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TEACHING IS A CULTURAL ACTIVITY

BY JAMES W. STIGLER AND JAMES HIEBERT

Editor's note: The discussions of Japanese and American teaching styles in this article are based on a videotape study of classroom teaching conducted by Professor Stigler in conjunction with the Third International Mathematics and Science Study, 1994-95. The videotape study is described in the accompanying article.

FOR MANY people, family dinners are everyday events. They participate in these events without realizing the many aspects that are taken for granted. Everyone comes to the table and begins eating at about the same time. There are no menus; the food is brought to the table in containers and everyone eats the same things. The food is then parceled out by passing the containers around the table, with everyone dishing up their own portions. Adults often help children with this task. Conversation usually is open, with no set agenda. Comments from everyone are welcome, and children and adults participate as conversational partners.

Family dinner is a *cultural* activity. Cultural activities are represented in cultural scripts, generalized knowledge about the event that resides in the heads of participants. These scripts not only guide behavior, they also tell participants what to expect. Within a culture, these scripts are widely shared, and therefore they are hard to see. Family dinner is such a familiar activity that it sounds strange to point out all of its customary features. We rarely think about how it might be different from the way it is. But, we certainly would notice if a feature were violated: We'd be surprised at a family dinner, for example, to be offered a menu or presented with a check at the end of the meal.

Cultural scripts are learned implicitly, through observation and participation—not by deliberate study. This differentiates cultural activities from other endeavors. Take, for example, the activity of learning to use a computer. For older Americans, using the computer is usually not a cultural activity. We learned how to use the computer by consciously working on our skills—by reading manuals,

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taking notes, getting help from experts, and practicing. Using computers is an interesting example because it is rapidly becoming a cultural activity. Children, for example, learn naturally, by hanging around computers. But there still are those for whom learning about computers has the distinctly noncultural trait of intentionally and deliberately and self-consciously working through the activity.

Teaching, in our view, is a cultural activity.[1] It is more like eating family dinners than using the computer. This may be surprising because teaching is rarely thought of in this way. Some people think that teaching is an innate skill, something you are born with. Others think that teachers learn to teach by enrolling in teacher-training programs. We believe that neither is the best description. Teaching, like other cultural activities, is learned through informal participation over long periods of time. It is something one learns to do by growing up in a culture rather than by formal study.

Although most people have not studied to be teachers, most people have been students. People within a culture share a mental picture of what teaching is like. We call this mental picture a *script*. The script is, in fact, a mental version of the teaching patterns we describe briefly in the accompanying article. The difference is that the patterns were observable in the videotapes; scripts are mental models of these patterns. We believe that the existence of scripts provides an explanation for the fact that the lessons within a country followed distinctive patterns. The lessons were designed and taught by teachers who share the same scripts.

It is not hard to see where the scripts come from or why they are widely shared. A cultural script for teaching begins forming early, sometimes even before children get to school. Playing school is a favorite preschool game. As children move through twelve years and more of school, they form scripts for teaching. Any adult probably could enter a classroom tomorrow and act like a teacher because all of us share this cultural script. In fact, one of the reasons that classrooms run as smoothly as they do is because students and teachers have the same script in their heads; they know what to expect and what roles to play.

TEACHING IS a complex system created by the interactions of the teacher, the students, the curriculum, the local setting, and other factors that influence what happens in the classroom. The way one component works—say the curriculum—depends on the other components in the system, such as the teaching methods being used. To say that teaching is a cultural activity reveals an additional truth: Cultural activities, such as teaching, do not appear full-blown but rather evolve over long periods of time in ways that are consistent with the stable web of beliefs and assumptions that are part of the culture. The scripts for teaching in each country appear to rest on a relatively small and tacit set of core beliefs about the nature of the subject, how students learn, and the role that a teacher should play in the classroom.[2] These beliefs, often implicit, serve to maintain the stability of cultural systems over time. Just as features of teaching need to be understood in terms of the underlying systems in which they are embedded, so too these systems of teaching, because they are cultural, must be understood in relation to the cultural beliefs and assumptions that surround them.

A good way of looking at these issues is to compare American teachers' use of the overhead projector with the use of the chalkboard by Japanese teachers. Many teachers in the U.S. have replaced the chalkboard with the overhead projector, whereas Japanese teachers have not. One can see this difference in terms of the different instructional systems in which the visual aids are used. In U.S. classrooms visual aids function to guide and control students' attention. Seen in this light, the overhead projector is preferred because it gives teachers a high degree of control over what students are attending to. Within the Japanese system of teaching, visual aids serve a different function. They are not used to control attention but to provide a cumulative record of the lesson's activities and their results. Japanese teachers do not use the overhead projector because it is not possible to fit the cumulative record on an overhead transparency.

To dig deeper, we must ask why Japanese teachers want a cumulative record of the lesson to be available to students and why U.S. teachers want to control students' attention. To answer these questions, we need to situate these two systems of teaching in the context of cultural beliefs about how students learn and the role the teacher can play in this process.

As we pursue deeper comparisons of teaching, we focus on Japan and the U.S. because this comparison is more dramatic than the comparison between U.S. and German teachers, and, therefore, illustrates well the role that beliefs can play in generating and maintaining cultural scripts for teaching.

THE TYPICAL U.S. lesson is consistent with the belief that school mathematics is a set of procedures. Although teachers may believe that there are other things that must be added to these procedures to get the complete definition of mathematics, many *act* as if it is a subject that is useful for students, in the end, as a set of procedures for solving problems.

