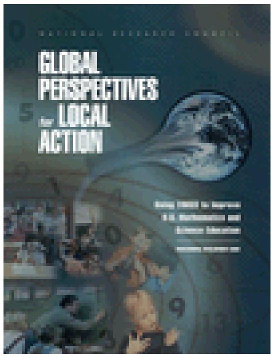

Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education, Professional Development Guide

Committee on Science Education K-12, Mathematical Sciences Education Board, and Continuing to Learn from TIMSS Committee, National Research Council

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GLOBAL PERSPECTIVES for LOCAL ACTION:

Using TIMSS to Improve U.S. Mathematics and Science Education

Professional Development Guide

A joint project of
the Committee on Science Education K–12
and
the Mathematical Sciences Education Board

Continuing to Learn from TIMSS Committee
Center for Science, Mathematics, and Engineering Education
National Research Council

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This report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following individuals for their participation in the review of this report:

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While the individuals listed above provided many constructive comments and suggestions, responsibility for the final content of this report rests solely with the authoring committee and the National Research Council.

Contents

Preface

This professional development guide is a companion piece to the National Research Council's report, *Global Perspectives for Local Action: Using TIMSS* to Improve U.S. Mathematics and Science Education* (NRC, 1999a). The guide, derived in part from the report and most usefully accompanied by it, is designed primarily for workshops for groups of education decision-makers—workshops that will support long-range planning efforts to improve K–12 student performance in mathematics and science.

Both the report and the guide were produced at the request of the U.S. Department of Education by the National Research Council's Center for Science, Mathematics, and Engineering Education (CSMEE). Within CSMEE, the Mathematical Sciences Education Board and the Committee on Science Education K–12 acted together to form the Continuing to Learn from TIMSS Committee. The charge to this committee was to help make the findings of TIMSS relevant and useful to leaders in K–12 mathematics and science education and to promote continued public discussion of the many components of TIMSS. The report and the guide are the results of the committee's work, culminating in a convocation held in November of 1999 at the National Academy of Sciences to introduce the report and the guide and to begin the process of ensuring their use at local levels.

Facilitators of workshops will be able to use this guide with a broad range of stakeholders, including teachers, parents, administrators, school board members, policy makers, curriculum developers, textbook publishers, teacher educators, and faculty in institutions of higher education. Teaching is a complex activity. Many stakeholders have questions about what to teach and how to teach, such as when teachers ask, "Are we teaching too many topics?" Administrators ask, "Should there be additional assessments of student performance?" Policy makers ask, "Should we raise standards for teacher preparation and enhancement, particularly in mathematics and science?" Parents ask, "Are my children getting the education they will need to lead successful lives?" The TIMSS data can offer one avenue for

* The Third International Mathematics and Science Study.

investigating these issues. However, no single data set and no set of professional development activities can hope to give definitive answers to every question of teaching and learning. The guide and the material in the report, which grow out of the rich array of TIMSS information, will help these stakeholders plan further investigation of these complex questions at the local level that can then lead to informed decision-making.

The report and the guide are not intended to prescribe but, rather, to expand the range of options considered in making decisions about making changes in our schools. Accordingly, the committee members and staff worked to ensure that the guide in particular is flexible enough to meet a variety of needs and, therefore, useful to facilitators in a variety of workshops of different lengths, foci, and intensity.

On behalf of the study committee, I want to acknowledge with deep appreciation the work of the principal writers of this professional development guide—consultants Susan Mundry and Nancy Love—and consulting editor Kathleen (Kit) Johnston. We also thank project directors Harold Pratt and Karen Hollweg and the other dedicated staff of CSMEE who helped us produce the report, and we express gratitude to the representatives of the U.S. Department of Education who worked closely with us on a complex project with a short timeline. All of us hope that the report, the professional development guide, and the convocation will indeed help education leaders strengthen mathematics and science education for all students in the United States in the years to come.

Melvin D. George, *Chair*
Continuing to Learn from TIMSS Committee

Introduction

TIMSS AND THE NRC REPORT

The Third International Mathematics and Science Study (TIMSS) is a rich source of information that can be used by a broad range of stakeholders to promote discussions and actions to improve K–12 mathematics and science teaching and learning. To support educators, administrators, parents, and others interested in education in using TIMSS materials, the National Research Council (NRC) has prepared a report, *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education* (see "Resources"). This report will help educators, administrators, parents and others interested in education to understand what can be learned from TIMSS findings, and it will encourage them to use the information to make improvements in mathematics and science education. Provided in the report are insights into mathematics and science achievement, curriculum, instruction, and school support systems, such as professional development, in the United States and around the world.

PURPOSE OF THE NRC PROFESSIONAL DEVELOPMENT GUIDE

To make TIMSS information more accessible and useful to educators and the public, the NRC prepared this professional development guide to accompany its report. This guide provides directions and support materials for leading workshops and planning sessions for teachers, educational administrators, higher education faculty, and the interested public. Through the workshops or planning sessions participants will be able

- To explore key themes and findings from the report;
- To ask questions about their current practices; and
- To consider alternatives for action at the local level.

AUDIENCES FOR THE GUIDE

The audiences for this guide are professional developers, facilitators, higher education faculty, school administrators, and others who lead workshops and/or planning sessions aimed at reflecting on and improving mathematics and science education.

TIMSS does not provide quick solutions for or easy answers to the complex problems of educational improvement. Rather, it offers the benefit of an international perspective from which to view educational practices. It is important, therefore, that the facilitators for the workshops and/or planning sessions described in this guide have strong backgrounds in the TIMSS study and findings and that they read and become thoroughly familiar with the NRC report.[1] This will enable the facilitators to explain findings and avoid misinterpretations of data or suggestions that U.S. achievement would improve if only the U.S. would emulate practices used in countries where students scored higher in the TIMSS achievement tests in mathematics and science. Many good resources summarize TIMSS, and these will help facilitators to prepare for their role. Facilitators should review the resources provided in the "Resources" section at the end of this report prior to conducting sessions based on this guide.

DESCRIPTION

The professional development guide includes

- Modules (Modules 1, 2—composed of three separate workshops—and 3) tailored for different audiences, purposes, lengths of time, and/or levels of engagement;
- Notes to facilitators;
- Overhead transparency masters, as well as masters of handouts for the workshop modules;
- References to relevant TIMSS and other resources; and
- Vignettes and lessons from educators who have used TIMSS to make educational improvements in their local schools.

Of the three modules in this guide, "Module 1: Framing the Dialogue," is designed primarily as an information session for administrators, legislative and state education staff, local school board members, and the interested public. It is designed as a 2–2.5 hour overview with the following objectives:

[1] Facilitators will want to keep in mind that the groups of students studied in TIMSS were designated as "populations" that do not necessarily match traditional grade levels in the U.S. In TIMSS, Population 1 was mostly 9-year-olds (grades 3 and 4 in the U.S.); Population 2, 13-year-olds (grades 7 and 8 in the U.S.); and Population 3, students in their final year of secondary school regardless of age (grade 12 in the U.S.).

- To develop participants' understanding of the value of using TIMSS as a catalyst for improvement of mathematics and science education; and
- To actively engage participants with the themes and findings of the NRC's TIMSS report and the implications.

"Module 2: Exploring Curriculum, Instruction, and School Support Systems" contains three 2–2.5 hour workshops, designed to provide more in-depth information on the TIMSS findings in the three topics of curriculum, instruction, and school support systems. Module 2 is primarily for school/district staff and higher education staff interested in exploring the implications of the TIMSS findings for their own practice. School board members also would benefit from extensive engagement with Module 2. It has the following objective:

- To engage teachers, administrators, and higher education faculty in exploring the key messages of the NRC report and to identify issues for further reflection and implications for action.

"Module 3: Global Perspectives for Local Action Planning" is an action-planning guide for audiences who wish to go deeper and use the report to inform their own reflection, inquiry, and/or decision making about curriculum, instruction, and support systems in schools, in school districts, or in higher education settings. Module 3 is intended as a guide for school- or higher education institution-based teams that have already participated in Modules 1 and 2. This third module will help these teams explore the TIMSS findings further and to study their own settings and practices to identify problems and plan improvements. The objective of the materials in Module 3 is

- To motivate and guide participants to use the NRC report and other data and information within existing school improvement efforts for the purposes of
  - reflecting on practice;
  - engaging in ongoing inquiry;
  - collecting data;
  - exploring alternative practices; and/or
  - making decisions about curriculum, instruction, and/or school support systems and alternative actions.

DESIGNING WORKSHOPS AND PLANNING SESSIONS

There are several ways that you—as the facilitator—may want to put together the modules in this guide to meet the needs of your particular audience. The guide is designed to be flexible so that you can choose the best module(s) and activities for a particular audience. It is essential, therefore, that you know the needs and expectations of your various audiences and communicate with them ahead of time to find out how best to meet their needs. Module 1 is a stand-alone session that introduces TIMSS to people with limited time, such as administrators, legislative staff, parents, and other members of the interested public. Module 1 can also be used as an introduction to Modules 2 and 3 for those who have the time and motivation to go more in depth with the TIMSS findings (typically, school and higher education staff and members of action-planning and school improvement groups). The stated goals of each module are briefly stated in this introductory section and again at the beginning of each module, later in the guide. Review these goals with your audience in mind, then choose the modules and activities most appropriate for your group. The chart on pg. 5 suggests how you can use the materials in Modules 1, 2, and 3 to design different workshops and/or planning sessions with different purposes and time available.

The learning activities in each module are put together in ways that vary the type of activity to ensure active engagement and time for reflection and application. If you modify this design or the activities of the modules, be sure to strike a balance between activities that explain or provide information to participants and activities that engage participants in talking with one another and generating meaning and insights that they can apply to their own situations.

Purpose	**Time Available**	**Suggested Module or Workshop/ Planning Session**
Create awareness among the interested public and administrators of how U.S. students, instruction, curriculum, and schools compare to those in other countries.	2–2.5 hours	Module 1
Explore one aspect of U.S. schooling in some depth (curriculum, instruction, or school support systems) to understand how it compares with those in other countries and generate implications for action.	4–5 hours	Module 1 ***and*** Module 2A ***or*** 2B ***or*** 2C
Explore all aspects of U.S. schooling investigated by TIMSS in some depth and generate implications for action.	8.5–9 hours	Module 1 ***and*** Module 2A, 2B, ***and*** 2C
Use the TIMSS findings to plan improvements in one aspect of U.S. schooling and to generate plans for local action (by schools, school districts, or higher education groups).	20 hours	Module 1 ***and*** Module 2A ***or*** 2B ***or*** 2C and Module 3
Use TIMSS findings to plan improvements in all aspects of schooling investigated by TIMSS and plan local actions with school district or higher education groups.	40+ hours	Module 1, Module 2A, 2B, ***and*** 2C, ***and*** Module 3
Convene a local action-planning group to collect data and recommend local improvements.	40+ hours	Module 1 ***and*** Module 3 ***or*** Modules 2A, 2B, and 2C ***and*** Module 3

Module 1: Framing the Dialogue

OVERVIEW

Module 1 is a 2 to 2.5 hour introduction to TIMSS and to the NRC report, *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education.* The module's purpose is to engage participants with the key findings of the report and to help them recognize the value of TIMSS as a catalyst for improvement. Although this module will conclude with a consideration of action that can be taken, it is necessary to complete Module 2 and spend considerable time on Module 3 before an action plan can be completed and improvement efforts begun.

Module 1 is designed to be used either as a self-contained unit or as the introductory material to Modules 2 and 3. As a self-contained unit, Module 1 has as its target audience school and higher education administrators, state education staff, legislators and legislative aides, parents, and the interested public. As an introduction to more in-depth, follow-up sessions, Module 1's target audience is school and district administrators and teachers and higher education administrators and faculty.

GOALS

- To provide an overview of the key messages and findings of the *Global Perspectives for Local Action: Using TIMSS to Improve U.S. and Mathematics and Science Education* report and the implications for different audiences.
- To highlight the value of using TIMSS as a catalyst for mathematics and science education improvement.

ACTIVITIES

1.1 Overview of Goals and Agenda (5 minutes)
1.2 Corners (15 minutes)

1.3 *Brief Overview of What TIMSS Is and of the* Global Perspectives for Local Action *Report (10 minutes)*
1.4 *What Does TIMSS Say about Student Achievement? (30 minutes)*
1.5 *A Walk Across the Data: Curriculum, Instruction, and School Support Systems (75 minutes)*
1.6 *Implications and Next Steps (15 minutes)*

Time: 2 to 2.5 hours. (If you have less time, particularly for audiences that are familiar with TIMSS, consider eliminating or shortening Activity 1.4 by quickly summarizing achievement results. This will cut 20–30 minutes. As an alternative or to shorten further, consider eliminating the video viewing activity embedded in Activity 1.5.)

SET UP AND MATERIALS

Room Arrangement and Equipment

- Tables for groups of four
- A room with plenty of wall space for posting newsprint
- Overhead projector and screen
- Video projection unit with screen or large monitor
- Newsprint and markers
- Paper for note-taking and pens/pencils, plus newsprint or transparencies and markers for recorders/reporters

Order in Advance

- TIMSS Videotape: "Eighth-Grade Mathematics Lessons: United States, Japan, and Germany" (from the TIMSS "toolkit"). (Check with your school district's science or math coordinator or local university's school of education to borrow their Resource Kit or kit or contact the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954; Phone: (202) 512-1800; FAX: (202) 512-2250; URL: http://www.access.gpo.gov/su_docs/sale/prf/prf.html; e-mail: orders@gpo.gov. When ordering, ask for *Attaining Excellence: A TIMSS Resource Kit,* GPO # 065-000-01013-5.)
- Copies of the *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education* report for each participant. (The report is available from the National Academy Press, 2101 Constitution Ave., NW, Lockbox 285, Washington, D.C. 20055; Phone: (800) 624-6242 [toll free] or (202) 334-3313 [in the Washington Metropolitan area].)

Make in Advance

- Overhead transparencies from masters for Module 1 in this guide (Note that the masters are labeled Slide 1-1, Slide 1-2, and so on…)[2]
- Copies of handouts for this module (see pgs. 121-144) (one set for each participant) (Distribute these early in the session for the participants to use in taking notes.)
- Copies of Slides 1-11 through 1-23 (one set for each participant)
- Three pieces of newsprint, one labeled "Curriculum," another labeled "Instruction," and a third labeled "Professional Development and Use of Time."
- Four poster-sized representations of data on Slides 1-20, 1-31, 1-41, and 1-47 copied on four pieces of colored paper, laminated if possible, and posted around the room (These also can be written on newsprint and posted.)

FACILITATOR NOTES

Activity 1.1
Overview of Goals and Agenda
(5 minutes)

- Welcome participants and provide them with copies of all of the handouts for this module. Note in particular that the last handout explains the student populations tested and studied in TIMSS. Using Slide 1-1, tell participants that the NRC report, *Global Perspectives for Local Action,* addresses findings in the four areas highlighted on the slide. However, be sure to point out that there are many other factors that influence achievement beyond curriculum, instruction, and school support systems. Remind participants that TIMSS data provides an international perspective through which we can analyze the factors of curriculum, instruction, and school support. This session will help to frame a beginning dialogue around some of the major issues raised in each of these areas.
- With Slides 1-2 and 1-3, review the goals and agenda.
- Transition participants to the next segment by telling them they are about to go deeper inside the TIMSS findings and to reflect more on their implications for each of the audiences represented.

Activity 1.2
Corners
(15 minutes)

- Tell participants that the next activity is designed to engage them in the major areas of the report.

[2] The source of data cited on masters is noted on the bottom of each master by title. For complete citations, see the "Resources" section of this guide.

- Note the three posters placed on walls close to three corners of the room labeled "Curriculum," "Instruction," and "Professional Development and Use of Time" (one of the school support systems addressed in the NRC report). Briefly define each of these terms as they are used in the report. Ask participants to think about which factor they believe has the greatest influence on student learning and why. Allow 30 seconds or so for participants to think and make a decision about their choice.
- Using Slide 1-4, explain the "Corners" directions to participants, one step at a time. First, ask participants physically to move to the corner labeled with the term or factor they chose. Before they move, tell them that they are to find two to three other people in their corner to talk to about why they made that choice. After participants move, monitor the groups to make sure that they are speaking in small groups and that everyone has a chance to speak. (If the groups do not divide evenly, don't be concerned. This only reflects the importance, or lack thereof, that they attribute to the three factors.) Allow 7–8 minutes for discussion. Then point out the factors participants considered more and less important (as indicated by their choices) and ask for one or two spokespeople from each group to summarize key points from their discussion. Ask participants to return to their seats.
- Transition by thanking the groups for their participation. Acknowledge that choosing any single factor as the main influence on student learning is impossible and that student learning is very complex and influenced by all of these factors. TIMSS does not provide us with magic bullets or simple causal links but, rather, with the opportunity to consider the complex interplay of the many factors that influence student achievement. Contrary to what one might think from reading the headlines, TIMSS goes far beyond an international comparison of student achievement in mathematics and science. Through case studies, surveys, and detailed studies of curriculum, TIMSS provides us with rich insights into the factors surrounding student achievement. The NRC report invites us to think about these factors anew with the benefit of an international perspective. In this session, we will briefly explore what TIMSS says about curriculum, instruction, and school support systems, but first it is important that we all become grounded in what TIMSS and the NRC report are.

Activity 1.3
Brief Overview of What TIMSS Is and the *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education* Report
(10 minutes)

- Use Slides 1-5 through 1-9 to provide an overview of TIMSS and the NRC report. If participants want more information, direct them to Chapter 2 of the report. For your own preparation, read Chapters 1 and 2.

- Transition by saying that we are now going to explore the NRC report's perspective on the TIMSS student achievement findings.

Activity 1.4
What Does TIMSS Say about Student Achievement?
(30 minutes)

- In preparation for this and the next activity, you will have created newsprint-sized posters of the selected achievement, curriculum, instruction, and school support systems findings that are illustrated by Slides 1-20, 1-31, 1-40, and 1-47, and you will have placed them around the room, ideally on the same wall. (Use the organizational configuration used in Slide 1-1.) You will have covered up these posters with additional pieces of blank newsprint until you are ready to present them.
- Provide participants with a little background on the achievement results. You may want to say something like the following: "In order to use TIMSS to help guide decision-making at the national, state, and local levels, we first need to understand the results. The data you are about to look at summarize several findings—the mathematics and science results for the fourth- and eighth-grade populations studied (Populations 1 and 2) and for the twelfth-grade population (Population 3). In Population 3, TIMSS tested students' general scientific and mathematical knowledge and knowledge of physics, and advanced mathematics for students who took those courses." (Use Slide 1-10 for background as you talk.)
- Give participants copies of Slides 1-11 through 1-23 and ask them to discuss the slides in groups of four. Or, if you prefer and are pressed for time, give a brief lecture on the same slides. After participants have seen the data, ask them in groups of four to discuss the questions on Slide 1-24. (Show Slide 1-24.) Encourage participants to focus on observations rather than explanations or interpretations of the data.[3]
- In the whole group, discuss the small groups' observations. Uncover the large poster illustrating achievement results (the poster made from Slide 1-20) and record key points from the small groups on the newsprint underneath the poster.

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[3] Participants may ask why some achievement results seem out of order, such as on Slide 1-14, where Sweden, with a score of 519, is grouped with the nations that are significantly higher than the U.S., and the first score in the next column is 522 (for Thailand). This is not an error. Although the country average for Sweden may appear to be out of place, statistically, its placement is correct. (On a more detailed level, note that each score is an estimate of how the entire country would perform based on a small sample of students actually tested. Statistically, it is possible to calculate the amount of error in the estimate and also to determine the "level (%) of confidence" that the reported score has within a given interval. For the data in Slide 1-14, there is a 95% confidence level that the score for Sweden is between 516 and 522. For the U.S., there is a 95% confidence level that the score is between 495 and 505. Since the two intervals do not overlap, there is a 95% confidence level that the scores of the two countries are different, with one being significantly higher than the other.)

- Summarize achievement findings, using Slide 1-25.[4, 5]

  (Note: The summary slides used in each workshop module list some main points but are not exhaustive. Additional conclusions can often be found in the NRC TIMSS report based on the larger array of data found there and from conclusions that were reported in TIMSS-issued documents listed in the "Resources" section at the end of the guide.)
- Transition participants to the next segment by saying that we are now going to look at other aspects of the educational system that TIMSS examined in order to understand better these results within a larger context. The message here is that "there is no single lever for improving achievement; we are about to begin an exploration of the many complex and interconnected factors that influence student learning."

  (Note: Several states, including Minnesota and Colorado, and some U.S. school districts, including those in the First in the World Consortium, have their own local TIMSS achievement data. Find out if local TIMSS data are available where you are conducting this session. If so, consider engaging participants with their local data.[6])

Activity 1.5
A Walk Across the Data: Curriculum, Instruction, and School Support Systems
(75 minutes)

- The purpose of this activity is to introduce participants briefly to the highlights of the NRC report on using TIMSS for local action and to help them see the interconnectedness of the TIMSS data. You can tell participants that the authors of the NRC report are particularly concerned that educational institutions and policy makers not jump to conclusions based on bits and pieces of TIMSS. To use TIMSS effectively, educators and policy makers need to consider the whole picture that TIMSS paints about mathematics and science teaching and learning.

[4] Participants may notice the frequent references to the U.S., Japan, and Germany studies and analysis. There is no official TIMSS explanation for the choice of countries that were involved in specific studies, such as the TIMSS Video Study. (This particular study was funded primarily by the U.S., so U.S. researchers selected the countries to be involved.) At the time of the study, Japan and Germany were our leading economic competitors.

[5] Similar statements about the top 10% of Population 3 students cannot be made because the results were not formulated this way. With the exception of U.S. AP Calculus students, top U.S. students do poorly on international comparisons in both math and science.

[6] TIMSS-R (TIMSS-Repeat) achievement tests (and contextual data gathering methodologies) were offered to school systems around the world. In the year 2001, those results will be made available. If possible, obtain relevant local data.

Overview of Curriculum Data

- Use Slide 1-26 to signal the shift in focus to a significant part of the TIMSS study—curriculum.
- Briefly, provide some background on the TIMSS curriculum study using Slides 1-27, 1-28, and 1-29. Mention that this part of the presentation will emphasize the TIMSS findings on curriculum focus. (For more information about other findings, refer participants to Chapter 4 of the NRC report. Module 2A will also take participants more deeply into Chapter 4 of the NRC report.)
- Use Slide 1-30 to show data about curriculum focus.
- Unveil the curriculum poster, an enlarged version of Slide 1-31.
- Using Slide 1-32, ask participants to discuss in groups of four the sense they make of these data, questions the data provoke, and the connections between the curriculum data and the achievement data. What questions do the curriculum findings raise about the achievement findings? Record responses on blank newsprint that you post under the curriculum poster.
- Summarize this overview of curriculum data by showing Slide 1-33.
- Transition to instruction, another factor that relates closely to curriculum and to student achievement.

Overview of Instruction Data

- Use Slide 1-34 to illustrate the shift in focus now to the instruction part of the TIMSS study.
- Tell participants that one of the unique aspects of TIMSS is the video study of mathematics instruction in the U.S., Germany, and Japan, which provides valuable insights into instruction in these three countries. The data for the study were collected by videotaping one class period for each of 81 randomly selected teachers in the U.S., 100 in Germany, and 50 in Japan. The video researchers noted far more differences between countries than within countries, indicating that teaching techniques and patterns are similar within each country and different between countries. The purpose of examining different teaching styles is to provide examples of different alternatives and to encourage educators to consider these alternatives. Use Slides 1-35, 1-36, and 1-37 to provide an overview of the video study.
- Let participants know that they are about to have the opportunity to glimpse a U.S. and a Japanese mathematics classroom and see firsthand the kind of data collected through the video study. Set up the group for viewing the video by reviewing the questions on Slide 1-38, asking participants to focus on how the different teachers introduce the lessons, engage the students, and teach the content in each of the examples on the video segments. The questions are: How does the teacher introduce the concept? What is the difference between how the students are engaged in the U.S. classroom and the

Japanese classroom? How challenging is the mathematics content supported by the lessons? (5 minutes)

- Before viewing the tape, ask participants to think about a typical U.S. eighth-grade mathematics classroom and to jot down the characteristics of teaching and learning that come to mind.
- Show Parts 1–3 of the U.S. Geometry lesson. Allow a few minutes for participants to take notes. (7.5 minutes)
- Show Parts 1–3 of the Japanese Geometry lesson. Again, allow a few minutes for notes. (7.5 minutes)
- Ask participants to work at tables in groups of three to four and to report their observations (what they saw or heard) to one another. Ask for volunteers to be prepared to report out to the large group by recording responses on chart paper or on a blank transparency. Note that the most significant standard in the NCTM *Standards* is the recommendation that mathematics be learned through problem solving. Ask, "What aspects of teaching did you see in the videos that follow such recommendations?" Help the groups by teasing out examples, such as that the Japanese teacher provides instructions to stop and think and to work in a group. And the U.S. teacher is doing call-and-response. (20 minutes)
  (Possible extension: If time permits, you can expand Module 1 by showing and discussing all of the U.S. and Japan lessons on the tape. You also can invite participants to obtain and view the rest of the videos themselves or with colleagues. If your participants will be participating in a Module 2B workshop, they will view the videos in more depth at that time.)
- Let participants know they will now have the opportunity to look briefly at what TIMSS researchers found from analyzing the teaching videos. For the purposes of this overview, the focus will be on the findings related to the structure of lessons. (Module 2B will take participants more deeply into the other instruction items in the NRC report.) Introduce two pieces of data from the video study: "Average Grade Level of Content in the Videotaped Lessons by International Standards" (lessons that engage students in conceptual thinking about mathematics), and "Lesson Structure—Percentages of Math Tasks that Students Decide How to Solve Rather than Using a Teacher-Prescribed Method" (Slides 1-39 and 1-40).
- Unveil the instruction poster, an enlarged version of Slide 1-41.
- Ask participants in groups of four to consider the instruction data now. What meaning do they make of the data? What questions do they raise? What new light do the instruction findings shed on the curriculum and achievement findings? (Slide 1-42.) Record participants' responses on newsprint under the instruction poster.
- Summarize with Slide 1-43.
- Make a transition to the fourth and final piece of the puzzle, school support systems. Use Slide 1-44.

Overview of School Support Systems Findings

- Using Slide 1-45, introduce participants to the study of school support systems. Let them know that data about support systems was collected in the case studies of educational systems in Japan, Germany, and the U.S. and questionnaires completed by teachers, administrators, and students in many of the TIMSS countries. The results allow us to put other TIMSS findings in the context of school cultures and other influences on teaching and learning both inside and outside of the classroom. Let them know about the areas addressed by the NRC report. Use Slide 1-46. For the purposes of this presentation, tell participants that the emphasis will be on the findings on teacher learning. (For more information on other support system findings, participants can read Chapter 5 of the NRC report and/or participate in Module 2C.)
- Unveil the poster on "Time to Collaborate" (Slide 1-47) that illustrates the decline in U.S. teacher time to collaborate from fourth grade to eighth grade.
- Summarize other points from the NRC report's chapter on school support systems, using Slide 1-48.
- Ask participants to connect these findings to their own settings and to other TIMSS findings with the prompts on Slide 1-49. Record the responses on blank newsprint and post them under the "Time to Collaborate" poster.

Activity 1.6
Implications and Next Steps
(15 minutes)

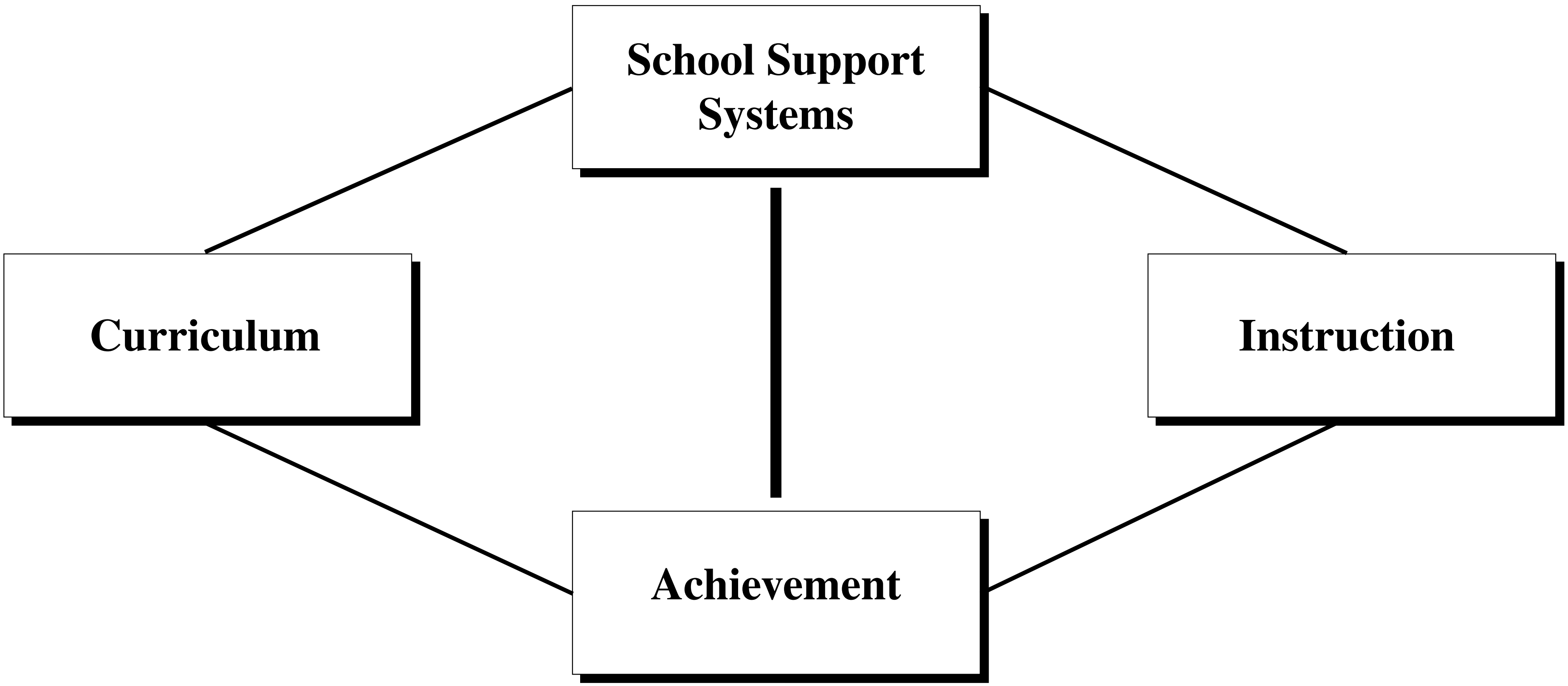
- Transition to implications with Slide 1-50. "We have now taken a very superficial look at all of the pieces of the TIMSS puzzle. The most important questions are, 'What are the implications for us?' and 'Where we are going next?' "
- Ask participants to form role-alike groups (e.g. policy-makers, state education staff, parents, administrators). Summarize by saying that we have explored the "what" and the "so what" of the NRC report. You would now like them to reflect on the "now what?" **What are implications for further reflection and next steps for their role-alike group?** As a catalyst for their discussion, direct participants to consider the "Actions" each audience can take, starting with the Module 1 handouts entitled "Actions to Improve Mathematics and Science Education" (see pgs. 139–143). Ask each group to assign a recorder and a spokesperson and to come up with 2–3 high-priority actions they wish to take. (10 minutes)
- Ask for a spokesperson to report out for each group. (5 minutes)
- If you are offering additional workshops for these participants, provide them with a brief overview of Modules 2 and 3 using the descriptions in the modules' introductions (general introductions to Module 2 and Module 3 are

given on pgs. 145 and 391, respectively. Refer participants to the "Resources" section of this guide and suggest that these resources will help them learn more about TIMSS.

- Wrap up with a quote from the NRC report on Slide 1-51.

Module 1:
Framing the Dialogue
Slides

Global Perspectives for Local Action: Framing the Dialogue



Goals

- To provide an overview of findings of the *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education* report and its implications for different audiences; and
- To highlight the value of using TIMSS as a catalyst for reflection and improvement.

Agenda

- What Is TIMSS, and What Is the NRC Report?
- What Are the Key Findings of the Report?
- How Do the Different Pieces of TIMSS Interconnect?
- What Are the Implications for Further Reflection and Action?

Corners Activity

- Move to the corner of your choice.
- Discuss your choice with 2–3 others in your corner.
- Spokespeople from each corner share with whole group.

What Is TIMSS?

- Third International Mathematics and Science Study
- Largest and most comprehensive study of math/science education ever conducted
- Involved more than 1/2 million students in Population 1 (9-year-olds); Population 2 (13-year-olds); and Population 3 (final year of secondary school)
- Spanned 41 countries

What Did TIMSS Study?

- Achievement in mathematics and science
- Curriculum practices
- Instructional practices
- Influences on teachers and students inside and outside the classroom

Why should we care about TIMSS?

- Recognize the importance of math/science education to the economy and quality of life
- Learn about alternative ways of dealing with educational challenges
- Gain insights into teaching and learning internationally
- Reexamine conventional practices
- Consider new possibilities for U.S. education

Why another report on TIMSS?

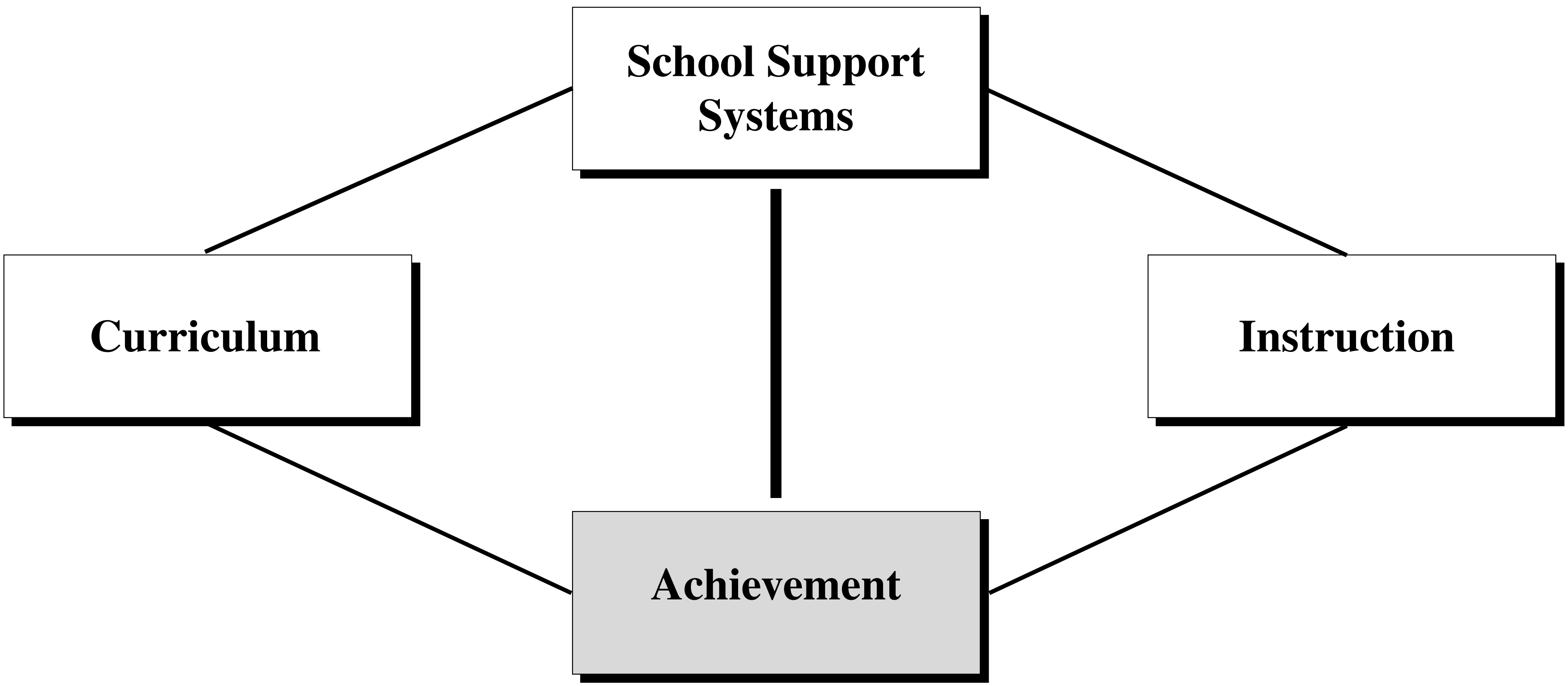
The NRC report

- Takes a comprehensive approach;
- Addresses a range of stakeholders;
- Informs rather than prescribes; and
- Raises questions for local investigation and changes.

What's in the NRC Report?

- Summary of the TIMSS findings
- Description of TIMSS
- What TIMSS says about curriculum
- What TIMSS says about instruction
- What TIMSS says about school support systems
- Answers to frequently asked questions

What Does TIMSS Say about Student Achievement?



TIMSS Achievement Results
Population 1—Science

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Korea	597

Not Significantly Different than the U.S.

Nations	*Average*
Japan	574
United States	**565**
Austria	565
Australia	562
Netherlands	557
Czech Republic	557

Significantly Lower than the U.S.

Nations	*Average*
England	551
Canada	549
Singapore	547
Slovenia	546
Ireland	539
Scotland	536
Hong Kong	533
Hungary	532
New Zealand	531
Norway	530
Latvia (LSS)	512
Israel	505
Iceland	505
Greece	497
Portugal	480
Cyprus	475
Thailand	473
Iran, Islamic Republic	416
Kuwait	401

International Average = 524

From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results Population 1—Mathematics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Singapore	625
Korea	611
Japan	597
Hong Kong	587
Netherlands	577
Czech Republic	567
Austria	559

Not Significantly Different than the U.S.

Nations	*Average*
Slovenia	552
Ireland	550
Hungary	548
Australia	546
United States	**545**
Canada	532
Israel	531

Significantly Lower than the U.S.

Nations	*Average*
Latvia (LSS)	525
Scotland	520
England	513
Cyprus	502
Norway	502
New Zealand	499
Greece	492
Thailand	490
Portugal	475
Iceland	474
Iran, Islamic Republic	429
Kuwait	400

International Average = 529

From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results
Population 2—Science

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Singapore	607
Czech Republic	574
Japan	571
Korea	565
Bulgaria	565
Netherlands	560
Slovenia	560
Austria	558
Hungary	554

Not Significantly Different than the U.S.

Nations	*Average*
England	552
Belgium-Flemish	550
Australia	545
Slovak Republic	544
Russian Federation	538
Ireland	538
Sweden	535
United States	**534**
Germany	531
Canada	531
Norway	527
New Zealand	525
Thailand	525
Israel	524
Hong Kong	522
Switzerland	522
Scotland	517

Significantly Lower than the U.S.

Nations	*Average*
Spain	517
France	498
Greece	497
Iceland	494
Romania	486
Latvia (LSS)	485
Portugal	480
Denmark	478
Lithuania	476
Belgium-French	471
Iran, Islamic Republic	470
Cyprus	463
Kuwait	430
Colombia	411
South Africa	326

International Average = 516

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results Population 2—Mathematics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Singapore	643
Korea	607
Japan	605
Hong Kong	588
Belgium-Flemish	565
Czech Republic	564
Slovak Republic	547
Switzerland	545
Netherlands	541
Slovenia	541
Bulgaria	540
Austria	539
France	538
Hungary	537
Russian Federation	535
Australia	530
Ireland	527
Canada	527
Belgium-French	526
Sweden	519

Not Significantly Different than the U.S.

Nations	*Average*
Thailand	522
Israel	522
Germany	509
New Zealand	508
England	506
Norway	503
Denmark	502
United States	**500**
Scotland	498
Latvia (LSS)	493
Spain	487
Iceland	487
Greece	484
Romania	482

Significantly Lower than the U.S.

Nations	*Average*
Lithuania	477
Cyprus	474
Portugal	454
Iran, Islamic Republic	428
Kuwait	392
Colombia	385
South Africa	354

International Average = 513

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results
Population 3—Science: General Knowledge

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Sweden	559
Netherlands	558
Iceland	549
Norway	544
Canada	532
New Zealand	529
Australia	527
Switzerland	523
Austria	520
Slovenia	517
Denmark	509

Not Significantly Different than the U.S.

