Humanistic Mathematics Network Journal

Issue 26 Article 14

6-1-2002

Book Review: The Teaching Gap by James W. Stigler and James Hiebert

Michael L. Brown
Simmons College

Book Review: *The Teaching Gap* by James W. Stigler and James Hiebert Review Part II: Contrasting U.S. and Japanese Beliefs about Mathematics Teaching

Michael L. Brown
Simmons College
Boston, MA 02115-5898
michael.brown@simmons.edu

The Teaching Gap. James W. Stigler and James Hiebert. The Free Press (Div. Simon & Schuster Inc.): New York, 1999. ISBN 0-684-85274-8

This is the second of three articles that together form an in-depth book review of The Teaching Gap. After a brief summary of the first article[1], we explore the contrasting cultural beliefs that support mathematics teaching in the U.S. and Japan, and in doing so, find several surprises that are relevant to college teaching.

SUMMARY OF THE FIRST ARTICLE

As our first book review article discusses, *The Teaching Gap* addresses critical questions about how mathematics teaching is actually done in the U.S., Japan, and Germany, based on uniquely valuable data: the first videotaped national random samples, in each country, of eighth-grade mathematics classroom lessons. Remarkably, teaching varied greatly from one culture to the next, and comparatively little within each culture, giving an empirical foundation to the pivotal claim in the book that "teaching is a cultural activity."[2] The authors claim, and we are persuaded, that their findings of cultural differences go far beyond the eighth grade. Indeed, we believe they have much of importance in common with what we encounter at the college level, as we explore in what follows.

For the perennial and largely unsuccessful efforts to reform American education, the authors accordingly offer a deep and elegant explanation: in these efforts, "we have been acting as if teaching is a noncultural activity." The Japanese system for improving teaching, on the other hand, "is built on the idea that teaching is a complex, cultural activity."

The U.S. and Japanese typical lesson patterns were starkly contrasting. While they both began with a review of previous work, in the U.S. this led into "presenting a few sample problems and demonstrating how to solve them," with students then practicing solving similar problems, followed by checking and correcting some of this practice. In Japan, the initial review led into presenting a new problem, *which students then worked on trying to solve*. Then the class discussed and compared the students' various methods, along with any the teacher showed. The teacher finished by highlighting the principal points.

Thus, after a new problem is presented, in Japan students develop solution procedures, "without first" being shown "how to solve the problem," while in the U.S. a solution procedure is "almost always" shown to students first. Only then are they required to work problems using it. Mathematics students in the U.S. are thus found to be occupied mainly with mastering unconnected skills by repetitive practice, while their Japanese counterparts devote time in comparable amounts to, on the one hand, solving problems that genuinely challenge them and having concept-focused discussions, and on the other hand, skill practice.

As we emphasized in the previous article, this is in our view a crucial contrast, and one which, as we examine here, seems to have much bearing on U.S. college mathematics teaching.

CULTURAL SCRIPTS AND BELIEFS ABOUT TEACHING

To explain why a nation's mathematics lessons follow these distinctive and, in the case of the U.S. and Japan, contrasting, patterns, the authors introduce the notion that these lessons were created and carried out by teachers who, as members of a culture, "share the same *scripts*" [italics ours]. A script is "a mental version of...teaching patterns" such as the U.S. and Japa-

nese patterns whose contrasts we have summarized above. In this way *The Teaching Gap* develops its claim that how one teaches is primarily determined by one's culture, rather than being an instinctive gift or acquired in "college teacher-training programs."

And the script, in turn, "begins forming early.... As children move through twelve years and more of school, they form scripts for teaching." So students (as well as teachers) come to the classroom after years of being socialized into a pattern of expectations that are mutually aligned in consonant ways. This is, I think, why the authors' generalizations have so much power beyond the eighth-grade context from which they were derived—these findings are statements about deeper patterns of cultural participation. In particular, as we remarked in the previous article, we at the college level may find it worthwhile to consider the extent to which our teaching also fits the U.S. pattern and contrasts with the Japanese pattern, as summarized above.

Teaching is therefore a complex system that, like other cultural activities, "evolve[s] over long periods of time in ways that are consistent with the stable web of beliefs and assumptions that are part of the culture."

Thus we see that the authors' fundamental logic is: *beliefs* give rise to and sustain cultural *scripts* (which characterize a culture's *system* of teaching), and the system in turn determines the various manifest *features* of teaching that we can observe, say, in video data.

And what are these beliefs about? A nation's teaching script seems to depend on a few central beliefs about (1) what mathematics is, (2) the way students learn about it, and (3) the teacher's function during the lesson. The authors have inferred a set of beliefs for Japanese and U.S. teaching in these three areas based not only on teachers' answers to questionnaires but directly on how they behave.

