, community characteristics, curriculum, instructional methods, and so on. While data on teacher preparation alone will never be *sufficient* to test hypotheses about student achievement, they are likely to be *necessary* to include in a truly comprehensive analyses of student achievement.

A Model of Teacher Education and Certification Policy

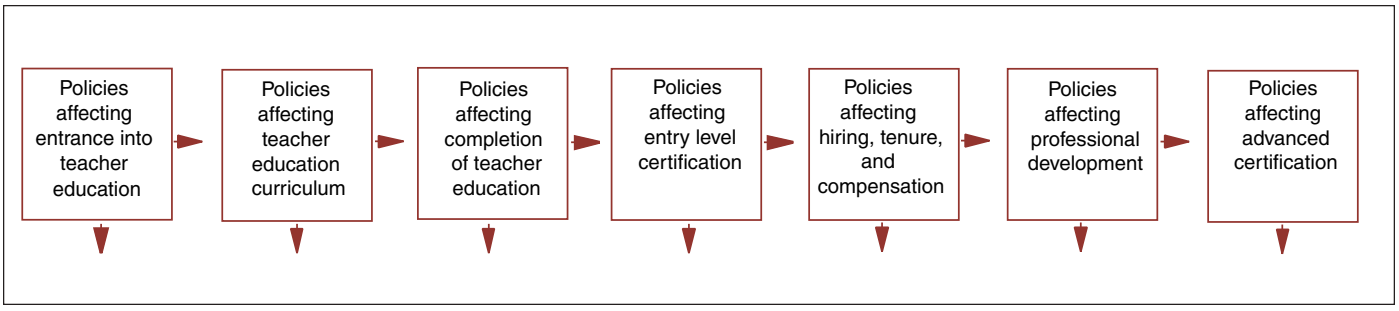
Figure 4 illustrates a "pipeline" model, adapted from one developed in earlier ETS research, that identifies various points where "filters" or "screens" can be installed to control the flow of individuals into and through the teacher education and certification system.[16]

The authors used this model as a guide for structuring the questionnaire development. Once drafted, the survey instrument was reviewed and then revised based on suggestions from representatives of leading teacher education and research organizations, such as the American Association of Colleges for Teacher Education (AACTE), the National Council for Accreditation of Teacher Education (NCATE), and the Educational Testing Service.

The questionnaire included the following thematic sections:

- Control and governance
- Standards for entrance into and exit from teacher education programs

Figure 4: Policy Model of the Teacher Supply Pipeline



[16] Margaret E. Goertz, Ruth B. Ekstrom, and Richard J. Coley, *The Impact of State Policy on Entrance into the Teaching Profession,* National Institute of Education, Princeton, NJ: Educational Testing Service, October 1984.

- Characteristics of the education programs for eighth-grade mathematics and science teachers
- Certification requirements
- Availability of advanced certification
- Alternative teacher certification programs
- Hiring and compensation
- In-service and professional development requirements

Selection Criteria

The initial criteria for selection into this study were: the country outperformed the United States on the TIMSS 1999 mathematics or science assessment, and it had an integrated curriculum in science at the eighth grade.[17] Eight countries met these criteria. The Netherlands also scored higher than the United States, and, although it does not have an integrated eighth-grade science curriculum,[18] it was included in the study because it can provide important contrasts. Finally, while Canada met the selection criteria, officials there were unable to participate in the study.

As a result of this selection process, eight countries participated in the study: Australia, England, Hong Kong, Japan, Korea, the Netherlands, Singapore, and the United States. While this study focuses on their teacher education and development policies, it is important to recognize that these countries differ in a number of areas. Appendix A provides a basic demographic profile.

Survey Methodology

At least two contacts in each participating country were identified on the basis of expertise in teacher education and certification policy, willingness to participate, and proficiency in English. These sources typically work in ministries of education, leading educational research organizations, or research universities. At least one contact in each country completed a detailed questionnaire on teacher education and certification policies, provided references to relevant materials, and responded to additional questions.

All selected countries responded. Responses to the questionnaire were combined with other relevant information into summary documents for each country. The summary sheets were then reviewed for accuracy and thoroughness by each country's original respondent(s).

The following sections of this report describe the survey findings—comparing eighth-grade mathematics and science teacher education and certification policies and practices.

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17 In an integrated science curriculum, science is taught as a single, general subject, as opposed to separate courses in different science subjects.

18 Eighth-grade students in the Netherlands can choose to take biology, chemistry, or other science courses, while students in other participating countries would be taking a more general science course.

Teacher Education

Governance

Who is responsible for teacher education and certification? What aspects are regulated?

United States. The United States has a decentralized system of teacher education and certification, in that each state is responsible for initial credentialing of its teachers. Some states refer to this initial credential process as certification. Certification requirements vary greatly across the states, depending on local needs and available resources. However, there are probably more commonalities than differences in state teacher education and certification systems. This is due, in part, to the existence of national accreditation bodies like NCATE that have established standards for teacher education and certification programs.[19] NCATE has been recognized by the U.S. Department of Education and the Council for Higher Education Accreditation as the professional accrediting body for teacher education programs. NCATE's professional standards for entry into the program include demonstrating content knowledge, pedagogical content knowledge, and a focus on student learning.[20]

Other Countries. In contrast to the United States, the other nations surveyed have more centralized systems of teacher education and certification, with the exception of Australia. As in the United States, education in Australia is a state responsibility. Teacher registration is carried out by statutory teacher registration bodies in four states and two territories. The registration bodies do not conduct any formal assessments in addition to, or separately from, those of the universities. Only teachers who are registered are permitted to teach in those states that have registration bodies. In the two states that do not have registration bodies, teachers must meet employers' requirements for employment.

Among the centralized systems, governance of teacher education and certification may be the responsibility of one government agency or multiple agencies. In Japan, Hong Kong, Korea, and Singapore, the Ministry of Education or department of education governs almost all aspects of the teacher education and certification process. In the Netherlands, the responsibility is shared between the Ministry of Education and the Inspector of Education. The Ministry sets minimum guidelines on entry and exit requirements and curriculum content for teacher education programs, while the Inspector monitors compliance with these guidelines.

In England, several national departments and agencies share responsibility for teacher education and certification, including the Teacher Training Agency, the Department for Education and Skills, the Office for Standards in Education, and the General Teaching Council for England. These agencies regulate various aspects of the teacher education and certification process, including accreditation of teacher education programs, entry and exit requirements, initial certification, and induction programs.

Providers of Teacher Education

What types of institutions prepare teachers? How many are there? Is teacher education provided at the undergraduate or graduate level?

United States. Across the states, there are approximately 1,500 teacher education programs,

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19 While NCATE accreditation is voluntary, a recent survey of 50 states found approximately 1,400 teacher education programs received approval or accreditation based on either state, regional, or NCATE standards (National Association of State Directors of Teacher Education and Certification (NASDTEC), *Manual on the Preparation and Certification of Educational Personnel, 7th Edition*. Sacramento, CA: School Services of California, 2002.)

20 Though NCATE is the largest, there are other accrediting bodies, both regional and national, for teacher education programs (e.g. Teacher Education Accreditation Council (TEAC)). National Council for Accreditation of Teacher Education, *Quick Facts: About NCATE*. Retrieved October 4, 2002. Available at www.ncate.org/ncate/fact_sheet.htm. National Council for Accreditation of Teacher Education, *Professional Standards for the Accreditation of Schools, Colleges, and Departments of Education,* Washington, DC, Retrieved October 1, 2002. Available at http://www.ncate.org/2000/unit_stnds_2002.pdf.

and almost all of them provide mathematics and science education programs.[21] Most are four-year undergraduate programs, but some five-year programs exist that add a fifth year to a standard undergraduate liberal arts program.[22]

Other Countries. All of the nations surveyed offer programs for prospective eighth-grade mathematics and science teachers at the undergraduate and graduate levels at colleges and universities. The only exception is England, where a small number of institutions, such as school-centered initial training providers, provide teacher education. Singapore is the only participating country that requires all prospective teachers to complete a graduate program for initial certification. Japan requires prospective teachers to complete an undergraduate teacher certification program and offers graduate programs to teachers who seek advanced certification.

The Netherlands provides teacher education through two different programs, depending on the academic track of the students they will teach. For teachers preparing to teach non-university-bound students, teacher education is provided at the undergraduate level through the professional colleges. For teachers preparing to teach university-bound students, teacher education is provided at the graduate level through universities.

Across the countries participating in this study, the number of teacher education providers ranges from one in Singapore to approximately 1,500 in the United States. The Singapore National Institute of Education's Nanyang Technological University is the country's only teacher education institution. In the Netherlands, teacher education programs are offered by 12 public universities and 13 professional colleges. In Australia, 35 institutions offer teacher preparation courses. In England, there are 123 initial teacher training institutions. In Japan, a total of 138 institutions were approved for mathematics teacher education and certification, and 149 institutions for science.

Entry Requirements: Undergraduate Level

What are the requirements for entry into undergraduate teacher education programs?

United States. There is wide variation across U.S. states and higher education institutions in entry standards for undergraduate mathematics and science education programs and in their enforcement.[23] In some instances students may begin teacher education coursework upon enrolling at the undergraduate institution. In other cases, prospective education students must complete two years of general or liberal arts studies and then apply for admission into the teacher education program. Some institutions require that prospective students pass an examination, such as Praxis I (a basic academic skills test for prospective teachers), before enrolling in the teacher education program.

In general, the majority of teacher education programs now require a minimum college GPA, recommendations, interviews, and experience working with children as requirements for entry. Many institutions also require prospective candidates to pass a basic skills test.[24] In fact, a recent survey found that 28 states required an exam for entry.[25]

Other Countries. Across the nations surveyed, there are important differences in entry requirements for teacher education programs, by level of program and criteria used. However, competency in mathematics and science knowledge is typically required, as demonstrated by grades and/or examinations. Entrance requirements are summarized in Table 1.

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[21] National Center for Education Statistics, *Digest of Education Statistics, 2001,* U.S. Department of Education, NCES 2002-130, Washington, DC, 2002.

[22] American Council on Education, *To Touch the Future: Transforming the Way Teachers Are Taught: An Action Plan for College and University Presidents*, Washington, DC, 1999.

[23] National Commission on Teaching & America's Future, *What Matters Most: Teaching for America's Future,* New York, NY, 1996.