Nations	*Average*
Germany	497
France	487
Czech Republic	487
Russian Federation	481
United States	**480**
Italy	475
Hungary	471
Lithuania	461

Significantly Lower than the U.S.

Nations	*Average*
Cyprus	448
South Africa	349

International Average = 500

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results
Population 3—Mathematics: General Knowledge

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Netherlands	560
Sweden	552
Denmark	547
Switzerland	540
Iceland	534
Norway	528
France	523
New Zealand	522
Australia	522
Canada	519
Austria	518
Slovenia	512
Germany	495
Hungary	483

Not Significantly Different than the U.S.

Nations	*Average*
Italy	476
Russian Federation	471
Lithuania	469
Czech Republic	466
United States	**461**

Significantly Lower than the U.S.

Nations	*Average*
Cyprus	446
South Africa	356

International Average = 500

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results
Population 3—Advanced Mathematics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
France	557
Russian Federation	542
Switzerland	533
Australia	525
Denmark	522
Cyprus	518
Lithuania	516
Greece	513
Sweden	512
Canada	509
Slovenia	475

Not Significantly Different than the U.S.

Nations	*Average*
Italy	474
Czech Republic	469
Germany	465
United States	**442**
Austria	436

Significantly Lower than the U.S.

Nations	*Average*
None	

International Average = 501

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

TIMSS Achievement Results
Population 3—Physics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Norway	581
Sweden	573
Russian Federation	545
Denmark	534
Slovenia	523
Germany	522
Australia	518
Cyprus	494
Latvia	488
Switzerland	488
Greece	486
Canada	485
France	466
Czech Republic	451

Not Significantly Different than the U.S.

Nations	*Average*
Austria	435
United States	**423**

Significantly Lower than the U.S.

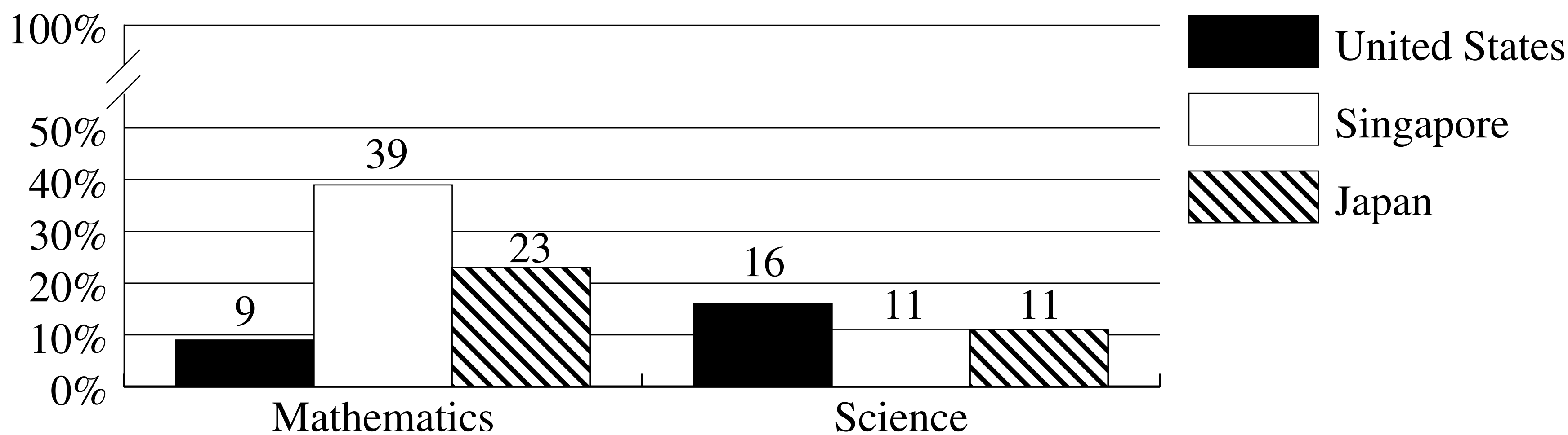
Nations	*Average*
None	

International Average = 501

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

How Do Our Best Fourth-Graders Stack Up?

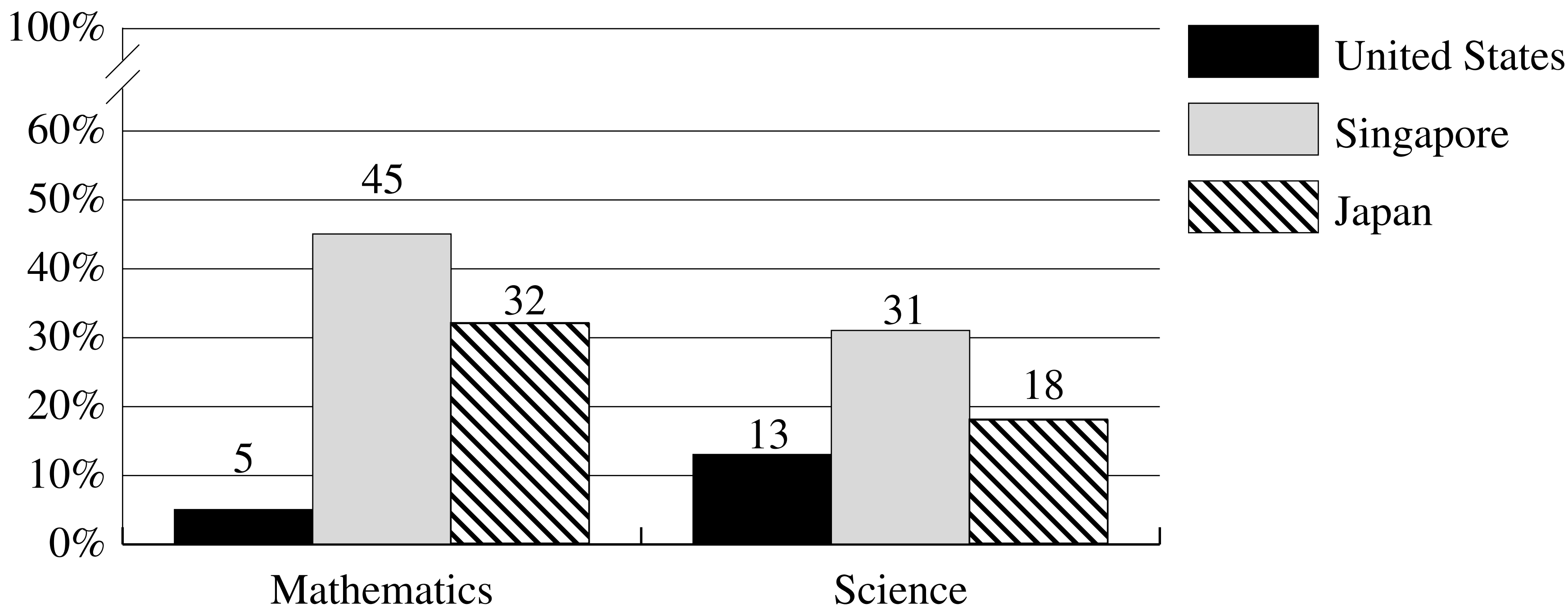
Percentage of Fourth-Graders (Population 1) in the World's Top 10%



From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

How Do Our Best Eighth-Graders Stack Up?

Percentage of Eighth-Graders (Population 2) in the World's Top 10%



From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

Performance of U.S. 8th-Graders in Mathematics Compared to the International Average

About Average

— Algebra

— Data Representation, Analysis, and Probability

— Fractions and Number Sense

Worse than Average

— Geometry

— Measurement

— Proportionality

One of 33 nations with no gender differences

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

Performance of U.S. 8th-Graders in Science Compared to the International Average

Better than Average

— Environmental Issues and the Nature of Science

— Life Science

— Earth Science

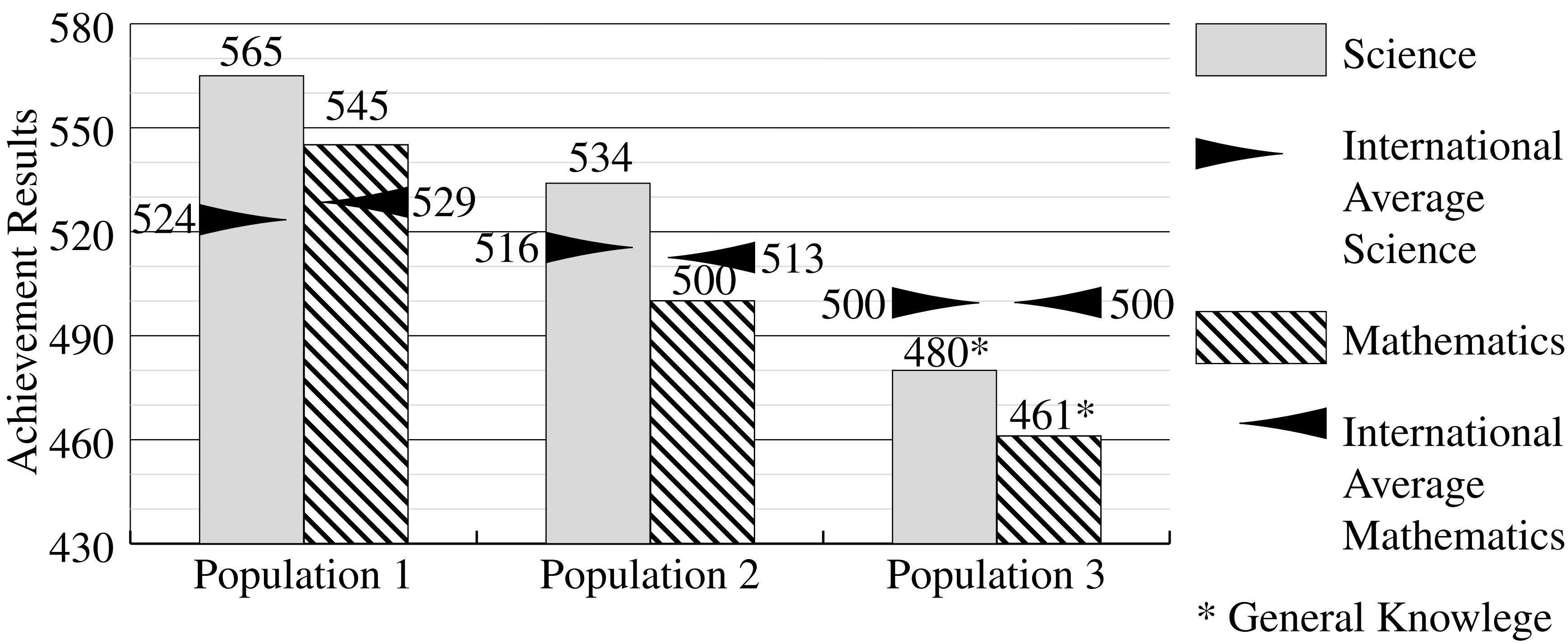
Worse than Average

— None

One of 11 nations with no gender differences

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

Summary: U.S. TIMSS Results



From: *Pursuing Excellence: A Study of Fourth-Grade Mathematics and Science Achievement; Pursuing Excellence: A Study of Eighth-Grade Mathematics and Science Achievement;* and *Pursuing Excellence: A Study of Twelfth-Grade Mathematics and Science Achievement*

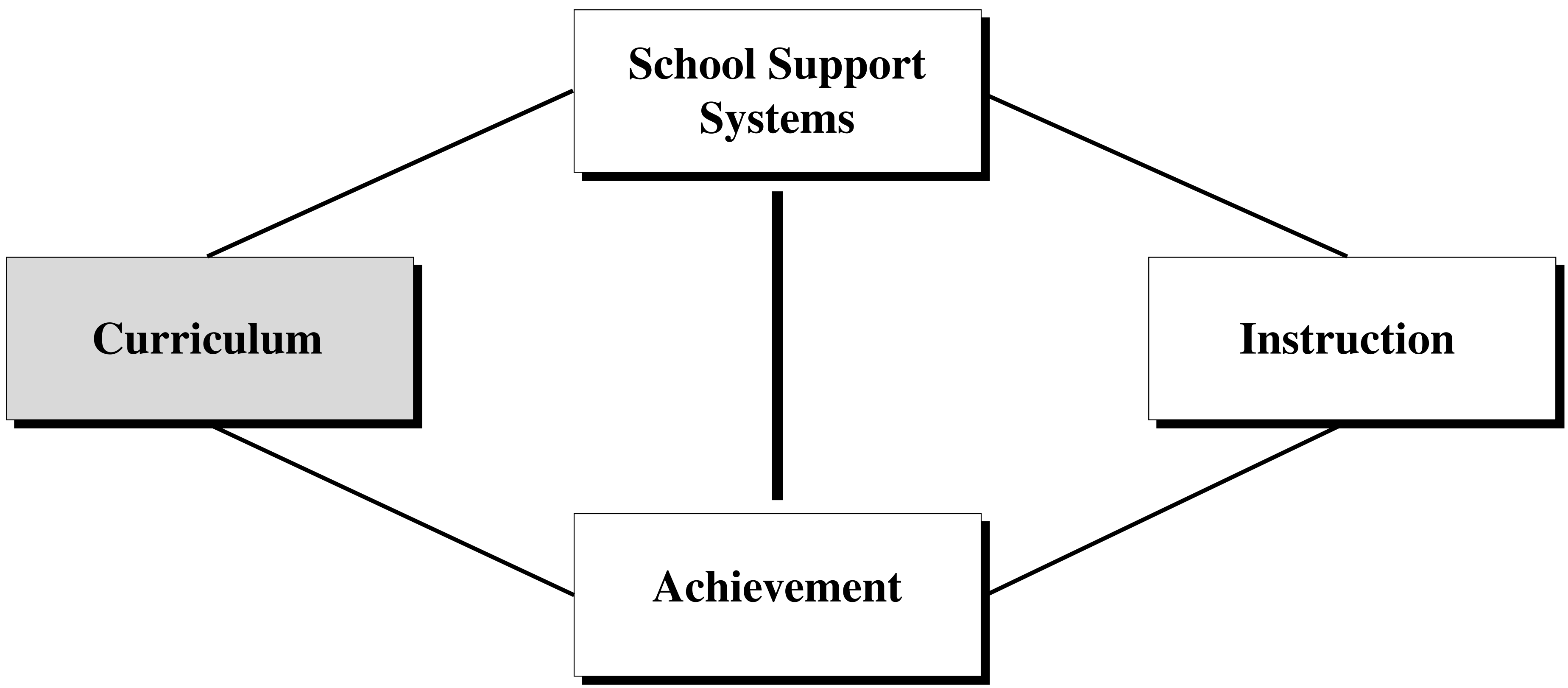
Exploring TIMSS Achievement Data

- What important points seem to be emerging?
- What patterns or trends seem to be emerging?
- What strikes you as surprising or unexpected?
- What questions do these data raise?

Summary: Achievement

- The U.S. starts strong but falls further and further behind as the years of schooling progress.
- By high school, the U.S. is at or near the bottom.
- Top U.S. students in Population 1 are above the international average in science but slightly below in mathematics.
- Top U.S. students in Population 2 are above the international average in science but below in mathematics.

What Does TIMSS Say about Curriculum?



What does TIMSS mean by curriculum?

- Content intended and taught
- Organization of content

Issues Related to Curriculum

- Time, tracking, and expectations:
  - — Time spent studying math/science;
  - — Different exposure to content and skills; and
  - — Expectations for students.

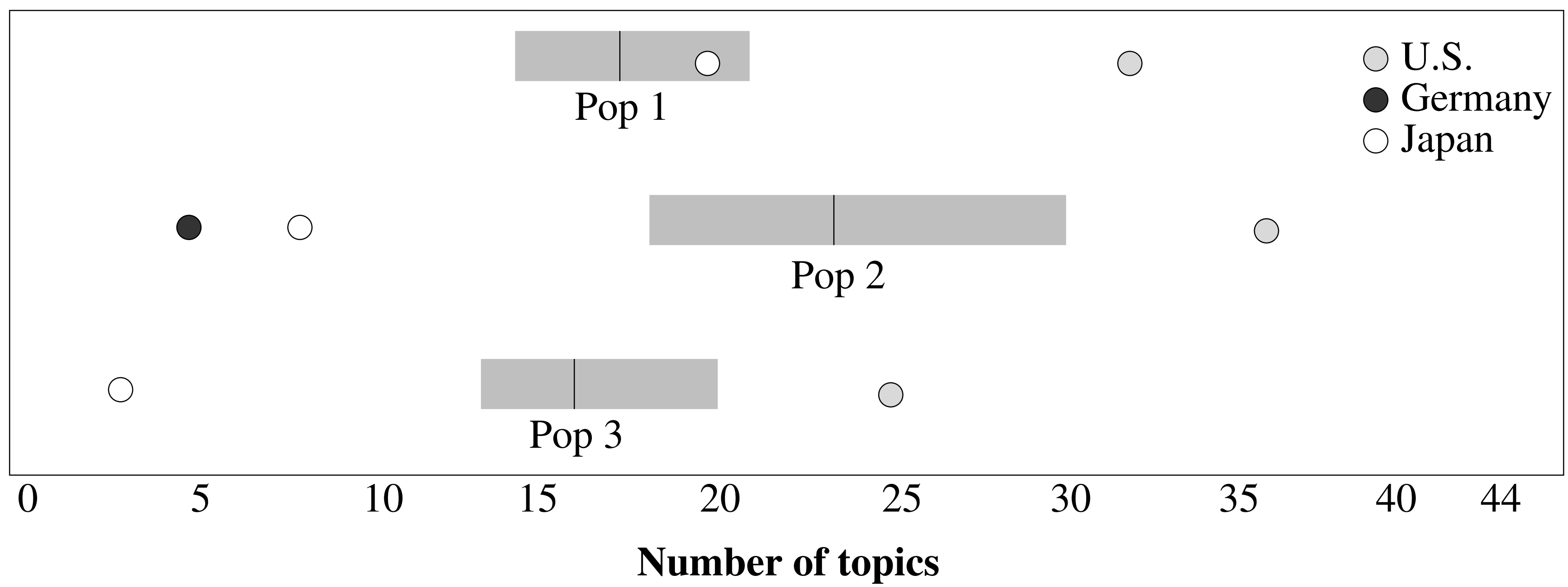
From: *Global Perspectives for Local Action*

Issues Related to Curriculum (continued)

- Structure of curriculum:
  - — Focus—attention given to single content topics, either within a single class session or across class sessions; and
  - — Coherence—“connectedness” of math/science ideas and skills presented to students over time.

From: *Global Perspectives for Local Action*

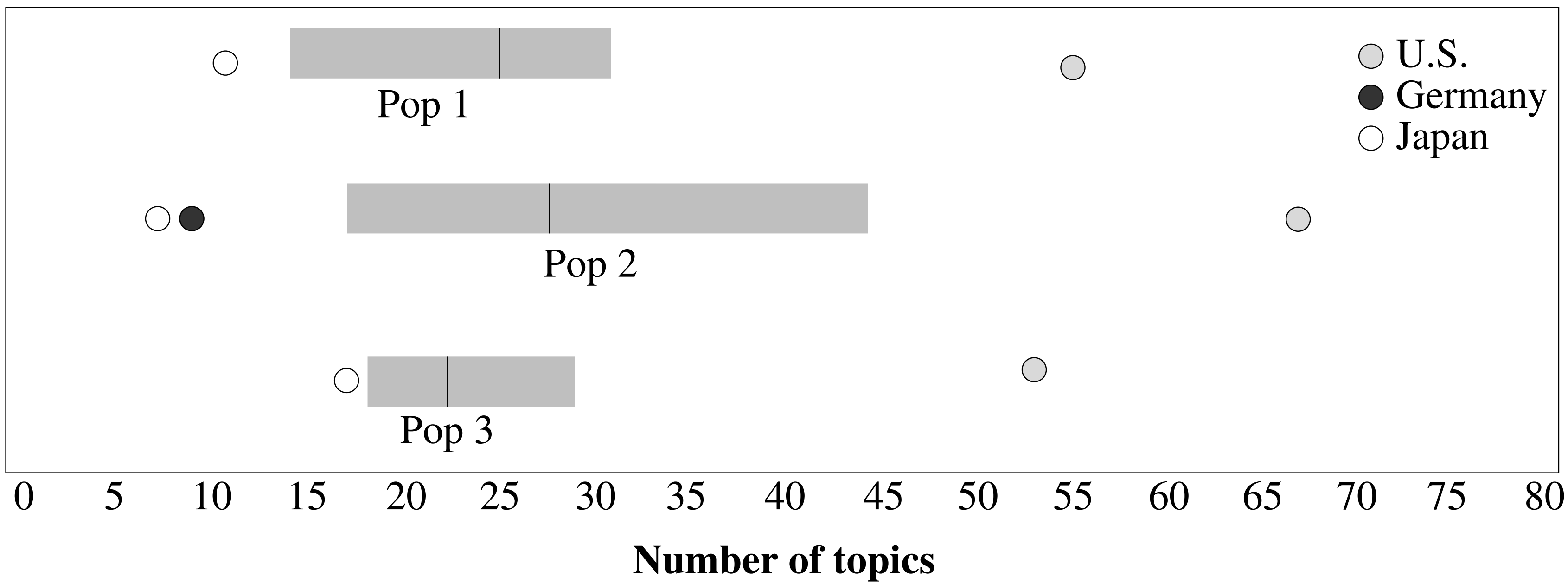
Number of Topics in Mathematics Textbooks



The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

Number of Topics in Science Textbooks



The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

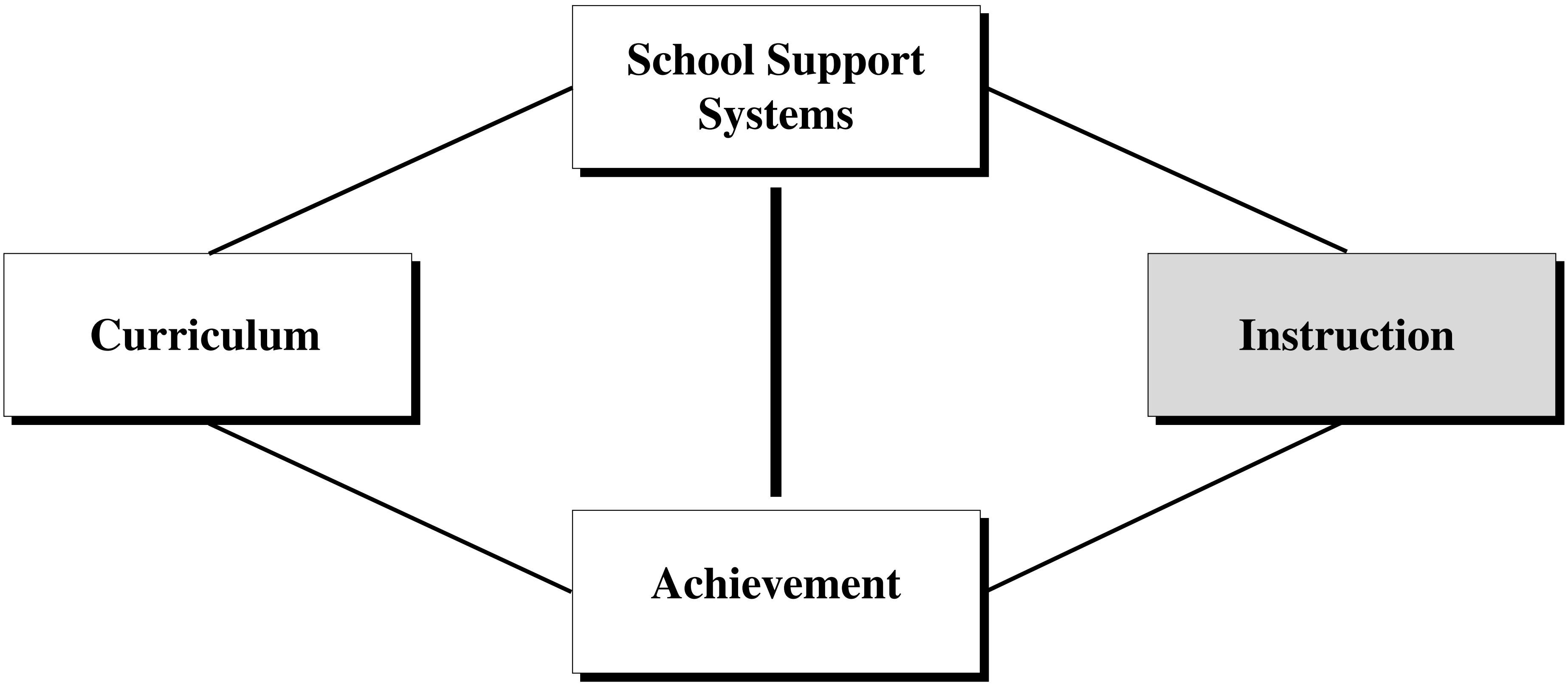
Making Sense of the Curriculum Data

- What meaning do you make of these curriculum data?
- What questions do they raise about U.S. curriculum in schools and in higher education?
- Do you see any connections between the curriculum data and the achievement data?
- What next steps might be taken?

Summary Points

- Curriculum matters.
- U.S. math and science curricula lack focus and coherence.
- U.S. math and science curricula have lower expectations than most high-achieving nations.

What Does TIMSS Say about Instruction?



Overview of Videotape Study

- First of its kind
- Nationally representative sample of Population 2 mathematics classrooms in Germany, Japan, and the U.S.
- Purposes
  - — To describe teaching practices in each nation
  - — To look at teaching with a fresh perspective
  - — To encourage reflection

From: *Global Perspectives for Local Action*

Video Study Analyzed

- Teachers' goals for lessons
- Treatment of concepts and applications
- Presence of alternative solution methods
- How mathematical principles, properties, and definitions were used
- Whether proofs were included
- Whether concepts were connected
- The kinds of tasks assigned

The NRC Report Looks at

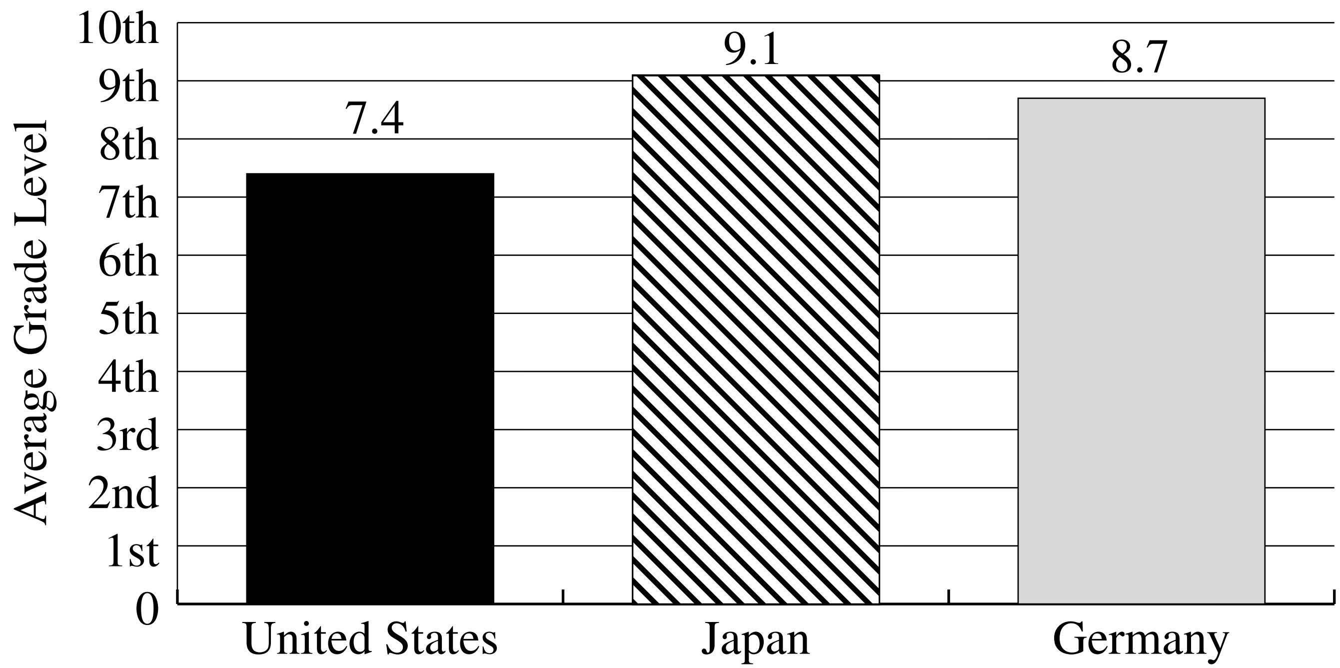
- Structure of lessons
- Objectives
- Beliefs
- Scripts

From: *Global Perspectives for Local Action*

Questions for Video Viewing

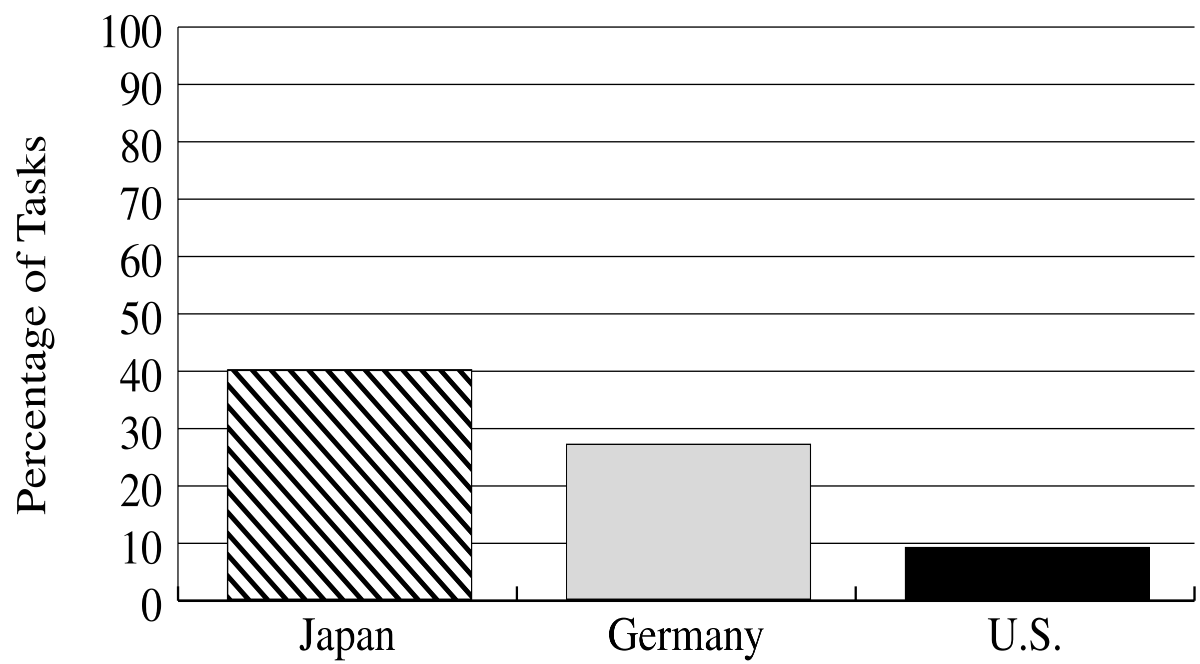
- How does the teacher introduce the concept?
- What is the difference between how the students are engaged in the U.S. classroom and in the Japanese classroom?
- How challenging is the mathematics content supported by the lessons?

Average Grade Level of Content in the Videotaped Lessons by International Standards



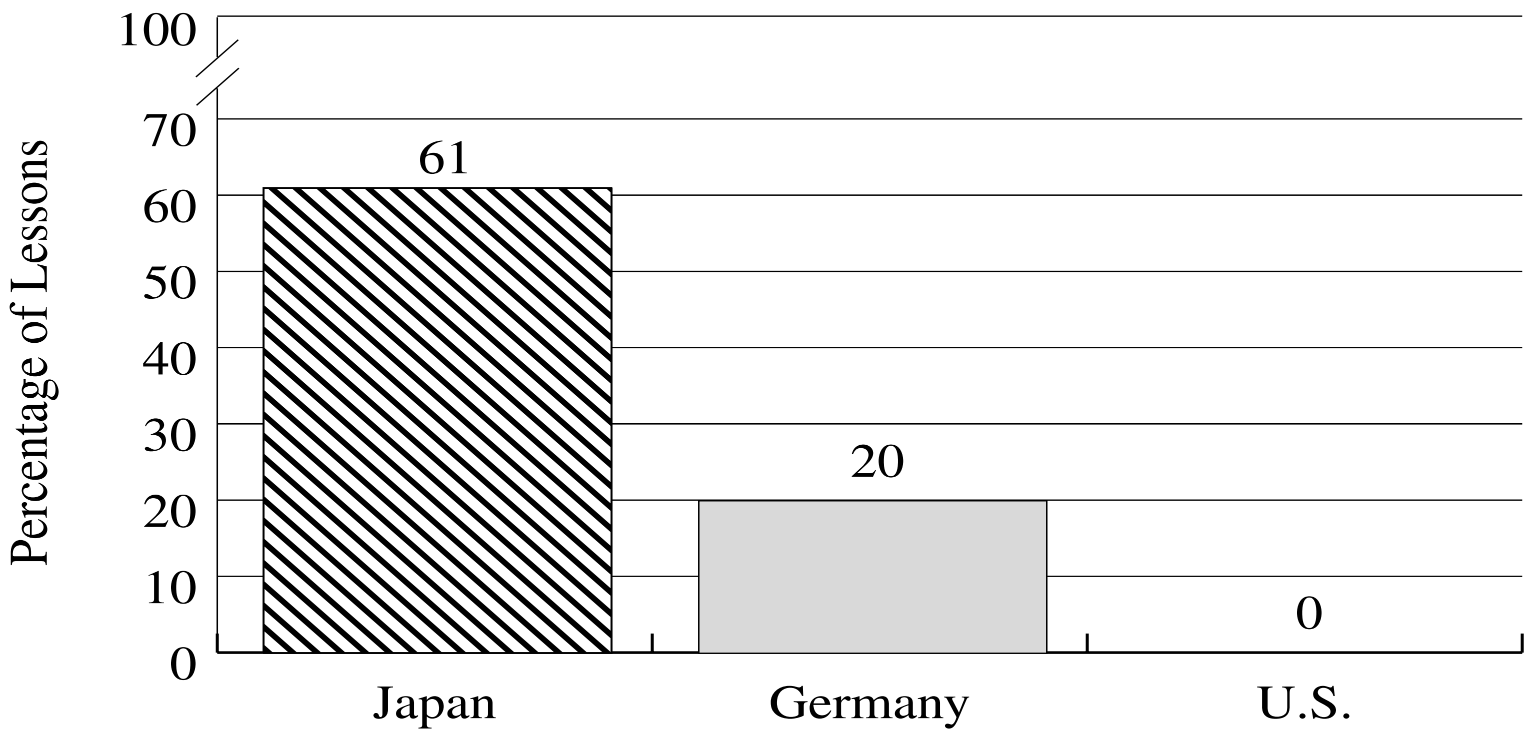
From: *The TIMSS Videotape Classroom Study*

Lesson Structure—Percentages of Math Tasks that Students Decide How to Solve Rather than Using a Teacher-Prescribed Method



From: *The TIMSS Videotape Classroom Study*

Percentages of 8th-Grade Mathematics Lessons with Instances of Mathematical (Deductive) Thinking



From: *The TIMSS Videotape Classroom Study*

Making Connections

- What meaning do you make of these teaching data?
- What questions do they raise about practices in schools and in higher education?
- What next steps might be taken?

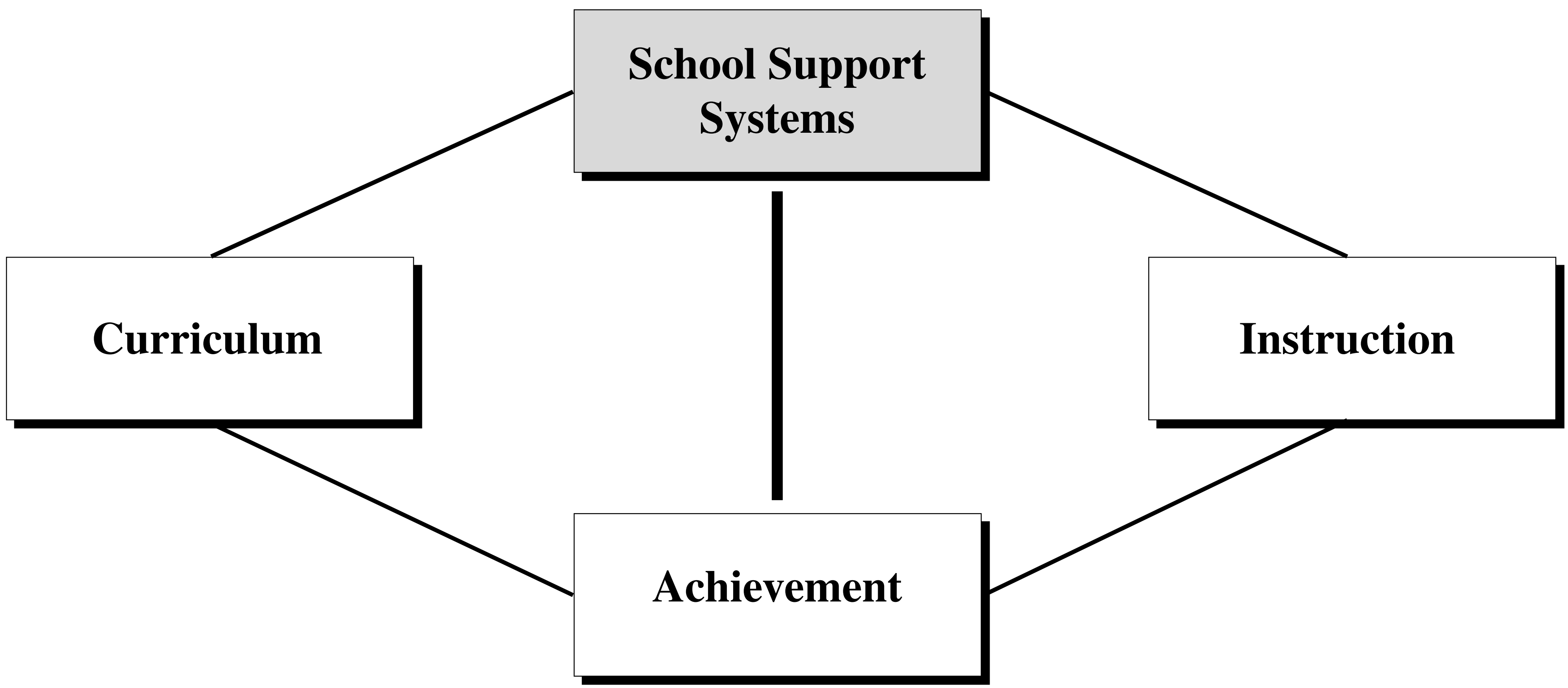
Summary—Structure of Lessons

U.S. Lessons

- Contain lower level content than in Japan or Germany;
- Demand less mathematical reasoning; and
- Emphasize teacher-prescribed methods over student-invented solutions.

From: *Global Perspectives for Local Action*

What Does TIMSS Say about School Support Systems?



