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Chapter 4: Using Curriculum-Based Measurement Fluency Data for Initial Screening Decisions

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Curriculum-based measurement (CBM) has enjoyed a long history of success and study as a practice for data-based decision-making (Deno, 2003). Originally developed and studied at the University of Minnesota in the mid-1970s (see Shinn, 2012 or Tindal, 2013 for a detailed history), Stan Deno and his colleagues developed CBM measures and the problem-solving process as part of one of the Institutes for Research on Learning Disabilities (IRLDs), centers funded by the Office of Special Education Programs that addressed significant issues for students with learning dis- abilities. With Deno's interests in applied behavior analysis, it seemed logical to apply methodologies such as collecting baseline data, setting goals for students, and collecting and graphing ongoing data and then using them to make educational decisions, as a student's data is compared to a goal. As part of work in the IRLD, that is exactly what Deno and colleagues did, developing a system of technically adequate (i.e., reliable and valid) assessments that could be administered quickly and efficiently up to three times per week. These data would be graphed on an ongoing basis and compared with a goal set for a student. If data fell below the student's goal for a specified number of points, a curricular change or instructional tweak would be instituted. All of these components were couched in a problem-solving process so that teachers and teams could utilize on a frequent basis to help make better decisions about student learning. As you will note already, the CBM process or model is not just the measures themselves, but the use of those measures in a more comprehensive, problem-solving process. In this chapter the use of CBM, and specifically CBMs as measures of fluency, is discussed in depth. The theoretical support for measures of fluency is discussed along with more detailed research that supports the use of CBM, basic components of the process, and using CBM data to make screening decisions across a variety of academic subjects.

Fluency as a Proxy for Academic Proficiency

Ask most educators to define what fluency is and many will say “fast reading or fast computing.” Defining fluency and providing a rationale for why fluency tasks might be important are critical, yet somewhat overlooked objectives. Fluency tasks are often associated with timing, working quickly, and are not always associated with a student’s best effort. Yet as this book illustrates, fluency is much more than just timed reading or math production. Fluency tasks embody characteristics of academic proficiency that students exhibit. Following administration directions, performance samples are elicited from students that are indicative of broader skills. For instance, some common CBM metrics include the number of words read correctly in a set amount of time or the number of mathematics problems completed during a given time. Both of these activities prompt students to work quickly (due to the timing) but also accurately; the final score represents the number correct, not just the number completed. When students have to work quickly and accurately, different skills are required than when they have unlimited time to complete a task. The cognitive skills accessed when students demonstrate fluent reading or computation are different from those accessed or applied on tasks where there is unlimited time or where accuracy is not paramount.

Fluency components in basic academic areas like reading, mathematics, and writing have been identified. In the area of reading, automaticity (LaBerge & Samuels, 1974), prosody (Schreiber, 1980), accuracy, and word recognition are all components that have been used in definitions of fluency (see Kuhn, Schwanenflugel, & Meisinger, 2010). In mathematics, the National Mathematics Panel (NMP, 2008) describes fluency in the area of whole numbers and fractions as critical foundational elements to prepare students for algebra. The NMP describes mathematical fluency as not just recalling basic facts, but being able to apply operational knowledge in problem solving. Fluency with algorithms for the basic mathematical areas is mentioned as well. In one paper, writing fluency is defined as the rate at which text is produced (Chenoweth & Hayes, 2001). Berninger and Fuller (1992) identified writing fluency as one of the key components in a two-part model to predict development skill and later writing achievement. Next, a brief discussion about the theory underlying each academic area is provided, prior to a

return to how fluency tasks are utilized for CBM screening decisions.

Theoretical Support for Fluency as a Construct in Reading, Mathematics, and Writing

Reading In the area of reading, fluency measures have often been criticized because they appear to be simplistic "quick reads," which only serve as an indication of how many words can be "called" in the time given. This lack of face validity has largely been overcome through careful discussion in the literature, as well as studies that address this issue head-on (c.f., Hamilton & Shinn, 2003).

