# Chapter 5
# The Science Curriculum

The first part of Chapter 5 presents information about the curricular goals in the TIMSS 1999 countries and Benchmarking states, districts, and consortia. The ways in which the curriculum is supported and monitored within each entity, and the relationship between the curriculum and system-wide testing, are examined. The second part of the chapter contains teachers' reports about the science topics actually studied in their classrooms.

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In comparing achievement across systems, it is important to consider differences in students' curricular experiences and how they may affect the science they have studied. At the most fundamental level, students' opportunity to learn the content, skills, and processes tested in the TIMSS 1999 assessment depends to a great extent on the curricular goals and intentions inherent in each system's policies for science education. Just as important as what students are expected to learn, however, is what their teachers choose to teach them, which ultimately determines the science students are taught.

Teacher's instructional programs are usually guided by an "official curriculum" that describes the science education that should be provided. The official curriculum can be communicated by documents or statements of various sorts (often called guides, guidelines, standards, or frameworks) prepared by the education ministry or by national or regional education departments. These documents, together with supporting material such as instructional guides or mandated textbooks, are referred to as the *intended curriculum*.

To collect information about the intended science curriculum at the eighth grade, the coordinators in each participating country and Benchmarking jurisdiction responsible for implementing the study completed questionnaires and participated in interviews. Information was gathered about factors related to supporting and monitoring the implementation of the official curriculum, including instructional materials, audits, and assessments aligned with the curriculum.

In many cases, teachers need to interpret and modify the intended curriculum according to their perceptions of the needs and abilities of their classes, and this evolves into the *implemented curriculum*. Research has shown that, even in highly regulated education systems, this is not identical to the intended curriculum. Furthermore, what is actually implemented is often inconsistent across an education system. Studies, including the Second International Mathematics Study, suggest that the implemented curriculum in the United States varies considerably from classroom to classroom – calling for more research into not only what is intended to be taught but what content is covered.[1] To collect data about the implemented curriculum, the science teachers of the students tested in TIMSS 1999 completed questionnaires about whether students had been taught the various science topics covered in the test.

1 Mayer, D.P., Mullens, J.E., and Moore, M.T. (2000), *Monitoring School Quality: An Indicators Report*, NCES 2001-030, Washington, DC: National Center for Education Statistics.

## Science Subjects Offered Up To and Including Eighth Grade

The most striking difference among science curricula of the TIMSS 1999 countries in the eighth and earlier grades is that the sciences are taught as separate subjects in some countries and integrated to form a general science course in others. Exhibit 5.1 shows how science instruction is organized in these grades in the TIMSS 1999 countries and Benchmarking jurisdictions. By the eighth grade, Chinese Taipei, Indonesia, and most of the European countries were teaching some or all of earth science, biology, physics and chemistry as separate subjects, not necessarily contemporaneously. Three of the Benchmarking states (Connecticut, Missouri, and Oregon) and four of the districts and consortia (the Academy School District, the Jersey City Public Schools, the Miami-Dade County Public Schools, and the Rochester City School District) reported teaching science as separate subjects by the eighth grade, predominantly life science, earth science, and physical science. Among the others, the practice was to integrate the sciences into a general science curriculum. Of the countries that taught science as separate subjects, most taught chemistry and physics as separate subjects by the eighth grade, while in separate-science Benchmarking jurisdictions these were taught together as physical science.

# Exhibit 5.1 Science Subjects Offered Up to and Including Eighth Grade

| | Separate Science Courses Offered | Science Subjects and Grades Taught |
|---|---|---|
| United States | No | General/integrated science course |
| Australia [1] | No | General/integrated science course |
| Belgium (Flemish) | Yes | World orientation (3-6); biology and earth science (7-8); scientific work (7-8); technological education (7-8); physics (8); applied science (8); natural science (8) |
| Bulgaria | Yes | General/integrated science (3-5); biology (6-8); chemistry (7-8); physics (7-8); earth science (6-8) |
| Canada [2] | No | General sciences organized by strands (grades K-8) |
| Chile | No | General integrated science (4-8) with some earth science taught in history/geography/social studies |
| Chinese Taipei | Yes | Natural science (1-6); biology (7); integrated physics/chemistry (8); integrated physics/chemistry continues to be taught at grade 9 in addition to earth science |
| Cyprus | No | General/integrated science course taught at grade 8. This course may be taught by separate subject area teachers in some schools. General science includes a combination of physics, chemistry and biology topics |
| Czech Republic | Yes | Elementary science (1-3), General/integrated science (4-5); physics (6-8); chemistry (8); life science/biology (6-8); earth science (6-8) |
| England | No | General/integrated science course, though some schools (especially independent ones) may offer physics, chemistry, and biology, separately |
| Finland | Yes | Integrated course of biology, geography and environmental studies (1-6); physics (7-8); chemistry (7-8); biology (7-8); natural geography (7-8); physics, chemistry, biology and natural geography are also taught at grade 9 |
| Hong Kong, SAR | No | General studies (1-6); science (7-8) |
| Hungary | Yes | Environment (5); biology, physics, geography (6-8); chemistry (7-8) |
| Indonesia | Yes | Biology, physics, and earth science taught separately, but one composite grade is given; chemistry is not taught until high school |
| Iran, Islamic Rep. | No | General/integrated science course (includes life sciences, physical sciences, earth sciences, and environmental and resource issues) |
| Israel | No | General/integrated science course |
| Italy | No | General/integrated science course |
| Japan | No | General/integrated science course |
| Jordan | No | General/integrated science course |
| Korea, Rep. of | No | Intelligent life (combined with social studies) (1-2); science (3-8) |
| Latvia (LSS) | Yes | Biology (5-8); chemistry (8); physics (8) |
| Lithuania [3] | Yes | Integrated science course 'cognition of the world' (1-4); integrated science course 'man and nature' (5); integrated science course 'man and nature'/geography (6); biology/geography (7); biology, physics, chemistry and geography (8); subjects taught at grade 8 continue through grade 10 |
| Macedonia, Rep. of | Yes | Nature and some earth science (1-4); biology (5-8); geography (5-8); chemistry (7-8); physics (7-8) |
| Malaysia | No | General/integrated science course |
| Moldova | Yes | Separate science subjects are taught in grade 8: biology, chemistry, physics, and geography |
| Morocco | Yes | Biology and physics (7); physics/chemistry and biology/geology (8) |
| Netherlands | Yes | General/integrated science (primary school up to grade 6); physics/chemistry, biology, geography which includes earth science (7-8) |
| New Zealand | No | General/integrated science course |
| Philippines | No | General/integrated science course (1-7) |
| Romania | Yes | General/integrated science (3-4); biology (5-8); geography (5-8); physics (6-8); chemistry (7-8) |
| Russian Federation | Yes | Science integrated with social studies (2-4); integrated science (5); geography (6-8); physics (7-8); biology (6-8); chemistry (8) |
| Singapore | No | General/integrated science course |
| Slovak Republic | Yes | General/integrated science (1-4); physics, chemistry, geography/geology, and biology taught as separate subjects (5-8) |
| Slovenia [3] | Yes | Knowledge about nature and society (1-3); knowledge about nature (4-5); geography (6-8); biology (6-8); chemistry (7-8); physics (7-8) |
| South Africa | No | General/integrated science and geography |
| Thailand | No | General/integrated science course |
| Tunisia | No | General/integrated science course |
| Turkey | No | General/integrated science course (grades 4-8) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by National Research Coordinators.

1 Australia: Yes in 4 of 8 states/territories.

2 Canada: Results shown are for the majority of provinces.

3 Lithuania and Slovenia: Geography is considered to be an integrated social studies and natural science course at grade 8; geography teachers were not sampled in the TIMSS studies.

| | Separate Science Courses Offered | Science Subjects and Grades Taught |
|---|---|---|
| **States** | | |
| Connecticut | Yes | Varies throughout the state |
| Idaho | No | General/integrated science course |
| Illinois | No | General/integrated science course |
| Indiana | No | General/integrated science course |
| Maryland | No | General/integrated science course |
| Massachusetts | No | General/integrated science course |
| Michigan | – | – |
| Missouri | Yes | Different schools teach earth science, life science, and physical science in middle school |
| North Carolina | No | There are not separate courses but each grade level has specific science areas that are emphasized |
| Oregon | Yes | Many districts offer science as separate subjects (e.g. life science, physical science, and earth science) |
| Pennsylvania | Varies | Districts have the ability to decide the structure of their science instruction |
| South Carolina | No | Integrated science course (K-8); science content in life science, earth science, and physical science will be integrated in grades 6-8 beginning 2000 |
| Texas | No | General/integrated science course (K-8) |
| **Districts and Consortia** | | |
| Academy School Dist. #20, CO | Yes | General/integrated science course (K-5), earth science or integrated science (6), life science (7), physical science (8) |
| Chicago Public Schools, IL | Varies | Schools have the ability to decide the structure of their science instruction as long as it meets the achievement standards set by the school district |
| Delaware Science Coalition, DE | Varies | Currently in grades K-5, curriculum units are available to cover required topics in physical science, earth science, life science, and ecology each year; at grades 6-8, a similar set of units is being piloted for eventual adoption |
| First in the World Consort., IL | No | General/integrated science course (K-8) |
| Fremont/Lincoln/WestSide PS, NE | No | General/integrated science course (K-8) |
| Guilford County, NC | No | There are not separate courses but each grade level has specific science areas that are emphasized |
| Jersey City Public Schools, NJ | Yes | Different science courses are offered in middle school: earth science (6); physical science (7); life science (8) |
| Miami-Dade County PS, FL | Yes | Comprehensive science, regular and advanced (6-8); earth/space science and biology honors courses (accelerator courses for 7-8) |
| Michigan Invitational Group, MI | No | General/integrated science course (K-8) |
| Montgomery County, MD | No | General/integrated science course (K-8) |
| Naperville Sch. Dist. #203, IL | No | General science course (K-8) with emphasis on earth science, life science, and physical science |
| Project SMART Consortium, OH | No | General/integrated science course (K-8) |
| Rochester City Sch. Dist., NY | Yes | Integrated physical science, life science, and earth science (K-6), life science (7), physical science (8) |
| SW Math/Sci. Collaborative, PA | Varies | Districts have the ability to decide the structure of their science instruction |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

A dash (–) indicates data are not available.

## Does Decision Making About the Intended Curriculum Take Place at the National, Regional, or Local Level?

Depending on the education system, students' learning goals are set at different levels of authority. Some systems are highly centralized, with the ministry of education (or highest authority in the system) being exclusively responsible for the major decisions governing the direction of education. In others, such decisions are made regionally or locally. Each approach has its strengths and weaknesses. Centralized decision making can add coherence and uniformity in curriculum coverage, but may constrain a school or teacher's flexibility in tailoring instruction to the needs of students.

Exhibit 5.2 presents information for each TIMSS 1999 country about the highest level of authority responsible for making curricular decisions and gives the curriculum's current status. The data reveal that 35 of the 38 countries reported that the specifications for students' curricular goals were developed as national curricula. Australia determined curricula at the state level, with local input; the United States did so at both the state and local (district and school) levels, with variability across states; and Canada did so at the provincial level.

In recent decades, it has become common for intended curricula to be updated regularly. At the time of the TIMSS 1999 testing, the official science curricula in 31 countries had been in place for less than a decade, and more than three-quarters of them were in revision. Of the seven countries with a science curriculum of more than 10 years' standing, four were being revised. In Australia, Canada, and the United States, curriculum change is made at the state, provincial, or local level, and some science curricula were in revision at the time of testing. The curricula in these three countries were relatively recent, having been developed within the 10 years preceding the study.

The development and implementation of academic content standards and subject-specific curriculum frameworks has been a central focus of educational change in the United States at both the state and local level. In science, most states are in the process of implementing new content or curriculum standards or revising existing ones.[2] Much of this effort has been based on work done at the national level over the past decade to develop standards aimed at increasing the science literacy of all students. The two most prominent documents are the American Association for the Advancement of Science (AAAS) *Benchmarks for Science Literacy* and the National Research Council's *National Science Education*

2 Glidden, H. (1999), *Making Standards Matter 1999*, Washington, DC: American Federation of Teachers.

*Standards* (NSES), both of which define standards for the teaching and learning of science that many state and local educational systems have used to fashion their own curricula.[3] All but four states now have standards in science.[4]

In all 13 states that participated in TIMSS 1999 Benchmarking, curriculum frameworks or content standards in science were published between 1996 and 2000 (see Exhibit 5.3). Four states detailed the standards for every grade including the eighth grade, seven states detailed them by a cluster or pair of grades that included the eighth grade, and two states reported the eighth grade as a benchmark grade at which certain standards should be met. Most states provided standards documents to guide districts and schools in developing their own curriculum, while some states, such as North Carolina, developed a statewide curriculum for all schools to use.

Exhibit 5.4 presents information about the curriculum of participating districts and consortia. Of the eight districts that participated, one reported that it used the statewide curriculum in all schools (Guilford County); five had a district-wide curriculum that supported the state-developed frameworks or standards (the Jersey City Public Schools, the Miami-Dade County Public Schools, Montgomery County, the Naperville School District, and the Rochester City School District); and two had a curriculum developed at the school level (the Academy School District and the Chicago Public Schools), with Chicago also offering an optional structured curriculum district-wide. Each participating consortium indicated that all or most of its districts developed their own curriculum at the district level.

3 Smith, T.A., Martin, M.O., Mullis, I.V.S., and Kelly, D.L. (2000), *Profiles of Student Achievement in Science at the TIMSS International Benchmarks: U.S. Performance and Standards in an International Context*, Chestnut Hill, MA: Boston College.

4 *Key State Education Policies on K-12 Education: 2000* (2000), Washington, DC: Council of Chief State School Officers.

# Exhibit 5.2 Countries' Science Curriculum

| | National or Regional Curriculum | Year Curriculum Introduced | Status of Curriculum |
|---|---|---|---|
| United States | Regional & Local | 1990-1999 | As of 1999, 47 out of 50 states have completed content standards |
| Australia | Regional & Local | 1984-1999 | In revision (in 4 states/territories); As introduced (in 4 states/territories) |
| Belgium (Flemish) [1] | National | 1989-1999 | As introduced |
| Bulgaria | National | 1989 (biology and chemistry); 1996 (physics); 1995 (earth science) | In revision |
| Canada | Regional | 1987-1998 | In revision (5 provinces); As introduced (5 provinces) |
| Chile | National | 1980 | In revision |
| Chinese Taipei | National | 1997 | In revision |
| Cyprus | National | 1978 | As introduced |
| Czech Republic | National | 1996 | In revision |
| England | National | 1995 | In revision, same structure with minor revisions (to be implemented 2000/01) |
| Finland | National | 1994 | As introduced |
| Hong Kong, SAR | National | 1986 | In revision |
| Hungary | National | 1995 | As introduced |
| Indonesia | National | 1994 | In revision |
| Iran, Islamic Rep. | National | 1996 | In revision |
| Israel | National | 1997-1998 | In revision |
| Italy | National | 1979 | As introduced |
| Japan | National | 1993 | As introduced |
| Jordan | National | 1993 | Slight revisions annually |
| Korea, Rep. of | National | 1995 | As introduced |
| Latvia (LSS) | National | 1992-1994 | In revision |
| Lithuania | National | 1997 | In revision |
| Macedonia, Rep. of | National | 1979 (adaptations in 1995) | As introduced |
| Malaysia | National | 1990 | In revision |
| Moldova | National | 1991 | In revision |
| Morocco | National | 1991 | In revision |
| Netherlands | National | 1993 (slight adaptations in 1998) | As introduced |
| New Zealand | National | 1995 | As introduced |
| Philippines | National | 1998 | In revision |
| Romania | National | 1993 | In revision |
| Russian Federation | National | 1998 | In revision |
| Singapore | National | 1993 | In revision |
| Slovak Republic | National | – | – |
| Slovenia | National | 1983 | In revision |
| South Africa | National | 1984 | In revision |
| Thailand | National | 1990 | In revision |
| Tunisia | National | 1997 | In revision |
| Turkey | National | 1992 | In revision |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by National Research Coordinators.

A dash (–) indicates data are not available.

1 Belgium (Flemish): Curricula were introduced as follows: 1997-98 (biology); 1997 (technological education), early 1990 (physics); 1997 (earth science); 1997-99 (applied sciences); 1989 (scientific work); 1989-97 (natural science).

# Exhibit 5.3 States' Curriculum Frameworks/Content Standards

8th Grade Science

| | Curriculum Framework/Content Standards and Year[1] | Grades Detailed in Framework/Standards |
|---|---|---|
| Connecticut | Connecticut's K-12 Science Curriculum Framework (1998) | Grade clusters: K-4, 5-8, 9-12 |
| Idaho | Skills-Based Scope and Sequence Guides K-6 (1996); Achievement Standards K-8 (In draft); Achievement Standards 9-12 (1999) | Every grade: K-6 Grade clusters: 7-8, 9-12 |
| Illinois | Illinois Learning Standards for Science (1997) | Grade clusters: Early Elementary School, Late Elementary School, Middle/Junior High School, Early High School, Late High School |
| Indiana | Indiana Science Proficiency Guide (1997); revised Indiana's Academic Standards for Science (2000) | Grade clusters: K-2, 3-5, 6-8, 9-12 (1997 version); Every grade: K-8, individual courses in high school (2000 version) |
| Maryland | Learning Outcomes (1990); Content Standards for Science (2000) | Grade clusters: K-3, 4-5, 6-8, 9-12 |
| Massachusetts | Massachusetts Science & Technology Curriculum Frameworks (1996; under revision) | Grade clusters: pK-4, 5-8, 9-10, 11-12 |
| Michigan | Michigan Essential Goals and Objectives for Science Education (1991); Michigan Curriculum Frameworks: Content Standards and Benchmarks (1996) | Grade clusters: Elementary School, Middle School, High School |
| Missouri | Frameworks for Curriculum Development in Science (1996) | Grade clusters: K-2, 3-4, 5-8, 9-12 |
| North Carolina | North Carolina Standard Course of Study (1994; revised 2000-01) | Every grade: K-8, individual courses in high school |
| Oregon | Oregon Science Content Standards (1996, 1998) | Benchmark grades: 3, 5, 8, 10, 12 |
| Pennsylvania | Academic Standards for Science and Technology (2000) | Benchmark grades: 4, 7, 10, 12 |
| South Carolina | South Carolina Science Curriculum Standards (2000) | Every grade: K-8; Grade clusters: 9-12 |
| Texas | Texas Essential Knowledge and Skills (1998) | Every grade: K-8, individual courses in high school |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

1 Indicates year(s) in which curriculum frameworks/content standards were instituted.

## Exhibit 5.4 Districts' and Consortia's Curriculum

8th Grade Science

| | Level of Curriculum Development |
|---|---|
| Academy School Dist. #20, CO | Curriculum is developed at the school level. Curriculum is currently in revision to reflect state standards. |
| Chicago Public Schools, IL | Curriculum is developed at the school level. The district writes standards statements which are aligned with state standards; schools translate these into a curriculum. The district also offers an optional structured curriculum. |
| Delaware Science Coalition, DE | Districts share a common curriculum in grades K-5 based on NSF-funded modules. In middle school, schools use NSF-funded units (FOSS, BCSC, STC, etc.) or units developed through the local systemic change program. The high school curriculum is mainly textbook driven with some NSF-funded modules and units developed by teachers with university faculty. |
| First in the World Consort., IL | Most districts within the Consortium have district-wide objectives and/or a curriculum based on state standards. |
| Fremont/Lincoln/ WestSide PS, NE | Each district has locally-developed standards and a curriculum based on state standards. |
| Guilford County, NC | The district uses the state-developed curriculum, the North Carolina Standard Course of Study. |
| Jersey City Public Schools, NJ | The science curriculum (pK-12) is developed by the district and is aligned with the New Jersey Core Curriculum Content Standards. |
| Miami-Dade County PS, FL | The district has developed a science curriculum, Competency-Based Curriculum (CBC), which is correlated to the Florida Sunshine State Standards for Science and the National Science Education Standards. Most recently, the state has developed Grade Level Expectations (GLEs) that further define what a student should know and be able to do at specific grade levels. The district is currently making revisions to the CBC to reflect the GLEs. |
| Michigan Invitational Group, MI | Most districts have district-wide curriculum guides aligned to the state standards. |
| Montgomery County, MD | The district develops curriculum based on state standards. |
| Naperville Sch. Dist. #203, IL | The district develops curriculum based on state standards. |
| Project SMART Consortium, OH | Each district in the consortium has a separate curriculum. |
| Rochester City Sch. Dist., NY | The district develops curriculum based on state standards. |
| SW Math/Sci. Collaborative, PA | Each district in the collaborative has a separate curriculum. District-level curriculum is not necessarily based on the state standards. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

## How Do Education Systems Support and Monitor Curriculum Implementation?

During the past decade, content-driven systemic school reform has emerged as a promising model for school improvement.[5] That is, curriculum frameworks establishing what students should know and be able to do provide a coherent direction for improving the quality of instruction. Teacher preparation, instructional materials, and other aspects of the system are then aligned to reflect the content of the frameworks in an integrated way to reinforce and sustain high-quality teaching and learning in schools and classrooms.