As noted in the accompanying article, we asked teachers who participated in the videotape study to identify the "main thing" they wanted students to learn from the lesson. Sixty-one percent of U.S. teachers described *skills:* They wanted the students to be able to perform a procedure, solve a particular kind of problem, and so on.

Many U.S. teachers also seem to believe that learning terms and practicing skills are not very exciting. We have watched them trying to jazz up the lesson and increase students' interest in non-mathematical ways: by being entertaining; by interrupting the lesson to talk about other things, like last night's local rock concert; or by setting the mathematics problem in a real-life or intriguing context, such as measuring the circumference of a basketball. Teachers act as if the interest must come from outside the mathematics.

Japanese lessons appear to be generated by different beliefs about the subject. Teachers act as if mathematics is a set of relationships between concepts, facts, and procedures. These relationships are revealed by developing methods to solve problems, studying the methods, working toward increasingly efficient methods, and talking explicitly about the relationships of interest.

In response to the same question, 73 percent of Japanese teachers said the main thing they wanted their students to learn from the lesson was to think about things in a new way, such as seeing new relationships between mathematical ideas.

Japanese teachers also act as if mathematics is inherently interesting; and they believe that students will be interested in exploring mathematics by developing new methods for solving problems. The teachers seem less concerned about motivating the topics in non-mathematical ways.

If one believes that mathematics is mostly a set of procedures and the goal is to help students become proficient in executing the procedures, as many U.S. teachers seem to believe, then it would be understandable also to believe that mathematics is learned best by mastering the material incrementally, piece by piece. This view of skill-learning has a long history in the U.S.[3] Procedures are learned by practicing them many times, with subsequent exercises being slightly more difficult than the exercises that preceded them. Practice should be relatively error-free, with high levels of success at each point. Confusion and frustration should be minimized; they are signs that the earlier material was not mastered. The more exercises, the more smoothly learning will proceed.

Suppose students are studying how to add and subtract fractions with unlike denominators, such as 2/3 + 4/7. These beliefs about learning would say that students should first master adding fractions with like denominators, such as 1/5 + 2/5; then be shown how to add simple fractions with unlike denominators, such as 1/2 + 1/4, being warned about the common error of adding the denominators (to minimize this error), before practicing the more difficult problems, such as 2/3 + 4/7.

Japanese teachers appear to hold a different set of beliefs about learning and probably would plan a different kind of lesson for adding fractions. They seem to believe that students learn best by first struggling to solve mathematics problems, then participating in discussions about how to solve them, and then hearing about the pros and cons of different methods and the relationships between them. Frustration and confusion are taken to be a natural part of the process because each person must struggle with a situation or problem first in order to make sense of the information he or she hears later. Constructing connections between methods and problems is thought to require time to explore and invent, to make mistakes, to reflect, and to receive the needed information at the appropriate time.[4]

What kind of lesson on adding and subtracting fractions with unlike denominators would these beliefs generate? A teacher's manual in a popular Japanese textbook series gives us a clue.[5] It alerts teachers that the error students are most likely to make is to add the denominators. Students will learn to understand the process more fully, says the manual, if they are allowed to make this mistake and then examine the consequences. Some suggestions are given for how to help students reflect on the inconsistencies they will encounter if they add, for example, 1/2 and 1/4, and get 2/6. Teachers are to begin the lesson with a problem like this and then compare the different methods that students develop to solve the problem. Obviously, struggling and making mistakes and then seeing why they are mistakes is believed to be an essential part of the learning process.

Japanese teachers often choose a challenging problem to begin the lesson.

GIVEN THE differences between the U.S. and Japan in the apparent beliefs about the subject and learning, it is not surprising that there seem to be marked differences in beliefs about the role of the teacher. U.S. teachers appear to feel responsible for shaping the task into pieces that are manageable for most students, providing all the information needed to complete the task, and assigning plenty of practice. Providing sufficient information means, in many cases, demonstrating how to complete a task just like those assigned for practice. Teachers act as though confusion and frustration are signs that they have not done their job. When they notice confusion, they quickly assist students by providing whatever information it takes to get the students back on track.

We have seen the following event happen over and over. Teachers assign students seatwork problems and circulate around the room, tutoring and monitoring students' progress. Several students ask, in quick succession, about the same problem. Teachers interrupt the class and say, "Number 23 may be a little confusing. Remember to put all the x-terms on one side of the equation and all the y-terms on the other, and then solve for y. That should give the answer." Teachers in the U.S. try hard to reduce confusion by presenting full information about how to solve problems.

Teachers also take responsibility for keeping students engaged and attentive. Given their beliefs about the nature of mathematics and how it is learned, moment-by-moment attention is crucial. If students are watching the teacher demonstrate a procedure, they need to attend to each step. If their attention wanders, they will be lost when they try to execute the procedure on their own. Now we have a deeper explanation for the frequent use of the overhead projector by U.S. teachers. The projector's capability of focusing attention fits well with the teachers' belief about teaching mathematics.

In addition to using the overhead projector, U.S. teachers use a variety of other techniques to hold students' attention. They pump up student interest by increasing the pace of the activities; by praising students for their work and behavior; by the cuteness or real-lifeness of tasks; and by their own power of persuasion through their enthusiasm, humor, and "coolness."

Japanese teachers apparently believe that they are responsible for different aspects of classroom activity. They often choose a challenging problem to begin the lesson, and they help students understand and represent the problem so they can begin working on a solution. While students are working, the teachers monitor the solution methods in order to organize the follow-up discussion in which students share solutions. The teachers also encourage students to keep struggling in the face of difficulty, sometimes offering hints to support students' progress. Rarely do teachers show students, midway through the lesson, how to solve the problem.

