Standards-based Improvement

Summary

All comprehensive strategies for standards-based improvement share a number of key elements. They are set out here, with links to various more specific strategic approaches that are built on these principles: *Building system capacity*; *Curriculum-led improvement*; *Assessment-led improvement; and Give professional development more impact*. The main essential elements are:

- **Informed mathematics leadership supported by the Superintendent's office.** Active support from the superintendent and the school board is essential before implementation – acquiescence is not enough to sustain the necessary long-term effort – along with *building system capacity* for reform.
- **Standards-based curriculum materials** that support teachers and students in the classroom in reaching the broader range of targets of mathematical understanding and performance of *standards-based mathematics curricula*.
- **Continuing professional development support for teachers**, covering both mathematics and pedagogy. This helps them to handle the additional demands of an improved curriculum.
- **Assessment that is aligned with the goals of the curriculum.** Students, teachers and parents need feedback on performance that covers the broader goals of the new curriculum. This needs to include both summative *standards-based assessment* tests and formative *assessment for learning*, some of which is provided in the curricula.
- **Communication with the Community.** This needs early attention to ensure that parents, and the community at large, understand how the new curriculum will address their hopes and fears, and the reasons for going beyond "what we learned at school".

These elements, within a coherent framework where you *plan long and short term*, lead to continuing improvement of the mathematics education and performance outcomes of students. Commitment by the system, careful preparation, and substantial support for teachers are all needed to make any such strategy work well. As with any change initiative, managing setbacks effectively is important – methods are suggested.

Challenges addressed

We have a mandate to implement a standards-based curriculum,

We have a mandate to align tests with standards,

How do we get to an evidence-based curriculum?

Background

This Toolkit is designed for those who are planning, or are already engaged in, standards-based improvement programs. They will already be familiar with the limitations of traditional curricula in equipping students for the broader and deeper mathematical demands of future life and work. The NCTM's *Principles and Standards for School Mathematics* set out what is essential for meeting the need of all students for greater mathematical power. Tools are now available to support school systems that wish to tackle the challenges of implementing a standards-based improvement program. This strategy,

with the associated more specific ones, reflects experience of what is needed to make these goals a reality.

Mathematics leadership

Any substantial planned change depends on establishing an infrastructure, including notably:

- **people** who understand in some depth the school system and the planned changes – successful implementation will require such people at every level, from superintendent through professional leadership to core groups of principals and classroom teachers;
- **a communication network** among these people through which they work together on common challenges, bringing in outside expertise where appropriate;
- **structures** that support alignment of curriculum, assessment and professional development so that adequate professional development and assessment resources are available to the implementation leadership.

Capacity will build as the change proceeds but *a substantial core is needed before the main work begins*. *Building system capacity* outlines a variety of opportunities and how they may be used effectively. Crucially, the funding of this core by the system should represent recognition that innovation activities are a specific area in the system's work, with a specific budget. (A common system reaction when money gets tighter, as it always will from time to time, is to cut improvement support – "getting all the best teachers back in the classroom where they can do most good", etc.; a specific well-publicized improvement budget, introduced in easier times, helps to reduce the risk of substantial cuts by making them politically obvious. Without integrated *long and short term planning*, progress is unlikely.)

Curriculum materials

Standards-based mathematics curricula are key tools for any standards-based reform strategy. These materials are realizations of the *Principles and Standards for School Mathematics* (PSSM), developed by the National Council of Teachers of Mathematics in consultation with, among many others, the thirteen leading societies of US mathematicians, pure and applied. These reflect international standards and the current state of research on the teaching and learning of mathematics.

The curriculum materials were designed and systematically developed to enable typical teachers with appropriate support to give their students the broader range of mathematics that they now need. They embody the variety of classroom learning activities needed to develop mathematical power.