Four main components have been utilized to describe fluent reading: automaticity, prosody, accuracy, and word recognition. Two major theories have emerged when linking word recognition with fluent reading: LaBerge and Samuels' (1974) theory of automaticity and Perfetti's (1985) verbal efficiency theory. Reading fluency is most frequently linked with the theory of automaticity, as described in LaBerge and Samuels' (1974) seminal article. In this article, the authors described automaticity as rapid and fluent word reading. LaBerge and Samuels theorized that if children were able to read words more fluently, not much time would be spent decoding individual sounds and words. This, in turn, would free up working memory, leaving room for comprehension to take place. The more fluently a child reads the more working memory available and the better the comprehension. Similar to LaBerge and Samuels' theory, Perfetti's verbal efficiency theory proposes that readers can become more efficient readers through practice, and that efficiency in word recognition frees up cognitive resources. Perfetti posits that slow rates of word recognition "clog" working memory, affecting comprehension and recall. Shankweiler and Crain (1986) extended Perfetti's verbal efficiency model by proposing that the combination of difficulties in orthographic decoding and limited-working memory capacity lead to difficulties in reading comprehension.

Moving from automaticity to prosody, Schreiber (1980) focuses on prosody, or expression, in reading and proposes that students' lack of reading fluency may be a result of their inattention to prosodic cues, like phrasing and the rhythmic characteristics of language. Schwanenflugel, Hamilton, Wisenbaker, Kuhn and Stahl (2009) provide their definition of

prosody, “when a child is reading prosodically, oral reading sounds much like speech with appropriate phrasing, pause structures, stress, rise and fall patterns, and general expressiveness” (p. 121). Meyer and Felton (1999) also include elements of prosody in their definition of reading fluency in a review of literature, where they describe fluency as “the ability to read connected text rapidly, smoothly, effortlessly, and automatically with little conscious attention to the mechanics of reading, such as decoding” (p. 284). Although Schreiber’s theory was proposed over 30 years ago, little research has been focused on prosody as an element of reading fluency. In a brief review for this chapter, out of 29 empirical articles on reading fluency interventions, only three included some form of prosody as a dependent measure. This search was conducted back to 2000 and involved a search of electronic databases using PsychInfo and Google Scholar but did not involve a hand search. The majority of articles used dependent measures that addressed accuracy, fluency, and comprehension. There is a paucity of research using prosody as an indicator of fluency (Schwanenflugel, Hamilton, Wisenbaker, Kuhn, & Stahl, 2009) and this lack of use of prosodic features as an outcome is due in part to the difficulty of measuring expression in students’ reading. For example, research by Young, Bowers, and MacKinnon (1996) and Young and Bowers (1995), in particular, have examined the effects of prosody on students’ reading fluency using voice-activated devices to measure prosodic cues, such as pausal intrusions.

Another theory of reading fluency offered by Adams (1990) is a “connectionist” approach, in which orthography, phonology, meaning, and context interact to produce reading fluency. Adams suggests that rapid word identification and phrasal knowledge are necessary components, but are not sufficient to produce fluent reading on their own. Adams hypothesizes that a failure to make connections between words, meanings, and ideas results in nonfluent reading.

Wolf and Katzir-Cohen (2001) cite research by Kame’enui, Simmons, Good and Harn (2000) and Berninger, Abbott, Billingsley, and Nagy (2001) that characterizes fluency in a different manner than either a single-word recognition, prosodic, or connectionist view. Kame’enui and colleagues discuss fluency as a developmental process, where efforts at remediation need to be focused on early reading skills.

Berninger and colleagues characterize fluency development as a systems approach, where the visual or verbal input, internal-language processes, and coordination of responses by the executive system all combine to influence growth in fluency.

The theory that underlies a researcher's position on fluency determines how studies are conducted and also what outcomes are measured. One of the keys to empirically examining a concept is operationalizing the term that you are studying. This has been difficult in the case of reading fluency, with definitions varying from study to study. Wolf and Katzir-Cohen (2001) discussed the lack of a clear definition of fluency and how even subtle changes in definition result in differences in assessment and intervention. Across all definitions, there are elements of speed and accuracy, including fluency described as verbally translating text with speed and accuracy (Fuchs, Fuchs, Hosp, & Jenkins, 2001) and accuracy of word recognition and reading speed, with an emphasis on speed (Samuels, 1997). Other researchers describe fluency as 3D, with expression or prosody accompanying rate and accuracy (Dowhower, 1991; Schreiber, 1980). Fluency has also been described as an indicator of comprehension.