Japanese teachers lead class discussion, asking questions about the solution methods presented, pointing out important features of students' methods, and presenting methods themselves. Because the teachers seem to believe that learning mathematics means constructing relationships between facts, procedures, and ideas, they try to create a visual record of these different methods as the lesson proceeds. Apparently, it is not as important for students to attend at each moment of the lesson as it is for them to be able to go back and think again about earlier events and connections between the different parts of the lesson. This presents a further explanation of why Japanese teachers prefer the chalkboard to the overhead projector—indeed of why they cannot use the projector.

AS A CONSEQUENCE of their apparent beliefs about the subject, learning, and the teacher's role, teachers appear to hold a set of beliefs about individual differences among students. U.S. teachers generally believe that individual differences are an obstacle to effective teaching.[6] Meeting each student's needs means, ideally, diagnosing each student's level of performance and providing different instruction for different levels. This is not easy to do in a large class. As the range of differences increases, the difficulties of teaching increase. In simple terms, this is the reason for tracking students into separate classes by ability or past performance. It is also the reason for reform efforts directed toward reducing class size. This belief says that the tutoring situation is best, academically, because instruction can be tailored specifically for each student or small group of students.

Japanese teachers view individual differences as a natural characteristic of a *group*. They view differences as a resource in the mathematics class, a resource both for students and teachers.[7] Individual differences are beneficial for the class because they produce a range of ideas and solution methods that provides the material for students' discussion and reflection. The variety of alternative methods allows students to compare them and construct connections among them. It is believed that all students benefit from the variety of ideas generated by their peers. In addition, tailoring instruction to specific students is seen as unfairly limiting and as pre-judging what students are capable of learning: All students should have the opportunity to learn the same material.

For the Japanese teacher, the differences within a group are beneficial because they allow a teacher to plan a lesson more completely. Japanese teachers plan lessons by using the information that they and other teachers have previously recorded about students' likely responses to particular problems and questions. If the student group is sufficiently large, the teachers can be quite sure that these same responses will be given by these students. The teachers then plan the nature of the discussion that is likely to occur. The range of responses also provides the vehicle teachers use to meet the needs of different students. Teachers expect that different students will understand different methods and will think about the material at different levels of sophistication. Not all students will be prepared to learn the same things from each lesson, and the different methods that are shared allow each student to learn *some* things.

Another set of beliefs pertains to the significance of the classroom lesson. Lessons, of course, are the most common form of teaching around the world. Students' lives in most schools are organized around a series of forty-five to sixty-minute periods that they move through in the course of a day. But different beliefs about teaching lead to treating lessons in quite different ways.

In Japan, classroom lessons hold a privileged place in the activities of the school. It would be exaggerating only a little to say that lessons are sacred. They are treated much as we treat lectures in university courses or even religious services. A great deal of attention is given to their development.[8] They are planned as complete experiences, as stories with a beginning, a middle, and an end. Their meaning is found in the connections between the parts. If you stay for only the beginning, or leave before the end, you miss the point. If lessons like this are going to succeed, they must be coherent. The pieces must relate to each other in clear ways. And they must flow, free from interruptions and unrelated activities. Now we know why Japanese lessons are never interrupted from the outside—not by announcements from the public address system, not by lunch-count monitors, not by anyone.

It is quite easy to see how the beliefs about mathematics, learning, and the role of the teacher lead to treating lessons in this way. Mathematics is made up of relationships between ideas, facts, and procedures. To understand these relationships, students must analyze mathematical problems and the different methods that can be used to solve them. Students must struggle with problems first in order to make sense of later discussions about how to solve them and to understand the summary comments made by the teacher. So, the lesson must tell a tightly connected, coherent story; the teacher must build a visible record of the pieces as they unfold so connections between them can be drawn; and the lesson cannot be sidetracked or broken by interruptions.

In the United States, lessons are treated differently. This is not surprising given the different beliefs about mathematics, learning, and the teacher. The activities within a lesson are more modular with fewer connections between them. Practice time might be devoted to the procedures demonstrated today, yesterday, or last week. Because it is believed that learning a procedure depends largely on practicing the procedure, temporary interruptions, such as outside intrusions or unrelated activities, will not ruin the lesson. These distractions might be annoying, but they just reduce the number of practice exercises for that day. It may not be surprising, then, that we found that more than one-fourth of the U.S. lessons were interrupted in some way.

CULTURAL ACTIVITIES are highly stable over time, and they are not easily changed, for two reasons: First, cultural activities are systems; and systems, especially complex ones such as teaching, can be very difficult to change. The second reason is that they are embedded in a wider culture, often in ways not readily apparent to members of the culture. If we want to improve teaching, we must recognize and deal with both its systemic and its cultural aspects.

Teaching systems, like other complex systems, are composed of elements that interact and reinforce one another; the whole is greater than the sum of the parts. One immediate implication of this fact is that it will be difficult, if not impossible, to improve teaching by changing individual elements or features. In a system, all the features reinforce each other. If one feature is changed, the system will rush to "repair the damage," perhaps by modifying the new feature so it functions like the old one did. If all teachers in the U.S. started using the chalkboard tomorrow, rather than the overhead projector, teaching would not change much. The chalkboard simply would be used to fill the visual aids slot in the teachers' system, and therefore would be used just as the overhead projector is—to catch and hold students' attention.

