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

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Book Review: *The Teaching Gap* by James W. Stigler and James Hiebert
Review Part I: Mathematics Teaching as a Cultural Activity

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

As any mathematician who has worked widely in applied statistics knows firsthand, it is true in the social sciences no less than the natural sciences that new discoveries often begin with the availability of new kinds of data. And such data, in the social sciences, in turn often owe their existence to novel ways of harnessing, to the purposes of science, technology for recording human behavior. Virtually whole new fields of study may be born in this way: a piquant example is the field of child language acquisition, which burgeoned with the availability of portable audiotape recorders in the 1970s.

The Teaching Gap is based on novel, indeed unique, data of high quality and unprecedented scope: a random sample, statistically controlled to minimize bias, of eighth-grade mathematics classroom lessons in the U.S., recorded on videotape, and corresponding information from Japan and from Germany—three national video samples, representative of teaching in each country. The video study "is the first to collect videotaped records of classroom instruction—in any subject—from national probability samples."[1]

This video study is actually one component of the Third International Mathematics and Science Study (TIMSS), itself as a whole a much more advanced study methodologically than its like-named predecessors. "Fortunately, the TIMSS sampling plan was highly sophisticated...the video sample [was] a random subsample of the full TIMSS sample. Not only were specific teachers selected, but specific class periods as well. No substitutions were allowed..."[2] It is evident that substantial efforts were made in the video study (and in TIMSS as a whole) to minimize both sampling and nonsampling errors.

The last quote is from an excellent overview article on the video study, written by the authors of *The Teaching Gap*, and available on the Web.[3] The authors maintain a Web site[4] with links to articles, including this one, that are related to *The Teaching Gap*, the video study, and TIMSS. One of the links (still under construction as of this writing) from this site will allow the viewing of some of the actual videos.

The decision by the National Center for Education Statistics to collect national videotape samples reflects the early influence[5] of one of the authors of *The Teaching Gap*, James W. Stigler, who was a co-author of an earlier highly regarded study[6] comparing Japanese and Chinese education to our own. Stigler realized that the problem of a lack of common understanding of basic terms to describe teaching, all the more serious in an international context, would require data more raw, less filtered, than questionnaire responses could offer.[7]

Based on these video data, the authors set out to address fundamental questions about mathematics teaching as it is actually and typically done, in the three countries: What methods do teachers use to teach? Does mathematics teaching differ in any significant ways from one country to another, or are teachers in all three cultures teaching mathematics more or less the same way? And, in the U.S., are high-profile reform recommendations actually being put into practice? Also, because the video data would show actual classroom teaching as it is, unmediated by measurement instruments such as questionnaires, such data would have the power to surprise and to reveal the unexpected.

And surprise they did: "To put it simply, we were amazed at how much teaching varied across cultures and how little it varied within cultures."[8] This core finding of the book, stated here in formal language reminiscent of a statistical analysis of variance, ought to cause a double-take: what is being said here seems important and fundamental, even stunning. With the authors' meticulous support, both qualitative and quantitative, this finding gives an empirical basis in the case of mathematics teaching to the claim which forms the title of the pivotal and most profound chapter in the book (Chapter 6): "Teaching is a Cultural Activity."

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> ***Teaching is a culture-bound activity, and this "explains why teaching has been so resistant to change," and our not taking that fundamentally into account is why we have failed.***

And this finding, with the evidence for it, is the central reason this review is being offered in a journal on humanistic mathematics, one essential concern of which we take to be how the expression of mathematical activity is shaped by its cultural backdrop.

Of course this empirical basis extends only to the teaching of mathematics, since all the data in the video study are from mathematics classes. To those of us whose main concern is the teaching of mathematics anyway, this is not of great consequence. But it is an inferential lapse, that mars the book's otherwise careful methodological presentation, to claim (as the authors implicitly do throughout the analysis of the video study) that the "points we make go well beyond mathematics" and thereby to extrapolate a conclusion well beyond the scope of the data. Seeing the authors' findings, one is certainly inclined to hypothesize that teaching in general *is* similarly culturally conditioned, but the authors present no proof of that general proposition.