When measuring or assessing fluency, nearly all studies use measures of reading speed and accuracy. This is not surprising given the theories just discussed and the emphasis on speed and accuracy as two of the primary components in addition to prosody. Reading speed is generally measured by counting the number of words that a student reads correctly in a constrained period of time, and accuracy is assessed by looking at the number of errors that a student makes in that reading. This is where CBM enters back into the picture.

Curriculum-Based Measurement CBM is a system of progress monitoring in academic areas that utilizes technically adequate measures to assess progress. Technical adequacy studies are completed in three phases or stages (Fuchs, 2004). Stage 1, technical features of the static score (including reliability and validity), involves evaluation of measures that can be used to administer all students at limited times during the year to check on student performance compared to established norms. Stage 2, technical features of slope, involves development of measures that can be utilized for ongoing monitoring of student progress in an academic area. These progress-monitoring measures might be given as often as

weekly. Stage 3, instructional utility, is focused on examining how the measures function when teachers utilize them for monitoring the progress of their students, including deter- mining when instructional changes need to be made. Please see Burns, Silberglitt, Christ, Gibbons, and Coolong-Chaffin, Chap. 5, this volume, for more information about progress monitoring decisions—including response to intervention decisions. CBM draws upon theories of automaticity and fluency, with a focus on development of measures that serve as indicators of broad constructs, such as reading proficiency. Deno, Mirkin, and Chiang (1982) initially identified the number of words read correctly in 1 min as a technically adequate indicator of overall reading proficiency. Initially, 1 min samples were collected to provide ease and efficiency for teacher administration. But there is nothing magic about 1-min timings; the duration of the assessment must be balanced with the item types and content of the measure. Thus, some CBM measures require 6 or 8 min to obtain adequate, reliable samples of information. More detail about average lengths of administration can be found in Table 4.1. In reading, repeated studies have been conducted on the efficacy of using the number of words read correctly in 1 min as a fluency indicator. It is important to note that the CBM research has shown the number of words read correctly in 1 min is not just a measure of decoding skill, but predicts general reading achievement. Multiple studies have been conducted on the validity and reliability of the CBM reading measure demonstrating strong correlations with other measures of fluency and comprehension (Shinn et al., 1992; Reschly et al., 2009).

Mathematics In the area of mathematics, Rhymer et al. (2000) cites literature suggesting that computational fluency, defined as responding accurately and rapidly, leads to better long-term outcomes, maintenance of skills, and better application to novel mathematics tasks. The National Council of Teachers of Mathematics (NCTM, 2000) describes fluency in mathematics as "…having efficient and accurate methods for computing. Students exhibit computational fluency when they demonstrate *flexibility* in the computational methods they choose, *understand* and can explain these methods, and produce accurate answers *efficiently*" (p. 152). In this definition, fluency is more than just production, but efficiency in application and explanation. Thomas (2012) suggests that perhaps we have

moved beyond simple speed and accuracy in mathematics and that there are three competing definitions of fluency when applied to this skill area: “(1) Speed/efficiency are the sole components; (2) Speed/efficiency are the emphasized components, but meaning is also necessary; or (3) Meaning is the emphasized component and speed/efficiency are characterized as natural outgrowths of deep understanding” (p. 327). The National Mathematics Advisory Panel (2008) suggests that mathematical fluency includes both computational and procedural fluency. As many states implement the Common Core State Standards (CCSS), fluency is included as an aspect to be practiced, but not at the expense of understanding. The CCSS defines fluency as both quickness and accuracy. Within the standards, fluency is built from grade to grade on increasingly difficult skills. Clearly, there is a common theme throughout these reports, manuscripts, and standards indicating that rapid naming of facts and the ability to quickly apply procedures are critical to developing further mathematics skill.

In their article on computational fluency for high-school students, Calhoon et al. (2007) cite work demonstrating the far-reaching influences of fluency. For instance, The National Research Council (2001) provides an analogy suggesting that lack of computational fluency may have negative effects on mathematical comprehension similar to the effects that poor decoding has on reading comprehension (in Calhoon et al., 2007). In addition, Calhoon and her coauthors provide a overview of the literature suggesting that higher-order mathematics cannot be accessed as efficiently if fluency is not present (Gerber & Semmel, 1994; Johnson & Layng, 1994; Pellegrino & Goldman, 1987 in Calhoon, 2007). See also Clarke, Nelson, and Shanley (Chap. 3, this volume) for more information about the importance of fluency in mathematics assessments.