Education systems use different ways to achieve this desired connection between the intended and the implemented curriculum. The methods used by the TIMSS 1999 countries to monitor curriculum implementation are shown in Exhibit 5.5, and by states, districts, and consortia in Exhibits 5.6 through 5.8. For example, teachers can be trained in the content and pedagogical approaches specified in the curriculum guides. Another way to help ensure alignment is to develop instructional materials, including textbooks, instructional guides, and ministry notes, that are tailored to the curriculum. Systems can also monitor implementation of the intended curriculum by means of school inspection or audit.

Of the methods for supporting and monitoring curriculum implementation shown in Exhibit 5.5, 10 countries reported using all six, and a further 13 countries used five. Support for the national/regional science curriculum as part of pre-service education was reported by 24 of the 38 countries. Nearly all countries (33) used in-service teacher education, and most countries (31) used mandated or recommended textbooks. Ministry notes and directives were used in 29 countries, and a system of school inspection or audit was used in 31 countries.

States, districts, and consortia provided data on policies related to textbook selection, pedagogical guides, and accreditation. As shown in Exhibit 5.6, seven of the Benchmarking states reported that they do not select textbooks for use at the local level. The other six states issue a list of books from which districts can choose. Almost all districts and consortia reported that their state does not select textbooks, while three reported state involvement in textbook selection. Ten jurisdictions indicated that textbooks were chosen or recommended at the district level, and four that selection occurs at the school level or, in the consortia, at the school and district level depending on the district.

5 O'Day, J.A. and Smith, M.S. (1993), "Systemic Reform and Educational Opportunity" in S.H. Fuhrman (ed.), *Designing Coherent Education Policy: Improving the System*, San Francisco, CA: Jossey-Bass, Inc.

As shown in Exhibit 5.7, eight of the 13 Benchmarking states developed materials that included pedagogical guidance for instruction and implementation of the curriculum frameworks and standards. Ten districts and consortia had at least state- or district-level guides to support curriculum implementation. Two states and one consortium reported having documents in draft. These materials, developed to support teachers in implementing the curriculum, span a variety of types including ideas for classroom activities, tool kits for planning instructional units, and sample lessons.

As shown in Exhibit 5.8, six of the participating states had accreditation systems, four of which included student performance on the state assessment in their accreditation review (Indiana, Michigan, Missouri, and Oregon). Two states without accreditation systems, Illinois and Texas, made periodic site visits to evaluate schools. Only one consortium, the Michigan Invitational Group, reported having an accreditation system at the state level. The Academy School District in Colorado reported that the state was in the process of implementing a system for 2001.

# Exhibit 5.5 Countries' Use of Methods to Support or Monitor Implementation of the Curriculum*

8th Grade Science

| | Pre-Service Teacher Education | In-Service Teacher Education | Mandated or Recommended Textbook(s) | Instructional or Pedagogical Guide | Ministry Notes and Directives | System of School Inspection or Audit |
|---|---|---|---|---|---|---|
| United States [1] | + | + | + | + | + | + |
| Australia [2] | ● | ● | | ● | ● | |
| Belgium (Flemish) | ● | ● | | ● | ● | ● |
| Bulgaria | ● | ● | ● | | ● | ● |
| Canada [3] | ● | ● | ● | ● | ● | |
| Chile | | | ● | | ● | |
| Chinese Taipei | ● | ● | ● | ● | | ● |
| Cyprus | | ● | ● | | ● | ● |
| Czech Republic | ● | | ● | | ● | ● |
| England | ● | ● | | | | ● |
| Finland | ● | ● | ● | ● | | |
| Hong Kong, SAR | | | ● | ● | | ● |
| Hungary | ● | ● | ● | ● | ● | |
| Indonesia | | ● | ● | ● | ● | ● |
| Iran, Islamic Rep. | ● | ● | ● | ● | ● | ● |
| Israel | ● | ● | ● | ● | ● | ● |
| Italy | | ● | | ● | ● | ● |
| Japan | | ● | ● | ● | ● | ● |
| Jordan | | ● | ● | ● | ● | ● |
| Korea, Rep. of | ● | ● | ● | ● | ● | ● |
| Latvia (LSS) | ● | ● | ● | ● | ● | ● |
| Lithuania | | ● | ● | | ● | |
| Macedonia, Rep. of | ● | ● | ● | ● | | ● |
| Malaysia | ● | ● | ● | ● | ● | ● |
| Moldova | | ● | ● | | ● | ● |
| Morocco | ● | ● | ● | ● | ● | ● |
| Netherlands | ● | ● | | ● | ● | ● |
| New Zealand | ● | ● | | | | ● |
| Philippines | | ● | ● | ● | ● | ● |
| Romania | ● | ● | ● | ● | ● | ● |
| Russian Federation | ● | ● | ● | ● | ● | ● |
| Singapore | ● | ● | ● | ● | ● | ● |
| Slovak Republic | ● | | ● | | ● | ● |
| Slovenia | ● | ● | ● | ● | | ● |
| South Africa | | ● | ● | | | ● |
| Thailand | ● | ● | ● | ● | ● | ● |
| Tunisia | | ● | ● | ● | ● | ● |
| Turkey | | ● | ● | | ● | ● |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by National Research Coordinators.

* Other than system-wide assessments and public examinations described in Exhibits 5.9 and 5.10, respectively.

1 United States: Methods are implemented by individual states and vary from state to state. As of 1998, 13 states have policies on textbook/materials selection; 8 states have policies recommending textbook/materials.

2 Australia: Results shown are for the majority of states/territories.

3 Canada: Results shown are for the majority of provinces.

## States', Districts' and Consortia's Use of Textbooks and Instructional Materials to Support Implementation of the Curriculum



| States | Policy on Textbooks and Instructional Materials |
|---|---|
| Connecticut | The state does not select textbooks. |
| Idaho | The state approves a list of textbooks and materials from which districts/schools must choose. The textbooks selection criteria include alignment with Idaho Skills-Based Scope and Sequence Guide and Achievement Standards, which specify skills that all students should know at different levels. Schools are required to select all their basic instructional materials from the Idaho Adoption Guide produced by the adoption committee. Schools not choosing from the adoption list can lose accreditation points. |
| Illinois | The state does not select textbooks. |
| Indiana | The state recommends a list of textbooks from which districts/schools must choose; however, waivers are granted. The state texts are not necessarily based on the state standards. The state intends to align textbook selections with Indiana's new Academic Standards (2000). |
| Maryland | The state does not select textbooks. |
| Massachusetts | The state does not select textbooks. |
| Michigan | The state does not select textbooks. |
| Missouri | The state does not select textbooks. |
| North Carolina | The state recommends textbooks and instructional materials; there is a fee arrangement between the state and the vendor that the districts are able to use. |
| Oregon | The state selects a list of textbooks and materials from which districts can choose. Districts may submit a waiver for an independent adoption to select textbooks and instructional materials of their own choice. These district-level adoptions must meet the state selection criteria. |
| Pennsylvania | The state does not select textbooks. |
| South Carolina | The state selects a list of textbooks and materials from which districts can choose. The state funds the instructional materials that are selected from the state approved list. |
| Texas | State Textbook Review Committee selects textbooks and instructional materials according to the state curriculum framework. Districts choose textbooks and/or instructional materials using local criteria. The state funds the purchase of textbooks and/or instructional materials that are on the selected list. Districts may waiver, at own expense, from selected textbooks or instructional materials. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

| Districts and Consortia | Policy on Textbooks and Instructional Materials |
|---|---|
| Academy School Dist. #20, CO | STATE: The state does not select textbooks.<br>LOCAL: Schools can select materials based on guidelines with acceptance by the Board of Education. |
| Chicago Public Schools, IL | STATE: The state does not select textbooks.<br>LOCAL: Schools in districts choose instructional materials. |
| Delaware Science Coalition, DE | STATE: The state does not select textbooks.<br>LOCAL: Textbook selection is usually made at the school level. |
| First in the World Consort., IL | STATE: The state does not select textbooks.<br>LOCAL: Textbooks and materials are selected and recommended at the district level. Consortium is reviewing materials to recommend as well. As of 1999/2000, the Consortium is looking to Project 2061/AAAS and NSF for guidance in textbook selection. Selection includes a committee reviewing materials against AAAS benchmarks, choosing materials, and submitting their recommendation for approval by the school board. |
| Fremont/Lincoln/ WestSide PS, NE | STATE: The state does not select textbooks.<br>LOCAL: Districts select textbooks/textbook series and schools select supplemental materials. |
| Guilford County, NC | STATE: The state selects a list of textbooks and materials based on the state content standards from which districts can choose.<br>LOCAL: One textbook used throughout county. A system-wide committee reviews the state selected list and one textbook per grade level is selected to be used system-wide. |
| Jersey City Public Schools, NJ | STATE: The state does not select textbooks.<br>LOCAL: A committee is formed at the district level to facilitate the selection of science textbooks and materials. There is a "standard operating procedure" for the formulation of the committee so as to include all constituent groups. All selected textbooks and materials are aligned with the district's science curriculum and the NJ Core Curriculum Content Standards in Science. |
| Miami-Dade County PS, FL | STATE: The state recommends the texts and instructional materials.<br>LOCAL: The district selection committee narrows the selection to two or three texts. The schools pick one of the selected textbooks. The new legislation makes waivers for using non-adopted texts more difficult, but schools are allotted some money to spend on non-state adopted materials with review at the district level. |
| Michigan Invitational Group, MI | STATE: The state does not select textbooks.<br>LOCAL: Textbook selection is made at the school level. Selection of textbooks is based on curriculum. |
| Montgomery County, MD | STATE: The state does not select textbooks.<br>LOCAL: The district recommends a few textbooks. Evaluation and approval of texts to support specific courses is done by a committee headed by the science supervisor. |
| Naperville Sch. Dist. #203, IL | STATE: The state does not select textbooks.<br>LOCAL: District uses criteria based on the learning outcomes to select instructional materials. No one textbook selected. |
| Project SMART Consortium, OH | STATE: The state does not select textbooks, but approves a liberal textbook list from which districts can choose.<br>LOCAL: A teacher review committee selects several texts and the teacher community involved usually votes or is given an opportunity to express their choice. |
| Rochester City Sch. Dist., NY | STATE: The state does not select textbooks.<br>LOCAL: A committee conformed by parents, teachers, building administrators and staff from central office selects textbooks. |
| SW Math/Sci. Collaborative, PA | STATE: The state does not select textbooks.<br>LOCAL: Each district selects instructional materials. Over forty districts are part of a local initiative which supports use of exemplary modules at the elementary level. At the middle school level, the Collaborative has engaged over 14 districts in selecting materials through a showcase-pilot adoption process. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

| States | Pedagogical Guides |
|---|---|
| Connecticut | Some pedagogical information is included with the state science framework. |
| Idaho | Pedagogical guides are not available at the state level. |
| Illinois | Performance descriptors have been completed (in draft form) to guide educators in implementing the standards. Classroom assessment tasks and student work exemplars will be available Summer 2001. |
| Indiana | The "Indiana Science Proficiency Guide" (1997) contains grade cluster ideas for activities. New Curriculum Frameworks are being written to support Indiana's new grade-specific Academic Standards (2000). |
| Maryland | Pedagogical guidance is not available at the state level. |
| Massachusetts | The curriculum frameworks provide appropriate teaching activities for each learning standard. |
| Michigan | Toolkits are designed to support the implementation of the curriculum frameworks including kits on planning subject area instructional units, curriculum integration, designing classroom assessments, and connecting with the learner. "The Science Education Guidebook" was developed specifically to assist in teaching the science frameworks. |
| Missouri | The Curriculum Frameworks provide appropriate teaching activities by discipline providing examples of how "Show-Me Standards" may be taught and assessed. |
| North Carolina | The development of a curriculum enhancement guide is in process. |
| Oregon | "Teaching and Learning to Standards" supports the Oregon content standards and provides best practices, example lessons, vignettes, scored student work, teaching resources, and common curriculum goals. A curriculum framework will be complete in January 2001. |
| Pennsylvania | Pedagogical guides are not available at the state level. |
| South Carolina | An implementation guide (2000) contains sample lesson plans, sample assessments, resources for teachers, and information for administrators on what to look for in exemplary science instruction. Content briefs are being developed to help teachers with implementation of the standards. |
| Texas | Under the direction of the Texas Education Agency, the Texas Science Center for Educator Development has produced different pedagogical guides: "TEXTEAMS" (modules for curriculum and instructional reform), "TEKSplorations Guides" for each grade and high school courses, "TEKS for Leaders" (materials and training for science reform), "Safety Handbook" (supports implementation of TEKS hands-on science in laboratory and field curriculum), "Curriculum Charts: K-12"; as well as a website and CD ROM: the "Science Teacher Toolkit" that includes support on many aspects of science teaching. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

| | Pedagogical Guides |
|---|---|
| **Districts and Consortia** | |
| Academy School Dist. #20, CO | No specific "how-to" instructional manuals are provided. The state has provided grade-appropriate sample assessments as well as released items and samples of scored student work which the district has expanded upon. |
| Chicago Public Schools, IL | The optional structured curriculum provides daily lesson plans at all grade levels. For high schools, test blueprints of the "Chicago Academic Standards Exam" (CASE) are provided to teachers for instructional purposes. |
| Delaware Science Coalition, DE | The "Delaware Performance Indicators for Curriculum Planning and Development" is a pedagogical guide for teachers. It defines expected performance in science but does not specify performance levels. All Performance Indicators are specifically limited to content standards and are included in the guide. Some districts have developed their own Performance Indicators, but most have adopted state Performance Indicators. |
| First in the World Consort., IL | There is no specific guide developed by the consortium. AAAS/Project 2061 provides professional development on content and instruction and evaluating materials for alignment to the Project 2061 benchmarks of science literacy. |
| Fremont/Lincoln/ WestSide PS, NE | Districts have curriculum-based instructional activities and commercially-developed materials. |
| Guilford County, NC | There is a locally-written book, Strategies for Instruction, detailing best practices, lessons, assessments, and teaching methods based on the North Carolina Course of Study. |
| Jersey City Public Schools, NJ | The "New Jersey Framework for Teaching in Science" published in May 1996, discusses essential components of a quality K-12 science program. The framework is not a curriculum, but a comprehensive digest of activities, curriculum connections, and instructional strategies related to the NJ Core Curriculum Content Standards in Science. In addition to the state standards and the state frameworks, the district's curriculum guides provide content guidelines based on grade-level competencies. In the district curriculum materials, hands-on learning kits, resources, and learning activities are provided at each grade level. |
| Miami-Dade County PS, FL | The Florida Curriculum Frameworks include the content knowledge and process skills for science that students should acquire, strategies to address various learning needs and styles, guidelines for effective assessment, professional development information, and sample evaluation criteria for school and district programs. The state recently has developed a CD-ROM entitled "Science Best Practices". The district produced a "Middle School Science Guide for Teachers" and "Elementary Science Guide for Teachers" that give specific information about the content and effective strategies that should be implemented. Most recently, the "Science Department Chairperson Handbook" was distributed that includes important information about curriculum, science inquiry, and technology use in the classroom. |
| Michigan Invitational Group, MI | Toolkits are designed by the state to support the implementation of the curriculum frameworks including kits on planning subject area instructional units, curriculum integration, designing classroom assessments, and connecting with the learner. The "Science Education Guidebook" was developed specifically to assist in teaching the science frameworks. |
| Montgomery County, MD | "Better Science" (1991), produced at the state level, provides pedagogical information and the "Outcomes Clarification Document" (1996) provides concept and process information. A website has been developed to provide the latest in best practices and exemplars. Local-level guides are adopted from commercial vendors. In addition, high school guides are developed locally. |
| Naperville Sch. Dist. #203, IL | The state provides goals, standards, and sample test items. Locally, the district develops K-5 detailed lessons and outcomes; grades 6-8 outcomes are connected to resources. |
| Project SMART Consortium, OH | There are not pedagogical guides at the state level. As soon as the state "Draft Content Science Standards" are approved by the Ohio State Board of Education (early 2001) plans are underway to provide pedagogical guides to locals. Ohio is a local-control state and thus many locals have developed various types of science guides. |
| Rochester City Sch. Dist., NY | New York State provides core curriculum guides based on the standards at all grade levels. Locally, the district develops K-12 curriculum guides based on standards. |
| SW Math/Sci. Collaborative, PA | Informal support is available connecting districts to exemplary materials, research findings, and best practices. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