CULTURAL BELIEFS ABOUT WHAT MATHEMATICS IS

In regard to what mathematics is, the U.S. pattern fits "the belief that school mathematics is a set of procedures...for solving problems." Sixty-one percent of American teachers, "asked what 'main thing' they wanted students to learn from the lesson,...described *skills*.... They wanted the students to be able to perform a procedure, solve a particular kind of problem, and so on."

It is also riveting and thought-provoking to learn that "[m]any U.S. teachers also seem to believe that" this view of mathematics ("learning terms and practicing skills") is "not very exciting. We have watched them trying to jazz up the lesson and increase students' interest in nonmathematical ways: by being entertaining, by interrupting the lesson to talk about other things...or by setting the mathematics problem in a real-life or intriguing context.... Teachers act as if student interest will be generated only by diversions outside of mathematics." While we may question the inclusion of creating a "real-life...context" in the list, the thrust of the description hits home, I think, surprisingly forcefully: I suspect it is a rare college mathematics educator indeed who has not taken it for granted, to one degree or another, that these extrinsic activities in the classroom are a necessary concomitant of winning the prize of students' enthusiasm for the mathematics. While the authors' description may at first be disturbing, on reflection it is encouraging, in that it gives us a new context in which to view these pulls away from the mathematics in our classrooms, and thereby a hope that they are not ineluctable.

These "diversions" are compromises, and thus to some extent compromising: they are moves away from where we, including those of us in the college classroom, feel we ought to be. What is hopeful in this formulation is that the blame is placed neither on us nor on our students, but on our *system*.

Contrasting beliefs about what mathematics is seem to underlie Japanese teaching. "Teachers act as if mathematics is a set of relationships between concepts, facts, and procedures. ...On the same questionnaire [as the one given to American teachers], 73% of Japanese teachers said that the main thing they wanted their students to learn from the lesson was to think about things in a new way, such as to see new relationships between mathematical ideas."

Moreover, in stunning contrast to the U.S. teachers' beliefs about what mathematics is, "Japanese teachers also act as if mathematics is inherently interesting and students will be interested in exploring it by developing new methods for solving problems. They seem less concerned about motivating the topics in

nonmathematical ways.

CULTURAL BELIEFS ABOUT HOW MATHEMATICS SHOULD BE LEARNED

Based on this U.S. belief about mathematics as largely a set of procedures, a natural belief about how mathematics should be learned then follows: "incrementally, piece by piece...practicing [procedures] many times, with later exercises being slightly more difficult than earlier ones." Again, does this not seem so familiar as to be taken as virtually the only way to do things?

The authors connect "this view of skill learning" and its "long history in the United States" to behaviorist psychology, B.F. Skinner, and related work. Unfortunately this fertile connection is relegated to a mere footnote[3] and seems very worthy of amplification.

A further American belief about how mathematics is learned also follows: "Practice should be relatively error-free, with high levels of success at each point. Confusion and frustration, in this traditional American view, should be minimized; they are signs that earlier material was not mastered." The authors offer the example of a lesson in adding fractions, saying that these beliefs would lead to a presentation sequence with "like denominators,...then...simple fractions with unlike denominators,...warn[ing] about the common error of adding the denominators (to minimize this error), and later...more difficult" unlike denominators. But (at a more advanced level of course) do we not act out of the same beliefs much of the time in our college teaching, and construct our lessons accordingly, seeking to maximize success rates all along the way, and minimize frustration?

The Japanese belief about how mathematics is to be learned involves "first struggling to solve" problems, then discussing how to find solutions, and then having various methods compared and related. "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 an appropriate time." They quote a Japanese teachers' manual that, in the lesson on adding fractions, advises allowing students to make the most common error, i.e., to add the denominators, then to reflect on the "inconsistencies" they will find thereby. The teacher should start with, "for example, _ + _," then compare the various ways that students come up with to solve this problem, such as adding denominators to get 2/6. Thus, the Japanese believe that "struggling and making mistakes and then seeing why they are mistakes" are necessary to learning.

CULTURAL BELIEFS ABOUT THE TEACHER'S RESPONSIBILITIES

The last set of beliefs concerns what teachers in each country regard themselves as responsible for in the classroom.

American teachers seem to think they should partition work into units that are doable for most of the class, telling students all that they need to know in order to do the work, and then giving them lots of drill. Note carefully, however, that telling students what they need to know to do the work typically reduces to showing them how to do problems just like the practice problems. "Confusion and frustration" are believed to be intrinsically bad, evidence that teachers have fallen short in some way, and, upon their occurrence, the teacher will rush to give whatever help is required to put students back on the right path. U.S. teachers thus "try hard to reduce confusion by presenting full information about how to solve problems." Again, I would surmise that we can see ourselves, at least some of the time, in this description, and indeed that we perhaps might not even have considered it too plausible that there was any alternative to doing what is described here.

Also, that we can see our choices in teaching as much as we do in these descriptions is indirect confirmation of the authors' thesis that these choices are culturally conditioned.