[24] Emily Feistritzer and D.T. Chester, *The Making of a Teacher: A Report on Teacher Preparation in the U.S.,* Washington, DC: National Center for Education Information, 1999.

[25] NASDTEC, 2002.

Most nations require prospective teacher candidates to pass a competitive national high school subject area examination in addition to exceeding a minimum high school grade point average threshold. England, Japan, and Hong Kong require prospective teachers to pass competitive national examinations in multiple subject areas. In England, candidates must have, at a minimum, passes in English and Mathematics at grade C or above on the General Certificate of Secondary Education, a test given in high school.

In Japan, all candidates must take the National Entrance Examination, which is composed of five areas: Japanese language, foreign language, mathematics, the sciences, and social studies. Candidates scoring highest on the National Entrance Examination are most likely to attend the most prestigious teacher education programs. Most national universities also administer their own entrance exams in addition to the National Entrance Examination. Each undergraduate program can have its own exam, which consists of specific subjects (i.e. the mathematics major program may have an advanced mathematics exam). Performance on both types of exams is considered when determining whether or not to accept an applicant. In some cases, interviews are also used as an entrance requirement.

In Korea, entry requirements for teacher education programs are based on students' senior high school records (achievement level in each subject area and homeroom teacher's recommendation) and their performance on the Scholastic Assessment Test (SAT). Higher education institutions also interview incoming students and ask them to take tests of teaching attitudes and ethics.

Table 1: Entrance Requirements for Teacher Education Programs

	Undergraduate				Graduate		
	Basic Skills Test	Interview	National Subject Area Exam	High School Record	Bachelor's Degree	Bachelor's Degree in Subject Area	Examination
Australia				X[b]	X		
England			X		X		X
Hong Kong			X			X	
Japan			X				
Korea	X[c]			X			
Netherlands						X[d]	
Singapore[a]						X	X
United States	X[e]	X		X	X		

[a]Teacher education is studied at the graduate level.
[b]The university entrance score may include some combination of high school course performance and state test.
[c]The SAT is the test used.
[d]Master's degree in education is required.
[e]28 states require a basic skills test as a prerequisite for some or all applicants (Feistritzer and Chester, 1999).

Australia also has entry requirements based on students' performance in secondary school. Each student has a university entrance score that is calculated based on an amalgam of marks attained on assessments and examinations of the final year of secondary schooling and, for some states, results from a state-wide assessment. Each university sets its own cut scores for acceptance with more competitive programs having higher cut scores than less competitive programs. Teaching courses in some universities require a higher score than in others.

In most other countries, too, university entry is more difficult than it is in the United States. Fewer places are available for students, and these slots are often allocated through high-level and high-stakes upper secondary examinations and individual university entrance exams. Since entry to teacher education programs usually requires university student status first, the relative difficulty of university entry is pertinent to any comparison of the rigor of teacher education program entry across countries.

Entry Requirements: Graduate Level

What are the requirements for entry into graduate teacher education programs?

United States. Graduate-level teacher education programs in the United States require at least a bachelor's degree. Compared with the other nations surveyed, these programs have the least stringent and most varied requirements for subject content mastery.

Other Countries. By contrast, most of the other countries surveyed require an undergraduate degree and, in some cases, a master's level degree in the subject area (see Table 1). For instance, Singapore requires students entering graduate-level teacher education programs to be university graduates with degrees and at least an A or B grade on the Singapore-Cambridge General Certificate of Education (GCE) Advanced "A" Level Mathematics/Science subjects, which is taken at the end of Grade 12.

Hong Kong requires prospective candidates to be university graduates with a major in the chosen area. England requires a university degree or its equivalent and at least a C grade or above on the national high school examination in English and mathematics. Although England formerly required a degree in the subject content area, new requirements effective September 2002 do not. Entry requirements for graduate study are especially rigorous in the Netherlands: a master's degree in the subject area prior to a 12- to 18-month graduate level teacher education program.

Mathematics and Science Teacher Education Curriculum

What courses or curriculum are required in teacher education programs? What is the balance between courses in mathematics and science and courses in education and pedagogy? What are the differences between undergraduate and graduate programs? Who determines the requirements?

United States. In the United States, the curriculum content of teacher education programs is determined by individual teacher training institutions, within the context of state and national accreditation policies.

There are similarities across institutions, however. In addition to subject area content courses, institutions typically require courses on education theory and pedagogy and some student teaching experience. Courses in special education, health and nutrition, and computer science may also be required.

Math and science majors in university liberal arts colleges focus on mathematics and science content knowledge and theory in addition to a number of liberal arts requirements. At most universities, the content courses for majors are more numerous and can be different than those taken by teacher education majors.

A typical undergraduate teacher education program might consist of 120 credit hours (the average required for graduation from most undergraduate liberal arts programs), or 134 credits (required to complete an undergraduate teacher education program). On average, 51 credits of general studies, 38 credits of major credits (includes courses in

certification teaching subject area), 28 credits of professional studies (includes school, college, or department of education courses), and 14 clinical credit hours (includes student teaching and other field-based experiences) are required to complete initial preparation for middle-school teaching.[26]

Some national organizations have developed standards for mathematics and science teacher preparation programs, and these documents can be quite lengthy and detailed (an example would be the standards developed by the National Science Teachers Association). The nature of those standards is the source of some controversy, however. The teacher preparation standards do not make any specific references to content knowledge but, rather, tend to emphasize preparing teachers to behave in certain ways in the classroom and manage certain instructional processes in a certain manner. Content knowledge, after all, is presumed to be assured by the passage of course requirements and, in some states, subject matter tests.[27]

Other Countries. In all of the countries surveyed, individual teacher education institutions determine the curriculum content of their degree programs for mathematics and science teachers. The curriculum is then approved or accredited by a national agency in all but the two federal countries, the United States and Australia, where independent national organizations and state statutory committees accredit (see Table 2).

The curricular content of teacher education programs can differ by level, with undergraduate teacher education programs focusing on both content knowledge and pedagogy. Graduate teacher education programs typically last one to two years and focus on pedagogy and practice.

For instance, in Japan, the curriculum typically consists of general education (26 credit hours) and professional education (20 credit hours in content courses, 22 credit hours in education courses, 12 credit hours in methods, 40 credit hours in other education electives, and 5 credit hours in student teaching).

Similarly, in Korea, prospective teachers must take at least 42 credits in their subject area, 14 credits in general education, 4 credits in subject-related pedagogy, and 80 credits of electives including methods. Hong Kong has a stronger emphasis on content knowledge, requiring students in the four-year Bachelor of Education (secondary) programs to minor in mathematics or science.

In Singapore, the Postgraduate Diploma in Education program consists of education modules, curriculum modules, a practicum, and the use of English in teaching, as well as two modules of

Table 2: Organizations Responsible for Reviewing and Approving Teacher Education Curriculum

Australia	Independent national organizations; state statutory committees
England	Teacher Training Agency
Hong Kong	Department of Education
Japan	Council for Educational Personnel Training
Korea	Ministry of Education
Netherlands	Inspector of Education
Singapore	Ministry of Education
United States	Independent national organizations; state statutory committees

[26] Feistritzer and Chester, 1999.

[27] For example, see U.S. Department of Education, Office of Postsecondary Education, *Meeting the Highly Qualified Teachers Challenge: The Secretary's Annual Report on Teacher Quality,* Washington, DC, 2002.

content-specific pedagogy. In the Netherlands, the 12- to 18-month graduate level teacher education program offers practical experience for interested teachers who have a master's degree in mathematics or in one of the sciences (e.g. physics, biology, or chemistry).

Exit Requirements

What requirements must be met to complete the teacher education program? Who determines these requirements?

United States. In the United States, exit standards for mathematics and science teacher education programs vary by state and institution, and are generally determined at the institutional level. Standards typically include such things as an adequate GPA, completion of required courses, and student teaching. In addition, virtually all institutions require passage of a content area test for completion of their teacher education programs. The types of tests used and the minimum scores required for passing vary considerably, however, with some states setting very low cut-scores.

Other Countries. Similar exit requirements are found across all nations studied, typically set by individual institutions and including completion of required courses and passage of classroom and institution examinations. For instance, in Australia, the exit standards for teacher education programs include examinations, assignments, a teacher practicum, and other forms of assessment. In Japan, prospective teachers who have completed the required set of courses above the pass level, graduate from the program with a bachelor's degree. In Singapore, the exit requirements are written tests, project assignments, fieldwork, and practicum in school. England is the only country studied that requires prospective teachers to take a national test in literacy, numeracy, and information and communication technology.

Practical Experience

What kinds of classroom experiences are required? What is the nature and duration of these requirements?

United States. In the United States, there are two types of practical experiences for teacher candidates: field experiences and student teaching. Program specifics vary by state and institution. Field experiences normally consist solely of observations and are required by most states prior to student teaching.[28] Other prerequisites for student teaching may include the completion of specific courses and an adequate GPA.

A university faculty member and a classroom teacher, or the school principal, typically supervise a student teacher. Student teachers may first spend time in the school observing classes and assisting teachers. They are then paired with an experienced teacher, who likely is paid for assuming the supervisory role. The length of time required for student teaching ranges from six weeks in Louisiana to a semester or more in Minnesota and Wisconsin. A recent survey found 21 states requiring at least 12 weeks.[29] Student teaching evaluation practices also vary by state.

Other Countries. All countries surveyed require student teaching or other in-school practical experiences. The duration of the practical experience ranges from three to four weeks in Japan, to 12 to 18 months in the Netherlands (see Figure 5). Supervision and evaluation of the practical experiences is most often shared among several individuals, including a university faculty member, an experienced teacher, and sometimes the principal of the school.

