Systematic catch-up for Middle School students

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Summary

Middle school students should be building on their understanding and proficiency with arithmetic and problem solving on their way to algebra. To reach levels of mathematics that open the door to college, they must be prepared to succeed in advanced high school courses. But many students enter middle school too far behind to reach these levels unless something is done. Middle school is the best chance to recover for these students.

Students who are behind cannot catch up merely by accelerating up to the pace of their peers who are on target. They must learn even faster or learn less. To learn faster, they will have to spend more hours per week learning mathematics or learn more efficiently than their peers, or both. Moving faster won't help unless the process of falling behind is stopped.

Because students will need different levels of intervention at different times, and because intervention can be expensive, especially if districts rely solely on the most intense types, a systematic layering of strategies is needed. The first layers serve the most students, least expensively. Each succeeding layer costs a little more per student and serves fewer students. The layers of intervention discussed are:

- Enhancing regular classroom instruction – the base level
- Classroom lesson planning for concentrated teaching of small groups
- Math clinics
- After school/community programs – homework and tutoring
- Diagnostic teaching
- Summer school "catch-up" programs
- Tutoring
- Double-period ramp-up courses
- Intensive interventions in the style of reading

with links and/or references to some useful tools.

Challenges addressed

Students who lag behind. Many students lag behind the pace needed to meet state and district standards. This achievement gap in mathematics will leave these students unprepared for grade level work as defined by the standards. Districts taking steps to upgrade their mathematics program, will also want to put in place systems to help students who are way behind.

Hard won test gains soon stop. Buildings and staff made a big effort and got a boost in test scores for two years. But after two years the scores flattened off. What went wrong and what can buildings do about it?

Our curriculum is not serving all kids. With current curriculum, some students are succeeding in achieving reasonable understanding of mathematics and, crucially for them and the school, reasonable test scores. However, some are not well served. Many students are low achievers, finding the work puzzling as well as difficult.

The strategy

Different students will need different amounts and intensity of instruction to keep up with a challenging program. Some will start behind and need help catching up. Some, routinely, will need extra attention. To manage these differences, a systematic support system is needed. This extra instruction can be costly if it is not efficient. Costs and benefits can be optimized by *layering graduated levels of service* that are delivered in a timely systematic manner.

A proportion of the students can be adequately supported through enhancing classroom instruction. Yet some will need more. A progression of increasingly intense interventions should be in place. Each level will prove support for an additional proportion of students to get "caught up".

Situation of student	**Needed to ramp up to standards level program**	**Intervention type**
Keeps up with adopted program	Regular instruction	none
Struggles with particular assignments	Extra support with regular program: feedback on assignments and concepts	Classroom discussion and small group work in classroom with attention from teacher
Not bringing enough from earlier lessons each day	Extra support with regular program: extra time as needed	Drop-in clinic before or after school or during day, homework clinic
Misconceptions and gaps disrupt participation in regular program	Instruction aimed at misconceptions: diagnostic teaching, in-depth concentration on troublesome topics	Instruction beyond regular program for weeks at a time supported by materials that help teach conceptual understanding of basics, tutoring
More than a year behind, gaps from multiple years of curriculum	Intensive ramp-up course	Double-period course, Summer school, intensive intervention program

When working properly, virtually all students can be supported with only a small number requiring the most intense and expensive interventions. The sequence is as follows:

Enhancing regular classroom instruction is the base level.
This first level of extra attention is within the ebb and flow of regular classroom instruction. Good lesson planning and organization can allow for a limited amount of individual and small group instruction tied closely to the current topic of study. The teacher's capacity to

assess and diagnose students on the fly, make instructional decisions and adjust teaching moves on the spot has a major impact on students' learning and on the effectiveness of this first level of catch-up. Professional development that addresses these pedagogical skills can improve practices to these ends.

A critical instructional component for dealing with student understanding and misconceptions is to engage students in productive mathematical discussions. Students' thinking and understanding about the mathematics at hand often becomes most visible in a carefully guided discussion. *Using professional literature to learn to facilitate mathematical discussions* describes strategies for professional study groups and other readings. *Professional development that targets understanding students' thinking through mathematical discourse* focuses on providing leaders with a set of tools to help facilitate professional development sessions that target understanding students' thinking.

