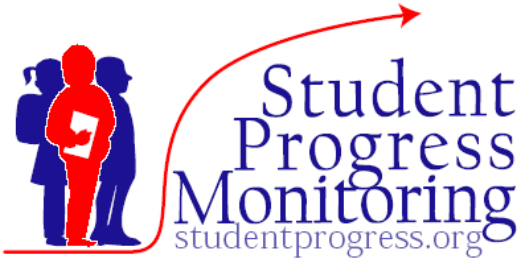

National Center on Student Progress Monitoring

What Is Scientifically-Based Research on Progress Monitoring?

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Abstract. When teachers use systematic progress monitoring to track their students progress in reading, mathematics, or spelling, they are better able to identify students in need of additional or different forms of instruction, they design stronger instructional programs, and their students achieve better. This document first describes progress monitoring procedures for which experimental evidence demonstrates these effects. Then, an overview of the research is presented.

Introduction. Progress monitoring is when teachers assess students' academic performance on a regular basis (weekly or monthly) for two purposes: to determine whether children are profiting appropriately from the typical instructional program and to build more effective programs for the children who benefit inadequately from typical instruction.

This document describes research on progress monitoring in the areas of reading, spelling, and mathematics at grades 1-6. Experimental research, which documents how teachers can use progress monitoring to enhance student progress, is available for one form of progress monitoring: Curriculum-Based Measurement (CBM). More than 200 empirical studies published in peer-review journals (a) provide evidence of CBM's reliability and validity for assessing the development of competence in reading, spelling, and mathematics and (b) document CBM's capacity to help teachers improve student outcomes at the elementary grades.

Most classroom assessment relies on mastery measurement. With mastery measurement, teachers test for mastery of a single skill and, after mastery is demonstrated, they assess mastery of the next skill in a sequence. So, at different times of the school year, different skills are assessed. Because the nature and difficulty of the tests keep changing with successive mastery, test scores from different times of the school cannot be compared (e.g., scores earned in September cannot be compared to scores earned in November or February or May). This makes it impossible to quantify or describe rates of progress. Furthermore, mastery measurement has unknown reliability and validity, and it fails to provide information about whether students are maintaining the previously mastered skills.

CBM avoids these problems because, instead of measuring mastery of a series of single short-term objectives, each CBM test assesses all the different skills covered in the annual curriculum. CBM samples the many skills in the annual curriculum in such a way that each weekly test is an alternate form (with different test items, but of equivalent difficulty). So, in September, a CBM mathematics test assesses all of the computation, money, graphs/charts, and problem-solving skills to be covered during the entire year. In November or February or May, the CBM test samples the annual

curriculum in exactly the same way (but with different items). Therefore, scores earned at different times during the school year can be compared to determine whether a student's competence is increasing.

CBM also differs from mastery measurement because it is standardized; that is, the progress monitoring procedures for creating tests, for administering and scoring those tests, and for summarizing and interpreting the resulting database are prescribed. By relying on standardized methods and by sampling the annual curriculum on every test, CBM produces a broad range of scores across individuals of the same age. The rank ordering of students on CBM corresponds with rank orderings on other important criteria of student competence (1). For example, students who score high (or low) on CBM are the same students who score high (or low) on the annual state tests. For these reasons, CBM demonstrates strong reliability and validity (2). At the same time, because each CBM test assesses the many skills embedded in the annual curriculum, CBM yields descriptions of students' strengths and weaknesses on each of the many skills contained in the curriculum. These skills profiles also demonstrate reliability and validity (3). The measurement tasks within CBM are as follows:

Pre-reading

Phoneme segmentation fluency: For 1 minute, the examiner says words; in response to each word, the child says the sounds that constitute the word.
Letter sound fluency: The examiner presents the student with a sheet of paper showing the 26 lower case letters displayed in random order; the student has 1 minute to say the sound identified with each letter.

Reading

Word identification fluency: The examiner presents the student with a list of words, randomly sampled (with replacement) from a list of high-frequency words; the student reads words aloud for 1 minute; the score is the number of words read correctly. (Word identification fluency is appropriate for first graders until the score reaches 40 words read correctly per minute.)
Passage reading fluency: The examiner presents the student with a passage of the difficulty expected for year-end competence; the student reads aloud for 1 minute; the score is the number of words read correctly. (Passage reading fluency is appropriate through the fourth-grade instructional level.)
Maze fluency: The examiner presents the student with a passage of the difficulty expected for year-end competence for 2.5 minutes; from this passage, every seventh word has been deleted and replaced with three possible choices; the student reads the passage while selecting the meaningful choice for every seventh word; the score is the number of correct replacements.

