The Impact of California's Back-to-Basics Policies: One Year after State Board Action

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I. Introduction.

This paper describes the impact of California's new mathematics policies on instructional materials and professional development. It begins with a short historical overview before going on to look at how California's K-6 instructional materials evolved during the 1990s. The historical overview is based upon written public documents or taped public policy sessions. Further background is available in Cohen & Hill (1998), Becker & Jacob (2000) http://www.pdk.intl.org/kappan/kbec0003.htm, and Jacob & Akers (2000) http://www.intermep.org [go to IJMTL].

In 1985, California adopted a new Mathematics Framework. It called for an increased emphasis on contextual problem solving and promoted "teaching for understanding". Introducing the *Delivery of Instruction* section, it stated,

> To isolate the acquisition of mathematical knowledge from it uses and its relationships is to limit the depth of understanding achieved. Mathematical concepts and skills must be learned as part of a dynamic process, with active engagement on the part of the student. (p. 12)

The Framework then offered the following chart (p.13) to emphasize the new directions that Teaching for Understanding would require.

Teaching for Understanding	*Teaching Rules and Procedures*
Emphasizes Understanding	Emphasizes Recall
Teachers a few generalizations	Teaches many rules
Develops Conceptual Schemas or interrelated concepts	Develops fixed or specific processes or skills
Identifies global relationships	Identifies sequential steps
Is adaptable to new tasks or situations (broad application)	Is used for specific tasks or situations (limited context)
Take longer to learn, but is retained more easily	Is learned more quickly but is quickly forgotten
Is difficult to teach	Is easy to teach
Is difficult to test	Is easy to test

But in 1986, the Curriculum Commission found that none of the submitted instructional materials met the criteria required by the new Framework, and the State Board of Education eventually accepted materials for which the publisher could demonstrate that 10% of its lessons were revised and aligned.

The *1992 California Mathematics Framework* endorsed the instructional approaches of the 1985 Framework and elaborated greatly on its notion of "mathematical power". The 1992 Framework also incorporated the grade span descriptions of mathematics content included in the NCTM Standards. But rather than focusing on this content, the Framework's major emphasis was on classroom and program characteristics that would promote student learning of mathematics. It emphasized instructional approaches that would encourage students to take responsibility for their own learning, with teachers as facilitators rather than leading direct instruction. The Framework stated that,

> Students construct their understanding of mathematics by learning to use mathematics to make sense of their own experience. (p. 33)

The 1992 Framework was followed by a K-8 instructional materials adoption in 1994, which meant that districts could purchase Framework aligned programs beginning the next year. However, by early 1995 opponents to the Framework, the State test, and the NCTM Standards gathered sufficient strength to initiate policy changes.

Within a year the State Board of Education (SBE) determined that an early revision of the Framework was necessary. California then enacted dramatic policy changes when it adopted Standards in 1997 and a revised Framework in 1998. A small cadre of university mathematics professors played key roles in writing both documents. Teachers' and educators' voices were absent from this process that by law was supposed to be public. The main changes were authored behind closed doors.

The messages of the 1999 Framework are quite different than those presented in 1992. The 1999 Framework promotes direct instruction leading to mastery of symbolic procedures. It proclaims the importance of balancing basic skills, problem solving, and conceptual understanding, but its views on problem solving and conceptual understanding differ greatly from those presented in 1992. The 1999 Framework also included the 1997 California Mathematics Standards which detail what topics should be studied at each grade level, and specifies the topics teachers should emphasize.

State Board of Education member Nancy Ichinaga summarized the new views in a recent statement to the Los Angeles School Board. She said[1],

> I am here to ask for your support in requiring all the K-12 schools in Los Angeles to adopt a systematic mathematics program which meets the state content standards. … Integrated math, reform math, CPM or college math, no matter what you call it, it is still watered down math, fuzzy and substandard math, and does not meet the new state math requirements. … Integrated math instruction is akin to the now discredited whole language instruction in reading. … The district must support its teachers by giving them a systematic skill-based program which tells them what to teach and how to teach it.

Many SBE members, as well as Gloria Tuchman, an unsuccessful candidate for Superintendent of Public Instruction, explicitly spoke of the changes as the new "back to basics". And although many of the mathematicians involved in the changes do not favor this terminology[2], the press uses it routinely.

So we next ask, what will happen? Will California abandon teaching for understanding in favor of systematic skills-based programs? Will students no longer be "expected to think and reason in all mathematical work" as called for in the 1992 Framework[3], and instead focus on speed and accuracy in standard computation? Will California continue to exclude education professionals from a process that used to require consensus, and allow a small group of math professors to "tell teachers what to teach and how to teach it?"

We will see that, intended or not, that the Teaching Rules and Procedures column from the 1985 table provides a good description of instructional practices encouraged by California's new policies.

II. Recent Changes in Policy Documents 1995-1999.

Although controversy about the 1992 Framework and the NCTM Standards had been present for a number of years, the first substantial evidence that policies would reverse in the state occurred in 1995 when the legislature adopted AB 170 which stipulated,

> It is the intent of the legislature that the fundamental skills of all subject areas, including systematic, explicit phonics, spelling, and basic computational skills, be included in the adopted curriculum frameworks and related tasks increase in depth and complexity from year to year.

This legislation was adopted as an emergency statute citing the "poor performance of pupils who took the California Learning Assessment System (CLAS) and the National Assessment of Education Progress tests". After state Assembly hearings on reading and mathematics[4], the SBE adopted two documents, a *Reading Program Advisory* and a *Mathematics Program Advisory*. The *Mathematics Program Advisory* (CDE 1996) called for "balance" explaining

> In a balanced mathematics program, students become proficient with basic skills, develop conceptual understanding, and become adept at problem solving. All three areas are important and included—none is neglected ore under emphasized. (p. 2)

This led many observers to believe the SBE was adopting a centrist position. But the details reveal other trends. In describing conceptual understanding the *Mathematics Program Advisory* stated "middle and high school students should:

> understand that the real number line has properties of a continuum[5],

and

> that proofs are required to establish the truth of mathematical theorems.

These statements provided the first hint of the new role that mathematicians were playing in California policy[6]. By the time the new Framework was complete, the development of understanding would be replaced by testable formal mathematics.

During 1996-97 a Standards Commission drafted California's first Mathematics Standards. But mathematicians and basic skill advocates objected to the Commission's draft. In describing the objections, Prof. Hung Hsi Wu listed "omissions" such as long division, and "mathematical defects", such as referring to "the relationship between perimeter and area", where he claims "there is no such relationship" (Wu, 1998). Four Stanford University mathematics professors substantially revised the draft for the SBE. The "Examples and Clarifications" section of the draft was removed, which they believed contained a "mixture of pedagogical statements with statements on content". For example, a clarification that mentioned "experience with measurement tools" in a seventh grade geometry discussion was criticized for failing to include proof (Wu, 1998). The revised Standards also incorporated the traditional US Algebra – Geometry – Algebra yearly sequence starting at eighth grade, and removed the Commission's integrated approach that included number, algebra, geometry, and statistics at these grades. In the Standards, many topics appear a grade level earlier than many teachers felt appropriate. But by far the most dramatic change was the movement of traditional ninth grade Algebra to eighth grade—meaning that the only instructional materials that could be submitted for state wide adoption at grade 8 were standard first year algebra texts.

Note: Those who follow US education know that there has been considerable discussion of the "standards movement" and of "standards-based instruction". However, the word "standards" is not used uniformly, so that a coherent discussion of the "standards" in the US is impossible without indicating whose standards are under consideration. The meaning of "standards" in California policy is vastly different from that say in the recent NCTM *Principals and Standards for School Mathematics* (NCTM, 2000). In California policy, "standards" are topics students should study, and implicit is the assumption that they are written in a way that a correct response to a specific type of question assesses attainment of the standard. In this paper we will use the word "standards" in the California sense, not because this approach is advocated, but because the story is about California.

The next year, in 1998, a draft Framework was revised by a small group of mathematics and psychology professors, and as required by state law, included "research-based instructional strategies". In an earlier report to the SBE (Dixon et. al., 1998), Douglas Carnine of the University of Oregon had defined valid research to mean only research with experimental and control groups. Cognitive psychologist David Geary, University of Missouri, wrote the section on instructional strategies for the revised Framework. The revision also included sample problems and content discussions written by the mathematicians. It promotes direct instruction leading to mastery of symbolic procedures, and stresses precision in mathematical formulation with a renewed emphasis on proof. The Framework states that in mathematics, timed computation tests play a "more basic role" in measuring understanding (p. 197).

The beliefs guiding the 1999 Framework authors are summarized in (Jacob-Akers, 2000). The discussion their explains that the psychologist- and mathematician-authors had different but mutually reinforcing views on skills, problem solving, and concepts. The psychologist-authors identified skills with procedures that must be learned to "automaticity" and may be divorced from meaning. Mathematician-authors felt that skills should be learned according to their logical structure, such as provided by deductive systems of formal mathematics. The psychologist-authors examples of "problems" were almost always routine calculations, and they argued that understanding results from practicing procedures. Mathematician-authors stated that problems must be posed with precise mathematical language, and believe that conceptual understanding is derived from using logical mathematical structure.

Missing from the Framework is the view of mathematics as "sense making" or that open-ended problems and investigations could be used as a basis for instruction. Nowhere is there discussion of the danger of having children mimic procedures without first developing understanding.

Linking Policy to the Classroom.