The parallels between reading and mathematics fluency are compelling and pro- vide a strong rationale for the use of fluency tasks as screening measures in systems of data-based decision-making. But more about that after we discuss theories of fluency in the area of writing.

Table 4.1 Summary of common curriculum-based measurement (CBM) tools across the academic areas of reading, mathematics, writing, and other content domains

CBM probe	Description	Grade levels assessed	Time of administration	Procedure	Content or skill assessed	Scoring
Reading						
Letter naming fluency	Measures students' ability to rapidly name a selection of random lower and uppercase letters	Kindergarten	1 min	Individual	Naming orthographic letter symbols	Number of letters named correctly
Letter sound naming	Measures students' ability to accurately produce the phonological sound of the presented letter	Kindergarten	1 min	Individual	Naming most com- mon sound for a given letter symbol	Number of correct letter sounds
Phoneme segmentation	Measures students' ability to accurately pronounce each phoneme of the presented word	Late Kindergarten	1 min	Individual	Segmentation of phonemes in words	Number of phonemes pronounced correctly
Nonsense word fluency	Measures students' ability to accurately segment or blend the sounds of a pseudo- word that primarily follows the CVC pattern	Grade 1	1 min	Individual	Letter-sound cor- respondence and phoneme blending	Number of sounds produced correctly
Word identifica- tion fluency	Measures students' ability to accurately read from a list of approximately 50 high- frequency words	Grade 1	1 min	Individual	Sight recognition of words	Number of words read correctly
Oral reading flu- ency (or passage reading fluency)	Measures students' ability to accurately and fluently read a brief passage at stu- dent's instructional level	Grades 1–8	1 min	Individual	Oral reading	Number of words read correctly per minute
Maze	Measures students' comprehension of a passage in which every seventh word is deleted; students must select the correct word from a series of distractors to fill in the missing word	Grades 1–6 Grades 7–12	1 min (elementary) 3 min (secondary)	Group	Comprehension	Number of words selected correctly

Table 4.1 (continued)

CBM probe	Description	Grade levels assessed	Time of administration	Procedure	Content or skill assessed	Scoring
Vocabulary- matching	Measures students' ability to correctly match a set of content vocabulary; answer choices include two distractors	Middle school	5 min	Group	Vocabulary com- prehension and knowledge	Correct vocabulary matches
Mathematics						
Oral counting	Measures students' ability to orally count out loud starting at one	Kindergarten and grade 1	1 min	Individual	Number counting	Numbers correctly counted
Number identification	Measures students' ability to rapidly name a series of randomly selected numbers between one and twenty	Kindergarten and grade 1	1 min	Individual	Number recognition	Numbers identified correctly
Quantity discrimination	Measures students' ability to accurately name the larger of two presented numbers	Kindergarten and grade 1	1 min	Individual	Discrimination of larger and smaller numbers	Number of correctly discriminated pairs
Missing number	Measures students' ability to accurately identify (name) the missing number in a sequence of three numbers; the missing number may be at the initial, medial, or final position	Kindergarten and grade 1	1 min	Individual	Recognizing a sequence and iden- tifying the number needed to complete the sequence	Number of correctly identified missing numbers
Computation	Measures students' basic computation skills in single, mixed, or multi-step addition, subtraction, multiplication, and division	Grades 2–6	2–3 min	Group	Basic arithmetic (addition, subtrac- tion, multiplication, division)	Number of correct digits
Concepts and application	Measures students' ability to correctly complete mathematical problems in an applied context	Grades 2–6	6–8 min	Group	Applied mathematics	Number of correct blanks

Table 4.1 (continued)