In Korea, students are required to teach full-time for four to six weeks toward the end of their teacher education program. In Hong Kong, students are required to teach a minimum of eight to ten weeks before graduation. In Australia, all programs require a

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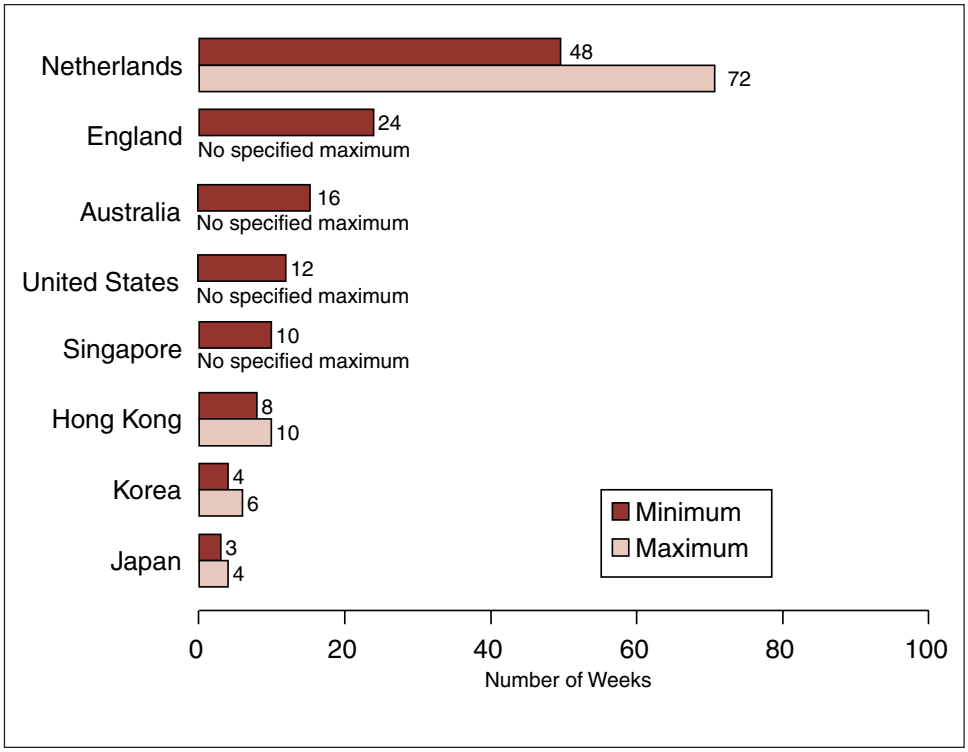
[28] Except for Arizona, Connecticut, Florida, Idaho, Maine, New Jersey and Rhode Island (NASDTEC, 2002).
[29] *Education Week*, October 8, 2002.

Figure 5: Duration of Practical Experience Requirement



supervised practical teaching experience in schools for a period of no less than 80 days. In Singapore, prospective teachers are required to participate in a compulsory practicum (nine weeks) and school experience (one week). In England, prospective teachers are required to student teach for at least 24 weeks.

Supervision and evaluation of the student teaching experience also vary across countries. In Korea, student teachers are supervised and evaluated by an experienced classroom teacher, principal, and university advisor. Similarly, in Japan, student teachers are supervised and evaluated by an experienced teacher under the approval of the principal; in addition, a committee composed of members from the teacher education program formally examines these evaluations. In Singapore, the practicum is supervised by specially selected collaborating teachers and by professors. Principals can choose to sit in to observe trainees in the classroom.

In Hong Kong, field experience performance is assessed via supervisor ratings and a portfolio that includes observations, reflections on classroom teaching, and reflective teaching journals. In one of the teacher programs, lecture staff conduct nine supervisory visits of student teachers during the two-year period.

In England, student teachers are observed, evaluated, and supervised by experienced teachers and staff from the higher education institutions. In the Netherlands, student teaching is supervised by university staff and evaluated by school staff. Prospective teachers teach part-time, observe other teachers, and are, in turn, observed by other teachers.

In Australia, student teachers are supervised and formatively evaluated by an experienced teacher. Their practicum includes a variety of experiences in addition to teaching (e.g., observation of lessons, conferences with teachers), including participation in extracurricular and professional development

activities. The university determines the evaluation criteria. Though the summative assessment is legally the responsibility of the school principal, in practice the supervising teacher typically exercises this responsibility, in consultation with visiting university staff observers.

Degree Earned

What degrees are awarded upon completion of teacher education programs? In what fields are they awarded?

United States. At the completion of traditional education programs for beginning eighth-grade mathematics and science teachers, U.S. graduates are awarded a bachelor's or a master's degree, depending on whether they completed their teacher training at the undergraduate or graduate level. All graduate degrees are in education, while undergraduate degrees may be in education or in an arts and sciences field.

Other Countries. Similarly, across all countries surveyed, graduates receive a bachelor's degree or a master's degree depending on the level of teacher education program completed. At the graduate level, most countries award a graduate degree in education (see Table 3).

Table 3: Teacher Education Degree Titles

	Undergraduate	Graduate
Australia	Bachelor of Science (B.Sc); Bachelor of Education/Bachelor of Science (B.Ed./B.Sc.) (double degree in education and science/mathematics; Bachelor of Education in Secondary (B.Ed. Secondary) (4 to 5 year degree in secondary teaching)	Post-graduate Diploma of Education (PGDE); Graduate Diploma of Education (Dip. Ed.); Masters of Education
England	Bachelor in Education (B.Ed.); Bachelor of Arts with Qualified Teaching Status [B.A.(QTS)]	Post-graduate Certificate in Education (PGCE)
Hong Kong	Bachelor for Education (Secondary) (B.Ed. Secondary); Bachelor of Science (Mathematics and Information Technology Education) (B.S. Mathematics/IT); Certficiate in Education (CE)	Post-graduate Diploma in Education (PGDE); Post-graduate Certificate in Education (PGCE)
Japan	Bachelor's Degree	Not applicable
Korea	Bachelor of Science (B.S)	Master's
Netherlands	Bachelor's Degree with restricted certification	Master's Degree in Mathematics or Science
Singapore	Not applicable	Post-gradate Diploma in Education (Secondary)
United States	Bachelor in Education, Science, or Arts	Master's in Education

Teacher Certification

Initial Certification

What are the requirements for the initial certification of teachers? Are tests used? Who sets the standards? For how long is the initial certificate valid?

United States. In the United States, individual states are responsible for certifying or licensing teachers. Most states award an initial teaching certificate after completion of an approved program of required courses, student teaching experiences, background checks, and successful passage of the state teacher licensing examination. States set their own cut scores on these examinations.

Requirements for initial certification vary widely in terms of the number of credit hours required in particular subject areas, the content of the licensing exam, and the acceptable exam passing score. Twenty-three states require at least 30 credits in a subject area or a subject area major. Thirty-seven states require passage of a basic skills test, 29 a test of subject knowledge, and 24 a subject-specific pedagogy exam; in addition to completion of a specified level of coursework.[30]

The teacher licensing exam used by most states is the Praxis Series: Professional Assessments for Beginning Teachers® developed by the Educational Testing Service. The Praxis Series consists of three parts: an academic skills assessment (Praxis I) commonly used for entry to teacher preparation programs; an assessment of content knowledge (Praxis II), most often used as a teacher licensing exam; and a classroom performance assessment (Praxis III) administered during the first year of teaching. Thirty-seven states use either the Praxis I or II as their teacher licensing exam.[31] Another teacher licensing exam that is used by some states is developed by National Evaluation Systems.

In most states, once a prospective teacher completes an approved program, passes the state licensure exam, completes a criminal background check, and obtains child abuse clearance, he or she is awarded an initial certificate, valid for approximately two years. In some states the initial certificate is not renewable. After expiration, teachers must apply for a standard or regular certificate and face additional requirements—usually some type of performance-based assessment and a specified number of classroom teaching hours.

Other Countries. The process of initial teacher licensure in the comparison nations is different (see Table 4). In fact, of all the countries in the study, England is the only one that requires a separate licensure examination in addition to the examinations given by the teacher education institution. In England, prospective teachers must pass the Teacher Training Agency's skills test in order to obtain Qualified Teacher Status (QTS). With QTS, teachers are certified to teach all age groups, from pre-school through secondary education.

Hong Kong and Singapore impose no additional certification requirements beyond the education and curriculum requirements described previously. Initial teacher certification is valid for life with no need for renewal. In the Netherlands, the letter or diploma the student receives from the university or college serves as the teaching certificate. University graduates may teach either lower or upper secondary school. Professional college graduates may only teach lower secondary school.

In Japan, the Board of Education of each Prefecture issues teacher certificates after approving the university course credits. In Korea, the initial teacher's certificate is awarded by the university after completion of its program.

The initial teaching certificate, then, is valid for life in all of the countries except the United States and Australia, where a specified length of teaching experience serves as prerequisite for a permanent license. Thus, the initial or provisional license serves as an indication that the teacher has completed all of the preparation necessary to begin teaching. The perma-

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30 *Education Week*, October 8, 2002

31 *The Praxis Series Registration Bulletin*, 2002-2003.

Table 4: Initial Certification Status

	Additional Requirements Beyond Teacher Education Program	Valid for Life
Australia		X[a]
England	X	
Hong Kong		X
Japan		X
Korea		X
Netherlands		X
Singapore		X
United States	X[b]	X[b]

[a]Must be renewed annually by payment of a fee. The length of time required before renewal varies among states and ranges from every year to every three years.
[b]Over 40 states have additional requirements for obtaining a second-stage certificate, which is required in 30 states (NASDTEC, 2002).

nent license is only granted after the teacher has demonstrated his or her teaching ability. Although valid for life, periodic renewal of certification by payment of a fee is required in some Australian states.

Advanced Certification

Is certification beyond the initial level available? Is it required or voluntary? How is it obtained? What incentives are offered for teachers who pursue advanced certificates?

United States. Advanced certification in the United States is voluntary, offered by the National Board for Professional Teaching Standards (NBPTS), a voluntary professional certification board. Key components include a candidate's assembly of a portfolio and participation in on-demand tasks at assessment centers.

Some states also offer a master teacher certificate, a voluntary certification issued to teachers demonstrating advanced competency and achievement. In some jurisdictions, NBPTS certification may be a prerequisite for a master teacher certification. This type of advanced certificate is usually held in conjunction with a professional license and often extends the validity of the professional license. Master teachers often provide mentoring to other teachers and play roles in curriculum development and other leadership activities. Incentives for achieving advanced certification vary by state, but usually include salary increases or bonuses and promotions.

Other Countries. Most nations in this study offer some form of advanced certification, Australia, Hong Kong and the Netherlands excepted (see Table 5).

England provides two routes to advanced certification: Threshold and the Advanced Skills Teacher (AST). The "Threshold" is a means to reward good teaching by enabling experienced and effective teachers access to an upper pay scale. Introduced in England and Wales in September 2000, two pay ranges are available for classroom teachers; a performance threshold at the end of the first range gives high-performing teachers access to a second range. In other words, teachers who have reached the top of the main pay scale are eligible to apply for a performance assessment against the national "threshold" standards and, if they are successful, they move to the beginning point on the upper pay scale.