Mathematics

Computation: The examiner presents the student with items systematically sampling the problems covered in the annual curriculum (adding, subtracting, multiplying, dividing whole numbers, fractions, and decimals, depending on grade); the student has a fixed time (depending on grade) to write answers; the score is the number of correct digits written in answers.
Concepts and applications: The examiner presents the student with items systematically sampling the problems covered in the annual curriculum (measurement, money, charts/graphs, problem solving, numeration, number concepts); the student has a fixed time (depending on grade) to write answers; the score is the number of correct answers written.

Spelling

Each test comprises 20 words randomly sampled from the pool of words expected for mastery during the year; the examiner dictates a word while the student spells on paper; the next item is presented after the student completes his/her spelling or after 10

seconds, whichever occurs sooner; the test lasts 2 minutes; the score is the number of correct letter sequences (pairs of letters) spelled correctly.

Written Expression
In response to a story starter (i.e., a short topic sentence or phrase to begin the written piece), the student writes for a fixed amount of time (3-10 minutes). The score is the number of correct word sequences.

CBM produces two kinds of information. The overall CBM score (i.e., total score on the test) is an overall indicator of competence. The CBM skills profile describes strengths and weaknesses on the various skills assessed on each CBM test.

Teachers use the **overall CBM score** in three ways.

First, overall CBM scores are used in universal screening to identify students in need of additional or different forms of instruction. For example, CBM can be administered to all students in a class, school, or district at one point in time (e.g., October or January). Then, children in need of additional attention are identified using (a) normative standards (i.e., identifying students who score low compared to other students in the class, school, or nation) or (b) CBM benchmarks (i.e., identifying students whose scores fall below a specific cut-point that predicts future success on state tests).

The second way teachers use overall CBM scores is to monitor students' development of academic competence. That is, students are measured weekly or monthly, with each student's CBM scores graphed against time. This graph shows the student's progress toward achieving competence on the annual curriculum. If the graphed scores are going up, then the student is developing competence on the annual curriculum; if the scores are flat, then the student is failing to benefit from the instructional program. The rate of weekly improvement is quantified as slope. Research provides estimates of the amount of CBM progress (or slope) students typically make. So, a teacher can compare the slope of her/his own class to the slope of large numbers of typically developing students to determine whether his/her instructional program is generally successful or requires adjustment. Teachers can also examine the slopes of individual students to determine which children are failing to make the amount of progress other children in the class (or nation) are demonstrating and therefore require additional help.

The third way teachers use overall CBM scores is to improve instructional programs. For students who are failing to profit from the standard instructional program (as demonstrated via universal CBM screening or via inadequate CBM progress-monitoring slopes), teachers use CBM to "experiment" with different instructional components. As teachers adjust instructional programs, in an attempt to enhance academic progress for these children, the teachers continue to collect CBM data. They then compare CBM slopes for different instructional components to identify which components optimize academic growth. In this way, teachers use CBM to build effective programs for otherwise difficult-to-teach children.

Teachers use the **CBM skills profiles** to identify which skills in the annual curriculum require additional instruction and which students are experiencing problems with maintaining skills after initial mastery was demonstrated. This kind of information can be accessed via CBM because every test assesses every skill covered in the annual curriculum. So, mastery status on every skill can be described directly from each CBM test.

Overview of research. Studies included in this overview met the following criteria. First, they relied on experimental design; that is, teachers volunteered to participate

in any of the study conditions and then were randomly assigned to conditions. Second, all studies included a control group (where teachers did not use systematic progress monitoring), against which the effects of progress monitoring procedures were assessed. Third, progress monitoring procedures were implemented for at least 15 school weeks, or 4 school months. Fourth, teachers' instructional plans were analyzed to determine how planning changed as a function of progress monitoring. Fifth, students' academic achievement was measured at the beginning and end of the study on global tests to determine whether students achieved differently in the various progress monitoring conditions.

This overview is organized in three sections: (a) evidence on CBM's utility to identify students in need of additional or different forms of instruction, (b) evidence on the usefulness of CBM's graphed analysis of the overall score to help teachers improve their instructional programs and effect better student achievement, and (c) evidence on the added value of CBM's skills profiles for designing superior instructional programs that produce greater learning.