For each grade range (elementary, middle and high school) there are now several alternative published curricula for systems to evaluate and choose from. Each has its own style and emphasis within the framework defined by the Standards. *Standards-based mathematics curricula* outlines the principal characteristics and lists the main published curricula currently available, with links to more detailed descriptions of each curriculum and its source.

Curriculum-led improvement describes in more detail an approach built around adopting a new standards-based curriculum.

Teaching and professional development

Standards-based curricula require of teachers a broader range, of pedagogy and of mathematical power, than do traditional curricula. Professional development needs to

- acquaint people with the different approach to curriculum embodied by the adopted program, and the reasons for it;
- help teachers see and acquire the broader range of teaching strategies and skills involved;
- bring everybody along, including the initially unconvinced or opposed, by providing published *evidence on effectiveness of curricula*, supported by feedback from teachers who are using the curriculum, illustrated with their students' work.
- teach mathematics; apart from the adoption of a new curriculum, teachers should learn more mathematics during their whole career. Students benefit from the teachers' deeper understanding of the mathematics they teach. *Developing content knowledge through professional development grounded in the practice of teaching* of teachers' identifies some helpful tools.

All this is not accomplished in an introductory workshop or two; it needs a coherent ongoing professional development program. Each of the published standards-based curricula for mathematics offers some support for professional development; this needs to be built on by the system in its own continuing program.

What are the new challenges of the standards-based curricula, in pedagogy and in mathematical understanding, and how do they affect students and teachers? To learn and use mathematics effectively, students need both to *add tools to their 'mathematical toolkit'*, and to *learn how to select and use tools that are appropriate for problems that arise* – whether in mathematics, further study, life or work.

Traditional mathematics curricula rely largely on learning only what can be learned imitatively. Typically:

- the teacher and/or the textbook introduce a new topic, *explaining* procedures fully but concepts briefly, if at all;
- an *example* or two is demonstrated;
- students are then asked to work *exercises* like the example, until they can remember how to do it (at the end of the unit – many soon forget);
- the teacher checks on student progress and helps those students with difficulties by repeating the explanation and/or working another example with them.

This imitative 'Triple E' approach (*explanation–examples–exercises*) is relatively *straightforward to teach*. It is *teacher-centered* in that it is built entirely around the way the teacher thinks through the mathematics. However, it has *serious limitations in helping students to learn* – notably it fails to develop:

- **Long term learning.** While most students can learn procedures by imitation, many soon forget them (hence all the time spent in traditional curricula on review). Learning for the long term depends on deeper conceptual understanding of the mathematics that underlies the procedures, which is not developed by the 'Triple E' approach.
- **Flexible problem solving and reasoning.** Each mathematics topic only becomes useful when you, yourself, can link it to other parts of mathematics and to practical situations where it can be used. This requires one to think flexibly through how one might tackle the new problem, select an approach, and carry it through. This often involves substantial 'chains' of reasoning, well beyond few step procedures.

- **Communicating** your conclusions and the reasoning behind them is an essential part of using mathematics in life and work.

Standards-based curricula have this broader agenda. However, employing such a curriculum places demands on teachers that are new to many. It requires the teacher to establish a classroom where *students accept more responsibility* for their own work, learning to work out what needs to be done to tackle and solve non-routine problems, checking themselves whether their answers seem correct and sensible in the context of the problem, and explaining their conclusions and reasoning to others. Since, for any substantial problem, there are often several different ways of reasoning, this requires a:

- **student-centered classroom** where the teacher is expected to listen to and understand students' lines of reasoning, providing appropriate guidance where needed without taking over by imposing a particular approach – this in turn demands
- **deeper understanding of the mathematics** involved, so as to follow the student's thinking, which is often not-too-clearly explained, and a
- **broader range of teaching strategies and tactics**, including for example: Use professional development to target students' understanding through mathematical discourse in a non-directive way so that the teacher is not the primary source of correct answers; learning to guide work on non-routine problems without simplifying the task (for example, breaking it up into smaller subtasks, or just showing the student how to do it), ensuring that students start to extend problems, and devise new ones, as well as solving those given.