The AST route allows excellent teachers to progress as classroom teachers, without taking on management responsibilities, and to be rewarded

Table 5: Availability of Advanced Certification

	Advanced
Australia	
England	X
Hong Kong	
Japan	X
Korea	X
Netherlands	
Singapore	X
United States	X

accordingly. It requires teachers to participate in an external assessment before being appointed to an AST post. ASTs spend 80 percent of their time in teaching their own classes and 20 percent working with teachers from other schools on their classroom organization and teaching methods, and developing teaching materials.

In Singapore, the advanced certification process is more centralized. The University, in consultation with the Ministry of Education, administers in-service courses and postgraduate degree programs. It offers Advanced Postgraduate Diplomas in Guidance and Counseling, Life Sciences, and Science Education. In-service courses can be taken at any time after a teacher has received certification. All teachers in Singapore are entitled to 100 hours per year of training paid for by the Ministry of Education. Professional degrees, such as M. Ed. (Mathematics Education) require two years of teaching experience. The Institute also offers a Ph.D. program. All advanced training is voluntary and portends no immediate salary increase. However, additional qualifications are taken into consideration when a teacher seeks promotion.

Similarly, in Japan, the Ministry of Education and/or Boards of Education in each Prefecture establish voluntary advanced certification policies for teachers. Japan is unique in its requirement of enrollment in a Master of Education program at an accredited university. Two routes to advanced certification are available in Japan. The first is through selection by the Board of Education of the Prefecture, and is very competitive. Every year, about 10 in-service teachers are accepted. Normally, these teachers receive 12 months (in some cases, 24) of paid leave. The Board of Education subsidizes the schools so they may hire instructors to cover the in-service teachers' classes for a year. Those who take 24 months of leave go to campus a half-day per week to meet with their supervisor-professors, as required for a Master's degree. Other teachers in their school compensate for their release time.

The second option is very new. Teachers seeking advanced certification apply for a "study leave" without pay for a maximum of two years without losing their teaching position. In this case, the school hires an interim instructor with money from the Board of Education. Although the Ministry of Education recommends this option, to date few teachers have taken advantage of it.

Korea's voluntary system of advanced certification is established and regulated by the Ministry of Education. After three years of teaching, teachers are eligible for 180 hours of training at programs approved by the Ministry of Education. Upon successful completion, they become "full" teachers with a better chance for later promotion to head teacher (an administration position), and a small salary increase.

In Australia, no professional body has responsibility for advanced certification nor is the term "advanced certification" commonly used.[32] Teachers may choose to pursue graduate study or advanced professional development but, unlike in the United States and England, there is no link to any possible salary increase should they do so.

[32] In the late 1980s Australia attempted to set up a new voluntary career structure for teachers working in the state education systems. This was called the Advanced Skills Teacher (AST) classification. It envisaged three levels—AST1, AST2, and AST3—which would provide a classroom-based, non-administrative career path for teachers (of all subjects at all grades) based on teachers' ability to demonstrate advanced teaching skills. Some states still have a form of AST, but on the whole, the initiative failed. For the states that still have AST, these teachers receive salary increases in the order of $3,000 to $5,000 (Australian) over two or three years.

Alternative Certification

Are there ways for individuals to become teachers outside of traditional teacher education programs? How do these operate?

United States. In response to critical teacher shortages in the United States, often in low-income school districts and in certain fields, such as mathematics and science, 45 states and the District of Columbia offer alternative teacher certification programs.[33] A recent survey estimated that more than 175,000 persons have been licensed through these programs, most of them in just the past several years.[34]

The alternative certification route typically provides on-the-job training to college graduates who are placed in teaching jobs and offered the necessary coursework, support, time, and supervision required for full certification. This training ranges from intensive summer programs to year-round programs that mirror regular teacher education programs. Most often, prospective teachers pursuing alternative certification have a bachelor's degree in a subject other than education, but have neither taken any education courses nor done any student teaching. Requirements for full licensure vary widely across states, depending on regional needs and local resources.[35] However, most states require that alternative route candidates achieve a passing score on state examinations and take additional coursework before a teaching credential is issued.

Alternative teacher certification programs are growing in popularity as many states use them to increase their pool of teachers from under-represented cultural groups; meet the staffing needs of urban and high-poverty schools; and attract mid-career professionals to teaching by avoiding the lengthy and arguably cumbersome certification process.[36] A number of such programs exist, such as Teach for America, Troops to Teachers, and Transition to Teaching.

Other Countries. England is the only other country with alternate teacher certification, with four alternate routes to Qualified Teacher Status (QTS): the Graduate Teacher Program, the Registered Teacher Program, the Fast Track Recruitment Initiative, and the Flexible Graduate Postgraduate Teacher Training. Approximately 5 percent of QTS teachers receive their certification through these alternate routes. As in the United States, these alternate routes were designed to encourage other individuals to enter the teaching profession. These employment-based routes enable schools to employ teachers who are not yet qualified and to support them through an individual training program leading to Qualified Teacher Status.

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33 National Association of State Boards of Education, *The Numbers Game: Ensuring Quantity and Quality in the Teaching Workforce,* Alexandria, VA, 1998.

34 Feistritzer and Chester, 2002.

35 NASBE, 1998.

36 NASBE, 1998.

Continuing Education and Support

Beginning Teacher Induction

Are there support programs for new teachers? How do they operate?

United States. In much of the United States, new teachers become oriented to their school when they first start teaching. These orientations tend to last, at the most, a few days. Many school districts also offer structured support programs for beginning or first year teachers. Recent analysis of national data on American teachers found that 56 percent of public school teachers in their first three years of teaching have participated in a formal beginning teacher support program.[37] These systematic efforts to support beginning teachers are known as induction programs and may involve a mentor or experienced teacher working with the beginning teacher.

There is a wide variety in induction program policies and components, however.[38] According to a recent review, only 22 of the 33 states with policies fund and mandate induction programs, and most of these states allow exemptions to participation that prevent many new teachers from receiving this support.[39]

A review of state induction policies and programs found that induction programs vary across these dimensions: availability and length of training for mentors or support teams, focus and degree of structure for the beginning teacher, availability and extent of additional funding, evaluation of the beginning teacher, evaluation of the induction program, and voluntary status of individual and district participation in the program.[40]

In sum, although many states have induction policies, the overall support for new teachers in the United States is fragmented due to wide variation in legislation, policy, and type of support available.

Other Countries. The existence or character of beginning teacher induction programs in other countries can vary for several reasons, but a key reason is the potential for overlap of functions across the three stages of teacher education, induction, and ongoing professional development. For example, some training systems may require a long period of practice teaching with a mentor before a teaching credential is awarded, while other systems may require the same after the credential is already obtained. In the former case, the mentoring activity is part of the teacher education process; in the latter, it is part of the teacher induction process.

Of the countries surveyed, only Korea and the Netherlands do not provide new teacher support programs (see Table 6). In Hong Kong, there is no national policy, and participation in such programs is not required, but the state does offer seminars and workshops oriented toward new teachers. In England and Singapore, the support programs are required by the national government; in Japan and Australia, they are required by the state (prefecture in Japan). In England and Australia, programs are organized by individual schools and not monitored. In Japan, programs are closely monitored, while Singapore's formal induction program is run by the national ministry itself.

Most teacher induction support programs consist of two separate components: in-school tutoring and mentoring, and out-of-school inservice workshops and seminars. In-school mentoring is common in England, Australia, and Japan, but is only closely monitored by the state in Japan. Out-of-school workshops and seminars are provided by all countries with induction programs, but are not mandatory in Hong Kong and not closely monitored in England or Australia.

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37 E. Hirsch, J.E. Koppich, and Michael S. Knapp, *Revisiting What States Are Doing to Improve the Quality of Teaching: An Update on Patterns and Trends,* Seattle, Washington: University of Washington, Center for the Study of Teaching and Policy, February 2001.

38 National Commission on Teaching & America's Future, 1996. American Federation of Teachers, "Beginning Teacher Induction: The Essential Bridge, *AFT Educational Issues Policy Brief*, 13, 1-13, 2001. Aubrey H. Wang, Alison Tregidgo, and Venus Mifsud, *Analyzing State Policies and Programs for Beginning Teacher Induction: A Comprehensive Framework* (RR-02-21), Princeton, NJ: Educational Testing Service, Research Report, 2002.

39 American Federation of Teachers, 2001.

40 NASDTEC, 2002.

Table 6: Continuing Education and Support

	Beginning Teacher Induction	Professional Development
Australia	Required	Required
England	Required	Voluntary
Hong Kong	Voluntary	Voluntary[a]
Japan	Required	Required
Korea	No program	Required
Netherlands	No program	Voluntary
Singapore	Required	Voluntary
United States	Varies[b]	Required[c]

[a]Required for those teachers seeking promotion.
[b]16 states require and finance induction programs for teachers, and 30 have programs (Education Week, *Quality Counts 2003: "If I Can't Learn From You*," January 9, 2003)
[c]43 states issue a life credential and all professional development after that is up to the employer and/or the teacher (NASDTEC, 2002).

Teachers may be compensated for their participation in induction programs in either of two ways: by payment above their regular salary or by reduced workload. Of the countries with induction programs, only Hong Kong requires teachers to pay fees for participation and, even there, the fees are usually either partially or fully reimbursed. Singapore provides a 2-day workshop before the school year starts. England, on the other hand, mandates first-year teachers to have a 10 percent reduced workload, and Japan mandates a day per week free for 30 weeks. Compensation policies are left up to the individual schools in Australia.

Professional Development

Are there additional educational programs or opportunities for practicing teachers? Are they required or voluntary? Are there incentives for participation?

United States. Some states issue a life teaching credential, and all professional development after that is up to the employer and/or the certificated staff member. Other states issue a permanent credential that must be verified periodically by the employer to ensure that the teacher has met the school district's professional development requirements. Other states require verification of professional development for renewal of the certificate. Delaware, Hawaii, Nebraska, New Mexico, and New York are the only states that do not require professional development.[41]

For decades, professional development programs in the United States largely have been organized by individual schools or districts and, typically, have consisted of one-day long or evening workshops scattered throughout the school year, on a wide variety of topics. In some districts and states, longer workshops might precede the school year, particularly when a major new program is being introduced. Some have criticized this system for its alleged sporadic and incoherent nature, lacking in alignment and adequate follow-up procedures.[42]

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[41] NASDTEC, 2002.