## Exhibit 5.8 States', Districts' and Consortia's Use of Accreditation to Support Implementation of the Curriculum



8th Grade Science

| States | Use of Accreditation |
|---|---|
| Connecticut | No accreditation system. |
| Idaho | Accreditation requires that curriculum developed at the local level be aligned with state standards. Schools must establish educational standards for all grade levels and develop high school exiting standards for graduation; these standards must be aligned with exiting standards established by the State Board of Education. It also requires that schools participate in state testing and adhere to text adoption policies. |
| Illinois | Quality Review Teams of the State Board of Education conduct periodic quality-assurance site visits to schools. |
| Indiana | The accreditation system requires K-8 schools to self-report alignment of curriculum with state standards (proficiencies); grade 9-12 schools submit a master schedule and course descriptions to verify compliance with state standards. Performance on the ISTEP+ is also considered in accreditation. Technical assistance is available to schools that do not meet the accreditation standards. |
| Maryland | No accreditation system. |
| Massachusetts | No accreditation system. |
| Michigan | Accreditation is based in part on student performance on state assessments. The system is being revised to include successful achievement as well as continuous improvement. |
| Missouri | The Missouri School Improvement Program, designed to accredit districts, assesses districts progress on the Show-Me Standards as measured by the Missouri Assessment Program. There are "success teams" that help districts improve student achievement in all subject areas. |
| North Carolina | No accreditation system. |
| Oregon | All schools are state accredited through a system of "standard" assurances, Consolidated District and School Improvement Plans, Annual Performance Reports and Schools Reviews. State accreditation is based on the Oregon Performance Accountability System (OPAS), that assesses school science performance. Any school falling in the low or unacceptable category receives targeted assistance including alignment with standards, instructional improvement and professional development. |
| Pennsylvania | No accreditation system. |
| South Carolina | The accreditation system is in revision. Schools must meet a battery of standards in the current accreditation system, but student academic performance is not included. The new accreditation system will include student academic performance and will go into effect in 2001. |
| Texas | Although not considered an accreditation system, there is an accountability system in place. The state's accountability system includes a variety of on-site evaluations designed to provide feedback for improvement. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

| Districts and Consortia | Use of Accreditation |
|---|---|
| Academy School Dist. #20, CO | The state will be implementing an accreditation system beginning in Fall 2001 based primarily on the success and/or progress on the standards-referenced state assessment (CSAP). |
| Chicago Public Schools, IL | No accreditation system. |
| Delaware Science Coalition, DE | No accreditation system. |
| First in the World Consort., IL | No accreditation system. |
| Fremont/Lincoln/ WestSide PS, NE | No accreditation system. |
| Guilford County, NC | No accreditation system. |
| Jersey City Public Schools, NJ | No accreditation system. |
| Miami-Dade County PS, FL | No accreditation system. |
| Michigan Invitational Group, MI | State-level accreditation is based in part on student performance on state assessments. The system is being revised to include successful achievement as well as continuous improvement. |
| Montgomery County, MD | No accreditation system. |
| Naperville Sch. Dist. #203, IL | No accreditation system. |
| Project SMART Consortium, OH | No accreditation system. |
| Rochester City Sch. Dist., NY | No accreditation system. |
| SW Math/Sci. Collaborative, PA | No accreditation system. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

## What TIMSS 1999 Countries Have Assessments And Exams in Science?

Assessments and exams that are aligned with the intended curriculum provide a means for evaluating system- and student-level achievement. System-wide assessments are designed primarily to inform policy makers about matters such as national standards of achievement of the intended curriculum objectives, strengths and weaknesses in the curriculum or how it is being implemented, and whether educational achievement is improving or deteriorating. The primary purpose of national public examinations, while providing information of interest to national and regional policy makers, is to provide information for making decisions about individual students.

Exhibit 5.9 shows that almost two-thirds of the participating countries had national assessments in science, with almost half of those assessing all students and just over half sampling students. The number of grades tested ranged from two in England and the Philippines to six in Korea. Generally, the purpose of system-wide assessments was to provide feedback to government policy makers and the public, although some countries provided feedback to individual schools. For example, in England and Hungary information about individual students was used for course placement or guidance.

Using public examinations as a way to select students for university or academic tracks in secondary school can be an important motivating factor for student achievement (see Exhibit 5.10). Thirty-six countries reported having public examinations or awards, at one or more grades, that included testing achievement in science. Most countries held their examinations in the final year of schooling for certification and selection to higher education (often, university education). In about one-third of the countries, public examinations were also used for selection or course assignment (tracking) within secondary schools.

## Exhibit 5.9 Countries' System-Wide Assessments in Science

| | System-Wide Assessments[1] | Grades | | Purpose/Consequences |
|---|---|---|---|---|
| | | Entire Grade Level | Sample from Grade Level | |
| United States | Yes | | 4, 8, 12 | National and state-level feedback |
| Australia [2] | Yes | 10 (1 state) | 3, 7, 10 (1 state) 10 (1 state) | System-level feedback |
| Belgium (Flemish) | No | | | |
| Bulgaria | No | | | |
| Canada [3] | Yes | 4, 7, 10 (1 province) | ages 13 and 16 nationally (most provinces) | System- and school-level feedback |
| Chile | Yes | 4, 8, 10 | | System- and school-level feedback, usually one grade level assessed each year |
| Chinese Taipei | No | | | |
| Cyprus | No | | | |
| Czech Republic | No | | | |
| England | Yes | 5, 8 | | System-, school- and student-level feedback |
| Finland | Yes | | 4, 8, 9 | System-level feedback |
| Hong Kong, SAR | No | | | |
| Hungary | Yes | | 4, 6, 8, 10, 12 | System-level, school-level, and individual-level feedback |
| Indonesia | Yes | | various grades | System-level feedback, assessments given irregularly at different primary grades |
| Iran, Islamic Rep. | No | | | |
| Israel | Yes | | 6 | System-level feedback |
| Italy | Yes | | 6, 8, 10, 13 | System-level feedback; first administered in 1999 with a grade 4 assessment instituted in 2000. |
| Japan | Yes | | 5, 6, 7, 8, 9 | System-level feedback |
| Jordan | Yes | | 4, 5, 8, 10 | System-level feedback; monitoring reform impact; curricular revisions |
| Korea, Rep. of | Yes | 4, 5, 6, 7, 8, 10 | | System-level feedback |
| Latvia (LSS) | No | | | |
| Lithuania | No | | | |
| Macedonia, Rep. of | Yes | | 5, 6, 7, 8 | System-level feedback and research purposes (projects and curriculum development) |
| Malaysia | Yes | 6, 9, 11, 13 | | System- and school-level feedback; "good schools" publicized |
| Moldova | No | | | |
| Morocco | Yes | 6, 9, 10, 11, 12 | | System- and school-level feedback |
| Netherlands | Yes | 10, 11, 12 | 6 | System-level feedback |
| New Zealand | Yes | | 3, 7 | System-level feedback |
| Philippines | Yes | 6, 10 | | System- and school-level feedback (the assessment was sample-based up until 1999) |
| Romania | No | | | |
| Russian Federation | Yes | | various grades | Irregularly for research purposes |
| Singapore | Yes | 6, 10, 12 | | System- and school-level feedback; selection into courses, certification and entry to university |
| Slovak Republic | No | | | |
| Slovenia | No | | | |
| South Africa | No | | | |
| Thailand | No | | | |
| Tunisia | Yes | 4, 6, 9, 13 | | System- and school-level feedback; may lead to redistribution of teachers in the regions; assessments at grades 4 and 6 developed regionally |
| Turkey | Yes | | 5, 8, 11 | System- and school- level feedback |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by National Research Coordinators.

1 Public examinations are also used for system-wide assessment purposes in these countries: Malaysia, Morocco, Netherlands, Philippines, Singapore, Tunisia, and Turkey.

2 Australia: System-wide assessments are administered in 3 of 8 states/territories.

3 Canada: System-wide assessments are administered in 5 of 10 provinces.

# Exhibit 5.10 Countries' Public Examinations in Science

8th Grade Science

| | Public Exams/ Awards | Grade(s) | Purpose/Consequences |
|---|---|---|---|
| United States [1] | Yes | varies | Primarily feedback to system and schools; in 8 states grade promotion is dependent on results; in 18 states graduation is dependent on results of grade 12 exams |
| Australia | Yes | 12 | Certification and selection for tertiary education |
| Belgium (Flemish) | No | | |
| Bulgaria | Yes | 7/8, 12 | Candidates for profile schools (grade 7 or 8); certification and entrance to university– not taken by all students (grade 12) |
| Canada [2] | Yes | 12 (2 provinces); 6, 9, 12 (1 province) | Certification (grade 12); feedback to system and schools |
| Chile | Yes | 12 | Entry to university |
| Chinese Taipei | No | | |
| Cyprus | Yes | 9, 12 | Certification (grade 9); certification and entry to university (grade 12) |
| Czech Republic | Yes | 13 | Certification (science can be chosen as one of four subjects for leaving examination) |
| England | Yes | 10, 12 | Certification (grade 10); certification and entry to university (grade 12); feedback to system and schools |
| Finland | Yes | 12 | Certification and selection for tertiary education; in the matriculation exam, the General Studies Test section includes questions related to physics, chemistry, and biology in addition to seven other topic areas. Students can choose to take either the General Studies Test or the Mathematics Test |
| Hong Kong, SAR | Yes | 6, 11, 13 | School placement (grade 6); certification and placement for 12th grade (grade 11); placement in tertiary institutions (grade 13) |
| Hungary | Yes | 12 | Certification and entry to university (science is not a compulsory subject) |
| Indonesia | Yes | 6, 9, 12 | Leaving exam, selection for junior secondary school (grade 6); selection for senior secondary school (grade 9); leaving exam (grade 12); system-level feedback, in some cases school- and classroom-level feedback |
| Iran, Islamic Rep. | Yes | 11, 12 | Certification (grade 11); entry to tertiary education (grade 12); in addition, provincial exams are administered at grade 8 |
| Israel | Yes | 11 or 12 | Matriculation certification for those choosing entry to specific areas in the university |
| Italy | Yes | 13 | Certification and entry to university |
| Japan | Yes | 9, 12 | Entry to prefectural and municipal upper secondary schools (grade 9); entry to national, prefectural and municipal universities (grade 12) |
| Jordan | Yes | 12 | Certification and entry to tertiary education |
| Korea, Rep. of | Yes | 12 | College entrance exam for selection of students |
| Latvia (LSS) | Yes | 12 | Certification |
| Lithuania | Yes | 12 | Leaving examination |
| Macedonia, Rep. of | Yes | 12 | Certification and entry to university; the exam constitutes 40% of the required points for entry to university with the remaining points based on university entry exams |
| Malaysia | Yes | 6, 9, 11, 13 | Feedback to system and schools, achievement test (grade 6); entry to course tracks (grade 9); certification and end of secondary (grade 11); certification and entry to university (grade 13) |
| Moldova | Yes | 9, 11/12 | Certification, selection for high school (grade 9); graduation (grade 11 or 12 depending on school) |
| Morocco | Yes | 6, 9, 10, 11, 12 | Remedial test for retention purposes (grade 6); certification, selection to secondary, and selection to courses (grade 9); certification and entry to tertiary (grade 12); feedback to system and schools |
| Netherlands | Yes | 10, 11, 12 | End-of-track examinations; exams recommended at grades 6 and 8 |
| New Zealand | Yes | 10, 12 | Certification, course selection (grade 10); entry to tertiary education (grade 12); feedback to system and schools; informal between-school comparisons |
| Philippines | Yes | 6, 10 | Feedback to system and schools; entry to university set by each institution |
| Romania | Yes | 12 | Certification (science can be chosen as one of 7 subjects) |
| Russian Federation | Yes | 9, 11 | Certification (not state compulsory, may be administered at the regional or school level) |
| Singapore | Yes | 6, 10, 12 | Feedback to system and schools; selection into courses; certification and entry to university |
| Slovak Republic | Yes | 12 | Certification (science can be chosen as one of four subjects for leaving exam) |
| Slovenia | Yes | 12 | Certification and entry to tertiary education |
| South Africa | Yes | 12 | Certification and selection for tertiary education |
| Thailand | Yes | 12 | Entry to university |
| Tunisia | Yes | 6, 9, 13 | Feedback to system and schools; regional exam for promotion (grade 6); selection for schools/courses; promotion (grade 9) |
| Turkey | Yes | 8, 11 | Placement in specialized schools for some students (grade 8); entry to university (grade 11) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by National Research Coordinators.

1 United States: As of 1997-1998, public examinations are administered in 36 of 50 states at grades 7-8 or 9-12.

2 Canada: Public examinations are administered in 3 of 10 provinces.

## What Benchmarking Jurisdictions Have Assessments in Science?

Across the United States, many states are conducting assessments based on their own content standards and are assessing whether students in their schools are meeting these standards for academic achievement. Twenty-nine states have some type of criterion-referenced science assessment aligned to state standards.[6]

While all Benchmarking states had developed or are developing state-level assessments aligned with their state curriculum in mathematics,[7] only 7 of the 13 states – Illinois, Maryland, Massachusetts, Michigan, Missouri, Oregon, and Texas – had such statewide assessments in science at the middle school grades (see Exhibits 5.11 and 5.12). Assessments of state science standards were reported to be in development in Indiana, Pennsylvania, and South Carolina, each of which developed science standards in 2000. Science assessments in Idaho were under discussion. Connecticut and North Carolina had no statewide science assessments at the middle school grades.

All the Benchmarking states except Pennsylvania have participated in recent state science assessments as part of the National Assessment of Educational Progress (NAEP). Eleven of the 13 states participated in both 1996 and 2000, and Idaho in 2000.

Although none of the Benchmarking states reported using student performance on a science assessment as a requirement for high-school graduation, Maryland and South Carolina reported developing assessments including science that students must pass in order to graduate from high school (see Exhibit 5.13). Benchmarking states reported a range of other consequences of their science assessments for students, apart from their use as a graduation requirement. For example, Connecticut, Illinois, and Oregon reported that they affix a certificate or seal to students' diplomas to show that they have met the performance goal on the state high school science assessment; Illinois and Oregon reported a policy of using assessment results to assist in making promotion decisions; and South Carolina planned to institute a promotion policy in 2002. As an incentive, students meeting the standards in Michigan and Missouri could receive state funds to support their academic careers through scholarship money and funds for advanced course work, respectively.

6 Orlofsky, G.F. and Olson, L. (2001), "The State of the States" in *Quality Counts 2001, A Better Balance: Standards, Tests, and the Tools to Succeed*, Education Week, 20(17).

7 Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., O'Connor, K.M., Chrostowski, S.J., Gregory, K.D., Garden, R.A., and Smith, T.A. (2001), *Mathematics Benchmarking Report, TIMSS 1999 – Eighth Grade: Achievement for U.S. States and Districts in an International Context*, Chestnut Hill, MA: Boston College.

Benchmarking states also reported a range of consequences at the district or school level. For example, Massachusetts reported that additional funding was made available to low-performing schools and districts to support remediation. In Oregon and South Carolina, districts were required to provide remediation to students with low scores on the state assessments. States had the right to take over schools or districts in Maryland and Massachusetts. While consequences of assessments for schools or districts usually involved remediation activities or sanctions, Maryland also provided monetary rewards to schools that showed improvement. In Massachusetts, schools receiving recognition were eligible for an Exemplary Schools Program.

As shown in Exhibit 5.14, 10 of the 14 Benchmarking districts and consortia participated in the science assessments administered by their state. Of these, the Michigan Invitational Group and Montgomery County were in states that were revising their science assessments to align more closely with their current standards. Ohio's Project SMART Consortium was in a state administering proficiency tests that were not standards-based assessments. Miami-Dade, Rochester, and the Southwest Pennsylvania Math and Science Collaborative were developing science assessments for 2003, 2001, and 2001, respectively. The Fremont/Lincoln/Westside Public Schools and Guilford County reported having no statewide science assessments at the eighth grade.

# Exhibit 5.11 States' Science Assessments

8th Grade Science

| | State-Developed Criterion-Referenced Science Assessment[1] | Other Science Assessments | Participated in NAEP | |
|---|---|---|---|---|
| | | | 1996 | 2000 |
| Connecticut | Connecticut Academic Performance Test (CAPT): In revision - Grade 10 | None | Yes | Yes |
| Idaho | In discussion | ITBS: Grades 3-8<br>TAP: Grades 9-11 | No | Yes |
| Illinois | Illinois Goal Assessment Program (IGAP): Grades 4, 7, 11 (1988-99)<br>Illinois Standard Achievement Test (ISAT): Grades 4, 7 (2000)<br>Prairie State Achievement Examination (PSAE): Grade 11 (2001) | None | Yes[2] | Yes |
| Indiana | In development for 2002 | None | Yes | Yes |
| Maryland | Maryland School Performance Assessment Program (MSPAP): Designed to assess the 1990 Learning Outcomes - Grades 3, 5, 8 | None | Yes | Yes |
| Massachusetts | Massachusetts Comprehensive Assessment System (MCAS): Grades 4, 8, 10 | None | Yes | Yes |
| Michigan | Michigan Educational Assessment Program (MEAP): Grades 5, 8, 11 | None | Yes | Yes |
| Missouri | Missouri Assessment Program (MAP): In revision - Grades 3, 7, 10 | MAP includes the Terra Nova | Yes | Yes |
| North Carolina | No state assessment for grades K-8; End-of-course tests: physical science, biology, chemistry, physics - Grades 9-12 | None | Yes | Yes |
| Oregon | Oregon Statewide Assessment System: Grades 5, 8, 10; Grade 6 (Fall 2001). | None | Yes | Yes |
| Pennsylvania | In development - Grades 4, 7, 10 | None | No | No |
| South Carolina | Palmetto Achievement Challenge Test (PACT): In development Grades 3-8 (2002) and 10 (2004) | None | Yes | Yes |
| Texas | Texas Assessment of Academic Skills (TAAS): Grade 8 | None | Yes | Yes |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