Conventional wisdom among many teachers is that state policies continually shift from one extreme to another, so ultimately they can shut their classroom doors, leave politics behind, and teach their students as they know works best. So a fair question is if these new state policies will result in a change in instructional practices on a day to day basis. One of the main findings in this paper is that the answer is "yes", but along unintended (although perhaps predictable) lines.

Accountability Measures

The legislature and the SBE understand that policies emerging from Sacramento have little meaning unless they are linked to classroom practice. Among other "reforms", California spends and estimated 1.5 billion dollars yearly on reducing class sizes to 20 in grades K-3, which led to increased numbers of non fully credentialed teachers, currently estimated at 13% (Kollars, 2000). Like other states in the USA, California politicians have mandated "accountability" measures to ensure schools and teachers take standards seriously. Readers familiar with the accountability movement in Texas, which received substantial press during the 2000 election, will note that California looks much the same.

California halted standardized testing after administering the 1994 CLAS test when Governor Wilson vetoed program funding, largely because of complaints that open-ended response questions invaded students' privacy. In 1998, a new state wide testing program, the Standardized Testing And Reporting (STAR) was created requiring yearly testing of all students in grades 2-11. The STAR consists of an "off the shelf test" (the SBE selected the Stanford 9 exam, published by Harcourt-Brace) and a special "Augmentation" section was specifically created for the new California Standards. Although multiple measures must be considered, a new mandatory retention law is tied to these scores in grades 2 through 8. Data from the STAR is supposed to be combined with other indicators to create a single number for each public school, the Academic Performance Index (API), which measures their performance. However, the API is currently based solely on the SAT-9 scores. The first API scores were compiled in summer 1999, and schools with low scores have improvement targets. Failure to improve has consequences: principals can be removed or the state could assume control of school administration and curriculum. School scores on both the SAT 9 and the API are publicized in local papers, and schools whose students show substantial improvement can receive bonus money.

A high school exit exam (HSEE) will be required for graduation beginning in 2004. Although pilot questions were tested in May 2000, the topics to be included in the exam have not yet been finalized. On June 30, 2000, the Governor's Scholarship program was signed into law, where students scoring in the top 10% state-wide or top 5% in their school on the standardized tests receive a $1,000 scholarship[7] (SB 1503, Sec. 69995 (d) (3) (A) and (B)). In short, California now has "high stakes tests", and teachers are feeling their presence far greater than any time in the state's history.

New Instructional Materials

During 1998-99 the legislature and the SBE turned attention to implementation of the new Standards and Framework. This included funding for instructional materials and professional development. The legislature appropriated $250 million per year for the academic years 1998-2002 for the purchase of Standards aligned instructional materials, approximately three times the usual amount. All programs must pass a *Content Review Panel* whose members must have a Ph.D. in mathematics—a doctorate in education is not acceptable to the SBE. An *Instructional Materials Advisory Panel* also reviews programs and does include teachers, but it is the Content Panel's views that the SBE relies on. Direct teaching of the standard computational algorithms identified in the Standards was the top priority of the panels in 1999. During their April 1999 deliberations, the Content Review Panels (CRP) determined that very few programs aligned with the Standards, and those that were close were given an opportunities in May and June to present changes to CRP, CDE and Commission members. In the end the SBE approved full and partial programs[8].

On September 22, 1999, the SBE and the Curriculum Commission sponsored a *Mathematics Standards and Framework Meeting* for publishers in preparation for the summer 2000 mathematics adoption. This meeting discussed materials submitted for California adoption for the period 2001-2008. The principal speakers were Drs. Hung Hsi Wu and R. James Milgram, two mathematics professors who played major roles in the revision of the Math Framework. They spoke about how publishers should prioritize their efforts in preparing materials for the 2000 adoption. In addition, Susan Stickel, representing the Curriculum Commission outlined "what we learned from the AB 2519 Adoption" including reasons why CRP's had rejected materials in the 1999 adoption. Their answers to audience questions (prepared in advance) provide the best indication we have of the thinking and vision that underlies the Standards and Framework[9]. Among points receiving substantial emphasis:

(1) According to Susan Stickel, "instructional strategies in the Framework are based upon research, not anecdotal research".

(2) Content explanations for teachers should also be included. Dr. Milgram cited a seventh grade Compound Interest Appendix as an example. Milgram added, "Its been a long time since compound interest has been taught".

(3) Dr. Milgram presented research supporting elimination of calculators prior to grade 6, saying, "It has been noted consistently that when calculators are used, students do not learn basic skills, they learn basic button pressing skills".

(4) Dr. Wu emphasized that mathematics should be formulated precisely, with proofs whenever realistic, adding that materials must make a distinction between definitions, simple theorems, and hard theorems. As and example for grade 7, Dr. Wu gave a proof of $(-2/5) \times (7/4) = -(2/5) \times (7/4)$. Publishers were urged to have mathematics professors review their work and a short list of names of recommended professors was distributed.

(5) Dr. Wu stated that hard calculations should not be "sugar coated", but there should be no "drill and kill". Susan Stickel stated that some 1999 programs were rejected because of "anti standards" statements such as "for difficult calculations use a calculator

Dr. Milgram's research presentation cited (unpublished) work by David Geary. He showed a graph and stated

> So here is the picture ... This is the graph that he found for the U.S. .... So this would be the age groups of 23 to 27, this would be to about to about age 35 and this would be about age 49 and this would be about age 50 and above. This is the picture of basic of basic math skills in the US that he found, and here is the picture of basic math skills that he found in China, and more or less in Japan and more or less in some of the Eastern European Countries and in Russia. It looked like this so, this was done a number of years ago and so you backtrack from this point 50 years old and you find out this is exactly coinciding with the introduction of the new math in the US. This is the research of David Geary and there are numerous other studies that tend to show the same thing. Typical results show that students coming into high school that come in from programs, the same groups of people that have come in from programs that involved extensive calculator use show a two to three a year lag in skills and in basic skills. So this is the situation which we tend to deal with – we don't - it is only for that reason that we wrote that calculators are not recommended, only for that reason.

When questioned about the relationship between calculator use and the new math (which preceded the calculator era), he agreed that calculators were not the key issue, but replied

> The new math is the first time for which the first for the primary part of the math education was no longer basic arithmetic". … But right now the most reliable and the best way I know of to make sure students learn it is through learning basic arithmetic.

Milgram also criticized invented algorithms and emphasized the importance of the long division algorithm, offering the following discussion.

> This is a middle school program and what does it do? Of course it will not teach long division. So long division is not being taught, but students are being asked to construct their own algorithms for division. Now this is fine, I do not have an objection to that. However if you are going to teach your own algorithms for division you had better have some discussion of whether the algorithm is correct or not. Unfortunately I don't see any way of discussing the correctness of an algorithm in the sixth grade level. So if you can find a way of teaching the concepts that long division encompasses without teaching long division, concepts of approximation, concepts of remainder, the remainder and the discrete process that develops the remainder, these processes which lead later on to really important things, then Okay.
>
> Some of you are going to say what am I talking about. I'm talking about polynomials. Now polynomials are depreciated in a lot of the textbooks these days. But oh, what we have run into in recent years, and this is at Stanford guys. We've run into with a larger percentage of students than I would like to see that

> these students are going into engineering and related technical areas or economics or operations research. Areas that involve optimization. Okay, optimization is done through the analysis of things - eigenvalues, eigenvectors, it is done through Laplace transforms, and systems of differential equations. In every single instance it is essential for students to have a basic foundation in polynomial manipulation and what we have been seeing is that these kids have been having an unreasonable amounts of difficulty with trying to become engineers. And when they come back in to our classes and I have time to analyze what has been going on I finally realized simply that they couldn't do this basic stuff. And because they couldn't do that they couldn't do the things they needed to do at the higher level. So, and so, if you take long division out you have to replace it with a huge amount to make up for what you took out.

Later in the same meeting, Prof. Wu discussed priorities in grades 7-12.

> From kindergarten through grade seven, these Standards have impressed upon the students the importance of logical reasoning in mathematics. Starting with grade eight, students should be ready for the basic message that logical reasoning is the underpinning of all mathematics. In other words, every assertion can be justified by logical deductions from previously known facts. Students should begin to learn to prove every statement they make. Every textbook or mathematics should try to convey this message and to convey it well.

Wu followed with the following example suitable for grade 7 instruction:

$(-2/5) \times (7/4) = -(2/5) \times (7/4)$

Reason: $(-2/5) \times (7/4) + (2/5) \times (7/4) = (-2/5 + 2/5) \times (7/4) = 0 \times (7/4) = 0$. Therefore since $(-2/5) \times (7/4)$ and $(2/5) \times (7/4)$ add to 0, we have $(-2/5) \times (7/4) = -(2/5) \times (7/4)$.

Wu also emphasized the distinction between "definitions, easy theorems and hard theorems" needs to be made. He gave the following example. .625 is a rational number while v2 is an example of an irrational number. Wu then explained he has seen expressions like

$\sqrt{2} = 1.414\ldots$ is irrational.

in textbooks. He stated that it appears to the student that if you write "…", then the implication is the number is irrational, and called this "psychological warfare on students".

Professional Development

California has allocated substantial funding for mathematics professional development for teachers in grades 4-12 Two Professional Development initiatives were passed by the legislature in June 1998. One provided $12.5 million for teachers to enroll in college mathematics courses. To put this number in perspective, this is about the same as the entirely yearly budget of the California Subject Matter Projects in all subjects[10]. In Santa Barbara and Ventura counties, math supervisors estimate that 90% of the $506,391 allocated the two counties for college courses will have to be returned to the state in another year because so few teachers chose to take advantage of the program[11].