Classroom lesson planning for concentrated teaching of small groups.

Classroom practices that require the teacher to attend to all activity all the time will not allow some students the needed individual attention. Individual attention from the teacher, particularly in response to a student's own work and struggles, is as hard to come by as it is crucial for the student. Within the framework of the regular classroom, teachers can deliberately plan to work with small groups of students who have similar need/misconceptions. Adding this strategy, and thus level of intervention to classroom practice, can be sufficient support for some students to keep them caught up with the mathematics for the grade level.

Classroom lesson planning that enables the teacher to spend 5 to 10 uninterrupted minutes with a small group (4 – 6) will require keeping the 25 other students productively learning. They have to work independently or in self managed peer groups during this time (evidence that peer group learning improves achievement at *www.w-w-c.org*). Many programs include suggestions for small group work that can be managed independently of constant supervision of the teacher. The students working independently will need *engaging tasks* to keep their attention. These could be, but not limited to, tasks that ask students to apply mathematical skills that they have already learned to new, unrehearsed situations.

In small groups, the teacher can concentrate on specific misconceptions and give feedback to specific students. Determining small groups and the instruction within the group will vary depending on the needs of the group. *Diagnostic teaching* methods and materials can help teachers understand how students are thinking and help students detect and correct their mistakes and misconceptions. Learning to manage the classroom to allow for concentrated attention on students who need it, individually or in small groups, may require professional development that targets analysis of students' misconceptions and next instructional moves, (see Cognitively Guided Instruction).

Some adopted programs include material to support intervention activities. The advantage of these is the fit and synchronization to the regular program. The disadvantages are uneven quality and similarity of approach to what has just failed with the students. Nonetheless, these materials from the adopted program should not be ignored but should be evaluated and used in accord with their value. Whoever organizes their use should also design appropriate staff development to help teachers implement these components of a program.

Math clinics

A mathematics teacher explained his experience with introducing homework clinics in his middle school, "Many students who we thought were a year or more behind were really just 15 minutes behind. At the end of the period, the bell rang and they were not ready to handle the homework. They come in next day without the homework and so were not ready

for class. The cycle repeats until they give up. The homework clinic gave them the 15 minutes they needed to handle the homework and be ready for the next day. Most students only need it occasionally, some need it everyday." The idea applies to keeping up with class work, not just homework.

A good model for math clinics teaches students how to learn mathematics as well as teaching mathematics through help with homework. A proven method is to tutor pairs, trios or quartets of students from the same class. Teach students how to help each other with questions and thinking out loud. Communication develops thought.

There are many models for staffing a math clinic. Staff can range from classroom teachers, retired teachers, math educated volunteers, college students with math experience, or math students from the middle or high school. If staff comes from outside the building, professional development on the program and strategies for tutoring and helping students is recommended and can go a long way.

The clinics can operate before and/or after school, during lunch and Saturday. With elementary students it works best when students are assigned to the clinic so that they and their parents know where and when the students is to be at the clinic.

Evening assistance can be delivered through homework hotlines using telephone and school supported email. Although this is primarily a secondary strategy, elementary schools might try partnering with a middle school who is using this strategy for those students (and their parents) that don't realize until they are home that they need some additional help.

After school and community programs – homework and tutoring.

After school programs can be provided by the school district and also by community groups including churches and youth organizations. These programs often include an extension to the academic school day as well as enrichment opportunities. Capturing some of this additional time and focusing it on the specific mathematical needs of students can help in the learning of more mathematics and, for some, catching up.

At least, these programs can offer help with homework. For many students such help will make the difference between success and failure in mathematics. Homework help can be augmented effectively with mentoring and social designs that develop values and habits associated with academic success. Students can aquire the social habit of encouraging and helping each other succeed academically.