CBM probe	Description	Grade levels assessed	Time of administration	Procedure	Content or skill assessed	Scoring
Algebra	Four probes: basic skills—measures students' basic algebra performance; algebra foundations—measures students' knowledge of foundational algebra content; content analysis—measures students' knowledge of various algebraic concepts; translations—measures students' understanding of numerical relations across various formats	Middle school and high school	5–7 min	Group	Algebra	Basic skills—total number correct; algebra foundations— number of correct items; content analy- sis—sum of points across problems; translations—number of correct matches
Writing						
Word dictation	Measures students' transcription skills at the word level; ability to accurately spell words that have been dictated orally	Grades 1–6	2–3 min	Individual	Spelling	Words written, words spelled correctly, cor- rect letter sequences, correct minus incorrect letter sequences
Picture word prompts	Measures students' transcription and text generation skills at the sentence level; ability to write sentences using pictures that are presented alongside the name of the picture	Grades 1–6	3 min	Group	Text generation at the sentence level	Words written, words spelled correctly, cor- rect word sequences, correct minus incor- rect word sequences
Story prompts	Measures students' transcription and text generation skills at the paragraph or dis- course level; ability to write a story using a story prompt that reflects the experiences of students attending U.S. public schools	Grades 1–6 Grades 7–12	3 min (elementary) 5 or 7 min (secondary)	Group	Text generation at the passage level	Words written, words spelled correctly, cor- rect word sequences, correct minus incor- rect word sequences

Writing In the area of writing, the skills most often targeted include transcription and text generation (McCutchen, 2006) or text production (Chenoweth & Hayes, 2001). Transcription, translation of language into written symbols, is most often measured through handwriting or spelling tasks for students. These tasks, which at first glance may appear to be fairly straightforward and perhaps even rudimentary, are strongly predictive of future writing performance (Graham, Harris, & Fink, 2000). In fact, in a recent study (Puranik & Alotaiba, 2012), the authors found that handwriting and spelling made statistically significant contributions to the prediction of written expression proficiency.

Text generation is the process of "turning ideas into words, sentences, and larger units of discourse" (McCutchen, 2006, p. 123). Text generation is also constrained by cognitive resources including working memory. How does working memory relate to writing fluency? Students who have strains on working memory may have difficulty retaining rules about use of grammar, accuracy in spelling, or simply brainstorming and retention of content ideas. Long-term memory resources are related to knowledge of topic and genre, which can constrain quality and quantity of text generation (McCutchen, 2006). Text generation has been found to be related to overall writing quality (Dellerman, Coirier, & Marchand, 1996) including that of beginning writers (Juel et al., 1986). Ritchey and colleagues (Chap. 2, this volume) have active research labs studying and refining theories supporting new and innovative measures of written language and are a great resource for further information on the topic.

Developing further understanding of the underlying theoretical constructs that support the use of fluency in each of these academic areas is important, as some would dismiss fluency tasks as simply "responding fast" if deeper understanding was not cultivated. As Deno and his colleagues at Minnesota, and others since, have reported, fluency with academic tasks serves as an indicator of something broader than just quick responding. As discussed in the preceding section, fluency

with tasks can be directly linked to stronger comprehension in reading, greater problem solving ability in mathematics, and lengthier compositions in the area of writing. Theoretical foundations of learning support the use of fluency tasks for brief assessment in academic areas. With a better understanding of how fluency undergirds more sophisticated processing in these academic areas, we next move to a discussion regarding how fluency measures might be utilized for teachers and schools as part of a data-based decision-making, particularly in the area of universal screening.

Basic Components of Data-Based Decision-Making

When CBM measures were developed in the mid-1970s, the initial framework for teacher-data utilization was termed as data-based program modification (DBPM; see Shinn, 2012 for a well-articulated account of this early work). DBPM had roots in teacher development, behavior analytic techniques, and precision teaching (Lindsley, 1990). Precision teaching included direct and explicit teaching methods, such as modeling and precise and frequent feedback using visual models. Deno and his colleague Phyllis Mirkin (1977) brought these components together in a manual that was published by the Council for Exceptional Children (CEC). The DBPM manual detailed methods that special education teachers could utilize to monitor the performance and progress of their students in basic skill areas. Special education teachers could empirically evaluate the progress of their students and make decisions about their instruction based on actual student performance data. This method differed from past practices where teachers might just guess about when to try something new or make judgments about the effectiveness of an intervention based on anecdotes or personal feelings. This new way of thinking brought about a more data-based scientific approach to education. Centered around a problem-solving process (see Marston et al., 2003), DBPM provided a model to assist teachers as they identified an area of need, developed an intervention, monitored the progress of the student in the intervention, and then continued or modified the intervention after examination of data at regular intervals. This basic model is now termed data- based individualization (National Center on Intensive Intervention, 2012), Prevention

Science (i.e., see Lembke, McMaster, & Stecker, 2009), or even response to intervention (RTI).

