Sabbatical Mini-Report # 11
Standards and Reform

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This report looks at the available standards and criticisms (state and national), and the effectiveness of various reform curriculum in the K-12 system (especially high school).

AVAILABLE STANDARDS

There are two national standards that directly impact community college mathematics education … National Council of Teachers of Mathematics (NCTM) and the American Mathematical Association of Two-Year Colleges (AMATYC). At the state level, Michigan just released the Michigan Merit Curriculum, with its grade level expectations. At this point, the report will focus on providing links to those source documents – and some very brief comments.

NCTM standards 2000 Web site http://standards.nctm.org/
The standards are a very thorough revision of the original 1989 document; in particular, "telling" and "practice" are addressed in a more positive manner. The standards web site provides free access to an overview of the grade level standards; NCTM also offers a free 120-day trial access to the full document in electronic format. (Normally, that access is limited to NCTM members.)

AMATYC standards 2006 Web site http://www.bc.amatyc.org/
"Beyond Crossroads"
The AMATYC standards of 2006 are a complete revision of the original (1995); in this edition, the emphasis is on curricular improvement and quantitative literacy. The Beyond Crossroads web site provides free access to the complete document, with online links; AMATYC is in the process of developing numerous digital resources to supplement the primary document. [AMATYC's online resources are open, and not restricted to members; however, most mathematics faculty at a community college should consider maintaining a membership in this organization – it is the leading national organization supporting the needs of community college mathematics.]

Michigan grade level expectations 2006 Web site
http://www.michigan.gov/mde/0,1607,7-140-42668---,00.html
The Merit Curriculum is a combination of learning objectives (expectations) with a required set of mathematics courses that are effective with the class of 2011; the content will be implemented in most Michigan schools in the 2007-08 year. The graduation requirements include 4 years of mathematics, and one of these must be in the senior year. (Some students take qualifying mathematics in middle

school; these are the students who could complete 4 years before being seniors.) The content expectations present conflicts between our usual visions of algebra at college; a typical college "beginning algebra" covers content from middle school and a little Algebra I … "intermediate algebra" covers some from middle school, most of Algebra I, and a little bit of Algebra II. Therefore, these documents should be on our MUST READ list.

The Mathematical Association of America has not produced any standards documents. However, the MAA has a Committee on Undergraduate Programs in Mathematics (web site http://www.maa.org/cupm/) and a "Curriculum Renewal Project Across the First Two Years" (CRAFTY) … web site http://www.maa.org/cupm/crafty/. In addition, see the book in the references by Hastings; this new book is one of the better resources for college mathematics teachers. For those with an interest in connections to science, see the reference by Steen. Biology has become very mathematical, even though many biology courses at the introductory level remain qualitative – either the faculty involved don't keep up, or they are trying to avoid putting a math prerequisite on their biology courses.

CRITICISMS OF STANDARDS

The original NCTM standards resulted in some polarization, both within the mathematics community and among the public … which generated the phrase "Math Wars". There are numerous people and groups actively involved in fighting this perceived 'war'; see the Mathematically Correct web site for an example http://www.mathematicallycorrect.com/ .

To help move beyond the confrontational situation, there are also groups working to achieve "peace". Daro (online) provides a "Peace Treaty", which documents a commitment to work collaboratively … even when participants hold strong and opposing views. Of course, this talk about a 'war' is inflammatory in the first place – and seems silly when people around the world confront very violent wars. In addition, if people would focus on the more recent Standards (NCTM, 2000) there would be less of a tendency for confrontation.

In some cases, the problems are being caused by university-level K-12 academicians. It seems that their philosophical preferences become more important than dealing with teacher issues or "what works to help students learn mathematics". See the references by Oakley (online, pg 10) and Carnine (online).

Woodrow presents some general criticisms of the Standards. One critique is that the current effectiveness movement is very narrow in focus, and does not consider wider societal issues; that the 'critical mathematics education' movement has much to offer, as it looks at the general role of mathematics in

society. (See Woodrow, pg19-20). A second point Woodrow makes is about the teachers themselves; from Woodrow pg 11:

> *"The constant context of assessment and critical comparisons engenders a protective relationship with the activity [of teaching]. The act of teaching becomes that of a highly-skilled artisan, delivering the goods designed and owned by someone else. It discourages risk-taking and de-professionalizes the activity."*

In other words, the teachers' decisions tend to do only with "how" (art?) … leaving out all other concerns that professionally are relevant.

A more specific criticism deals with the basic concepts of mathematics education, especially at the college level. The classical view of mathematics (since the 17th century) is that we are dealing with continuous objects and "points as zero diameter disks". Most areas of development in mathematics are in discrete models – where points are members of a set with certain properties. However, the classic view (placing calculus at the top of the pyramid) is still paramount in our profession; discrete mathematics is gaining, but it still is not represented as being as important as it should be (Lakoff and Nunez, pg 278). In the case of developmental mathematics, we could at least update our definitions of "continuous" and "function" to account for their uses in discrete mathematics.

REFORM CURRICULA EVALUATION

The literature generally refers to "curriculum based on implementing standards" as a "reform curriculum", even though there may not be any "reforming" involved. (Example: A college has been keeping up-to-date with current issues and needs, so there curriculum is not being reformed – it might be a 'standardization'.) Some authors prefer the term "standards-based", which primarily refers to school programs based on the NCTM standards – though there is much confusion about WHICH standards (1989 or 2000).