This point is missed in many popular attempts to reform teaching in the U.S. These reforms start with indicators, like those we present in the accompanying article, and try to improve teaching by influencing the level of the indicator. For example, having found that Japanese and German students encounter more advanced mathematics, reformers might propose that we present more challenging content in our schools. Or, because Japanese teachers switch back and forth between classwork and seatwork more often than American teachers do, reformers might propose lessons with shorter classwork and seatwork segments. German and Japanese students do proofs, so perhaps we should include proofs in our lessons. Educational reforms in this country often have been driven by an effort to change our performance on quantifiable indicators like these.

Because teaching is a complex system, these attempts to change it generally don't work. It has now been documented in several studies that teachers who are asked to change features of their teaching often modify the features to fit within their pre-existing system instead of changing the system itself. The system assimilates individual changes and swallows them up. Thus, although surface features appear to change, the fundamental nature of the instruction does not. When this happens, anticipated improvements in student learning fail to materialize, and everyone wonders why.[9]

A WELL-KNOWN example comes from the "New Math" reforms of the 1960s. A major thrust of these reforms was changing the textbooks. Because most mathematics teachers rely quite heavily on the textbook, one might think that changing the textbook would change teaching. In 1975, after the changes had time to take effect, the National Advisory Committee on Mathematical Education commissioned a study of school mathematics instruction. The committee concluded that in elementary schools, "Teachers are essentially teaching the same way they were taught in school. Almost none of the concepts, methods, or big ideas of modern mathematics have appeared."[10] Even textbooks can get swamped by the system.

A more recent and personal illustration of the stability of systems of teaching occurred when one of us was participating with a group of American teachers analyzing videotapes of Japanese mathematics instruction. A fourth-grade teacher decided to shift from his traditional approach to more of a problem-solving approach as shown in the Japanese lessons. Instead of asking short-answer questions, he began his next lesson by presenting a problem and asking students to spend ten minutes working on a solution. Although the teacher changed his behavior to correspond with the teacher in the videotape, the students, not having watched the video and not having thought about their own participation, failed to respond like the students on the tape. They played their traditional roles and waited to be shown how to solve the problem. The lesson did not succeed. Even students are part of the system.

Systems of teaching are much more than the things the teacher does. They include the physical setting of the classroom; the goals of the teacher; the materials, including textbooks and district or state objectives; the roles played by the students; the way the school day is scheduled; and other factors that influence how teachers teach. Changing any one of these individual features is unlikely to have the intended effect.

TRYING TO improve teaching by changing individual features usually makes little difference, positive or negative. But it can backfire and leave things worse than before. When one or two features are changed, and the system tries to run as before, it can operate in a disabled state. Geoffrey Saxe and his colleagues at UCLA found that when elementary school teachers were asked to teach fractions by implementing an innovative curriculum, some did so with higher student achievement than a comparison traditional program, and some did so with lower student achievement.[11] The difference was that the successful teachers were provided with information and assistance that, in our words, helped them improve their *system.* The less successful teachers did not receive such assistance and tried to operate their conventional system with the new curriculum. This was not a good fit and did not promote students' learning. The point here is that trying to improve by changing individual features is not just ineffective; it is downright risky.

Bombarding teachers with waves of ineffective reforms can have another downside: Teachers can grow weary. They are asked over and over to change the way they do x, y, or z. Even when they try to accommodate the reformers and adopt a new feature or two, nothing much happens. They do not notice much improvement in students' learning. Although it may feel to teachers as though they are changing, the basic system is running essentially as it did before. Always changing, and yet staying the same, is a discouraging state of affairs. It can lead to a defeatist kind of cynicism. "Not another reform," says the veteran teacher. "I'll just wait this one out." Quick fixes that focus on changing individual features leave behind a skeptical teaching corps.

The fact that teaching is cultural further complicates and impedes efforts to change it. The widely shared cultural be-

> The more widely shared a belief is, the less likely it is to be questioned, or even noticed.

liefs and expectations that underlie teaching are so fully integrated into teachers' worldviews that they fail to see them as mutable. The more widely shared a belief is, the less likely it is to be questioned, or even noticed. This tends to naturalize the most common aspects of teaching, to the point that teachers fail to see alternatives to what they are doing in the classroom, thinking that this is just the way things are. Even if someone wanted to change, things that seem this natural are perceived as unchangeable. It is no wonder that the way we teach has not changed much for many years. Is it impossible to change? We don't think so. But we must be sure that our efforts to improve are appropriate for changing *cultural* activities. If teaching were a noncultural activity, then we could try to improve it simply by providing better information in teachers' manuals, or asking experts to demonstrate better techniques, or distributing written recommendations on more effective teaching methods. Notice: This is exactly what we have been doing. We have been acting as though teaching is a noncultural activity.

If we took seriously the notion that teaching is a cultural activity, we would begin the improvement process by becoming more aware of the cultural scripts that we are using. This requires comparing scripts, seeing that other scripts are possible, and noticing things about our own script that we had never seen before. Becoming more aware of the scripts we use helps us see that they come from choices we make. The choices may be understandable, but still they are choices, and, once aware of them, other choices can be made.

Improving cultural scripts for teaching is a dramatically different approach than improving the skills of individual teachers. But it is the approach called for if teaching is a cultural activity. No matter how good our teachers are, they will only be as effective as the script they are using. To improve teaching over the long run, we must improve the script.