The Meaning of School Support Systems

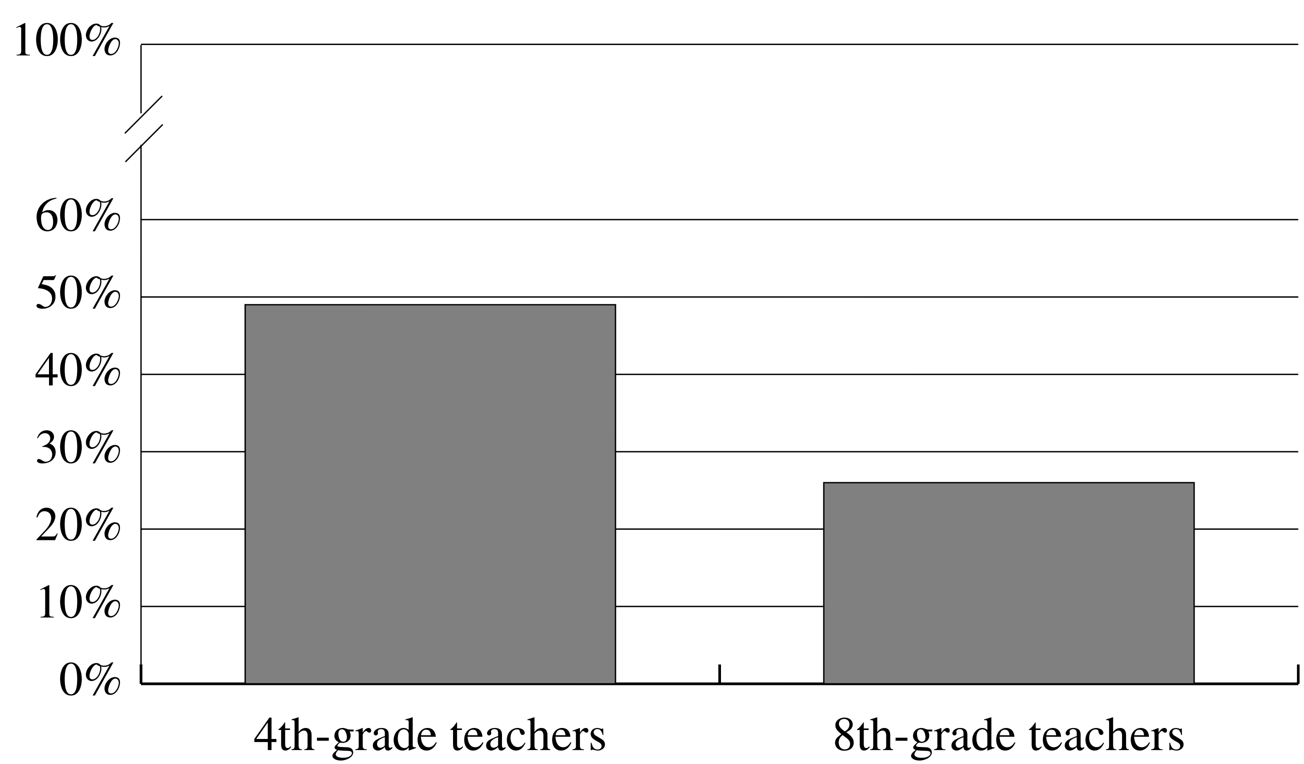
- Preparation and support of teachers
- Attitudes toward the profession of teaching
- Attitudes of teachers, students, and parents toward learning
- Lives of teachers and students in and out of school

The NRC Report Looks at

- Teacher’s time;
- Teacher learning;
- Cultural influences on teaching; and
- Student attitudes.

From: *Global Perspectives for Local Action*

Time to Collaborate: Percent of Science Teachers Who Meet with Other Teachers 1, 2, or 3 Times Per Week



From: *Science Achievement in the Middle School Years* and *Science Achievement in the Primary School Years*

Summary: School Support Systems

- Japanese teachers have more opportunities to discuss teaching.
- Beginning teachers in Japan have a structured induction plan.
- Japanese students watch as much TV as U.S. students but do better in school.
- Attitudes of U.S. students toward math/science are similar to the international average; they are positive and decline from the 4th grade to the 8th grade.

Making Connections: School Support System Findings

- What sense do you make of these findings?
- What questions do they raise about our practices in schools and in higher education?
- What next steps might be taken?

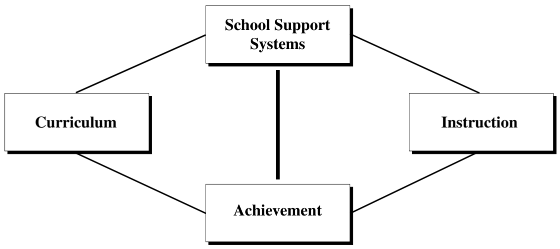
What Are Some Implications for Further Action and Reflection?

"Educational systems tend to overcorrect for what is seen as a problem and end up with a different situation that may be just as unsatisfactory. We seek in this report to help decision-makers balance the pendulum swings so as to make more likely steady progress toward a better education in science and mathematics for all our students and for our nation."

From: *Global Perspectives for Local Action*

Module 1: Framing the Dialogue Handouts

Global Perspectives for Local Action: Framing the Dialogue



1-1

Goals

- To provide an overview of findings of the *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education* report and its implications for different audiences; and
- To highlight the value of using TIMSS as a catalyst for reflection and improvement.

1-2

Agenda

- What Is TIMSS, and What Is the NRC Report?
- What Are the Key Findings of the Report?
- How Do the Different Pieces of TIMSS Interconnect?
- What Are the Implications for Further Reflection and Action?

1-3

Corners Activity

- Move to the corner of your choice.
- Discuss your choice with 2–3 others in your corner.
- Spokespeople from each corner share with whole group.

1-4

What Is TIMSS?

- Third International Mathematics and Science Study
- Largest and most comprehensive study of math/science education ever conducted
- Involved more than 1/2 million students in Population 1 (9-year-olds); Population 2 (13-year-olds); and Population 3 (final year of secondary school)
- Spanned 41 countries

1-5

What Did TIMSS Study?

- Achievement in mathematics and science
- Curriculum practices
- Instructional practices
- Influences on teachers and students inside and outside the classroom

1-6

Why should we care about TIMSS?

- Recognize the importance of math/science education to the economy and quality of life
- Learn about alternative ways of dealing with educational challenges
- Gain insights into teaching and learning internationally
- Reexamine conventional practices
- Consider new possibilities for U.S. education

1-7

Why another report on TIMSS?

The NRC report

- Takes a comprehensive approach;
- Addresses a range of stakeholders;
- Informs rather than prescribes; and
- Raises questions for local investigation and changes.

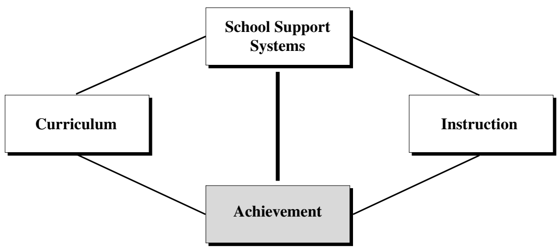
1-8

What's in the NRC Report?

- Summary of the TIMSS findings
- Description of TIMSS
- What TIMSS says about curriculum
- What TIMSS says about instruction
- What TIMSS says about school support systems
- Answers to frequently asked questions

1-9

What Does TIMSS Say about Student Achievement?



1-10

TIMSS Achievement Results Population 1—Science

Significantly Higher than the U.S.		Nations with Average Scores Not Significantly Different than the U.S.		Significantly Lower than the U.S.	
Nations	***Average***	***Nations***	***Average***	***Nations***	***Average***
Korea	597	Japan	574	England	551
		United States	**565**	Canada	549
		Austria	565	Singapore	547
		Australia	562	Slovenia	546
		Netherlands	557	Ireland	539
		Czech Republic	557	Scotland	536
				Hong Kong	533
				Hungary	532
				New Zealand	531
				Norway	530
				Latvia (LSS)	512
				Israel	505
				Iceland	505
				Greece	497
				Portugal	480
				Cyprus	475
				Thailand	473
				Iran, Islamic Republic	416
				Kuwait	401

International Average = 524

From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

1-11

TIMSS Achievement Results Population 1—Mathematics

Significantly Higher than the U.S.		Nations with Average Scores Not Significantly Different than the U.S.		Significantly Lower than the U.S.	
Nations	***Average***	***Nations***	***Average***	***Nations***	***Average***
Singapore	625	Slovenia	552	Latvia (LSS)	525
Korea	611	Ireland	550	Scotland	520
Japan	597	Hungary	548	England	513
Hong Kong	587	Australia	546	Cyprus	502
Netherlands	577	**United States**	**545**	Norway	502
Czech Republic	567	Canada	532	New Zealand	499
Austria	559	Israel	531	Greece	492
				Thailand	490
				Portugal	475
				Iceland	474
				Iran, Islamic Republic	429
				Kuwait	400

International Average = 529

From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

1-12

TIMSS Achievement Results
Population 2—Science

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Singapore	607
Czech Republic	574
Japan	571
Korea	565
Bulgaria	565
Netherlands	560
Slovenia	560
Austria	558
Hungary	554

Not Significantly Different than the U.S.

Nations	*Average*
England	552
Belgium-Flemish	550
Australia	545
Slovak Republic	544
Russian Federation	538
Ireland	538
Sweden	535
United States	**534**
Germany	531
Canada	531
Norway	527
New Zealand	525
Thailand	525
Israel	524
Hong Kong	522
Switzerland	522
Scotland	517

Significantly Lower than the U.S.

Nations	*Average*
Spain	517
France	498
Greece	497
Iceland	494
Romania	486
Latvia (LSS)	485
Portugal	480
Denmark	478
Lithuania	476
Belgium-French	471
Iran, Islamic Republic	470
Cyprus	463
Kuwait	430
Colombia	411
South Africa	326

International Average = 516

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

1-13

TIMSS Achievement Results
Population 2—Mathematics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Singapore	643
Korea	607
Japan	605
Hong Kong	588
Belgium-Flemish	565
Czech Republic	564
Slovak Republic	547
Switzerland	545
Netherlands	541
Slovenia	541
Bulgaria	540
Austria	539
France	538
Hungary	537
Russian Federation	535
Australia	530
Ireland	527
Canada	527
Belgium-French	526
Sweden	519

Not Significantly Different than the U.S.

Nations	*Average*
Thailand	522
Israel	522
Germany	509
New Zealand	508
England	506
Norway	503
Denmark	502
United States	**500**
Scotland	498
Latvia (LSS)	493
Spain	487
Iceland	487
Greece	484
Romania	482

Significantly Lower than the U.S.

Nations	*Average*
Lithuania	477
Cyprus	474
Portugal	454
Iran, Islamic Republic	428
Kuwait	392
Colombia	385
South Africa	354

International Average = 513

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

1-14

TIMSS Achievement Results
Population 3—Science: General Knowledge

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Sweden	559
Netherlands	558
Iceland	549
Norway	544
Canada	532
New Zealand	529
Australia	527
Switzerland	523
Austria	520
Slovenia	517
Denmark	509

Not Significantly Different than the U.S.

Nations	*Average*
Germany	497
France	487
Czech Republic	487
Russian Federation	481
United States	**480**
Italy	475
Hungary	471
Lithuania	461

Significantly Lower than the U.S.

Nations	*Average*
Cyprus	448
South Africa	349

International Average = 500

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

1-15

TIMSS Achievement Results
Population 3—Mathematics: General Knowledge

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Netherlands	560
Sweden	552
Denmark	547
Switzerland	540
Iceland	534
Norway	528
France	523
New Zealand	522
Australia	522
Canada	519
Austria	518
Slovenia	512
Germany	495
Hungary	483

Not Significantly Different than the U.S.

Nations	*Average*
Italy	476
Russian Federation	471
Lithuania	469
Czech Republic	466
United States	**461**

Significantly Lower than the U.S.

Nations	*Average*
Cyprus	446
South Africa	356

International Average = 500

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

1-16

TIMSS Achievement Results
Population 3—Advanced Mathematics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
France	557
Russian Federation	542
Switzerland	533
Australia	525
Denmark	522
Cyprus	518
Lithuania	516
Greece	513
Sweden	512
Canada	509
Slovenia	475

Not Significantly Different than the U.S.

Nations	*Average*
Italy	474
Czech Republic	469
Germany	465
United States	**442**
Austria	436

Significantly Lower than the U.S.

Nations	*Average*
None	

International Average = 501

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

1-17

TIMSS Achievement Results
Population 3—Physics

Nations with Average Scores

Significantly Higher than the U.S.

Nations	*Average*
Norway	581
Sweden	573
Russian Federation	545
Denmark	534
Slovenia	523
Germany	522
Australia	518
Cyprus	494
Latvia	488
Switzerland	488
Greece	486
Canada	485
France	466
Czech Republic	451

Not Significantly Different than the U.S.

Nations	*Average*
Austria	435
United States	**423**

Significantly Lower than the U.S.

Nations	*Average*
None	

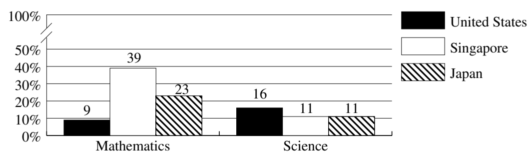
International Average = 501

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

1-18

How Do Our Best Fourth-Graders Stack Up?

Percentage of Fourth-Graders (Population 1) in the World's Top 10%

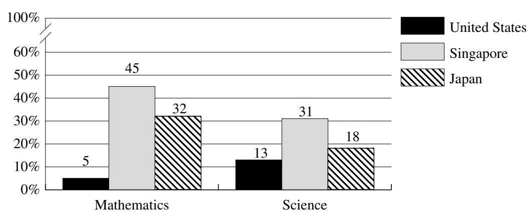


From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

1-19

How Do Our Best Eighth-Graders Stack Up?

Percentage of Eighth-Graders (Population 2) in the World's Top 10%



From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

1-20

Performance of U.S. 8th-Graders in Mathematics Compared to the International Average

About Average

— Algebra

— Data Representation, Analysis, and Probability

— Fractions and Number Sense

Worse than Average

— Geometry

— Measurement

— Proportionality

One of 33 nations with no gender differences

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

1-21

Performance of U.S. 8th-Graders in Science Compared to the International Average

Better than Average

— Environmental Issues and the Nature of Science

— Life Science

— Earth Science

Worse than Average

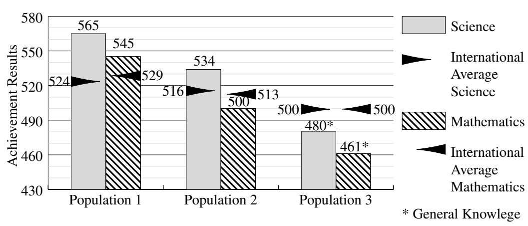
— None

One of 11 nations with no gender differences

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

1-22

Summary: U.S. TIMSS Results



From: *Pursuing Excellence: A Study of Fourth-Grade Mathematics and Science Achievement*; *Pursuing Excellence: A Study of Eighth-Grade Mathematics and Science Achievement*; and *Pursuing Excellence: A Study of Twelfth-Grade Mathematics and Science Achievement*

1-23

Exploring TIMSS Achievement Data

- What important points seem to be emerging?
- What patterns or trends seem to be emerging?
- What strikes you as surprising or unexpected?
- What questions do these data raise?

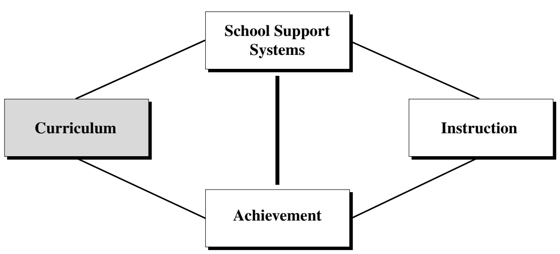
1-24

Summary: Achievement

- The U.S. starts strong but falls further and further behind as the years of schooling progress.
- By high school, the U.S. is at or near the bottom.
- Top U.S. students in Population 1 are above the international average in science but slightly below in mathematics.
- Top U.S. students in Population 2 are above the international average in science but below in mathematics.

1-25

What Does TIMSS Say about Curriculum?



1-26

What does TIMSS mean by curriculum?

- Content intended and taught
- Organization of content

1-27

Issues Related to Curriculum

- Time, tracking, and expectations:
  - — Time spent studying math/science;
  - — Different exposure to content and skills; and
  - — Expectations for students.

From: *Global Perspectives for Local Action*

1-28

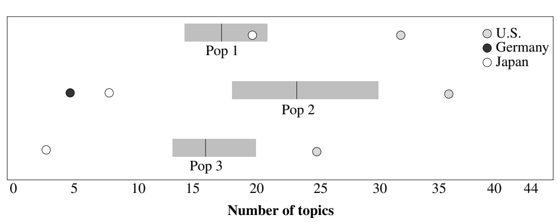
Issues Related to Curriculum (continued)

- Structure of curriculum:
  - — Focus—attention given to single content topics, either within a single class session or across class sessions; and
  - — Coherence—"connectedness" of math/science ideas and skills presented to students over time.

From: *Global Perspectives for Local Action*

1-29

Number of Topics in Mathematics Textbooks

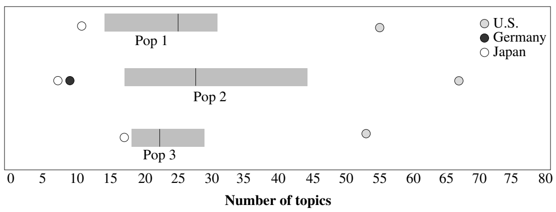


The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

1-30

Number of Topics in Science Textbooks



The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

1-31

Making Sense of the Curriculum Data

- What meaning do you make of these curriculum data?
- What questions do they raise about U.S. curriculum in schools and in higher education?
- Do you see any connections between the curriculum data and the achievement data?
- What next steps might be taken?

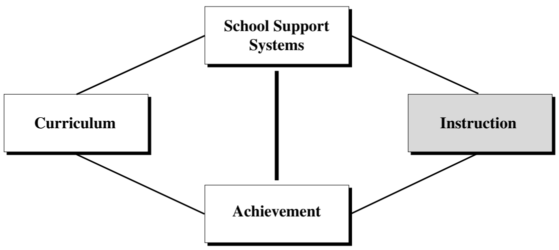
1-32

Summary Points

- Curriculum matters.
- U.S. math and science curricula lack focus and coherence.
- U.S. math and science curricula have lower expectations than most high-achieving nations.

1-33

What Does TIMSS Say about Instruction?



1-34

Overview of Videotape Study

- First of its kind
- Nationally representative sample of Population 2 mathematics classrooms in Germany, Japan, and the U.S.
- Purposes
  - — To describe teaching practices in each nation
  - — To look at teaching with a fresh perspective
  - — To encourage reflection

From: *Global Perspectives for Local Action*

1-35

Video Study Analyzed

- Teachers' goals for lessons
- Treatment of concepts and applications
- Presence of alternative solution methods
- How mathematical principles, properties, and definitions were used
- Whether proofs were included
- Whether concepts were connected
- The kinds of tasks assigned

1-36

The NRC Report Looks at

- Structure of lessons
- Objectives
- Beliefs
- Scripts

From: *Global Perspectives for Local Action*

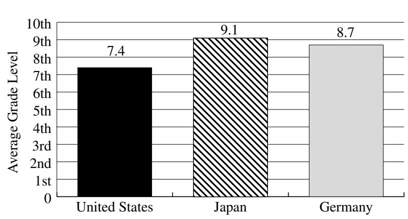
1-37

Questions for Video Viewing

- How does the teacher introduce the concept?
- What is the difference between how the students are engaged in the U.S. classroom and in the Japanese classroom?
- How challenging is the mathematics content supported by the lessons?

1-38

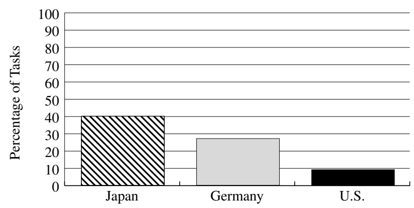
Average Grade Level of Content in the Videotaped Lessons by International Standards



From: *The TIMSS Videotape Classroom Study*

1-39

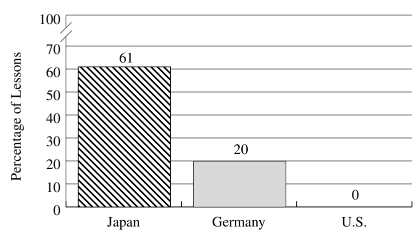
Lesson Structure—Percentages of Math Tasks that Students Decide How to Solve Rather than Using a Teacher-Prescribed Method



From: *The TIMSS Videotape Classroom Study*

1-40

Percentages of 8th-Grade Mathematics Lessons with Instances of Mathematical (Deductive) Thinking



From: *The TIMSS Videotape Classroom Study*

1-41

Making Connections

- What meaning do you make of these teaching data?
- What questions do they raise about practices in schools and in higher education?
- What next steps might be taken?

1-42

Summary—Structure of Lessons

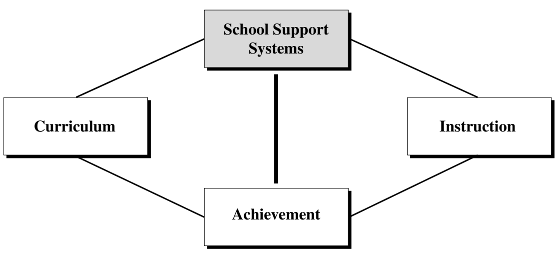
U.S. Lessons

- Contain lower level content than in Japan or Germany;
- Demand less mathematical reasoning; and
- Emphasize teacher-prescribed methods over student-invented solutions.

From: *Global Perspectives for Local Action*

1-43

What Does TIMSS Say about School Support Systems?



1-44

The Meaning of School Support Systems

- Preparation and support of teachers
- Attitudes toward the profession of teaching
- Attitudes of teachers, students, and parents toward learning
- Lives of teachers and students in and out of school

1-45

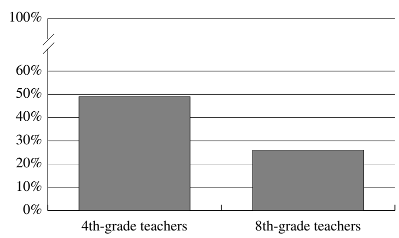
The NRC Report Looks at

- Teacher's time;
- Teacher learning;
- Cultural influences on teaching; and
- Student attitudes.

From: *Global Perspectives for Local Action*

1-46

Time to Collaborate: Percent of Science Teachers Who Meet with Other Teachers 1, 2, or 3 Times Per Week



From: *Science Achievement in the Middle School Years* and *Science Achievement in the Primary School Years*

1-47

Summary: School Support Systems

- Japanese teachers have more opportunities to discuss teaching.
- Beginning teachers in Japan have a structured induction plan.
- Japanese students watch as much TV as U.S. students but do better in school.
- Attitudes of U.S. students toward math/science are similar to the international average; they are positive and decline from the 4th grade to the 8th grade.

1-48

Making Connections: School Support System Findings

- What sense do you make of these findings?
- What questions do they raise about our practices in schools and in higher education?
- What next steps might be taken?

1-49

What Are Some Implications for Further Action and Reflection?

1-50

"Educational systems tend to overcorrect for what is seen as a problem and end up with a different situation that may be just as unsatisfactory. We seek in this report to help decision-makers balance the pendulum swings so as to make more likely steady progress toward a better education in science and mathematics for all our students and for our nation."

From: *Global Perspectives for Local Action*

1-51

ACTIONS TO IMPROVE MATHEMATICS AND SCIENCE EDUCATION

Actions that Teachers Can Take

Get to know the results from TIMSS.

Be cautious about jumping to conclusions about one aspect of the TIMSS findings—keep in mind the connections of curriculum, instruction, and school culture to overall student achievement.

Examine equity issues in your classroom.

Working with an existing school planning or improvement group, gather data to identify areas for improvement in mathematics and science learning, curriculum, instruction, and culture in your own school. Here are some possibilities for improvement:

- *Focus the curriculum by prioritizing curriculum topics and eliminating the low priorities.*
- *Develop a curriculum framework based on the NCTM* Standards *and the* National Science Education Standards *that identifies where and how fundamental concepts and ideas are developed K–12.*
- *Adopt new professional development strategies, such as teacher-led study groups for examining lessons.*
- *Conduct textbook review and curriculum selection with TIMSS findings in mind.*
- *Mentor new teachers.*
- *Engage groups of teachers in micro-teaching lessons on the same topic.*
- *Watch and discuss the TIMSS teacher videos with colleagues, then discuss and consider the different teaching alternatives shown.*
- *Use data to examine, analyze, and improve instruction.*

ACTIONS TO IMPROVE MATHEMATICS AND SCIENCE EDUCATION

Actions that Administrators Can Take

Learn what TIMSS found about mathematics and science instruction, curriculum, and school culture.

Watch and discuss the TIMSS teaching videos with other administrators and with teachers.

Work with existing school or district planning, accreditation, or improvement groups to investigate your own practices related to the TIMSS findings:

- *How do your own students' performances compare with the U.S. findings?*
- *Explore your curriculum—how focused and coherent is it?*
- *Examine the instruction—how challenging is it?*
- *Consider your school culture—how collegial is it?*

Encourage/organize ongoing professional development in math/science.

Support teachers to make improvements in learning by providing time for learning and collegial exchanges.

Create a mentor program for beginning teachers in your school. Protect all teachers' time so they have time to learn and reflect on practice.

ACTIONS TO IMPROVE MATHEMATICS AND SCIENCE EDUCATION

Actions that Higher Education Faculty Can Take

Develop a curriculum framework based on the NCTM Standards *and the* National Science Education Standards *that identifies where and how fundamental concepts and ideas are developed K–12 and apply this framework within and across undergraduate mathematics and science programs and the teacher education program to increase focus and coherence. Examine whether the curriculum framework shows evidence of tracking or grouping of kinds of knowledge and explore the implications for prospective teachers.*

Map out what kinds of mathematics and science content all teacher education students learn with your program. Explore the focus of this curriculum, its coherence, and the ways in which coherence exists between this disciplinary content and content related to instruction, such as methods, curriculum, and so on.

Help teacher education students learn the value of developing curriculum frameworks and topic tracing and engage them in doing this type of activity in the schools where they are observing or interning.

Examine the methods teaching faculty are using and explore alternatives.

Share the TIMSS findings with schools in your area and in the clinical settings through which you prepare pre-service teachers and work with in-service educators.

Examine the ways and places in which your teacher education students learn about curricular tracking. Share TIMSS findings with students and brainstorm ways in which they could engage in similar activities.

Organize a series of faculty seminars/discussions to view TIMSS videotapes as an opportunity to begin a serious discussion about visions of teaching. Use this as an opportunity to reflect on your program's shared visions of goals for teaching lessons, how content gets represented, and desired scripts for lessons. Consider undertaking a video study of instruction in schools in which you are engaged (as sites for student teaching or collaborative research) that could extend these discussions.

Organize a seminar involving those most directly engaged in supporting field-based teacher education: university supervisors, collaborating teachers, and others. Together, explore the report's discussions of preparation and support of teachers (and examine parts of the TIMSS case studies) to launch a discussion about assumptions undergirding your program about how beginning teachers learn best. Through discussion of TIMSS findings, examine how your program enacts its own "cultural" beliefs about teacher autonomy, the meaning of professional development, stages of teacher learning, and so on. Reflect on implications of this for who participates in supporting beginning teacher learning, the division of labor within that support community (of university and school people), and the allocation of time given teacher education students for learning in the field. Include the TIMSS findings in courses to help pre-service and in-service teachers explore the implications for their current or future instruction and curriculum planning.

Actions that the Interested Public (Parents and Business and Community Leaders) Can Take

Be cautious of simplistic solutions to complex problems, such as student learning, when considering potentially useful suggestions, such as using computers and/or calculators and lengthening the school day.

Promote the use of data-driven decision making and become aware of what data might be locally useful and how it can be gathered and used. Ask questions such as, How do we know that? What is the data? Could there be another contributor to the problem that hasn't been considered?

Support improvements in your local schools by efforts such as volunteering to find resources, bringing business or workforce perspectives into the schools, appreciating that time for professional development is needed, and remaining open to new ways of teaching and learning.

Make teachers and educational administrators in your community aware of the TIMSS findings.

Encourage existing planning and school improvement groups in your community to investigate the extent to which your schools' actions reflect the TIMSS findings.

Fund and/or support the development and implementation of standards-based mathematics and science programs.

ACTIONS TO IMPROVE MATHEMATICS AND SCIENCE EDUCATION

Actions that State Education Department Staff Can Take

Use textbook adoption processes to analyze curriculum based on TIMSS and to make improvements in state-approved materials.

Review state curriculum frameworks for focus and coherence. Make adjustments to deepen the focus on key topics.

Support local educators in developing curriculum frameworks based on the NCTM Standards and the National Science Education Standards that identify where and how fundamental concepts and ideas are developed K–12. Do this providing resources and training in framework development.

Review policies on professional development to ensure that state funds that are provided to local sites can be used to support teacher time to collaborate, rather than just to support their participation in expert-led workshops.

Provide summaries of the TIMSS data to all schools in your state.

Create a lending library of TIMSS videos and other, related resources.

Groups of Students Studied in TIMSS

	Ages	Grade Levels in the U.S.
Population 1	9-year-olds	Grades 3 and 4
Population 2	13-year-olds	Grades 7 and 8
Population 3	Final year of secondary school	Grade 12

Module 1 Handout

Module 2:
Exploring Curriculum, Instruction, and School Support Systems

OVERVIEW

The goal of Module 2 is to take participants who have gone though Module 1 deeper into one, two, or all three of the major topics in the NRC's *Global Perspectives for Local Action* report: curriculum, instruction, and school support systems. The module consists of three sessions ranging from 1 hour and 45 minutes to 2 hours and 30 minutes each. These sessions may be combined for one 6-hour and 15-minute day session (as reflected in the sample on the following page) or they may be conducted individually. It is recommended that the sessions be presented in the 2A, 2B, 2C sequence. Within each session, participants will learn more about the key findings of TIMSS and explore implications for their own work. The primary audiences for Module 2 are school and district administrators and teachers and higher education administrators and faculty.

Sample Schedule of Module 2: Full-day Session with 2A, 2B, and 2C

Time	*Activities*	
8:30	2A.1, 2B.1, and 2C.1	Welcome, overview, purpose, and agenda (5 minutes)
8:35	2A.2	Making meaning from TIMSS data on curriculum (45 minutes)
9:20	2A.3	Implications and questions raised by the data (20 minutes)
9:40	2A.4	Curriculum focus and coherence lecture (brief) with discussion (20 minutes)
10:00	2A.5	Issues for further reflection and dialogue (30 minutes)
10:30	Break	
10:45	2B.2	Brief overview of videotape study (5 minutes)
10:50	2B.3	Set up for video viewing (10 minutes)
11:00	2B.4	Video viewing and discussion (60 minutes)
12:00	Lunch	
12:45	2B.5	Key findings (20–30 minutes)
1:15	2B.6	Issues for further reflection and dialogue (40 minutes)
1:55	2C.2	What do we mean by school support systems? (20 minutes)
2:15	2C.3	Collegiality and professional development of teachers (20 minutes)
2:35	2C.4	"The Secret of Trapezes" video (30 minutes)
3:05	2C.5	Issues for further reflection and dialogue (30 minutes)
3:35		Wrap up/evaluation (10 minutes)

Module 2A:
What Does TIMSS Say about Curriculum?

GOALS

- To explore what TIMSS found in its study of U.S. mathematics and science curricula as compared with curricula from other countries;
- To understand what makes curriculum focused and coherent;
- To explore factors that contribute to the lack of focus in U.S. classrooms and the lack of connections between curriculum, instruction, and school supports; and
- To identify issues for further reflection and dialogue and possible action to improve the mathematics and science curricula in participants' own schools, districts, and/or higher education institutions.

ACTIVITIES

2A.1 Overview of Goals and Agenda (5 minutes)
2A.2 Making Meaning from TIMSS Data on Curriculum (45 minutes)
2A.3 Implications and Questions Raised by the Data (20 minutes)
2A.4 Curriculum Focus and Coherence: Brief Lecture with Discussion (20 minutes)
2A.5 Issues for Further Reflection and Dialogue (30 minutes)

Time: 2 hours

SET UP AND MATERIALS

Room Arrangement and Equipment

- Tables for groups of four
- Overhead projector and screen
- Newsprint and markers

- Paper for note-taking and pens/pencil, plus newsprint or transparencies and markers for recorders/reporters (For Activity 2A.5 you will need markers in seven different colors.)

Order in Advance

- Copies of the *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education* report for each participant (The report is available from the National Academy Press, 2101 Constitution Ave., NW, Lockbox 285, Washington, D.C. 20055; Phone: (800) 624-6242 [toll free] or (202) 334-3313 [in the Washington Metropolitan area].)

Make in Advance

- Overhead transparencies from masters for Module 2A in this guide (Note that the masters are labeled Slides 2A-1 through 2A-35.) (Also needed are transparencies from the masters of Slides 1-11 through 1-18 from Module 1.)[7]
- Seven stations around the room with one newsprint sheet at each labeled as follows: 1) teachers, 2) administrators, 3) higher education faculty, 4) textbook and curriculum publishers, 5) state and local policy makers, 6) designers of student assessments, and 7) parents (Provide two differently colored markers at each station.)
- For each table of four, four different packets with five pieces of TIMSS data in each packet (using Slides 2A-8 through 2A-11; 2A-13 through 2A-20; and Slides 1-11 through 1-18 from Module 1) (In each packet, use one slide from slides labeled 2A-8 through 2A-11 plus two slides from 2A-13 through 2A-20 plus two slides from 1-11 through 1-18.)
- Copies of handouts for this module (see pgs. 227–238) (one set per participant) (Also copy the Module 1 handout on TIMSS Populations 1, 2, and 3 from pg. 144 if needed.)

FACILITATOR NOTES

2A.1
Overview of Goals and Agenda
(5 minutes)

- Welcome participants and provide them with copies of the handouts for this module. Then use Slides 2A-1 and 2A-2 to review the session's goals and agenda. (If people do not know one another have them introduce themselves at their individual tables.)

[7] The source of data cited on masters is noted on the bottom of each master by title. For complete citations, see the "Resources" section of this guide.

2A.2
Making Meaning from TIMSS Data on Curriculum
(45 minutes)

- Let participants know that this session is designed around a report prepared by the National Research Council (NRC) on the findings of the Third International Mathematics and Science Study (TIMSS). Tell them this portion of the session focuses on Chapter 3 of the report—"What Does TIMSS Say about the Mathematics and Science Curriculum?" (Show Slide 2A-3.)

  The chapter draws on data from the analysis of 491 curriculum guides and 628 textbooks from around the world collected as part of TIMSS. It also presents detailed information on teachers' curriculum practices in the U.S., Japan, and Germany from video and case studies and surveys.

  The study documented the state of U.S. mathematics and science curricula, textbooks, and teaching practices in a cross-national context. TIMSS researchers concluded that the lack of a single coherent vision of how to educate children in the U.S. today produces unfocused curricula and textbooks that influence teachers to implement diffuse learning goals (Schmidt, McKnight, and Raizen, 1997d).

  Using Slide 2A-4, tell participants that the NRC report's section on curriculum looks at the content that is intended to be taught and the organization of that content.
- Showing Slide 2A-5, say that TIMSS provides insights into major issues surrounding curriculum, such as "Time and Tracking." TIMSS provides data on the amount of time that U.S. students spend studying mathematics and science and on expectations for courses and programs of study. (See background in Chapter 3 of the NRC report.)
- TIMSS also provides data on the "Structure of the Curriculum" along two dimensions—focus and coherence (show Slide 2A-6). Focus means the attention given to single topics either within single class sessions or across class sessions. (See background in Chapter 3.) Coherence means the connectedness of the mathematics and science ideas and skills presented to students within a lesson and over an extended period of time within the curriculum. (See background in Chapter 3.) Tell participants they will explore these and other issues about U.S. mathematics and science curricula.
- Ask participants to jot down their predictions of the differences between U.S. curriculum and curriculum from other countries (Slide 2A-7). Ask them to report their predictions at their tables and ask for two to three of these to be shared with the whole group. As participants are doing this, place four different packets of TIMSS information on achievement and curriculum at each table of four participants. Each packet should include two sheets (copies of slides) from the "TIMSS Achievement Results," which are displayed in Module 1 of this guide—Slides 1-11 through 1-18—and three different data displays from the slides for this module (2A), numbers 2A-8 through

2A-11 and 2A-13 through 2A-20. Most groups will need some help interpreting Slides 2A-14 through 2A-17. Point out that the TIMSS researchers picked the five longest topics in the textbooks and determined what percentage of the total book they represented. It is one measure of the degree to which a book treats a few topics in depth.

- Tell participants that they will be spending some time making sense of TIMSS data. They now each have a packet with several pieces of data. They should examine their data, noting any patterns, what interests or surprises them, and their preliminary conclusions. As each participant finishes with one set of data, he or she should switch packets with the next person. Each person should review all four packets at the table if time allows.

2A.3
Implications and Questions Raised by the Data
(20 minutes)

- Give participants a chance to examine the data, allowing enough time so that everyone has examined at least two of the packets of TIMSS information. Then have each group discuss what the data suggest to them and any insights gained from looking at the curriculum data. Ask them to note questions that the data raised for them. Ask each group to have a recorder make a list of their findings and questions.
- Have the groups report out their findings. List questions on a blank transparency or on newsprint. Ask groups what was surprising and how their findings relate to their predictions. (As the groups report out, show the slides of the data.)

2A.4
Curriculum Focus and Coherence: Brief Lecture with Discussion
(20 minutes)

- Picking up on the conclusions the groups came to from their analysis, go back to the two primary curriculum areas of the report that you pointed out earlier (Sides 2A-5 and 2A-6). Beginning with *time and tracking,* briefly summarize findings the group came up with and add points that were not raised, using Slides 2A-12, 2A-17, and 2A-19. (Refer to Chapter 3 of the report for background information.)

  Points to bring out in summary, using Slide 2A-21:
  - Time to teach mathematics and science is not the problem.
  - The U.S. tracks students through ability grouping starting in elementary school.
  - Because of the different patterns for tracking students in both high- and low-performing countries, it is not possible to make a connection between tracking and performance.

Stop after each topic and have participants discuss in table groups how these findings compare with their findings.

- Ask participants to reflect on practices related to *time and tracking* (Slide 2A-22).
  - — How much time do students spend on mathematics and science in your schools?
  - — Are there different expectations for mathematics and science learning for different groups of students? If so, are they justified? What are they based on? How early in a student's study of mathematics and science do these expectations appear?
  - — How does your school measure the extent to which students are meeting expectations for mathematics and science learning? How can expectations be increased? What is the anticipated outcome of increased expectations?
- Ask participants to think about the implications for action on *time and tracking* (Slide 2A-23). Some examples are
  - — Document and compare the expectations that teachers, students, and parents have for the learning of mathematics and science.
  - — Measure differences in opportunity to learn (time and participation in elective courses) in your schools and district.
- Then turn to *focus and coherence*. Using Slides 2A-24 and 2A-25, remind participants what is meant by *focus.* Summarize key findings about focus using Slide 2A-26.

  Points to bring out about focus:
  - — The curriculum to which students are exposed is considered to be one important factor associated with what students learn.

  Data: U.S. 8th grade students performed well in environmental and life sciences, subjects emphasized in the middle-school curriculum. (Caution participants that they must be careful not to jump to quick answers or fixes since the design of the TIMSS research does not allow us to reach unambiguous conclusions about the cause-and-effect relationships between different parts of the data, such as the achievement data and the curriculum data. Nevertheless, several of the U.S. TIMSS researchers [Schmidt et al.] have reached their own conclusions about the connection between the number of topics in the curriculum and student achievement. [In Module 3 individual schools and systems will have the opportunity to investigate this issue in their own context.].)
  - — Other countries teach fewer content areas in any given year than does the U.S. U.S. textbooks cover more mathematics and science topic areas than textbooks in other nations. The typical U.S. 8^{th-} grade mathematics textbook covers 35 topics, while the typical Japanese eighth-grade (or Population 2) textbook covers 7.

Data: The Number of Topics and Topic Segments graph (on Slide 2A-18) and other data show that U.S. lessons contain more topics (with less time and emphasis given for each topic) than lessons in Germany and Japan.

- Finally, look at the issue of *coherence.* Using Slide 2A-27, define coherence and summarize any of the groups' findings around coherence.

While showing Slides 2A-27 and 2A-28, make the following points about coherence:

— "Coherence is a measure of the connectedness of the mathematics and science ideas and skills presented to students over an extended period of time." (*Global Perspectives for Local Action,* 1999)

Data: Overall, the videotape study found that "of 30 lessons analyzed from each country, 45% of the U.S. lessons, 76% of the German lessons, and 92% of the Japanese lessons fit this criterion of coherence." (*Global Perspectives for Local Action,* 1999)

— Other countries appear to teach subjects with greater depth and, as students progress through school, with greater rigor.

Data: Eighth-grade mathematics and science curricula in the U.S. provided more repetitive and less challenging material than other countries. Most other nations included topics from algebra, geometry, physics, and chemistry. U.S. 8th-graders engaged in less high-level mathematical reasoning than do students in Germany and Japan.

Data: In their final year of school, the proportion of graduating students taking mathematics was lower in the U.S. (66 percent) than the average in all the countries participating in the general knowledge assessments (79 percent). The same was also true for science (53 percent for the U.S. and 67 percent for all the TIMSS countries).

- Ask participants to reflect on their practice with respect to *focus and coherence* (Slide 2A-29).

— How many mathematics and science topics are covered each year in your schools?