Professional development. Most teachers will rise to meet these demands *provided* there is appropriate support for the professional development involved. They and their students will likely enjoy this much more stimulating pattern of learning. The authors and publishers of each standards-based curriculum recognize the need for professional development and provide substantial support for school systems that seek to provide it. The support that teachers need ranges from initial workshops to introduce the materials through support for continuing professional development by the system leadership, to support for new teachers entering the system. Communication between teachers is important; it makes sharing experience and challenges easy.

The curriculum itself is, of course, a key professional development tool but, on its own, far from enough. Written materials cannot convey the changes in the nature of the teacher-student and student-student interactions that are involved; video can make a significant contribution here. However, there is no substitute for a sequence of workshops in which new classroom experiences and student work can be shared, backed up by effective networking, both electronic and face-to-face.

Professional development planning suggests that a sensible minimum is:

- 1-week summer institute each year to introduce the new curriculum units to all teachers who will be teaching them
- a 'listserv club' for all involved, serviced by system professional leadership
- monthly inter-school meetings throughout the year, backed up by
- weekly meetings of the teachers involved within each school.

The meetings need to be well-structured around specific issues in teaching the units involved, with occasional reflective overview sessions. More than one teacher from each school needs to be involved – for mutual support.

Give professional development more impact describes how a well-developed professional development program can lead to progress system-wide.

Communications with the community

If the first thing that parents see of the new curriculum is the work their kids bring home, many will be concerned. "This is not the math we learned at school" is a normal and reasonable reaction. Most curricula include a skills component that will look more familiar to parents. It is essential that much of the homework is associated with this aspect, particularly at the beginning,, to provide parents with a sense of security.

It is wise to begin early on the slow process of educating parents, and the community at large, about the essence of what the changes are, and why they are positive and important.

This is not a matter of formal announcements but of communication – in some depth for those that want it. Well-structured parents' meetings are important in reassuring those most concerned – the publishers should offer materials to use for these sessions.

Handouts, the local press and other familiar channels of communication can also be used. The press is most interested in two things: eyewitness accounts of colorful stories and data about student achievement (see assessment, below), local and national. *Evidence on effectiveness of curricula* can be useful for this.

In the event your program becomes a target of attacks, *math wars* outlines strategies for managing the situation.

Carefully selected tasks from the curriculum have an important role in all such communications. They provide compact and vivid illustrations of the new goals. Parents should find them both interesting and challenging, answering worries about 'dumbing down'. Samples of good student work are then particularly effective, often transforming initial concern into "I wish I'd had this when I was at school".

The roles of assessment

Because of its direct impact on teachers and students, assessment plays a number of key roles in any effective strategy. Good assessment tasks, with their rubrics:

- epitomize in compact form the performance goals of the curriculum and of the standards;
- provide a tool for assessing progress against benchmarks chosen by the system for individual students, for classrooms, and for the program as a whole.

For all these purposes, the *assessment must be aligned with the standards on which the curriculum is based* – *standards-based assessment* has been developed in parallel with the NSF-funded curricula for these purposes, complementing the assessment built into each curriculum unit.

It is common for those active in reform to regard assessment as secondary (if not undesirable: "It is the learning that matters, not measuring it.") This is a serious mistake. Assessment has *three* major roles:

- **A: to 'measure' performance** – i.e., *"to enable students to show what they know, understand and can do"*

  But, also, with high-stakes assessment that impacts students' and teachers' lives, ***inevitably***
- **B: to exemplify the performance goals** – assessment tasks and rubrics communicate vividly what is valued to teachers, students and their parents, and thus
- **C: to drive classroom learning activities**[1] – in most classrooms the balance of learning activities will mirror that in the high-stakes tests on which students, teachers and schools will be judged.