(Note: In the three chapters that conclude The Teaching Gap, *Stigler and Hiebert discuss how teachers can become aware of the cultural scripts that influence their teaching and take steps to alter them. The author s' suggestions have a good deal in common with ideas about professional development discussed in the articles by Catherine Lewis and Ineko Tsuchida and by Anthony Alvarado, which follow.)* □

Endnotes

[1] Ronald Gallimore makes many of these same points in a 1996 chapter, "Classrooms are just another cultural activity." In D.L. Speece & B.K. Keogh (Eds.), *Research on classroom ecologies: Implications for inclusion of children with learning disabilities* (pp. 229-250). Mahwah, NJ: Erlbaum.

[2] The same categories of core beliefs have been suggested by other researchers. See, for example, Griffin, S., & Case, R. (1997). "Rethinking the primary school math curriculum: An approach based on cognitive science." *Issues in Education, 3*(1), 1-49; Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127-146). New York: Macmillan.

[3] There is a strong American tradition in behaviorist psychology, a psychology that addresses, most directly, issues of skill learning. Behaviorism, or connectionism, was developed most fully by E. L. Thorndike in the early 1900s and elaborated in different ways by B. F. Skinner and R. M. Gagne.

[4] The psychology of learning that underlies this approach is familiar in the U.S., but it is not the psychology that has taken hold in everyday teaching in the U.S. See, for example, the writings of J. Dewey and J. Piaget and numerous recent works that have elaborated these ideas.

[5] Kyoshiyo shidosho: Shogakko sansu 5 nen (*Teacher's guidebook: Elementary mathematics 5th-grade)* (1991). Gakkotosho: Tokyo.

[6] One item on the questionnaire given to U.S. eighth-grade mathematics teachers in the TIMSS sample asked them to select, among sixteen choices, those that limited their effectiveness in the classroom. The second most frequent choice, just behind lack of student interest, was the range of abilities among students in the same class (selected by 45 percent of the respondents). See also a survey of its members by the American Federation of Teachers, reported in the Spring 1996 (Volume 20, Number 1) issue of *American Educator*, pages 18-21.

[7] See the following article for an analysis of how the variety of student responses in a Japanese classroom benefits the whole class: Hatano, G., & Inagaki, K. (1991). "Sharing cognition through collective comprehension activity." In Resnick, L.B. Levine, J.M. & Teasley, S.D. (Eds.), *Perspectives on socially shared cognition* (pp. 331-348). Washington, DC: APA.

[8] Lewis, C., & Tsuchida, I. (1997). "Planned educational change in Japan: The case of elementary science instruction." *Journal of Educational Policy*, 12, 313-331; Sasaki, Akira (1997) Jugyo kenkyu no kadai to jissen (*Issues and implementation of lesson study*). Kioiku kaihatsu kenkyujo: Tokyo.

[9] Cohen, D. (1996). "Standards-based school reform: Policy, practice, and performance." In Ladd, H F. (Ed.)., *Holding schools accountable: Performance-based reform in education.* Washington, DC: Brookings Institution; Guthrie, J.W. (Ed.) (1990). *Educational and Policy Analysis, 12* (3), Special Issue.

[10] Conference Board of the Mathematical Sciences (1975). *Overview and analysis of school mathematics, K-12.* p.77 Washington, DC: Author.

[11] Saxe, G. B., Gearhart, M., & Dawson, V. (1996). "When can educational reforms make a difference? The influence of curriculum and teacher professional development programs on children's understanding fractions." Unpublished paper.

The TIMSS Videotape Study

By James W. Stigler and James Hiebert

THE VIDEO study that we conducted as a part of the Third International Mathematics and Science Study (TIMSS) collected samples of classroom instruction from 231 eighth-grade math classrooms in Germany, Japan, and the United States. It was the first time anyone had videotaped classroom instruction from nationally representative samples of teachers.

The study was a test run to allow us to see whether such a study would be feasible on a large scale. In the meantime, we hoped to get insight into what actually goes on inside the eighth-grade math classrooms in these three countries. It is relatively easy to gather data about classroom input by looking at curricula and textbooks and to get an idea about results from test scores. However, the classes themselves have been a black box; we have had little or no information about the process of teaching. Once coded and analyzed, the videotapes opened a new window on classroom practice. Furthermore, they revealed some fascinating national differences in a number of areas, including the following:

- The way the lessons are structured and delivered
- The kind of mathematics taught
- The kind of thinking students engage in during the lessons
- The way teachers view reform

Procedures

We videotaped each classroom one time,on a date convenient for the teacher. In order to discourage teachers from making special preparations for the videotaped lesson, we issued instructions telling them that our goal was to capture a typical lesson and that we wanted them to show us exactly what they would have done had we not been videotaping.

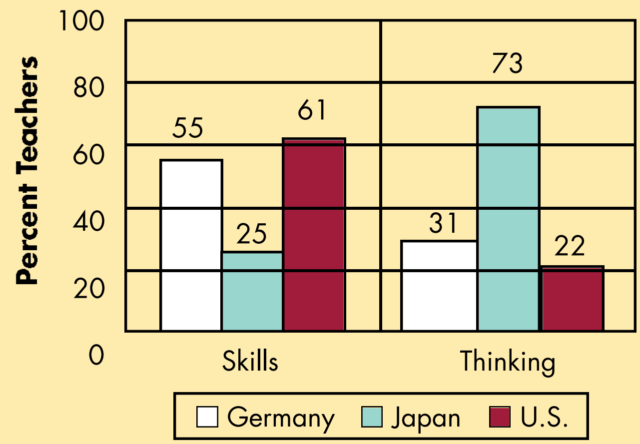
In addition to the data from the videotapes, we collected responses to a questionnaire and some supplementary materials—for example, copies of textbook pages or worksheets. The questionnaire asked teachers to describe the goal of the lesson, its place within the current sequence of lessons,how typical the lesson was, and whether teachers had used methods recommended by current reforms.