1 Specifically developed to be aligned with the curriculum framework/content standards indicated in Exhibit 5.3.

2 Illinois participated in NAEP in 1996 but results were not reported due to low participation rates.

# Exhibit 5.12 Status of State-Developed Science Assessments

| | Status of State-Developed Science Assessment |
|---|---|
| Connecticut | The Connecticut Academic Performance Test (CAPT), first administered in 1995, was developed to be aligned with the 1987 Common Core of Learning. It is now being revised for 2000-01 based on Connecticut's 1998 K-12 Science Curriculum Framework. |
| Idaho | The development of state-wide science assessments is in discussion. |
| Illinois | Starting in 2000, the Illinois Standard Achievement Test (ISAT), administered at grades 4 and 7, replaced the Illinois Goal Assessment Program (IGAP) which was administered from 1988-1999 at grades 4, 7, and 11. Beginning in 2001, the state will give new high school tests, the Prairie State Achievement Examination (PSAE), based on the 1997 Illinois Learning Standards. |
| Indiana | A state science assessment is in development for implementation in 2002. Currently, there is no mandatory state science assessment. Voluntary state science assessments of high schools courses (Core 40 assessments) are available. |
| Maryland | The Maryland School Performance Assessment Program (MSPAP) assesses students at grades 3, 5, and 8. Currently, the MSPAP is based on the 1990 Learning Outcomes. By 2003, the MSPAP will be revised to assess the 2000 standards. The High School Assessment, in development, is proposed as an end-of-course test which will be part of the graduation requirement. Unlike the Maryland Functional Assessment that is currently required for high school graduation, the new High School Assessment will have a science component. |
| Massachusetts | Massachusetts Comprehensive Assessment System (MCAS) was first administered in 1998 to grades 4, 8, and 10. Integrated science assessments for grades 5 and 8 and discipline-specific assessments for secondary grades are in development and will be included from 2002. The Science & Technology MCAS was developed to assess the 1996 Curriculum Frameworks which are currently in revision. |
| Michigan | The Michigan Educational Assessment Program (MEAP) will introduce revised science tests at grades 5, 8, and 11 in 2002. Each of these tests are based on the Michigan Curriculum Frameworks science standards. |
| Missouri | The Missouri Assessment Program (MAP) has been developed for science in grades 3, 7, and 10. This assessment is currently in revision. Each test includes multiple-choice, short constructed-response, and performance-event items. The test consist of three sessions. The first two sessions include items designed to assess the Show-Me Standards (1996) which are directly related to the curriculum frameworks. Items that match the Show-Me Standards from the norm-referenced Terra Nova are administered in the third session. |
| North Carolina | There are no state-level science assessments in grades K-8. The four end-of-course science assessments (physical science, biology, chemistry and physics) are being revised in accordance with the new curriculum for the 2001-2002 administration. |
| Oregon | The Oregon Statewide Assessment System includes a multiple-choice state test in science at grades 5, 8, and 10. Classroom work samples are required as local assessment in science for grades 3-12. All assessments are based on the content standards and are revised annually. |
| Pennsylvania | Science assessments are in development with field testing scheduled for Spring 2001. |
| South Carolina | The Palmetto Achievement Challenge Test (PACT) is being developed to be aligned with the 2000 science standards. The grades 3-8 assessments will be implemented in 2002 and the grade 10 exit-level assessment will be implemented in 2004. The PACT will replace the Basic Skills Assessment Program (BSAP) given at grades 3, 6, and 8. Additionally, a biology end-of-course assessment will be implemented in 2004. |
| Texas | The Texas Assessment of Academic Skills (TAAS) was recently revised to more specifically assess the current standards for the 2000 administration. TAAS is administered in science at grade 8 and the TAAS end-of-course biology exam is administered in high school. As a prerequisite to receiving a high school diploma, students must demonstrate satisfactory performance on either the biology or the U.S. History end-of-course examination. Beginning in 2003, science will be tested at grades 5, 10, and 11. Students will be required to pass the grade 11 examination for graduation. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

# Exhibit 5.13 States' Use of Science Assessments with Consequences

| | Assessment | Graduation Requirement | Other Consequences |
|---|---|---|---|
| Connecticut | Connecticut Academic Performance Test (CAPT) | No | STUDENT: Students meeting the state performance goal on the 10th grade CAPT assessment receive a certificate of mastery. This certificate is affixed to students' official transcripts. Students who do not meet the state goal may retake the test in grades 11 and 12. Results are reported publicly (e.g., newspapers) but there are no direct consequences. |
| Idaho | In discussion | – | – |
| Illinois | Illinois Standards Achievement Tests (ISAT)<br>Prairie State Achievement Examination (PSAE) | No | STUDENT: Test results may be used, in conjunction with other data, to make decisions about students' promotion/retention, summer school requirements, and remediation. Students receiving high scores on the PSAE will receive honors designations.<br><br>DISTRICT/SCHOOL: Test results are considered at both the district and school levels as part of the state accountability system. |
| Indiana | In development | No | – |
| Maryland | Maryland School Performance Assessment Program (MSPAP); High School Assessment (HSA) | The HSA is being developed as a graduation requirement. | STUDENT: There are no student-level consequences based on the MSPAP since each student is given only a portion of the assessment.<br><br>DISTRICT/SCHOOL: The MSPAP is a school accountability assessment. Part of schools' performance rating is based on MSPAP assessment scores. Schools that improve significantly over a two-year period receive monetary rewards. Schools are required to develop school improvement plans for areas in which standards were not met. The State Board of Education has the right to reconstitute schools based on low MSPAP test scores and lack of improvement. Thus far, three schools in Maryland have been reconstituted. |
| Massachusetts | Massachusetts Comprehensive Assessment System (MCAS) | No | STUDENT: There are no student-level consequences.<br><br>DISTRICT/SCHOOL: Results are being used as a high-stakes accountability measure to evaluate performance and improvement for schools and districts. Schools will be rated based on performance and progress. Recognized schools may be eligible for an Exemplary Schools Program. Low performance and inadequate progress may result in the removal of principals and/or state-takeover of districts. Targeted resources and funding will be provided to low-performing schools and districts. |
| Michigan | Michigan Educational Assessment Program (MEAP) | No | STUDENT: Students who meet the standards on the MEAP High School Tests are eligible for graduation certificate endorsement and scholarship awards. |
| Missouri | Missouri Assessment Program (MAP) | No | STUDENT: Students scoring at the lowest performance level must retake a shortened version of the exam the following year. Students performing at proficient or above on the 10th grade test receive state funds for college-level courses or Advanced Placement exams.<br><br>DISTRICT/SCHOOL: Test results will be a part of district-level accreditation. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

A dash (–) indicates data are not available.

| | Assessment | Graduation Requirement | Other Consequences |
|---|---|---|---|
| North Carolina | NC Testing Program | No | STUDENT: For biology, the student's score on the biology test must be included as 25% of student's final grade for the course. |
| Oregon | Oregon State-wide Assessment System | No | STUDENT: Students who meet the performance standard on the state-level and local standards-based assessments receive Certificates of Initial Mastery in each area in which the standard is met. Students who do not meet the 10th grade science performance standard have an opportunity to take the test again. Low-performing students receive additional support and individual instruction to help them meet the standards. These students can change schools if instruction at one school is not meeting their needs. Districts may use the results of the tests to determine student promotion.<br><br>DISTRICT/SCHOOL: Test results are part of the accountability system. Districts must meet set goals for the assessments to avoid possible sanctions. |
| Pennsylvania | In development | – | – |
| South Carolina | Palmetto Achievement Challenge Tests (PACT) | Beginning in 2004, students will have to pass a standards-based exam to graduate. | STUDENT: Promotion policy considers students' performances on the state assessments as of 2002.<br><br>DISTRICT/SCHOOL: Schools will be rated based on student performance and improvement. Accreditation of schools will take into account student performance. Districts are required to provide remediation to low-performing students. |
| Texas | Texas Assessment of Academic Skills (TAAS) | No | STUDENT: No consequences.<br><br>DISTRICT/SCHOOL: No consequences. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

## Exhibit 5.14 Districts' and Consortia's State and Local Science Assessments

8th Grade Science

| | Science Assessments | |
|---|---|---|
| | State | Local |
| Academy School Dist. #20, CO | Colorado State Assessment Program (CSAP) administered in science at grade 8. | In addition to the CSAP, students take ITBS (grade 7), and ITED (grade 10). District-developed performance assessment units are optional. |
| Chicago Public Schools, IL | Starting in 2000, the Illinois Standard Achievement Test (ISAT), administered at grades 4 and 7, replaced the Illinois Goal Assessment Program (IGAP) which was administered from 1988-1999 at grades 4, 7, and 11. Beginning in 2001, the state will give new high school tests, the Prairie State Achievement Examination (PSAE), based on the Illinois Learning Standards. | Chicago Academic Standards Exam was developed to assess the district framework and is being piloted 1999-2000. Students are assessed in science in grades 9 and 10 with end-of-course exams (Biology, Physics, Chemistry, Earth and Space Science, Environmental Science). Chicago uses the norm-referenced TAP (9-11). Also, ACT's PLAN nationally-normed tests are administered at grade 11. |
| Delaware Science Coalition, DE | The Delaware Student Testing Program (DSTP) first administered in science at grades 8 and 11 (Spring 2000) and at grades 4 and 6 (Fall 2000). | There are no district-wide assessments based on the standards. Some districts administer the SAT-9 or the Terra Nova. The Delaware Science Coalition has developed some curriculum-based summative performance-based assessments complete with rubrics, anchor papers and instructions for administering in Grades 1-5. Middle School Assessments are planned. There are also plans to develop annual assessments and formative assessments based on the curriculum. |
| First in the World Consort., IL | Starting in 2000, the Illinois Standard Achievement Test (ISAT), administered at grades 4 and 7, replaced the Illinois Goal Assessment Program (IGAP) which was administered from 1988-1999 at grades 4, 7, and 11. Beginning in 2001, the state will give new high school tests, the Prairie State Achievement Examination (PSAE), based on the Illinois Learning Standards. Consortium schools receive a measure of improvement based on the percentage of students in each performance level. | The consortium administered TIMSS in 1996 and is developing assessments for districts' use. There are no assessments at this time but will begin review of the curriculum against Project 2061 Benchmarks (2000-2001). Consortium districts administer the Terra Nova CTBS Battery which includes science. School-improvement goals/plans include professional development and instructional initiatives based on students' performance on the CTBS Battery. |
| Fremont/Lincoln/ WestSide PS, NE | There are no assessments at the state level. Assessing students is local responsibility. | Districts administer the ITBS. |
| Guilford County, NC | There are no state-level science assessments in grades K-8. The North Carolina Testing Program includes high school end-of-course exams in biology, physical science, chemistry, and physics. These end-of-course exams are used to rate individual schools. State assistance teams may be sent to low-performing schools. | Assessments were created by the state and given as a local option in grades 3, 5, 6, 7, and 8 through 1998-99. They were continued in grades 5 and 7 in 1999-2000. There are no plans for K-8 science assessments after 1999-2000. |
| Jersey City Public Schools, NJ | Starting in May 1999, the New Jersey Elementary School Proficiency Assessment (ESPA) was administered at grade 4. The ESPA contains a science component. Similarly, beginning in March 1999, the NJ Grade Eight Proficiency Assessment (GEPA) was administered at grade 8. This test replaced the Early Warning Test which had been previously administered to eighth graders. The science component of the GEPA was administered for the first time in March 2000. Both the ESPA and the GEPA are tests of excellence and measure student performance in relation to the NJ Core Content Curriculum Standards in Science. The High School Proficiency Assessment (HSPA) is presently in development at the state level and will be used beginning in the spring 2001 for first time juniors (Class of 2002) as the mandated test for graduation. Presently, the High School Proficiency Test (HSPT) has been administered statewide since the early 1990s as the mandated test for high school graduation. The HSPT does not contain a science component. | In addition to the state assessments, at the elementary level, the district has developed district-wide midterms in science in grades 3-8. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

| | Science Assessments | |
|---|---|---|
| | State | Local |
| Miami-Dade County PS, FL | The state criterion-referenced science assessment is in development (2003 administration). | The SAT-9 Science test is administered to students in grades 5, 7, and 9. The EXPLORE, which has mathematics and science assessments, is administered to all grade 8 students. District-level curriculum-based science assessments will be developed and implemented by 2001-02. |
| Michigan Invitational Group, MI | The Michigan Educational Assessment Program (MEAP) will introduce revised science tests at grades 5, 8, and 11 in 2002. Each of these tests are based on the Michigan Curriculum Frameworks science standards. | A variety of tests are used by local districts. |
| Montgomery County, MD | The Maryland School Performance Assessment Program (MSPAP) assesses students at grades 3, 5, and 8. Currently, the MSPAP is based on the 1990 Learning Outcomes. By 2003, the MSPAP will be revised to assess the 2000 standards. The High School Assessment is in development. It is proposed as an end-of-course test which will be part of the graduation requirement. | No formal local-level assessments for elementary or middle school in science. There are county-wide high school exams required for each high school science course. |
| Naperville Sch. Dist. #203, IL | Starting in 2000, the Illinois Standard Achievement Test (ISAT), administered at grades 4 and 7, replaced the Illinois Goal Assessment Program (IGAP) which was administered from 1988-1999 at grades 4, 7, and 11. Beginning in 2001, the state will give new high school tests, the Prairie State Achievement Examination (PSAE), based on the Illinois Learning Standards. Schools could be placed on academic warning based on state test results. State NAEP is also administered at the 4th grade. | There are force choice and performance local science assessments at grades 2, 5, 6, 7, and 8. The science assessments are currently under revision. |
| Project SMART Consortium, OH | Proficiency assessments in science are administered at grades 4, 6, 9, and 12. As of 2000/01, students must pass the 9th grade assessment to graduate. A high school graduation exam is in development and will be required for the Class of 2005. | Districts have their own assessments in addition to state assessments. District assessments are given at grades 1-3, 5, and 7 to assess student progress. These are both standardized and district-developed assessments. |
| Rochester City Sch. Dist., NY | The state science test for grade 4 has been in place since 1989. The state science test for grade 8 starts in Spring 2001. The class entering grade 9 in 2001 will be the first class required to pass Regents exams (with a grade of 65% or higher) in all subject areas, including science. Beginning in June 2001, New York will assess students using new state-developed final exams for biology and earth science. Chemistry and physics will follow in later years. Exams are based on new state standards. New York is currently phasing out high school competency exams; instead, students will be required to pass at least one Regents exam. New York State has developed a school accountability system that will be phased in by 2003. School districts must provide academic intervention services to students who score below the state designated performance level on state assessments and/or students at risk of not achieving the state learning standards. | There are district-wide mid-terms and final exams for courses not ending in a Regents exam for grades 6 through 12. |
| SW Math/Sci. Collaborative, PA | The science assessment is in development with field testing scheduled for Spring 2001. | Each of the 118 districts has its own assessment system in addition to the state assessments. Forty of the districts have worked together to develop classroom-based assessment tools for the STC modules at the elementary level. |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

## How Do Education Systems Deal with Individual Differences?

The challenge of maximizing opportunity to learn for students with widely differing abilities and interests is met differently in different education systems. Exhibit 5.15 summarizes questionnaire and interview data on how selected comparison countries, as well as states, districts, and consortia, organized their curricula to deal with this issue.

Some participants indicated using more than one method of dealing with individual differences among students, and in these cases the category describing the main method was reported. In the United States, and in Canada, Chinese Taipei, the Czech Republic, Hong Kong, and the Russian Federation among the comparison countries, the same curriculum was intended for all students, but it was recommended that teachers adapt the level and scope of their teaching to the abilities and interests of their students. In the Czech Republic and England, the science curriculum was taught at different levels to different groups, two in the Czech Republic and nine in England – so many because in England the levels are defined in terms of progressively more complex performance to be demonstrated. Another approach to differentiated provision was followed in Belgium (Flemish), the Netherlands, and Singapore, which assign different curricula to students of different levels of ability and interest. Three of the comparison countries, Italy, Japan, and Korea, reported that their official science curricula did not address the issue of differentiating instruction for eighth-grade students with different abilities or interests.

All of the Benchmarking states and most of the districts and consortia generally resembled the United States in that they provided the same curriculum for all, but expected teachers to adapt the level and scope of their teaching to their students' needs. The First in the World Consortium, Miami-Dade, and Montgomery County provided the same curriculum to all, but at different levels for different groups – three levels in First in the World and two levels in each of the other two.

Schools' reports on how they organize to accommodate students with different abilities or interests are shown in Exhibit R2.1 in the reference section. Substantial percentages of students in many countries were in schools that offered remedial science (53 percent, on average internationally) and enrichment science (50 percent). While high-performing Singapore and Chinese Taipei reported that 97 and 78 percent of their students, respectively, were in schools that offered remedial science, all Benchmarking jurisdictions reported that less than 30 percent of their students were in such schools. Six Benchmarking jurisdictions reported higher percentages of students in schools that offer enrichment science than internationally, with Miami-Dade and Rochester reporting that 100 percent of their students were in such schools.

# Exhibit 5.15 Differentiation of Curriculum for Students with Different Abilities or Interests

8th Grade Science

| | Curriculum Addresses Differentiation | Approaches to Addressing Students with Different Abilities or Interests at Grade 8 | | | |
|---|---|---|---|---|---|
| | | Same Curriculum for All Students, and Teachers Adapt to Students' Needs | Same Curriculum with Different Levels for Different Groups | Different Curricula for Different Groups | Number of Curriculum Levels |
| **Countries** | | | | | |
| United States [1] | Yes | Yes | No | No | 1 |
| Belgium (Flemish) | Yes | No | No | Yes | 2 |
| Canada | Yes | Yes | No | No | 1 |
| Chinese Taipei | Yes | Yes | No | No | 1 |
| Czech Republic [2] | Yes | Yes | Yes | No | 2 |
| England [3] | Yes | No | Yes | No | 9 |
| Hong Kong, SAR | Yes | Yes | No | No | 1 |
| Italy | No | | | | |
| Japan | No | | | | |
| Korea, Rep. of | No | | | | |
| Netherlands | Yes | No | No | Yes | 4 |
| Russian Federation | Yes | Yes | No | No | 1 |
| Singapore | Yes | No | No | Yes | 3 |
| **States** | | | | | |
| Connecticut | Yes | Yes | No | No | 1 |
| Idaho | Yes | Yes | No | No | 1 |
| Illinois | Yes | Yes | No | No | 1 |
| Indiana | Yes | Yes | No | No | 1 |
| Maryland | Yes | Yes | No | No | 1 |
| Massachusetts | Yes | Yes | No | No | 1 |
| Michigan | Yes | Yes | No | No | 1 |
| Missouri | Yes | Yes | No | No | 1 |
| North Carolina | Yes | Yes | No | No | 1 |
| Oregon | Yes | Yes | No | No | 1 |
| Pennsylvania [4] | – | – | – | – | – |
| South Carolina | Yes | Yes | No | No | 1 |
| Texas | Yes | Yes | No | No | 1 |
| **Districts and Consortia** | | | | | |
| Academy School Dist. #20, CO | Yes | Yes | No | No | 1 |
| Chicago Public Schools, IL | Yes | Yes | No | No | 1 |
| Delaware Science Coalition, DE | Yes | Yes | No | No | 1 |
| First in the World Consort., IL | Yes | No | Yes | No | 3 |
| Fremont/Lincoln/WestSide PS, NE | Yes | Yes | No | No | 1 |
| Guilford County, NC | Yes | Yes | No | No | 1 |
| Jersey City Public Schools, NJ | Yes | Yes | No | No | 1 |
| Miami-Dade County PS, FL | Yes | No | Yes | No | 2 |
| Michigan Invitational Group, MI | Yes | Yes | No | No | 1 |
| Montgomery County, MD | Yes | No | Yes | No | 2 |
| Naperville Sch. Dist. #203, IL | Yes | Yes | No | No | 1 |
| Project SMART Consortium, OH | Yes | Yes | No | No | 1 |
| Rochester City Sch. Dist., NY | Yes | Yes | No | No | 1 |
| SW Math/Sci. Collaborative, PA [4] | – | – | – | – | – |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

1 United States: Most state standards are designed for all students.

2 Czech Republic: There is the same curriculum with different levels for different groups in physics and chemistry (2 levels); there is one curriculum for all students, and teachers adapt to students' needs, in life science and earth science.

3 England: While there is one "programme of study" for grades 6-8, the document identifies nine performance-levels describing the types and range of performance that pupils working at a particular level should demonstrate.

4 Due to the variation across the state/collaborative, a representative response cannot be provided for these questions.

A dash (–) indicates data are not available.