[1] WYTIWYG: *What You Test Is What You Get*

These roles carry responsibilities; most high-stakes tests focus on A, and then only measure a small part of the range of performances we are interested in. If that is the only assessment that the system takes seriously, many teachers will focus their efforts on this restricted area. Further, they will resent, or ignore, a curriculum that 'wastes time' on other things.

Balanced Assessment accepts these responsibilities, which imply that assessment should be designed to have two properties:

- **Curriculum balance**, such that the teacher who "teaches to the test", as most will, is led to provide a rich and balanced curriculum covering *all* the learning and performance goals that state, national and/or international standards embody.
- **Learning value** – because such high-quality assessment takes time, the assessment tasks should be worthwhile learning experiences in themselves.

Assessment with these as prime design goals will support rather than, as so often, undermine high-quality learning. This is well recognized in some school systems (and in other countries), where assessment is used to actively encourage improvement. Summative *standards-based assessment* is now available in the form of tests from major publishers.

It needs to be complemented by formative assessment that provides feedback to students and their teacher on the progress they are making and their continuing difficulties (e.g., *use performance tasks for classroom instruction and assessment*) . The standards based curriculum materials have embedded assessment of this kind and other resources are available.

To summarize, because of A, B and particularly C above, it is important for the success of any strategy that the accountability system moves to include tests that offer balanced standards-based assessment, covering the broader range of performance goals of the new curriculum. Otherwise, teachers will face conflicting pressures – *encouraged* to teach a broad curriculum but *judged* only on much narrower measures. Broad and balanced tests can be introduced at an early stage with 'low stakes' attached, moving over a few years to become a major part of the accountability system.

Assessment-led improvement, an approach that begins the improvement process by improving assessment, has the advantages of gradual change with modest initial cost.

Making the case

Adopting and implementing a serious standards-based improvement program, ultimately including a new standards-based curriculum, is a major step for any school system. For many systems, it involves a substantial culture shift in their view of mathematics, and how to learn and teach it. Active support from the superintendent and the school board is essential before implementation – acquiescence is not enough to sustain the necessary long-term effort.

Gaining agreement from decision makers will depend on making a strong case. *Making the case* describes some ways to tackle this challenge. Here we list the main elements in the specific case for standards-based improvement. They include evidence on:

- **current system performance,** and the shortcomings shown by benchmarking performance against that in similar districts;
- **student scores** on standardized tests will improve significantly over a few years;
- **students' ability to use mathematics** to solve both mathematical and practical problems will greatly improve (not surprising, since traditional curricula hardly address these important goals);

- **student attitudes** to, and motivation for mathematics will improve, particularly for students who are currently low achievers (this "narrowing the performance gap" is an important equity issue).

Evidence on effectiveness of curricula summarizes the research evidence that shows the greater effectiveness of standards-based curricula, with references to the original studies. It shows gains in student performance on traditional tests (and massive gains on broader, more balanced tests of mathematics), built on improved understanding and motivation.

Carefully selected outside experts can help make the case – professional and research leaders, mathematicians, teachers and administrators who know these curricula can all play useful roles.

It is also important to emphasize the benefits for specific constituencies that will be crucial for the success of the program, for example:

- **teachers**, provided they are given appropriate support, will enjoy the professional development and the greater strength they gain from moving to standards-based teaching. Though there will be initial resistance from some, teachers come to appreciate how much better their students are learning mathematics. (Once change is achieved, teachers rarely revert to the narrower range of traditional teaching and learning.);
- **principals** will appreciate how the new program energizes the staff, and the spin-off benefits for other subjects from students' improved understanding of mathematics (e.g., of algebra in science, of statistics in social studies and science, of number in many subjects.);
- **parents and the community**, provided they are properly introduced to the curriculum and their concerns addressed, will appreciate mathematics that has more obvious connections with the rest of the world than "what we had at school";
- **academic mathematicians, engineers and physicists** and other professional users of mathematics are a subgroup that needs specific attention – with good communications they can be of help to the implementation (particularly in helping to counter a few individuals who, though discontented with the status quo and despite the evidence, feel strongly opposed to standards-based reform – see *Math Wars*).