The other piece of 1998 legislation provided another $12.5 for district based programs, which was augmented by the SBE using federal Eisenhower money. After a competitive application process, the SBE disseminated $43 million in mathematics professional development funds to schools and counties in spring 2000, to be expended during AY 2000-2001. Schools must either use licensed providers or their own personnel. Two mathematics professors screened the state providers and the programs they developed were revised. The materials developed by the two major state approved providers are discussed in the last section. The materials must stress direct instruction in number computation, geometry, and algebra as listed in the standards, and must include "research based instructional strategies" as provided in the Framework[12].

One state funded professional development programs at grades 4-6 (CISC 1999) proposes to begin with the following. A mathematics professor authored it.

> (1) Introduction to a Whole Number Content Module
>
> The question:
>
> "What is a counting number?"
>
> "A counting number is an attribute of a set"
>
> - just as length is an attribute of a line segment
> - area is an attribute of a plane shape
> - so does the set (collection) of people in a room have an attribute that is readily described in terms of the symbols 1, 2, 3
>
> Natural numbers can be **characterized** in terms of their properties.
>
> 1. There is a first counting number, i.e., one or uno.
> 2. Every counting number has a successor.
> 3. No two counting numbers have the same successor.
> 4. One is not the successor of any counting number.
> 5. The successors of one exhaust the counting numbers.
>
> From these properties alone, it is possible to deduce many of the important properties of numbers.

Later, this same program shows the standard algorithm for 7x483 and explains it as follows:

> Underlying this way of getting '483 added to itself 7 times' is the fact that the multiplication algorithm provides an efficient format for implementing equivalent calculations based on the commutative, associative, and distributive laws.
> 7x(400+80+3)=
> (7x400)+(7x80)+7x3=
> (7x4)x100+(7x8)x10+21=
> 28x100+56x10+21=
> (20+8)x100+(50+6)x10+(20+1)=
> [(2x10)+8]x100+[(5x10)+6]x10+[(2x10)+1]=
> (2x10)x100+(8x100)+(5x100)+(6x10)+(2x10)+1=
> (2x1000)+[(8+5)x100]+[(6+2)x10]+1=
> 2000+1300+80+1=
> 3,381.

Finally, the module begins and ends with pre- and post-tests involving natural number addition, subtraction, multiplication, and division, where participating teachers will demonstrate facility with standard computational algorithms.

In June 2000, the legislature approved funding for 25,000 teachers in grades 4-12 to attend algebra institutes or run algebra academies, largely to prepare teachers and students for the content required in the forthcoming High School Exit Exam. The RFP says the institutes

> share the goal of deepening teachers' content knowledge of mathematics so that they are better able to provide comprehensive mathematics instruction that is consistent with the *California Academic Content Standards* and the 1999 *Mathematics Framework* and will increase student performance on state-mandated assessments. (p. 2)

Participating teachers are required to take pre- and post-tests on algebra content, and they in turn give their students a common assessment "to document and assess the performance of their students on a regular systematic basis (at least three times during the academic year)". Jacob and Akers (2000) noted the belief among mathematician authors of the 1999 Framework that axiomatic mathematics should guide instruction and professional development. This approach is apparent in Appendix D of the RFP, which includes a content statement for an institute for teachers in grades 4-6 authored by Hung Hsi Wu. The RFP says the following

> Wu's elementary statement is formal and axiomatic. It is a statement of the mathematics that a number-and-operations Institute could be about, beginning with the whole numbers and moving up to the rationals. Wu emphasizes that it is not a statement of the tone of the institute; the document is not for the teachers but rather for you, the Institute leaders. (p. 13.)

For example, in discussing the role of algorithms we find

> We stress that while solving problems and setting up calculations requires thinking, the algorithms are designed to be mechanical; they are meant to be carried out without thinking. (p.14)

Wu has stressed the importance of teaching the meaning of long division during a presentation to Institute leaders. In the RFP discussion "How does long division work?" he states in a math note:

> Division-with-remainder. Given whole numbers a and b, there are unique whole numbers q and r so that a = qb+r, where 0_< r_<(b-l). While such a distinction may be inappropriate for children in their first encounter with division, such sophistication is entirely acceptable for teachers. (p, 14)

Finally, in his discussion "What do addition, subtraction, multiplication, and division of fractions mean?" Wu asserts,

> **Division** of two fractions a/b ÷ c/d is the fraction p/q so that a/b = c/d x p/q. Note that the 'invert and multiply' rule follows from the definition. (p. 15)

Although a less formal discussion of content for an Algebra Institute was also included in the RFP, the pressure to design a curriculum that stresses symbolic computation may be dictated by the format of the proposed pre- and post-test for teachers. Teachers receive a $100 per day stipend for their summer work at the Institutes. Staff at California Department of education estimate that if all academy proposals are funded and are fully attended, 2,500 teachers will participate during AY 2000-2001. Presumably the remaining 90% of the funds will be carried over to subsequent years.

III. Textbook Adoption Trends.

In grades K-8 the California State Board adopts a list of textbooks, and districts may use state money to purchase materials from the list[13]. This occurs every seven years after a new Framework is adopted (called major adoptions) and also at regular intervals in between (minor adoptions). The Curriculum Commission supervises a review process and makes a (non-binding) recommendation to the SBE. To a large extent, local adoption decisions determine what type of curriculum and students will experience. The following chart illustrates the adoption cycles between 1986 and 1999.

SBE	Districts
1986: “Traditional” texts are adopted, and overall little changes from 1973.	1987: Available for school purchase. Many schools continued with the same series.
1994: Most texts adopted are “reform” and align with 1992 Framework. Some traditional texts were also added.	1995: Many schools purchase reform, texts, some choose the traditional texts, and others don’t adopt at all.
1997: Small interim adoption. Several program rejections were controversial. (see Jacob 1999).	1997: Most schools were skeptical of texts as policies were changing.
1999: Standards-aligned adoption. Included partial (“test-prep”) and full (“basic skills”) programs.	1999. The test-prep option is very popular. But some major districts do select basic skills programs.

2000: Yet another adoption based upon the 1998 Framework with SBE decision to be announced in January, 2001.

In 1986, the Curriculum Commission found that no texts met the criteria of the 1985 Framework. So the board adopted texts from publishers that could show they changed 15 of approximately 150 lessons. These texts could be classified as “traditional” and many schools continued with the same series chosen in prior years. In 1994, the board adopted 9 “reform” textbook series and 3 traditional programs, and most districts purchased new materials. The 1997 minor adoption was controversial (Jacob, 1999) and most schools ignored it, realizing that policy changes were on the way. In 1999, the board adopted full and partial programs that were supposed to be aligned with the 1997 Standards. The evidence is that districts overwhelmingly chose the latter, which many refer to as the “test-prep option.”

But what happened at the school level? A 1995 state task force on mathematics noted a lack of data on instruction stating,

> The task force was astonished, … that we do not know how widely or in what ways mathematics frameworks have been implemented in California’s classrooms (CDE 1995).

In order to develop a picture of what happens on a local level in California, data was collected from a purposeful sample of district administrators and/or district recognized teacher leaders who were knowledgeable of their district’s instructional materials history. They first completed a written questionnaire and were subsequently interviewed to check that their answers were understood. The only information sought was about K-6 materials, where usually adoptions are district wide. At the middle and high school level, most districts allow schools freedom to make decisions independently, and often multiple curricula are chosen per school. So the picture at those grades is very complicated.

All information collected was of public record (that is, it would have been reported to school boards in public session, and known by all teachers) and everyone interviewed were informed of this in advance. All data was corroborated by multiple sources for accuracy. This approach was selected because the information is difficult to obtain through public documents (such records are not maintained by counties or the state). Everyone interviewed was also invited to offer comments, first in writing, and then verbally, on issues related to materials adoptions. Some of their written remarks are included. No claim is made that the quotations contained in these discussions are representative of the opinions of the teachers in their district. They were selected because they are consistent with and clarify the general picture.

Thirty participants representing 12 districts completed questionnaires, and collectively information was received from districts accounting for approximately half of the K-6 students in Santa Barbara and Ventura Counties, as well as several districts outside this region. In Santa Barbara County there are twenty districts with approximately 40,100 K-6 students, of which 35,400 are in the six largest districts. All six of these districts adopted traditional state approved textbook series in during 1986-88. During 1995-96, four of them adopted the reform program *MathLand* (published by Creative publications) and two retained their more traditional programs. In 1999, none of them chose a full program—all six adopted partial programs for skill practice.

Here are some sample stories developed from the questionnaire responses and interviews that depict typical patterns.

Sample 1. Teachers from five adjacent rural districts, each consisting of one K-8 school reported adopted the same traditional program during the late 1980's *(Mathematics Unlimited*, Holt Rinehart and Winston.) After 1994, two adopted a new traditional program, two a reform program, and the fifth adopted nothing. Two adopted a basic skills program in 1999, but the other three districts remain undecided about what to do; hoping the 2000 adoption will yield better alternatives. One teacher wrote:

> When *MathLand* was adopted (1995), everyone was very excited and ready to use the series. About 4-5 months into the first year of use many teachers went back to using *Math Unlimited* because of the time *MathLand* required and its lack of 'practice' pages. Now there are very few teachers who use *MathLand* at all.

