Public Testimony
To the National Math Panel
Dr. Martha Schwartz
November 6, 2006

My name is Martha Schwartz. I am a former math teacher, geophysicist, occasional educational consultant, and parent.

I came early to the Math Wars, having been introduced to the issues in 1994 by a group of furious Torrance, CA parents. They were brandishing a ninth grade math book which required students to – I paraphrase -- "not ask your teacher questions unless your whole group agrees you can't figure it out." The book in question was notably deficient in algebra. Its parallel adoption and implementation in San Diego led directly to the formation of Mathematically Correct, our opposition to the 1989 NCTM Math Education Standards, and the struggle for better academic standards, frameworks, and textbooks in California.

The NCTM has recently made an encouraging step in the right direction with the release of its new elementary school Focal Points. The national press had a field day upon the Focal Points release, proclaiming that basic skills were once again "in." This press coverage produced some predictable consternation among 1989 Standards fans. One of them wrote a letter to the Seattle Times, defending NCTM against the calumny that it had somehow retreated from "teaching for understanding." I can empathize with the letter writer; for more than a decade sloppy newspaper stories have characterized *my* side as favoring blind rote teaching instead of conceptual understanding. This is an obvious misapprehension; only in a bad newspaper story could anyone oppose children understanding mathematics or any other school subject. The Math Wars are not and never were about pro and con opinions about conceptual understanding. (See Wu, 1999)

What the Math Wars are truly about are Mathematics Content (what is taught and at what grade) and Mathematics Pedagogy (how to transfer that content – with understanding – to students). Usually Mathematically Correct and its allies have argued on the basis of *content* -- on the supposition that it was most important to guarantee *what* students should learn. There are, after all, many reasonable teaching styles. But content is inevitably connected to pedagogy, since pedagogical adherents will argue for *content* based on what they think their favorite pedagogy is able to deliver. With the Focal Points providing a start toward agreement on content – and, more importantly, clear, measurable and certainly attainable goals –it's time to break with the past and use my few minutes to discuss the effectiveness of competing pedagogies.

In today's American educational industry the most popular instructional schemes center about some variant of constructivism. Constructivism, as an epistemological theory, is intuitively appealing and quite possibly correct. However, this unobjectionable learning theory has led to a collection of highly questionable pedagogies. I think the reason for this is that the simple theory has been taken to mean that students' knowledge-building must come from implicit discovery, "hands-on" (often "top down") activities, without much direct explanation from a teacher. But this doesn't necessarily follow logically. I believe, from experience, that students can also -- and much more efficiently -- build their own knowledge from reading and from teacher lecture and careful explanation.

Highly or moderately unguided constructivist-inspired pedagogies have been pushed relentlessly by teacher-training institutions. They have been equated with "improved instruction" in grants from private philanthropies and taxpayer entities such as the National Science Foundation. Less-guided instruction is always billed as "innovation and improvement," a great break with the so-called "factory model" of the past.

While most teacher training programs have their eggs firmly in the minimally-guided basket, their institutions do house a few educational/cognitive psychologists (folks who talk about things like working and long-term memory) who hold a radically different view. For example, a recent widely circulated summary paper (Kirschner, Sweller and Clark *Educational Psychologist, 41*(2), 75-86, 2006) goes so far as to state

> The goal of this article is to suggest that based on our current knowledge of human cognitive architecture, minimally guided instruction is likely to be ineffective. The past half-century of empirical research on this issue has provided overwhelming and unambiguous evidence that minimal guidance during instruction is significantly less effective and efficient than guidance specifically designed to support the cognitive processing necessary for learning.

(snip) and

> Each new set of advocates for unguided approaches seemed either unaware of or uninterested in previous evidence that unguided approaches had not been validated. This pattern produced discovery learning, which gave way to experiential learning, which gave way to problem-based and inquiry learning, which now gives way to constructivist instructional techniques. Mayer (2004) concluded that the "debate about discovery has been replayed many times in education but each time, the evidence has favored a guided approach to learning" (p. 18).

more

> problem-solving search overburdens limited working memory and requires working memory resources to be used for activities that are unrelated to learning. As a consequence, learners can engage in problem-solving activities for extended periods and learn almost nothing (Sweller et al., 1982).

The authors also refer to a "worked-example" effect

> The worked-example effect was first demonstrated by Sweller and Cooper (1985) and Cooper and Sweller (1987), who found that algebra students learned more studying algebra worked examples than solving the equivalent problems. Since those early demonstrations of the effect, it has been replicated on numerous occasions using a large variety of learners studying an equally large variety of materials (Carroll, 1994; Miller, Lehman, & Koedinger, 1999; Paas, 1992; Paas & van Merriënboer, 1994; Pillay, 1994; Quilici & Mayer, 1996; Trafton & Reiser, 1993). For novices, studying worked examples seems invariably superior to discovering or constructing a solution to a problem.