## What Are the Major Characteristics of the Intended Curriculum?

Exhibit 5.16 indicates the relative emphasis given to various aspects of science instruction in the intended curriculum. Knowing basic science facts and understanding science concepts received major emphasis in the curriculum of most participating countries, and at least moderate emphasis was placed on application of science concepts in almost all national curricula. In addition to these three areas, the United States reported placing major emphasis on using laboratory equipment, performing experiments, and designing and conducting scientific experiments, as did top-performing Singapore, Korea, and Japan. The Czech Republic's intended curriculum had minor or no emphasis on any aspect of practical work.

The Benchmarking jurisdictions were similar to the United States overall in the curricular areas that they reported placing major emphasis on. All Benchmarking jurisdictions reported placing major emphasis on understanding science concepts and on applying science concepts, and all jurisdictions except Pennsylvania and the Fremont/Lincoln/Westside Public Schools on designing and conducting scientific experiments. There were also areas of different emphasis. Although the pattern varied quite a lot, relatively less emphasis was reported by Benchmarking states on knowing basic science facts (particularly in Massachusetts and Michigan), on using laboratory equipment, and on performing experiments, and relatively more emphasis on assessment. The Benchmarking districts and consortia resembled the United States overall rather more closely, although again there was relatively more emphasis on assessment, as well as on communicating scientific procedures and explanations, reported in almost all of these jurisdictions.

It is possible that in some entities some of the approaches and processes reported as being given minor or no emphasis in the intended curriculum may receive more emphasis in the implemented curriculum. Conversely, it is also possible that some of the approaches and processes reported as being given major or moderate emphasis in the intended curriculum may receive less emphasis in the implemented curriculum.

| | Knowing Basic Science Facts | Understanding Science Concepts | Applying Science Concepts to Solve Problems and Develop Explanations | Using Laboratory Equipment | Performing Experiments | Designing and Conducting Scientific Investigations | Communicating Scientific Procedures and Explanations in Written and Oral Form | Integration of Science with Mathematics | Science, Technology and Society | Cross-Disciplinary Approach (Integration of the Sciences and Other School Subjects) | Thematic Approach | Multicultural Approach | Assessing Student Learning |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Countries** | | | | | | | | | | | | | |
| United States | ● | ● | ● | ● | ● | ● | ◉ | ○ | ○ | ○ | ◉ | ○ | ◉ |
| Belgium (Flemish) [1] | ◉ | ◉ | ◉ | ◉ | ◉ | ◉ | ◉ | ○ | ◉ | ◉ | ◉ | ○ | ◉ |
| Canada [2] | ● | ● | ● | ◉ | ◉ | ◉ | ● | ○ | ● | ○ | ◉ | ○ | ◉ |
| Chinese Taipei | ● | ● | ● | ◉ | ◉ | ● | ○ | ○ | ◉ | ○ | ○ | ○ | ◉ |
| Czech Republic | ● | ● | ◉ | ○ | ○ | ○ | ● | ◉ | ◉ | ○ | ● | ○ | ● |
| England | ● | ● | ● | ◉ | ◉ | ● | ● | ○ | ◉ | ○ | ○ | ○ | ● |
| Hong Kong, SAR | ● | ● | ◉ | ● | ● | ○ | ○ | ○ | ◉ | ○ | ◉ | ○ | ● |
| Italy | ● | ● | ● | ◉ | ● | ● | ◉ | ● | ● | ● | ● | ◉ | ◉ |
| Japan | ● | ● | ● | ● | ● | ● | ◉ | ○ | ◉ | ○ | ○ | ○ | ● |
| Korea, Rep. of | ● | ● | ● | ● | ● | ● | ◉ | ○ | ● | ○ | ◉ | ○ | ● |
| Netherlands | ◉ | ◉ | ● | ◉ | ◉ | ◉ | ◉ | ◉ | ● | ◉ | ● | ◉ | ◉ |
| Russian Federation [1] | ● | ● | ● | ◉ | ◉ | ○ | ◉ | ◉ | ◉ | ◉ | ● | ○ | ● |
| Singapore | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ● | ○ | ● | ◉ | ● |
| **States** | | | | | | | | | | | | | |
| Connecticut | ◉ | ● | ● | ◉ | ● | ● | ◉ | ○ | ◉ | ○ | ○ | ◉ | ◉ |
| Idaho | ● | ● | ● | ● | ● | ● | ◉ | ● | ◉ | ◉ | ◉ | ○ | ○ |
| Illinois | ◉ | ● | ● | ◉ | ◉ | ● | ◉ | ○ | ● | ○ | ◉ | ○ | ○ |
| Indiana | ● | ● | ● | ◉ | ● | ● | ● | ● | ● | ● | ● | ● | ◉ |
| Maryland | ◉ | ● | ● | ◉ | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ● |
| Massachusetts | ○ | ● | ● | ◉ | ◉ | ● | ● | ◉ | ◉ | ◉ | ◉ | ○ | ● |
| Michigan | ○ | ● | ● | ◉ | ● | ● | ◉ | ○ | ● | ○ | ◉ | ● | ● |
| Missouri | ◉ | ● | ● | ● | ● | ● | ● | ◉ | ● | ◉ | ○ | ○ | ● |
| North Carolina | ◉ | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ○ | ◉ | ◉ | ◉ |
| Oregon | ● | ● | ● | ◉ | ◉ | ● | ● | ○ | ○ | ○ | ○ | ○ | ● |
| Pennsylvania | ● | ● | ● | ◉ | ◉ | ◉ | ○ | ◉ | ● | ◉ | ● | ○ | ○ |
| South Carolina | ◉ | ● | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ○ | ● |
| Texas | ◉ | ● | ● | ● | ● | ● | ● | ○ | ● | ○ | ● | ◉ | ● |
| **Districts and Consortia** | | | | | | | | | | | | | |
| Academy School Dist. #20, CO | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Chicago Public Schools, IL | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ○ | ◉ | ◉ | ● |
| Delaware Science Coalition, DE | ◉ | ● | ● | ● | ● | ● | ● | ○ | ● | ◉ | ● | ◉ | ● |
| First in the World Consort., IL | ● | ● | ● | ◉ | ● | ● | ● | ● | ● | ◉ | ◉ | ○ | ◉ |
| Fremont/Lincoln/WestSide PS, NE | ◉ | ● | ● | ● | ● | ◉ | ● | ◉ | ● | ● | ● | ● | ◉ |
| Guilford County, NC | ◉ | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ◉ | ◉ | ● |
| Jersey City Public Schools, NJ | ● | ● | ● | ◉ | ● | ● | ● | ◉ | ● | ● | ● | ◉ | ● |
| Miami-Dade County PS, FL | ◉ | ● | ● | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ● |
| Michigan Invitational Group, MI | ● | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ○ | ◉ | ● |
| Montgomery County, MD | ◉ | ● | ● | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ● |
| Naperville Sch. Dist. #203, IL | ● | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ◉ | ○ | ● |
| Project SMART Consortium, OH | ◉ | ● | ● | ● | ● | ● | ● | ◉ | ● | ○ | ● | ● | ● |
| Rochester City Sch. Dist., NY | ◉ | ● | ● | ● | ● | ● | ● | ● | ● | ◉ | ◉ | ◉ | ● |
| SW Math/Sci. Collaborative, PA [3] | – | – | – | – | – | – | – | – | – | – | – | – | – |

● Major Emphasis
◉ Moderate Emphasis
○ Minor/No Emphasis
– Not Available

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions.

1 Belgium (Flemish) and Russian Federation: The single codes are derived from a combination of codes for individual sciences.

2 Canada: Results shown are for the majority of provinces.

3 SW Math/Sci. Collaborative: Covering a workforce region of 118 autonomous districts, the Collaborative cannot provide a representative response for these questions.

## What Science Content Do Teachers Emphasize at the Eighth Grade?

Teachers from the Benchmarking jurisdictions and the countries where eighth-grade science was taught as a general or integrated course were asked what subject matter they emphasized most in their classes (general science, earth science, biology, etc.). Their responses, shown in Exhibit 5.17, reveal that on average across all the TIMSS 1999 single-science countries, more than half the eighth-grade students (58 percent) were in classes where the emphasis was on general or integrated science. Next most common was biology with 14 percent, and physical science (physics and chemistry combined) with 11 percent.

In the United States, 41 percent of students were in classes emphasizing general science, 28 percent earth science, and 21 percent physical science. Just five percent of U.S. students were in science classes emphasizing biology, three percent chemistry, and two percent physics. The United States was unusual in its emphasis on earth science. Among the 21 single-science countries in TIMSS, only Canada, Italy, and the U.S. had more than 10 percent of their students in classes emphasizing earth science. It was more common for single-science countries to place emphasis on physical science.

There was considerable variation across the Benchmarking jurisdictions in the reported subject matter emphasis in science classes. Among states, the percentage of students in classes emphasizing general science ranged from four percent in Idaho to 72 percent in North Carolina. The only Benchmarking states besides Idaho with percentages lower than the U.S. average were Connecticut, Missouri, Oregon, Pennsylvania, and Texas. Earth science received least emphasis in Michigan (nine percent of students) and greatest in Texas (52 percent). Benchmarking states with more than one-fifth of the students in classes emphasizing earth science, in addition to Texas, were Connecticut, Idaho, Missouri, Oregon, Pennsylvania, and South Carolina. Physical science received least emphasis in Texas and North Carolina (five and six percent, respectively), and most in Idaho (50 percent). Eight of the states had more than one-fifth of their students in classes emphasizing physical science.

Among the districts and consortia, the greatest emphasis on general science was reported in Chicago, the Fremont/Lincoln/Westside Public Schools, Guilford County, Miami-Dade, and Naperville, all of which had two-thirds or more of their students in classes emphasizing general science. In contrast, the First in the World Consortium, Jersey City, the

Project SMART Consortium, and Rochester each had less than one-quarter of their students in such classes. There was less variation among districts and consortia in the emphasis given earth science. While 68 percent of the students in the Delaware Science Coalition were in classes emphasizing earth science, nine of the districts and consortia had less than 10 percent of their students in such classes, and seven of them had one percent or less. There was substantial variation among districts and consortia in the emphasis given physical science. The Academy School District, Jersey City and Rochester each had more than half their students in classes emphasizing physical science, while Chicago, the Delaware Science Coalition, the Fremont/Lincoln/Westside Public Schools, Guilford County, the Michigan Invitational Group, and Naperville had less than one-fifth of the students in such classes.

## Exhibit 5.17 Subject Matter Emphasized Most in General/Integrated Science Class

| | | Percentage of Students Whose Teachers Report the Subject Matter Emphasized Most in Their Grade 8 Science Class | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | General/ Integrated Science | Earth Science | Biology | Physics | Chemistry | Physical Science (chemistry/ physics) | Other |
| **Countries** | | | | | | | | |
| United States | r | 41 (4.7) | 28 (4.8) | 5 (1.5) | 2 (0.8) | 3 (1.0) | 21 (3.1) | 1 (0.4) |
| Canada | r | 55 (3.5) | 14 (2.3) | 6 (1.7) | 1 (0.7) | 1 (0.6) | 19 (2.7) | 3 (1.2) |
| England | | – – | – – | – – | – – | – – | – – | – – |
| Hong Kong, SAR | | 92 (2.6) | 0 (0.0) | 3 (1.5) | 0 (0.0) | 1 (0.0) | 4 (1.9) | 0 (0.0) |
| Italy | | 0 (0.0) | 20 (3.2) | 49 (3.9) | 13 (2.6) | 3 (1.2) | 11 (2.6) | 3 (1.4) |
| Japan | | 64 (4.6) | 1 (1.0) | 7 (2.4) | 6 (2.1) | 11 (2.7) | 6 (2.1) | 5 (1.9) |
| Korea, Rep. of | | 49 (4.0) | 2 (1.0) | 10 (2.0) | 5 (1.6) | 5 (1.7) | 26 (3.2) | 4 (1.6) |
| Singapore | | 69 (4.1) | 0 (0.0) | 5 (2.0) | 4 (1.8) | 7 (2.3) | 11 (2.5) | 4 (1.6) |
| **States** | | | | | | | | |
| Connecticut | s | 30 (7.8) | 22 (6.2) | 5 (4.1) | 4 (2.4) | 5 (2.4) | 32 (7.7) | 3 (2.1) |
| Idaho | r | 4 (2.8) | 32 (6.6) | 8 (4.6) | 3 (1.2) | 0 (0.0) | 50 (7.3) | 3 (2.7) |
| Illinois | r | 46 (7.1) | 14 (4.7) | 8 (3.4) | 0 (0.0) | 6 (2.0) | 24 (6.7) | 1 (0.6) |
| Indiana | r | 52 (8.1) | 16 (4.8) | 3 (1.5) | 0 (0.0) | 3 (2.2) | 23 (8.0) | 4 (1.7) |
| Maryland | s | 41 (6.9) | 18 (4.7) | 1 (1.4) | 0 (0.0) | 5 (2.3) | 32 (6.7) | 2 (2.0) |
| Massachusetts | r | 42 (5.9) | 17 (5.3) | 0 (0.1) | 0 (0.0) | 0 (0.0) | 41 (7.0) | 1 (0.0) |
| Michigan | r | 54 (5.7) | 9 (3.9) | 3 (2.5) | 2 (2.1) | 0 (0.3) | 32 (5.0) | 0 (0.4) |
| Missouri | r | 38 (7.2) | 37 (7.2) | 6 (3.8) | 0 (0.0) | 0 (0.1) | 16 (4.6) | 2 (0.2) |
| North Carolina | | 72 (5.7) | 10 (3.4) | 1 (1.3) | 1 (0.1) | 8 (4.0) | 6 (2.7) | 2 (0.1) |
| Oregon | r | 36 (6.2) | 41 (7.7) | 5 (2.6) | 0 (0.0) | 4 (2.7) | 12 (5.1) | 2 (1.0) |
| *Pennsylvania* | r | 16 (3.2) | 40 (5.5) | 6 (2.5) | 0 (0.0) | 2 (0.9) | 35 (6.1) | 1 (0.9) |
| South Carolina | | 41 (6.6) | 48 (7.1) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 11 (4.1) | 1 (0.3) |
| *Texas* | s | 40 (5.6) | 52 (6.7) | 1 (0.7) | 0 (0.0) | 1 (1.0) | 5 (3.2) | 0 (0.0) |
| **Districts and Consortia** | | | | | | | | |
| Academy School Dist. #20, CO | | 28 (0.4) | 0 (0.0) | 0 (0.0) | 15 (0.4) | 0 (0.0) | 57 (0.6) | 0 (0.0) |
| Chicago Public Schools, IL | r | 66 (8.5) | 6 (4.0) | 7 (4.7) | 0 (0.0) | 0 (0.0) | 19 (8.1) | 3 (0.3) |
| Delaware Science Coalition, DE | r | 31 (4.1) | 68 (4.2) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 1 (0.0) |
| First in the World Consort., IL | | 20 (9.3) | 0 (0.0) | 15 (1.5) | 0 (0.0) | 7 (1.0) | 47 (8.1) | 11 (4.7) |
| Fremont/Lincoln/WestSide PS, NE | | 87 (3.9) | 0 (0.3) | 1 (0.1) | 4 (2.6) | 0 (0.0) | 8 (2.9) | 1 (0.5) |
| Guilford County, NC | | 86 (4.5) | 8 (3.6) | 0 (0.0) | 0 (0.0) | 0 (0.0) | 6 (3.9) | 0 (0.0) |
| Jersey City Public Schools, NJ | r | 0 (0.0) | 0 (0.0) | 8 (4.1) | 14 (1.4) | 0 (0.0) | 68 (4.1) | 9 (0.9) |
| Miami-Dade County PS, FL | s | 70 (5.9) | 1 (0.8) | 1 (0.5) | 0 (0.0) | 6 (3.5) | 20 (6.2) | 3 (2.7) |
| Michigan Invitational Group, MI | | 47 (4.3) | 32 (3.3) | 4 (0.2) | 0 (0.0) | 3 (0.7) | 14 (2.6) | 0 (0.0) |
| Montgomery County, MD | | x x | x x | x x | x x | x x | x x | x x |
| Naperville Sch. Dist. #203, IL | | 68 (3.4) | 0 (0.0) | 0 (0.0) | 13 (0.7) | 0 (0.0) | 18 (3.5) | 0 (0.0) |
| Project SMART Consortium, OH | r | 22 (4.2) | 33 (3.3) | 11 (3.0) | 0 (0.0) | 7 (3.1) | 22 (3.4) | 4 (1.7) |
| Rochester City Sch. Dist., NY | | 17 (5.3) | 0 (0.0) | 22 (6.2) | 0 (0.0) | 0 (0.0) | 61 (6.5) | 0 (0.0) |
| SW Math/Sci. Collaborative, PA | | 31 (7.8) | 18 (6.6) | 10 (5.8) | 2 (2.1) | 7 (3.8) | 31 (5.9) | 0 (0.0) |
| **International Average (All General Science Countries)** | | 58 (0.8) | 5 (0.4) | 14 (0.5) | 6 (0.4) | 4 (0.4) | 11 (0.6) | 2 (0.3) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

## What Science Topics Are Included in the Intended Curriculum?

In the course of their meetings on planning and implementation of TIMSS 1999, the National Research Coordinators developed a list of science topics that they agreed covered most of the content in the intended science curriculum in their respective countries. These topics, presented in Exhibit 5.18, built on the topics covered in the TIMSS 1995 science test and included in the teacher questionnaire. They represent all topics likely to have been included in the curricula of the 38 participating countries up to and including eighth grade. From the following choices, the coordinators from the participating entities indicated the percentages of students in their own countries or jurisdictions expected to have been taught each topic up to and including eighth grade:

- All or almost all students (at least 90 percent)
- About half of the students
- Only the more able students (top track – about 25 percent)
- Only the most advanced students (10 percent or less).

Exhibit 5.19 summarizes the data according to the percentage of topics intended to be taught to all or almost all students (at least 90 percent) in each entity, across the entire list of topics and for each content area. Information on specific topics in the intended curricula for each content area is presented in Exhibits R2.2 through R2.7 in the reference section of this report.

Internationally on average, curricular guidelines up to and including eighth grade called for nearly all students to have been taught about two-thirds of the topics overall. There was, however, marked variation between countries and between content areas in intended curricular coverage. The greatest percentages of topics intended to be taught to 90 percent or more of the students were in biology (77 percent, on average across countries), earth science (72 percent), and environmental and resource issues (69 percent). Next came physics (64 percent) and scientific inquiry and the nature of science (60 percent), with chemistry having the lowest percentage (52 percent). In six of the comparison countries, it was intended that all or nearly all students be taught all of the earth science topics. All environmental and resource issues topics were intended to be taught to practically all students in seven comparison countries, while in Hong Kong, Japan, and Korea, none of these topics were in the intended curriculum for most students.

In the United States overall, 86 percent of the science topics – compared with the international average of 63 percent – were intended to be taught to 90 percent or more of the students. This relatively high level of coverage resulted from the inclusion of 100 percent of the topics in each of the content areas except chemistry.