— What connections among topics exist within the curriculum? How are those connections made explicit to students from year to year, over the year, from topic to topic, from lesson to lesson, and within a single lesson? Should the connections be made more explicit, and, if so, how?

What might be the unintended negative consequences of a more focused and coherent curriculum?

- Ask participants to consider the implications of actions to increase *focus and coherence.* Possible examples:

— Explicitly point out to students the connections among curricular ideas by making concrete statements that connect current ideas or activities with those in other parts of the lesson or in previous lessons.

— Engage in the development of a K–12 curriculum framework. Identify the curriculum's big ideas and where they are addressed.

— Assess the quality of the curriculum. How rigorous is it? To what extent does it encourage students to study topics in depth?

2A.5
Issues for Further Reflection and Dialogue
(30 minutes)

- Make the connection between focus, coherence, and quality by describing the judgments made in TIMSS about mathematics content (Slide 2A-30). (See Chapter 3 for background.) Show Slide 2A-31. Is this the picture of mathematics and science education we want for U.S. children?
- What can be done? Some possibilities are (Slide 2A-32):
  — Examine the focus of your curriculum.
  — Increase curriculum depth in some areas.
  — Look for new opportunities to link new learning to what children already know.
  — Check alignment of curriculum with national or state standards.
- How do we get there? (Slide 2A-33)
  — That involves many people—teachers, parents, administrators, textbook publishers, higher education faculty, test developers…
- Post the seven labeled sheets of newsprint on the walls around the room. There should be one for each of the role groups that needs to be involved in making improvements in U.S. education—teachers, administrators, higher education faculty, textbook and curriculum publishers, state and local policymakers, designers of student assessments, and parents. Pose the question, "What actions are possible?"
- In their groups of four, ask participants to walk to their first newsprint and brainstorm a list of the actions this audience can take to improve the mathematics and science curricula. Ask one person for each group of four to be a recorder. Give each recorder a different colored marker so they can keep track of their own group's ideas.
- After 3–5 minutes, have groups move to the next newsprint, reading what is there and adding to it. When the groups reach their last stations, ask them to read the list, add to it, and then identify one to three high priority actions for this audience to take. Report out the priority actions by audience group and/or have the participants walk around the room reading the lists and noting ideas for their own next steps. (A starting list of action implications is included on Slide 2A-34.)
- Wrap up (Slide 2A-35). Ask participants to write down an insight they gained and an action they intend to take drawing on the ideas generated in the carousel brainstorm. Ask participants to share a few insights and ideas with the whole group.
- Point out that although this module concluded with a consideration of action

that can be taken, Module 3 contains a process for developing an action plan that should be completed before improvement efforts can begin. Are any members of the group interested in moving to Module 3 after completing Modules 2B and 2C?

Module 2A:
What Does TIMSS Say about Curriculum?
Slides

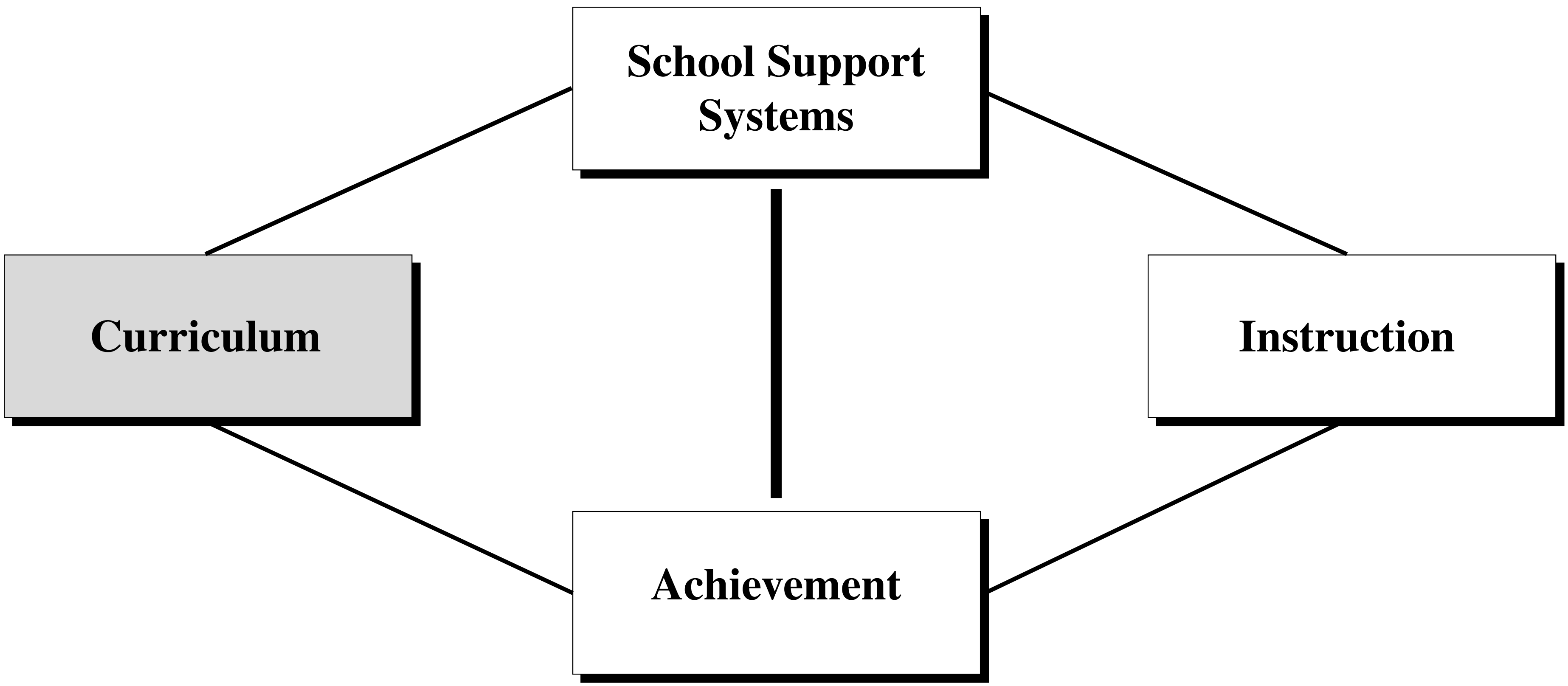
Goals

- To establish that curriculum matters
- To explore what TIMSS tells us about mathematics and science curriculums around the world
- To understand what makes curriculum focused and coherent
- To identify issues for further reflection and dialogue and possible actions to improve the mathematics and science curriculums in participants' own schools, districts, or higher education institutions

Agenda

- Making Meaning of TIMSS Data
- Questions Raised by the Data
- Key Findings about Curriculum
- Issues for Reflection and Dialogue

What Does TIMSS Say about Curriculum?



What do we mean by curriculum?

Content that is intended and taught

Organization of the content

Time and Tracking

- Time spent studying mathematics and science
- Different exposure to content and skills
- Expectations for students to learn mathematics and science

Structure of Curriculum

Focus

Coherence

Predictions about Curriculum

United States	Other Countries

U.S. Population 2 Mathematics and Science Performance Compared to International Average

Better than Average

— Earth Science

— Life Science

— Environmental Issues and the Nature of Science

Worse than Average

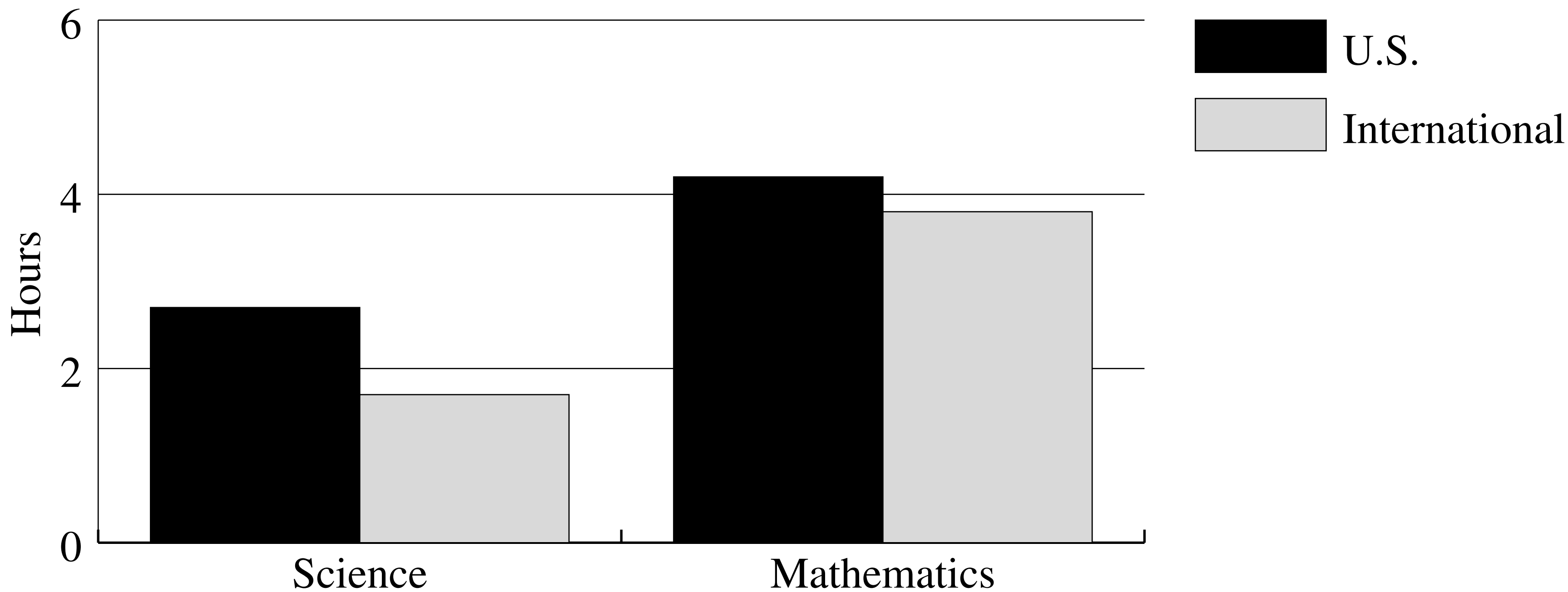
— Geometry

— Measurement

— Proportionality

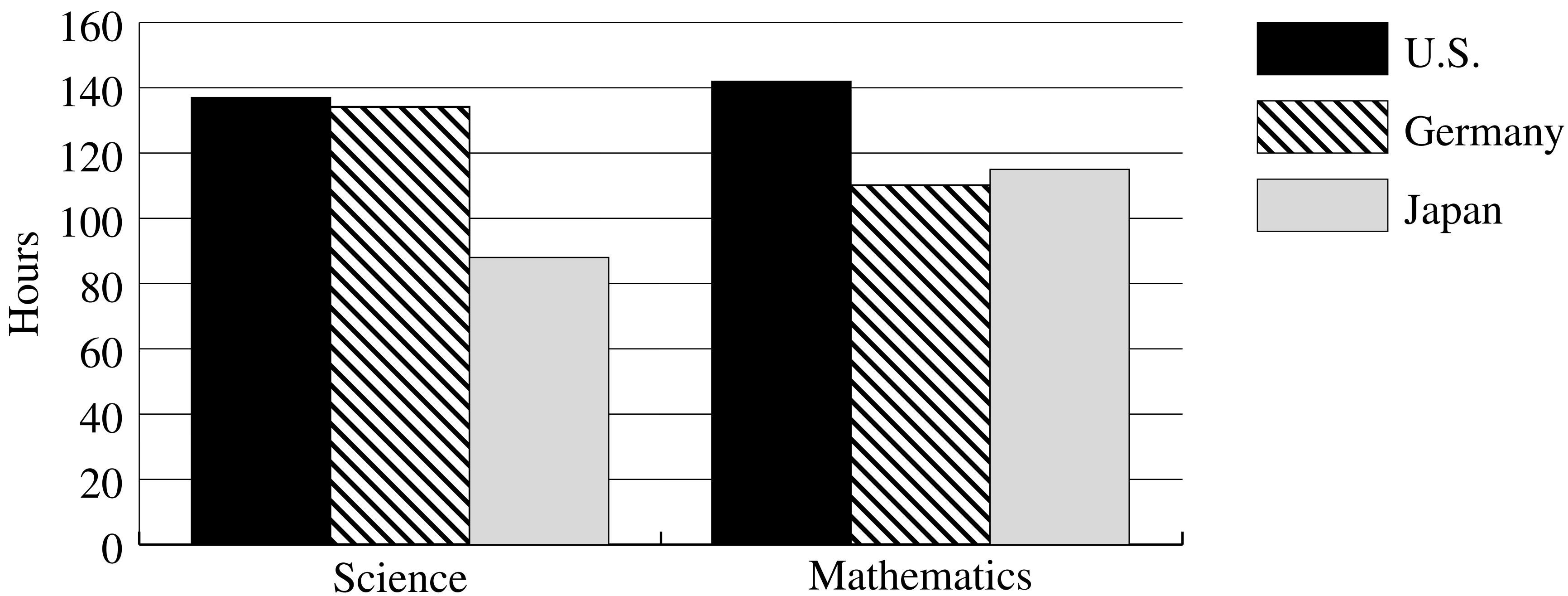
From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

Class Hours Population 1 Students Spend on Science and Mathematics Per Week



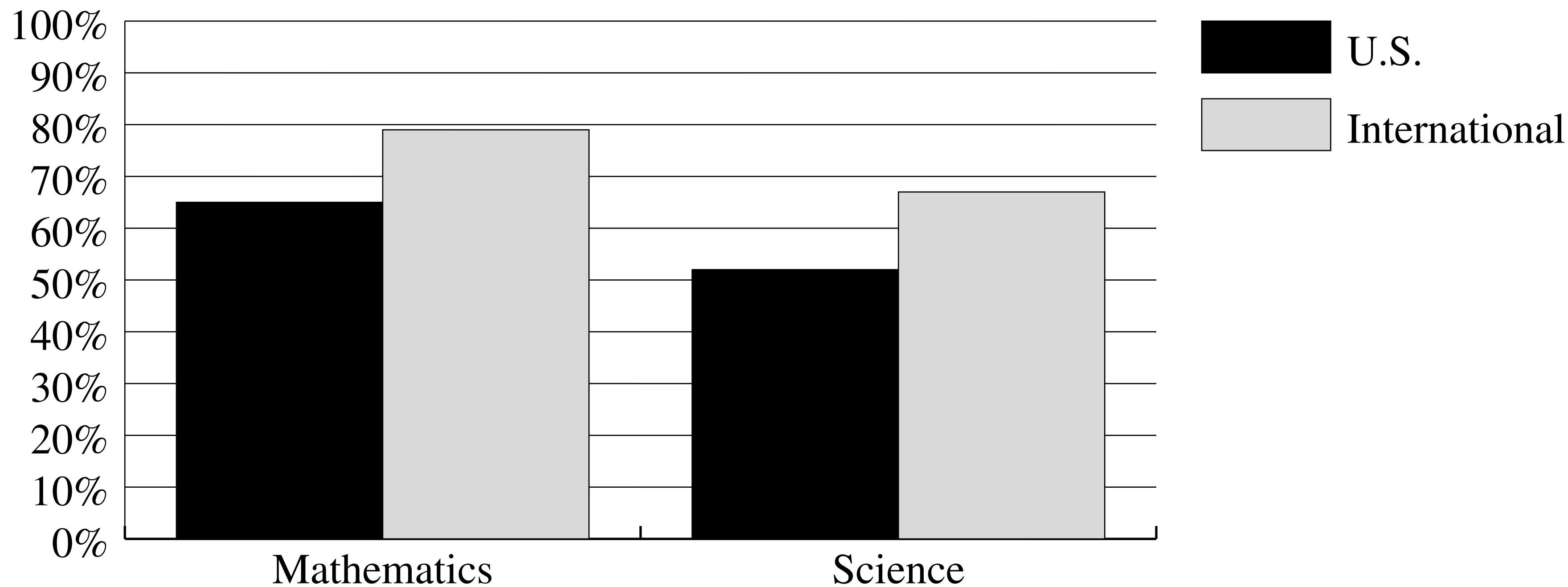
From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

Hours Population 2 Students Spend on Science and Mathematics Per Year



From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

Percentage of Population 3 Students Taking Mathematics and Science



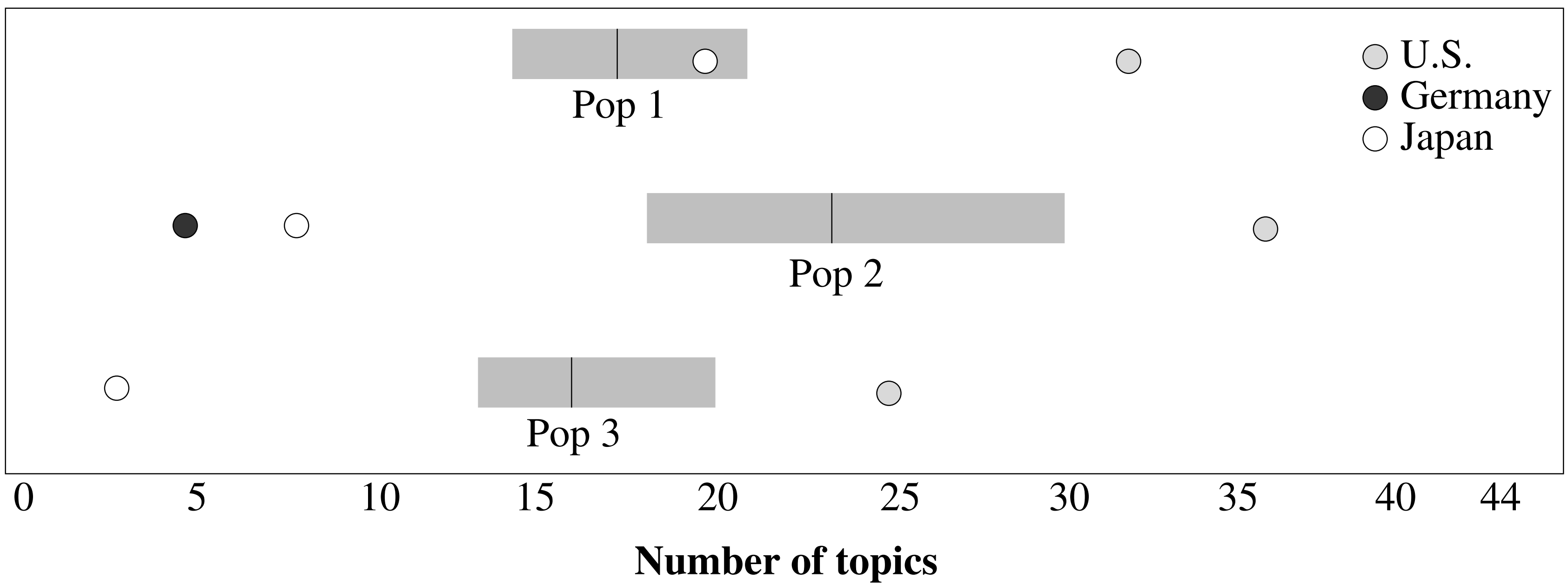
From: *Pursuing Excellence: A Study of Twelfth-Grade Mathematics and Science Achievement in International Context*

Tracking

- Japan offers a single curriculum for all students through the end of 9th grade.
- Germany sorts students into one of three types of schools at the end of 4th grade through examinations, ability grouping, and teacher recommendations.
- U.S. utilizes within-class grouping and individualization of instruction in elementary schools. In 8th grade, 80% of schools track students in mathematics and 17% in science. The tracking into different mathematics and science classes continues in the high schools.

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

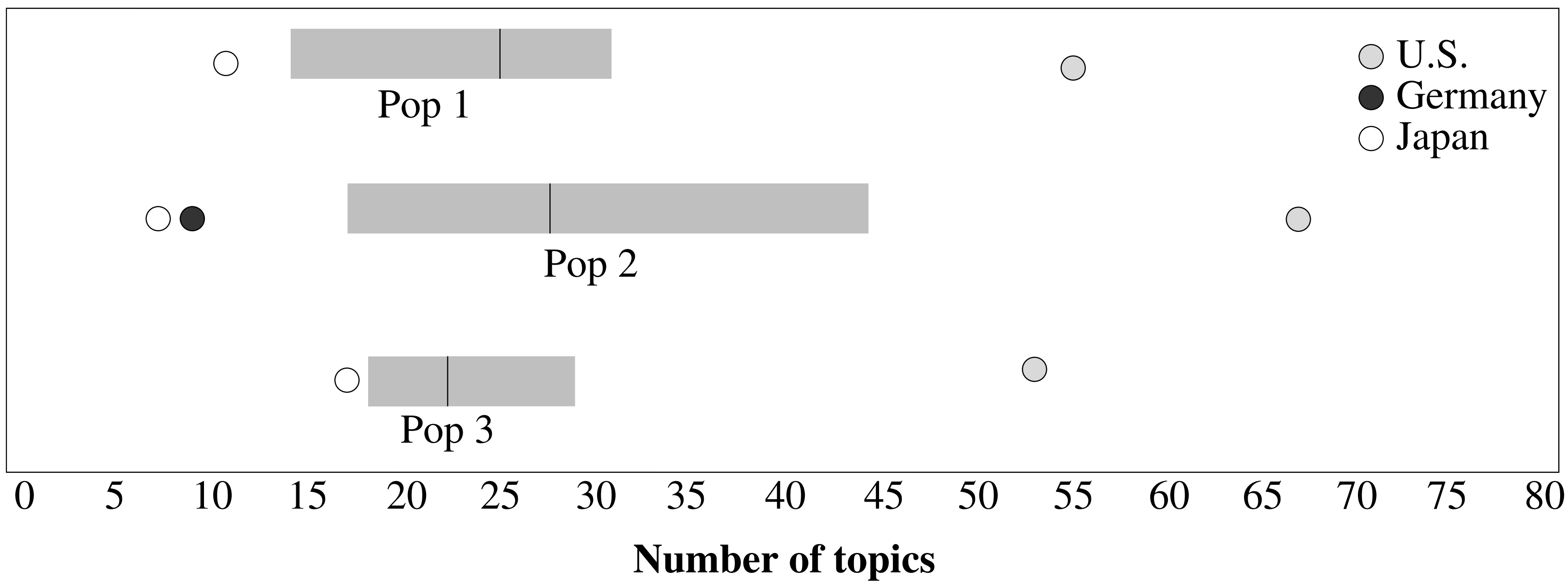
Number of Topics in Mathematics Textbooks



The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

Number of Topics in Science Textbooks



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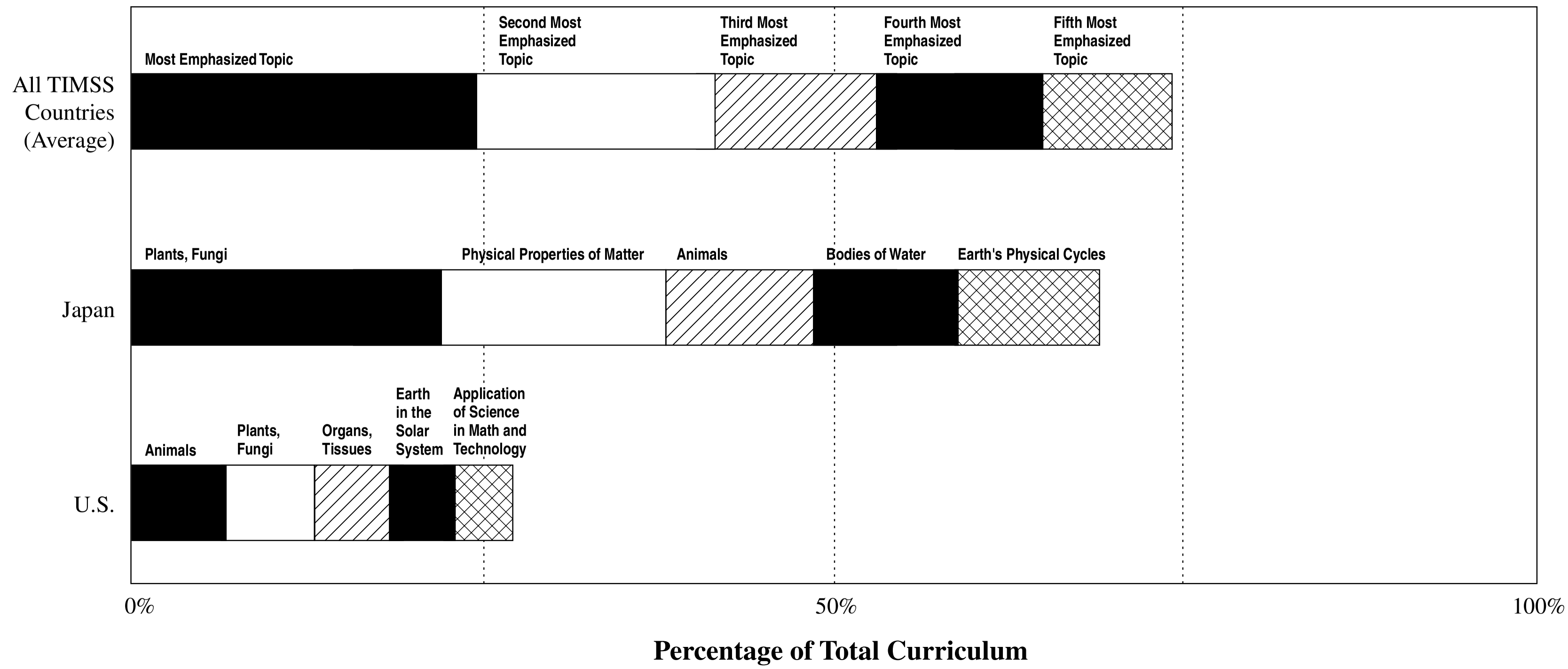
From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

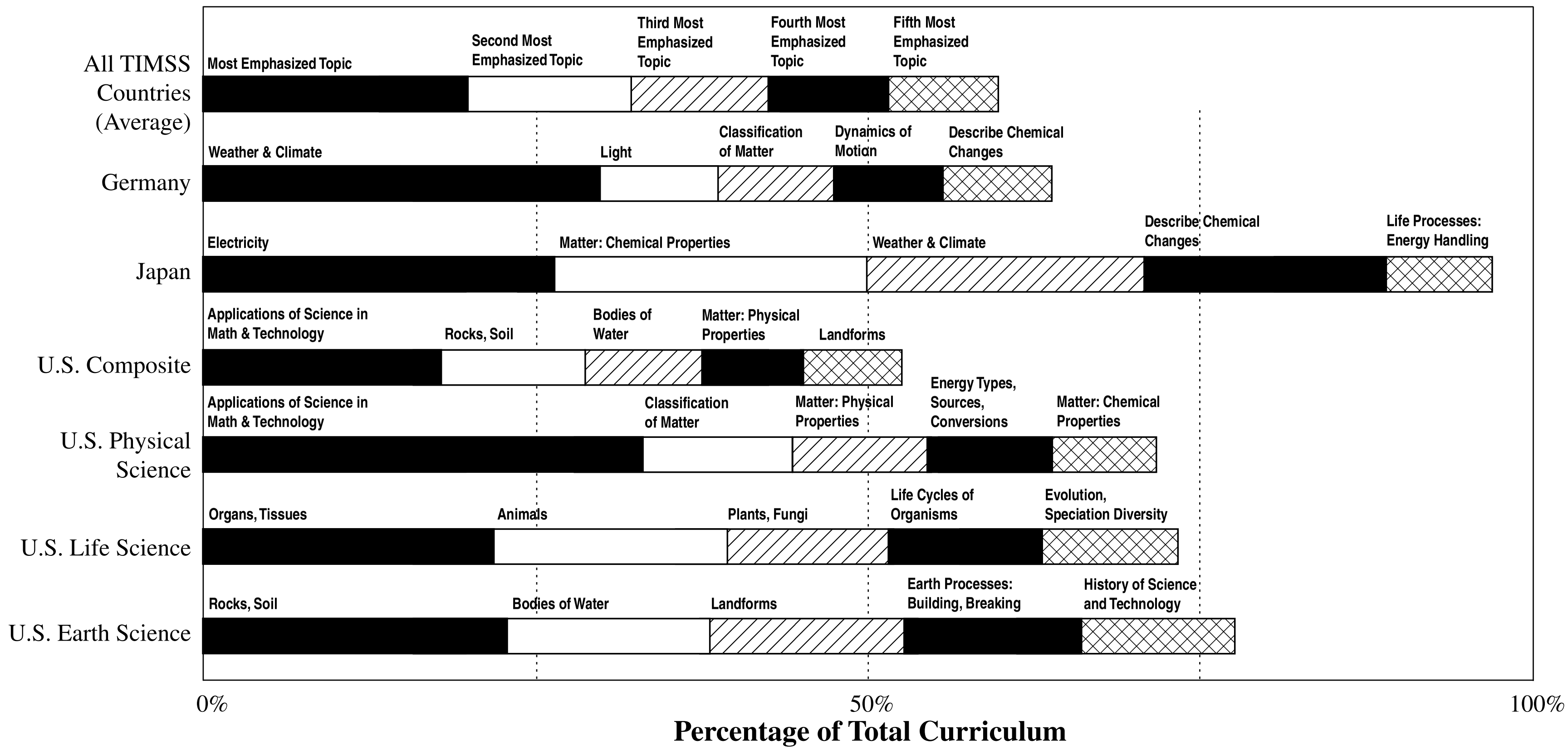
Attention Given to Science Topics in Population 1



The five topics emphasized most in Population 1 science textbooks: On average, the five most emphasized topics accounted for just over 25% of U.S. science textbooks, compared to 70–75% internationally and for Japan.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

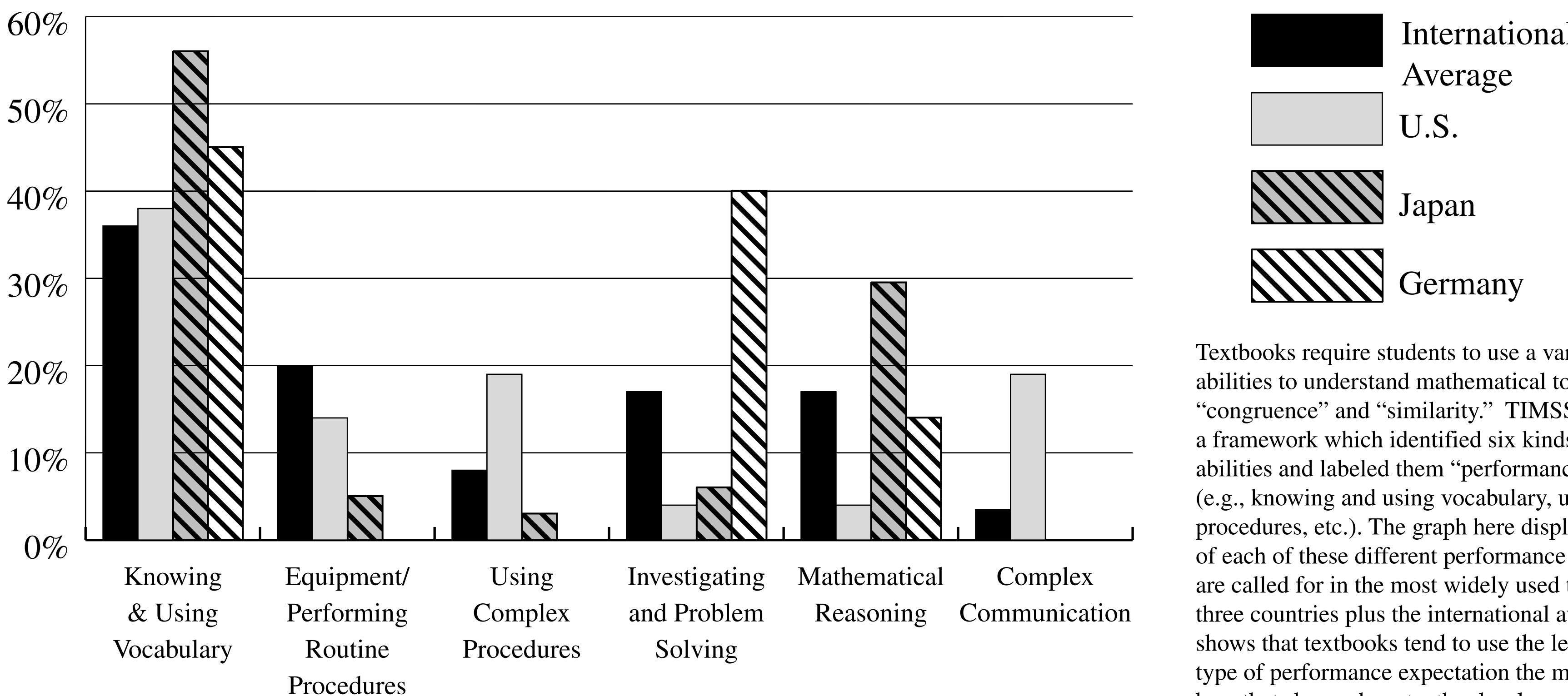
Attention Given to Science Topics in Population 2



The five topics emphasized most in Population 2 science textbooks: In Population 2 U.S. science books, about 50% of the content was accounted for by the five most emphasized topics, compared to an international average of about 60%. U.S. single area textbooks in physical science, life science, or earth science were highly focused, with the five most emphasized topics accounting for more of the books together than was true internationally.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

Grade 8 Mathematics Textbook Performance Expectations for Two Mathematical Topics—"Congruence" and "Similarity"

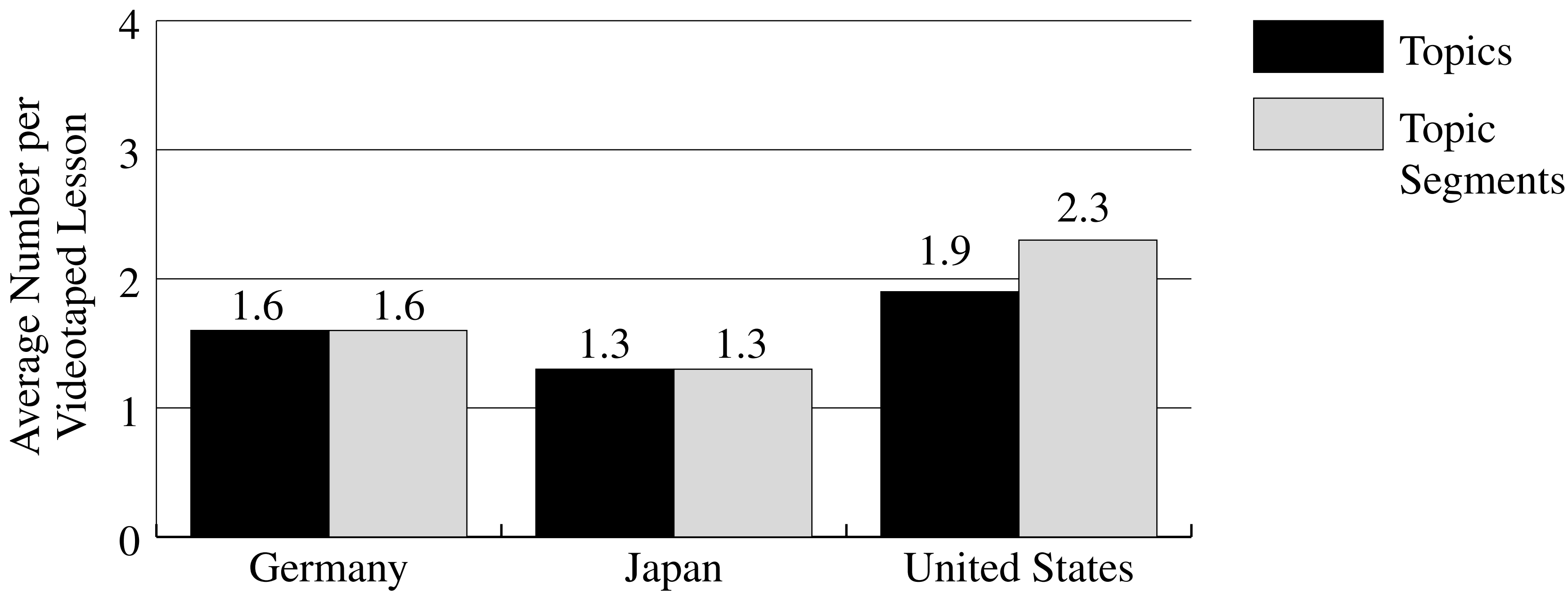


From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

Textbooks require students to use a variety of thinking abilities to understand mathematical topics, such as "congruence" and "similarity." TIMSS researchers used a framework which identified six kinds of thinking abilities and labeled them "performance expectations" (e.g., knowing and using vocabulary, using complex procedures, etc.). The graph here displays the percent of each of these different performance expectations that are called for in the most widely used textbooks from three countries plus the international average. The graph shows that textbooks tend to use the least demanding type of performance expectation the most. Look for bars that show where textbooks also require higher level thinking abilities more than the international average.

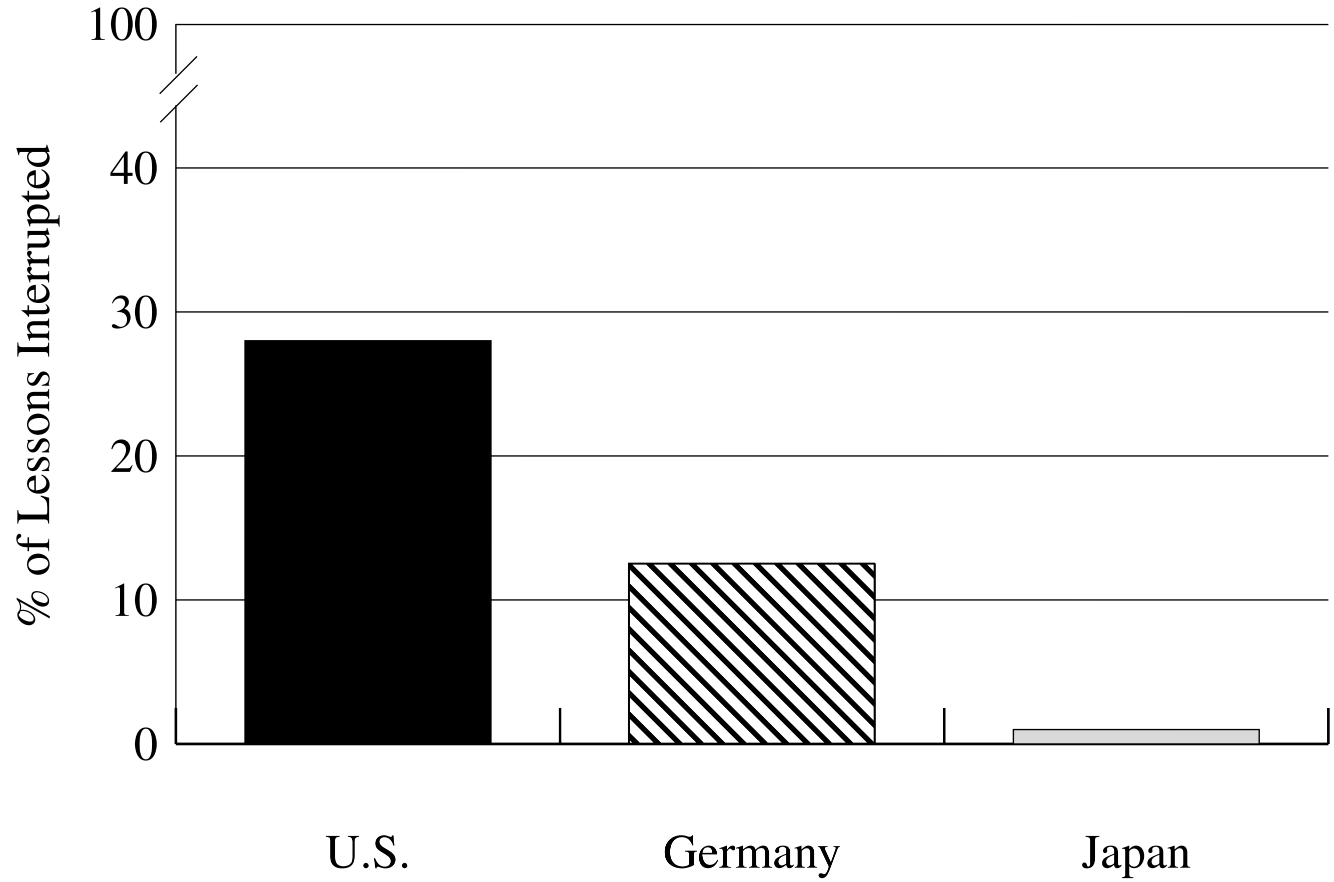
*Missing "bars" indicate that the performance expectation was not included for this topic.