In addition to programs offered by the school, *Tutoring* and *Homework clinics* can be provided by community organizations. Churches, boys and girls clubs, parent organizations and city services have all had successful and important programs. Schools can cooperate with community-based programs to increase their effectiveness and alignment with the schools' mathematics program. Cooperation might include training program leaders and helpers on the districts mathematics program.

Shelter programs for homeless students (see www.utdanacenter.org for school tools related to homeless education) can bolster homeless students chances of success.

Diagnostic teaching

The basic idea of diagnostic teaching is that a teacher engages a student (or small group of students) in mathematical work related to specific difficulties the student has exhibited. The nature of the instruction differs from "more of the same" on a topic associated with the difficulty. Indeed, a difficulty is not a topic. Mathematics instruction has had a long history of failure relying on the model that gives the student more exercises in the topics on which they score low. More thought needs to be given to causes of students' difficulties.

Misconceptions can span topics taught across several grade levels, so re-teaching a particular lesson from the regular program cannot solve the problem. For example, the place value system presents difficulties to students from addition in grade 1 to division in grade 4. A student's difficulties with division may be rooted in misconceptions about place value and its role in subtraction and multiplication as well as division. Students in this situation need instruction that goes beyond the regular program. They need instruction that focuses on understanding basic concepts across applications in several grade levels of topics.

Often enough, the student having difficulties may be over-generalizing some procedure he or she has successfully learned or applying a procedure to a situation where it does not work. Such a student does not need to reinforce memorized procedures as much as the student needs to understand the situation and the mathematical concepts that apply. The instruction that is needed, then, is to upgrade the student's mathematical conceptualization. To do this, the student, with the help of a teacher, must confront what is wrong with the student's initial way of thinking about the mathematics. And then reformulate the concept so it works across the general range of situations to which it applies.

There is a nest of common misconceptions with costly consequences in the curriculum from upper elementary through middle school. Systematic diagnostic sequences of problems with ensuing instructional sequences of problems have been developed for the most common misconceptions by the Shell Centre at the University of Nottingham. The student materials are framed in a professional development program of 2 days with 1/2-day follow up sessions. They are appropriate for middle and high school teachers and students and mathematics program leaders, and can be adapted to fit with a wide variety of programs and formats.

Summer school catch-up programs

Summer school can be a viable source of extra time needed by some students to catch up. Summer programs that focus on quality teaching, not drill and practice worksheets, can make a real difference. Curriculum and instruction that focuses on a mix of looking back and looking forward: clearing up major misconceptions that disable advancement and getting a head start on the next year's content. Instructional material for summer school might include selected units from the adopted program (some from last year, some from next). If you are considering a new program, summer might be a good time to trial some units.

Remember, it is summer and these are children. Learning is fun, but failing again and again is demoralizing. Aim for interactive classrooms where students get plenty of action and feedback on their mathematics and thinking.

Tutoring

Tutoring matches the student to the tutor in a one-on-one or one-on-two situation. Its power stems from the individual attention and immediate feedback the student receives. Many tutoring programs begin each session with the student's current homework assignment. Yet, for a student who has fallen behind, tutoring can also address specific mathematical skills that are critical to the student's understanding of the current assignment.

The demands on the tutor do NOT include classroom management, so a broader pool of people can succeed with tutoring than can with classroom teaching. College students, older students, community volunteers, and peers can be successful tutors. There is some evidence that peer tutoring can be effective. See www.w-w-c.org for research.

A program can be established where students are recruited to tutor other students and earn community service or elective credit. A mathematics teacher can support the tutors through

an 'elective course' in mathematics tutoring. Research indicates that tutors learn even more than tutees. Peer programs can also enhance the social support for academic effort in the school.