The basic components in the DBPM process include universal screening, goal setting, diagnostic assessment, hypothesis generation about potentially effective interventions, development and implementation of an instructional plan, weekly progress monitoring, and making ongoing changes in intervention using decision- making rules. Each step is described in more detail below using a case study of Mrs. Hammond's classroom and one of her students, Samuel.

Step 1–Screening Using CBM Measures All students should be screened using CBM measures, ideally, three times per year (fall, winter, spring). Universal screening means that all students in a building are tested. Typical measures used for screening are short-duration tasks that are matched to students' grade levels; the results of those tests are then compared to established normative levels of performance. These norms are developed as a result of national, state, or local data collection, and trans- late into benchmark levels of performance that are standard criteria where students need to be performing to be deemed "not at risk" at a particular time of year (see Smolkowski, Cummings, and Stryker, Chap. 8 this volume, for more information about how benchmark levels of performance may be statistically determined). The criteria that determine risk status are determined statistically after examining data that has been collected for each grade at each time of year. Students who fall below a pre- determined benchmark on the CBM are identified as needing additional instruction or interventions and their progress will be monitored more frequently.

Case Study Mrs. Hammond teaches literacy to students in grades 1–3 who have difficulties or are on individualized education programs (IEPs) for reading or writing. At her school, these students come to work with her on their academic skills for at least 30 minutes per day in her classroom. Mrs. Hammond screens all of her students fall, winter, and spring using CBM measures. After scoring those measures, she has a sense of how her students compare to others who have completed these measures and she also has a better sense of the students' skill deficits. In the fall when she screens her students, she determines that several may have needs in the area of spelling.

Step 2—Setting an Ambitious Goal for the Student and

Labeling the Goal Line on the Student's Progress Monitoring Graph An ambitious yet attainable goal is set for all of Mrs. Hammond's students who scored below criterion. The specified goal is for a given time period (e.g., several months, a semester, end of year, etc.). Goals can be determined in one of three ways: (1) according to national norms, which vary by CBM product, (2) grade-level benchmarks, which also vary by CBM product or (3) an intraindividual framework, where a student's individual data are used to project a reasonable goal in the time allotted using expected rates of growth. For example, using the intraindividual framework, a teacher could specify that a student would gain two words per week on a test of oral reading fluency (ORF). The end goal would be determined by the following formula:

$$\textit{Goal} = \left(\textit{Words per week expected gain} \times 27\ \textit{weeks left in the school year}\right) + \textit{CBM screening score}$$

If a student had an initial score of 20, the goal score in 27 weeks would be 74.

However the goal is decided, it along with the student's current level of fluency (baseline; present level of performance) is marked on an individual student graph. The baseline and goal points are connected and a line is drawn between them. This goal line spans the number of instructional weeks between the baseline level of performance and the point by which the goal is desired to be achieved. This goal line determines the most direct route to take when attempting to reach the desired level of performance.

Case Study Mrs. Hammond sets a goal for each student based on the national normative data available from the publisher of the measures and marks this goal on each student's graph. She then marks each student's baseline score, or current level of spelling fluency, and connects the two points to create a goal line (Fig. 4.1).

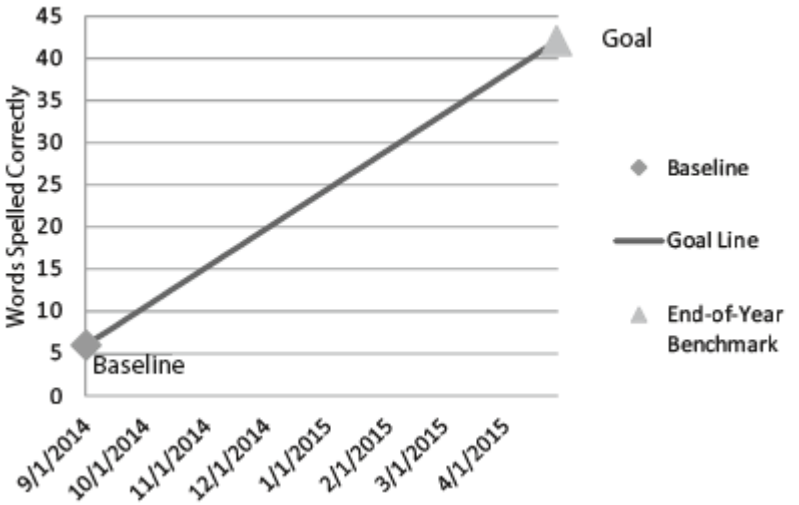

Fig. 4.1 Example progress monitoring graph with baseline level of performance, desired goal level performance (associated with a given time point in the school year), and the goal line