A natural consequence of the foregoing beliefs in the U.S.—because students must pay continuous close attention to their teacher solving model problems in order to be able to carry out the same solution methods on their own—is that "U.S. teachers also take responsibility for keeping students engaged and attending." In particular, as one illustrative consequence, a detail that is nevertheless emblematic is that the U.S. teacher typically prefers the overhead projector rather

than the blackboard, because the projector is better able to focus attention. U.S. teachers have other ploys whose goal is to keep the attention of students from wandering: "They pump up students' interest by increasing the pace of the activities, by praising students for their work and behavior, by the cuteness or reallifeness of tasks, and by their own power of persuasion through their enthusiasm, humor, and 'coolness.'" Notice that this is a whole category of teacher behavior in the U.S. that is distinct from the injection of extrinsic diversions as discussed above, but which I think can often share some of the same dubious or compromising qualities.

Taking "responsibility for keeping students engaged and attending" is so fundamental to the way we do things in American classrooms that, here again, one might well have taken for granted that it could not be any other way. Tying this to an emphasis on procedural learning is encouraging, I think, because it suggests that the necessity for such measures is mutable.

Surprisingly, teachers in Japan "apparently believe they are responsible for different aspects of classroom activity" from their U.S. counterparts. The Japanese beliefs about what the proper role for the teacher is are at the heart of what college teachers can most benefit from in *The Teaching Gap*, since it is this third set of beliefs that goes directly to what Japanese teachers actually do in the classroom. We accordingly quote the authors' description at some length:

> ... 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 their solution methods so they can organize the follow-up discussion when students share solutions. They also encourage students to keep struggling in the face of difficulty, sometimes offering hints to support students' progress. Rarely would teachers show students how to solve the problem midway through the lesson.
>
> Japanese teachers lead class discussions, asking questions about the solution methods presented, pointing out important features of students' methods, and presenting methods themselves. Because they 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 to see connections between the different parts of the lesson.

The authors then say, picking up on an example cited above, that, "Now we understand why Japanese teachers prefer the chalkboard to the overhead projector. Indeed, now we see, in a deeper way, why they cannot use the projector."

This priority that they "go back and think again...and see connections," and the consequent depotentiation of the need for continuous attention, seem to address at once two prominent issues in our college teaching: respectively, how to encourage the making of higher-order, more abstract connections, and how to lessen those diversionary pulls away from the mathematical material itself to extrinsic matters, as discussed above, and instead allow the inherent qualities of the mathematics to be what keep students attending. Indeed, this priority seems to be, in the context of course of the whole Japanese system, an explicit remedy for the latter problem.

A COROLLARY BELIEF ABOUT VARIATIONS IN STUDENTS' PERFORMANCE

A further fascinating and striking consequence of the Japanese script, closely related to the three sets of beliefs that we have just considered, is a positive valuation of what is often viewed as a chronic barrier to better results in American classrooms, certainly including those in the colleges—namely, differing levels of performance and ability in the classroom. (In fact, the statistical distribution of such levels is not only often widely spread out but, very likely much more often in the colleges than in the public schools, indeed actually bimodal or even multimodal, due to the implementation of two or more distinct tiers of admissions policies at many colleges. This multimodality typically makes this barrier even more awkward to surmount.)

Remarkably, the Japanese see such individual differences "as a resource for both students and

teachers...because they produce a range of ideas and solution methods that provide the material for students' discussion and reflection." The larger the class, the more assured the teacher can be that a satisfactory range and an assortment of types of responses will be produced, hence the more reliably planned the lesson can be! Moreover, this range also gives teachers the means to address the differing levels of performance and ability among students. The Japanese have in fact quantified and systematized this approach: "Japanese teachers have ready access to information of the form 'When presented with problem A, 60% of students will use Strategy One, 20% Strategy Two, 15% Strategy Three, and 5% some other strategy.'"

What a very different and more constructive "take" on the problem of disparate performance levels the Japanese script seems to allow.

CLOSING

In this second book review on *The Teaching Gap*, we have given detailed emphasis to the contrasting sets of teachers' beliefs in the U.S. and Japan because these findings seem exceptionally relevant to the practice of mathematics teaching at the college level. In the third and concluding article, we focus on ideas related to improving mathematics teaching in the U.S., and on ways to carry these explorations onward, both in action and in reflection. There as well, the focus is on what we find most worthy of being better known among mathematics educators at the college level.

REFERENCES

1 Brown, Michael L., "Book Review: *The Teaching Gap*, by James W. Stigler and James Hiebert. Review Part 1: Mathematics Teaching as a Cultural Activity," *Humanistic Mathematics Network Journal*, *24* (May 2001).

2 All unattributed quotes in this article are, like this quote, from *The Teaching Gap*.

3 This is Footnote 3 on Page 187 of *The Teaching Gap*.