A positive attitude from all key constituencies is important for long-term success.

Making the case does not end with the decision to adopt new curriculum and assessment; it continues to be an important, though decreasing, part of communication with the community.

Managing setbacks

All initiatives have setbacks; predicting them and handling them to minimize their impact is key in sustaining the improvement program. The following are some common problems, and strategies and tools that can be effective in handling them:

- **Teachers don't teach the curriculum.** "The textbook determines what *might* be taught" is, alas, only too true. Initially many teachers will look through the published lesson, identify the topic, think "I know how I teach that" and do what they always have done. That is *not* implementing the new curriculum, in which an essential element is a different pattern of learning activities from the traditional. Professional development based on specific curriculum units should overcome this, provided the problem is recognized and made an explicit focus. Feedback is important in all learning – students' work, video and/or observation from each

classroom can contribute. A good preventive measure is prior professional development that works through the first unit or two in detail.

- **Cuts in professional development support.** The level of professional development support needed for this approach is substantial. Even when it is funded initially, cuts are often imposed for a variety of reasons: financial stringency; a belief that teachers are only working when they are teaching; skilled people leaving, particularly when the program is seen by nearby school systems as successful. System commitment to a rolling five-year plan can limit the scale of this problem. In the worst case, when funds *must* be cut, revise the implementation schedule to make clear to system leadership and parents the delays this will cause. The revision should reflect scheduled restoration of funds in future years.
- **Backlash from parents or outside opponents.** Good communications, before and during the introduction of the new curriculum, should minimize the number of concerned parents, and ensure that there are plenty that offer strong support. However, there is also a politically well-organized national alliance that opposes the introduction of standards-based mathematics. *Math Wars* describes this challenge and how to counter it. Of course, it is always important to listen to the concerns of parents and others within the system, and make improvements where it makes sense.
- **New superintendent and/or school board.** Perhaps the most serious problems in establishing any coherent program of improvement in mathematics education are its role as a local political issue, and the short tenure of superintendents (below two years in large urban school districts). School boards live by short time scales – looking for visible success before the next election. Candidates for superintendent have to present new visions that offer quick cures for long standing problems. Plan *Long and short term* offers ways to reconcile this conflict of time scales between these short term pressures and the decade time scale of general improvement.

Careful preparation in the introduction of the program reduces the chance of these setbacks happening, and the damage they cause. However, unexpected blows from federal, state or local sources are a regular experience in any school system; defining and maintaining a long-term plan is the key to sustaining improvement through this buffeting.

Where next?

In a system that has established standards-based curriculum and assessment, with a culture of continuing professional development, everyone has reason to be pleased with progress. However, that is not the end of improvement. Ways to develop further include:

- **Further curriculum enrichment.** In order to be accessible to most systems, published curricula have to play safe in the demands they make on teachers, many of whom will have only worked with traditional curricula. After several years of teaching and professional development on a standards-based curriculum, many teachers will be ready for further progress. This will be involve: students sustaining longer and deeper investigations with less guidance, much of it given by the teacher through further questions; students building a portfolio of solutions to extended problems that fit their own interests, both within mathematics and in its application to problems from the world outside; students learning mathematics outside the main core of the curriculum to increase their power over such problems. There are many sources of materials for advanced learning that support this kind of curriculum enrichment.

- **Students at both ends of the performance spectrum** merit special attention – not easy to find much time for in a typical classroom. Lack of long-term learning is a particular problem for many students, but particularly for those with learning difficulties. *Systematic catch-up* is the challenge with students who are behind. What to do with my gifted students is a very different but important challenge – it is more easily ignored when passing tests is the focus and the whole class is demanding support. There are strategies for tackling both these areas of challenge.