Benchmarking participants generally resembled the United States in topic coverage in the intended curriculum, although there were differences, particularly among the districts and consortia. Earth science, biology, environmental and resource issues, and scientific inquiry and the nature of science were included in the curriculum for almost all students in almost all Benchmarking jurisdictions, but the coverage of physics and particularly chemistry was more variable. Among states the percentage of physics topics intended for almost all students ranged from 60 percent in Idaho and Oregon to 100 percent in Illinois, Massachusetts, and North Carolina, and among districts and consortia from 50 percent in the Delaware Science Coalition to 100 percent in the First in the World Consortium, Guilford County, Jersey City, and Montgomery County. The percentage of chemistry topics ranged from just eight percent in Oregon to 100 percent in Texas, and from zero in the Michigan Invitational Group to 100 percent in First in the World, Jersey City, and Montgomery County.

It should be noted that some countries reported having different curricula or different levels of curriculum for different groups of students, as detailed in Exhibit 5.15. Not surprisingly, then, these countries often reported that about half, only the more able (25 percent), or the top 10 percent of students were expected to have been taught substantial percentages of the topics. Surprisingly, the Benchmarking jurisdictions that reported having different levels of curriculum for different groups, First in the World, Miami-Dade, and Montgomery County, indicated that at least 90 percent of the topics in each content area were intended to be taught to 90 percent or more of the students. It should also be noted that if content within a topic area required different responses, coordinators from participating entities chose the response that best represented the entire topic area and noted the discrepancy (see Exhibits A.8 and A.9 in the appendix for details).

## Exhibit 5.18 Science Topics Included in the TIMSS Questionnaires

8th Grade Science

### Earth Science

- ■ Earth's physical features (layers, landforms, bodies of water, rocks, soil)
- ■ Earth's atmosphere (layers, composition, temperature, pressure)
- ■ Earth processes and history (weather and climate, physical cycles, plate tectonics, fossils)
- ■ Earth in the solar system and the universe (interactions between Earth, sun, and moon; relationship to planets and stars)

### Biology

- ■ Human body – structure and function of organs and systems
- ■ Human bodily processes (metabolism, respiration, digestion)
- ■ Human nutrition, health, and disease
- ■ Biology of plant and animal life (diversity, structure, life processes, life cycles)
- ◆ Photosynthesis
- ■ Interactions of living things (biomes and ecosystems, interdependence)
- ■ Reproduction, genetics, evolution, and speciation

### Physics

- ■ Physical properties and physical changes of matter (weight, mass, states of matter, boiling, freezing)
- ■ Subatomic particles (protons, electrons, neutrons)
- ■ Energy types, sources, and conversions (chemical, kinetic, electric, light energy; work and efficiency)
- ■ Heat and temperature
- ◆ Gas laws (relationship between temperature/pressure/volume)
- ■ Wave phenomena, sound, and vibration
- ■ Light (reflection, refraction, light and color)
- ■ Electricity and magnetism (circuits, conductivity, magnets)
- ■ Forces and motion (types of forces, balanced/unbalanced forces, fluid behavior, speed, acceleration)
- ◆ Buoyancy

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

■ Topics included in the curriculum and teacher questionnaires (intended and implemented curriculum).

◆ Topics also included in the curriculum questionnaire (intended curriculum).

## Chemistry

- ■ Classification of matter (elements, compounds, solutions, mixtures)
- ■ Structure of matter (atoms, ions, molecules, crystals)
- ◆ Formation of solutions (solvents, solutes, soluble/insoluble substances)
- ◆ Acids, bases, and salts
- ■ Chemical reactivity and transformations (definition of chemical change, oxidation, combustion)
- ■ Energy and chemical change (exothermic and endothermic reactions, reaction rates)
- ◆ Chemical bonding and compound formation (ionic, covalent)
- ◆ Chemical equations
- ◆ Atomic structure
- ◆ Atomic number and atomic mass
- ◆ Periodic table
- ◆ Valency

## Environmental and Resource Issues

- ■ Pollution (acid rain, global warming, ozone layer, water pollution)
- ■ Conservation of natural resources (land, water, forests, energy resources)
- ■ Food supply and production, population, and environmental effects of natural and man-made events

## Scientific Inquiry and the Nature of Science

- ■ Scientific method (formulating hypotheses, making observations, drawing conclusions, generalizing)
- ■ Experimental design (experimental control, materials, and procedures)
- ■ Scientific measurements (reliability, replication, experimental error, accuracy, scales)
- ■ Using scientific apparatus and conducting routine experimental operations
- ■ Gathering, organizing, and representing data (units, tables, charts, graphs)
- ■ Describing and interpreting data

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

■ Topics included in the curriculum and teacher questionnaires (intended and implemented curriculum).

◆ Topics also included in the curriculum questionnaire (intended curriculum).

# Exhibit 5.19 Science Topics in the Intended Curriculum for At Least 90% of Students, Up to and Including Eighth Grade

| | Percentage of Topics Intended to Be Taught to All or Almost All (at least 90%) Students | | | | | | |
|---|---|---|---|---|---|---|---|
| | Overall | Earth Science | Biology | Physics | Chemistry | Environmental and Resource Issues | Scientific Inquiry and the Nature of Science |
| **Countries** | | | | | | | |
| United States | 86 | 100 | 100 | 100 | 50 | 100 | 100 |
| Belgium (Flemish) | 38 | 0 | 71 | 40 | 0 | 67 | 83 |
| Canada | 48 | 75 | 86 | 20 | 17 | 100 | 67 |
| Chinese Taipei | 69 | 25 | 86 | 80 | 58 | 67 | 83 |
| Czech Republic | 79 | 100 | 86 | 90 | 83 | 33 | 50 |
| England | 71 | 75 | 71 | 80 | 42 | 100 | 100 |
| Hong Kong, SAR | 50 | 25 | 100 | 60 | 42 | 0 | 33 |
| Italy | 67 | 75 | 100 | 70 | 25 | 100 | 83 |
| Japan | 62 | 100 | 57 | 70 | 50 | 0 | 83 |
| Korea, Rep. of | 60 | 100 | 71 | 70 | 50 | 0 | 50 |
| Netherlands | 24 | 0 | 43 | 20 | 0 | 100 | 33 |
| Russian Federation | 71 | 100 | 29 | 70 | 100 | 100 | 33 |
| Singapore | 79 | 100 | 100 | 70 | 58 | 100 | 83 |
| **States** | | | | | | | |
| Connecticut | 86 | 100 | 100 | 80 | 67 | 100 | 100 |
| Idaho | 74 | 100 | 100 | 60 | 42 | 100 | 100 |
| Illinois | 95 | 100 | 100 | 100 | 83 | 100 | 100 |
| Indiana | 79 | 75 | 100 | 80 | 50 | 100 | 100 |
| Maryland | 71 | 100 | 100 | 80 | 17 | 100 | 100 |
| Massachusetts | 76 | 100 | 57 | 100 | 42 | 100 | 100 |
| Michigan | 71 | 100 | 100 | 70 | 25 | 100 | 100 |
| Missouri | 62 | 100 | 57 | 80 | 25 | 100 | 67 |
| North Carolina | 93 | 100 | 100 | 100 | 75 | 100 | 100 |
| Oregon | 52 | 75 | 71 | 60 | 8 | 33 | 100 |
| Pennsylvania [1] | – | – | – | – | – | – | – |
| South Carolina | 76 | 100 | 71 | 90 | 50 | 100 | 83 |
| Texas | 98 | 100 | 100 | 90 | 100 | 100 | 100 |
| **Districts and Consortia** | | | | | | | |
| Academy School Dist. #20, CO [2] | – | – | – | – | – | – | – |
| Chicago Public Schools, IL | 64 | 100 | 100 | 60 | 42 | 67 | 50 |
| Delaware Science Coalition, DE | 60 | 100 | 86 | 50 | 17 | 67 | 100 |
| First in the World Consort., IL | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Fremont/Lincoln/WestSide PS, NE | 74 | 100 | 100 | 80 | 33 | 100 | 83 |
| Guilford County, NC | 95 | 100 | 100 | 100 | 83 | 100 | 100 |
| Jersey City Public Schools, NJ | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Miami-Dade County PS, FL | 95 | 100 | 100 | 90 | 92 | 100 | 100 |
| Michigan Invitational Group, MI | 62 | 100 | 100 | 70 | 0 | 100 | 83 |
| Montgomery County, MD | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Naperville Sch. Dist. #203, IL | 95 | 100 | 100 | 90 | 92 | 100 | 100 |
| Project SMART Consortium, OH | 79 | 100 | 100 | 80 | 42 | 100 | 100 |
| Rochester City Sch. Dist., NY | 67 | 100 | 71 | 80 | 42 | 33 | 83 |
| SW Math/Sci. Collaborative, PA [1] | – | – | – | – | – | – | – |
| **International Avg. (All Countries)** | 63 | 72 | 77 | 64 | 52 | 69 | 60 |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by coordinators from participating jurisdictions according to the official curriculum. Coordinators indicated the percentage of students who should have been taught each of the topics listed in Exhibit 5.18. The response categories were: all or almost all of the students (at least 90%); about half of the students; only the more able students (top track – about 25%); only the most advanced students (10% or less); not included in curriculum through grade 8. (See Reference Exhibits R2.2-R2.7 for detail by topic.)

1 Due to the variation across the state/collaborative, a representative response cannot be provided for these questions.

2 Academy School Dist. #20: As a district that has site-based curriculum development, the district cannot provide a representative response for these questions.

A dash (–) indicates data are not available.

## Have Students Been Taught the Topics Tested by TIMSS?

In interpreting the achievement results, it is important to consider how extensively the topics tested are taught in the participating entities. As shown in Exhibits 5.20 through 5.25, the six major science content areas assessed in TIMSS 1999 were represented by 31 topic areas. For each area, teachers indicated whether their students had been taught the topics before this year (i.e., the eighth grade), one to five periods this year, more than five periods this year; whether the topics had not yet been taught; or whether the teacher did not know. Exhibits 5.20 through 5.25 show the percentages of students in each entity reported to have been taught each topic before or during the year of testing.

According to their teachers, more than two-thirds of students on average across all TIMSS 1999 countries had been taught the topics in earth science, as shown in Exhibit 5.20. The international average for each topic exceeded 70 percent of students. Nearly all students in the Czech Republic were taught each of the earth science topics, while less than half the students in Belgium (Flemish), Hong Kong, and Japan were taught two or more of the four topics in this content area. Teachers in the United States overall as well as in the Benchmarking jurisdictions reported greater percentages than did teachers internationally, with more than 80 percent of students in most jurisdictions being taught each topic. The major exceptions were Idaho, where about half the students were taught the earth science topics, and Rochester, where one-third or less of the students had been taught these topics. In contrast, all students in Jersey City and Naperville were taught three or more of the topics.

Exhibit R2.8 in the reference section indicates that many students in the U.S. as a whole and in the Benchmarking jurisdictions had instruction in the earth science topics both before and during the eighth grade. While 31 percent of students on average across countries had not yet been taught half or more of these topics, only 11 percent of the students in the United States overall had not been taught them. Thirty-two percent of U.S. students were taught more than half the earth science topics before the eighth grade and not again during the eighth grade, and a further 46 percent were taught more than half these topics during the eighth grade. Although many students in most Benchmarking jurisdictions were taught the earth science topics before and during the eighth grade, the percentage of students who had not yet been taught them ranged from three percent in South Carolina to 50 percent in Idaho among states, and from zero in Jersey City and Naperville to 87 percent in Rochester among districts and consortia.

With the exception of "reproduction, genetics, evolution, and speciation" (61 percent of students), instructional coverage was high for the biology topics presented in Exhibit 5.21. At least 77 percent of students, on average internationally, were taught each of the other six topics. Teachers in Belgium (Flemish), England, Italy, the Netherlands, as well as the United States reported that 80 percent or more of their students were taught all of the biology topics. Like the United States overall, the Benchmarking participants reported percentages above the international average for almost all of the topics, although there was some variation. More than 90 percent of the students in Massachusetts, Oregon, the Academy School District, the First in the World Consortium, and Jersey City were taught each of the biology topics, while less than 80 percent of the students in the Michigan Invitational Group were taught five of the six topics in this content area.

As indicated by Exhibit R2.9 in the reference section, biology topics received considerable emphasis before the eighth grade in the United States, more than in any of the comparison countries except Italy, and in the Benchmarking jurisdictions. Fifty-five percent of U.S. students received instruction in more than half the biology topics before the eighth grade only, compared with 16 percent on average across countries. In contrast, 44 percent of students internationally were taught more than half these topics during the eighth grade, compared with 26 percent in the U.S., and 21 percent of students internationally had not yet been taught half or more of the topics, compared with only 10 percent in the U.S. With some exceptions, results for the Benchmarking jurisdictions generally were similar to those of the United States.

Of the physics topics (see Exhibit 5.22), "physical properties and the physical changes of matter" had the greatest coverage internationally, with 91 percent of students, on average, having been taught this topic. "Energy types, sources, and conversions" and "subatomic particles" received less emphasis, with 75 and 71 percent of students, respectively, having been taught them. "Light," "electricity and magnetism," and "forces and motion" also had lower percentages of students, between 65 and 68 percent, compared with other physics topics. Least emphasis was given to "wave phenomena, sound, and vibration," with an international average of 52 percent. All students in the Netherlands were taught each of the physics topics. The United States overall and the Benchmarking jurisdictions reported percentages of students taught the physics topics that were generally greater than the international averages.

However, as indicated by Exhibit R2.10 in the reference section, physics topics received very little emphasis before the eighth grade in the United States and in the Benchmarking jurisdictions. This was true internationally as well. Only 12 percent of the students in the U.S., and nine percent on average across countries, were taught more than half the physics topics before the eighth grade and not again during the eighth grade. Fifty-eight percent of U.S. students, compared with 44 percent internationally, were taught more than half these topics during the eighth grade. More than half the topics were taught before or during the eighth grade to three-fourths or more of the students in Michigan, South Carolina, Texas, the Academy School District, Jersey City, and Miami-Dade. However, half or more of the topics had not yet been taught to one-third or more of the students in Connecticut, Idaho, Pennsylvania, and Rochester.

Instructional coverage was high for three of the four chemistry topics, "classification of matter" (90 percent of students taught), "structure of matter" (84 percent), and "chemical reactivity and transformations" (76 percent), but less for "energy and chemical change," which just 58 percent of students, internationally on average, had been taught (see Exhibit 5.23). As with physics, nearly all students (99 percent) in the Netherlands were taught each of the chemistry topics. The United States as a whole and the Benchmarking participants had similar or even higher percentages of students taught these topics than internationally. Highest percentages across all topics were reported in Naperville and the First in the World Consortium.

Exhibit R2.11 in the reference section shows that, like physics, topics in chemistry received very little emphasis before the eighth grade internationally, in the United States, and in the Benchmarking jurisdictions. Only 13 percent of the students on average across countries, and 10 percent in the U.S., had been taught the chemistry topics before the eighth grade only. Sixty-three percent of U.S. students, compared with 54 percent of students internationally, were taught more than half these topics during the eighth grade. Results for the Benchmarking jurisdictions generally resembled those of the United States.

Most students in most countries, with the notable exception of Japan among the comparison countries, were taught the topics in environmental and resource issues (see Exhibit 5.24), especially those dealing with "pollution" and "conservation of natural resources." Four-fifths or more of the students in the United States had been taught each of the topics in this content area, which was above the international average in each case. Among Benchmarking entities the lowest percentages were in

Idaho, Chicago, and Rochester, where two-thirds of the students or less were taught these topics. Ninety-five percent or more of the students in the Academy School District and the First in the World Consortium were taught all three topics in this content area.

As may be seen in Exhibit R2.12 in the reference section, topics in environmental and resource issues received considerable emphasis before the eighth grade in the United States and in most Benchmarking jurisdictions, more than in most of the comparison countries. More than half the students were taught more than half the topics in this content area before the eighth grade only in Connecticut, Massachusetts, the Academy School District, the First in the World Consortium, and the Michigan Invitational Group. However, 43 percent or more of the students in Idaho, Chicago, and Rochester had not yet been taught half or more of these topics.

Instructional coverage of the six scientific inquiry and the nature of science topics was high in most countries, with between 75 and 88 percent of students, on average internationally, having been taught these topics (see Exhibit 5.25). Coverage was particularly high in the United States overall and in all of the Benchmarking jurisdictions. In 20 Benchmarking jurisdictions, ninety percent or more of the students were taught all six topics. Teachers in all jurisdictions and comparison countries except Belgium (Flemish) reported that each topic had been taught to more than 60 percent of their students.