[42] M. Fullan and S. Steigelbauer, *The New Meaning of Educational Change,* New York: Teacher's College Press, 1991. Laurie Lewis et al., *Teacher Quality: A Report on the Preparation and Qualifications of Public School Teachers*, NCES 1999-080, U.S. Department of Education, National Center for Education Statistics, Washington, DC, 1999. J. Mullens et al., *Student Learning, Teacher Quality, and Professional Development: Theoretical Linkages, Current Measurement, and Recommendations or Future Data Collection,* (NCES 96-28), U.S. Department of Education, National Center for Education Statistics, Washington, DC, 1996.

A recent NCES survey of teachers on their professional development activities discovered the following:

- The most common topical focus of professional development activities was curriculum and performance standards, with educational technology integration, subject-area study, new instructional methods, and student performance assessment being the next most popular topics.

- Less common professional development topics concerned addressing the needs of disabled or limited-English proficient students, encouraging community involvement, classroom management and student discipline, and addressing the needs of students of diverse backgrounds.

- Given any of the topical areas mentioned above, with only one exception, the amount of time devoted to the topic during the year for any given teacher was, most commonly, about one day.

- More experienced teachers were less likely to participate in professional development activities concerning in-depth study of their subject area or classroom management, but just as likely to participate in other topics.

- 56 percent of teachers who participated in professional development activities indicated they were linked to other program improvement activities to a moderate or great extent. 44 percent indicated they were linked to no or only a small extent.

- 43 percent of participants asserted their professional development activities were followed by school administration support in applying what was learned to a moderate or great extent. 35 percent indicated the activities were followed by needed follow-up sessions or additional training to a moderate or great extent. 32 percent claimed the activities were followed by school activities in which teachers help other teachers put the new ideas to use to a moderate or great extent.[43]

Other Countries. All countries provide professional development opportunities, either through their education ministries or by providing teachers the free time or compensation to partake in the offerings of other providers (Table 6).

In Japan and Korea, the state or school district requires and operates professional development activities. In Japan, teachers participate in six-day workshops after their fifth and tenth years as teachers; in Korea, all third-year teachers must complete a formal ministerial training program of four consecutive weeks, six days a week, during their winter or summer break, with some financial aid available. The state of South Australia requires all teachers to participate in 30 hours of professional development each year. In Hong Kong, professional development participation is required only of those teachers who wish to attain higher rank.

In England, Singapore, and the Netherlands, teachers are encouraged to participate in professional development activities through the granting of paid leave each year: five days for teachers in England, 100 hours in Singapore, or over a month in the Netherlands. Teachers may use this time to pursue the offerings available from numerous providers, both public and private. Participation, however, is not monitored in the Netherlands.

Hong Kong and most Australian states have no formal requirements for participation. In Hong Kong, teachers who wish to partake in programs offered by the ministry can obtain partial reimbursement. In most Australian states, professional development requirements, activities, and compensation are the responsibility of each school, though some substantial participation is a fairly standard expectation of first-year teachers.

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[43] Basmat Parsad, Laurie Lewis, and Elizabeth Farris, *Teacher Preparation and Professional Development: 2000*, U.S. Department of Education, National Center for Education Statistics, NCES 2001-088, Washington, DC, 2001.

Teaching Profession

Hiring

Who is responsible for hiring teachers? What are the criteria?

United States. Schools and school districts are responsible for recruiting and hiring teachers. There are approximately 88,000 public elementary and secondary schools in 15,000 school districts that employ 2.7 million teachers throughout the nation. The size of these schools and school districts ranges from very small to very large, resulting in great differences in hiring needs and hiring processes.[44]

The system for recruiting and hiring teachers is not universal and has been characterized as fragmented by policy bodies like the National Commission for Teaching and America's Future. The most common hiring criteria are completion of an undergraduate program, an application, and an interview.

Even in geographic locations or in subject areas suffering from a shortage of qualified applicants, very few school districts offer differential incentives to attract teachers. In some cases, districts are restricted by labor contracts from doing so, in other cases, obtaining a waiver from the credential requirements from the state may seem an easier alternative.[45]

Other Countries. Hiring practices differ across the countries surveyed (see Table 7). In Korea, the school district decides whom to hire; in Japan, the prefecture (state) decides; and in Singapore, the Education Ministry does the hiring. The state makes decisions regarding permanent positions in most Australian states, through the mechanism of "Appointment Panels."

Korea's hiring criteria include the appropriate university degree and subject matter specialization, plus a teacher induction test (that only 40 percent pass, on average) including subject matter content (70 percent of the test) and pedagogical theory and

Vignette: Teacher Hiring Practices in Pennsylvania

In one of the few systematic studies of teacher hiring practices and procedures, Robert Strauss compiled the results from a Pennsylvania State Board of Education survey of every district superintendent, school board president, and union president. Some of his major findings include:

- *About 40 percent of current teachers attended high school in the district where they work;*
- *Only 49 percent of districts have written hiring policies;*
- *About one-third of districts fill full-time openings from substitutes or part-time teachers whom they already know. Another 14 percent of full-time positions are filled by within-district transfers;*
- *Only 25 percent of districts advertise openings outside of Pennsylvania; and*
- *Independent evidence on content knowledge and caliber of certifying institution was about as important in recruiting as indications of community involvement, willingness to assist in extracurricular activities, and non-teaching work experience.*[46]

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44 Feistritzer and Chester, 2002.

45 Susan P. Choy et al., *America's Teachers: Profile of a Profession*, U.S. Department of Education, National Center for Education Statistics, (NCES 93-025), Washington, DC, 1993.

46 Robert P. Strauss, "Who Gets Hired to Teach? The Case of Pennsylvania," in Marci Kanstoroom and Chester E. Finn, Jr. (Eds.), *Better Teachers, Better Schools,* Washington, DC: Thomas B. Fordham Foundation, July 1999.

Table 7: Level of Government at Which Teacher Hiring Decisions Are Made

	National Government	State Government	School District	Individual School
Australia[a]		X		X
England				X
Hong Kong				X
Japan		X		
Korea			X	
Netherlands				X
Singapore	X			
United States			X	X

[a]States hire for permanent positions; schools hire for contract positions.

methods (30 percent of the test). Hiring criteria in Singapore and Japan include an appropriate university degree, subject matter specialization, passage of a test of English language skills (Singapore only), demonstration of communication skills, proper attitude, and interviews.

In the other countries surveyed, the criteria used in hiring, and the weight given to each criterion, rest with the individual school. This is the case in Hong Kong, the Netherlands, England (subject to teacher union review), and Australia (for contract teachers).

Tenure

What is the job security status of teachers? Under what circumstances can teachers be terminated?

United States. In most states, teachers earn the right, after an average probationary period of three years, to continue teaching in their school district. It is very difficult to terminate a tenured teacher, and this action usually requires proof of misconduct.

Other Countries. Teacher tenure exists in all the other countries surveyed, and is generally automatic once one is hired into a permanent position. Most countries maintain some type of probation period, however. Only in Korea and Singapore, where the initial entry requirements are very tough, is tenure granted upon first hiring. In Japan, the probation period is one year, during which the new teacher must perform satisfactorily. In Hong Kong, the probationary period is two years. In the Netherlands, new teachers typically work part-time or as temporary replacements for some time before they can obtain permanent positions. Similarly, in England and Australia, many new teachers work under contracts at first, until they can get hired into a permanent position.

As in the United States, it is very difficult to fire tenured teachers and usually requires proof of professional misconduct or position redundancy.

Compensation

How are teacher compensation policies determined? What factors influence teacher salaries? How do teacher salaries compare with the salaries of other professionals?

United States. School districts set teacher compensation for public schools in the United States. Due to differences in tax structures, revenue sources, cost-of-living, supply and demand, and union power, salaries for teachers vary enormously. A recent study cited an average minimum salary of $27,989 for beginning teachers in the United States and an average salary of $41,820 for all public school teachers. Across the states, minimum salary ranges from $20,422 (North Dakota) to $33,676 (Alaska). Average salary ranges from $29,525 (Oklahoma) to $52,410 (Connecticut).[47]

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[47] U.S. Department of Education, National Center for Education Statistics, *The Digest of Education Statistics 2001*, 2002.

Compensation generally differs by the level of education taught, too, with high school teachers earning a slightly higher starting salary than elementary teachers. Teachers typically earn incremental cost-of-living salary increases and one-time increases for advanced degrees. Teachers at all levels earn less than professionals with similar educational credentials, and this difference can be substantial.[48]

Other Countries. As in the United States, teacher compensation is set at the local level in Korea and Japan. In Hong Kong, Singapore, England, and the Netherlands, decisions are set at the national level. Australia's teacher compensation setting process is described as "industrial agreements that are negotiated between employers and teacher unions in each state."

In a consistent pattern across the countries surveyed, salary levels parallel educational attainment and certification levels. Furthermore, all have some type of mechanism in place for teachers to earn salary increases.

Table 8 shows average lower secondary education teacher salaries for the OECD countries participating in this study at three career points. Figure 6 shows these data graphically.

Figure 6 shows that the salary gap among these countries widens as teachers go through their careers. While the difference between the highest (the Netherlands) and lowest (England) starting salary is $6,000, the difference increases to over $34,000 at the top end (the difference between Korea and England).

Beginning teacher salaries are higher than salaries paid to similarly educated professionals in Australia, Japan, and Hong Kong, and comparable in Singapore. In England and Korea, beginning teachers earn less than other comparable professionals. In all of these countries except England, the relative position of teacher salaries, compared with other similar professionals, is stagnant or worsens over time. In England, the salary disparities diminish as seniority progresses.

Another way to compare teacher salaries across countries is to relate salary to gross domestic product (GDP) per capita. The resulting ratio is a measure that, essentially, compares average teacher salary to a country's overall wealth. Table 9 shows the ratio of teacher salaries after 15 years of experience to GDP per capita for OECD countries participating in this study.