A related extrapolative claim that the authors make is indirectly better supported, however, namely that the points they make extend "certainly well beyond eighth grade." Indeed, there are enough commonalities even with our own experiences at the college level, as we suggest below and in Part II, to make this claim persuasive.

It is widely known that American educational achievement (not only) in mathematics does not stack up well in international comparisons; e.g., TIMSS showed this, and did so even more authoritatively than did its two antecedent international studies. Nor is it any secret that wave after wave of efforts to reform American education (not only) in mathematics has failed to result in improved student performance.

For this dismal record the authors have a simple yet profound core explanation, one that reverberates like a theorem understood for the first time, feeling like something we have known liminally all along: in our efforts to reform American education, "We have been acting as if teaching is a noncultural activity." But teaching is a culture-bound activity, and this "explains why teaching has been so resistant to change," and our not taking that fundamentally into account is why we have failed. (Again, as noted above, the authors overreach their empirical base, which is only in mathematics teaching, but the reader is inclined to go along.)

Taking this fundamentally into account is also why the Japanese, in particular, have succeeded: "In Japan, by contrast, teaching practices appear to have changed markedly over the past fifty years." And Japanese students, correspondingly, now perform among the top internationally. The authors look, for a model, to the Japanese system for the improvement of teaching not only for these reasons but also, and crucially, because "Japan's system of improvement ... is built on the idea that teaching is a complex, cultural activity."

The Teaching Gap's analysis and interpretation of the video data work up to the chapter mentioned above, entitled "Teaching is a Cultural Activity," and substantiate this claim. This analysis is concerned with the details of what actually goes on in classrooms and characterizes teaching in the three countries, showing both qualitatively and quantitatively the stark inferiorities of U.S. mathematics teach*ing* (not teachers) to the other countries', especially Japan's. This material can raise our awareness of features of our teaching that we might well have been taking for granted, and offer fertile images of alternatives.

The authors follow this analysis by proposing a mechanism for slow, organic change of our teaching methods, based on the system in Japan whereby teachers, acting as researchers, seek to improve classroom teaching, lesson by lesson. This proposal speaks to our concerns for the preparation of our future students, as well as our sense of responsibility for the improvement of mathematics education in the public schools.

What then does teaching look like in the U.S., Japan, and Germany? To show this qualitatively and as an image, the authors synthesize the video data into a single typical pattern for each country's mathematics lesson. We focus on the U.S. and Japanese patterns, since these exhibit the most stark contrast.

Both the Japanese and U.S. lessons typically began with a review of previous work. In the U.S. this was followed by "presenting a few sample problems and demonstrating how to solve them." Then the students practiced solving problems like those presented. Finally, there was checking and correcting some of the students' practice work (and assigning homework). In Japan, the initial review was followed by the presentation of a new problem for the day's lesson. Students then worked on trying to solve the problem. There followed a discussion of various methods of solution that the students had come up with or that the teacher showed them. The lesson ended with the teacher emphasizing the main points.

Thus, while within-culture variation (such as different ways to demonstrate a procedure) looked so large when the authors watched only U.S. lessons, when they "watched a Japanese lesson...we noticed that the teacher presents a problem to the students without first demonstrating how to solve the problem. We realized that U.S. teachers almost never do this, and now we saw that a feature we hardly noticed before is perhaps one of the most important features of U.S. lessons—that the teacher almost always demonstrates a procedure for solving problems before assigning them to students." Thus, while both systems have the presentation of a new problem, this activity in Japan is preparation for students to develop solution procedures, while in the U.S. it allows a procedure to be demonstrated and is followed by students practicing the procedure.

This is, I think, the most critical single observation in the book. I find it thought-provoking indeed to reflect on how this contrast may also fit our U.S. mathematics teaching at the college level.

The authors accordingly find the teaching of mathematics in the U.S. to be very constricted, "focused for the most part on a very narrow band of procedural skills." Regardless of whether students are working individually or in groups, or whether they are using computers, American mathematics students "spend most of their time *acquiring isolated skills through repeated practice*" [italics ours]. "Japanese teaching... [shows] what it can look like to teach mathematics in a deeper way, teaching for conceptual understanding. Students in Japanese classrooms spend as much time solving challenging problems and discussing mathematical concepts as they do practicing skills."