Lessons: Structure and Delivery

1. Lesson Goals

To evaluate a classroom mathematics lesson, you must first know what the teacher was trying to accomplish. We asked teachers,on the questionnaire,to tell us what they "wanted students to learn" from the lessons we videotaped.Most of the answers fell into one of two categories:

FIGURE 1



Teachers' descriptions of the lesson goal

Skills—These answers focused on students being able to *do* something:perform a procedure,solve a specific type of problem.

Thinking—These answers focused on students being able to *under stand* mathematical concepts or ideas.

As the graph indicates, Japanese teachers focused on thinking and understanding; German and U.S. teachers on skills.These different goals led Japanese teachers to construct their lessons in a different way from U.S. and German teachers.

2. Lesson Scripts

The videotaped lessons revealed a clear distinction between the "script"—the underlying pattern or template—used by Japanese teachers as they create a lesson and the scripts used by German and U.S.teachers.These different scripts follow from the different instructional goals, and they are probably based on different assumptions about the role of problem solving in the lesson,the way students learn from instruction, and what the proper role of the teacher should be.

U.S. and German lessons tend to have two phases. In the first or acquisition phase, the teacher demonstrates and/or explains how to solve a sample problem.The explanation might be purely procedural (this is what most often happens in the U.S.) or it might include developing concepts (this is more often the case in Germany). Still, the goal in both countries is to teach students a method of solving the sample problem.In the second or application phase, students practice solving similar examples on their own while the teacher helps individual students who are having difficulty.

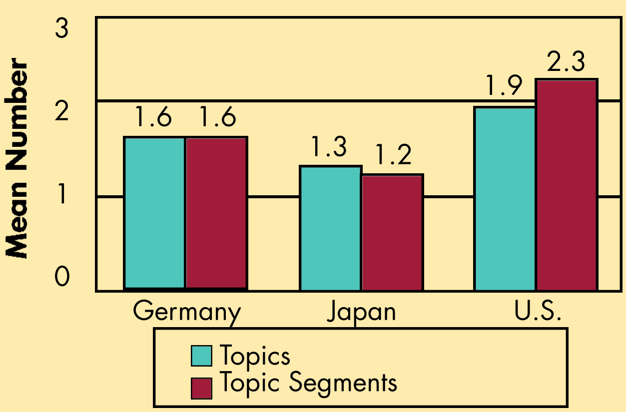
Japanese lessons generally follow a different script.

Problem solving comes first, followed by a time in which students share the methods for solving the problem that they have found on their own or in small groups. So while students in U.S. and German classrooms are expected to follow the teacher as she leads them through the solution of a sample problem or problems, Japanese students have a different job.They must invent their own solutions and then reflect together on those solutions in an attempt to increase their understanding of various ways to approach a problem.

3. Coherence

Students are more likely to make sense of a lesson that is coherent.When we compared U.S.lessons with those in Germany and Japan, we found the American to be less coherent by several criteria. First,American lessons contained significantly more topics than Japanese lessons, and significantly more topic segments than both Japanese and German lessons.

FIGURE 2



Mean number of topics and topic segments per lesson

Second, when changing from one topic or segment to another,American teachers were less likely than Japanese teachers to make a transition linking the different parts of the lesson.

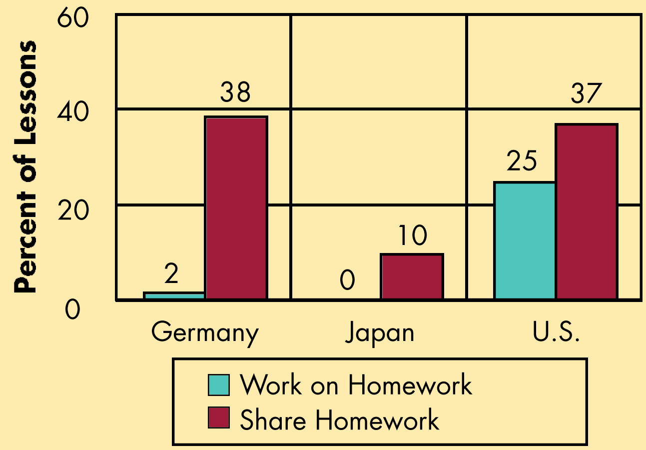
Third, American teachers devoted significantly more time during the lesson to irrelevant diversions such as discussing last night's rock concert or an upcoming field trip than German or Japanese teachers. Depending when these diversions occur, they can weaken the coherence of the lesson.

Finally, American lessons were more frequently interrupted by outside events, such as PA announcements or visitors.Lessons were halted by such interruptions in 28 percent of American lessons, 13 percent of German lessons, and zero percent of Japanese lessons.

4. Homework During the Lesson

Another cross-national difference revealed by the videotaped lessons was in the role of homework. The graph below shows the percentage of lessons in which students reviewed and shared homework in class and the percentage in which they worked on their homework for the next day.