Average Number of Topics and Topic Segments in Germany, Japan, and the U.S.



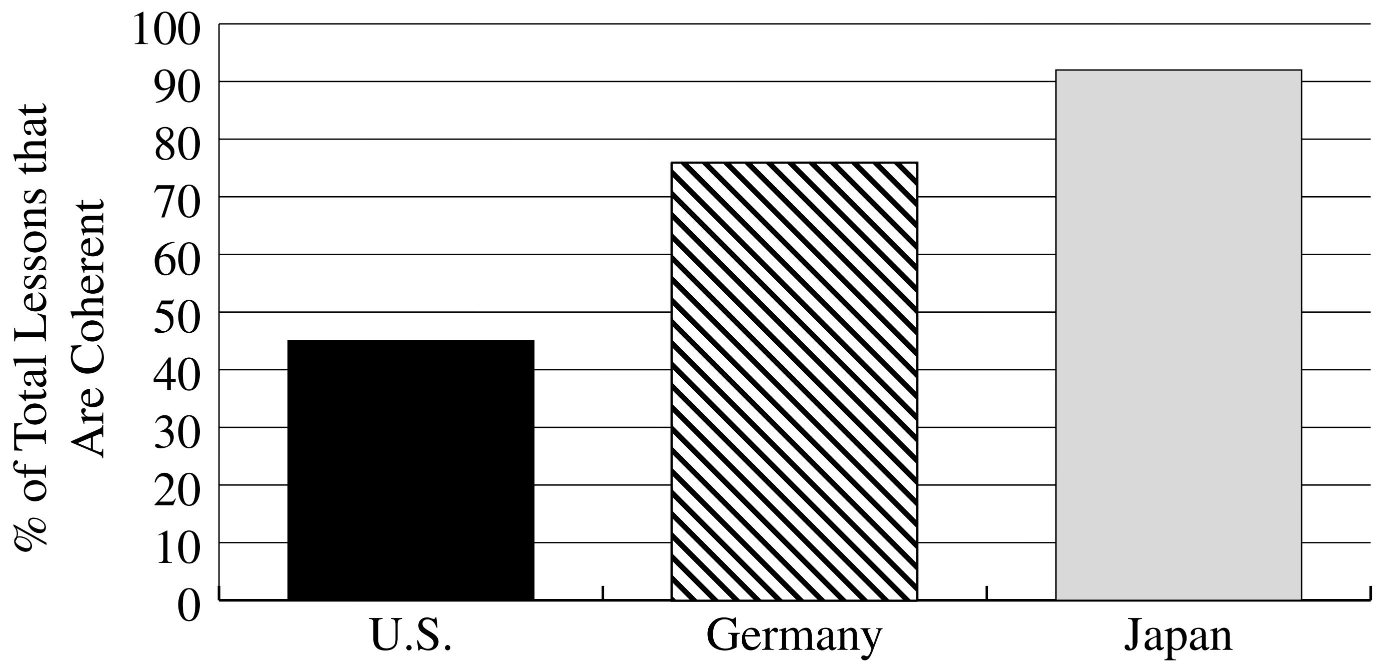
From: *The TIMSS Videotape Classroom Study*

Interruptions in Lessons



From: *The TIMSS Videotape Classroom Study*

Percentage of Mathematics Lessons Characterized as Coherent (Population 2)



From: *The TIMSS Videotape Classroom Study*

Time and Tracking

- Time to study mathematics and science is not the problem.
- U.S. tracks students through ability grouping starting in elementary school.
- Because of the different patterns for tracking students in both high- and low-performing countries, it is not possible to make a connection between tracking and performance.

Reflection on Time and Tracking

- How much time do students spend on mathematics and science in your schools?
- Are there different expectations for mathematics and science learning for different groups of students? If so, are they justified? What are these based on? How early in a student's study of mathematics and science do these expectations appear?
- How does your school measure the extent to which students are meeting expectations for mathematics and science learning? How can expectations be increased? What is the anticipated outcome of increased expectations?

Implications for Action on Time and Tracking

- Document and compare the expectations that teachers, students, and parents have for the learning of mathematics and science for different groups of students, such as boys, compared to girls.
- Measure differences in opportunity to learn (time and participation in elective courses) in your schools and in your district.
- Others:

Structure of Curriculum

Is it focused?
Is it coherent?

Focus

"Attention given to single content areas either within single classes or across class sessions."

Focus

- Repetition and review and large numbers of topics may contribute to lack of focus in the U.S.

- The curriculum to which students are exposed is considered to be one important factor associated with what students learn.

- Other countries teach fewer content areas in any given year than does the U.S. U.S. textbooks cover more mathematics and science topic areas than textbooks in other nations. The typical U.S. 8th-grade mathematics textbook covers 35 topics, while the typical Japanese 8th-grade textbook covers 7.

Coherence—
The Smoothly Developing Story in Mathematics and Science:

- Connectedness of the mathematics or science ideas and skills presented to students over an extended period of time
- Involves artfully piecing together segments, creating tensions and dilemmas, and building toward a conclusion

Coherence

- "In a coherent curriculum, new or more complex ideas and skills build on previous learning, applications are used to reinforce prior learning, and extensive repetition is avoided."
  Global Perspectives for Local Action

- Eighth-grade mathematics and science curricula in the U.S. provide more repetitive and less challenging material than in other countries.

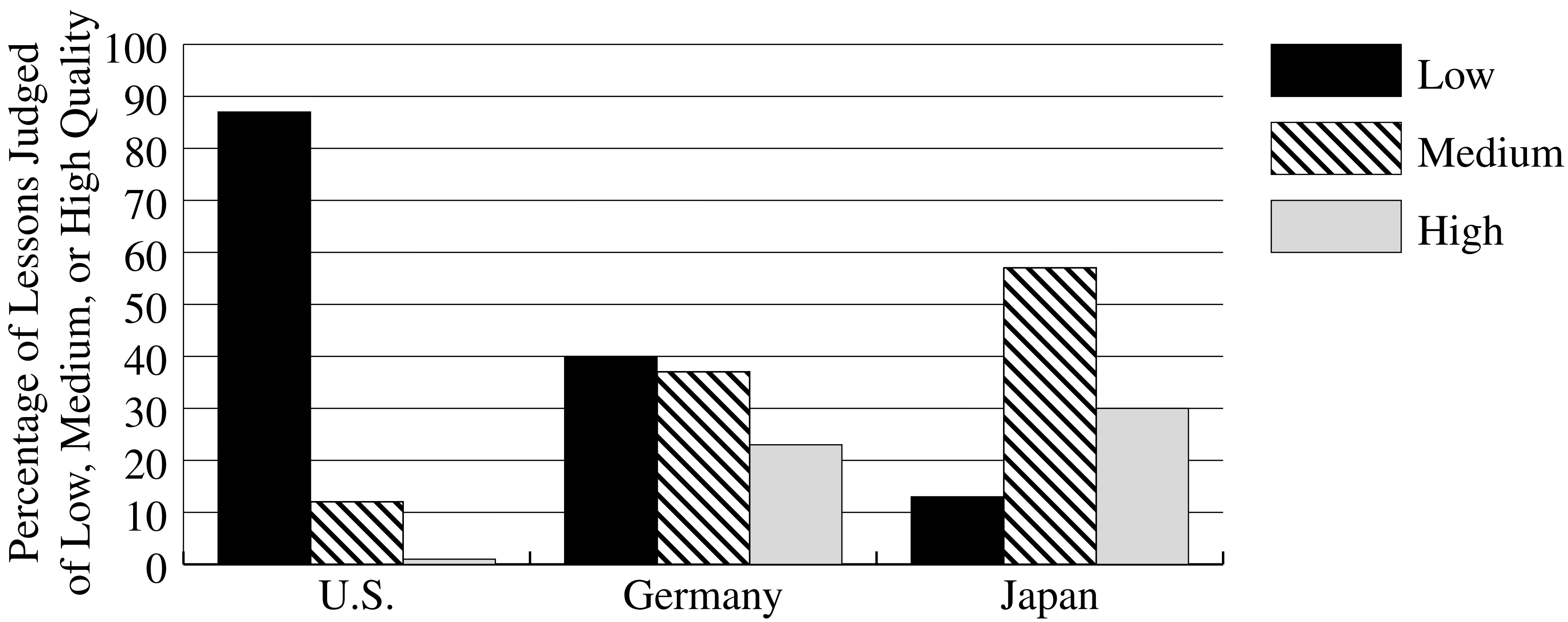
- The organization of topics in textbooks suggests that topics are not well connected; e.g., U.S. texts have more topics more widely scattered across class sessions.

Reflection on Focus and Coherence

- How many mathematics and science topics are covered each year in your schools?

- What connections among topics exist within the curriculum? How are those connections made explicit to students from year to year, from topic to topic, from lesson to lesson, and within a single lesson? Should connections be made more explicit, and if so, how?

Percentage of Lessons Rated as Having Low, Medium, and High Quality Mathematical Content



From: *The TIMSS Videotape Classroom Study*

Is this the mathematics and science education we want for U.S. children?

What can be done?

- Examine the focus of your curriculum.
- Increase curriculum depth in some areas.
- Look for opportunities to link new learning to what children already know.
- Check alignment of curriculum with national or state standards.

How do we get there?

- Teachers
- Parents
- Administrators
- Textbook Publishers
- Higher Education Faculty
- Test Developers

Implications for Action

- Increase the coherence of the curriculum by pointing out the connections among topics.

- Develop a curriculum framework based on the NCTM *Standards* and the *National Science Education Standards* that identifies where and how fundamental concepts and ideas are developed K–12.

- Assess the quality of the curriculum. How rigorous is it? To what extent does it encourage students to study topics in depth? How closely does it align with the content in the *NSES* and NCTM *Standards*?

- Others:

Wrap Up

An insight you have gained.

An action you intend to take.

Module 2A:
What Does TIMSS Say about Curriculum?
Handouts

Goals

- To establish that curriculum matters
- To explore what TIMSS tells us about mathematics and science curriculums around the world
- To understand what makes curriculum focused and coherent
- To identify issues for further reflection and dialogue and possible actions to improve the mathematics and science curriculums in participants' own schools, districts, or higher education institutions

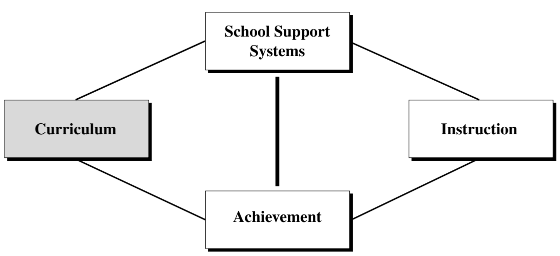
2A-1

Agenda

- Making Meaning of TIMSS Data
- Questions Raised by the Data
- Key Findings about Curriculum
- Issues for Reflection and Dialogue

2A-2

What Does TIMSS Say about Curriculum?



2A-3

What do we mean by curriculum?

Content that is intended and taught

Organization of the content

2A-4

Time and Tracking

- Time spent studying mathematics and science
- Different exposure to content and skills
- Expectations for students to learn mathematics and science

2A-5

Structure of Curriculum

Focus
Coherence

2A-6

Predictions about Curriculum

United States	Other Countries

2A-7

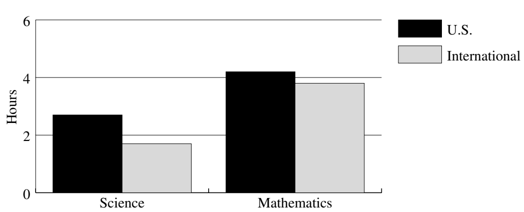
U.S. Population 2 Mathematics and Science Performance Compared to International Average

Better than Average	Worse than Average
— Earth Science	— Geometry
— Life Science	— Measurement
— Environmental Issues and the Nature of Science	— Proportionality

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

2A-8

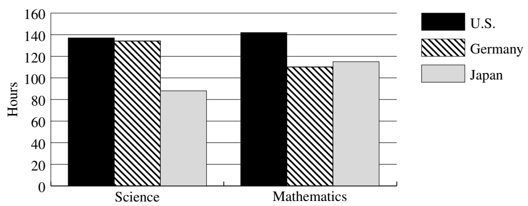
Class Hours Population 1 Students Spend on Science and Mathematics Per Week



From: *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*

2A-9

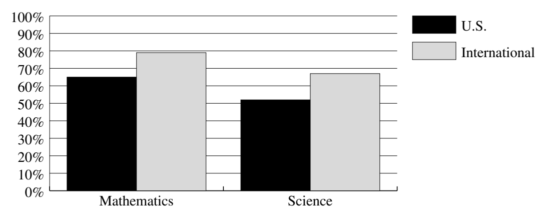
Hours Population 2 Students Spend on Science and Mathematics Per Year



From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

2A-10

Percentage of Population 3 Students Taking Mathematics and Science



From: *Pursuing Excellence: A Study of Twelfth-Grade Mathematics and Science Achievement in International Context*

2A-11

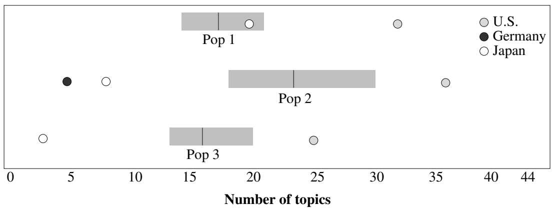
Tracking

- Japan offers a single curriculum for all students through the end of 9th grade.
- Germany sorts students into one of three types of schools at the end of 4th grade through examinations, ability grouping, and teacher recommendations.
- U.S. utilizes within-class grouping and individualization of instruction in elementary schools. In 8th grade, 80% of schools track students in mathematics and 17% in science. The tracking into different mathematics and science classes continues in the high schools.

From: *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Achievement in International Context*

2A-12

Number of Topics in Mathematics Textbooks

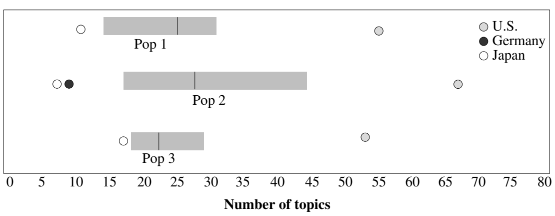


The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

2A-13

Number of Topics in Science Textbooks

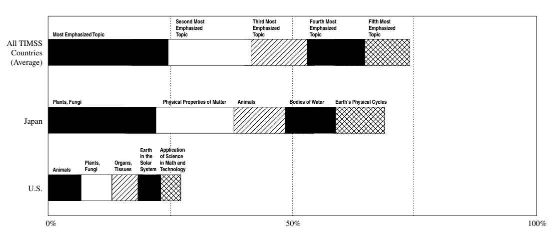


The gray bars extend from the 25th percentile to the 75th percentile for the number of topics among countries studied in the TIMSS curriculum analysis. The black line within each gray bar indicates the median number of topics for each population. German textbook data were not available for Populations 1 and 3.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

2A-14

Attention Given to Science Topics in Population 1

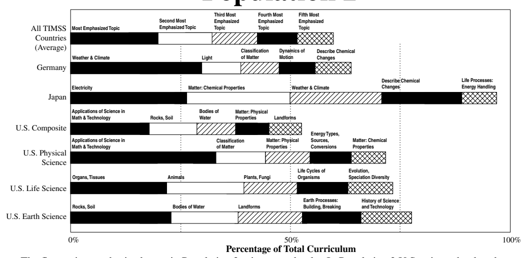


The five topics emphasized most in Population 1 science textbooks: On average, the five most emphasized topics accounted for just over 25% of U.S. science textbooks, compared to 70–75% internationally and for Japan.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

2A-15

Attention Given to Science Topics in Population 2

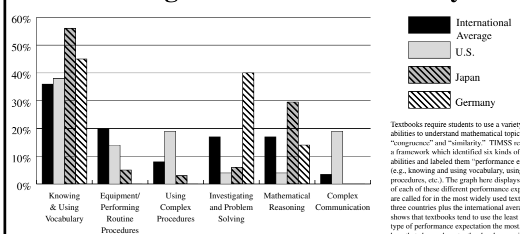


The five topics emphasized most in Population 2 science textbooks: In Population 2 U.S. science books, about 50% of the content was accounted for by the five most emphasized topics, compared to an international average of about 60%. U.S. single area textbooks in physical science, life science, or earth science were highly focused, with the five most emphasized topics accounting for more of the books together than was true internationally.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

2A-16

Grade 8 Mathematics Textbook Performance Expectations for Two Mathematical Topics—"Congruence" and "Similarity"



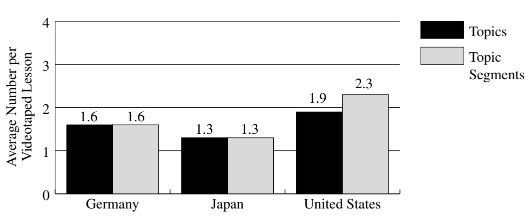
Textbooks require students to use a variety of thinking abilities to understand mathematical topics, such as "congruence" and "similarity." TIMSS researchers used a framework which identified six kinds of thinking abilities and labeled them "performance expectations" (e.g., knowing and using vocabulary, using complex procedures, etc.). The graph here displays the percent of each of these different performance expectations that are called for in the most widely used textbooks from three countries plus the international average. The graph shows that textbooks tend to use the least demanding type of performance expectation the most. Look for bars that show where textbooks also require higher level thinking abilities more than the international average.

From: *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*

*Missing "bars" indicate that the performance expectation was not included for this topic.

2A-17

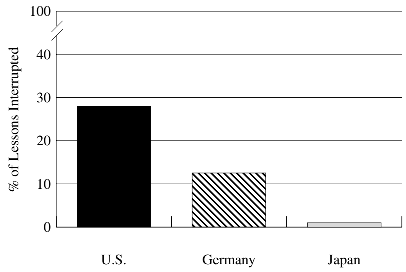
Average Number of Topics and Topic Segments in Germany, Japan, and the U.S.



From: *The TIMSS Videotape Classroom Study*

2A-18

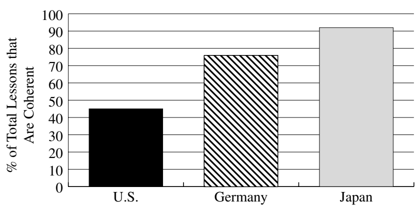
Interruptions in Lessons



From: *The TIMSS Videotape Classroom Study*

2A-19

Percentage of Mathematics Lessons Characterized as Coherent (Population 2)



From: *The TIMSS Videotape Classroom Study*

2A-20

Time and Tracking

- Time to study mathematics and science is not the problem.
- U.S. tracks students through ability grouping starting in elementary school.
- Because of the different patterns for tracking students in both high- and low-performing countries, it is not possible to make a connection between tracking and performance.

2A-21

Reflection on Time and Tracking

- How much time do students spend on mathematics and science in your schools?
- Are there different expectations for mathematics and science learning for different groups of students? If so, are they justified? What are these based on? How early in a student's study of mathematics and science do these expectations appear?
- How does your school measure the extent to which students are meeting expectations for mathematics and science learning? How can expectations be increased? What is the anticipated outcome of increased expectations?

2A-22

Implications for Action on Time and Tracking

- Document and compare the expectations that teachers, students, and parents have for the learning of mathematics and science for different groups of students, such as boys, compared to girls.
- Measure differences in opportunity to learn (time and participation in elective courses) in your schools and in your district.
- Others:

2A-23

Structure of Curriculum

Is it focused?
Is it coherent?

2A-24

Focus

"Attention given to single content areas either within single classes or across class sessions."

2A-25

Focus

- Repetition and review and large numbers of topics may contribute to lack of focus in the U.S.
- The curriculum to which students are exposed is considered to be one important factor associated with what students learn.
- Other countries teach fewer content areas in any given year than does the U.S. U.S. textbooks cover more mathematics and science topic areas than textbooks in other nations. The typical U.S. 8th-grade mathematics textbook covers 35 topics, while the typical Japanese 8th-grade textbook covers 7.

2A-26

Coherence— The Smoothly Developing Story in Mathematics and Science:

- Connectedness of the mathematics or science ideas and skills presented to students over an extended period of time
- Involves artfully piecing together segments, creating tensions and dilemmas, and building toward a conclusion

2A-27

Coherence

- "In a coherent curriculum, new or more complex ideas and skills build on previous learning, applications are used to reinforce prior learning, and extensive repetition is avoided."
Global Perspectives for Local Action
- Eighth-grade mathematics and science curricula in the U.S. provide more repetitive and less challenging material than in other countries.
- The organization of topics in textbooks suggests that topics are not well connected; e.g., U.S. texts have more topics more widely scattered across class sessions.

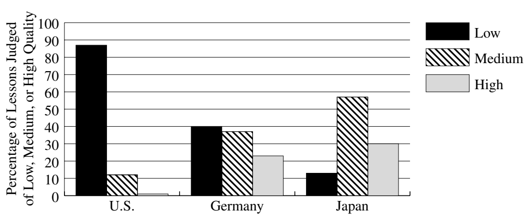
2A-28

Reflection on Focus and Coherence

- How many mathematics and science topics are covered each year in your schools?
- What connections among topics exist within the curriculum? How are those connections made explicit to students from year to year, from topic to topic, from lesson to lesson, and within a single lesson? Should connections be made more explicit, and if so, how?

2A-29

Percentage of Lessons Rated as Having Low, Medium, and High Quality Mathematical Content



From: *The TIMSS Videotape Classroom Study*

2A-30

Is this the mathematics and science education we want for U.S. children?

2A-31

What can be done?

- Examine the focus of your curriculum.
- Increase curriculum depth in some areas.
- Look for opportunities to link new learning to what children already know.
- Check alignment of curriculum with national or state standards.

2A-32

How do we get there?

- Teachers
- Parents
- Administrators
- Textbook Publishers
- Higher Education Faculty
- Test Developers

2A-33

Implications for Action

- Increase the coherence of the curriculum by pointing out the connections among topics.
- Develop a curriculum framework based on the NCTM *Standards* and the *National Science Education Standards* that identifies where and how fundamental concepts and ideas are developed K–12.
- Assess the quality of the curriculum. How rigorous is it? To what extent does it encourage students to study topics in depth? How closely does it align with the content in the *NSES* and NCTM *Standards*?
- Others:

2A-34

Wrap Up

An insight you have gained.

An action you intend to take.

2A-35

Module 2B: What Does TIMSS Say about Instructional Practices?

GOALS

- To explore differences in the structure of lessons, goals, and beliefs about teaching mathematics in the U.S, Germany, and Japan;
- To examine the "scripts" that shape the characteristics of a typical lesson in each of these countries;
- To identify issues for further reflection and dialogue about teaching practices in participants' own schools, districts, and higher education institutions; and
- To assess how familiar U.S. teachers are with the National Council of Teachers of Mathematics *Standards*.

ACTIVITIES

2B.1 Overview of Goals and Agenda (5 minutes)
2B.2 Brief Overview of the Videotape Case Study (5 minutes)
2B.3 Set Up for Video Viewing (10 minutes)
2B.4 Video Viewing and Discussion: Japan and the U.S. (60 minutes)[8]
2B.5 Key Findings: Simple Jigsaw (30 minutes) or Brief Lecture with Discussion (20 minutes)
2B.6 Issues for Further Reflection and Dialogue (40 minutes)

Time: 2.5 hours

[8] Adapted from *Teachers Change: Improving K-12 Mathematics*, by Cathy Cook and M. Christensen. Columbus, OH: Eisenhower National Clearinghouse, 1999.

SET-UP AND MATERIALS

Room Arrangement and Equipment

- Tables for groups of four
- Overhead projector and screen
- Video projection unit with large screen or monitor
- Newsprint and markers
- Post-It notes (large) in two colors
- Paper for note-taking and pens/pencils, plus newsprint or transparencies and markers for recorders/reporters

Order in Advance

- Videos of U.S. and Japanese 8th grade geometry lessons included in "Eighth-Grade Mathematics Lessons: United States, Japan, and Germany" (from the TIMSS "toolkit"). (Check with your school district's science or math coordinator or local university's school of education to borrow their Resource Kit or kit or contact the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954; Phone: (202) 512-1800; FAX: (202) 512-2250; URL: http://www.access.gpo.gov/su_docs/sale/prf/prf.html; e-mail: orders@gpo.gov. When ordering, ask for *Attaining Excellence: A TIMSS Resource Kit,* GPO # 065-000-01013-5.)

Make in Advance

- Overhead transparencies from masters for Module 2B in this guide (Note that the masters are labeled 2B-1 through 2B-31.)[9]
- Copies of the handouts for this module (see pgs. 309–319) (one set for each participant) (Also copy the handout on the TIMSS Populations from Module 1 on pg. 144, if needed.)
- Copies of Slides 2B-6, "Prediction and Observation," and 2B-9, "Comparing Instruction in Three Countries" (one set for each participant)
- Copies of four sections of Chapter 4 of the *Global Perspectives for Local Action* report (one set of the four sections for each group of four participants) (The sections are entitled "Lesson Structure," "Objectives of Lessons," "Beliefs about Mathematics Teaching," and "Teaching Scripts.") (The report is available from the National Academy Press, 2101 Constitution Ave., NW, Lockbox 285, Washington, D.C. 20055; Phone: (800) 624-6242 [toll free] or (202) 334-3131 [in the Washington Metropolitan area].)
- Table tents for each table

[9] The source of data cited on masters is noted on the bottom of each master by title. For complete citations, see the "Resources" section of this guide.

FACILITATOR NOTES

2B.1
Overview of Goals and Agenda
(5 minutes)

- Welcome participants and provide them with copies of the handouts for this module. Use Slides 2B-1, 2B-2, and 2B-3 to provide an overview of the goals and agenda.

2B.2
Brief Overview of the Videotape Case Study
(5 minutes)

- Let participants know that Chapter 4 of the NRC report draws on both the videotape study of eighth-grade mathematics in the U.S., Germany, and Japan and on the background questionnaires given to administrators, teachers, and students. The next activity will focus on the videotape study and give participants the opportunity to observe classrooms in the U.S. and Japan just as the researchers did. (Because of the time that would be required, this module does not include viewing and discussing the German classrooms. You can add this if you have an additional 30 minutes. Viewing video from the three countries will broaden participants' perspectives and avoid a narrow comparison between just the U.S. and Japan.)
- Use Slides 2B-4 and 2B-5 briefly to provide an overview of the videotape study. If participants have questions about the methodology or findings of the study, refer them to "Research Methods and Findings of the TIMSS Videotape Classroom Study" in the *Moderator's Guide to Eighth-Grade Mathematics Lessons: United States, Japan, and Germany,* which is part of *Attaining Excellence: A TIMSS Resource Kit* (U.S. Department of Education, 1997d).

2B.3
Set Up for Video Viewing
(10 minutes)

- Ask participants to predict what they think they will see in the video using the "Prediction and Observation" matrix, copies of which were made and handed out (Slide 2B-6). The predictions will then provide a focus for participants' video viewing.
- Suggest to participants that while they view the lesson, they focus on their observations, rather than on judgments or evaluations. They also should consider issues or questions that the video segments raise for them. Clarify the difference between observations (just the facts!) and issues, which are questions about teaching and learning. For example, an issue raised by the

video for a teacher might be, "How can we deal more effectively with students' confusion and frustration?" An issue for an administrator might be, "How can the administration support teachers in using more complex problem solving in the classroom?" An issue for someone in higher education might be, "How can we better align our teacher preparation and mathematics programs with the most effective instructional practices in mathematics?"

2B.4
Video Viewing and Discussion: Japan and the U.S.
(60 minutes)

- Show the video of the U.S. eighth-grade geometry lesson first. Then show the Japanese video. (Field tests have found that participants tend to be less defensive when they view the videos in this order.)
- After viewing each video, ask participants individually to compare their observations to their predictions and to record their observations on the matrix. Then have them share their observations with a partner. Encourage them to talk about what surprised them as well as what validated their assumptions.
- Next, have participants work in groups of four to discuss the issues or questions raised by the videos. Using one color of Post-It notes, have participants write each issue in the form of an open-ended question, one per Post-It.
- Discuss participants' observations in the whole group, recording them on newsprint. Then ask participants to share some of their issues. Let participants know that their issues will continue to be collected as more of the findings from the video study and the report are examined. Also let participants know that they will form issue discussion groups later.

2B.5
Key Findings: Simple Jigsaw
(30 minutes)
OR
Brief Lecture with Discussion
(20 minutes)

- *Simple Jigsaw:* Tell participants that now they are going to find out what the researchers learned from analyzing the videos and what the authors of the report highlighted. In groups of four, participants will read about four topics from Chapter 4 of the NRC report—"Lesson Structure," "Objectives of Lessons," "Beliefs about Mathematics Teaching," and "Teaching Scripts." Use Slide 2B-7 as an advanced organizer for the material they will be covering. Then go over the directions for the simple jigsaw on Slide 2B-8, which participants will follow while continuing to work in groups of four. (If the numbers are not even, make some groups of three. When it is time for a team of three to learn about the fourth topic, have them join with a group of four.) The copies of the slide provided as a worksheet (Slide 2B-9) will help participants organize the information that they are learning from the jigsaw.

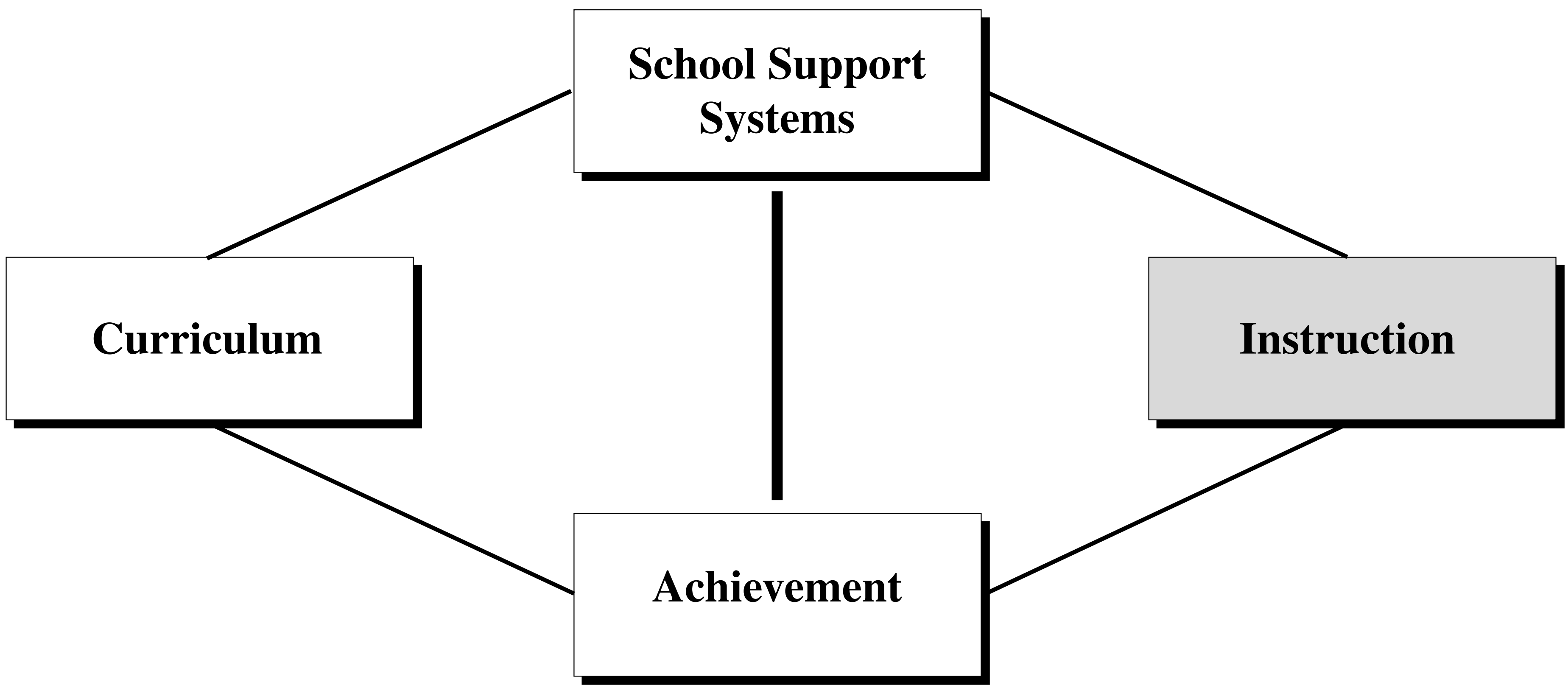
- After the jigsaw, ask participants in their groups of four to generate any additional issues or questions that this material raised. Have them add these questions to their collection of issue Post-Its, one item per Post-It.
- *Brief lecture with discussion:* This is a less time-consuming but also less engaging alternative to the jigsaw. Use Slides 2B-10 through 2B-18 to provide an overview of the major findings about structure. Stop and have participants discuss in table groups how these findings compare with their observations. Then ask them to generate additional questions or issues about these findings. Have them add these to their collection of Post-Its, one question or issue per Post-It (Slide 2B-19).
- Then go to Slides 2B-20 through 2B-29 to highlight the findings regarding influences on instructional practices and scripts (typical characteristics, including sequence, of typical lessons). Ask participants in their table groups to reflect on these findings and add any new issues or questions to their Post-Its.

2B.6
Issues for Further Reflection and Dialogue
(40 minutes)

- In their groups of four, ask participants to cluster, categorize, and name the issues on their Post-Its (Slide 2B-30). Have them write the names of categories on the second color of Post-Its provided. As they do this, circulate around the room, observing the groups and identifying common themes. Put the themes that lend themselves best to discussion on cardboard table tents. Create one theme for every four to eight participants.
- Ask participants to move to the table with the theme that they are most interested in discussing. Ask them to assign a reporter and a recorder. Allow about 20 minutes for discussion. Summarize with brief reporting out by each group. If the group (or a subset of the group) intends to continue with Module 3, they should be encouraged to keep a record of their reflections for later use.
- Wrap up by asking participants individually to reflect on an insight they gained or an action they intend to take (see Slide 2B-31). Share a few of each of these—insights and actions—with the whole group.
- Point out that although this module concluded with a consideration of action that can be taken, Module 3 contains a process for developing an action plan that should be completed before improvement efforts can begin. Are members of the group interested in moving to Module 3 after Module 2C?

Module 2B: What Does TIMSS Say about Instructional Practices? Slides

What Does TIMSS Say about Instructional Practices?



Goals

- To explore differences in the structure of lessons, goals, and beliefs about mathematics teaching in Germany, Japan, and the U.S.
- To examine the “scripts” that shape characteristics of a typical lesson in each country
- To identify issues for further reflection and dialogue in your own setting

Agenda

- Video Viewing: U.S. and Japan
- Key Findings
- Issues for Further Reflection

Overview of Videotape Study

- First of its kind
- Nationally representative sample of Population 2 mathematics classrooms in Germany, Japan, and the U.S.
- Purposes
  - — To describe how each country teaches mathematics
  - — To allow us to see teaching with a fresh perspective
  - — To encourage reflection

Video Study Analyzed

- Teachers' goals for lessons
- Treatment of concepts and applications
- The presence of alternative solution methods
- How mathematical principles, properties, and definitions were used
- Whether proofs were included
- Whether concepts were connected
- The kinds of tasks assigned

Prediction & Observation

	Japan: What I expect to see	Japan: What I saw	U.S.: What I expect to see	U.S.: What I saw
• Teachers' goals for the lesson				
• What teachers are doing				
• What students are doing				
• The mathematics in the lesson				

Jigsaw Topics of the Report

- Lesson Structure
- Objectives of Lessons
- Beliefs about Mathematics Teaching
- Teaching Scripts

Key Findings—Simple Jigsaw: Teams of Four

- Divide the four topics among team members.
- Read and study the section you are assigned.
- Teach your teammates about your section.