Teachers from all five districts expressed concerns about finding materials aligned with the state tests.

Sample 2. In 1987 this mid-sized suburban district with 10 elementary schools selected *Heath Mathematics* for use in all its grade levels. A committee of teachers made the selection, choosing from the state list. In 1996, the committee could not reach consensus on materials except to provide one 4-week unit of a reform program at each grade level. District teachers on the 1999 textbook committee reported that they are in "desperate need of new textbooks" and stated that administrators are "extremely worried that far too little mathematics was being taught". Yet the 1999 committee chose to adopt the partial program *MathSteps* because of "the need to choose a test preparation program".

Sample 3. This is a large K-12 suburban district with 17 elementary, 4 middle, and 2 senior high schools, with approximately 650 elementary teachers. The district adopted *Silver Burdett Mathematics* in 1988 based upon recommendation of a district committee of administrators and teachers. In 1996, three programs were piloted and *Investigations in Number, Data, and Space* was the first choice at all grade levels except kindergarten, which preferred *MathLand*. So Investigations was chosen K-5. Since Investigations was only adopted by the state at grades 3,4, the district had to make sure that grades K-2 and 5 were purchased with 30% monies. The middle schools never adopted. In 1999, a district committee selected *Math Coach*, a one-year consumable package to supplement skills and to “prepare students for standardized tests”.

Sample 4. This is a medium sized urban district with 9 elementary schools, 4 Jr. High schools, and 3 High Schools. In 1987, a district committee selected *Silver Burdett Mathematics* for K-6 use. A district committee selected *MathLand* in 1995, and between 1995 and 1998 another district committee rewrote district math standards. But the school board replaced them with the state Standards in 1999. Teachers in grades K-6 received *MathSteps* as supplement in September 1999 which teachers refer to as “a test preparation program”. Teachers report that many use it exclusively for math, while others only occasionally use it.

Sample 5. This is a suburban district with mostly middle class families, with 16 elementary schools and 4 middle schools. The district adopted *Silver Burdett Mathematics* in 1988 and in 1996 implemented a “dual adoption” where each teacher received the new Silver Burdett materials and two to three units of *Investigations in Number, Data, and Space*. This district adopted no programs in 1999 “nor do they plan to adopt materials in the near future”. The district emphasized that they developed grade level objectives in 1995 that they do not intend to change, even though they are not aligned with the SBE standards.

Sample 6. This is a multi-track year round K-8 district with 14 elementary and 3 Jr. High schools with approximately 700 teachers, and a high percentage of ESL and low-income students. After a math task force organized a pilot program, the district selected *Addison Wesley Mathematics* in 1988, with final decision based upon a one vote per school. In 1996 the district adopted *Mathland* in grades K-2, which was extended to grades 3-6 in 1997. This time the decision was made using a one teacher-one vote ballot. The district says it cannot afford new math texts and therefore adopted supplemental programs “for test preparation” in 1999, choosing *Skill Power* in grades K-2, *MathSteps* in grades 3-5, and *Math Coach* for grade 6.

Overall, one pattern jumps out from the full data set. The district personnel interviewed clearly indicated their 1999 decisions were guided by concerns over testing as opposed to seeking a full instructional program to align with Standards. These concerns are reflected in their choices. Districts overwhelmingly chose materials labeled by the state as “partial programs” rather than “full programs”; most of which consist entirely of computation practice sheets. Some of these programs are considered next. The author adds a personal observation. Although district personnel were often hesitant to discuss it, many teachers indicated that a majority of teachers did not use the 1994 materials because they either found them too much work to implement, or they failed to find “the mathematics” or sufficient “skill practice” in the programs. This is probably universal and may be the most significant feature of the 1994 adoption.

IV. Instructional Materials: What Do Teachers and Students Experience?

The goal of this section is to illustrate some of the differences between the instructional materials selected in California during the 1990s. For this, eight different instructional programs and three professional development programs were selected. The instructional materials list includes programs adopted in 1994 and 1999 that were chosen by sizable numbers of districts (the "big sellers"), as well as programs given high marks by participants on both sides of the "debate". Although formal data is not available, informal reports indicate that vast majority of California K-6 students' come from districts that purchased at least one of the instructional programs considered here[14].

For each of three topics, five specific items were selected and each program (teacher and student materials) was examined for evidence of the fifteen items. The starting point for this analysis are the first three topics studied in Liping Ma's recent book (1999), multi digit subtraction and multiplication, and division of fractions. Issues important to the California debate as well as key points raised by Ma were considered when selecting items to consider. Although other characteristics of instruction, such as classroom culture, are of greater significance for teaching and learning, these topics do provide a lens for contrasting California's approaches. The three topics considered are:

(1) The introduction of subtraction with regrouping.
(2) The introduction of 2-digit multiplication.
(3) The introduction of division of fractions.

Ma's book has received enthusiastic endorsement from participants on both sides of California's debate, and is mentioned prominently in the Algebra Institute call for proposals (UCOP, 2000). Both sides find attractive her notion that a "profound understanding of fundamental mathematics" (PUFM) is important for mathematics teachers. Ma noted for the teachers she studied, PUFM was "developed during their teaching careers" (p. 129). In describing how it PUFM is attained Ma tells us the following in a summary statement (p. 143),

> The two studies suggest that, although their schooling contributes a sound basis for it, Chinese teachers develop PUFM during their teaching careers—stimulated by a concern for what to teach and how to teach it, inspired and supported by their colleagues and teaching materials.

Ma noted that teachers with PUFM learned from working with students over the years as well as from instructional materials. For this reason, when materials were examined for this project, explicit discussions are not the only evidence sought. Instead, materials were examined to see if they encouraged classroom practices that would raise the relevant issues. For example, a teacher demonstration that is not followed by student work dealing with the idea may not be considered good evidence for that item. On the other hand, student activities that force them to tackle an issue head on, even in the absence of explicit text discussion, may lead to important insights and could be recorded as evidence. When reading the yes/no tables this point needs to be kept in mind.

The second topic, the introduction of 2-digit multiplication, is discussed in greatest detail here. More information about the other two topics is included in the Appendix. Two-digit multiplication is a fourth grade standard in California (Number Sense 3.3, 3.4) and most textbook material here was taken from the fourth grade materials. The five items identified for the second topic are stated next. In each case, the item was formulated as a question that would elicit a yes or no response. Since a yes or no answer cannot accurately capture the complexity of the situation, a paragraph description was created for each program (citing specific pages) and the overall yes and no values tabulated for comparison purposes. Samples of these are given below. Summaries of each item, as well as each topic, record overall observations. The items are not ordered according to any priority, and positive evidence of any particular item should not be viewed as being necessarily good—in fact for some items readers may prefer a strong yes and for others a resounding no.

Topic 2. The Introduction of 2-Digit Multiplication.

1. **Distributive Law.** Is it mentioned or illustrated, and do students utilize it implicitly, if not explicitly?
2. **Artificial PlaceHolders or Lined Paper**. Are they used to facilitate procedural teaching without emphasizing meaning?
3. **Alternate Representations**. Are rectangular arrays, non-standard summation of sub-products, alternate algorithms or other representations used to convey meaning of the procedure?
4. **Place Value**. Is the "nonwriting of zeros in the algorithm" explained using place value?
5. **Manipulatives**. Are they used to develop meaning?

The findings in a Yes/No format are presented next. The item descriptions give a far more complete picture. An overall summary and a sampling of the item descriptions are given below. The trends identified here are similar to those found for the other two topics. Details about topics 1 and 3 can be found in the Appendix.

Topic 2: 2-digit Multiplication. - Summary

	Q1	Q2	Q3	Q4	Q5
(1994#1)	N	N	Y	N	Y
(1994#2)	N	N	Y	N	Y
(1994#3)	Y	N	Y	Y	Y
(1997)	Y	N	Y	N	Y
(1999#1)	y/n	Y	y/n	Y	y/n
(1999#2)	N	Y	N	N	N
(1999#3)	N	Y	N	N	N
(1999#4)	N	N	N	N	N
(PD1975)	Y	N	Y	Y	Y
(PD00#1)	Y	N	Y	Y	Y
(PD00#2)	Y	N	N	N	N

y/n means that teacher demonstrates, but students are not subsequently asked to follow-up.

Topic 2 Overall. Overall, the analysis revealed substantial differences between 1994 and 1999 materials. Most (but not all) instructional programs made little attempt to directly connect the distributive law to computational procedures. In contrast, all professional development programs explicitly discuss the distributive law. The 1994/97 programs did not use procedural devices for computation, while the 1999 programs do, where one finds lined paper and x's used as placeholders. Rectangular arrays were located in all four 1994/1997 programs and often provided the basis for student calculation, while none of the 1999 programs included arrays. One program (1997) emphasized writing out all sub-products in multiplication and three 1994 programs developed alternate algorithms. But the 1999 programs only included the standard algorithm recorded in the standard format. Discussion of the nonwriting of zero using place value was rarely found, as most programs either have students write the zero or use a placeholder. Most of the 1994/97 programs used manipulatives as part of multiplication representations, while the 1999 programs did not.

As an aside, in spite of all the tension in California about calculators, only one of the programs (1999#1) contained any discussion or use of multiplication on a calculator. It illustrated which keys to push to compute 10x$.6, noting for students, "There is no $ key on the calculator." (This issue was not singled out as an item, however.)

Sample Observations for Topic 2

The following paragraphs illustrate the type of results obtained from the analysis. A short discussion of this type was compiled for each topic, item, and text.