FIGURE 3



Percentage of lessons in which class worked on or shared homework

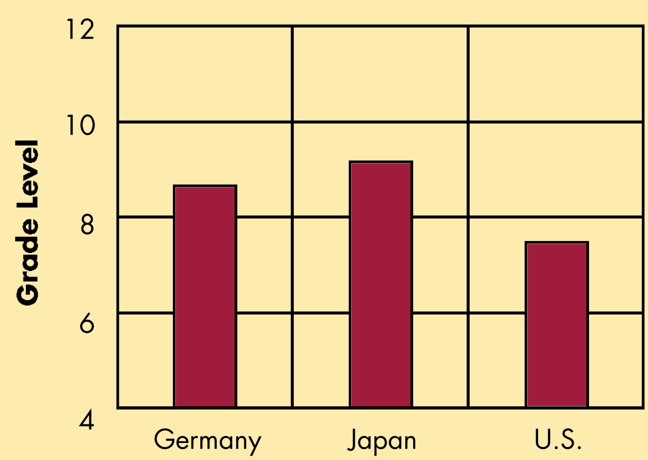
Japanese students never worked on the next day's homework during class and rarely shared homework results.Both German and American students shared homework frequently, but only American students commonly spent time in class working on the next day's homework.When we calculated the total percentage of time during the lesson that was devoted to assigning, working on, or sharing homework we got a similar result: Only 2 percent of lesson time in Japan involved homework in any way, compared with 8 percent in Germany and 11 percent in the United States.

The Kind of Mathematics Taught

1. Level of the Mathematics

Although it is not possible, a priori, to say that one mathematical topic is more complex than another, looking at where a topic appears in mathematics curricula around the world shows how advanced the topic is generally considered to be. This is what experts from forty-one countries did in order to establish a TIMSS math framework.

FIGURE 4



Average grade-level content of lessons

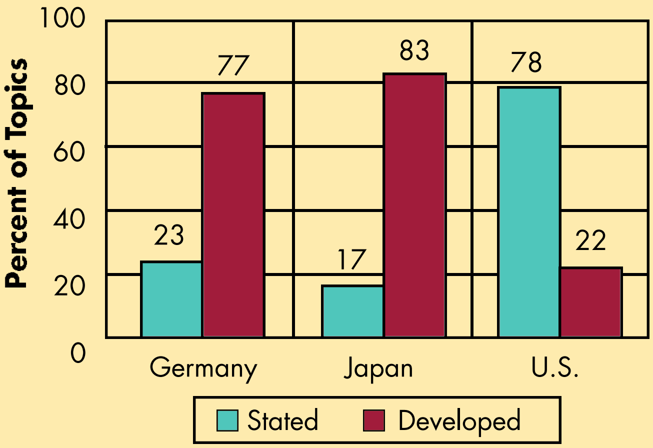
When we coded our videotapes, we used the TIMSS framework and were thus able to compare the topics taught with the international average. By international standards,the mathematical content of U.S. lessons was, on average, at a seventh-grade level, whereas German and Japanese lessons fell in the high eighth-grade or low ninth-grade levels.

2. Nature of the Mathematics

The videotaped lessons also revealed that the nature of the content differed across countries. For example,most mathematics lessons include some mixture of concepts and the application of those concepts to solving problems. How concepts are presented, however, varies a great deal. They might simply be stated, as in "the Pythagorean theorem states that $a^2 + b^2 = c^2$" or they might be developed and derived over the course of the lesson. The graph shows the percentage of topics in each lesson that contained concepts that were developed and the percent that were only stated.

Although constructing proofs and reasoning deductively are important aspects of mathematics, American students lacked opportunities to engage in these kinds of activities.None of the U.S.lessons that we videotaped included proofs, whereas 10 percent of German lessons and 53 percent of the Japanese lessons included proofs.

FIGURE 5

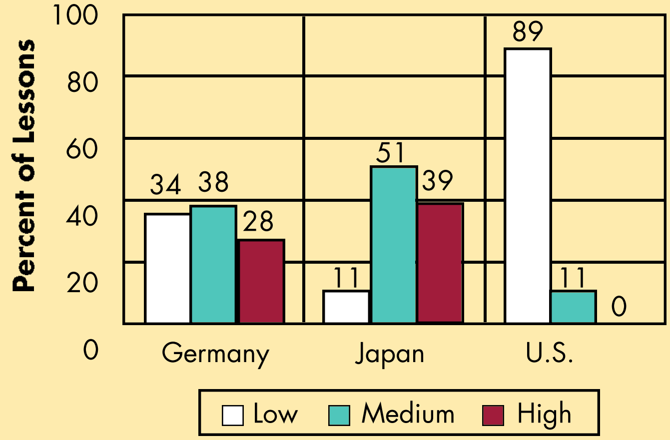


Average percentage of topics per lesson containing concepts that were stated and concepts that were developed

3. Quality of Mathematical Content

As part of the video study, we asked an independent group of American college mathematics teachers to evaluate the quality of mathematical content in a representative selection of the video lessons. Basing their judgments on detailed written descriptions, they examined thirty lessons from each country. In order to decrease the likelihood of bias, we deleted information that might identify the country in which a lesson took place. The group's judgments are summarized in the following graph.

FIGURE 6



Percentage of lessons with content of low, medium, or high quality

Whereas 39 percent of the Japanese lessons and 28 percent of the German lessons received the highest rating, none of the U.S. lessons received the highest rating. Furthermore, 89 percent of U.S. lessons received the lowest rating,compared with 11 percent of Japanese lessons.