Exhibit R2.13 reveals that while relatively little emphasis was placed on scientific inquiry and the nature of science topics before the eighth grade, considerable attention was paid to them during that year. Ninety-two percent of students in the United States, and two-thirds of the students internationally, were taught more than half these topics during the eighth grade. Benchmarking participants reported percentages similar to those of the U.S., as 90 percent or more of the students in all Benchmarking entities except Missouri, North Carolina, and Pennsylvania were taught more than half the topics during the eighth grade.

| | | Earth's physical features (layers, landforms, bodies of water, rocks, soil) | | Earth's atmosphere (layers, composition, temperature, pressure) | | Earth processes and history (weather and climate, physical cycles, plate tectonics, fossils) | | Earth in the solar system and the universe (interactions between earth, sun, and moon; relationship to planets and stars) |
|---|---|---|---|---|---|---|---|---|
| **Countries** | | | | | | | | |
| United States | r | 87 (2.5) | r | 84 (2.7) | r | 92 (2.0) | r | 84 (2.3) |
| Belgium (Flemish) | r | 93 (3.0) | r | 45 (4.3) | r | 64 (5.2) | r | 16 (3.4) |
| Canada | s | 91 (1.9) | s | 83 (2.1) | s | 86 (2.3) | s | 80 (3.1) |
| Chinese Taipei [1] | | – – | | – – | | – – | | – – |
| Czech Republic | | 99 (0.4) | | 98 (1.2) | | 97 (1.7) | | 98 (1.2) |
| England | s | 86 (4.0) | s | 64 (3.9) | s | 71 (3.5) | s | 90 (3.6) |
| Hong Kong, SAR | s | 17 (3.2) | r | 61 (5.0) | s | 17 (4.0) | s | 15 (3.8) |
| Italy | | 82 (2.9) | | 95 (1.5) | | 81 (3.2) | | 70 (3.6) |
| Japan | | 6 (2.2) | | 74 (3.7) | | 39 (4.1) | | 99 (0.7) |
| Korea, Rep. of | | 91 (2.4) | | 98 (1.2) | | 95 (1.5) | | 52 (4.0) |
| Netherlands | | 76 (5.6) | | 91 (2.7) | | 92 (4.1) | r | 82 (4.8) |
| Russian Federation | | – – | | – – | | – – | | – – |
| Singapore | | x x | | x x | | x x | | x x |
| **States** | | | | | | | | |
| Connecticut | s | 84 (6.0) | s | 83 (5.9) | s | 81 (5.7) | s | 85 (5.8) |
| Idaho | s | 53 (6.8) | s | 50 (7.3) | s | 52 (7.2) | s | 48 (6.6) |
| Illinois | r | 84 (6.6) | r | 83 (7.0) | r | 81 (6.9) | r | 75 (7.3) |
| Indiana | r | 93 (3.0) | r | 92 (3.7) | r | 89 (3.8) | r | 91 (4.0) |
| Maryland | s | 83 (4.3) | s | 81 (5.1) | s | 82 (4.1) | s | 79 (6.4) |
| Massachusetts | r | 83 (4.6) | r | 80 (4.5) | r | 84 (4.6) | r | 79 (4.5) |
| Michigan | r | 89 (4.3) | r | 86 (4.9) | r | 93 (3.0) | r | 88 (4.1) |
| Missouri | r | 93 (3.1) | r | 95 (1.6) | r | 93 (3.8) | r | 77 (4.4) |
| North Carolina | | 93 (1.5) | | 91 (2.2) | r | 90 (3.0) | | 88 (3.6) |
| Oregon | | 94 (3.2) | | 83 (4.6) | | 90 (4.0) | | 85 (5.0) |
| *Pennsylvania* | r | 83 (4.2) | r | 80 (4.8) | r | 83 (4.0) | r | 75 (4.4) |
| South Carolina | r | 98 (1.5) | r | 91 (3.6) | | 98 (1.0) | | 90 (3.6) |
| *Texas* | r | 94 (3.3) | r | 89 (3.8) | r | 93 (3.6) | r | 85 (4.2) |
| **Districts and Consortia** | | | | | | | | |
| Academy School Dist. #20, CO | | 91 (0.2) | | 90 (0.2) | | 90 (0.2) | | 90 (0.2) |
| Chicago Public Schools, IL | r | 92 (4.9) | r | 94 (4.2) | r | 82 (4.9) | r | 80 (7.9) |
| Delaware Science Coalition, DE | s | 85 (5.4) | s | 83 (4.6) | s | 84 (5.4) | s | 83 (4.8) |
| First in the World Consort., IL | | 86 (7.8) | | 86 (7.8) | | 100 (0.0) | | 82 (7.5) |
| Fremont/Lincoln/WestSide PS, NE | r | 97 (2.4) | r | 96 (2.5) | r | 97 (2.4) | | 68 (6.6) |
| Guilford County, NC | | 95 (2.8) | | 96 (2.5) | | 92 (2.7) | | 88 (3.6) |
| Jersey City Public Schools, NJ | r | 100 (0.0) | r | 100 (0.0) | r | 100 (0.0) | s | 100 (0.0) |
| Miami-Dade County PS, FL | s | 98 (1.2) | s | 93 (5.1) | s | 97 (2.6) | s | 82 (6.6) |
| Michigan Invitational Group, MI | r | 83 (2.3) | r | 94 (1.8) | r | 90 (1.4) | r | 96 (1.5) |
| Montgomery County, MD | | x x | | x x | | x x | | x x |
| Naperville Sch. Dist. #203, IL | | 100 (0.0) | | 90 (2.9) | | 100 (0.0) | | 100 (0.0) |
| Project SMART Consortium, OH | r | 84 (1.8) | r | 81 (3.7) | r | 94 (0.9) | r | 85 (3.3) |
| Rochester City Sch. Dist., NY | s | 22 (3.5) | s | 25 (4.0) | s | 22 (3.5) | s | 35 (5.9) |
| SW Math/Sci. Collaborative, PA | | 79 (5.0) | | 79 (4.9) | | 80 (6.4) | r | 72 (7.4) |
| **International Avg. (All Countries)** | | 77 (0.6) | | 73 (0.6) | | 71 (0.6) | | 71 (0.6) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

* Taught before or during this school year.

1 Chinese Taipei: Data for grade 9 earth science teachers not available.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

# Exhibit 5.21 Percentages of Students Taught Biology Topics*

8th Grade Science

| | Human body – structure and function of organs and systems | Human bodily processes (metabolism, respiration, digestion) | Human nutrition, health, and disease | Biology of plant and animal life (diversity, structure, life processes, life cycles) | Interactions of living things (biomes, ecosystems, and interdependence) | Reproduction, genetics, evolution, and speciation |
|---|---|---|---|---|---|---|
| **Countries** | | | | | | |
| United States | r 90 (2.6) | r 90 (2.1) | r 91 (2.2) | r 92 (1.9) | r 90 (2.0) | r 83 (2.8) |
| Belgium (Flemish) | 98 (1.0) | 100 (0.0) | 100 (0.0) | r 91 (2.6) | r 85 (3.7) | 94 (2.2) |
| Canada | s 54 (3.0) | s 49 (3.6) | s 54 (3.8) | s 70 (3.2) | s 77 (2.7) | s 45 (3.7) |
| Chinese Taipei [1] | – – | – – | – – | – – | – – | – – |
| Czech Republic | 99 (0.4) | 99 (0.5) | 98 (1.1) | 96 (2.1) | 73 (4.4) | 57 (5.4) |
| England | s 96 (1.9) | s 99 (0.8) | s 95 (2.5) | s 91 (3.2) | s 84 (4.2) | s 80 (3.6) |
| Hong Kong, SAR | 79 (3.8) | 76 (3.6) | r 30 (4.7) | r 69 (4.6) | r 57 (4.9) | r 61 (4.6) |
| Italy | 99 (0.9) | 99 (0.9) | 97 (0.9) | 100 (0.0) | 89 (2.4) | 87 (2.9) |
| Japan | 97 (1.7) | 96 (1.8) | 82 (3.3) | 86 (3.0) | 15 (3.2) | 8 (2.5) |
| Korea, Rep. of | 91 (2.2) | 92 (2.2) | 87 (2.8) | 76 (3.7) | 57 (4.3) | 54 (4.3) |
| Netherlands | r 100 (0.0) | r 100 (0.0) | r 100 (0.0) | r 100 (0.0) | r 100 (0.0) | r 99 (0.9) |
| Russian Federation | – – | – – | – – | – – | – – | – – |
| Singapore | 97 (1.5) | 97 (1.6) | 97 (1.8) | r 86 (3.8) | r 69 (4.4) | 92 (2.7) |
| **States** | | | | | | |
| Connecticut | s 91 (4.7) | s 95 (2.2) | s 97 (1.2) | s 93 (2.8) | s 96 (2.6) | s 78 (5.9) |
| Idaho | s 76 (7.7) | s 77 (7.7) | s 80 (7.0) | s 87 (4.4) | s 83 (5.6) | s 76 (5.8) |
| Illinois | r 84 (5.3) | r 89 (4.6) | r 88 (3.6) | r 95 (2.5) | r 91 (3.3) | r 84 (4.0) |
| Indiana | r 91 (3.5) | r 91 (3.6) | r 94 (2.7) | r 93 (3.1) | r 93 (2.9) | r 84 (5.5) |
| Maryland | s 99 (1.0) | s 99 (1.0) | s 97 (1.9) | s 96 (2.5) | s 89 (4.3) | s 83 (5.8) |
| Massachusetts | r 96 (2.8) | r 93 (3.3) | s 97 (2.2) | r 96 (1.9) | r 92 (1.8) | r 91 (3.3) |
| Michigan | r 87 (4.1) | r 85 (4.7) | r 86 (4.5) | r 98 (1.2) | r 97 (1.4) | r 81 (5.1) |
| Missouri | r 83 (4.1) | r 86 (4.9) | r 83 (5.6) | r 89 (4.4) | r 89 (4.1) | r 83 (5.7) |
| North Carolina | r 92 (3.4) | r 89 (4.1) | r 91 (3.6) | r 90 (3.0) | r 84 (3.9) | r 85 (4.5) |
| Oregon | r 92 (3.6) | r 92 (3.2) | r 93 (3.4) | r 93 (3.2) | r 94 (3.4) | r 92 (3.7) |
| *Pennsylvania* | r 78 (3.5) | r 77 (3.7) | r 86 (3.2) | r 91 (3.3) | r 90 (3.6) | r 74 (3.6) |
| South Carolina | 96 (2.6) | r 97 (2.0) | r 96 (2.2) | r 89 (4.3) | r 90 (3.6) | r 95 (2.8) |
| *Texas* | r 94 (2.8) | r 91 (4.1) | r 91 (3.5) | r 94 (3.0) | r 95 (2.8) | s 89 (4.6) |
| **Districts and Consortia** | | | | | | |
| Academy School Dist. #20, CO | 100 (0.0) | 100 (0.0) | 100 (0.0) | r 100 (0.0) | r 100 (0.0) | 100 (0.0) |
| Chicago Public Schools, IL | r 75 (12.5) | r 75 (12.5) | r 86 (8.3) | r 89 (7.7) | r 79 (8.0) | r 77 (10.6) |
| Delaware Science Coalition, DE | s 81 (6.9) | s 82 (6.3) | s 86 (5.7) | s 89 (5.3) | s 85 (6.3) | s 86 (6.0) |
| First in the World Consort., IL | 95 (1.7) | 95 (1.7) | 100 (0.0) | 96 (1.5) | 96 (1.5) | 96 (1.5) |
| Fremont/Lincoln/WestSide PS, NE | s 96 (1.4) | x x | s 96 (3.2) | r 87 (0.8) | 90 (3.3) | r 82 (7.5) |
| Guilford County, NC | r 94 (2.8) | r 94 (2.9) | r 94 (2.9) | 94 (2.7) | r 79 (4.5) | r 87 (3.0) |
| Jersey City Public Schools, NJ | r 93 (4.2) | r 91 (4.3) | r 92 (4.0) | r 98 (0.2) | r 96 (0.4) | r 96 (0.4) |
| Miami-Dade County PS, FL | s 98 (0.8) | s 94 (4.0) | s 86 (5.0) | s 96 (2.9) | s 91 (5.5) | s 83 (4.6) |
| Michigan Invitational Group, MI | r 76 (2.8) | r 74 (3.5) | r 79 (4.0) | r 73 (2.4) | r 85 (3.5) | r 65 (1.5) |
| Montgomery County, MD | x x | x x | x x | x x | x x | x x |
| Naperville Sch. Dist. #203, IL | 86 (4.2) | 100 (0.0) | r 100 (0.0) | 100 (0.0) | 100 (0.0) | 83 (1.7) |
| Project SMART Consortium, OH | r 87 (3.5) | r 84 (3.8) | r 97 (1.5) | r 94 (2.9) | r 87 (3.9) | r 86 (3.2) |
| Rochester City Sch. Dist., NY | r 86 (3.0) | r 90 (3.4) | r 88 (3.9) | r 90 (3.4) | r 81 (4.9) | r 83 (3.7) |
| SW Math/Sci. Collaborative, PA | r 76 (8.4) | r 74 (7.0) | r 82 (7.3) | 82 (5.0) | r 85 (3.8) | r 64 (8.2) |
| **International Avg. (All Countries)** | 84 (0.5) | 83 (0.5) | 79 (0.6) | 87 (0.5) | 77 (0.6) | 61 (0.7) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

* Taught before or during this school year.

1 Chinese Taipei: Data for grade 7 biology teachers not available.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

# Exhibit 5.22 Percentages of Students Taught Physics Topics*

| | Physical properties and physical changes of matter (weight, mass, states of matter, boiling, freezing) | Subatomic particles (protons, electrons, neutrons) | Energy types, sources, and conversions (chemical, kinetic, electric, light energy; work and efficiency) | Heat and temperature | Wave phenomena, sound, and vibration | Light | Electricity and magnetism | Forces and motion (types of forces, balanced/ unbalanced forces, fluid behavior, speed, acceleration) |
|---|---|---|---|---|---|---|---|---|
| **Countries** | | | | | | | | |
| United States | r 93 (1.7) | r 86 (2.6) | r 76 (3.4) | r 82 (3.0) | r 65 (3.8) | r 67 (3.3) | r 70 (3.2) | 75 (3.4) |
| Belgium (Flemish) | s 58 (5.3) | s 8 (2.9) | s 35 (4.7) | s 54 (5.4) | s 5 (2.1) | s 31 (4.0) | s 38 (4.3) | 33 (4.5) |
| Canada | r 97 (1.3) | s 44 (3.4) | r 82 (2.6) | r 91 (2.1) | s 35 (3.8) | s 50 (4.0) | s 48 (3.3) | 56 (3.1) |
| Chinese Taipei | 98 (1.0) | 98 (1.0) | 47 (4.3) | 93 (2.3) | 79 (3.1) | 89 (2.6) | 20 (3.2) | 29 (3.5) |
| Czech Republic | 96 (2.1) | 96 (2.0) | 94 (2.4) | 98 (1.3) | 10 (3.1) | 81 (4.1) | 71 (4.8) | 100 (0.2) |
| England | s 97 (1.4) | s 66 (4.1) | s 96 (1.7) | s 92 (2.8) | s 82 (3.6) | s 98 (1.1) | s 97 (1.8) | 98 (1.1) |
| Hong Kong, SAR | r 87 (3.4) | r 34 (4.9) | 87 (3.4) | 84 (3.2) | r 58 (4.6) | r 50 (5.2) | 83 (3.5) | 41 (4.9) |
| Italy | 98 (1.2) | 89 (2.6) | 77 (3.1) | 95 (1.5) | 44 (4.0) | 38 (4.0) | 55 (3.9) | 85 (2.9) |
| Japan | 100 (0.0) | 43 (4.1) | 15 (3.5) | 99 (0.9) | 99 (1.3) | 99 (1.3) | 90 (2.6) | 20 (3.1) |
| Korea, Rep. of | 95 (1.9) | 66 (4.1) | 63 (4.3) | 85 (3.1) | 33 (3.9) | 41 (4.0) | 96 (1.7) | 87 (2.6) |
| Netherlands | 100 (0.0) | r 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) |
| Russian Federation | – – | – – | – – | – – | – – | – – | – – | – – |
| Singapore | 96 (1.8) | s 80 (4.5) | 97 (1.6) | 99 (0.9) | 85 (3.4) | 99 (0.8) | 92 (2.6) | 82 (4.2) |
| **States** | | | | | | | | |
| Connecticut | s 92 (4.2) | s 79 (7.4) | s 74 (6.2) | s 87 (5.3) | s 58 (7.7) | s 67 (7.6) | s 68 (7.6) | 65 (7.5) |
| Idaho | s 87 (6.4) | s 87 (6.6) | s 67 (6.6) | s 69 (7.1) | s 56 (7.9) | s 53 (7.3) | s 46 (7.6) | 65 (7.1) |
| Illinois | 91 (2.4) | 89 (4.7) | r 79 (6.7) | r 70 (6.9) | s 50 (6.2) | r 54 (6.9) | r 70 (5.8) | 87 (4.9) |
| Indiana | r 97 (1.7) | r 94 (3.0) | r 77 (7.8) | r 78 (8.0) | s 56 (9.1) | r 62 (9.2) | r 69 (9.0) | 91 (3.6) |
| Maryland | s 98 (1.4) | s 88 (3.3) | s 85 (4.0) | s 79 (5.3) | s 69 (4.7) | s 71 (4.6) | s 80 (5.6) | 89 (4.4) |
| Massachusetts | r 97 (2.0) | r 91 (3.8) | r 78 (5.6) | r 82 (5.7) | s 58 (7.5) | r 62 (7.6) | r 70 (7.1) | 81 (5.5) |
| Michigan | r 97 (2.6) | r 91 (4.1) | r 95 (2.8) | r 94 (3.1) | r 79 (5.1) | r 77 (5.2) | r 74 (5.5) | 87 (4.7) |
| Missouri | r 97 (1.6) | r 94 (3.3) | r 81 (5.6) | r 85 (5.5) | r 69 (5.1) | r 70 (6.7) | r 78 (4.9) | 83 (4.4) |
| North Carolina | r 97 (3.2) | 97 (3.1) | r 82 (6.1) | r 88 (5.5) | r 77 (6.8) | r 76 (6.7) | 73 (6.1) | 78 (6.4) |
| Oregon | 98 (1.3) | 96 (2.7) | r 81 (5.1) | r 86 (4.9) | r 57 (5.9) | r 63 (6.0) | r 74 (6.2) | 80 (5.9) |
| *Pennsylvania* | r 85 (3.4) | r 85 (3.9) | r 74 (6.4) | r 73 (6.4) | s 49 (8.1) | s 56 (7.8) | s 67 (6.6) | 61 (5.9) |
| South Carolina | 97 (1.8) | 98 (1.1) | r 87 (3.4) | r 93 (2.7) | r 79 (4.6) | r 82 (4.6) | r 85 (4.5) | 76 (6.0) |
| *Texas* | r 96 (2.4) | r 98 (1.3) | s 82 (4.8) | s 87 (5.5) | s 78 (7.1) | s 77 (5.5) | s 77 (4.8) | 79 (5.5) |
| **Districts and Consortia** | | | | | | | | |
| Academy School Dist. #20, CO | 100 (0.0) | 86 (0.2) | 100 (0.0) | 91 (0.1) | 41 (0.4) | 38 (0.4) | r 47 (0.4) | 69 (0.4) |
| Chicago Public Schools, IL | r 86 (7.3) | r 86 (7.3) | r 87 (7.4) | r 83 (8.5) | r 66 (10.8) | r 69 (10.4) | r 73 (10.0) | 84 (8.1) |
| Delaware Science Coalition, DE | s 99 (0.4) | s 91 (4.8) | s 77 (7.3) | s 94 (3.2) | s 55 (7.2) | s 89 (5.0) | s 68 (6.7) | 83 (2.6) |
| First in the World Consort., IL | 100 (0.0) | 98 (2.2) | 94 (1.9) | 86 (7.8) | 69 (3.1) | 69 (3.1) | 92 (0.8) | 87 (1.5) |
| Fremont/Lincoln/WestSide PS, NE | r 99 (0.6) | r 100 (0.3) | r 73 (3.2) | r 78 (8.1) | s 65 (10.1) | r 61 (6.0) | r 86 (3.7) | 91 (1.4) |
| Guilford County, NC | r 97 (1.1) | 95 (2.3) | r 94 (2.2) | r 97 (2.2) | s 89 (4.9) | r 95 (3.6) | 95 (2.3) | 87 (4.6) |
| Jersey City Public Schools, NJ | r 98 (0.3) | r 93 (0.7) | r 100 (0.0) | r 100 (0.0) | s 48 (5.0) | r 55 (4.5) | r 69 (4.2) | 100 (0.0) |
| Miami-Dade County PS, FL | s 99 (1.2) | s 96 (2.5) | s 92 (2.6) | s 90 (4.0) | s 76 (6.4) | s 67 (7.9) | s 78 (6.7) | 82 (4.3) |
| Michigan Invitational Group, MI | r 97 (0.4) | r 96 (0.4) | r 79 (1.6) | r 86 (3.4) | r 69 (2.4) | r 56 (6.6) | r 80 (2.6) | 89 (1.9) |
| Montgomery County, MD | x x | x x | x x | x x | x x | x x | x x | x x |
| Naperville Sch. Dist. #203, IL | 100 (0.0) | 100 (0.0) | 100 (0.0) | 89 (0.4) | 36 (4.3) | 19 (3.5) | 44 (3.3) | 90 (2.9) |
| Project SMART Consortium, OH | r 95 (2.6) | r 82 (3.7) | r 93 (1.5) | r 84 (2.3) | r 75 (3.5) | r 78 (3.1) | r 76 (3.0) | 81 (2.8) |
| Rochester City Sch. Dist., NY | r 86 (4.7) | r 100 (0.4) | r 83 (5.4) | r 60 (4.8) | r 22 (3.8) | r 28 (5.6) | r 57 (6.8) | 74 (7.4) |
| SW Math/Sci. Collaborative, PA | 96 (2.6) | 93 (3.0) | r 79 (7.3) | 80 (6.9) | r 44 (8.7) | r 53 (6.9) | r 62 (6.3) | 72 (9.0) |
| **International Avg. (All Countries)** | 91 (0.4) | 71 (0.6) | 75 (0.5) | 83 (0.5) | 52 (0.6) | 68 (0.6) | 67 (0.6) | 65 (0.6) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