So, constructivist pedagogies, widely taught in education school and implemented in current math programs, are unpopular with some cognitive psychologists. Their fighting words are consistent with my own experience, but are the authors right? Dr. Clark (one author) told me that this paper caused enough uproar that it went through four rounds of review and all reasonable objections were addressed. So far, all rebuttal papers have been rejected. But, who knows -- perhaps there really exists some optimal balance which employs a percentage of each approach for different purposes. Details matter. But it's time to open the door to this line of research. We are risking the future of our children by not looking squarely at teaching methods. At the very least, we should quit spending the children's share of our tax dollars to push unproven programs.

Thank you.

In an appendix, I show some test-score examples of California districts and schools which moved away from constructivism toward more teacher-centered mathematics instruction.

References

Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching.
http://www.cogtech.usc.edu/publications/kirschner_Sweller_Clark.pdf

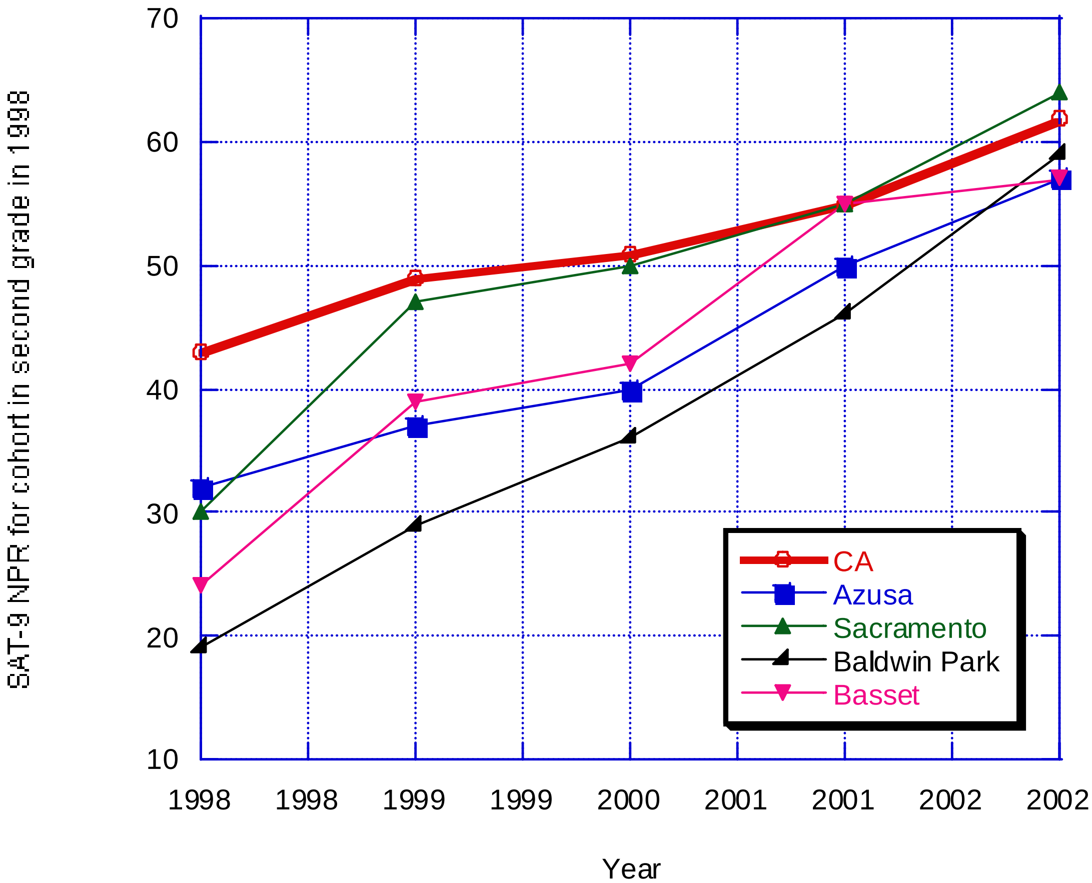
The California Math Standards
http://www.cde.ca.gov/board/pdf/math.pdf

The California Mathematics Framework (long document!)
http://www.cde.ca.gov/cdepress/math.pdf

Basic Skills Versus Conceptual Understanding: A Bogus Dichotomy In Mathematics Education, H. Wu
http://www.aft.org/publications/american_educator/fall99/wu.pdf