This table summarizes the general outline of 5 high-school curricula often classified as "standards-based"; see the Senk & Thompson reference:

	Core Plus (CP)	**MATH Connections (MC)**	**Interactive Mathematics Program (IMP)**	**Systemic Initiative Montana Math & Science "Integrated Mathematics" (SIMMS)**	**University of Chicago School Mathematics Project (UCSMP)**
Year 1	Linear & Exponential Models; Patterns of Change	Data, numbers, patterns (linear regression, functions, probability)	Linear Models, data analysis, geometry	3-d geo; linear equations & models; exponential equations; variation; probability	Algebra: Linear, Exponential, & quadratic growth; transformations; slope; transformations

Year 2	Finite Math	Shapes in Space (Geometry, 3-D geo, trig)	Statistics, 3-D Geo, exponents	matrix operations; rt tri trig; statistics; 3-d geo; finite; exponential laws & models;	Geometry: Transformations; measurement formulas; 3-d figures; proof (van Hiele model)
Year 3	Multi-Variables, symbolic sense, families of functions	Mathematical Models (algebraic and exponential functions)	Quadratics, circles, systems, rates of change	discrete mth; trig; probability; systems; linear power quadratic functions; conic sections	Advanced Algebra: Functions, with related equations and inequalities; linear, quadratic, exponential; log & trig functions
Year 4	Rates of change, logarithmic funct., [Pre-Calc] or [More Finite Math]	no year 4	Trig, transformations, functions	rational functions; trig functions; graph theory; parametric equations; vectors; matrices; linear regression	FST: descriptive stat; inferential stat; polynomial, exponential, log, trig functions; circ trig
Other				SIMMS IM also has courses for years 3 and 4 that are 'math/science' intensive	Transition Math: applied arithmetic; prealgebra; elementary geometry
Source	Schoen and Hirsch (pg 313) in Senk & Thompson	Cichon and Ellis (pg 347) in Senk & Thompson	Webb (pg 377-378) in Senk & Thompson	Lott, et al (pg 400-402) in Senk & Thompson;	Senk (pg 427-429) in Senk & Thompson

SIMMS information also available online at
http://www.montana.edu/~wwwsimms/descript.html

Except for the UCSMP curriculum, these all tend to focus on “situated learning”; see the separate report on that issue.

Schoenfeld makes this summative statement (online, pg 5):

> *When Standards-based curriculum are implemented in consistent ways (curriculum, assessment and professional development are aligned), the "performance gap" between whites and underrepresented minorities can be narrowed.*

However, Senk & Thompson conclude (based on the evaluation studies summarized in their book) that there is little evidence that these curricula have an impact on equity and access (see their chapter).

Each of these curricula is addressed in a separate chapter in Senk & Thompson, with many detailed results provided. Of these curricula, UCSMP is the most researched; the results are generally slightly positive for the program. SIMSS and IMP have the weakest research base, with little positive reported. The other two programs have significant research, with evidence that they do maintain comparable levels of procedural skills and may add some ability to apply knowledge in problem solving.

Confrey & Stohl, in their book, also look at research on standards-based curricula. Citing a study by Adams et al (conducted for NSF), the reviewers state (specifically about Connected Math and Mathematics In Context) on page 78:

"Our central criticism of Mathematics in Context curriculum concerns its failure to meet elements of the 2000 NCTM number strands. Because MiC is so fixated on conceptual underpinnings, computational methods and efficacy are slighted. ... Students would come out of the curriculum very calculator-dependent."

The problem here may be that the curricula are still based on the 1989 standards; the 2000 NCTM standards do describe a more complicated spectrum of objectives – including computational and procedural. I suspect that many college curricula would be vulnerable to the same criticism.
[The Mathematics In Context curriculum did not extend through high school; therefore, it was not included in the table above.]

Overall, however, the largest problem with 'reform' is not these curricula – it's support for teacher professional development. Schorr et al, after studying the implementation of standards in one state, concluded that teachers do implement content standards … but do not usually change their instructional practices (pg 397-398). Some teachers might resist changes in their practices; however, most do not have the support (in time and money) to examine other practices and ideas.

References:

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Schoenfeld, Alan	Making Mathematics Work for All Children: Issues of Standards,Testing, and Equity	2002	Available online; see link below

URL: http://www.aera.net/uploadedFiles/Journals_and_Publications/Journals/Educational_Researcher/3101/3101_Schoenfeld.pdf

MARS team	Toolkit for Change (mathematics reform)	2006	Available online at http://www.toolkitforchange.org/index.php as of December 14, 2006
Illinois Loop	Understanding the Battles Over Math	2006	Available online at http://www.illinoisloop.org/math.html
Star, Jon; Hoffmann, Amanda	Assessing the Impact of Standards-based Curricula: Investigating Students' Epistemological Conceptions of Mathematics	2005	Available online at http://www.msu.edu/~jonstar/papers/TME05.pd
Star, Jon; Smith, Jack; Hoffmann, Amanda	Students' perceptions of difference between traditional and Standards-based mathematics curricula	2004	Available online at http://www.msu.edu/~jonstar/papers/MTPNCTM04.pd
West Point	Required Mathematical Skills for Entering Cadets	2000	Available online; see link below

URL: http://www.dean.usma.edu/departments/math/about/prospects/fund_skills.htm