* Taught before or during this school year.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

## Exhibit 5.23 Percentages of Students Taught Chemistry Topics*

8th Grade Science

| | Classification of matter (elements, compounds, solutions, mixtures) | Structure of matter (atoms, ions, molecules, crystals) | Chemical reactivity and transformations (definition of chemical change, oxidation, combustion) | Energy and chemical change (exothermic and endothermic reactions, reaction rates) |
|---|---|---|---|---|
| **Countries** | | | | |
| United States | r 88 (2.2) | r 88 (2.6) | r 76 (3.4) | r 66 (3.9) |
| Belgium (Flemish) | s 13 (2.9) | s 8 (2.6) | s 8 (3.0) | s 4 (1.9) |
| Canada | r 80 (2.3) | s 63 (3.1) | s 54 (4.2) | s 36 (3.6) |
| Chinese Taipei | 100 (0.0) | 97 (1.4) | 100 (0.0) | 84 (2.9) |
| Czech Republic | 100 (0.0) | 100 (0.0) | 92 (3.0) | 53 (5.3) |
| England | s 98 (1.7) | s 84 (4.1) | s 94 (2.1) | s 73 (4.7) |
| Hong Kong, SAR | 90 (2.7) | r 66 (4.6) | r 57 (5.0) | r 71 (4.8) |
| Italy | 95 (1.8) | 91 (2.0) | 78 (3.6) | 58 (4.0) |
| Japan | 99 (1.2) | 75 (3.6) | 96 (1.7) | 46 (4.2) |
| Korea, Rep. of | 99 (0.8) | 97 (1.4) | 91 (2.3) | 51 (3.8) |
| Netherlands | r 99 (1.0) | r 99 (0.9) | r 99 (0.9) | r 99 (0.8) |
| Russian Federation | – – | – – | – – | – – |
| Singapore | 98 (1.3) | 93 (2.5) | r 89 (2.9) | x x |
| **States** | | | | |
| Connecticut | s 80 (6.4) | s 81 (6.2) | s 70 (7.6) | s 67 (6.8) |
| Idaho | s 85 (6.7) | s 85 (6.7) | s 73 (6.9) | s 64 (7.5) |
| Illinois | r 90 (4.2) | r 91 (3.9) | r 78 (5.2) | r 71 (4.6) |
| Indiana | r 91 (4.2) | r 88 (4.7) | r 84 (5.1) | r 71 (6.6) |
| Maryland | r 92 (3.4) | r 91 (3.2) | s 85 (4.5) | s 73 (4.7) |
| Massachusetts | r 94 (2.7) | r 86 (3.4) | r 76 (5.4) | r 61 (6.8) |
| Michigan | r 90 (5.1) | r 89 (5.2) | r 78 (6.3) | r 78 (6.5) |
| Missouri | r 92 (3.0) | r 87 (4.8) | r 69 (7.0) | r 56 (7.6) |
| North Carolina | r 87 (4.6) | 91 (4.1) | 84 (5.0) | r 73 (5.3) |
| Oregon | 95 (2.5) | 92 (3.3) | r 88 (3.6) | r 81 (4.6) |
| *Pennsylvania* | r 91 (3.3) | r 91 (3.3) | s 69 (6.2) | r 58 (7.0) |
| South Carolina | 97 (1.5) | 96 (1.7) | r 83 (4.4) | r 70 (5.2) |
| *Texas* | r 92 (3.0) | r 93 (3.3) | s 81 (5.3) | s 72 (6.0) |
| **Districts and Consortia** | | | | |
| Academy School Dist. #20, CO | 86 (0.2) | 86 (0.2) | 86 (0.2) | 86 (0.2) |
| Chicago Public Schools, IL | r 81 (9.3) | r 79 (9.7) | r 76 (9.4) | r 66 (11.4) |
| Delaware Science Coalition, DE | x x | s 97 (2.7) | x x | x x |
| First in the World Consort., IL | 100 (0.0) | 100 (0.0) | 93 (0.7) | 91 (1.8) |
| Fremont/Lincoln/WestSide PS, NE | r 86 (8.3) | r 94 (2.8) | s 61 (7.8) | s 46 (7.1) |
| Guilford County, NC | 94 (2.8) | 94 (2.8) | 79 (4.7) | 83 (5.1) |
| Jersey City Public Schools, NJ | r 98 (0.2) | r 97 (0.3) | r 75 (2.5) | s 57 (4.1) |
| Miami-Dade County PS, FL | s 97 (1.0) | s 97 (1.7) | s 93 (2.8) | s 95 (3.0) |
| Michigan Invitational Group, MI | r 95 (0.7) | r 95 (0.7) | r 83 (2.5) | r 73 (4.2) |
| Montgomery County, MD | x x | x x | x x | x x |
| Naperville Sch. Dist. #203, IL | 100 (0.0) | 100 (0.0) | 100 (0.0) | 79 (3.6) |
| Project SMART Consortium, OH | r 82 (3.5) | r 86 (3.5) | r 75 (4.2) | r 58 (4.5) |
| Rochester City Sch. Dist., NY | r 100 (0.4) | r 100 (0.4) | r 72 (6.1) | r 68 (6.6) |
| SW Math/Sci. Collaborative, PA | r 94 (3.5) | 92 (3.8) | r 65 (7.0) | r 64 (5.5) |
| **International Avg. (All Countries)** | 90 (0.3) | 84 (0.4) | 76 (0.6) | 58 (0.7) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

* Taught before or during this school year.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

| | | Pollution (acid rain, global warming, ozone layer, water pollution) | | Conservation of natural resources (land, water forests, energy sources) | | Food supply and production, population, and environmental effects of natural and man-made events |
|---|---|---|---|---|---|---|
| **Countries** | | | | | | |
| United States | r | 83 (2.4) | r | 79 (2.5) | s | 81 (2.9) |
| Belgium (Flemish) | r | 89 (3.3) | r | 82 (3.7) | r | 63 (4.3) |
| Canada | s | 92 (1.4) | s | 90 (2.2) | s | 83 (2.9) |
| Chinese Taipei | r | 73 (3.5) | r | 48 (4.4) | r | 41 (4.7) |
| Czech Republic | | 92 (2.6) | | 92 (2.5) | | 82 (4.1) |
| England | s | 79 (4.5) | s | 71 (5.1) | s | 71 (4.6) |
| Hong Kong, SAR | | 74 (4.3) | r | 54 (5.3) | r | 30 (4.7) |
| Italy | | 84 (2.6) | | 80 (2.8) | | 70 (3.4) |
| Japan | | 26 (3.4) | | 7 (2.4) | | 7 (2.4) |
| Korea, Rep. of | | 75 (3.8) | | 58 (4.5) | | 49 (4.4) |
| Netherlands | | 99 (1.0) | | 98 (1.0) | r | 98 (1.1) |
| Russian Federation | | – – | | – – | | – – |
| Singapore | | 93 (2.4) | r | 86 (3.5) | s | 64 (5.0) |
| **States** | | | | | | |
| Connecticut | s | 91 (4.4) | s | 87 (5.5) | | x x |
| Idaho | s | 65 (7.5) | s | 64 (6.6) | s | 55 (8.3) |
| Illinois | r | 86 (3.7) | r | 81 (4.7) | r | 88 (3.6) |
| Indiana | s | 87 (4.3) | s | 82 (5.1) | s | 76 (5.5) |
| Maryland | s | 84 (5.7) | s | 82 (4.8) | s | 82 (5.4) |
| Massachusetts | r | 93 (2.2) | r | 88 (3.2) | s | 87 (3.9) |
| Michigan | r | 92 (3.2) | r | 84 (4.8) | s | 90 (4.2) |
| Missouri | r | 90 (3.3) | r | 91 (3.0) | r | 90 (3.6) |
| North Carolina | r | 76 (5.8) | r | 78 (5.8) | r | 77 (5.2) |
| Oregon | r | 84 (5.7) | r | 84 (5.3) | r | 84 (5.9) |
| *Pennsylvania* | r | 77 (5.9) | r | 74 (6.3) | r | 75 (6.1) |
| South Carolina | r | 93 (2.7) | r | 94 (2.1) | r | 90 (3.4) |
| *Texas* | r | 90 (2.9) | r | 88 (3.2) | s | 85 (4.7) |
| **Districts and Consortia** | | | | | | |
| Academy School Dist. #20, CO | s | 100 (0.0) | s | 100 (0.0) | s | 100 (0.0) |
| Chicago Public Schools, IL | r | 65 (11.2) | r | 53 (12.5) | r | 63 (11.7) |
| Delaware Science Coalition, DE | s | 79 (6.0) | s | 66 (5.2) | s | 56 (5.6) |
| First in the World Consort., IL | | 95 (2.5) | | 100 (0.0) | | 100 (0.0) |
| Fremont/Lincoln/WestSide PS, NE | s | 81 (6.5) | s | 76 (6.2) | r | 73 (5.4) |
| Guilford County, NC | r | 66 (4.1) | r | 90 (2.7) | r | 74 (4.5) |
| Jersey City Public Schools, NJ | r | 100 (0.0) | r | 98 (0.2) | r | 90 (0.9) |
| Miami-Dade County PS, FL | s | 82 (6.7) | s | 83 (7.0) | s | 81 (6.6) |
| Michigan Invitational Group, MI | s | 80 (4.0) | s | 84 (3.9) | r | 83 (3.5) |
| Montgomery County, MD | | x x | | x x | | x x |
| Naperville Sch. Dist. #203, IL | | 100 (0.0) | | 89 (3.9) | r | 77 (3.4) |
| Project SMART Consortium, OH | r | 89 (2.1) | r | 90 (1.7) | r | 91 (1.6) |
| Rochester City Sch. Dist., NY | r | 46 (4.5) | s | 33 (6.3) | s | 36 (7.1) |
| SW Math/Sci. Collaborative, PA | r | 85 (6.8) | r | 93 (4.3) | s | 87 (5.4) |
| **International Avg. (All Countries)** | | 78 (0.6) | | 76 (0.6) | | 66 (0.7) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

* Taught before or during this school year.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available.

An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

# Exhibit 5.25 Percentages of Students Taught Scientific Inquiry and the Nature of Science Topics*

TIMSS 1999 Benchmarking
Boston College

8th Grade Science

| | Scientific method (formulating hypotheses, making observations, drawing conclusions, generalizing) | Experimental design (experimental control, materials, and procedures) | Scientific measurements (reliability, replication, experimental error, accuracy, scales) | Using scientific apparatus and conducting routine experimental operations | Gathering, organizing, and representing data (units, tables, charts, graphs) | Describing and interpreting data |
|---|---|---|---|---|---|---|
| **Countries** | | | | | | |
| United States | r 99 (0.6) | r 97 (1.2) | r 89 (2.5) | r 95 (1.4) | r 97 (1.4) | r 98 (1.1) |
| Belgium (Flemish) | r 86 (3.8) | r 46 (4.6) | r 64 (4.6) | r 66 (4.9) | r 91 (2.8) | r 90 (3.2) |
| Canada | r 99 (0.5) | r 97 (1.7) | s 84 (2.8) | r 99 (0.8) | r 100 (0.2) | r 99 (0.7) |
| Chinese Taipei | 85 (3.2) | 71 (4.0) | 83 (3.3) | 90 (2.7) | 68 (4.0) | 69 (3.9) |
| Czech Republic | r 79 (4.4) | r 73 (4.9) | r 81 (4.4) | r 80 (4.8) | r 86 (3.7) | r 81 (4.8) |
| England | s 96 (1.6) | s 95 (1.9) | s 92 (2.2) | s 98 (0.9) | s 98 (0.8) | s 98 (0.9) |
| Hong Kong, SAR | 85 (3.4) | 68 (4.5) | 63 (4.8) | 88 (3.1) | 81 (3.4) | r 80 (3.3) |
| Italy | 100 (0.0) | 94 (1.8) | 84 (3.1) | 84 (3.2) | 95 (1.7) | 94 (1.8) |
| Japan | 90 (2.6) | 96 (1.8) | 77 (3.4) | 99 (1.0) | 97 (1.6) | 95 (1.9) |
| Korea, Rep. of | 93 (2.1) | 89 (2.6) | 84 (3.1) | 99 (0.7) | 92 (2.1) | 86 (2.9) |
| Netherlands | 92 (3.7) | 96 (3.0) | 99 (0.7) | 100 (0.0) | 100 (0.0) | 100 (0.0) |
| Russian Federation | – – | – – | – – | – – | – – | – – |
| Singapore | 94 (2.2) | r 93 (2.6) | r 91 (3.0) | 97 (1.7) | 95 (2.1) | 96 (1.9) |
| **States** | | | | | | |
| Connecticut | s 99 (0.8) | s 100 (0.0) | s 89 (5.8) | s 100 (0.0) | s 100 (0.0) | s 100 (0.0) |
| Idaho | s 99 (0.6) | s 96 (2.3) | s 94 (3.2) | s 97 (1.6) | s 99 (0.6) | s 100 (0.2) |
| Illinois | 98 (2.1) | r 98 (1.0) | r 92 (1.8) | 94 (3.4) | 97 (2.0) | 98 (1.9) |
| Indiana | 100 (0.0) | r 97 (1.5) | r 96 (2.6) | r 100 (0.0) | r 98 (2.0) | r 98 (2.0) |
| Maryland | r 100 (0.1) | r 100 (0.1) | r 98 (1.4) | r 98 (1.4) | r 99 (0.8) | r 100 (0.1) |
| Massachusetts | r 100 (0.2) | r 97 (1.7) | r 94 (2.6) | r 99 (0.6) | r 98 (1.7) | r 100 (0.0) |
| Michigan | r 100 (0.5) | r 99 (0.5) | r 94 (3.3) | r 94 (3.8) | r 100 (0.0) | r 100 (0.0) |
| Missouri | r 99 (0.8) | r 97 (2.7) | r 88 (4.2) | r 93 (3.7) | r 100 (0.1) | r 100 (0.1) |
| North Carolina | 96 (3.2) | 91 (3.7) | r 88 (4.3) | r 93 (3.3) | 96 (3.2) | 96 (3.2) |
| Oregon | 100 (0.0) | 97 (1.9) | 93 (2.9) | 100 (0.4) | 98 (1.4) | 99 (1.3) |
| *Pennsylvania* | 100 (0.0) | 97 (1.9) | r 91 (2.0) | r 94 (1.5) | 100 (0.2) | 100 (0.2) |
| South Carolina | 99 (0.4) | r 98 (1.4) | r 93 (2.5) | 97 (1.9) | r 100 (0.0) | 100 (0.0) |
| *Texas* | r 100 (0.2) | r 97 (2.5) | r 96 (2.8) | r 100 (0.3) | r 100 (0.2) | r 100 (0.2) |
| **Districts and Consortia** | | | | | | |
| Academy School Dist. #20, CO | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) |
| Chicago Public Schools, IL | r 100 (0.0) | r 94 (5.7) | r 89 (7.9) | r 94 (5.7) | r 96 (4.0) | r 100 (0.0) |
| Delaware Science Coalition, DE | s 100 (0.0) | s 100 (0.0) | s 91 (4.4) | s 98 (0.4) | r 100 (0.0) | r 100 (0.0) |
| First in the World Consort., IL | 99 (0.8) | 99 (0.8) | 99 (0.8) | 99 (0.8) | 99 (0.8) | 99 (0.8) |
| Fremont/Lincoln/WestSide PS, NE | r 100 (0.0) | r 99 (0.6) | r 94 (5.9) | r 98 (0.6) | 100 (0.0) | 100 (0.0) |
| Guilford County, NC | r 99 (0.0) | r 94 (0.9) | r 94 (0.9) | r 97 (2.7) | r 100 (0.0) | r 100 (0.0) |
| Jersey City Public Schools, NJ | r 100 (0.0) | r 100 (0.0) | r 80 (4.1) | r 96 (0.4) | r 100 (0.0) | r 100 (0.0) |
| Miami-Dade County PS, FL | s 100 (0.0) | s 99 (0.7) | s 100 (0.2) | s 99 (0.7) | s 100 (0.0) | s 100 (0.0) |
| Michigan Invitational Group, MI | r 100 (0.0) | r 98 (0.1) | r 97 (0.1) | r 100 (0.0) | r 100 (0.0) | r 100 (0.0) |
| Montgomery County, MD | x x | x x | x x | x x | x x | x x |
| Naperville Sch. Dist. #203, IL | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) | 100 (0.0) |
| Project SMART Consortium, OH | r 100 (0.0) | r 95 (2.6) | r 99 (0.1) | r 98 (2.2) | r 100 (0.0) | r 100 (0.0) |
| Rochester City Sch. Dist., NY | r 100 (0.0) | r 100 (0.0) | r 72 (5.0) | s 100 (0.0) | r 98 (2.4) | r 98 (2.4) |
| SW Math/Sci. Collaborative, PA | 100 (0.0) | 95 (4.3) | r 92 (6.1) | 99 (0.9) | 100 (0.0) | 100 (0.0) |
| **International Avg. (All Countries)** | 88 (0.5) | 84 (0.6) | 75 (0.7) | 87 (0.5) | 87 (0.5) | 87 (0.5) |

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1998-1999.

Background data provided by teachers.

* Taught before or during this school year.

States in *italics* did not fully satisfy guidelines for sample participation rates (see Appendix A for details).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

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An "r" indicates teacher response data available for 70-84% of students. An "s" indicates teacher response data available for 50-69% of students. An "x" indicates teacher response data available for <50% of students.

## What Can Be Learned About the Science Curriculum?

In contrast to the United States, most countries around the world have well-established, centrally-mandated national curricula. Recently, however, states and districts in the U.S. have been making great strides in establishing content standards and curriculum frameworks to guide curriculum implementation in schools. Furthermore, many education systems in the U.S. have begun to assess whether the intended curriculum in science is being attained or learned by their students. Thoroughly examining the Benchmarking jurisdictions' results in an international context can provide insights into what students are expected to learn in science, what is taught in classrooms, and what policies and practices provide the best match between the intended and the implemented curriculum to improve student achievement.