Results of these studies are described in terms of statistical significance and effect sizes. Statistical significance means that one treatment group performed so much better than another group that it is highly unlikely that the results could be attributed to chance. This speaks to the reliability of the findings: If a similar study were conducted again, we would expect to find similar results, and if a teacher were to implement the treatment, we would expect similar effects for her/his students. It is possible, however, to have a statistically significant effect, which is accurate and reliable, but is small.

To address the question about whether a treatment effect is big or small, we look at effect sizes. Effect sizes tell us how many standard deviations one treatment group performed better than another. If the mean of a test is 100 and its standard deviation is 15 (like an IQ test), then an effect size of 1 standard deviation would mean, for example, that the treatment group ended the study with a score of 100 while the control group ended with a score of 85. Generally, in educational research, an effect size of .30 is considered small, .50 is considered moderate, and .70 is considered large.

Identifying students in need of additional or different forms of instruction. Research shows that CBM can be used to prompt teacher concern about student progress and to signal the need for additional or different forms of instruction. For example, in a recent study (4), 24 second-grade teachers were randomly assigned to control or CBM progress monitoring groups. Progress monitoring teachers, with the assistance of computers, collected CBM oral reading fluency data with every student in their classes. The computer organized the CBM information into individual student graphs as well as class reports. These reports showed CBM class graphs; noted students who fell in the lowest quartile of the class; and identified students in need of comprehension instruction, fluency development, or decoding work. In addition, the report provided a rank ordering of the students in the class, sorting them into those who already had met the year-end CBM benchmark, those who were on track to meet the year-end benchmark, and those who were at risk of failing to achieve the year-end benchmark. Teachers collected CBM data for 15 weeks, with individual graphs shown at the end of every data-collection session and with class reports printed every 3 weeks. Every 3 weeks, teachers answered the questions, "Do you have children whose progress seems problematic? Which children are you concerned about?" Progress monitoring teachers expressed concern about statistically significantly more students, with effect sizes exceeding 1 standard deviation. Moreover, when asked, "Why are you

concerned about _____ ?," Progress monitoring teachers described features of student performance to explain their concern; by contrast, control teachers cited reasons beyond their control (such as English Language Learner status, special education status, attention or motivation problems, or inadequate parental involvement). This pattern of results was statistically significant. Therefore, systematic progress monitoring can be used to raise teacher concern about students' reading progress and to signal the need for additional or different forms of instruction.

Usefulness of graphed analysis of thee overall CBM scores. Evidence strongly supports the utility of graphed analysis of overall CBM scores in helping teachers plan more effective programs. Studies (5) conducted over the past decade provide corroborating evidence of strong effects on students' reading, spelling, and mathematics achievement when teachers rely on CBM progress monitoring to help them plan their instruction. A study conducted in the New York City Public Schools (6) illustrates this research. Teachers participated for 18 weeks in a control group (i.e., no systematic progress monitoring) or a CBM progress monitoring group. In the progress monitoring group, teachers measured students' reading performance with CBM oral reading fluency twice weekly, scored and graphed CBM performances, and applied CBM decision rules (described in the next three paragraphs) to those graphs to plan their students' reading programs. Children whose teachers employed CBM progress monitoring to develop reading programs achieved statistically significantly better than students in the control group on measures tapping a variety of reading skills, including a fluency test as well as the decoding and comprehension subtests of the Stanford Diagnostic Reading Test. Effect sizes were large, ranging between .94 and 1.18 standard deviations. So, teachers used CBM's graphed analysis to effect greater reading achievement in terms of fluency, decoding, and comprehension.

CBM progress monitoring, using the graphed analysis, relies on decision rules that help teachers set ambitious student goals and help them determine when instructional adjustments are needed to prompt better student growth. The student's initial CBM scores are graphed. The teacher uses normative information about expected rates of CBM growth to set a goal for the end of the school year. A diagonal line is drawn from the initial scores to the goal level/date. This diagonal line represents the desired rate of improvement for that student. As the instructional program is implemented, weekly CBM data are collected and graphed. A line of best fit is drawn through the student's graphed scores to estimate the child's actual weekly rate of improvement, or CBM slope. The steepness of the goal line is compared to the steepness of the student's actual rate of improvement. If the steepness of the student's actual rate of improvement is greater, then the CBM decision is to raise the goal. If the steepness of the goal line is greater, then the CBM decision is to adjust the instructional program to stimulate greater learning.