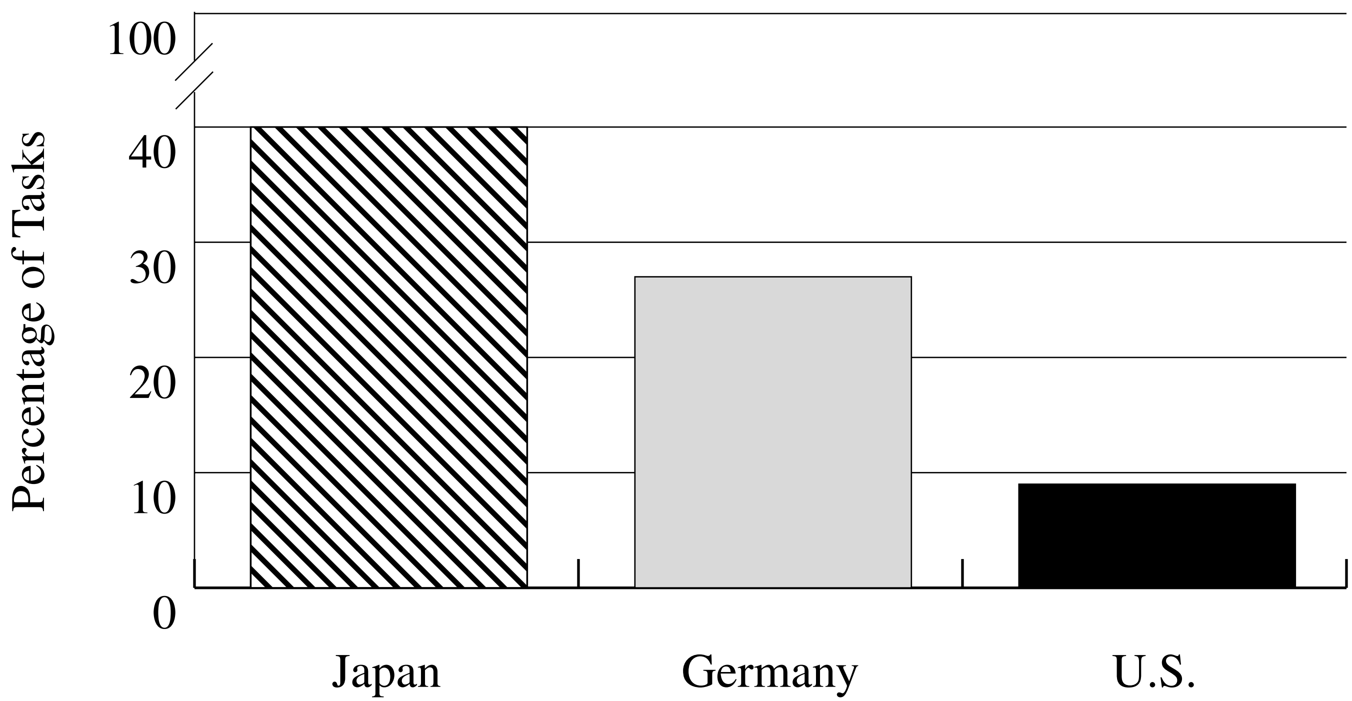
Comparing Instruction in Three Countries

	Germany	Japan	U.S.
• Structure			
• Objectives			
• Beliefs			
• Scripts			

Variations in Instructional Practice

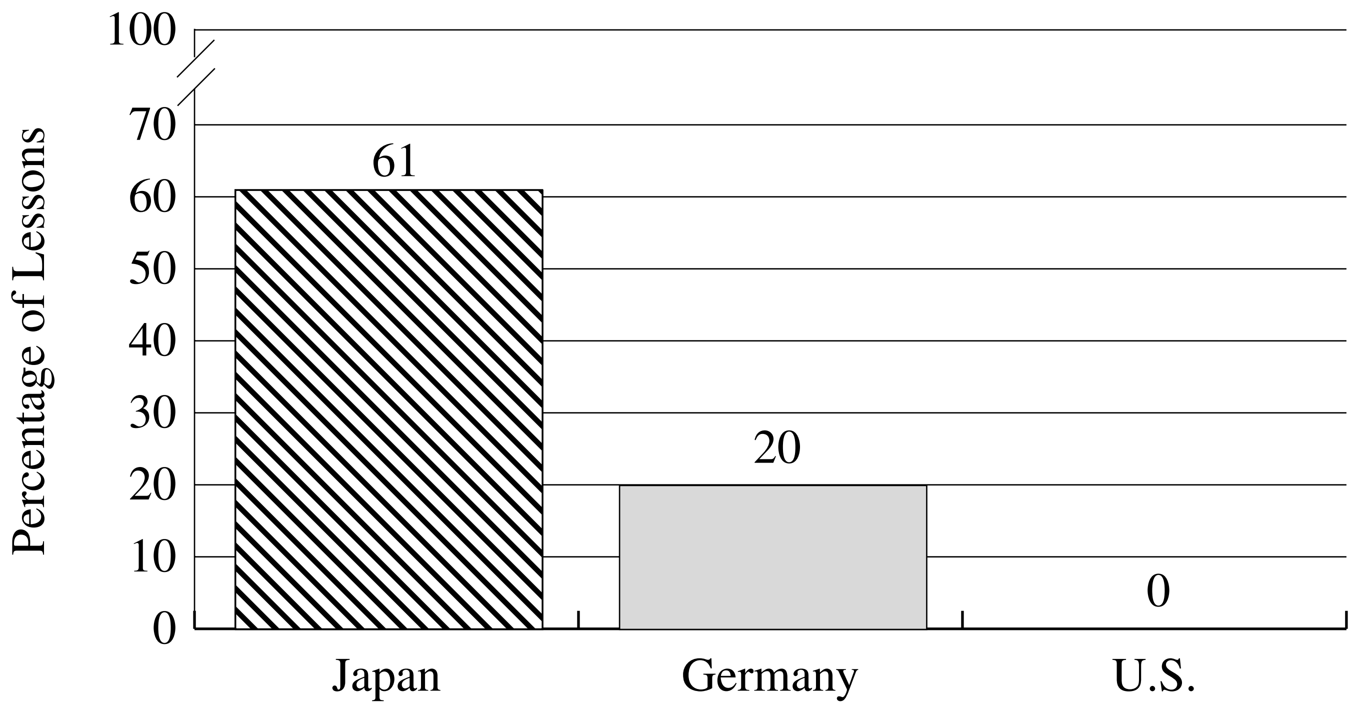
- Lesson Structure
- Tests, Quizzes, External Exams
- Homework
- Calculators and Computers

Lesson Structure—Percentages of Math Tasks that Students Decide How to Solve Rather than Using a Teacher-Prescribed Method



From: *The TIMSS Videotape Classroom Study*

Percentages of 8th-Grade Mathematics Lessons with Instances of Mathematical (Deductive) Thinking



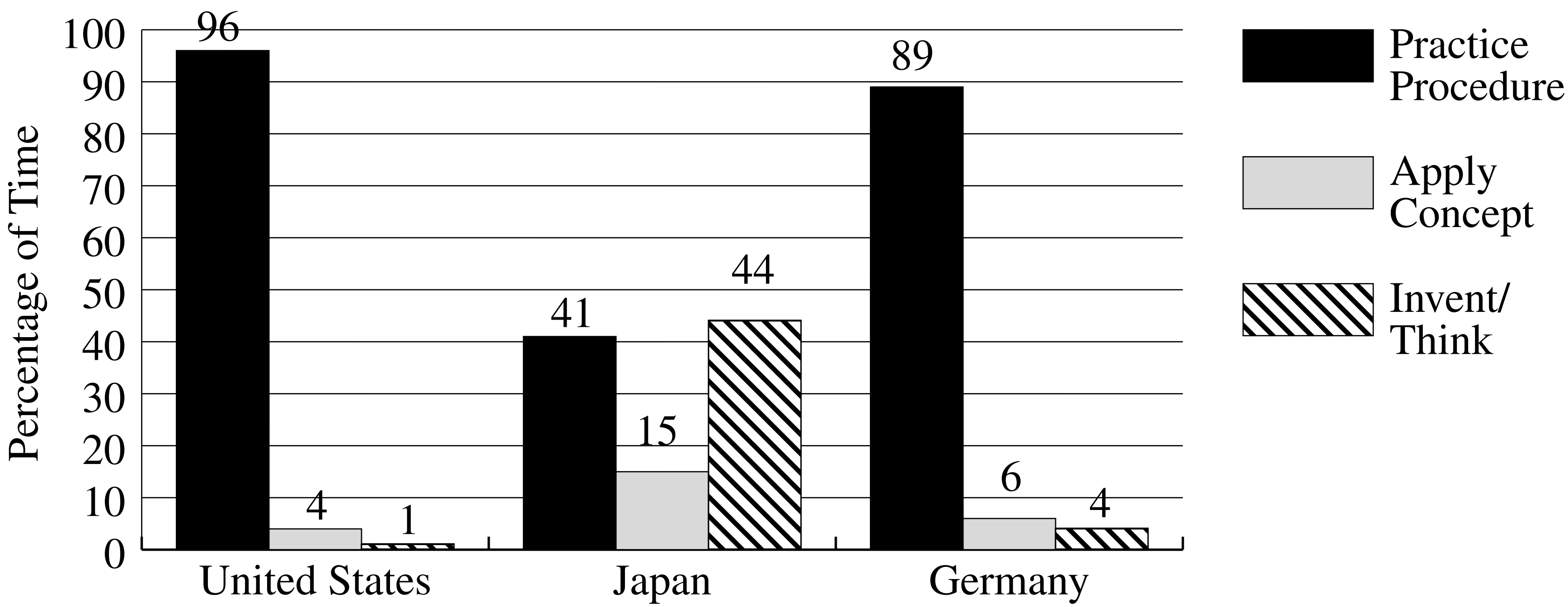
From: *The TIMSS Videotape Classroom Study*

Lesson Structure—
Type of Mathematics Seatwork

What do you think?

- Practice Routine Procedures
- Apply Concept
- Invent New Solutions/Think
- Compare Japan, Germany, U.S.

Lesson Structure—
Type of Mathematics Seatwork

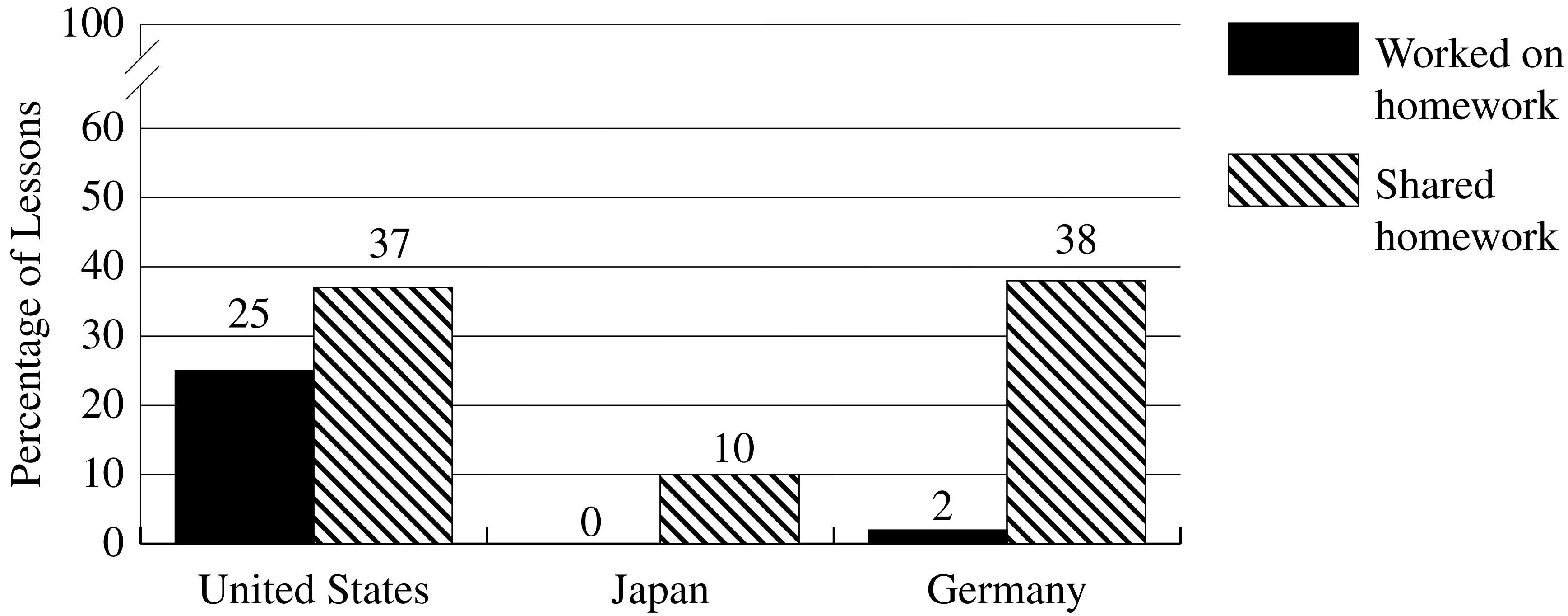


From: *The TIMSS Videotape Classroom Study*

Tests, Quizzes, External Exams

- U.S. math and science teachers test more than any other country.
- In many countries, external exams require extended student responses.

Lessons in Which Class Worked on and Shared Homework



From: *The TIMSS Videotape Classroom Study*

Calculators and Computers

U.S. teachers use calculators and computers as much or more than teachers in other countries when compared to the international average.

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

Lesson Structure—Summary and Analysis

U.S. lessons…

- Demand less mathematical reasoning
- Emphasize routine procedures over inventing something new
- Use more class time for homework than in Japan or Germany
- Use tests more than other countries

Stop and Discuss

- How do these findings compare with your observations?
- What additional issues or questions do they raise for you?

Influences on Instructional Practices

- Deciding What to Teach
- Objectives of Lessons
- Beliefs about Mathematics Teaching
- “Scripts” that Shape Teaching

Deciding What to Teach

"…the high achieving countries in TIMSS place greatest control in the hands of education experts, either national leaders (e.g., in Japan or Singapore) or classroom teachers (e.g., in the Czech Republic and the Netherlands). The U.S. introduces a third influence—a middle-level agency, the district school board, composed of individuals who do not work full time in education and generally are not professionally trained in the field."

From: *Global Perspectives for Local Action*

Objectives of Lessons

- Germany — developing advanced procedures
- Japan — solving structured problems
- U.S. — learning terms and practicing procedures

From: *The TIMSS Videotape Classroom Study*

Beliefs Inferred about Mathematics Teaching

U.S.

— Teachers value student understanding of concepts, but emphasize skills.

— Skills are mastered incrementally.

— Student confusion and frustration mean that material is not mastered.

Japan

— Students learn by struggling with problems.

— Student confusion and frustration are a natural part of the process.

From: *The TIMSS Videotape Classroom Study*

Beliefs Inferred about Mathematics Teaching (continued)

U.S.

— Teacher's role is to demonstrate how to complete tasks and help students who are stuck.

Japan

— Teacher's role is to choose engaging problems, manage discussion to help different methods surface, and summarize.

From: *The TIMSS Videotape Classroom Study*

Scripts Are …

Mental Images of How One Should Teach Based on Beliefs about:

- Goals for instruction
- The nature of mathematics and science
- Ways these subjects are taught that shape the characteristics of a typical lesson

From: *The TIMSS Videotape Classroom Study*

U.S. Script for Eighth-Grade Mathematics (Inferred)

- Teacher reviews previous material, homework.
- Teacher demonstrates how to solve problem for the day.
- Students practice.
- Teacher corrects problems, assigns homework.

From: *The TIMSS Videotape Classroom Study*

Japanese Script for Eighth-Grade Mathematics (Inferred)

- Teacher reviews previous material.
- Teacher presents problem for the day.
- Students work on problem.
- Whole class discusses solution method.
- Teacher highlights and summarizes major points.

From: *The TIMSS Videotape Classroom Study*

Are U.S. Mathematics Teachers Implementing Reform Recommendations?

- 95% of the teachers in the video study indicated that they were "aware" or "somewhat aware" of current ideas about mathematics teaching and learning.
- 75% indicated that the lessons in the study were "a lot" or "a fair amount" in accordance with current ideas about mathematics teaching and learning.
- 20% indicated that they had implemented the focus on mathematical (deductive) thinking.

From: *Pursuing Excellence: A Study of Eighth-Grade Mathematics and Science Achievement in International Context*

Stop and Discuss

- What are our scripts for teaching mathematics? Other subjects?
- What do the scripts and other results of the video study indicate about the implementation of reform recommendations in the U.S.?
- What additional issues/questions do these findings raise?

Reflection and Dialogue

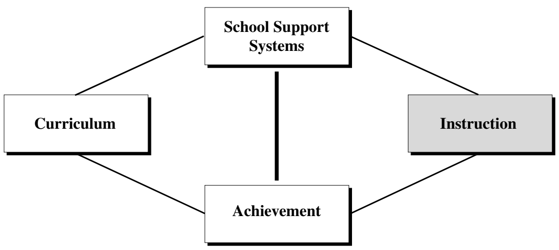
- In groups of four, cluster, categorize, and name the issues on Post-Its.
- Move to the table with a theme that is interesting to you. Assign a reporter and recorder. Discuss the theme.
- Briefly report out.
- Reflect on an insight gained or an action intended.

Wrap Up

- What insight do you have or action will you take as a result of this workshop?
- How might the NCTM standards for teaching and the *National Science Education Standards* for teaching help you?

Module 2B: What Does TIMSS Say about Instructional Practices? Handouts

What Does TIMSS Say about Instructional Practices?



2B-1

Goals

- To explore differences in the structure of lessons, goals, and beliefs about mathematics teaching in Germany, Japan, and the U.S.
- To examine the "scripts" that shape characteristics of a typical lesson in each country
- To identify issues for further reflection and dialogue in your own setting

2B-2

Agenda

- Video Viewing: U.S. and Japan
- Key Findings
- Issues for Further Reflection

2B-3

Overview of Videotape Study

- First of its kind
- Nationally representative sample of Population 2 mathematics classrooms in Germany, Japan, and the U.S.
- Purposes
  — To describe how each country teaches mathematics
  — To allow us to see teaching with a fresh perspective
  — To encourage reflection

2B-4

Video Study Analyzed

- Teachers' goals for lessons
- Treatment of concepts and applications
- The presence of alternative solution methods
- How mathematical principles, properties, and definitions were used
- Whether proofs were included
- Whether concepts were connected
- The kinds of tasks assigned

2B-5

Prediction & Observation

	Japan: What I expect to see	Japan: What I saw	U.S.: What I expect to see	U.S.: What I saw
• Teachers' goals for the lesson				
• What teachers are doing				
• What students are doing				
• The mathematics in the lesson				

2B-6

Jigsaw Topics of the Report

- Lesson Structure
- Objectives of Lessons
- Beliefs about Mathematics Teaching
- Teaching Scripts

2B-7

Key Findings—Simple Jigsaw: Teams of Four

- Divide the four topics among team members.
- Read and study the section you are assigned.
- Teach your teammates about your section.

2B-8

Comparing Instruction in Three Countries

	Germany	Japan	U.S.
• Structure			
• Objectives			
• Beliefs			
• Scripts			

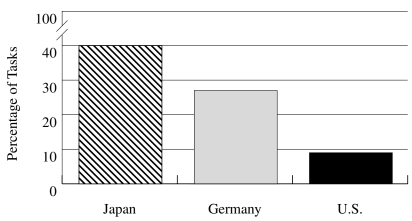
2B-9

Variations in Instructional Practice

- Lesson Structure
- Tests, Quizzes, External Exams
- Homework
- Calculators and Computers

2B-10

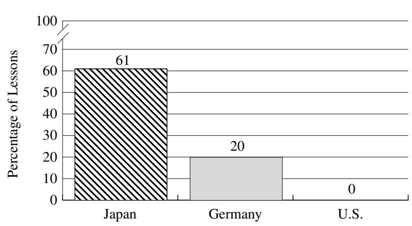
Lesson Structure—Percentages of Math Tasks that Students Decide How to Solve Rather than Using a Teacher-Prescribed Method



From: *The TIMSS Videotape Classroom Study*

2B-11

Percentages of 8th-Grade Mathematics Lessons with Instances of Mathematical (Deductive) Thinking



From: *The TIMSS Videotape Classroom Study*

2B-12

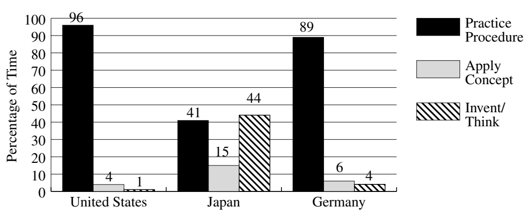
Lesson Structure—
Type of Mathematics Seatwork

What do you think?

- Practice Routine Procedures
- Apply Concept
- Invent New Solutions/Think
- Compare Japan, Germany, U.S.

2B-13

Lesson Structure—
Type of Mathematics Seatwork



From: *The TIMSS Videotape Classroom Study*

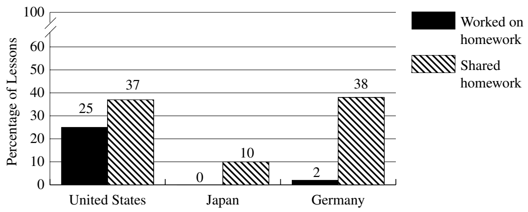
2B-14

Tests, Quizzes, External Exams

- U.S. math and science teachers test more than any other country.
- In many countries, external exams require extended student responses.

2B-15

Lessons in Which Class Worked on and Shared Homework



From: *The TIMSS Videotape Classroom Study*

2B-16

Calculators and Computers

U.S. teachers use calculators and computers as much or more than teachers in other countries when compared to the international average.

From: *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*

2B-17

Lesson Structure— Summary and Analysis

U.S. lessons…

- Demand less mathematical reasoning
- Emphasize routine procedures over inventing something new
- Use more class time for homework than in Japan or Germany
- Use tests more than other countries

2B-18

Stop and Discuss

- How do these findings compare with your observations?
- What additional issues or questions do they raise for you?

2B-19

Influences on Instructional Practices

- Deciding What to Teach
- Objectives of Lessons
- Beliefs about Mathematics Teaching
- "Scripts" that Shape Teaching

2B-20

Deciding What to Teach

"…the high achieving countries in TIMSS place greatest control in the hands of education experts, either national leaders (e.g., in Japan or Singapore) or classroom teachers (e.g., in the Czech Republic and the Netherlands). The U.S. introduces a third influence—a middle-level agency, the district school board, composed of individuals who do not work full time in education and generally are not professionally trained in the field."

From: *Global Perspectives for Local Action*

2B-21

Objectives of Lessons

- Germany — developing advanced procedures
- Japan — solving structured problems
- U.S. — learning terms and practicing procedures

From: *The TIMSS Videotape Classroom Study*

2B-22

Beliefs Inferred about Mathematics Teaching

U.S.

— Teachers value student understanding of concepts, but emphasize skills.

— Skills are mastered incrementally.

— Student confusion and frustration mean that material is not mastered.

Japan

— Students learn by struggling with problems.

— Student confusion and frustration are a natural part of the process.

From: *The TIMSS Videotape Classroom Study*

2B-23

Beliefs Inferred about Mathematics Teaching (continued)

U.S.

— Teacher's role is to demonstrate how to complete tasks and help students who are stuck.

Japan

— Teacher's role is to choose engaging problems, manage discussion to help different methods surface, and summarize.

From: *The TIMSS Videotape Classroom Study*

2B-24

Scripts Are …

Mental Images of How One Should Teach Based on Beliefs about:

- Goals for instruction
- The nature of mathematics and science
- Ways these subjects are taught that shape the characteristics of a typical lesson

From: *The TIMSS Videotape Classroom Study*

2B-25

U.S. Script for Eighth-Grade Mathematics (Inferred)

- Teacher reviews previous material, homework.
- Teacher demonstrates how to solve problem for the day.
- Students practice.
- Teacher corrects problems, assigns homework.

From: *The TIMSS Videotape Classroom Study*

2B-26

Japanese Script for Eighth-Grade Mathematics (Inferred)

- Teacher reviews previous material.
- Teacher presents problem for the day.
- Students work on problem.
- Whole class discusses solution method.
- Teacher highlights and summarizes major points.

From: *The TIMSS Videotape Classroom Study*

2B-27

Are U.S. Mathematics Teachers Implementing Reform Recommendations?

- 95% of the teachers in the video study indicated that they were "aware" or "somewhat aware" of current ideas about mathematics teaching and learning.
- 75% indicated that the lessons in the study were "a lot" or "a fair amount" in accordance with current ideas about mathematics teaching and learning.
- 20% indicated that they had implemented the focus on mathematical (deductive) thinking.

From: *Pursuing Excellence: A Study of Eighth-Grade Mathematics and Science Achievement in International Context*

2B-28

Stop and Discuss

- What are our scripts for teaching mathematics? Other subjects?
- What do the scripts and other results of the video study indicate about the implementation of reform recommendations in the U.S.?
- What additional issues/questions do these findings raise?

2B-29

Reflection and Dialogue

- In groups of four, cluster, categorize, and name the issues on Post-Its.
- Move to the table with a theme that is interesting to you. Assign a reporter and recorder. Discuss the theme.
- Briefly report out.
- Reflect on an insight gained or an action intended.

2B-30

Wrap Up

- What insight do you have or action will you take as a result of this workshop?
- How might the NCTM standards for teaching and the *National Science Education Standards* for teaching help you?

2B-31

Module 2C: What Does TIMSS Say about School Support Systems?

GOALS

- To identify the influences of school support systems on learning;
- To learn about the TIMSS findings on school support systems around the world;
- To identify alternatives to current U.S. teacher development practices; and
- To identify issues for further reflection, dialogue, and possible action that could be taken to improve the mathematics and science curricula in participants' own schools, districts, and higher education institutions.

ACTIVITIES

2C.1 Overview of Goals and Agenda (5 minutes)
2C.2 What Do We Mean by School Support Systems? Brief Overview Lecture (20 minutes)
2C.3 Collegiality and Professional Development of Teachers (20 minutes)
2C.4 "The Secret of Trapezes" (30 minutes)
2C.5 Issues for Further Reflection and Dialogue (30 minutes)

Time: 1.75 hours

SET UP AND MATERIALS

Room Arrangement and Equipment

- Tables for groups of four
- Overhead projector and screen
- Video projection unit with a large monitor
- Newsprint and markers

- Paper for note-taking and pens/pencils, plus newsprint or transparencies and markers for recorders/reporters
- Post signs that you have made (see "Make in Advance") around the room.

Order in Advance

- Videotape entitled "The Secret of Trapezes" (subtitled "Science Research Lessons on Pendulums") (This video is available from Catherine Lewis, Mills College, 5000 McArthur Blvd., Oakland, CA 94613; Phone: (510) 430-3129; FAX: (510) 430-3233; e-mail: c_lewis@post.harvard.edu.)
- Copies of the *Global Perspectives for Local Action* report for each participant (This report is available from the National Academy Press, 2101 Constitution Ave., NW, Lockbox 285, Washington, D.C. 20055; Phone: (800) 642-6242 [toll free] or (202) 334-3131 [in the Washington Metropolitan area].)

Make in Advance

- Overhead transparencies made from masters for Module 2C in this guide (Note that the presentation slides or masters are labeled Slides 2C-1 through 2C-26.)[10]
- Copy of handouts for this module (see pgs. 381-389) (one set for each participant)
- Five large signs labeled "Create Awareness," "Build Knowledge," "Translate into Practice," "Practice Teaching," and "Reflect on Practice" (Use Slides 2C-13 through 2C-17.)

FACILITATOR NOTES

2C.1
Overview of Goals and Agenda
(5 minutes)

- Welcome participants and provide them with copies of all of the handouts for this module. Then use Slides 2C-1, 2C-2, and 2C-3 to review the session's purposes and agenda. (Have people introduce themselves at their tables and share an expectation they have for the meeting. Ask for a report of a few of the expectations.)

[10] The source of data cited on masters is noted on the bottom of each master by title. For complete citations, see the "Resources" section of this guide.

2C.2
What Do We Mean by School Support Systems? Brief Overview Lecture (20 minutes)

- Let participants know that the session is designed around the National Research Council (NRC) report that looks at some of the findings of the Third International Mathematics and Science Study (TIMSS). This portion of the session will focus on Chapter 5 of the report—"What Does TIMSS Say about School Support Systems?"
- Begin by asking participants to jot down what they think of when they hear the term "school support systems." What are some of the organizational systems that influence teaching and learning? Ask participants to report their ideas to the whole group. List their ideas on newsprint or on a blank transparency, grouping similar ideas. After the report out, look at the list and name the categories. Summarize by showing Slides 2C-4 and 2C-5.
- Tell participants that many of the items on the list contribute to creating an environment or culture for learning. Using Slides 2C-6, 2C-7, 2C-8, and 2C-9, review what TIMSS found regarding *teacher time* in the U.S. as compared to other countries. In groups of four, have participants discuss the reflection questions and brainstorm possible actions around teacher time, using Slide 2C-10.
- Next, note that this session will focus on one major element of school support systems—the ways teachers learn to improve their teaching through professional development. While showing Slide 2C-11, say what is meant when we use the term *teacher learning*. Remind participants that professional development for teachers has different purposes. Review these using Slide 2C-12.

2C.3
Collegiality and Professional Development of Teachers (20 minutes)

- Point to the signs on the wall (which you created from Slides 2C-13 through 17) labeled "Create Awareness," "Build Knowledge," "Translate Knowledge into Practice," "Practice Teaching," and "Reflect on Practice." Ask participants to stand under the sign that best describes the purpose of most of the professional development experiences they have had in their school or higher education setting.

  After everyone has moved to a place, have participants look around and see where everyone is. Ask, "Where are most of you?" (Most likely, most will be positioned near "Create Awareness" and "Build Knowledge.") Ask participants, "What are the implications of focusing professional development of teachers (or college faculty) in this area?"

Then ask participants to reflect on their own needs for professional development: Do they need more knowledge building, reflecting, and so on? Ask them to move to the sign that best describes the kind of professional development they would like to have more of in their lives. Point out the moves that everyone has made and the disconnection between what most people get versus what they say they need.

Ask for a show of hands by participants who didn't move. Ask them what they think contributes to the alignment (or lack of alignment) between the professional development experiences they have had and what they need.

- Have everyone return to their seats and use Slides 2C-18, 19, and 20 to review the TIMSS findings on professional development and begin thinking about different professional learning strategies. Refer to the table at the end of the Module 2C handout packet entitled "Strategies for Professional Learning " (pgs. 388–389) and point out how the different professional development strategies there are focused on different purposes, such as practicing teaching and reflection. U.S. teachers have fewer of these types of professional development than types focused on creating awareness and building new knowledge.

2C.4
"The Secret of Trapezes"
(30 minutes)

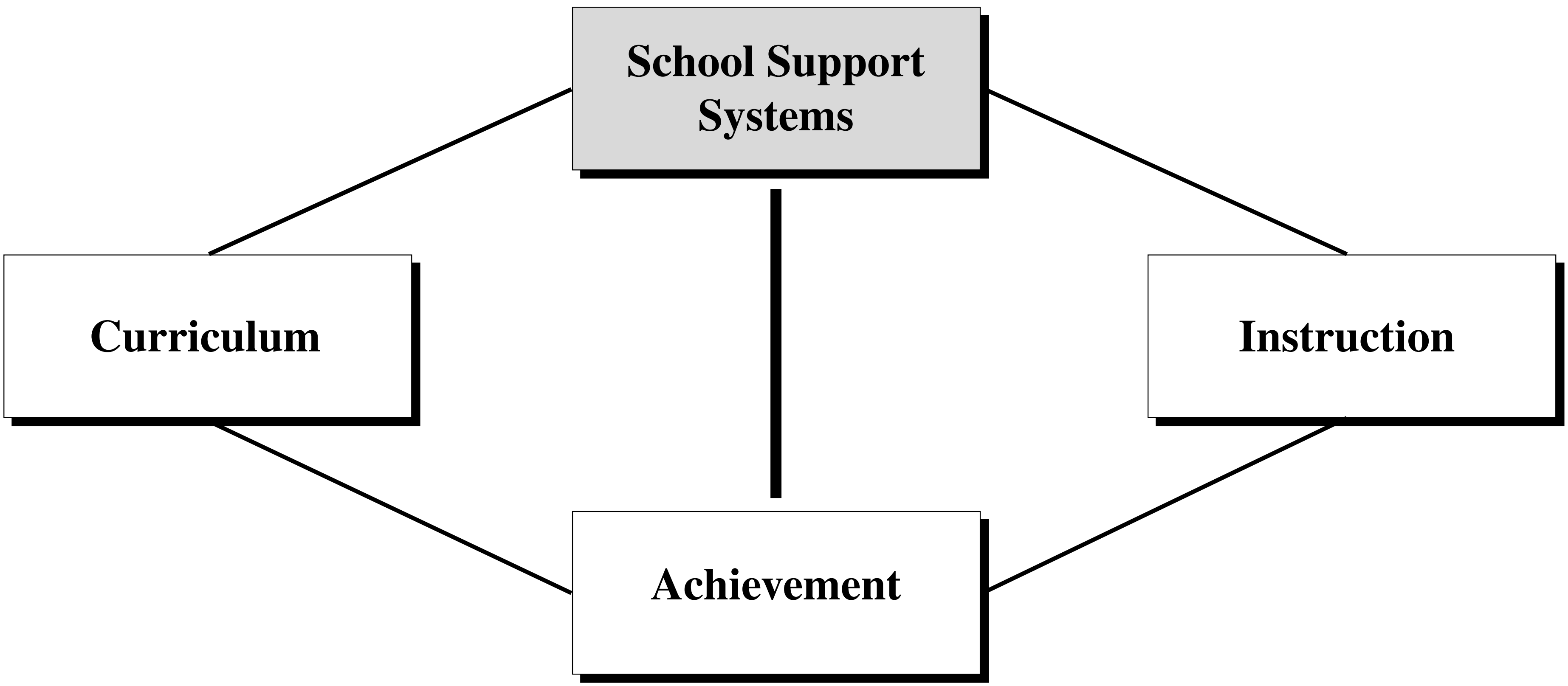
- Next, let participants know that they are going to look at one example that shows how Japanese teachers reflect deeply on and refine their teaching. The recommended video, "The Secret of Trapezes," is not from TIMSS but does provide a glimpse of collegial learning in Japan. Tell participants they will see a Japanese science lesson. In it, the teacher's colleagues are visiting to observe the class and gather data on the teacher's practice. Ask participants to view the tape as if they were one of the teachers visiting the classroom. Ask them to focus their viewing on the lesson—how it is structured, what seems to work, and what needs improvement.
- After the viewing, ask for general reactions to the professional development approach participants saw in the video. What do they think are the purposes of this type of professional learning? Write up the reactions using Slide 2C-21. Then ask what they saw and what the teacher who is teaching and the teachers who are observing could be learning from their collaboration. Next, ask participants to reflect on their own school or setting. How do they get feedback on their lessons? How might they use this practice to increase collegiality and improve their own teaching?
- Summarize while using Slides 2C-22 and 2C-23.

2C.5
Issues for Further Reflection and Dialogue
(30 minutes)

- In groups of four, ask participants to reflect on the questions on Slide 2C-24 and to generate ideas for improving teacher learning. Have the groups report out and, if needed, show Slide 2C-25 to expand the ideas they had for action.
- Wrap up: Ask participants to write about an insight that they gained and an action that they intend to take (Slide 2C-26) drawing upon the ideas generated in this session. Ask for participants to share a few insights and ideas with the whole group.
- Point out that although this module concluded with a consideration of action that can be taken, Module 3 contains a process for developing an action plan that should be completed before the improvement efforts can begin. Are there members of the group who are interested in moving to Module 3?

Module 2C: What Does TIMSS Say about School Support Systems? Slides

What Does TIMSS Say about School Support Systems?



Goals

- To identify the influences of school support systems on learning
- To learn the TIMSS findings on school support systems around the world
- To identify alternatives to current U.S. teacher development practices
- To identify issues for further reflection and dialogue and possible actions to improve the school support systems in participants' own schools, districts, and higher education institutions

Agenda

- Overview of Goals and Agenda
- What Do We Mean by School Support Systems:
  Brief Overview Lecture
- Collegiality and Professional Development of Teachers
- "The Secret of Trapezes"
- Issues for Further Reflection and Dialogue

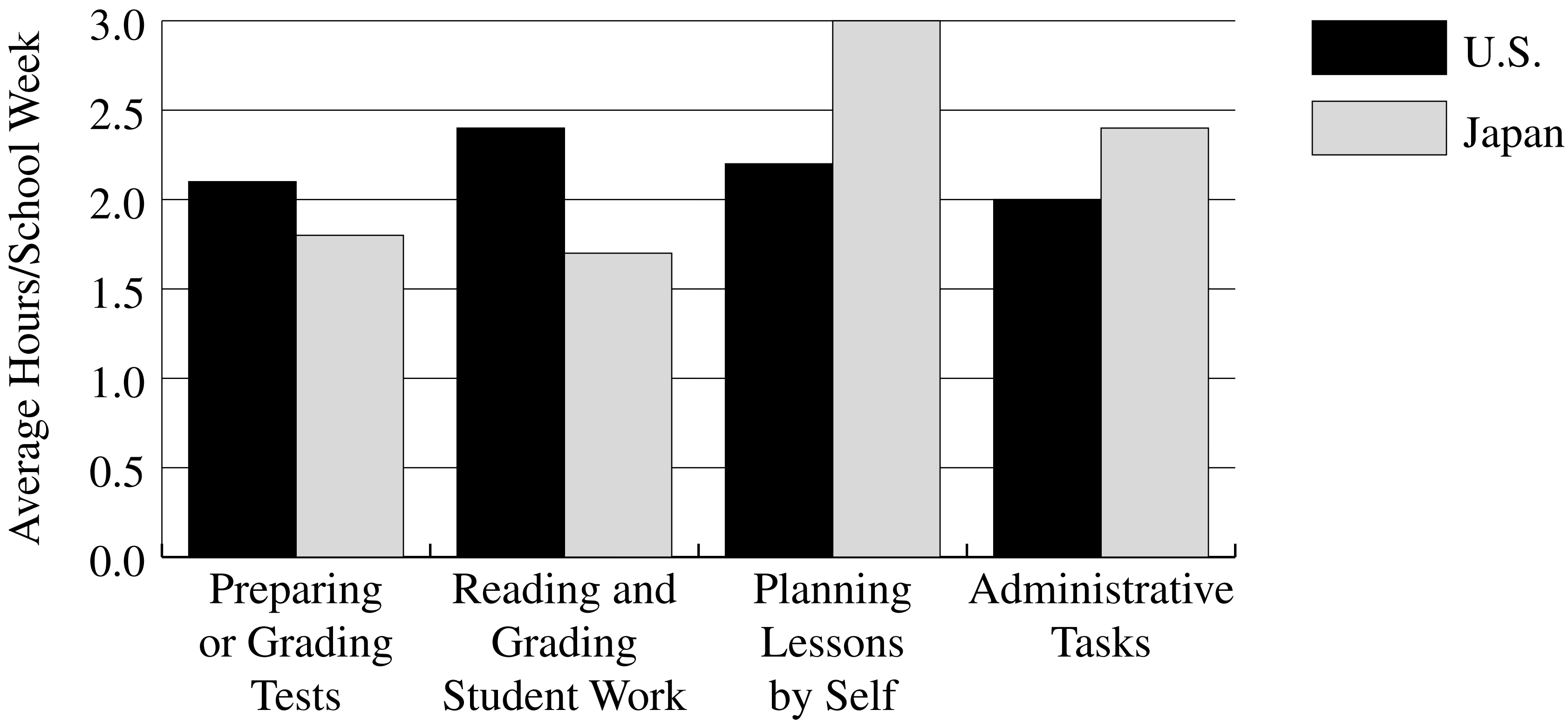
What do we mean by school support systems in the NRC report?