Whoever they are, tutors must know the subject matter and have the ability to work with students. Tutoring can be even more effective for a broader range of students when tutors have the capacity to listen and watch for the thinking of the student. Good materials can support tutors. Such programs can be informally arranged by parents, be part of a school organized *homework clinic*, an after school program, or part of *community support programs*. Americorps supports tutoring programs in many areas, see http://www.nationalservice.org/areads/math. The AVID program has, among other things, well designed tools for setting up tutoring programs, see http://www.avidonline.org

Double Period Ramp-up Course

More time each day in a course that takes students more than a year behind and ramps them up to courses leading to college eligibility. Such a course should focus forward toward algebra while rehabilitating misconceptions and bad habits from the elementary curriculum. This can be accomplished by taking an algebraic approach to difficult topics in arithmetic. For example, use letters and numerical expressions in statements with the = sign, rather than repeated practice with algorithms that have no = sign. The use of simple equations to model problem situations will prepare students better than memorizing procedures for each specific type of problem. The situations should call for use of mathematics known to be confusing to students who are behind. Avoid courses that face backward and attempt to help these students through remedial repetition of what failed for them in the first place.

Use algebra to strengthen arithmetic. Don't use arithmetic to track these students to nowhere. A ramp-up course aims up to the course sequence that leads to college. It's content is built down from high school toward the irregular preparation of lagging students. It is not built up from the immature mathematics of elementary school.

The double period allows more time for students to work under the eye of a teacher who can give feedback. Part of the time can be supervised homework, but some homework should be given to establish the habit.

Intensive interventions

Just as in reading, some small numbers of students have deficiencies in the development of fundamental mathematical proficiencies that require intensive intervention. Unlike reading, struggles with mathematics must resolve understanding specific conceptual topics in mathematics as well as more general proficiencies. This would include proficiencies like place value, fractions, the basic syntax of simple equations. Such interventions can be 1/2 hour sessions over a 3 or 4 week period for a specific topic. The mathematics should be conceptually coherent and target underlying misconceptions. Typically, the mathematics comes from multiple grade levels, so the material from any one course will not be adequate.

Students who need interventions often need help keeping their focus on the mathematics, persisting when solving a problem, and keeping track of where they are in a process. These kinds of learning issues require intensive feedback from someone with the patience of a professional and the mathematical and pedagogical knowledge to diagnose and address students' difficulties and learning problems. *Diagnostic teaching* could be adapted for this use beginning in the upper elementary grades.

The What Works Clearinghouse web site, *www.w-w-c.org*, reports few research studies of high quality methodology on mathematics interventions. Their web site is a potentially good source of what the research says on any topic, even if it says little so far.

Evaluative evidence

Many of the tools that these interventions employ have research-based evaluations.

Strengths

An ounce of prevention is worth a pound of cure. It is cost-effective to respond in a timely way to the need for extra help. By layering the back-up systems, students can get just what they need when they need it. This will reduce the need for large-scale expensive interventions.

Likely challenges

Marshalling resources and organizing staff and programs will present the usual challenges.

Tools

Using professional literature to learn to facilitate mathematical discussions describes strategies for professional study groups and other readings, and the associated tools.

Encouraging mathematical thinking: discourse around a rich problem.

Diagnostic teaching strategies have well-engineered materials for teaching and professional development, focused on *Learning from mistakes and misconceptions*.

Cognitively Guided Instruction, a program that develops teachers and students ability to understand their thinking about mathematics and make their thinking more mathematical.

Math clinics have a useful role to play, as do

Community programs.

References

The following web sites have good explanations of mathematical concepts, illustrations and some interactive tools for teachers and students. Most are aimed at teachers, but could also be used by teacher or tutor side-by-side with small groups of students.

www.mathforum.org/dr.math www.themathpage.com
http://matti.usu.edu/nlvm/nav/vlibrary.html
http://www.wcer.wisc.edu/MIMS/Parent_Newsletters/
http://www.mathsolutions.com/newsletter/ http://www.tenet.edu/teks/math/index.html

The "What Works" website summarizes the (usually scant) research on issues in education; see *www.w-w-c.org*

Resources for tutoring programs can be found at the Americorps website, see http://www.nationalservice.org/areads/math/

AVID is a program for developing students from poor communities into college going and succeeding students. It has a strong record of success across many states and schools. It has a well designed elective period and good tools for setting up tutoring programs. See http://www.avidonline.org