Korean teachers do far better (relative to GDP) than U.S. teachers and teachers in the other countries, as well. Average teacher salary in a country could be low by comparison to those in other countries, but still relatively high on this measure, if the country has a low GDP per capita. Indeed, very poor countries, with relatively low GDP per capita, tend to have relatively high ratios of average teacher salary to GDP per capita. The practical effect is that one often finds

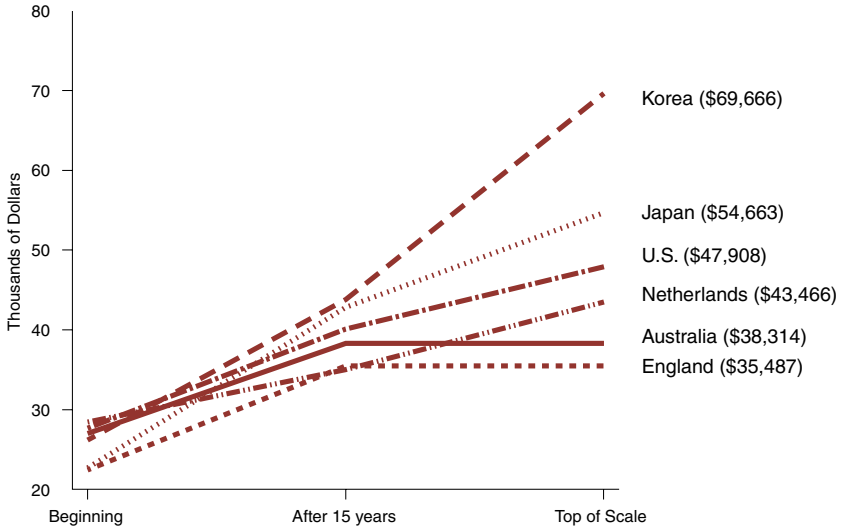
Table 8: Annual Salaries for Lower Secondary Education Teachers in U.S. Dollars, 2000

	Start	After 15 Years	Top
Australia	$29,946	$38,312	$38,314
England	22,428	35,487	35,487
Japan	22,670	42,820	54,663
Korea	26,148	43,800	69,666
Netherlands	28,443	34,985	43,466
United States	27,643	40,072	47,908

Note: Salaries are converted to U.S. dollar equivalents using a purchasing power parity index. Equivalent data are unavailable for Hong Kong and Singapore.
Source: Organization for Economic Cooperation and Development, *Education at a Glance: OECD Indicators 2002*, Paris, 2002.

[48] American Council for Education, 1999.

Figure 6: Annual Salaries for Lower Secondary Education Teachers in U.S. Dollars, 2000



Note: Salaries are converted to U.S. dollar equivalents using a purchasing power parity index. Equivalent data are unavailable for Hong Kong and Singapore.
Source: Organization for Economic Cooperation and Development, *Education at a Glance: OECD Indicators 2002*, Paris, 2002.

Table 9: Ratio of Average Teacher Salary After 15 Years of Experience to GDP per Capita, 2000

Korea	2.48
Japan	1.62
England	1.48
Australia	1.43
Netherlands	1.26
United States	1.12

Source: Organization for Economic Cooperation and Development, *Education at a Glance: OECD Indicators 2002*, Paris, 2002.

that some of the brightest and most ambitious graduates enter the teaching profession in poorer countries.

Average teacher salary per GDP per capita is associated with the relative employment opportunities available. In poorer countries, with small private sectors, a teaching career may be one of the few high-status professions. In richer countries, with very large private sectors, a teaching career must compete for graduates' interest with many other attractive, well-paying, and high-status occupations. Generally, the richer a country is, the lower its average teacher salary per GDP per capita.

All that withstanding, two countries can have the same GDP per capita and different ratios of average teacher salaries per GDP per capita. In that case, one could argue that the higher ratio probably represents a greater "fiscal effort" to support teachers' welfare, or a greater financial commitment to teaching as a profession.

Outcomes of Teacher Education: Preparation and Confidence

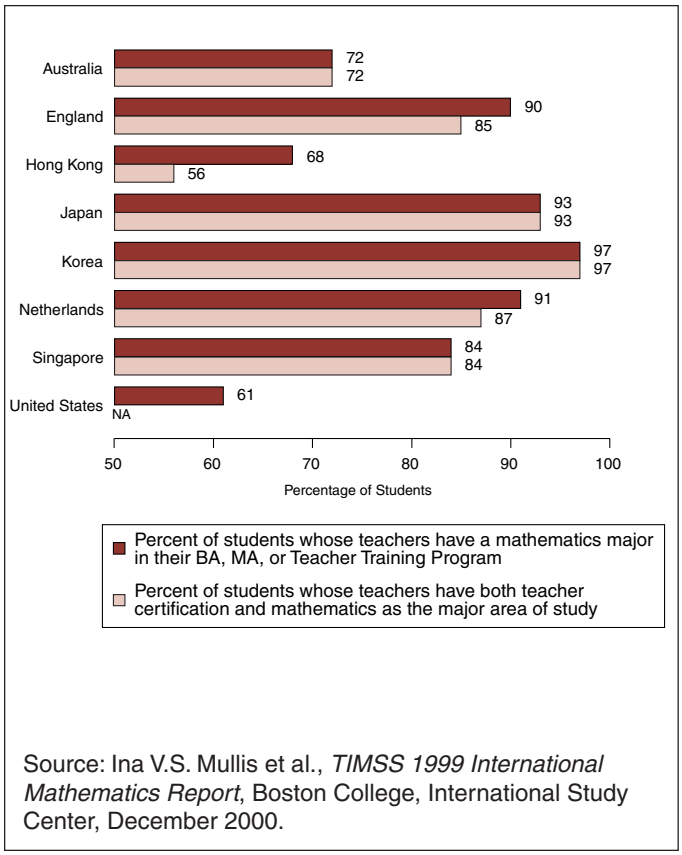
As a result of the divergent policies and practices discussed in the preceding sections of this report, one might expect to find different outcomes across the countries with the respect to the qualifications of eighth-grade mathematics and science teachers. To explore whether or not this appears to be the case, it is helpful to compare the qualifications of teachers in each country. Two indicators of teachers' preparedness to teach mathematics are presented in Figure 7: the percentage of students in each country whose teachers possess a mathematics major as a result of their bachelor's, master's, or teacher training program; and the percentage of students whose teachers have both teacher certification and mathematics as their major area of study.

Eighth-grade students in the United States and those in Hong Kong were less likely than those in the other countries surveyed to have teachers with mathematics and/or mathematics education as a major area of study. Just 61 percent of students in the United States and 68 percent of students in Hong Kong were taught by such teachers. In contrast, 90 percent or more of the students in England, Japan, Korea, and the Netherlands had teachers with a mathematics major.

Nearly three-quarters (73 percent) of the students in the surveyed countries had teachers with both teacher certification and a mathematics major. (This indicator is not available for the United States.) Again, the vast majority of students in Korea and Japan (97 and 93 percent, respectively) are taught by teachers with these qualifications, while in Hong Kong only 56 percent of the students were taught by such teachers.

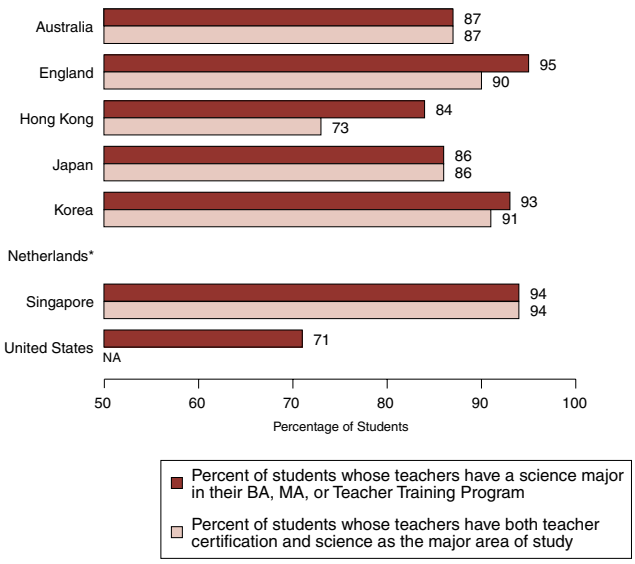
The data on teachers' qualifications to teach science are similar to the findings for mathematics (Figure 8). Across the countries, the percentage of students whose teachers possessed a science major ranged from a low of 71 percent in the U.S. to more than 90 percent in England, Singapore, and Korea.

Figure 7: Teacher Preparation in Mathematics, 1999



Source: Ina V.S. Mullis et al., *TIMSS 1999 International Mathematics Report*, Boston College, International Study Center, December 2000.

Figure 8: Teacher Preparation in Science, 1999



*99 and 99% in earth science; 91 and 85% in biology; and 69 and 60% in physics and chemistry, respectively.

Source: Ina V.S. Mullis et al., *TIMSS 1999 International Science Report*, Boston College, International Study Center, December 2000.

Between 86 and 94 percent of students in all but one of the participating countries (Hong Kong, at 73 percent) were taught by teachers with both certification and science as a major. Data are unavailable for the United States.

To obtain a sense of how confident teachers are about their ability to teach science and mathematics, TIMSS constructed an index measuring teachers' confidence in their preparation to teach each of 10 science topics and 12 mathematics topics. The percentage of students in each country who were being taught by teachers reporting a high level of confidence in their preparation are shown in Figure 9.

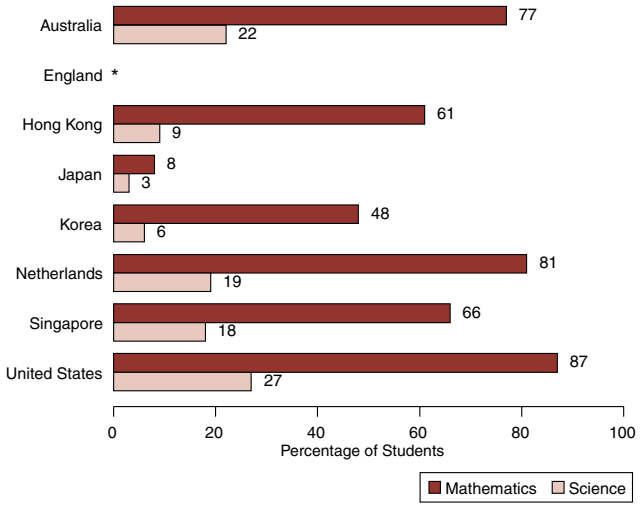
Across all of the surveyed countries, students were far more likely to have teachers who were highly confident about teaching mathematics (63 percent, on average) than about teaching science (20 percent). Interestingly, of all the countries surveyed, U.S. students were most likely to have teachers who were highly confident about their ability to teach mathematics (87 percent), followed by the Netherlands (81 percent) and Australia (77 percent). In contrast, only 8 percent of the students in Japan were taught by teachers with a high level of confidence in their ability to teach this subject. Part of these differences may be explained by cultural mores; in Asian countries, for example, it is considered unseemly to express self-confidence in one's ability to do something.