Topic 2 Item 1. (1994 #2) There is no explicit discussion of the distributive law in this section (subtitled "*Getting Close to Two-Digit Multiplication and Division"*.) Students do work on problems such as 12x13, and they may develop instances of the distributive law as they are decomposing rectangles. However no clear expectation is set that they will. The standard algorithm for two-digit multiplication is not introduced. Since there is no evidence that students will record instances of the distributive law we score No here.

Topic 2 Item 1. (1997) When partial products are introduced the distributive law is not discussed. (Grade 3 p. 412). But the distributive law is made explicit in a game "Multiplication Wrestling" where students see expressions such as (60+4)*(90+1)=(60*90)+(60*1)+(4*90)+(4*1). Teachers are then supposed to ask students to explain "how the partial-products algorithm is similar to finding a team's score in a game of *Multiplication Wrestling*." (Grade 4 p. 350). Since students are expected to record many instances of the distributive law, we score Yes here.
Note: When partial products are listed in vertical form, products are computed right to left instead of the US conventional left to right.

Topic 2 Item 1. (1999 #2) The distributive law is not discussed in this section introducing 2-digit multiplication. All that is taught is the standard multiplication algorithm. Since students never record any instances of the distributive law, we score No here.

Topic 2 Item 1. (1999 #3) The distributive law is not discussed in this section introducing 2-digit multiplication. The teacher's manual (p. 160) scripts a procedural explanation for students.

> Some problems multiply by 2-digit values that do not end in zero. This problem multiplies by 24. You can see the problem: 32 times 24. To get the answer you have to work two problems. If you cover the first digit of 24, you can see the first problem you work. The first digit of 24 is blocked out. You multiply 32 times 4. The answer is 128. You write the answer right below the problem. That's the first thing you do. If you cover the second digit of 24, you can see the second problem you work: 32 times 20. Remember, that's not just 2 you're multiplying by. That's 20. So you have to have a zero in the ones column of the answer. You write the answer below the answer for 32 times 4. The answer is 640. Remember, that answer goes right below the answer for the first problem. Then to find the answer to the whole problem you add 128 and 640. You can see the answer to the whole problem is 768. Remember the steps. Cover the first digit. Work the problem and write the answer right below the problem. Cover the second digit. Work the problem and write the answer right below the first answer. Then add both answers to find the answer to the whole problem.

Since students never record any instances of the distributive law, we score No here.

Topic 2 Item 2. (1999#2) Artificial place-holders or lined paper are not suggested anywhere in the initial discussion, however, in supplemental materials for special needs students, students are specifically instructed to use an x as a place holder in multiplication, such as 34 x 12, where a student would write 34x instead of 340. So we score Yes here.

Topic 2 Item 2. (1999#3) Students are routinely expected to use lined paper turned sideways when calculating multi-digit multiplication. Often, in the same problem set, they must repeatedly rotate their papers 90%, and a little sketch in the sidebar of their text provides a prompt of when to do so. . So we score Yes here.

Topic 2 Item 3 (1994#1) Rectangular arrays are used to illustrate partial products in multiplication (pp. 194-5). However, even though the diagrams illustrate 4 sub-regions, the only sub-products illustrated in the student text correspond to the two sub-products arising in the standard algorithm. (E.g. 45x23 is shown as 135+900, but not as 800+100+120+15.) It is a close call, but because rectangle subdivision is used to illustrate the ideas behind the procedure we score Yes here. Estimated products (which are obtain by rounding to the nearest ten and multiplying) are used to check answers, but are not used to develop alternate approaches to exact calculation.

Topic 2 Item 3 (1999#1) All student work is based upon using the standard algorithm. Estimation is suggested for checking answers, but the estimation procedure is rounding to nearest 10 and multiplying, so this is not an alternate method for understanding calculation. Teachers demonstrate the distributive law and demonstrate calculations using overhead base-ten blocks (p. 150), but students do not do this themselves unless selected for diagnostic reteaching (p. 151). So we score No here.

Topic 2 Item 3 (1997) Alternate formulations are central to instruction. Included are geometric arrays, various orders and formats for listing partial products, as well as alternative algorithms such as the lattice method or the “ancient Egyptian” (powers of 2) algorithm. So we score Yes here.

Topic 2 Item 3 (1999#2) All student work is based on the standard algorithm which is stated procedurally. No alternate formulations are presented. So we score No here.

Topic 2 Item 4 (PD00 #2) Although the shortened notation is used (966 is written for the second partial product in 27x483) there is no explanation or discussion about it what so ever. So we score No here.

Topic 2 Item 5 (1994#3) Graph paper is cut to represent decomposition of arrays. However in later work with multiplication clusters, manipulatives are not used. We score Yes because the graph paper cutting is linked to student’s conceptual work.

V. Summary and Conclusions.

In conclusion, we return to the chart from the 1985 California Framework.

Teaching for Understanding	*Teaching Rules and Procedures*
Emphasizes Understanding	Emphasizes Recall
Teachers a few generalizations	Teaches many rules
Develops Conceptual Schemas or interrelated concepts	Develops fixed or specific processes or skills
Identifies global relationships	Identifies sequential steps
Is adaptable to new tasks or situations (broad application)	Is used for specific tasks or situations (limited context)
Take longer to learn, but is retained more easily	Is learned more quickly but is quickly forgotten
Is difficult to teach	Is easy to teach
Is difficult to test	Is easy to test

The evidence collected about the test preparatory materials now being utilized as primary instructional materials shows California has moved quickly towards the right hand column. Although this may be an unintended consequence of the new policies, it is not a surprise.

The test preparation programs are usually designed around a "two-page spread" for students containing one days work. One of the best selling programs states in an informational video that its teaching strategies are "based upon over 25 years of confirmed research". In this program (1999#4), the teacher's manual gives a half-page description for teaching the daily skill. Most two-day spreads have a diagram that illustrates how to execute that day's procedure. For example, at grade 4, the diagram introducing the standard 2-digit multiplication algorithm offers the following step by step instructions

> You know how to multiply by 1-digit numbers. Now you can multiply by 2-digit numbers. Find: 36x24. 1. Multiply 24 by 6 ones. … 6x24 —> 144. 2. Multiply 24 by 3 tens. … 30x24 —> 720.
> 3. Add the products.

Although the result of the standard procedure is written down for this example, nowhere in the teacher's manual or in the student materials is there any discussion of where the little 1's and 2's in the tens column written above the factors represent or where they come from. This example is followed by thirty 2-digit multiplication problems for student practice. Then there are four word problems that require 2-digit multiplication to solve. The second sheet concludes with multiple choice "Test Prep * Mixed Review" questions, which are formulated using the same wording as the Stanford 9 exam. Teachers are given the following instructions for closing the lesson,

> Today you learned about multiplying by 2-digit numbers. When a 2-digit number is multiplied by a 2-digit number, what is the least number of digits you might find in the product? The greatest number? (Least:3, greatest: 4)

In many California classrooms today, a daily pair of pages such as these represent the full mathematical experience. Two-digit multiplication is introduced as a procedure to be practiced. No geometric arrays or explanations are included to help students make sense of the procedure. These two pages synopsize the main impact of three years of back to basics policies.

From the point of view of most teachers, the main events discussed in this paper can be summarized as follows. California's introduction of new K-8 instructional materials during the 1995-1996 academic year was followed by a reversal of policy within two years. By 1998, K-6 curriculum, standards, and assessment were headed in three different directions. But since the tests are "high stakes", at least compared to what Californians were used to, and they are what matters to your district leadership and the press. So as a teacher, you teach to the test. Now in 2000, California politicians have proclaimed that Standards, frameworks, curriculum, and assessment are aligned. The Framework and Standards may be aligned, but instructional materials are not yet aligned with these documents, and the Stanford 9 test is not aligned with the Standards either. So as a teacher, your priority is finding test preparatory materials.

And what do we find has happened? Districts selected instructional materials in 1999 largely as preparation for statewide testing. These materials emphasize direct instruction in "standard algorithms". Many include procedural devices to ensure accurate calculation, and the big sellers are identified by the state as "partial programs", e.g. skill supplements. This is in stark contrast to the 1994 adopted materials that emphasized multiple representation, use of manipulatives, and had students develop varied approaches to calculation.

Mathematics professors continue to play a dominant role in curriculum and professional development. They believe approaches to instruction should be based upon rigorous formal mathematics. Their views are quite different from those expressed by politicians (i.e. SBE members) who oversimplify their position as being "back to basics". The mathematicians are also leading a professional development drive and California has committed enormous sums of money for the effort. The programs are based upon a new paradigm. They are content specific and include "rigorous mathematical reasoning" as defined by mathematics professors, but are not focused on student curriculum. So they different from the approaches previously used in California. For example, Cohen & Hill (1998) classified professional development as either being generic (e.g. "using manipulatives") or directly linked to instructional materials. Researchers will have to keep this new paradigm in mind as they evaluate the new efforts.

This overview of California's mathematics education changes indicates what it means for our students in the next decade. One expects differences of opinion in education, and what we have in California is yet another instance of some old debates. This by itself is not a major problem. But in California, policies are no longer developed by consensus, where different views are treated with respect. Instead small group of mathematics professors are effectively ruling by decree. Teachers, university education faculty, parents, and community members have been excluded from the process. This is a travesty.

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Appendix: Further Instructional Material Comparisons.

Liping Ma's First Question.