- Preparation and support of teachers
- Attitudes toward the profession of teaching
- Attitudes of teachers, students, and parents toward learning
- Lives of teachers and students, both in and out of school

Data about
School Support Systems

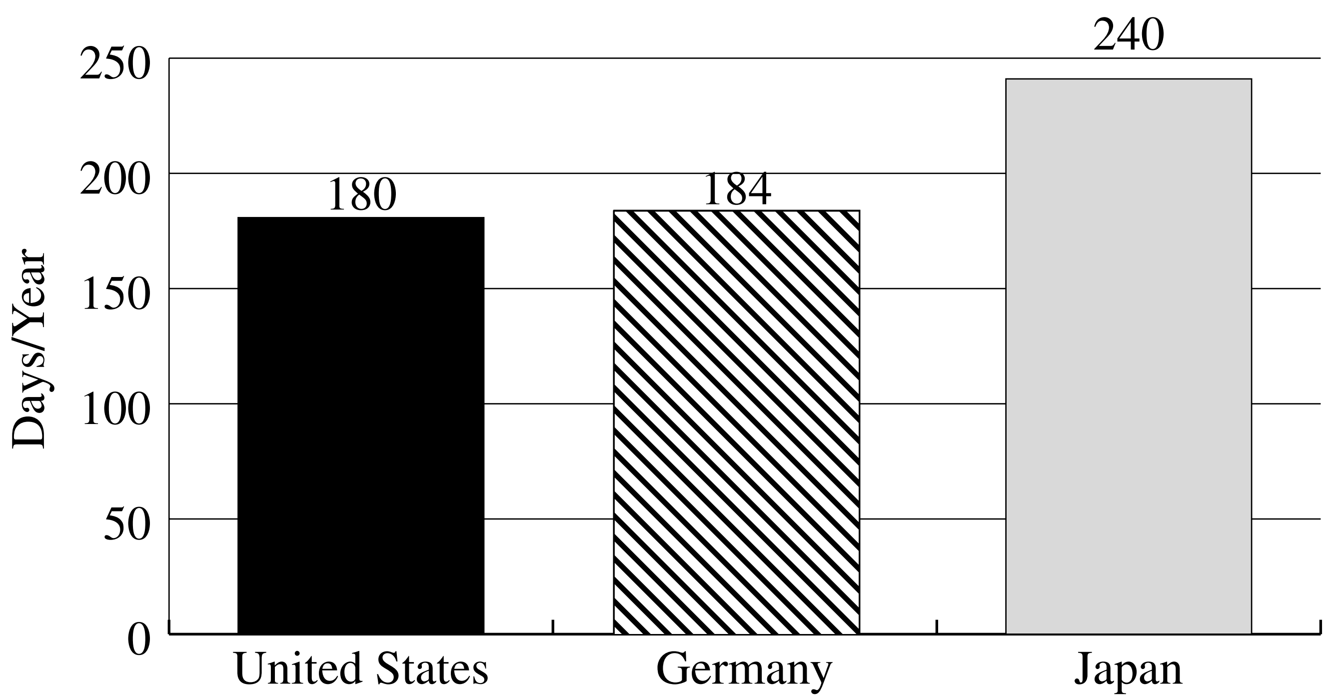
- Teachers' Time
- Teacher Learning
- Cultural Influences on Teaching
- Student Attitudes

Time Science Teachers Spend on Various Tasks



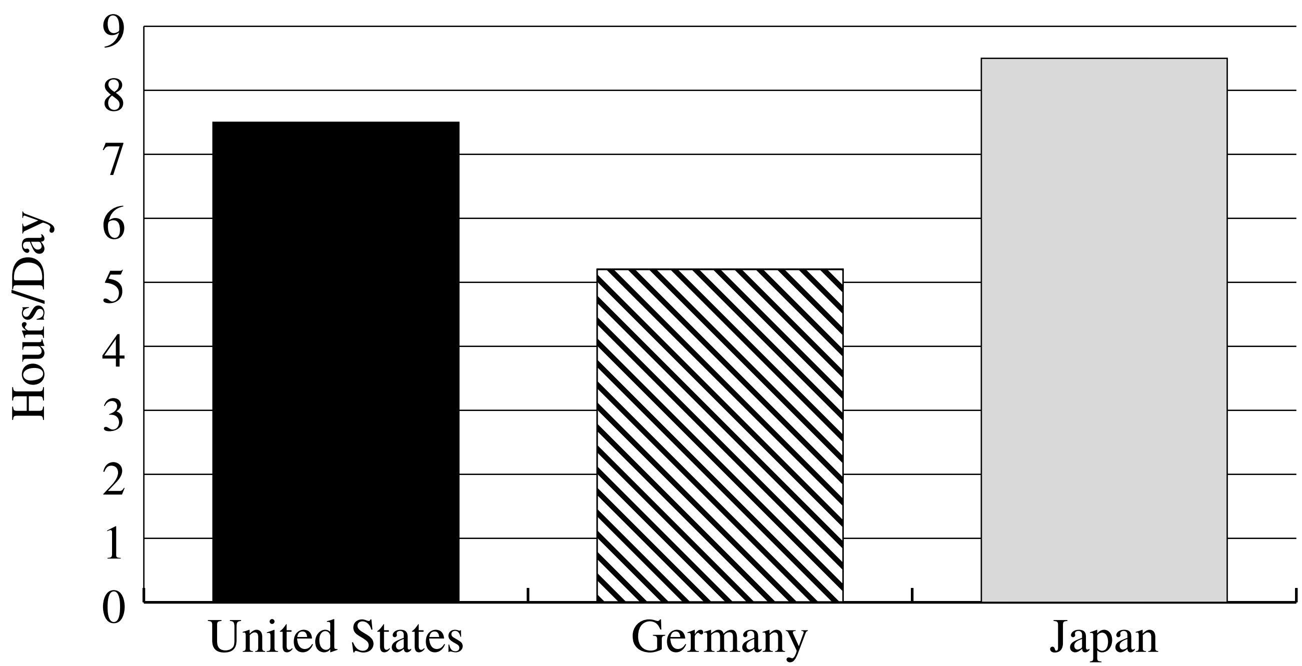
From: *Science Achievement in the Middle School Years*

Work Year of Teachers



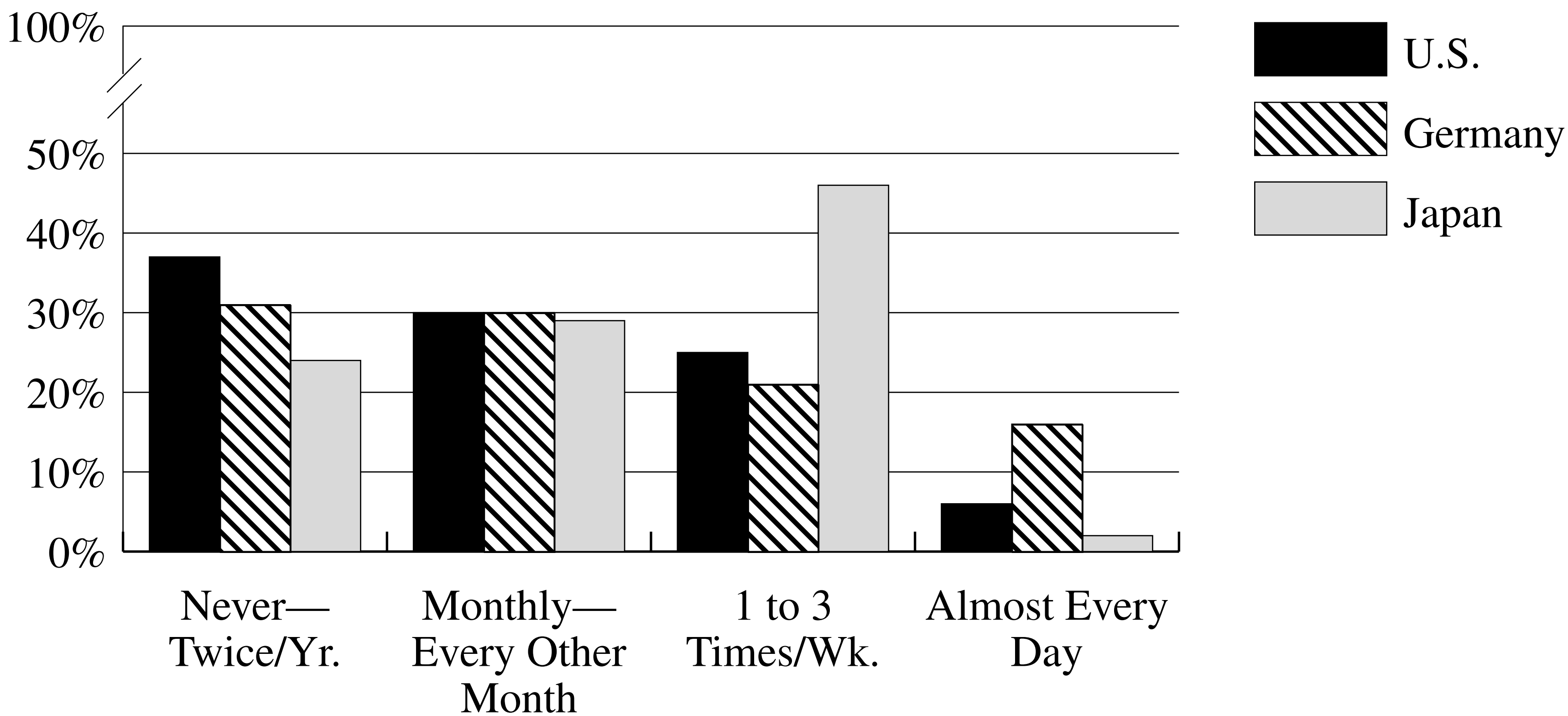
From: *Global Perspectives for Local Action*

Work Day of Teachers



From: *Global Perspectives for Local Action*

Time to Collaborate—Percent of Population 2 Students Taught Science by Teachers Who Met with Their Colleagues



From: *Science Achievement in the Middle School Years*

Reflecting on Practice

- How does the daily schedule in your setting encourage or discourage collaboration among teachers?
- How could the opportunities for collaboration among teachers be enhanced?
- What are the trade-offs to providing teachers more collaborative planning time—for example, would the average class size grow or would teachers need to do more of their planning at school?

Teacher Learning

- Teacher Preparation
- Professional Development for New Teachers
- Career-long Professional Development

Purposes of Professional Development

- Create Awareness
- Build Knowledge
- Translate Knowledge into Practice
- Practice Teaching
- Reflect on Practice

Create Awareness

Build Knowledge

Translate Knowledge into Practice

Practice Teaching

Reflect on Practice

Professional Development for New Teachers

U.S.

expects beginning teachers to take on immediately the same duties and schedules as their more experienced peers, typically without formal assistance.

Japan

assigns a mentor and requires additional study for first-year teachers.

Germany

requires all new teachers to participate in a two-year, field-based student teaching experience.

From: *Global Perspectives for Local Action*

Professional Development

Japan

locates professional development close to the classroom and regards teachers as primary resources.

U.S.

teachers are "only peripherally aware" of approaches to professional development that grow out of practice and that allow them to "study and improve their own practice."

Top quote from: *Global Perspectives for Local Action*
Bottom quote from: "Teachers and the Teaching Profession in the United States"

In Japan,

some teachers engage in mandatory professional development away from their school in the sixth, tenth, and twentieth years.

In the U.S.,

teachers' formal opportunities for professional growth are infrequent. Teachers get little guidance about particular paths of study or career development.

From: *Global Perspectives for Local Action*

Purposes of Professional Learning Strategies

Summary

- Teacher learning at the pre-service, novice, and experienced teacher levels varies widely.
- Japanese professional development emphasizes the improvement of teaching lessons and the teacher as a resource.
- Teachers in Japan learn from one another through mentorship and teacher-run study groups.

Summary (continued)

- In the U.S., teachers engage in more short-term, expert-led workshops.
- In Japan, many beginning teachers have a structured development plan and a lighter schedule to support their development.

Reflecting on Practice

- How are new teachers inducted in your setting? Who is involved, and what is involved? To what end?
- To what extent is professional development relevant, focused, and coherent? What are the focal areas, methods, and content, and how are these aligned with learning goals?
- How is teacher development organized across the career of a teacher? What kinds of opportunities exist for what kinds of learning?
- Do teachers engage in collaborative learning through teacher-led study groups, examination of student work, or videotaped classroom lessons? How could you increase collaborative learning?

Implications for Action for Teacher Learning

- Create opportunities for teachers to collaborate.
- Recognize teacher expertise.
- Provide opportunities for teachers to share what they know with each other.
- Assign mentors for beginning teachers and provide time for mentoring.
- Have teachers create individual professional development plans.

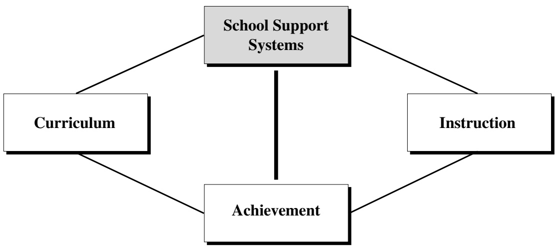
Wrap Up

An insight you have gained.

An action you intend to take.

Module 2C:
What Does TIMSS Say about School Support Systems?
Handouts

What Does TIMSS Say about School Support Systems?



2C-1

Goals

- To identify the influences of school support systems on learning
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2C-2

Agenda

- Overview of Goals and Agenda
- What Do We Mean by School Support Systems: Brief Overview Lecture
- Collegiality and Professional Development of Teachers
- "The Secret of Trapezes"
- Issues for Further Reflection and Dialogue

2C-3

What do we mean by school support systems in the NRC report?

- Preparation and support of teachers
- Attitudes toward the profession of teaching
- Attitudes of teachers, students, and parents toward learning
- Lives of teachers and students, both in and out of school

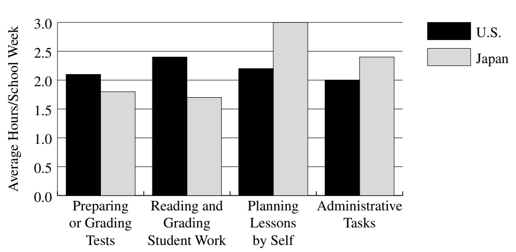
2C-4

Data about School Support Systems

- Teachers' Time
- Teacher Learning
- Cultural Influences on Teaching
- Student Attitudes

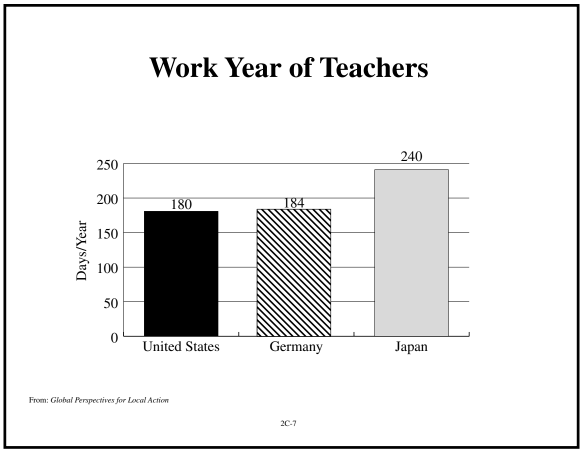
2C-5

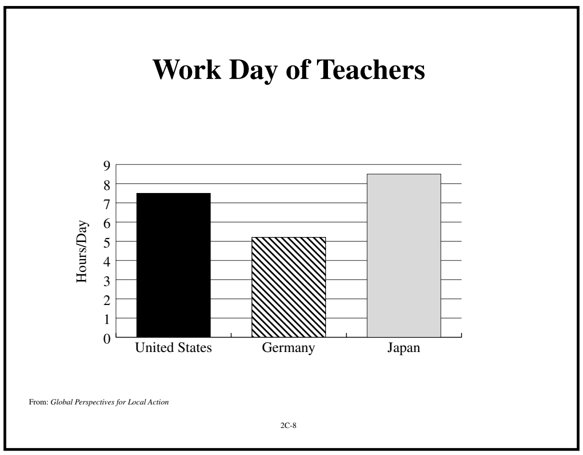
Time Science Teachers Spend on Various Tasks

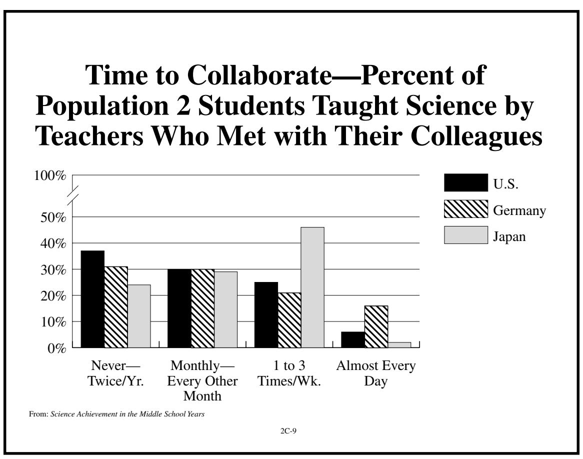


From: *Science Achievement in the Middle School Years*

2C-6


Work Year of Teachers
Days/Year
250
200
150
100
50
0
180
184
240
United States
Germany
Japan
From: Global Perspectives for Local Action
2C-7


Work Day of Teachers
Hours/Day
9
8
7
6
5
4
3
2
1
0
United States
Germany
Japan
From: Global Perspectives for Local Action
2C-8


Time to Collaborate—Percent of Population 2 Students Taught Science by Teachers Who Met with Their Colleagues
100%
50%
40%
30%
20%
10%
0%
U.S.
Germany
Japan
Never—Twice/Yr.
Monthly—Every Other Month
1 to 3 Times/Wk.
Almost Every Day
From: Science Achievement in the Middle School Years
2C-9

Reflecting on Practice

- How does the daily schedule in your setting encourage or discourage collaboration among teachers?
- How could the opportunities for collaboration among teachers be enhanced?
- What are the trade-offs to providing teachers more collaborative planning time—for example, would the average class size grow or would teachers need to do more of their planning at school?

2C-10

Teacher Learning

- Teacher Preparation
- Professional Development for New Teachers
- Career-long Professional Development

2C-11

Purposes of Professional Development

- Create Awareness
- Build Knowledge
- Translate Knowledge into Practice
- Practice Teaching
- Reflect on Practice

2C-12

Professional Development for New Teachers

U.S.
expects beginning teachers to take on immediately the same duties and schedules as their more experienced peers, typically without formal assistance.

Japan
assigns a mentor and requires additional study for first-year teachers.

Germany
requires all new teachers to participate in a two-year, field-based student teaching experience.

From: *Global Perspectives for Local Action*

2C-18

Professional Development

Japan
locates professional development close to the classroom and regards teachers as primary resources.

U.S.
teachers are "only peripherally aware" of approaches to professional development that grow out of practice and that allow them to "study and improve their own practice."

Top quote from: *Global Perspectives for Local Action*
Bottom quote from: "Teachers and the Teaching Profession in the United States"

2C-19

In Japan,
some teachers engage in mandatory professional development away from their school in the sixth, tenth, and twentieth years.

In the U.S.,
teachers' formal opportunities for professional growth are infrequent. Teachers get little guidance about particular paths of study or career development.

From: *Global Perspectives for Local Action*

2C-20

Purposes of Professional Learning Strategies

2C-21

Summary

- Teacher learning at the pre-service, novice, and experienced teacher levels varies widely.
- Japanese professional development emphasizes the improvement of teaching lessons and the teacher as a resource.
- Teachers in Japan learn from one another through mentorship and teacher-run study groups.

2C-22

Summary (continued)

- In the U.S., teachers engage in more short-term, expert-led workshops.
- In Japan, many beginning teachers have a structured development plan and a lighter schedule to support their development.

2C-23

Reflecting on Practice

- How are new teachers inducted in your setting? Who is involved, and what is involved? To what end?
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- Do teachers engage in collaborative learning through teacher-led study groups, examination of student work, or videotaped classroom lessons? How could you increase collaborative learning?

2C-24

Implications for Action for Teacher Learning

- Create opportunities for teachers to collaborate.
- Recognize teacher expertise.
- Provide opportunities for teachers to share what they know with each other.
- Assign mentors for beginning teachers and provide time for mentoring.
- Have teachers create individual professional development plans.

2C-25

Wrap Up

An insight you have gained.

An action you intend to take.

2C-26

Strategies for Professional Learning

STRATEGIES	PURPOSES* A	B	C	D	E
1. Immersion in Inquiry into Science and Mathematics: Engaging in the kinds of learning that teachers are expected to practice with their students—that is, inquiry-based science investigations or meaningful mathematics problem solving.	❏	■			■
2. Immersion into the World of Scientists and Mathematicians: Participating in an intensive experience in the day-to-day work of a scientist or mathematician, often in a laboratory, industry, or museum, with full engagement in research activities.	❏	■			
3. Curriculum Implementation: Learning, using, and refining use of a particular set of instructional materials in the classroom.		❏	❏	■	
4. Curriculum Replacement Units: Implementing a unit of instruction that addresses one topic or concept and incorporates effective teaching techniques and learning strategies to accomplish learning goals.		❏	❏	■	
5. Curriculum Development and Adaptation: Creating new instructional materials and strategies or tailoring existing ones to meet the learning needs of students.		❏	■		
6. Workshops, Institutes, Courses, and Seminars: Using structured opportunities outside the classroom to focus intensely on topics of interest, including science or mathematics content, and learn from others with more expertise.	❏	■	❏		
7. Action Research: Examining teachers' own teaching and their student's learning by engaging in a research project in their classroom.		❏			■
8. Case Discussions: Examining written narratives or videotapes of classroom teaching and learning and discussing what is happening, the problems, issues, and outcomes that ensue.	❏	❏			■

■ = Primary
❏ = Secondary

PURPOSES:

A. Strategies that focus on developing ***awareness*** are usually used during the beginning phases of a change, which calls for introducing teachers to new approaches or content. The strategies are designed to raise awareness through the introduction of new information and to elicit thoughtful questioning on the part of the teachers concerning the new information.

B. Strategies that focus on ***building knowledge*** provide opportunities for teachers to increase their understanding of science and mathematics content and teaching practices.

C. Strategies that help teachers ***translate new knowledge into practice*** engage teachers in drawing on their knowledge base to plan instruction and improve their teaching.

D. Strategies that focus on ***practicing teaching*** help teachers learn through the process of using a new approach, practice, or process with their students. As they practice new moves in their classrooms, they increase their understanding and their skills.

E. Strategies that provide opportunities to ***reflect deeply on teaching and learning*** engage teachers in examining their experiences in the classroom, assessing the impact of the changes they have made on their students, and thinking about ways to improve. The strategies also encourage teachers to reflect on others' practice, relating it to their own and generating ideas for improvement.

Strategies for Professional Learning (continued)

STRATEGIES	PURPOSES A	B	C	D	E
9. Study Groups: Engaging in regular, structured, and collaborative interactions regarding topics identified by the group, with opportunities to examine new information, reflect on their practice, or assess and analyze outcome data.	❏		❏		■
10. Examining Student Work and Student Thinking and Scoring Assessments: Carefully examining students' work and products to understand their thinking and learning strategies and identify their learning needs and appropriate teaching strategies and materials.	❏	❏	❏		■
11. Coaching and Mentoring: Working one-on-one with an equally or more experienced teacher to improve teaching and learning through a variety of activities, including classroom observation and feedback, problem solving, and co-planning.		❏	❏	■	❏
12. Partnerships with Scientists and Mathematicians in Business, Industry, and Universities: Working collaboratively with practicing scientists and mathematicians with the focus on improving teacher content knowledge, instructional materials, access to facilities, and acquiring new information.	❏	■			
13. Professional Networks: Linking in person or through electronic means with other teachers or groups to explore and discuss topics of interest, set and pursue common goals, and address common problems.	❏	■	❏		❏
14. Developing Professional Developers: Building the skills and knowledge needed to create learning experiences for other educators, including design of appropriate professional development strategies; presenting, demonstrating, and supporting teacher learning and change; and understanding in depth the content and pedagogy required for effective teaching and learning of students and other educators.		❏	❏	■	❏
15. Technology for Professional Learning: Using various kinds of technology, including computers, telecommunications, videoconferencing, and CD-ROMs and videodiscs to learn content and pedagogy.	❏	■	❏		❏

■ = Primary
❏ = Secondary

"Strategies for Professional Learning" table adapted from *Designing Professional Development for Teachers of Science and Mathematics* by Susan Loucks-Horsley, Peter W. Hewson, Nancy Love, and Katherine E. Stiles, with Hubert M. Dyasi, Susan N. Friel, Judith Mumme, Cary I. Sneider, and Karen L. Worth (Thousand Oaks, CA: Corwin Press, 1998). The book is a product of the National Institute for Science Education, funded by the National Science Foundation.

*The "Purposes" section of this table was adapted from a framework devised by QUASAR project researchers (Brown and Smith, 1997).

Module 3: Global Perspectives for Local Action Planning

OVERVIEW

Modules 1 and 2 of this guide provide formats for workshop sessions. Module 3 is different because it is designed to provide guidance and structure for action planning. It is for use by local teams conducting inquiry and action planning regarding mathematics and/or science education in individual schools or school districts based on the TIMSS findings. Working with this module will provide these teams with a framework for continuous improvement of their mathematics and/or science program (a process that often requires many years).

Facilitators may use the Module 3 materials to assist local teams or local teams may use the materials without a facilitator. If local teams use Module 3 without a facilitator, it is essential that team members have a good grasp of the information in Modules 1 and 2 of this guide and of the information provided in the National Research Council (NRC) report, *Global Perspectives for Local Action* (see "Resources"). This will ensure that the teams have the background needed to make good decisions during the action planning process.

If groups from different schools and districts are working through Module 3 together, it is recommended that facilitators be used to ensure ample representation from each different school or district and to permit meaningful planning focused on individual sites.

Module 3 has two parts: Part A, which will help teams set up a process for their investigations and action planning, and Part B, which will help teams begin to execute the process.

Part A: The Inquiry and Action-Planning Process

The NRC's *Global Perspectives for Local Action* report is, at its core, a call to teachers, educational administrators, higher education staff, and the interested public to use the TIMSS findings to examine their own practices and the results of these practices more closely and consciously. It invites these audiences to inquire into their own curriculum, teaching, and school practices and to think about and plan actions they could take to address problems and improve student learning. Where school and district planning, accreditation, and improvement teams already exist, Module 3 can help these teams employ the TIMSS findings to plan improvements in mathematics and science curricula, instruction, and school culture.

Module 3 contains

- Vignettes of schools that are using TIMSS to improve mathematics and science education;
- Ideas for how to get started with action planning;
- An eight-stage inquiry process, along with examples and forms; and
- Planning templates for achievement, curriculum, instruction, and school support systems that include a summary of relevant TIMSS data, possible questions and data sources for inquiring into practice, and ideas for action planning.

Several school districts around the country are using TIMSS as a springboard for reflection and action to improve mathematics and science education. Lessons can be drawn from an urban school in Paterson, New Jersey, schools involved in the First in the World Consortium in Chicago's northern suburbs, and the Lake Shore School District in Michigan. The vignettes on pgs. 393–397 from these sites offer some images of actions others around the country could take to improve their local mathematics and science education.

TIMSS-INSPIRED LEARNING IN AN URBAN SCHOOL— MIMICRY OR DEEP CHANGE?

"Last year the book did the thinking. This year we did the thinking." That's how one eighth-grader recently described the change in how she is learning mathematics at the Paterson School #2 in Paterson, New Jersey. What you might see in her classroom are students grappling with complex mathematical problems, presenting solutions, and discussing their solution methods, while the teacher analyzes errors. That approach builds on what students know, develops their thinking, and drives home the major concept of the lesson. Students are highly engaged and are communicating with each other about mathematics. The level of mathematics is a good half-year ahead of what it used to be.

The rigor and structure of eighth-grade mathematics lessons at Paterson School #2 closely resemble typical Japanese lessons. That is not an accident. For the last two years, a group of the school's teachers, with the full support and active participation of the principal, have undertaken careful study of TIMSS. This has led them to examine closely their own beliefs about teaching mathematics, to conduct action research into classroom practice, and to change dramatically their approach to instruction.

Although some observers have mistaken a class of Paterson School #2 eighth-graders for a class of gifted and talented students, the class is, in fact, composed of regular students from a historically poor-performing, urban school where 98% of students qualify for free lunch, 30% are bilingual, and virtually 100% are Latino, African-American, or Bengali. What has made the difference is that the teachers have been transforming the way they teach mathematics with TIMSS as the catalyst. Coinciding with these changes has been a 20% jump in the school's state mathematics test scores.

It all began in the spring of 1997, when Dr. Frank Smith from Columbia University presented a three-day TIMSS workshop to the district, which included showing the TIMSS videotapes of eighth-grade mathematics classrooms in Japan, Germany, and the U.S. One eighth-grade mathematics teacher was hooked immediately. "I read everything about TIMSS and constructivist teaching that I could get my hands on. Then I started to think we could teach more the way the Japanese did, so I tried it. I gave my students interesting problems to solve instead of presenting them with information. The lessons worked out incredibly well, " Bill Jackson explains.

Since then, with funding for summer curriculum work arranged by principal Lynn Liptak, eighth-grade mathematics teachers have developed 100 "Japanese-style" lessons. "What's amazing," says Jackson, "is that the students took to the lessons immediately. Not that things went perfectly. They didn't. But we started seeing them do some very sophisticated mathematics."

TIMSS researcher James Hiebert agreed when he recently viewed videos of

Jackson's classrooms. "Perhaps the strongest impression is of students seriously engaging in thinking and reasoning mathematically, a surprising rare phenomenon in American classrooms."

Paterson staff admit that their lessons began as mimicry, but they don't think that is necessarily bad. "Of course, real change is not just a matter of simplistically imitating steps," comments Lynn Liptak. "But it is important to start somewhere, even if it is simplistic, initially."

What began as mimicry has grown into something much deeper—at the level of changing teachers' beliefs about teaching and learning mathematics. What's more, their TIMSS-inspired lessons have given rise to ongoing professional development for the entire staff. For example, eighth-grade teachers meet weekly with the principal to discuss how their lessons are going, to study relevant research, and to "polish the stone."

In addition, these teachers are part of a school-wide "Math Study Group," where teachers from grades 1-8 and the principal meet regularly to inquire into teaching and learning mathematics and to examine their own practices and beliefs. In addition to studying the TIMSS findings and videos, they share videos of each other's classes, analyze the assumptions and beliefs that underlie their own practice, and conduct action research. One action research project involved eighth-grade students analyzing TIMSS Japanese and U.S. geometry lessons and developing lessons for lower-grade students using the steps of the Japanese lesson. In another project, a second-grade teacher divided her students in half and taught one group using a traditional approach and the other using the Japanese style. She concluded that both cognitive and linguistic production were more complex during the Japanese-style lessons.

TIMSS has also inspired school staff to rethink their mathematics curriculum K-8. "Our curriculum is a mile wide and an inch deep. When we look at how students learn and how our beliefs and practice have changed, we had to look at our curriculum. We are moving to fewer topics in more depth," Liptak explains.

It is no surprise that Paterson School #2 also is looking into Japanese research lessons, a staff development process through which lessons are continually refined and honed through teachers observing each other and sharing insights. They are also tapping many other outside resources, including Columbia University and the Mid-Atlantic Eisenhower Consortium at Research for Better Schools.

"You can't take the TIMSS information or the Japanese teaching style and just implement it without having conversations about what teaching should look like," warns Bill Jackson. On the other hand, when study of TIMSS is combined with collaborative inquiry into teaching and learning and strong administrative support, the results can be dramatic. Paterson School #2 is living proof.

(For more information, contact Lynn Liptak, Principal, School #2, 22 Passaic St., Paterson, NJ 07501; Phone: (973) 881-6002; e-mail: lliptak3@aol.com.)

FIRST IN THE WORLD CONSORTIUM— BENCHMARKING WITH TIMSS IN A MULTI-DISTRICT PARTNERSHIP

The First in the World Consortium is not shy about its ambitious agenda. As its title reflects, the Consortium's goal is to work together to achieve National Education Goal #5: "U.S. students will be first in the world in mathematics and science achievement." An outgrowth of a study group of superintendents from Chicago's North Shore, the Consortium is a collaboration of 19 school districts, representing 32 elementary schools, 17 middle schools, and 6 high schools in suburban Chicago. By leveraging federal resources and engaging Congressional support, the Consortium has mounted a well-resourced effort to administer TIMSS student achievement tests and teacher and student surveys locally to benchmark its schools' performance against world-class standards. The results are now being used to create a forum for dialogue with business and government leaders, to inform local decision-making, and to foster instructional improvement and professional growth.

At the heart of the First in the World initiative are teacher learning networks—learning communities comprising teachers from each of the Consortium's school districts. Seventy-five teachers are now active in four different learning networks: curriculum standards, models of instruction, assessment, and technology. Learning networks are teacher-directed, with their primary purpose being to promote teachers' own learning about their focus area. Participants meet monthly to study TIMSS and local data, access relevant research and resources, and take what they are learning back to their own schools and classrooms.

Sue Winski, a teacher at the Field Middle School in Northbrook, Illinois, describes her work with the models of instruction network: "We didn't just look at what was happening in other countries. We got into a full examination of our own practice. For example, in our learning network, we studied the results on homework. The Japanese don't spend a lot of time on homework, but we do. Then I began to look at the type of homework I was giving. Was it relevant? Challenging? I've been keeping a journal about my own homework assignments and how the students react to them."

Teacher learning networks are supported by the instructional support network, a group of curriculum and instructional directors who provide technical assistance to the networks, and by staff from the North Central Regional Education Laboratory (NCREL). In addition to helping to conceptualize and launch the learning network structure, NCREL and its Midwest Consortium for Mathematics and Science Education have become active participants in the planning and evaluation of Consortium activities.

Clearly, not every group of school districts has the resources of the First in the World Consortium to mount the comprehensive use of TIMSS. Still, the

Consortium's work to date provides some valuable lessons: the importance of a common and coherent vision; the value of collaboration with other school districts, universities, research centers, and other partners; the power of data as a vehicle for inquiry and self-reflection; and the importance of building infrastructures, such as learning networks, that sustain teacher growth.

(For more information, contact Paul L. Kimmelman, Superintendent, School District #31, 3131 Techny Rd., Northbrook, IL 60062; Phone (847) 272-6880; e-mail: Pkimmelm@dist31.k12.il.us.)

TIMSS SPARKS DISTRICT-BASED CURRICULUM REFORM

Lake Shore Public Schools is a small school district just outside of Detroit— in the heartland of America's auto industry. But the district's approach to education is far from parochial. The district's schools are making changes in their curriculum with the benefit of an international perspective.

In collaboration with research scientists from the University of Michigan's Center for Human Growth and Development, the district is piloting the "M-Math Program," an elementary school mathematics curriculum based on East Asian approaches to teaching mathematics. The program features well-defined content in five strands of mathematics (consistent with National Council of Teachers of Mathematics [NCTM] standards) and laid out so that students can learn and master concepts systematically and sequentially. It also emphasizes the use of manipulatives, with an emphasis on student reasoning and discussion. While "M-Math" contains fewer topics than traditional U.S. mathematics curriculums, students are expected to master all the concepts, thereby eliminating repetition from year to year.

"We looked closely at TIMSS and tried to figure out what it said and what it didn't say," Lake Shore Superintendent John Brackett explains. "Inquiry learning, introducing students to fewer concepts, and working toward mastery just made good sense to us. We decided to implement the 'M-Math Program' because it had those features and was an opportunity to do something better for our students, not because Japan or Singapore scored higher than the U.S."

Lake Shore administrators were influenced not just by TIMSS but by analysis of their own students' mathematics achievement and curriculum. Performance on mathematics problem solving was unsatisfactory, and the curriculum was not aligned with state frameworks. "M-Math" is very much in keeping with the state frameworks and has already produced encouraging achievement results. For example, students participating in the first-grade pilot test are achieving 95% or greater mastery on concepts taught.

Lake Shore's approach to curriculum implementation is to take it slow. The district started with grade one in one building and is gradually phasing in the program in grades 1-5, one grade level at a time. Each cohort of teachers will participate in in-depth professional development, including summer training and follow-up sessions with University of Michigan staff, to enhance their knowledge of mathematics and pedagogy within the context of the curriculum. In addition, teachers will have the opportunity to meet regularly and observe each other's classrooms.

"We're not just realigning our curriculum," Brackett summarizes. "We're supporting a different way of teaching, a different way of thinking."

(For more information, contact John R. Brackett, Superintendent, Lake Shore Public Schools, St. Clair Shores, MI; Phone (810) 285-8480; e-mail: jb4mlak@moa.net.)

GETTING STARTED WITH ACTION PLANNING: THE ACTION-PLANNING TEAM

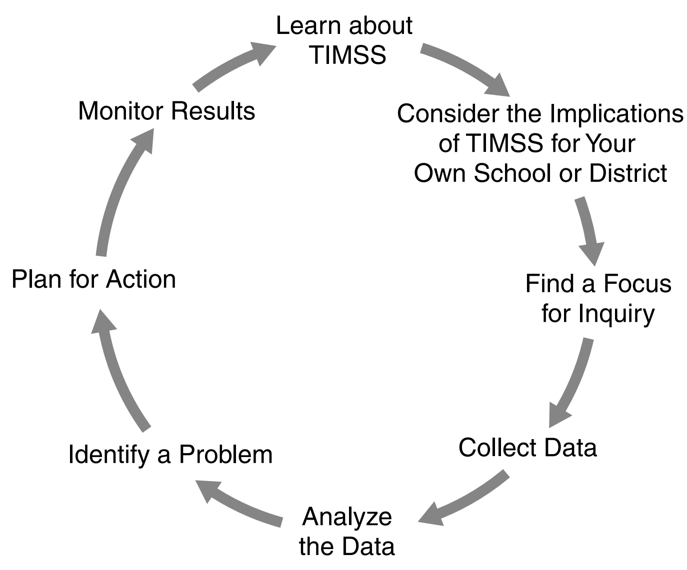
As illustrated in the vignettes, local sites can take different actions to use TIMSS to improve mathematics and/or science education. Module 3 provides a process for local school teams to use to plan the actions that are best for them.

There are several things to consider in using Module 3. First, the team or group that will engage in the action planning process needs to be identified. Asking questions about school practices should not be an add-on to existing duties and responsibilities, however. Rather, it should be viewed as helping to further the work and planning of existing efforts. Think about what teams or groups your school or district has in place to make decisions or recommendations about curriculum, professional development, or changes in school programs. Subject area curriculum groups, accreditation teams, or school-based management groups are a good place to start. These types of teams are often charged with reviewing and selecting new curriculum or textbooks, planning professional development programs for teachers, or making decisions about scheduling and teacher time that affect school culture. People and teams with these responsibilities would likely enhance their effectiveness by investigating the questions that TIMSS raises.

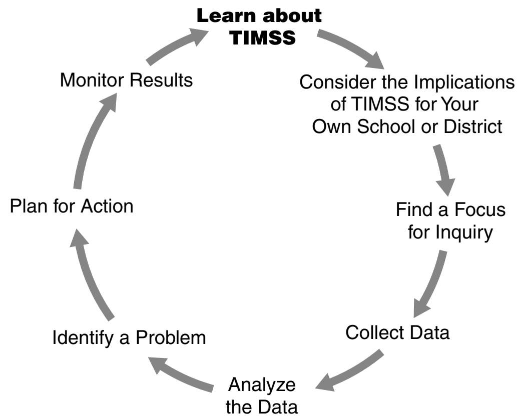
THE INQUIRY PROCESS

The following eight-stage Inquiry Process will guide you as you use TIMSS to inquire into the practices in your setting. Use it to guide your action-planning group through each of the stages.

The cycle includes



In the section that follows, each of these stages in the Inquiry Process is described, and examples are given. Part B provides templates of forms that can used during each stage's activities.



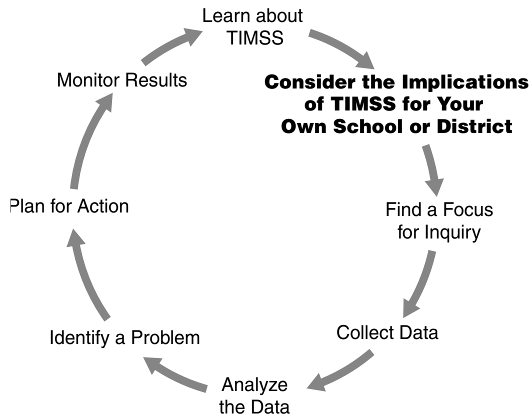
Stage 1—Learn about TIMSS

The first step in using TIMSS as a catalyst for reflection and improvement of the teaching and learning of mathematics and science is learning about the TIMSS findings. At this stage, it is important to go beyond TIMSS "sound bites" to begin to understand the study in all of its richness and complexity. TIMSS does not provide us with simple answers to complex problems but, rather, offers us the benefit of an international perspective from which to view our own practice. Before your action teams can think about TIMSS implications for their own work, they need to know what TIMSS says and what it doesn't say.

Everyone who is involved in the planning team should learn the materials found in Modules 1 and 2A, 2B, and 2C of this guide and read the NRC report referred to in the introduction of this module. Learning about TIMSS can take a variety of forms. You can

- Organize several sessions for the planning team to work through the information in Modules 1 and 2A, 2B, and 2C to give team members the background they need to use the TIMSS findings to study their own practices;
- Form a TIMSS study group to delve more deeply into specific aspects of TIMSS, such as the curriculum or instruction findings. Read and discuss *Global Perspectives for Local Action* and other reports on TIMSS referenced in the "Resources" section of this guide; and
- View and discuss the TIMSS Videotape Study, which focuses on different questions about instruction and content (refer to the *Moderator's Guide to Eighth-Grade Mathematics Lessons: United States, Japan, and Germany* [U.S. DoEd., 1997d] listed in the "Resources" section of this guide).

Consider what other key audiences you need to educate about TIMSS to build support for your improvement efforts, including parents, school board members, and other members of the school community. Offer a Module 1 session to help these key audiences learn more about TIMSS and support your efforts.



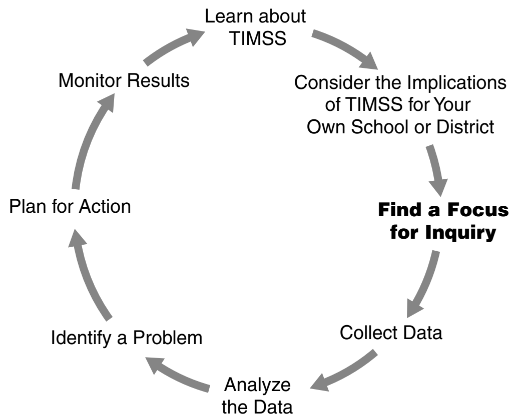
Stage 2—Consider the Implications of TIMSS for Your Own School or District

As your action-planning team learns more about TIMSS, keep bringing the conversation back to your own school or district. At this stage, your planning team can engage in open-ended exploration about what the TIMSS findings mean for you, reflecting on questions such as

- How do TIMSS achievement findings compare with our students' achievement? Do we share some of the same strengths and weaknesses?
- What are the leverage points for improving student learning in mathematics and science in our school or district?
- Do any of the curriculum findings raise questions about our curriculum?
- Do the video study findings make us aware of teaching practices we may not have noticed?
- How can we strengthen the systems of support in our setting?

The questions embedded in the NRC report offer useful prompts for reflection and dialogue. In addition, Modules 1 and 2 provide opportunities for generating further thinking and discussion about the implications of TIMSS for the work of your team.

Once your action team has explored TIMSS findings and implications for its work, the team may be eager to take action. But the last thing the authors of the NRC report want is for schools or districts to leap to action based on TIMSS without thoughtful analysis and planning. Instead, action teams are urged to make a commitment to more rigorous inquiry into their own practices, using data to target local problems and to guide local action planning.



Stage 3—Find a Focus for Inquiry

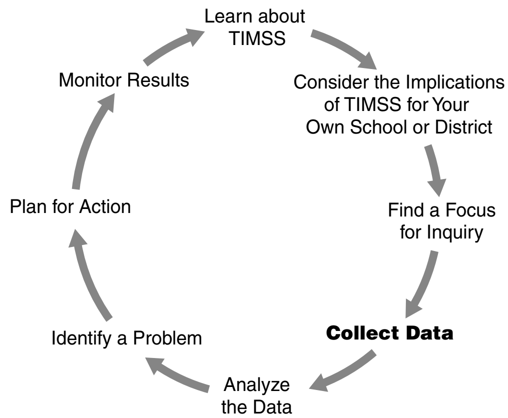
Once the team has made a commitment to inquire into local mathematics and science practice, the next step is to find a focus. The NRC report emphasizes how interconnected curriculum, instruction, and school support systems are and that they alone are not the only influences on student achievement. Yet, it is impossible to move full throttle ahead in all of these areas at the same time. While keeping in mind the many other factors at play, the team will need to make a decision about where to start. So, where to begin the inquiry?