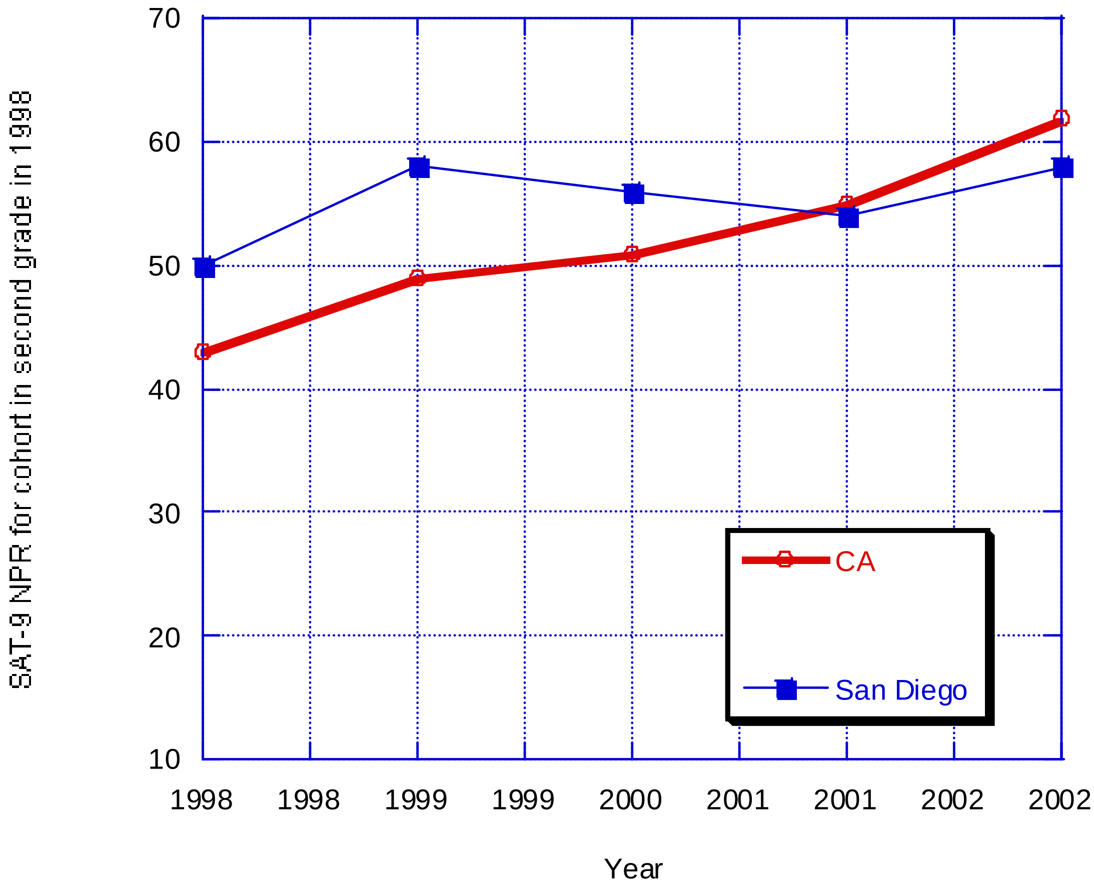
Appendix

Here are some elementary school (1998-2002) cohort data showing the effects of elementary Saxon Math, which is not quite perfect in content but has some novel but distinctly teacher-directed pedagogical features.



The graph shows the four-year Stanford 9 score progress for four early-adopting districts with, contrasted with the state of California as a whole. The scores are for the cohort which was in second grade in 1998.

All of these districts have significant numbers of economically disadvantaged students; progress toward “closing of the achievement gap” is substantial.



In contrast, we see a similar record for San Diego, which tried hard to improve but maintained a more constructivist point of view.

Further examples of non-constructivist progress based on 1992-2002 Stanford 9 State testing in California:

Manhattan Beach school district: This affluent school district proves even excellence can be improved upon with more structured curriculum.

Lunch count=6.7%	1998	1999	2000	2001	2002
Grade 2	74	82	89	93	92
Grade 3	79	81	87	92	93
Grade 4	81	82	82	87	92

Grade 5	83	85	88	87	92

Inglewood school district Several schools in this diverse but high-poverty district were already non-constructivist prior to the adoption of the CA standards..

Lunch count= 58.9%	1998	1999	2000	2001
Grade 2	50	64	72	75
Grade 3	47	60	66	74
Grade 4	37	48	53	57
Grade 5	43	48	50	54

Individual schools

School "A" (LAUSD) 1999 Saxon pilot

Lunch count= 85.2%	1998	1999	2000	2001
Grade 2	33	49	50	57
Grade 3	28	42	62	71
Grade 4	22	27	48	65
Grade 5	23	28	47	62

School "B" (LAUSD) Adopted partial program last year (HM MathSteps) in 1999:

Lunch count=96.6%	1998	1999	2000	2001
Grade 2	18	28	29	39
Grade 3	16	27	26	38
Grade 4	18	20	19	34
Grade 5	16	21	19	31

School "D" (Garvey District) adopted Sadlier-Oxford in 1999

Lunch count=87.6%	1998	1999	2000	2001
Grade 2	45	34	30	54
Grade 3	25	51	41	52
Grade 4	26	34	33	46
Grade 5	30	26	38	41

School "H" (LAUSD) adopted Saxon in 1999

Lunch count=74.4%	1998	1999	2000	2001
Grade 2	30	19	33	44

Grade 3	31	25	36	45
Grade 4	23	17	37	40
Grade 5	22	21	37	43

School "E" (LAUSD) Adopted Saxon around 1997

Lunch count=74.8%	1998	1999	2000	2001	2002
Grade 2	39	39	48	57	71
Grade 3	48	52	61	66	74
Grade 4	27	52	50	61	67
Grade 5	41	25	48	44	62

(Source: California department of Education website, www.cde.ca.gov)