The first question studied in Ma (1999) considers subtraction with regrouping. For the most part, second grade materials were considered even though this type of subtraction is listed in the California First Grade Standards (Number Sense 2.6). The California Standards call for 3-digit subtraction in second grade, where the Framework lists it as an emphasis standard (p. 30, Number Sense 2.2).

After presenting a typical 2-digit subtraction question, Ma asked (p. 1),

> How would you approach these problems if you were teaching second grade? What would you say pupils need to understand or be able to do before they could start learning subtraction with regrouping?

The items below were selected after taking into account issues raised in Ma's discussion as well as issues arising in the debate over California's Standards and Framework. The same remarks about the items for question 2 in the body of this paper apply here.

1. "Bigger" Ones Digit? Do the materials actually tell teachers and students "You can't subtract a bigger number from a smaller one"?

2. "Borrowing". Do the materials teach "borrowing" as a procedure, as if a two-digit number is a sequence of two one-digit numerals?

3. Decomposing and Composing. While preparing for and working with this topic is the connection between decomposing and composing in addition considered as part of making sense of subtraction calculations? A no answer may mean the process taught is simply limited to exchanging 1 ten for 10 ones.

4. Multiple Ways of Regrouping: While preparing for and working with this topic, are students expected to develop multiple ways of regrouping or is two-digit subtraction limited to the standard algorithm?

5. Manipulatives. Are they used to develop meaning?

Nine programs were checked for evidence of the five items (the two professional development programs developed for AB 1331 providers did not treat this topic since they started with grade 4 material). We give the summary first, which is followed by a chart, and then some samples of the observations recorded.

Summary. Roughly speaking, there are three different instructional approaches. In the first, students explore various problems involving addition and subtraction of two-digit numbers, which they solve by creating different decomposition/composition strategies. The standard algorithm is either not taught or emerges much later. In the second approach, the focus is teaching the standard algorithm, and typically, students use base-ten to help them visualize the decomposition that corresponds to "borrowing". In the third case, students are told directly when to borrow or not when to borrow and then emphasis is on their following instructions. One might be tempted to use the adjectives, "conceptual", "traditional", "procedural" in describing these three approaches.

Of the 1994/7 programs, only one teaches the standard algorithm. Its approach is traditional and students are told not to subtract larger ones from smaller ones when they need to regroup. The other three programs exhibit the conceptual approach and have students develop their own procedures and encourage multiple methods of calculation; all based upon different decomposition and composition strategies. Two use base-ten blocks and the other is based upon mental and paper/pencil recording of varied decompositions.

Two of the 1999 programs are traditional and expect students to develop understanding of the standard procedure by using base ten blocks to illustrate regrouping. The other two 1999 programs are procedural. There is no evidence that students develop strategies for decomposing numbers other than as required for the algorithm as part of preparation or part of working with two-digit subtraction. Two use base ten blocks, but they are limited to illustrating the procedure and one program uses dimes and pennies and makes exchanges using them (which in this case was not counted as a manipulative).

The table below summarizes the findings in a yes/no format. In some cases, the judgement call between yes and no is close and the discussions must be studied to see how lines were drawn.

Topic 1: Addition with Regrouping. – Summary

	Q1	Q2	Q3	Q4	Q5
(1994#1)	Y	N	N	N	Y
(1994#2)*	N	N	Y	Y	Y
(1994#3)	N	N	Y	Y	Y
(1997)	N	N	Y	Y	N
(1999#1)**	Y	N	Y	N	N*
(1999#2)	Y	N	N	N	N
(1999#3)	Y	Y	N	N	N
(1999#4)	N	Y	N	N	N*
(PD1975)	N	N	Y	Y	Y
(PD00#1)	*	*	*	*	*
(PD00#2)	*	*	*	*	*

* This program delays the topic until grade 3. All other texts were in grade 2.
** This program teaches the topic in grade 1, the approach in grade 2 is the same.
N* Base-10 blocks are used, but they are limited to following direct instructions of decomposing one ten only.

Sample Observations for Topic 1

The statements illustrate the type of results obtained from the analysis.

Topic 1 Item 1. (1994 #1) Page 343. In a section titled "Assessing Learning" Teachers ask, "When do you need to regroup in subtraction? (When there are not enough ones thin the greater number from which to subtract.)" On side bar in explaining why regrouping is necessary for calculation 62-35 the reply is "You cannot subtract 5 ones from 2 ones.) So I answer Yes.

Topic 1 Item 1. (1994 #2). No, this does not occur. The standard algorithm is not used.

Topic 1 Item 1. (1999 #1). Yes. On p. 363 in setting up the first calculation requiring regrouping, students are explicitly asked "Do you have enough ones to take 5 ones away from 2 ones?"

Topic 1 Item 2. (1994 #3). No, the standard procedure is not taught. Problems requiring regrouping are posed, but students are supposed to use counting up and down strategies in various ways to answer these questions.

Topic 1 Item 2. (1999 #2). Yes. On p. 36 students are told "you are going to do borrowing", and then they procedurally write the 1 above the ones digit. There is no attempt to explain that the two-digit number is being broken apart. Students subtract in the columns as if they are separate problems.

Topic 1 Item 3. (1994 #2). Yes. The day prior to playing hidden numbers, students compose two digit numbers in many different ways (in fact finding different ways to represent numbers using base-ten blocks)

Topic 1 Item 3. (1999 #3). No. There is no connection to addition. In fact there is no decomposition of any form displayed.

Topic 1 Item 4. (1994 #1). No. The only regrouping considered in this introduction is standard regrouping as in the standard algorithm.

Topic 1 Item 4. (1994 #3) Students are explicitly told to use different strategies (p. 120) which will require different groupings. So the answer is Yes

Topic 1 Item 4. (1999 #4). No. Only the standard algorithm is allowed.

Topic 1 Item 5. (1994 #2) Yes, base-ten blocks are used to represent both composing and decomposing and students must actively utilize them in doing this.

Topic 1 Item 5. (1999 #1). Students use base-ten paper cut outs to model regrouping process, imitating the pictures on the page. Some might consider it as a yes, but students do not appear to make decisions on their own as part of a sense making process. So the score is N* here.

Topic 1 Item 5. (1999 #2). No. I do not count dimes and pennies as manipulatives, as its shape does not represent the concept that a dime is of equal value as 10 pennies. This is unlike the situation with base 10 blocks, where the 10-block is physically equivalent to ten one blocks. (This is a judgement call some may disagree with.)

Liping Ma's Third Question

This question asks teachers to compute 1 3/4 ÷ 1/2 and concludes by asking

> "What would be a good story or model for 1 3/4 ÷ 1/2"

In California, such calculations are a fifth grade standard (Number Sense 2.5), but are not an emphasis standard until grade 6. Most materials studied are from grades 5 and 6, although one program does not treat the topic until grade 7. The comparisons did not focus on stories or models, but was based on the issues raised in Ma's book as well and incorporated some issues raised in California's discussions. The five items are

1. Measurement Model: Do the materials explicitly formulate such division questions in the form "How many 1/2's are in 1 3/4"?

2. Invert and Multiply. Is the invert and multiply rule included? If yes, is it merely stated without explanation, or is it explained somehow, say, for example with the measurement model.

3. Partative Model or Find a Factor. Do the materials explicitly formulate such division questions in the form "Find a number such that 1/2 of it is 1 3/4"? Or is the following approach present in the materials, "Find a number that when multiplied by 1/2 gives 1 3/4"? Here we include the notion of inverse operations, such as saying "1 3/4 ÷ 1/2=A" is the same as " 1/2 x A = 1 3/4".

4. Expressed as Division by Whole Numbers. Are division by fraction problems re expressed as an equivalent division by whole numbers? (Such as 1 3/4 ÷ 1/2 = 7/4 ÷ 2/4 = 7 ÷ 2.)

5. Manipulatives. Are they used to develop meaning?

Ten of eleven programs were checked for evidence of the five items. One program, (1994#3) was only created for grades K-5 and does not treat the topic. We give the summary first, which is followed by a chart and some samples of the observations recorded.

Summary. The measurement model appeared in all but one 1999 program and students are generally expected to reason using it. (It was mentioned in 1999#3, but no student work was linked to it.) All programs gave the invert and multiply rule and some offered explanations. No programs discussed the partative model or find a factor approaches as described in Ma's book, except for one professional development program which explicitly cited Ma's book. This gives evidence that unlike the measurement model, these alternate formulations have not entered the US mainstream. Only one instructional program (1997) made reference to converting a division problem into a whole number division, although this was pointed out in two professional development programs. A fairly uniform pattern appears in the instructional materials: students first use the measurement model for some calculations which are then followed by practice with the invert and multiply rule. The only noticeable difference (which may not be apparent from the table alone) is that in the 1994 programs, students spend considerably more time with manipulatives constructing representations. In contrast, in the typical 1999 programs, students look at a visual representation and then immediately proceed to practice in computation with the invert and multiply rule.

Topic 3: Representing Division of Fractions. - Summary

	Q1	Q2	Q3	Q4	Q5
(1994#1)	Y	Y-E	N	N	Y
(1994#2)	Y	Y-WO	N	N	Y
(1994#3)	*	*	*	*	*
(1997)	Y	Y-E	N	Y	N
(1999#1)	Y	Y-WO	N	N	Y
(1999#2)	Y	Y-E	N	N	N
(1999#3)	N	Y-WO	N	N	N
(1999#4)	Y	Y-WO	N	N	N
(PD1975)	Y	Y-E	N	Y	Y
(PD00#1)	Y	Y-E	Y-Both	N	N
(PD00#2)	Y	Y-E	N	Y	N

* Topic not included in this K-5 program
Y-WO means stated without explanation and Y-E means stated with some explanation provided

Sample Observations for Topic 3:

The following statements illustrate the type of results obtained from the analysis.