To guide your team's decision, consider the following:

- What student learning data do you already have? What do they tell you about priority needs and problem areas?
- What improvement efforts in curriculum, instruction, or school support systems are already underway that you can build on?
- What are areas of high concern among staff, students, parents? What focus is most likely to mobilize support for change?
- What do you already know about strengths and weaknesses in curriculum, instruction, and school support structures that suggest priorities?
- What are you most curious about? Excited about?
- What is manageable right now given your available resources?

Example

> **Focus**
>
> *We want to investigate the coherence and focus of our mathematics curriculum.*



Stage 4—Collect Data

Once the team has chosen a focus, members are ready to start thinking about data collection. TIMSS reinforces the importance of using sound, reliable data to guide decision-making. Data are as useful for local improvement efforts as they are for international comparisons or national policy-making. Thoughtful investigation of local practice has several purposes:

- To understand better a problem or practice before rushing to "fix it";
- To base decisions on quality information rather than on assumptions or speculation;
- To uncover issues or problem areas that might otherwise have gone unnoticed;
- To build support for change; and
- To monitor the results of an improvement effort.

Data can be defined quite broadly. They are not only achievement results but also include teacher and student survey results, curriculum analyses, videotapes of classrooms, and many other potential sources of information. Whether you use data for the purposes of international comparisons or for local improvement, it is important to examine student learning in the context of the many factors that influence it, including curriculum, instruction, and school support systems. Without understanding the interplay of these factors, it is easy for school systems and/or individual schools to fall into the trap of quick fixes and bandwagon solutions that fail to produce results for students.

Using the template sets in Part B of this module, you can investigate each one of the areas highlighted in NRC report: student achievement, curriculum, instruction, and school support systems. For each area, a template set is provided that includes

- A summary of relevant TIMSS findings;
- Possible questions for you to investigate;
- Possible sources of data and tools for collecting them; and
- Possible actions you can take.

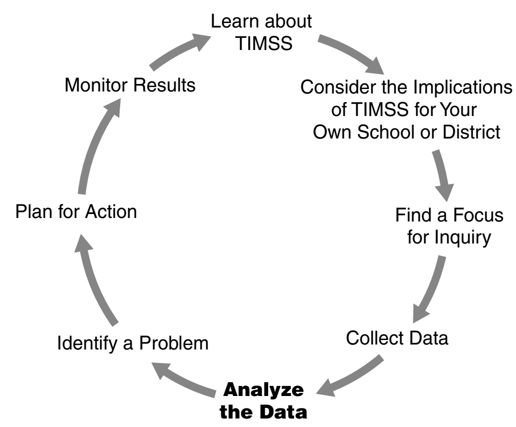
Following the template set for the team's area of focus, develop a plan for your data collection as follows:

- Review the possible questions in your area of focus (see the sample below);
- Check the questions that you are most interested in investigating;
- Record your questions and the possible data sources in the first two columns of the Data Collection Plan form included in Part B of this module (see also Columns 1 and 2 of the sample Data Collection Plan below); and
- Finalize your plans for data collection by determining who is going to do what by when (see also Columns 3 and 4 of the sample Data Collection Plan below.)

Example

Data Collection Plan: Curriculum

What Do We Want to Find Out?	**How Will We Find Out?**	**Who Will Collect the Data?**	**By When?**
How connected our science curriculum is	*Map the existing curriculum by identifying grade levels where major topics are addressed, K–12. Determine where the prerequisite knowledge for each topic is introduced.*	*Teachers from each grade level and science curriculum committee*	*October 15*
How much time is spent on science	*Survey Teachers' Schedules*	*Curriculum committee*	*November 15*



Stage 5—Analyze the Data

After you have collected data, the next step is to figure out what they tell you. Working with your team to guide your analysis, ask yourselves:

- What important points seem to emerge?
- What patterns or trends are we noticing?
- What seems surprising?
- What else do we need to know?
- What conclusions can we draw?
- What additional evidence do we need to validate our conclusions?
- How do these results compare with our own standards or goals? With TIMSS results?
- How can these data inform our decision-making?

Additional resources for interpreting data are listed in the "Resources" section of this guide. Write up the key ideas or results from your preliminary analysis. See the example below.

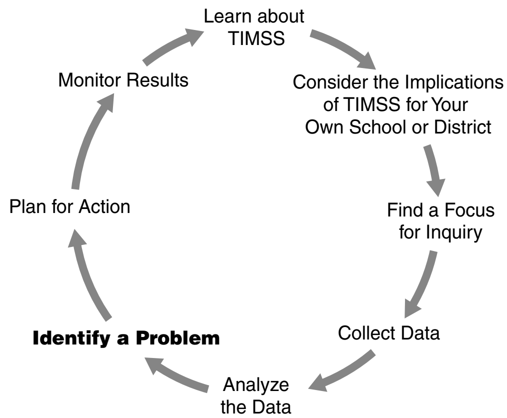
Example

Data Analysis: Curriculum

Our investigation tells us that

- *Our curriculum includes 27 topics in eighth-grade mathematics. Many topics, including algebra and geometry, are taught for one or two weeks.*
- *Eighth-grade students perform poorly in mathematics, especially in algebra, geometry, and problem solving.*

Tip: Be careful not to jump to conclusions. Initial data analysis often raises more questions than it answers. Be prepared to dig deeper into the questions you have, the data available, and the data still needed before deciding on a course of action.



Stage 6—Identify a Problem

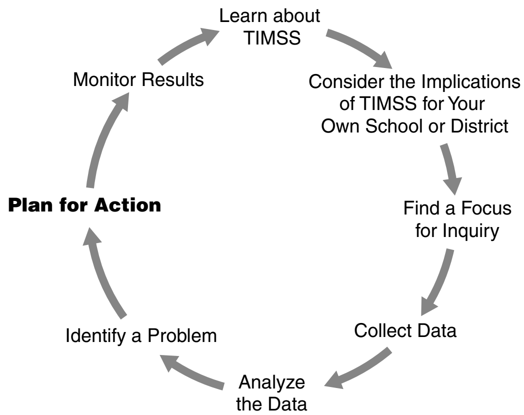
Careful data analysis often will lead to clarity about a problem. Improvement teams have found that taking the time to craft a problem statement, such as in the example below, helps them crystallize their conclusions and pave the way for action planning. Clarity about the problem is the first step to finding a solution.

Example

Problem Statement: Curriculum

Describe the problem: *Our eighth-grade students perform poorly in mathematics assessments, especially in problem solving, algebra, and geometry.*
Who is affected? *Our students in eighth grade, especially those who are not taking algebra.*
What do you think is causing the problem? What evidence do you have? *Our curriculum in grades 5–8 covers too many topics too superficially and does not emphasize problem solving, geometry, or algebra. This is based on our curriculum analysis and our analysis of student work.*
What are your goals for improvement? *We want our eighth-grade students to improve their performance in algebra, geometry, and mathematics problem solving. We want to bring more focus to our curriculum, emphasizing understanding of algebraic and geometric concepts and multi-step problem solving skills.*

Tip: It is important that goals for improvement be S.M.A.R.T.: specific, measurable, attainable, related to student learning, and time-bound.



Stage 7—Plan for Action

Planning for action entails deciding on a solution to the problem you have defined and translating that solution into action steps. When deciding on a solution, it is important to cast the net broadly first and to consider a wide range of possibilities. For example,

- What have other schools or districts in the U.S. done to solve this problem?
- What does the research literature say about this issue?
- What can we learn from high-achieving TIMSS countries?
- What can we imagine as ideal solutions?

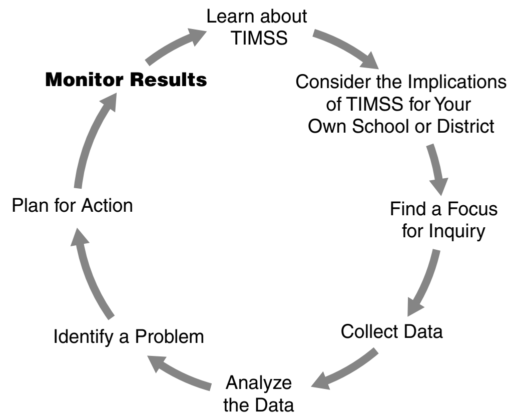
The following example lists actions that could be taken to improve curriculum. The template sets in Part B of this module list other possible actions to consider in the other areas of TIMSS—student achievement, instruction, and school support systems.

Example

Stage 7—Plan for Action				
Goals	**Actions**	**Timeline**	**Person Responsible**	**Accountability**
What do you want to accomplish?	What actions do you want to take to address the problem?	When will the different actions take place?	Who will be responsible?	How will you know that you have been successful?
Increase student achievement in science by implementing a more focused and connected curriculum.	Draft a K–12 science curriculum framework based on the *NSES* that shows grade levels at which topics are introduced and when a learner needs mastery.	August-October	Science Curriculum Committee	Draft framework completed and presented to administrators, teachers, and the community for their review. Revised draft, reflecting the standards and stakeholder input, is approved by the School Board (Spring).
	Review instructional materials currently in use to identify those that support the framework, plus grade levels and topics where new materials are needed.	Summer	Teams of teachers from each grade level	Results presented to Science Curriculum Committee, and plan for selecting new instructional materials approved (Fall).

Once the team has generated a number of possible solutions, members will need to home in on the best one based on the team's own criteria. Clearly, available resources will need to be considered. Consider other criteria that will enter into the decision.

After you have decided on a solution, the next challenge is to figure out how to implement it. Careful planning, including action goals, steps to reach those goals, clear lines of responsibilities, and deadlines, can help ensure follow-through and eventual success. Also make sure that the team coordinates its plans with other ongoing initiatives, such as textbook selection committees or staff development plans (see the Plan for Action form near the end of Part B, on pg. 438).



Stage 8—Monitor Results

One important feature that distinguishes data-driven initiatives from others is the careful monitoring of results. How many times do school districts undertake programs and never stop to find out if they have achieved what was intended? The hallmark of a good action plan is measurable indicators of success. If you set goals that are *specific, measurable, attainable, related to student learning, and time-bound (S.M.A.R.T.),* monitoring will be easier.

It is important to check the indicators periodically to make sure that you are on the right track or to help you identify roadblocks or new problems to solve along the way. Committing to a monitoring plan is one way to help ensure that this important function does not get lost in the flurry of action. A Plan for Monitoring form is included in Part B of this module (see pg. 439).

Example

Stage 8-Plan for Monitoring*

Goals	Indicators	Data collection (How? When? By whom?)	How will data be analyzed?	How will data be reported and disseminated?
Increase student achievement in algebra, geometry, and problem solving.	Students increase performance on tests and demonstrate more in-depth understanding of mathematics.	Middle grade teachers will submit results of standardized tests and teacher-made tests and assessments designed to measure higher-level problem solving ability.	Improvement team will compare achievement results to prior year data and compile observation and teacher report data.	Prepare a report and presentation for stakeholders: • Middle grades teachers' study group • Parents of middle grade students • School administrators
	Students are engaged in problem solving, and algebraic thinking in the classroom.	Improvement team classroom observations		Data used to decide next steps on curriculum changes.

*Adapted with permission from *Using Data—Getting Results: Collaborative Inquiry for School-Based Mathematics and Science Reform,* by Nancy Love (TERC, 1999).

Part B:
Template Sets

This section of Module 3 provides sets of templates for action-planning teams to use to guide their inquiry into the four areas addressed in the TIMSS report. Each set begins on the page number indicated below:

Masters for the "Plan for Action" and "Plan for Monitoring" charts, which are referred to in each of the template sets, are on pages 438 and 439.

TEMPLATE SET 1: INQUIRING INTO STUDENT ACHIEVEMENT

Stage 1—Learn about TIMSS

Summary of U.S. TIMSS Achievement Findings

- The U.S. starts strong but falls further and further behind.
- By high school, the U.S. is at or near the bottom.
- Top U.S. students in Population 1 are above the international average in science but slightly below in mathematics.
- Top U.S. students in Population 2 are above the international average in science but below in mathematics.

(See footnote 5 on page 11 for information about the scores of top U.S. students in Population 3.)

Stage 2—Consider Implications for Your Own School or District

What do these findings mean for us?
What are our school's or district's strengths and weaknesses?
How can we improve student learning?

Stage 3—Find a Focus for Inquiry

Focus

Stage 4—Collect Data

First, consider what questions you want to ask and what data sources you will use. See the possible questions and data sources below. Then develop a plan. See the Data Collection Plan form on pg. 413.

Student Achievement

Possible Questions	**Data Sources**
How well do our students perform in mathematics and science? What topics or skills do we do well in? Poorly in? How do these coincide with what is emphasized in our curriculum? Are the tests we use or parts of them aligned with our standards?	National Assessment of Educational Progress (NAEP) National standardized tests (i.e., CTBS, Iowa, SATs…) State assessments District or school assessments Performance assessments—student work *National Science Education Standards*, NCTM *Standards* TIMSS sample assessment questions TIMSS U.S. achievement results
What gaps exist in achievement among racial, gender, or socioeconomic groups? Do some students have less opportunity to learn mathematics and science than others do?	Disaggregated achievement and course enrollment data
How do our results compare with the U.S. TIMSS results? How well do our students do on specific TIMSS items (include the performance items)?	TIMSS released items, TIMSS performance items
What specific improvements in student learning do we hope to achieve?	
Our questions: ______________________________ ______________________________	

Data Collection Plan: Student Achievement

What Do We Want to Find Out? (Questions)	How Will We Find Out? (Data Sources)	Who Will Collect the Data?	By When?

Tips:

1. Disaggregation is separating data by useful categories. Wherever possible, disaggregate student achievement data by race, gender, socioeconomic status, school, grade, topic, and skill area.

2. It is important to consider multiple measures in examining student achievement, including single-response, open-ended response, and performance assessments.

3. Consider administering some of the TIMSS sample items to your students.

Stage 5—Analyze the Data

Data Analysis: Student Achievement

What important points seem to emerge?

What patterns or trends are we noticing?

What seems surprising?

What else do we need to know?

What conclusions can we draw?

What additional evidence do we need to validate our conclusions?

How do these results compare with our school's or district's standards or goals? With TIMSS results?

How can these data inform our decision-making?

Stage 6—Identify a Problem

Use a Problem Statement form, like the one below.

Problem Statement: Student Achievement

Describe the problem:

Who is affected?

What do you think is causing the problem? What evidence do you have?

What are your goals for improvement?

Stage 7—Plan for Action

See the Actions to Consider, below, and the Plan for Action form on pg. 438.

Actions to Consider for Improving Student Achievement

Inquire into curriculum, teaching, or school support systems to identify key problem areas linked with student achievement and plan for improvement.

Tip: It is important that goals for improvement be S.M.A.R.T.: specific, measurable, attainable, related to student learning, and time-bound.

Stage 8—Monitor Results

See the Plan for Monitoring form on pg. 439.

TEMPLATE SET 2: INQUIRING INTO CURRICULUM

Stage 1—Learn about TIMSS

Summary of U.S. TIMSS Curriculum Findings

- Curriculum matters.
- U.S. mathematics and science curricula lack focus and coherence.

Stage 2—Consider Implications for Your Own School or District

What do these findings mean for us?
How focused and coherent is our curriculum?
How much time do students spend learning? Mathematics? Science?
What are our tracking practices? Do all students have the opportunity to learn challenging mathematics and science?
How can we improve the mathematics and science curricula?

Stage 3—Find a Focus for Inquiry

Focus

Stage 4—Collect Data

First, consider what questions you want to ask and what data sources you want to use. See the possible questions and data sources below. Then develop a plan. See the Data Collection Plan form on pg. 419.

Curriculum

Possible Questions	Data Sources
How well aligned is our curriculum with the appropriate national, state, or local standards? To what extent does it encourage students to study topics in depth?	*National Science Education Standards, Benchmarks for Science Literacy*, NCTM *Standards*, state standards, and local standards, if applicable.
How well do our students achieve in a given course or grade level? Are data available similar to the achievement data in Exhibits 5.7-5.10 in *Facing the Consequences*?	*Facing the Consequences: Using TIMSS for a Closer Look at U.S. Mathematics and Science Education* (Schmidt et al., 1999) Local student achievement data
How many mathematics and science topics do we intend to cover each year in our schools? How many do we cover each year in our schools?	Curriculum and teacher survey
How does the number of topics covered compare with averages from the U.S. and other countries?	TIMSS curriculum findings
What connections among topics exist within your curriculum framework? How are those connections made explicit to students from year to year, over the year, from topic to topic, from lesson to lesson, and within a single lesson? Should connections be made more explicit, and, if so, how?	See *Designing Mathematics or Science Curriculum Programs: A Guide to Using Mathematics and Science Education Standards* (NRC, 1999b)

How much time do students spend on mathematics and science in our schools?	Schedule, teacher and student surveys
How does the percentage of students in our secondary schools who take mathematics and science compare with the percentage in other U.S. schools or schools in other countries?	Local data, TIMSS and national data
Do we have different expectations for mathematics and science learning for different groups of students? If so, are they justified? What are they based on? How early in a student's study of mathematics and science do these expectations appear? What are our tracking practices?	Participation levels in different courses, review of tracking and grouping practices
Are there differences in achievement among students of different genders, races, and ethnicity? Does our district or school show any patterns of performance?	Disaggregate local performance data by gender, race, and ethnicity
Do our students have different levels of achievement on different topics? Is there a pattern across the grade levels for any mathematics or science topic, such as the low achievement in physical science by U.S. students in TIMSS?	Disaggregate data by mathematics and science topic and skill (higher reasoningvs. skills) (See *Facing the Consequences,* Exhibits 5.1–5.4 [Schmidt et al., 1999])
Our questions: ________________________ ________________________ ________________________ ________________________	

Data Collection Plan: Curriculum

What Do We Want to Find Out? (Questions)	How Will We Find Out? (Data Sources)	Who Will Collect the Data?	By When?

Stage 5—Analyze Data

Data Analysis: Curriculum

What important points seem to emerge?

What patterns or trends are we noticing?

What seems surprising?

What else do we need to know?

What conclusions can we draw?

What additional evidence do we need to validate our conclusions?

How do these results compare with our school's or district's standards or goals? With the TIMSS results?

How can these data inform our decision-making?

Stage 6—Identify a Problem

Use a Problem Statement form, like the one below.

Problem Statement: Curriculum

Describe the problem:

Who is affected?

What do you think is causing the problem? What evidence do you have?

What are your goals for improvement?

Stage 7—Plan for Action

See the Actions to Consider, below, and the Plan for Action form on pg. 438.

Actions to Consider for Improving Curriculum

- Bring faculty and parents together to discuss their expectations for student performance in mathematics and science. Present data on the content of the curriculum and how it connects. Seek to build a shared commitment to high expectations for learning.
- Find ways to point out explicitly to students the connections among curricular ideas by making concrete statements that connect current ideas or activities with those in other parts of the lesson or in previous lessons.
- Develop a K–12 curriculum framework. See the NRC publication, *Designing Mathematics or Science Curriculum Programs: A Guide for Using Mathematics and Science Education Standards* (NRC, 1999b). Identify when a learner needs mastery and prior knowledge to understand a topic and make sure this mastery is developed earlier in the curriculum. Identify the number of topics and connections between topics in the curriculum. Note when topics are reviewed and make decisions about where review should occur.

Stage 8—Monitor Results

See the Plan for Monitoring form on pg. 439.

TEMPLATE SET 3: INQUIRING INTO INSTRUCTION

Stage 1—Learn about TIMSS

Summary of the TIMSS Findings about U.S. Lessons

- They demand less mathematical reasoning.
- They emphasize routine procedures over inventing something new.
- They use more class time for homework than in Japan or Germany.
- They use tests more than other countries.

Stage 2—Consider Implications for Your Own School or District

What do these findings mean for us?
How can our mathematics and science teaching be improved?

Stage 3—Find a Focus for Inquiry

Focus

Stage 4—Collect Data

First, consider what questions you want to ask and what data sources you will use. See the possible questions and data sources below. Then develop a plan. See the Data Collection Plan form on pg. 427.

Instruction

Possible Questions	Data Sources
To what extent are teachers using instructional practices that are consistent with the NCTM standards for teaching or the *National Science Education Standards* for teaching?	*National Science Education Standards* (NRC, 1996) and the NCTM *Professional Standards for Teaching Mathematics* (NCTM, 1991) Use survey questions and data from: • TIMSS Teacher Survey on Pedagogy (Part of the IEA Third International Mathematics and Science Study, Teacher Questionnaire [Science] Section D: Pedagogical Approach) • National Assessment of Educational Progress questionnaires • Horizon Research, Inc., "Science and Mathematics Education Studies" [surveys]
To what extent are students doing computation versus multi-step problems?	Classroom observations Classroom videos Student surveys Sample tests, quizzes, homework
To what extent are teachers stating versus developing concepts?	
To what extent are students using complex reasoning?	
How much freedom are students given to explore their own solution methods to problems?	

How much time do students spend practicing routines versus solving challenging problems? How much class time is devoted to homework? How much homework is given? What kind of homework is given? To what extent does time spent working on homework during lessons extend students' understanding? How frequently do teachers give tests or quizzes? To what extent do tests or quizzes reinforce a deeper understanding of mathematics or science? What types of items are included on tests: one right answer; open ended; projects or performances? To what extent do standardized tests influence what and how we teach? How are computers, calculators, and other technologies currently being used? Who makes decisions about curriculum and instruction? What are the goals of the lessons as reflected in the teaching practices?	Use survey questions and data from: • TIMSS Teacher Survey on Pedagogy (Part of the IEA Third International Mathematics and Science Study, Teacher Questionnaire [Science] Section D: Pedagogical Approach) • National Assessment of Educational Progress questionnaires • Horizon Research, Inc., "Science and Mathematics Education Studies" [surveys Classroom observation Classroom videos Student surveys Sample tests, quizzes, homework

What beliefs about teaching and learning underlie our instructional practices?

How do teachers view and handle frustration and confusion in the classroom? To what extent do teachers take advantage of students' confusion to deepen learning?

What are the discrepancies between what we say we believe about teaching and what we do?

What are our "scripts" for teaching mathematics and science?

To what extent are our "scripts" compatible with our goals for improving mathematics and science education?

Our questions:

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Data Collection Plan: Instruction

What Do We Want to Find Out? (Questions)	How Will We Find Out? (Data Sources)	Who Will Collect the Data?	By When?

Stage 5—Analyze Data

Data Analysis: Instruction

What important points seem to emerge?

What patterns or trends are we noticing?

What seems surprising?

What else do we need to know?

What conclusions can we draw?

What additional evidence do we need to validate our conclusions?

How do these results compare with our own school's or district's standards or goals? With the TIMSS results?

How can these data inform our decision-making?

Stage 6—Identify a Problem

Use a Problem Statement form, like the one below.

Problem Statement: Instruction

Describe the problem:

Who is affected?

What do you think is causing the problem? What evidence do you have?

What are your goals for improvement?

Stage 7—Plan for Action

See the Actions to Consider, below, and the Plan for Action form on pg.438.

Actions to Consider for Improving Instruction

- Create opportunities for teachers to watch and discuss TIMSS and other classroom videos together.
- Create opportunities for teachers to reflect on their practice, such as through case discussion or study groups.
- Give students more opportunity to struggle with problems.
- Increase emphasis on thinking; decrease emphasis on skill acquisition.
- Support teachers in becoming more comfortable with students' frustration and confusion and in using these as tools for learning.
- Create opportunities to explore beliefs that underlie approaches to teaching and contradictions between espoused beliefs and actual practices.
- Shift the locus of control for decision-making about curriculum and instruction to those with educational expertise.

Stage 8—Monitor Results

See the Plan for Monitoring form on pg. 439.

TEMPLATE SET 4: INQUIRING INTO SCHOOL SUPPORT SYSTEMS

Stage 1—Learn about TIMSS

Summary of the TIMSS Findings about School Support Systems

- Japanese teachers have more opportunity to discuss teaching with other teachers than U.S. teachers do.
- Time for U.S. teachers to collaborate decreases from 4th to 8th grade.
- Japanese students watch as much TV as U.S. students do.
- U.S. student attitudes toward mathematics and science decline from 4th to 8th grade.
- Teachers in the U.S. engage in more short-term, expert-led workshops.

Stage 2—Consider Implications for Your Own School or District

What do these findings mean for us?
How can we improve professional development in our school or district to support learning?
What are the opportunities for teacher collaboration?
What are parents' and students' attitudes toward mathematics and science?

Stage 3—Find a Focus for Inquiry

Focus

Stage 4—Collect Data

First, consider what questions you want to ask and what data sources you want to use. See the possible questions and data sources below. Then develop a plan. See the Data Collection Plan form on pg. 434.

School Support Systems

Possible Questions	Data Sources
How does the daily schedule encourage or discourage collaboration among teachers? What opportunities are provided during the workday for teachers to engage in professional development and collaboration?	Analyze schedule; interview teachers
What are the trade-offs to providing teachers more collaborative planning time—for example, would the average class size grow or would teachers need to do more of their planning at school?	Analyze projected enrollments and current class size; interview or survey teachers
How are new teachers inducted? Who and what is involved, and to what end? What supports are in place for new teachers? Who provides it and what takes place?	Review district policies and interview principals and new teachers and mentors (if relevant)
To what extent is professional development relevant, focused, and coherent? What are the focal areas, methods and content, and how are they aligned with learning goals? How is teacher development organized across the career of a teacher? What kinds of opportunities exist for what kinds of learning? What features support this?	Review professional development plan; interview staff development or curriculum coordinators; and map professional development programs the district has had for the past year

To what extent do teachers engage in collaborative learning through teacher-led study groups, examination of student work or videotaped classroom lessons? How could we increase the incidence of such collaboration?	Teacher interviews
What factor promotes community and collegiality among teachers in our school(s)? What inhibits it? What supports autonomy in teachers, and what inhibits it?	Interviews or surveys
How does the physical environment and schedule of our school(s) contribute to the teaching culture? What changes would teachers and other staff like to see in the environment or schedule to increase collegiality?	Interviews or surveys
What do the students in our school(s) believe about their achievement and interest in mathematics and science?	Student and parent survey
Are actions consistent with their beliefs?	Student, parent, and teacher survey
How do beliefs compare with performance?	Survey and achievement data

Our questions:

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Data Collection Plan: School Support Systems

What Do We Want to Find Out? (Questions)	How Will We Find Out? (Data Sources)	Who Will Collect the Data?	By When?

Stage 5—Analyze Data

Data Analysis: School Support Systems

What important points seem to emerge?

What patterns or trends are we noticing?

What seems surprising?

What else do we need to know?

What conclusions can we draw?

What additional evidence do we need to validate our conclusions?

How do these results compare with our school's or district's standards or goals? With the TIMSS results?

How can these data inform our decision-making?

Stage 6—Identify a Problem

Use a Problem Statement form, like the one below.

Problem Statement: School Support Systems

Describe the problem:

Who is affected?

What do you think is causing the problem? What evidence do you have?

What are your goals for improvement?

Stage 7—Plan for Action

See the Actions to Consider, below, and the Plan for Action form on pg. 438.

Actions to Consider for Improving School Support Systems

- Examine the schedule to find more time for teachers. Consider combining classes and having teachers pair for duties (e.g., lunch and recess together) to create more time for them to share ideas.
- Create a common workspace for teachers with comfortable chairs and desks as well as resources to encourage collaboration and for use in planning lessons and meeting informally.
- Establish a culture for sharing expertise, e.g., use faculty meeting and professional development time for teachers to present cases of teaching or lessons and gain input from colleagues.
- Be explicit about the decisions teachers are expected to make and the areas in which they should be autonomous.
- Assign mentors for beginning teachers and release mentor and beginning teachers from some duties to provide time for mentoring.
- Have teachers create individual professional development plans that are tied to learning goals, and recognize milestones when they are reached.
- Keep students interested in mathematics and science by relating them to students' real lives.
- Encourage all students to take mathematics and science courses every year.
- Engage students in examining contradictions between what they believe (e.g., hard work is needed to do well in mathematics and science) versus what they do (e.g., reject in-depth projects or schoolwork that requires substantial effort).

Stage 8—Monitor Results

See the Plan for Monitoring on pg. 439.

Stage 7—Plan for Action

Goals	Actions	Timeline	Person Responsible	Accountability
What do you want to accomplish?	What actions do you want to take to address the problem?	When will the different actions take place?	Who will be responsible?	How will you know that you have been successful?

Stage 8-Plan for Monitoring*

Goals	Indicators	Data collection (How? When? By whom?)	How will data be analyzed?	How will data be reported and disseminated?

*Adapted with permission from *Using Data—Getting Results: Collaborative Inquiry for School-Based Mathematics and Science Reform,* by Nancy Love (TERC, 1999).

Resources

American Association for the Advancement of Science. 1993. *Benchmarks for Science Literacy*. New York: Oxford University Press.

Baker, David P. 1997a. "Good News, Bad News, and International Comparisons: Comment on Bracey." *Educational Researcher*, 26(April):16-17.

Baker, David P. 1997b. "Surviving TIMSS." *Phi Delta Kappan*, (Dec.):295-300.

Beaton, Albert E., Ina V.S. Mullis, Michael O. Martin, Eugenio J. Gonzalez, Dana L. Kelly, and Teresa A. Smith. 1996a. *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, Mass.: TIMSS International Study Center, Boston College. See also http://www.timss.bc.edu.

Beaton, Albert E., Michael O. Martin, Ina V.S. Mullis, Eugenio J. Gonzalez, Teresa A. Smith, and Dana L. Kelly. 1996b. *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, Mass.: TIMSS International Study Center, Boston College. See also http://www.timss.bc.edu.

Beatty, Alexander (ed.). 1997. *Learning from TIMSS: Results of the Third International Mathematics and Science Study. Summary of a Symposium*. Washington, D.C.: National Academy Press. See also http://www.nap.edu.

Bernhardt, Victoria L. 1998. *Data Analysis for Comprehensive School-wide Improvement.* New York: Eye on Education.

Boston College, TIMSS Website, http://www.timss.bc.edu.

Bracey, Gerald W. 1996. "International Comparisons and the Condition of American Education." *Educational Researcher*, 25(Jan.-Feb.): 5-11.

Bracey, Gerald W. 1997. "On Comparing the Incomparable: A Response to Baker and Stedman." *Educational Researcher*, 26(April): 19-26.

Bracey, Gerald W. 1998. "Tinkering with TIMSS." *Phi Delta Kappan*, (Sept.):32-36.

Brown, C.A., and M. S. Smith. 1997. "Supporting the Development of Mathematical Pedagogy." *The Mathematics Teacher*, 90 (2), 138-143.

Business Coalition for Education Reform. 1998. *The Formula for Success: A Business Leader's Guide to Supporting Math and Science Achievement*. Washington, D.C.: U.S. Department of Education.

Center for Science, Mathematics, and Engineering Education Website, http://www4.nas.edu/csmee/center.nsf.

Cook, Cathy, and M. Christensen. 1999. *Teacher Change: Improving K-12 Mathematics*. Columbus, OH: Eisenhower National Clearinghouse. See also http://change.enc.org.

Eisenhower National Clearinghouse for Mathematics and Science Education, TIMSS Website, http://www.timss.enc.org.

Elmore, Richard. 1997. "Education Policy and Practice in the Aftermath of TIMSS." Paper commissioned by the Board of International Comparative Studies in Education.

Forgione, Pascal D., Jr. 1998. "Responses to Frequently Asked Questions About 12th-Grade TIMSS." *Phi Delta Kappan*, (June):769-772.

Harmon, M., T.A. Smith, M.O. Martin, D.L. Kelly, A.E. Beaton, I.V.S. Mullis, E.J. Gonzalez, and G. Orpwood. 1997. *Performance Assessment in IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, Mass.: TIMSS International Study Center, Boston College. See also http://www.timss.bc.edu.

Horizon Research, Inc., Website, http://www.horizon-research.com/public.htm. (See this site for the questionnaires used in the 2000 National Survey of Science and Mathematics Education.)

Kinney, C. 1998. "Teachers and the Teaching Profession in Japan." Pp. 183-253 in *The Educational System in Japan: Case Study Findings.* Washington, D.C.: U.S. Department of Education.

Lapointe, A.E., J.M. Askew, and N.A. Mead. 1992. *Learning Science*. Princeton, N.J.: Educational Testing Service.

Lewis, Catherine. 1998. "The Secret of Trapezes." Oakland, CA: Development Studies Center.

Love, Nancy. 1999. *Using Data—Getting Results: Collaborative Inquiry for School-Based Mathematics and Science Reform.* Cambridge, Mass.: TERC.

Lubeck, S. 1996. "Teachers and the Teaching Profession in the United States." Pp. 241-318 in the draft volume of *The Education System in the United States: Case Study Findings*. Ann Arbor: University of Michigan Center for Human Growth and Development.

Manaster, Alfred B. 1998. "Some Characteristics of Eighth Grade Mathematics Classes in the TIMSS Videotape Study." *The American Mathematical Monthly*, 105 (9, Nov.):793-805.

Martin, Michael O., Ina V.S. Mullis, Albert E. Beaton, Eugenio J. Gonzalez, Teresa A. Smith, and Dana L. Kelly. 1997. *Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, Mass.: TIMSS International Study Center, Boston College. See also http://www.timss.bc.edu.

McKnight, C.C., F.J. Crosswhite, J.A. Dossey, E. Kifer, J.O. Swafford, K.J. Travers, and T.J. Cooney. 1989. *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective*. Champaign, Ill.: Stipes Publishing Co.

Milotich, U. 1996. "Teachers and the Teaching Profession in Germany." Pp. 295-379 in the draft volume of *The Education System in Germany: Case Study Findings*. Ann Arbor: University of Michigan Center for Human Growth and Development.

Mullis, Ina V.S., Michael O. Martin, Albert E. Beaton, Eugenio J. Gonzalez, Dana L. Kelly, and Teresa A. Smith. 1997. *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, Mass.: TIMSS International Study Center, Boston College. See also http://www.timss.bc.edu.

Mullis, Ina V.S., Michael O. Martin, Albert E. Beaton, Eugenio J. Gonzalez, Dana L. Kelly, and Teresa A. Smith. 1998. *Mathematics and Science Achievement in the Final Year of Secondary School: IEA's Third International Mathematics and Science Study (TIMSS)*. Chestnut Hill, Mass.: TIMSS International Study Center, Boston College. See also http://www.timss.bc.edu.

National Academy Press Website, http://www.nap.edu.

National Assessment of Educational Progress Website, http://www.ed.gov/NCES/naep.

National Council of Teachers of Mathematics. 1989. *Curriculum and Evaluation Standards for School Mathematics*. Reston, Va.: National Council of Teachers of Mathematics. See also http:///www.ganstcweb.gisd.k12.mi.us/cgi-bin/wi/ma/mathorg.852230758.html.

National Council of Teachers of Mathematics. 1991. *Professional Standards for Teaching Mathematics*. Reston, Va.: National Council of Teachers of Mathematics. See also http:///www.ganstcweb.gisd.k12.mi.us/cgi-bin/wi/ma/mathorg.

National Council of Teachers of Mathematics. 1998. *Principles and Standards for School Mathematics: Discussion Draft*. Reston, Va.: National Council of Teachers of Mathematics. See also http:///http:///www.ganstcweb.gisd.k12.mi.us/cgi-bin/wi/ma/mathorg.852230758.html.

National Research Council. 1996. *National Science Education Standards*. Washington, D.C.: National Academy Press. See also http://www.nap.edu.

National Research Council. 1997. *What Have We Learned About Making Education Standards Internationally Competitive?* Washington, D.C.: National Academy Press. See also http://www.nap.edu.

National Research Council. 1998. *Protecting Youth at Work: Health, Safety, and Development of Working Children and Adolescents in the United States*. Washington, D.C.: National Academy Press. See also http://www.nap.edu.

National Research Council. 1999a. *Global Perspectives for Local Action: Using TIMSS to Improve U.S. Mathematics and Science Education*. Washington, D.C.: National Academy Press. See also http://www.nap.edu.

National Research Council. 1999b. *Designing Mathematics or Science Curriculum Programs: A Guide for Using Mathematics and Science Standards*. Washington, D.C.: National Academy Press. See also http://www.nap.edu.

Regional Alliance TIMSS Resource Page, http://ra.terc.edu /TIMSS.

Robitaille, David F., ed. 1997. *National Contexts for Mathematics and Science Education*. Vancouver, Canada: Pacific Educational Press.

Rotberg, Iris C. 1998. "Interpretation of International Test Score Comparisons." *Science*, 280(May 15):1030-1031.

Schmidt, William H., and Curtis C. McKnight. 1998. "What Can We Really Learn from TIMSS?" *Science*, 282(Dec. 4):1830-1831.

Schmidt, William H., Curtis C. McKnight, Gilbert A. Valverde, Richard T. Houang, and David E. Wiley. 1997a. *Many Visions, Many Aims: Volume 1: A Cross-National Investigation of Curricular Intentions in School Mathematics*. Boston: Kluwer Academic Publishers.

Schmidt, William H., Curtis C. McKnight, Gilbert A. Valverde, Richard T. Houang, and David E. Wiley. 1997b. *Many Visions, Many Aims: Volume 2: A Cross-National Investigation of Curricular Intentions in School Science*. Boston: Kluwer Academic Publishers.

Schmidt, William, and G. Valverde. 1997c. "Policy Lessons on TIMSS." Paper prepared for the National Governors' Association.

Schmidt, William H., Curtis C. McKnight, and Senta A. Raizen. 1997d. *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*. Boston: Kluwer Academic Publishers.

Schmidt, William H., et al. 1999. *Facing the Consequences: Using TIMSS for a Closer Look at U.S. Mathematics and Science Education*. Boston: Kluwer Academic Publishers.

Stedman, Lawrence C. 1997. "International Achievement Differences: An Assessment of a New Perspective." *Educational Researcher*, 26(April):4-15.

Stevenson, Harold W. 1998. "A Study of Three Cultures. Germany, Japan, and the United States—An Overview of the TIMSS Case Study Project." *Phi Delta Kappan*, (March):524-529.

Stevenson, Harold W., and Roberta Nerison-Low. 1997. *To Sum It Up: Case Studies of Education in Germany, Japan, and the United States*. Washington, D.C.: U.S. Government Printing Office.

Stigler, J.W., and James Hiebert. 1997. "Understanding and Improving Classroom Mathematics Instruction: An Overview of the TIMSS Video Study." *Phi Delta Kappan*, 79(Sept.):14-21.

Stigler, J.W., and James Hiebert. 1998. "Teaching Is a Cultural Activity." *American Educator* (Winter, 1998).

Stigler, James W., and James Hiebert. 1999. *The Teaching Gap*. New York: Free Press.

Stigler, James W., Patrick Gonzales, Takako Kawanaka, Steffen Knoll, and Ana Serrano. 1999. *The TIMSS Videotape Classroom Study: Methods and Findings from an Exploratory Research Project on Eighth-Grade Mathematics Instruction in Germany, Japan, and the United States*. Washington, D.C.: U.S. Government Printing Office.

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U.S. Department of Education. 1992. *International Mathematics and Science Assessments: What Have We Learned?* Washington, D.C.: U.S. Department of Education. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1996. *Pursuing Excellence: A Study of U.S. Eighth-Grade Mathematics and Science Teaching, Learning, Curriculum, and Achievement in International Context*. Washington, D.C.: U.S. Government Printing Office. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1997a. *Introduction to TIMSS*. Washington, D.C.: U.S. Department of Education. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1997b. *Pursuing Excellence: A Study of U.S. Fourth-Grade Mathematics and Science Achievement in International Context*. Washington, D.C.: U.S. Government Printing Office. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1997c. "Eighth-Grade Mathematics Lessons: United States, Japan, and Germany." Videotape. Washington, D.C.: U.S. Department of Education. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1997d. *Moderator's Guide to Eighth-Grade Mathematics Lessons: United States, Japan, and Germany.* Washington, D.C.: U.S. Government Printing Office. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1998a. "Policy Brief: What the Third International Mathematics and Science Study (TIMSS) Means for Systemic School Improvement." See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1998b. *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context*. Washington, D.C.: U.S. Government Printing Office. See also http://nces.ed.gov/timss/.

U.S. Department of Education. 1999. *The TIMSS Videotape Classroom Study: Methods and Findings from an Exploratory Research Project in Eighth-Grade Mathematics Instruction in Germany, Japan, and the United States*. Washington, D.C.: U.S. Government Printing Office. See also http://nces.ed.gov/timss/.

U.S. Department of Education. "Attaining Excellence: Guidebook to Examine School Curricula**."** Washington, D.C.: U.S. Office of Educational Research and Improvement.

U.S. Department of Education's National Center for Education Statistics Website, http://nces.ed.gov/timss/.