Similarly, of all the countries surveyed, students in the United States were most likely to have teachers with a high level of confidence in their preparation to teach science (27 percent), compared to just 9, 6, and 3 percent of the students, respectively, in Hong Kong, Korea, and Japan.

In summary, compared to their counterparts in other countries, eighth-grade students in the United States were least likely to have teachers who had majored in mathematics or science and most likely to have teachers who were highly confident about their ability to teach these subjects.

The apparent lack of congruity between teacher preparation and confidence in the United States may be due to many different factors, cultural and otherwise. For example, it may be that teachers who lack a mathematics major have nonetheless taken an array of mathematics courses that have given them confidence in their ability to teach the subject. Alternatively, it may be that some of these teachers are teaching in schools that use well-developed curricula or that offer strong professional development opportunities that strengthen their confidence. Whatever the reasons, the difference observed between the preparation and confidence of teachers in the United States, in contrast to the other countries surveyed, is an interesting finding that deserves scrutiny.

Figure 9: Percentage of Students Whose Teachers Reported a High Level of Confidence in Their Preparation to Teach Mathematics and Science, 1999



*Data are unavailable.

Source: Ina V.S. Mullis et al., *TIMSS 1999 International Mathematics Report*, Boston College, International Study Center, December 2000.

Discussion and Conclusions

As part of the larger push for reform in mathematics and science education in the United States, many observers have criticized the ways in which this country trains and certifies teachers and have advocated sweeping changes in its policies and practices. This impetus is now being renewed—and indeed, increased—with the passage of the No Child Left Behind Act, which requires that all teachers in core academic subjects be highly qualified by the end of the 2005-6 school year. The adoption of this ambitious legislation means that all teachers must be fully certified and have an academic background in the subject they teach.

The data on teacher qualifications discussed in the preceding section of this report, in addition to the findings accumulated from other sources, suggest that meeting the requirements of this legislation will be extraordinarily challenging. There is already a great need for mathematics and science teachers in this country, and this need will grow even more acute as the baby boomers retire in the coming years, leaving many vacant teaching positions behind them. Ensuring that all of the teachers who assume these positions are well qualified to teach will demand creative, energetic solutions that need to begin soon and be sustained for many years to come.

As part of the search for successful approaches to pursue in the United States, it may be helpful to look abroad, particularly to those countries that perform well in international assessments of mathematics and science proficiency. This was the impetus of the current study. The international comparison of teacher education and certification policies and practices reported herein reveals some surprising similarities as well as many striking differences across the countries examined.

Our analytical model, or pipeline, can be viewed in at least two ways: as a collection of separate or independent issues, or as a sequence, from beginning to end, of the teacher training and certification process. Even if one chooses to concentrate on the issues separately, it can be informative to keep the pipeline model in mind.

This is especially true if one wishes to make general comparisons across countries that reach beyond a single stop in the pipeline. Say, for example, country A has very strict, highly structured, and tightly monitored requirements for a new teacher's first year induction requirements. In country B, on the other hand, new teachers are sent out to their schools, and it is up to each school to have or not have an induction process. Having only this information, one might be prone to jump to the conclusion that the teacher training process as a whole must be more strict, highly structured, and tightly monitored in country A than it is in country B. That may or may not be true, however. It is possible that, in country A, the requirements for entry into and exit from the teacher training colleges are lax (ergo the need for close monitoring during the induction year), whereas those in country B are difficult and highly selective, allowing schools more discretion in whether or not to provide induction programs.

Indeed, as this report shows, countries do seem to vary with respect to where along the teacher-training pipeline they impose pressure points. Some countries seem to "front load" their requirements—in other words, emphasize selection into and from teacher education programs. Others seem to "back load" their requirements—that is, emphasize rigorous induction during a probation period after which some teachers will not receive permanent posts. In others, like the United States, for example, nearly all of the dense filtering is applied before or at the point of initial certification. After that, the filters in place might be considered "pro forma" or low-stakes.

The "valves" and "filters" that line the teacher education and development pipeline can be used to screen out certain candidates from the profession. In some cases, one country may keep a certain valve open all the time, essentially not using that available pressure point as a candidate screen, whereas another country might use a dense filter, screening out a substantial proportion of teacher candidates.

Table 10 describes the situation graphically and comparatively—across our eight countries, and along the pipeline. We identify eight pressure points along

Table 10: Filters Used Along the Teacher Education and Development Pipeline

	Entry to teacher education program	Evaluation of practical experience requirement	Exit from teacher education program	Certification	Hiring	Evaluation of induction period	Evaluation of professional development	Evaluation of probation period (for tenure)
Australia*	◎	◎	●	◎	○	○	○	◎
England	○	●	○	●	○	○	○	◎
Hong Kong	◎	◎	○	○	○	○	◎	●
Japan	●	●	○	○	◎	◎	●	●
Korea	●	◎	●	○	●	○	●	○
Netherlands	●	●	◎	○	○	○	○	◎
Singapore	●	◎	●	○	◎	◎	○	○
United States*	◎	○	◎	●	○	○	○	○

● High-Stakes ◎ Medium-Stakes ○ Low- or No-Stakes

*Since teacher education and certification are the responsibility of individual states, practices can differ among them.
See Appendix B for the rubrics for the classifications in the table.

the teacher education and development pipeline: from entry into a teacher education program to evaluation of probation period (for tenure). Pressure points are arranged sequentially, in the same order as any teacher-trainee would experience them. The density of each filter is shown and is classified as being high-, medium-, or low-stakes. Appendix B describes the rubrics used to determine the stakes of the filters. Briefly, a high-stakes filter requires the candidate to satisfy a certain criterion or be prevented from continuing. An example of a high-stakes filter would be a requirement for a high score on subject matter or university entrance exams as a requirement for entrance into a teacher education program. A medium-stakes filter would be one where the criterion the candidate must satisfy is moderated is some substantial way or is easier to satisfy than it could be (or is in other countries). A low-stakes filter would be characterized as a very minimum or voluntary requirement.

Interestingly, there are no pressure points at which even a majority of our sample countries apply high-stakes filters—the locations of the filters vary across our countries, and the "density" of the filters varies, too. All countries use either high- or medium-stakes filters at at least three pressure points. Moreover, all the countries studied have at least two low-stakes filters; England and the United States lead with five.

We make no claim that these rubrics represent the only reasonable classification scheme of the "density" or rigor of the filters. Other classifications may be possible too, though we suspect that the overall results are likely to be similar. Nor do we claim that the classifications across filters are equivalent or directly comparable. We made cuts between high-, medium-, and low-stakes where clear, practically demonstrable, and empirically knowable separations existed. But these classifications were idiosyncratic—unique to each filter.

The results of this classification exercise are also displayed in Table 11. Keep in mind that we refer here to systemwide pressure points. If the level of stakes at a pressure point is left up to each individual school in a country, we cannot know what level of stakes are applied and, essentially, we assume low- or no-stakes. Hong Kong and the United States both defer many important decisions to local schools or local school districts. In the much larger and more decentralized United States, at least, such deferral is tantamount to dispersal and, ultimately, renders the decision low- or no-stakes in our classifications.

Summarizing the information from Tables 10 and 11, and reclassifying by country, we count the number of high-, medium-, and low- or no-stakes pressure points for each country in our sample. The result of this re-aggregation is displayed in Figure 10. Countries are sorted from high to low based on the total number of high- and medium-stakes filters they employed (and secondarily sorted by the number of high-stakes filters).

One should keep in mind that while we have attempted to rank the level of stakes for each pressure point, we have made no attempt to rank the relative stakes (or density) across pressure points. If, for example, Korea's high-stakes professional development evaluation represents a denser filter than its high-stakes hiring process, that disparity is not reflected in Figure 10, where both processes are classified simply as "high-stakes." Nor have we attempted to rank the relative density of the filters within each cell of Figure 10. The high-stakes filter at a given pressure point for one country may be more rigorous than that for another.

Indeed, a country could make a deliberate policy decision to employ just one filter at a single pressure point, but make that filter so "dense" that only a small proportion of teacher candidates pass through. In this extreme case, that country might validly be described as having a more rigorous (or, some might say, more arbitrary) teacher selection process, using only one filter, than do other countries that employ more filters.

This scenario does not well describe any in our group of countries, however. In the countries included in this study, there appears to be a strong relationship between the number of pressure points with stakes attached and the number of high-stakes filters used. Nonetheless, the general point is valid. Countries are not necessarily ranked in Figure 10 in pure order of rigor (i.e., stakes of the filters). Rather, the ranking combines rigor (the use of high-stakes filters) and frequency (i.e., number of filters, or selection points, used).

The information gathered in this study shows that each country's teacher education and certification pipeline differs in some important and interesting ways from those in other countries. The reasons for these differences are numerous, of course, ranging from the cultural to the political to the practical. Whether the reasons are valid and the resulting policies and practices are accomplishing the desired ends evoke the essential policy questions.