Topic 3 Item 1. (1994 #1) The measurement model is investigated prior to using the algorithm, so the answer is Yes.

Topic 3 Item 1. (1999 #1) The measurement model is used to introduce division by fractions and students are expected to create models and write about them, so the answer is Yes.

Topic 3 Item 2. (1994 #2) The invert and multiply rule is introduced at the end of the week. There is no justification (students are supposed to check that they obtained the same answers as earlier.) So the answer is Y-WO.

Topic 3 Item 2. (1999 #2) The invert and multiply rule comes out of the explanation based upon the measurement model. So the answer is Yes-E

Topic 3 Item 2. (1999 #3) Lesson 82 presents the first set of computational exercises where students divide by fractions. In the student text, p 335 one finds

> • You have learned the rule that dividing by a value is the same as multiplying by the reciprocal of that value.
> • You can use that rule to work division problems without using your calculator. You just rewrite division problems as multiplication problems and work them.

No explanation for this version of the invert and multiply rule is provided. So the answer is Y-WO.

Topic 3 Item 3. (1999 #1) Neither the partative model nor find a factor approaches is discussed. So the answer is No.

Topic 3 Item 4. (1997) Yes, the common denominator method is introduced in Gr 6. p. 436 where one finds the following sample calculation:
2/3 ÷ 3/5 = 10/15 ÷ 9 15 = 10 ÷ 9 = 1 1/9 .

Topic 3 Item 4. (PD 00#1). Division problems are not re-expressed as a division by whole numbers. So the answer is No.

Topic 3 Item 5. (1994#2). Manipulatives are used extensively in early calculations. Students are expected to create models of multiplication and division problems involving fractions, and in each case they must develop their own representations and identify the unit being used. So the answer is Yes.

Topic 3 Item 5. (PD 1975). Manipulative use is discussed in detail with many illustrative projects and commentary about the idea they are supposed to develop. So the answer is Yes.

Topic 3 Item 5. (PD 00#2). Manipulatives are not discussed. So the answer is no.

Source Material for the Comparisons.

Note: Many of these programs have been updated recently, and a few were substantially revised for the 2000 California adoption. The volumes used in this analysis are those submitted during the year indicated—not the revisions—for the reason that this paper is examining historical trends instead of currently available programs.

(Text 1994#1) From the 1994 California SBE Adoption List: Silver Burdett Ginn Mathematics, *Exploring Your World,* Grade 2. 342-347; Grade 4 TE 186-199; Grade 7 TE 186-199

(Text 1994#2) From the 1994 California SBE Adoption List: Creative Publications *MathLand,* Grade 3,TE 62-69; Grade 4 TE 222-229; Grade 6 TE 126-133

(Text 1994#3) From the 1994 California SBE Adoption List: Dale Seymour, *Investigations in Number, Data, and Space*. Grade 2 Coins Coupons and Combinations unit,. 115-123; Grade 4 Arrays and Shares unit 41-71;

(Text 1997) From the 1997 California SBE Adoption List: Everyday, *Everyday Mathematics*, Grade 2, Lessons 76, 77. TE 314, 318; Grade 3 Lesson 87 TE 411-413, Lesson 94 TE 432-434, Grade 4 Lesson 75 TE 349-351; Grade 6 Lessons 80, 81 TE 431-437

(Text 1999#1) From the 1999 California SBE Adoption List, William H. Sadlier, *Progress in Mathematics,* Grade 1 TE 361-364 Grade 2, TE 217-225; Grade 4 TE 146-155; Grade 5 TE 212-219

(Text 1999#2) From the 1999 California SBE Adoption List, Saxon, *Saxon Mathematics*, Grade 2, Lesson 107, TE 5; Grade 3, Lesson 97 332-333; Grade 5 Lesson 97 242-244

(Text 1999#3) From the 1999 California SBE Adoption List, SRA/McGraw Hill, *Connecting Math Concepts*, Grade 2. Lessons 14 and 39, TE36-38; Grade 3 T. 160-163, S p. 129-132; Grade 5 Lesson 82 S 335-336

(Text 1999#4) From the 1999 California SBE Adoption List, Houghton Mifflin, *MathSteps*, Grade 2, T106-7, S 171-174; Grade 4. T43-51, 64-68; Grade 5 T83 S 131-133

(Prof.D. 1975) Teaching Elementary School Mathematics for Understanding, fourth edition, John L. Marks, et. al. Mc-Graw Hill (1975), First published 1958. 89-93; 112-115;

(Prof.D. 2000#1) AB 1331 Professional Development Materials, CISC, *The Winning Equation* (1999) Primary Content Module II, T-3 to T-5; Primary Content Module V, T-33 to T-41.

(Prof.D. 2000#2) AB 1331 Professional Development Materials, CORE Inc., *Core Math* (1999), Day 1 pp. 28-35; Day 3 32-35

Appendix 2: The 2001 SBE Mathematics Adoption.

In January 2001 the SBE adopted mathematics materials at grades K-8 for California use during 2001—2008. The materials were supposed to align with the Framework and Standards and had to pass the same review process used in 1999. In the end, two K-5, five K-6, one 7-8 and two 6-8 programs were adopted. One K-5, one K-6, and six programs with various 6-8 combinations were rejected. Because of the controversy in the US surrounding the programs identified in 1999 by the US Department of Education as *Exemplary and Promising,* observers watched for them closely. But in the end, only two of these ten programs were submitted (*Cognitive Tutor Algebra 1* and *Everyday Mathematics*) and both were rejected. According to *Education Week* (October 18, 2000), publishers of most of the exemplary texts felt there was no point in bothering to submit, quoting one publisher "The deck is stacked against any text that isn't in the traditional format."

Unlike two of the 1999 adopted materials studied in this paper (Texts 1999 #3, 4), partial programs were not allowed in the 2001 adoption. However, both of the full 1999 programs, William H. Sadlier, *Progress in Mathematics* (Text 1999 #1) and Saxon, *Saxon Mathematics* (Text 1999 #2) were adopted, and the 1997 adopted program, *Everyday Mathematics* (Text 1997), was rejected by the SBE. Because these texts were submitted in forms nearly identical to these versions, the earlier analyses remain relevant. However, as California's evaluation does not consider the issues raised in Ma's book, the 2001 adoption discussions were quite different. To illustrate them, three controversial cases where the SBE disregarded the recommendations of its "expert" panels are discussed below.

Undoubtedly the most significant change in California education policy as reflected in the 2001 adoption came as no surprise. The only eighth-grade materials available are three, traditional, first-year algebra texts. Many people viewed this action as an attempt to push high schools to align with the limited collection of 8th grade choices and thereby reverse trends towards integrated and/or problem-solving materials that had gained momentum since the 1992 Framework. One of the algebra texts chosen by the SBE was a well-known US textbook (Dolciani) that has remained essentially unchanged for several decades. For the past half-century, significant numbers of 9th grade US students who enroll in courses identical to those adopted have failed. Now, California is pushing this course on all 8th grade students.

Three Controversial K-6 Programs.

Both *Saxon Mathematics* and *Everyday Mathematics* are among the four cases where the Curriculum Commission and the SBE reversed the recommendations of the panels. A third program, *McGraw Hill Mathematics*, was recommended for rejection by both panels at grades 3-6 yet was approved by the SBE. Its case is interesting because two of the four mathematics professors who revised the Standards and served on the 1999 Content Review Panels had advised McGraw Hill's authoring team and came to its defense at the Commission hearing. The final decisions were political and followed heavy lobbying on the part of publishers. Fifteen of thirty-one speakers to the Commission gave testimonials about Saxon's success in their schools. And although Everyday Mathematics had sixteen district superintendents write on its behalf, last minute interventions by the Governor's office seems to have halted its adoption.

McGraw Hill Mathematics. Among the Content Review Panel criticisms was "The failure of this series to take definitions seriously". The CRP report (p.4) criticizes McGraw Hill's introduction of division of fractions stating,

> one would expect the division of fractions to be also done by fiat, and naturally it is (pp. 323-324): "dividing is the same as multiplying by the reciprocal of the divisor". This completely ignores the call for "providing logical explanations for all aspects of the teaching of fractions" on p. 138 of the Framework.

But in discussing subtraction and multiplication the report says (p. 3), "The addition and subtraction of whole numbers are the principal concern of K – 2 and these are done consistently well". The CRP also said "the explanation of the multiplication algorithm on pp. 361-362 and that of long division on p. 400 of grade 3 are exceptions. Both are good." Yet the IMAP report offered a different opinion (p. 54), "In 4th grade the students are to understand the complete reasoning for the multiplication algorithm, yet not a single page of the textbook is given over to this proof."

The two mathematics professors hired by McGraw Hill disputed the reported weaknesses, explaining that program provided informal introductory explanations for students in "math word boxes". They complained that the objections were based on different views of pedagogy, rather than content. An example was given, "in explaining the concept of a fraction, models such as pizza pies and fraction strips, various kinds of graphical explanations are more effective in getting the idea across." It was explained that formal definitions followed later, were complete, and that the "adoption should not be based upon any preference for pedagogical style." Regarding the issue of multiple representations, a major distinction noted between the 1994 and 1999 programs, the CRP said,

> an overriding theme of these seven volumes is to say "there is more than one way!" and proceed to list two or three methods for computing something. In the overwhelming majority of the cases, neither the reason for the validity of each of them nor the connection among them is ever pointed out. We are of the opinion that both are critical to students' understanding.