Fuchs, Fuchs, and Hamlett (7) explored the contribution of the goal-raising CBM decision rule. Teachers were assigned randomly to and participated in one of three treatments for 15 weeks in mathematics: no CBM, CBM without a goal-raising rule, and CBM with a goal-raising rule. The goal-raising rule required teachers to increase goals whenever the student's actual rate of growth (represented by the slope through the actual, graphed scores) was greater than the growth rate anticipated by the teacher (reflected in the goal line). Teachers in the CBM goal-raising condition raised goals statistically significantly more frequently (for 15 of 30 students) than teachers in the nongoal-raising conditions (for 1 of 30 students). Moreover, concurrent with teachers' goal

raising was statistically significantly differential student achievement on pre/post standardized achievement tests: The effect size comparing the pre/post change of the two CBM conditions (i.e., with and without the goal-raising rule) was .50 standard deviation. Consequently, using CBM to monitor the appropriateness of instructional goals and to adjust goals upward whenever possible is one means by which CBM can be used to assist teachers in their instructional planning.

A second way in which CBM can be used to enhance instructional decisions is to assess the adequacy of student progress and determine whether, and if so when, instructional adjustments are necessary. When actual growth rate is less than expected growth rate, the teacher modifies the instructional program to promote stronger learning. Fuchs, Fuchs, and Hamlett (8) estimated the contribution of this CBM decision-making strategy with 29 teachers who implemented CBM for 15 school weeks with 53 students. Teachers in a "CBM-measurement only" group measured students' reading growth as required but did not use the assessment information to structure students' reading programs. Teachers in the CBM-"change the program" group measured student performance and used CBM to determine when to introduce program adjustments to enhance student learning. Results indicated that, although teachers in both groups monitored student progress, important differences were associated with the use of the "change the program" decision rule. As shown on the Stanford Achievement Test-Reading Comprehension subtest, students in the "change the program" group achieved statistically significantly better than a no-CBM control group (effect size=.72), whereas the "measurement only" CBM group did not (effect size=.36). Moreover, the slopes of the two CBM treatment groups were significantly different, favoring the achievement of the "change the program" group (effect size=.86). As suggested by these findings and results of other studies (9), collecting CBM data, in and of itself, exerts only a small effect on student learning. To enhance student outcomes in substantial ways, teachers need to use the CBM data to build effective programs for difficult-to-teach students.

Added value of skills profiles. To obtain rich descriptions of student performance, alternative ways of summarizing and describing student performance are necessary. Because CBM assesses performance on the year's curriculum at each testing, rich descriptions of strengths and weaknesses in the curriculum can be generated, and studies show how these skills profiles enhance teacher planning and student learning. In a series of investigations in reading (10), math (11), and spelling (12), teachers were assigned randomly to one of three conditions: no CBM, CBM with goal-raising and change-the-program decision rules, and CBM with goal-raising and change-the-program decision rules plus CBM skills profiles. In all three studies, teachers in the skills profile group generated instructional plans that were statistically significantly more varied and more responsive to individuals' learning needs. Moreover, they effected statistically significantly better student learning as measured on change between pre- and posttest performance on global measures of achievement. Effect sizes associated with the CBM diagnostic profile groups ranged from .65 to 1.23 standard deviations. This series of studies demonstrates how structured, well-organized CBM information about students' strengths and difficulties in the curriculum can help teachers build better programs and effect greater learning.

Summary. As demonstrated via the randomized field trials described above, teachers can use systematic progress monitoring in reading, mathematics, and spelling to identify students in need of additional or different forms of instruction, to design stronger instructional programs, and to effect better achievement outcomes for their students.

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Implications for Practice.

- Teachers should monitor student progress in reading, spelling, and mathematics using standardized progress monitoring systems, such as curriculum-based measurement (CBM).

- Teachers should use progress monitoring systems to identify students in need of additional or different forms of instruction.

- For students who do not respond adequately to the standard instructional program, teachers should use graphed analyses of CBM scores to insure ambitious goals and to identify instructional components that result in improved learning for otherwise difficult-to-teach students.

- Teachers should use skills profiles, derived from progress monitoring systems, to formulate strong instructional programs and to effect better student outcomes.

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