To support these qualitative generalizations, the authors characterize lessons in each country with statistics on various salient features—"in research parlance, 'indicators'—that might influence students' learning." The U.S. lessons fall correspondingly short on these quantitative summaries. The percent of U.S. vs. Japanese lessons respectively exhibiting "concepts developed rather than [merely] stated" was 22% vs. 83%; "medium [or] high quality of mathematical content" (as opposed to low quality of content) was 11% or 0% vs. 51% or 39%. The "average percentage of seatwork time spent in ... apply[ing] [or] invent[ing]/think[ing]" (as opposed to merely "practic[ing]" in familiar contexts) was 3.5% or 0.7% vs. 15% or 44%. The list goes on.

Among its uses, this list can serve as a brief but salutary cold shower for any of us at the college level who may be entertaining misattributions as to what our students' preparations might be like. "[T]here were *no* mathematics proofs in U.S. lessons. In contrast, there were proofs in 53 percent of Japanese lessons..." [italics theirs].

Probably more importantly, we can evaluate our own teaching by the criteria in this list and reflect on how the results of this evaluation might follow from the critical observation contrasting U.S. and Japanese teaching cited above.

Part II of this review of *The Teaching Gap* resumes with a consideration of teaching as a tightly interconnected *system* of features and the underlying cultural *beliefs* that vivify such a system in the U.S. and in Japan. There are some surprises here that have relevance to college classrooms.

NOTES AND REFERENCES

[1]U.S. Department of Education, National Center for Education Statistics (February 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,* NCES 99-074, by James W. Stigler, Patrick Gonzalez, Takako Kawanaka, Steffen Knoll, and Ana Serrano. Washington, D.C.: U.S. Government Printing Office, 1999. Note that this article is available on the Web at http://nces.ed.gov/pubs99/timssvid/, or as a link from the authors' Web site given below.

[2]James W. Stigler and James Hiebert (1997). "Understanding and Improving Classroom Mathematics Instruction," Phi Delta Kappan. This article is available on the Web as specified in the next footnote.

[3] http://www.kiva.net/~pdkintl/kappan/kstg9709.htm or as a link from the authors' Web site, given in the next footnote.

[4] *The Teaching Gap* authors' Web site is: http://www.lessonlab.com/teaching-gap

[5] Steve Olson (May/June 1999). "Candid Camera," Teacher Magazine on the Web. *The Teaching Gap* authors' Web site has a link to this article.

[7]Harold W. Stevenson and James W. Stigler (1992). *The Learning Gap.* New York (Simon & Schuster Inc.).

[7] Steve Olson, "Candid Camera," *op. cit.*

[8] This quote, along with all others not footnoted, is from *The Teaching Gap.*

Funny Problems

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A selection of original or collected recreational mathematical problems.

1) Prove that 2 = 1
Solution:
2 pints = 1 quart.

2) A man weighs the following weights on the following dates. How is this possible?

6/1/70	150 lbs.
6/3/70	0 lbs.
6/5/70	25 lbs.
6/7/70	0 lbs.
6/9/70	145 lbs.

Solution:
The man is an astronaut who went to the moon and back.
Outerspace weightlessness: 0 lbs.
$\frac{1}{6}$ of Earth's gravity, or gravity of the moon: 25 lbs.

3) If you have a couple of threes and divide them in half, why do you end up with 4 pieces?
Solution:
33 cut in half horizontally will make four pieces.

4) How 70 > 3 = LOVE?
Solution:
Move the characters of 70 > 3 around.

5) 10 - 1= 0
Solution:
If you have a stick (1) and an egg (0) and you give away the stick (1) you still have the egg (0) left.

6) All monkeys eat bananas.
I eat bananas.
Therefore, I am a monkey!

7) Twelve minus one is equal to two.
Solution:
12 - 1 = 2 (take digit 1 from 12).

8) 7 + 7 = 0.
Solution:
Take the sticks from the 7's and rearrange them to form a rectangular zero 0.