Overall, many of the controversial issues surrounding California's new policies confounded the McGraw Hill adoption. University mathematics professors argued over the appropriateness and timing of the use of informal verses formal definitions in elementary school. Some argued that pedagogy and content are distinct while others could not find the boundary. Was mathematical reasoning for children the same as mathematicians' "proof"? Agreement wasn't reached. And the use of multiple methods as opposed to a single one remained controversial, even though different approaches didn't include the nonstandard algorithms or geometric representations common in 1994.

Everyday Mathematics. Both the IMAP and CRP panels recommended the adoption of Everyday at grades K-3. The reports did not cite significant content problems at these grades although the IMAP reports says "There is a concern at second grade, when so much of the material reviews sums to 20, and this is a first grade standard". Referring to the grade 4 requirement of teaching the standard multiplication algorithm, the CRP report stated "does not meet standard." As in the 1999 adoption, a concern here was the use of "nonstandard algorithms". The partial product algorithm for multiplication (for example summing four partial products when multiplying two two-digit numbers instead of summing two partial products as in the "US standard" algorithm) and the "lattice method" introduced in Everyday, were not considered compatible with the California Standards. At grade 5 the CRP report states, "There is no treatment that we could find of division of fractions." Everyday's careful treatment of this topic described in Appendix I is at grade 6, where both the measurement model and the "invert and multiply" algorithm are included.

On the surface, the two main Panel criticisms were that Everyday has material a grade later than the California Standards specify and that "nonstandard" procedures for computation supplant the traditional ones. But on deeper level, the real objection was that the program expects deeper understanding on the part teachers and students than a typical procedure driven program. For example, in its 4-6 summary the CRP report states

> In the hands of a good teacher, this could be an excellent book. It contains extremely interesting and thought-provoking material. However, this strength is also a potential weakness, in that it is highly teacher-dependent (and consequently, not teacher-proof.)

This same criticism was leveled at grades K-3 by CRP panelist Jim Milgram who subsequently made a special appeal to the Curriculum Commission to block Everyday on these grounds, where he raised the bar to a ridiculous extreme. He said

> As currently written Everyday math requires in the teacher that is teaching it, and this is at grades K through 3, the mathematical maturity equivalent to the following college level courses at a serious Tier 1 school. At least one course in calculus, a strong course in linear algebra, a strong course in abstract algebra—I don't mean intermediate algebra, I mean groups, rings, and fields, and a junior level course in classical geometry. Less than that will not do.

The defeat of Everyday in the Commission hearing included no new discussion. The decision was made behind the scenes ignoring public input and was sustained by the SBE. The documented success of the program in California schools was no match for what many believed was a (political) need to defeat National Science Foundation developed programs that expected high levels thinking and reasoning from all students.

Saxon Mathematics. This program is, without doubt, the favorite among many of California's basic skill advocates. At the May 2, 2000 Los Angeles School Board hearing it was heavily promoted by SBE member Nancy Ichinaga and other pro-skill speakers. It is based upon direct instruction in procedural skills and provides teachers scripts for presenting lessons. In the topics considered in Section IV and Appendix I, it was noted that Saxon did not include multiple representations or use manipulatives to develop these ideas. The panels, which by and large supported the new state policies, also noted its lack of conceptual development. The IMAP report on Saxon K-3 begins its discussion of mathematical content as follows.

> The IMAP found that the mathematics content of the Saxon program does not support teaching the Mathematics Content standards at each grade level as details, discussed, and prioritized in Chapters 2 and 3 of the Framework. … The lack of support for the CA standards begins in kindergarten.

Later the panel was more specific and differed with the Content Panel which found Saxon did address the Standards at K-3.

> The foundation for mathematical reasoning begins in these early grades. The IMAP disagrees with the CRP findings that the levels of reasoning expected by the Saxon program are appropriate for these grade levels and that the problems are mathematically interesting and challenging.

At grades 3-6 both panels were acutely aware of the fact that Saxon limits is development to mastery of procedure. The IMAP report states it "concurs with the Haimo-Wu CRP report that a major shortcoming of the program is its preoccupation with procedure at the expense of mathematical reasoning." During a CRP verbal discussion of Saxon grade 3-6, Professor Hung Hsi Wu offered the following remarks.

> But I think that what perhaps disturbs me the most about Saxon is to read through it, I myself do not get the feeling that I am reading something that when that the children use it they would even have a remotely correct impression of what mathematics is about. It is extremely good at promoting procedural accuracy. And what David says about building everything up in small increments, that's correct, but the great pedagogy is devoted, is used, to serve only one purpose, which is to make sure that the procedures get memorized, get used correctly. And you would get the feeling that—I think of it as a logical analogy—you can see the skeleton presented with quite a bit of clarity, but you never see any methods, your never see any flesh, nothing—no connective tissue, you only see the bare stuff.
>
> A little bit of this is okay, but when you read through a whole volume of it really I am very, very, uneasy. … When I do this I want to emphasize that I do not single out one or two examples. I am trying to describe through one or two examples the overall the overriding impression that I have. And when that happens, you get the feel that if my students use this, how could they not get the idea that mathematics is just a collection of techniques? If that is the case, what happens to them when they go on to middle school, and then to high school, and after that, God forbid, you might be facing them in your freshman calculus classes. And that is a frightening thought.

In spite of these criticisms, the Commission and the SBE adopted Saxon mathematics with essentially no discussion.

The Implications of the SBE Action.

In Section III it was observed that the main impact of the 1999 California adoption was the selection of partial programs that provided drill and practice on computational topics on the state's high-stakes tests. The impact of the 2001 adoption, will, by necessity be somewhat different. For partial programs were not allowed and the adopted programs do make an attempt to fill out mathematical connections. Moreover, the Governor has proposed yet more professional development, and his legislation offers $2500 per teacher to districts that adopt the new materials within 7 months of the SBE's January decision. So it is expected that a significant number of districts will act quickly.

One would hope that the new materials represent an acceptable "middle ground," allowing for students to develop conceptual understanding, problem solving and basic skills. This is hardly the case. While most do not take the form of tightly scripted lessons that allow for no variation by a teacher, the materials satisfy the bare necessities of matching procedures to standards, and little else. Topics are reduced to what is known in the publishing trade as the "2-page spread." In fact, the CRP report on McGraw Hill stated, "Every topic discussed is given the same emphasis as any other, usually at a fairly routine and superficial level. This may have something to do with the decision to limit *every* section to exactly two pages." The 2001 materials are literal translations of each standard, providing a tidy capsule lesson in which teachers are encouraged to do what they have been doing for decades: 1) Explain a topic, 2) show an example from the book on the chalkboard, and 3) have the students practice similar examples.

In short, the primary result of California's back-to-basics push has been to resurrect the instructional approaches that were common in the US during the 1980's. Indeed, one of the more popular Algebra programs from that era is back at grade 8. The only noticeable difference is that many topics appear earlier. Although the mathematician-authors of the Framework called for a renewed emphasis on proof, the CRP documents lead one to question that this happened. There was no evidence for it in the 1999 texts examined here, two of which passed nearly unchanged and may become among 2001's top sellers. The SBE has proudly proclaimed that teachers have standards aligned texts. Instead it appears California is now confidently marching forward into the past.

Footnotes

[1] From tape recording of public session, May 3, 2000.

[2] They characterize the changes as a new call for mathematical rigor, which includes mathematical reasoning and proof.

[3] From the *Instructional Materials Criteria*, p. 180.

[4] Featuring Barbara Foorman and Douglas Carnine in reading, and the leadership of a new group, *Mathematically Correct*, in mathematics.

[5] In the September 5, 1997 draft Framework, this statement was reworded "the real number line has no gaps and consequently it has the properties of the continuum" (p. 11).

[6] Mathematicians also rejected an Appendix to the *Program Advisory* addressing how students might represent multiplication across grade levels.

[7] The state wide 10% must include the standards aligned augmentation, and the school wide 5% consists only the SAT-9 scores. Both mathematics and language arts scores are considered, and there are no restrictions on parental income. In addition, scholarships of $2500 are provided to students with high scores on advanced placement math and science tests.

[8] Partial programs were allowed in this special adoption with the hope that they would enable districts to move more quickly towards Standards aligned instruction. This is not allowed in regular adoptions

[9] There were no public sessions where Drs. Wu and Milgram spoke during their work revising the Framework.

[10] There are 100 projects in nine content areas, History-Social Science, World History and International Studies, Mathematics, Reading and Literature, Science, Writing, Arts, Foreign Language, Physical Education-Health. The projects typically run summer programs for teachers and most are housed at University of California and California State University campuses.

[11] No public records of teacher participation in AB 1331 classes exist at this point. Although some areas of the state may have higher participation rates, anecdotal reports suggest the majority of funds will not be used unless format for expenditure is changed.

[12] The Framework's report on experimental research (Dixon, et. al. 1998) was supplied to prospective provider applicants.

[13] Actually, districts are free to use 30% of their instructional materials funds on non-adopted programs. If they want to spend more than 30% they must obtain a waiver from the SBE.

[14] As noted in the last section, this does not mean that students experienced the curriculum.