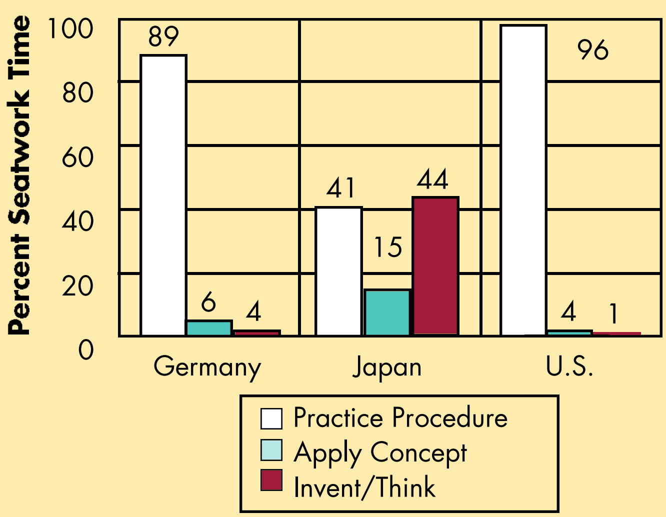
Students' Thinking

1. Tasks During Seatwork

When we examined the kind of work students engaged in during the lesson, we found a strong resemblance between Germany and the U.S.Three types of work were coded in the video study:

- Practicing routine procedures
- Applying concepts to novel situations
- Inventing new solution methods/thinking

FIGURE 7



Average percentage of seatwork time spent working on three kinds of tasks

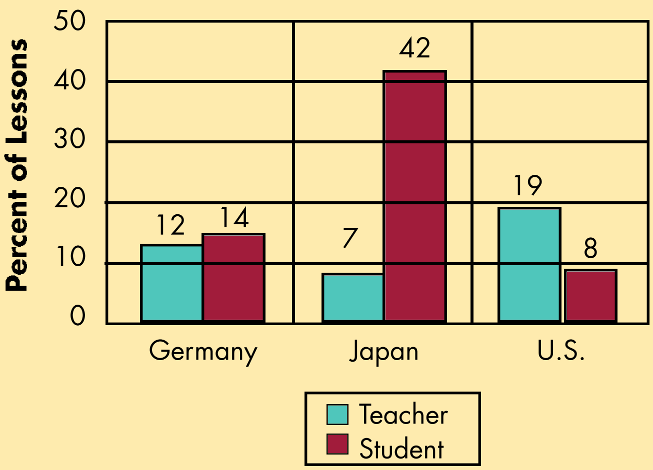
Approximately 90 percent of student working time in Germany and the U.S. was spent in practicing routine procedures, compared with 41 percent in Japan. Japanese students spent nearly half their time inventing new solutions and attempting to grapple with mathematical concepts.

2. Alternative Methods for Solving Problems

We also were interested in the frequency with which students were exposed to alternative methods of solving problems. We distinguished two types of alternative methods—those presented by the teacher, and those generated by the students.

As shown on the graph below, 42 percent of Japanese lessons contained student-generated alternative methods, more than twice as many as German (14 percent) or U.S. (only 8 percent) lessons. The percentage of teacher-presented alternative methods did not differ significantly in the three countries.

FIGURE 8

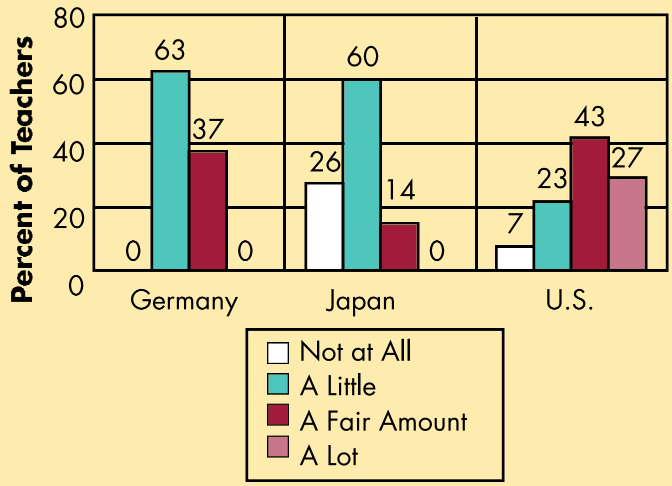


Percentage of lessons including teacher-presented and student-generated alternative solution methods

Teachers' View of Reform

U.S. teachers believe that they are implementing current reform ideas in their classrooms. When asked specifically to evaluate their videotaped lesson, almost three-fourths of the American teachers rated it as reasonably in accord "a lot" or "a fair amount" with current ideas about the teaching and learning of mathematics. They were more than twice as likely to respond this way than either the Japanese or the German teachers.

FIGURE 9



Teachers' ratings of their videotaped lessons in terms of current ideas

Teachers who said that the videotaped lesson was in accord with current ideas about the teaching and learning of mathematics were asked to justify their responses. Although the range and variety of responses to this question were great, the vast majority of American teachers' responses pointed to surface features, such as the use of real-world problems, manipulatives, or cooperative learning, rather than to the deeper characteristics of instruction such as the depth of understanding developed by their students.

The findings of the video study suggest that written reports that are disseminated to teachers may have little impact on practices in the classroom. One reason for this may be that teachers do not have widely shared understanding of what such terms as "problem solving" mean, leading to idiosyncratic interpretations in the classroom. Video examples of high-quality instruction tied to descriptions of what quality instruction should look like may help, in the future, to solve this problem.

Of course, not all teachers in these three countries follow the "script" sketched here, and not all lessons take the forms we have described. But what is striking, viewing the videotapes, is how many of the lessons display common national—or perhaps we should say cultural—patterns. □