Although U.S. policymakers can learn some valuable lessons from this study, some words of

Figure 10: Number and Density of Filters Applied Along the Teacher Education and Certification Pipeline

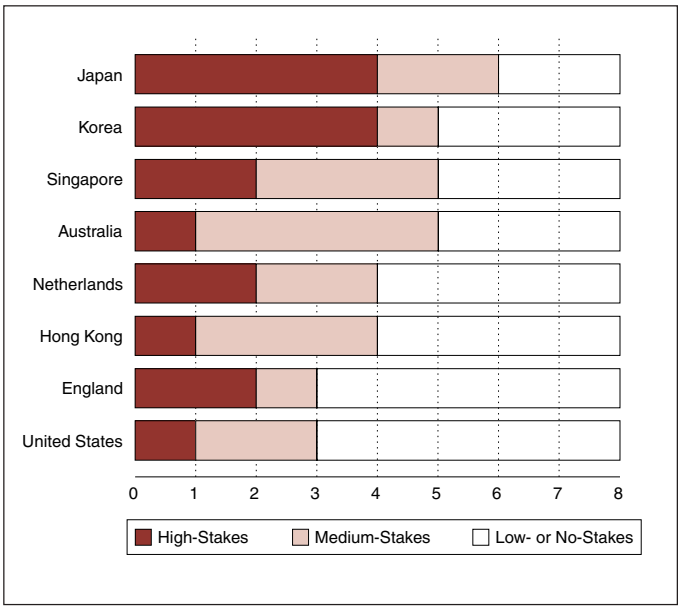


Table 11: Summary of Filters Used Along the Teacher Education and Development Pipeline

	Entry to Teacher Education Program (undergraduate or graduate)	Evaluation of Practical Experience Requirement	Exit From Teacher Education Program	Certification	Hiring	Evaluation of Induction Period	Evaluation of Professional Development	Evaluation of Probation Period (before tenure)
High-Stakes	Japan Korea Netherlands Singapore	England Japan Netherlands	Australia Korea Singapore	England Untied States	Korea		Japan Korea	Hong Kong Japan
Medium-Stakes	Australia Hong Kong Untied States	Australia Hong Kong Korea Singapore	Netherlands Untied States	Australia	Japan Singapore	Japan Singapore	Hong Kong	Australia England Netherlands
Low- or No-Stakes	England	Untied States	England Hong Kong Japan	Hong Kong Japan Korea Netherlands Singapore	Australia England Hong Kong Netherlands Untied States	Australia England Hong Kong Korea Netherlands Untied States	Australia England Netherlands Singapore Untied States	Korea Singapore Untied States

caution, along with a few caveats, are in order. Just because other countries that perform well in international comparative assessments engage in certain practices or processes does not, in and of itself, suggest that the United States should, too. There are several reasons for this. First, as research analysts are so fond of saying, "correlation does not equal causation." Our study examines the teacher education and development process in several countries whose students demonstrated relatively high proficiency in the TIMSS. We cannot say, however, which specific components of each country's process are causally related to their students' performance. Some components might be, some might not be. Some might even be negatively related. Ultimately, our study is more exploratory and descriptive than analytical.

Second, some practices are simply not transferable to the United States, no matter how successful or prevalent they might be in other countries. The United States, for example, simply cannot run all of its teacher education and development programs out of a single institution, as is done in Singapore, or imitate other practices unique to smaller countries, such as Hong Kong, or even the Netherlands, where single national programs can be operated that all teachers can travel to and from within a day's time. The United States is too large for such an approach to be practical, and our federal governance structure, with the states being the original founding entities that retain authority over education matters, would not allow it simply as a matter of constitutional law.

Other practices described in our report may not be transferable to the United States because we have a different education tradition and culture, with different expectations and perceptions of what is acceptable and normal. Some of the "die is cast at an early age" characteristics of other countries' education systems, for example, might seem out-of-place in U.S. culture, where citizens appreciate the notion that they can be whatever they want to be at any point in their lifetime if they decide to devote their effort (and resources) to that end.

Some practices in the United States seem to be uncommon in other countries and, consequently, other countries provide little information from which we can learn. This seems to be particularly true, unfortunately, in some of the more controversial aspects of the teacher education and development process, such as alternative certification and emergency credentialing. For example, among our surveyed countries, only England offers any alternative certification routes and, even there, they are either new or changing in character, and currently account for only about 5 percent of teacher-trainees. In all other countries surveyed, students become teachers through a fairly standard civil-service-type training process. No other countries surveyed allowed emergency credentialing.

So, what lessons can this study offer policymakers? Even though some teacher education and development practices employed in other countries may be good and may be transferable, this study has not been extensive enough to recommend which ones. Moreover, most of the other countries surveyed seem to have, generally, quite similar processes and governance structures that regulate those processes.

What does vary substantially across countries, however, is where along the "pipeline" the screens or pressure points are applied. Some countries make entry into teacher education programs very difficult, while some make it relatively easy. Some countries make exit from teacher education programs very difficult, while some make it relatively easy. In some countries, induction is a formality, whereas in others it is rigorous and seriously monitored. In some countries, tenure is virtually assured at the end of induction or even before, whereas, in other countries, a not insignificant proportion of teachers remain to be screened from the profession before they can be said to have tenure.

In any country, policymakers concerned with teacher education and development can choose:

- The number of filters to use in the teacher education and development pipeline;
- Where to locate the filters along the pipeline; and
- The nature and density of each filter along the pipeline.

Lessons for U.S. policymakers derived from this study include:

- Other countries tend to use more filters than the United States;
- Other countries use more high-stakes filters than the United States;
- U.S. policymakers might find it instructive how other countries filter teacher candidates at those pressure points we leave unused; and
- Efforts to extract lessons from other countries based only upon comparisons of individual segments of the pipeline should be considered inconclusive; conclusive judgments can be derived only after consideration of the entire length (i.e., the entire teacher education and development process).[49]

As policymakers and educators in the United States continue to search for effective ways to expand and improve the supply of qualified mathematics and science teachers in the coming years, it will be important to examine our own pipeline closely to determine whether the mechanisms that currently govern the flow of prospective teachers are the proper ones, and whether they are succeeding or failing to achieve their intended goals: to train desirable candidates for the teaching profession and to ensure their success once there. There is also a need to recognize the factors that affect the attractiveness of teaching as a career and the tension between the impact of imposing high-stakes filters and being able to adequately staff the nation's schools.

[49] While this study has examined the entire length of the teacher education and development pipeline, teachers' professional lives do not stop once they have attained tenure. As mentioned earlier in the report, the Milken Family Foundation sponsored a recent study by the Council for Basic Education on that very topic, *Teachers' Professional Lives: A View from Nine Industrialized Countries*. Across the countries surveyed, the Milken/CBE survey shows an emphasis on teacher qualifications, with rigorous requirements for years of study, content knowledge and certification, and less concern with teacher performance. Student achievement is rarely a factor in teacher pay and teachers are not held accountable, collectively or individually, for student achievement. Yet, as in the United States, there is a growing interest among these countries in linking rewards to student achievement and mastery teaching. Teacher assessment, where it occurs and involves classroom performance, usually serves as an advisory tool for professional development and sometimes for performance-based pay, bonuses or promotion. A teacher can be dismissed for legal infractions, but rarely for reasons of incompetence or for poor performance evaluations.

Appendix A: Country Demographic Profile

	Size (thousand km^2)[a]	Population density (persons/km^2)[a]	Population size (millions)[b]	Population of students ages 15-19 (millions)[c]	Primary and secondary classroom teachers (% of total labor force)[d]	Per capita GDP (US$)[a]	Control
Australia	7,700.0	2	18.5	1.3	2.3	17,250[aa]	Federated
England	130.4	372	50.0	3.0	2.4[dd]	14,058[aa]	National
Hong Kong	1.1	5,404	6.5	Not available	Not available	13,430[bb]	National
Japan	377.8	330	126.1	7.6	1.5	31,490[aa]	National
Korea, Republic of	99.0	441	46.0	3.7	1.4	7,660[aa]	National
Netherlands	41.0	372	15.6	0.9	2.8	18,780[bb]	National
Singapore	0.6	4,481	3.1	Not available	Not available	20,414[cc]	National
United States	10,000.0	27	267.6	18.7	2.2	25,744[aa]	Federated

[a]Source: David F. Robitaille (ed.), *National Context for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*. Vancouver, Canada: Pacific Educational Press.
[b]Source: Ina V.S. Mullis et al., *Mathematics Benchmarking Report, TIMSS 1999 - Eighth Grade: Achievement for U.S. States and Districts in an International Context*. Boston, MA: International Study Center, Lynch School of Education, Boston College, 2000. P. 27, Exhibit 2.
[c]Source: Organisation for Economic Co-Operation and Development. *Education at a Glance: OECD Indicators*. Table A1.1. Paris, France: OECD Publications, 2001. This is done by multiplying percent of population of students ages 15-19 (around 6 to 7 percent for each country) by total population.
[d]Source: Organisation for Economic Co-Operation and Development. *Education at a Glance: OECD Indicators*. Table D2.4. Paris, France: OECD Publications, 2001.
[aa]GDP per capita for 1993.
[bb]GDP per capita for 1991.
[cc]GDP per capita for 1994.
[dd]The figure was calculated for United Kingdom.

Appendix B: Classification Rubrics

	High-Stakes	Medium-Stakes	Low- to No-Stakes
Entry to teacher education	(Undergraduate programs): must exceed threshold levels on subject area examinations, advanced level national examinations or university entrance examinations. (Graduate programs): must hold a bachelor's degree in subject area.	(Undergraduate programs): must exceed threshold levels on secondary school exit examinations or national examinations. (Graduate programs): must hold a bachelor's degree in relevant field.	(Undergraduate programs): must pass a basic skills test. (Graduate programs): must hold a bachelor's degree or its equivalent in some field.
Evaluation of practical experience requirement	Formal monitoring and enforcement, with successful performance required for graduation.	Formal monitoring.	May be required but, generally, no monitoring or enforcement.
Exit from teacher education	Systemwide exit examinations in subject areas and on other topics (e.g., pedagogy).	Institutional examinations in subject area and on other topics (e.g., pedagogy).	Degree requirements, and no others, other than perhaps a basic skills test.
Certification	Systemwide examinations.	Some evaluation of teaching is required and is reviewed by statutory authorities.	Degree requirements only.
Hiring	National examination with high cut-score required; additional tests required locally.	Decision is made by state authorities or national ministry (thus, is standardized) with set thresholds for passage required on multiple criteria.	Up to individual school.
Evaluation of induction period	Programs are systematically monitored and satisfaction with candidate performance must exceed a certain threshold level.	Programs are formally monitored by state authorities or national ministry.	Programs are typically required or provided, but are not monitored.
Evaluation of professional development	State authorities or national ministry operates formal, standardized program (which can be lengthy) and requires participation.	National authority operates programs, but requires participa- only for those seeking promotion.	Programs are offered, but neither monitored nor standardized, and participation is not required.
Evaluation of probation period	One- to two-year waiting period before tenure is considered.	Many new teachers only able to obtain contract employment at first, which has no tenure.	Tenure is automatic at first hiring; teacher can lose job only through furloughs or improper personal conduct.

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