Specific improvement strategies

The following implementation strategies are built on the principles outlined here:

- *Building system capacity*
- *Curriculum-led improvement*
- *Assessment-led improvement*
- *Give professional development more impact*

The tools and their roles:

The following are the main tools that are available to support this strategy. Others, including planning tools, can be found through links above.

Standards-based mathematics curricula outlines their principal characteristics and lists the main published curricula currently available, with links to more detailed descriptions of each curriculum. These curricula, often developed with funding from the National Science Foundation, offer comprehensive sets of materials for a specific grade range, along with associated support for professional development.

Standards-based assessment provides parallel information on the main published standards-based tests.

Evidence on effectiveness of curricula is a download document that summarizes the current research on the effectiveness of these curricula, absolutely and in comparison with traditional curricula.

Other Considerations

Planning essentials It is important to *Plan long and short term*, with active commitment, personal and financial, from the school system management structure, and adequate personnel to support the professional development needed – together with a plan for *building system capacity* before and after implementation begins.

Budget issues: These include the year-by-year costs of assessment materials, professional development, and curriculum materials during implementation, and of effective communication with the community on the nature, goals, effectiveness and progress of the program. A curriculum change planning tool will enable you to make sensible estimates of the likely costs.

Benefits

Gains in student performance on traditional tests (and massive gains on more balanced tests of mathematics). Improved understanding of mathematics, by students and teachers. Improved student motivation. Growing teacher professionalism.

Implementation pitfalls

Change of superintendent and/or school board leads to program abandonment mid-way. Professional development support does not meet the needs year-by-year. *Teachers don't teach the curriculum*. *Math Wars* backlash from parents or outside opponents.

Evaluative evidence

Evidence on effectiveness of curricula shows some gains in student performance on traditional tests (and massive gains on more balanced tests of mathematics), built on improved understanding and motivation.

Evidence on the influence of assessment on teachers' classroom practice shows the value of well-aligned *standards-based assessment* in forwarding improvement

There is case study evidence in the accounts of those who have taken this approach, with local variations, to systemic improvement. See 'Stories'.

Development status

Draft in development by the Toolkit team in consultation with many of those involved in standards-based improvement programs.

Comments please to **team@toolkitforchange.org**

'Stories'

We are seeking further accounts of experience in implementing strategies like this

If you might be able to help, please email **team@toolkitforchange.org**

Complementary strategies: *Building system capacity*, *Assessment-led improvement*, *Curriculum-led improvement*

Other comments:

Keywords: standards-based, school improvement, reform, alignment, curriculum, assessment, professional development, leadership, accountability

Links referenced in sLA_stdsbsdimp.doc

Do these need to be put in the website entry?

Those deleted don't seem to exist yet, and have been removed from the text

Page(s)	**Tools**
2, 5, 6, 10W	*Evidence on effectiveness of curricula*
5, 6,	*Standards-based assessment*
	Balanced Assessment in Mathematics: the tests
	Balanced Assessment for the Mathematics Curriculum: classroom packages
	New Standards Reference Examination
	Balanced Assessment: the professional development series
	Balanced Assessment: classroom packages
1, 2,	*Standards-based mathematics curricula*
	Connected Mathematics
	MathScape
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1, 2, 10W, 11W	*Building system capacity*
1, 2, 11W	*Curriculum-led improvement*
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	Professional development for and through performance assessment
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1, 2, 8, 10W	*Plan long and short term*
4,	*Engaging students in mathematical discussions*
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8,	*Catching up*
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1, 10W	*Our curriculum is not serving all kids*
1, 10W	*Can we make school math seem relevant?*
1, 10W	*Nothing seems to work for long*
1, 10W	*Hard won test gains soon stop*
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1, (%% I don't see a fit w/ this doc) 10WE	*We want to use technology in teaching and learning*
8,	*Lack of long term learning*
10W,	*Teachers don't teach the curriculum*