Step 3–Identification of Strengths and Weaknesses Using Diagnostic Measures In addition to CBM screening measures, students who have been identified as requiring more intensive interventions may be given diagnostic measures. CBMs tell us *if* there is a problem. Diagnostic assessments tell us specifically *what* skills are deficient and what the student is able to do well. Diagnostic information is then used to develop an intervention plan and determine where to focus instruction. An example of a diagnostic fluency assessment is a miscue analysis (Fuchs, Fuchs, Hosp, & Jenkins, 2001), which determines the specific types of errors a student is making in reading. Teachers make notation about student errors as the student is reading aloud and then later go back and categorize the types of errors the student made.

Case Study Mrs. Hammond needs to decide what to teach for each student or group of students in her classroom who scored below the normative criterion at the screening point. She conducts an error analysis on each student's spelling to deter- mine which letter patterns are in error. She groups students based on strengths and specific needs identified from the use of this diagnostic tool before initiating step 4.

Step 4–Generating a Hypothesis About Appropriate Method to Individualize Instruction for the Student Using CBM results and diagnostic data as appropriate, educators

should come up with logical ideas about what type of intervention program, instructional content, and delivery setting would be appropriate for each student. It is important to consider not only the specific skills the student needs to work on but also the amount and frequency of supplemental instruction and the size and composition of the intervention group.

Case Study Mrs. Hammond uses each student's school instructional plan or IEP as a template for how to individualize her lessons. She also brings back the error analysis data, as well as any other information she has about the students, to bear in terms of selecting an intervention plan that is most likely to be successful. She considers that some students will likely do well in a small-group intervention setting, while a few students have significant needs that may be better served in a one-to-one or very small group structure. She also uses her own personal knowl- edge of student behavior to decide if students will work well together in their small groups. Perhaps Samuel and Sally tend to feed off each other in terms of who can be the biggest class clown; however, they work fine when paired with other students. She would then choose to separate them so that instructional time is more wisely used. After grouping considerations are finalized, the content of the lesson is made specific. We talk about this more in step 5.

Step 5–Creating an Instructional Plan for Each Student or Group of Stu- dents Based on the above discussion, educators will develop an instructional plan with a goal and instructional activities for each student. These activities should be research- or evidence-based and typically include direct, explicit, and systematic intervention for the deficit area(s) identified during the diagnostic step above.

Case Study To identify the content and activities she will use in the plan, Mrs. Hammond examines her menu of available intervention options matched to each student's needs and goals to further individualize for each student. In addition to determining the size of each student's intervention group, Mrs. Hammond thinks about whether a standardized intervention package that is delivered the same way to all students in a group might be appropriate, or if a more individualized strategy targeting specific spelling patterns may fit a student's needs. She must consider the intervention strategies and activities available, how much time each intervention will take, and the order of

spelling patterns and targeted content she will cover with each student or group of students.

Step 6–Beginning Regular and Frequent Instruction Using the Instructional Plan The instruction or intervention will be provided for as much time as possible, relevant to the skill needs. The greater the academic needs of the students, the more often the intervention should be implemented and for a greater length of time each session.

Case Study Mrs. Hammond begins implementing the instructional plan for each student. She monitors her own fidelity of implementation, keeping data on how long she is able to implement the plan each day and to what extent she is able to implement the essential elements of the plan. She also regularly and informally checks for mastery of content before moving on to the next unit or subunit in the instruction. This informal measurement is not CBM, but is critical to ensuring that instruction is effective for each student.

Step 7–Regular Progress Monitoring, Including Scoring and Graphing, Using a CBM Measure To continuously monitor student response to the intervention, regular weekly progress monitoring data using a CBM is necessary. Continue to graph these data on the student's graph to determine if the student's performance is changing and how close his or her data points are to the goal line (see step 2 and Chap. 5 for more details about progress monitoring decision rules and evaluating a student's response to instruction). Weekly progress monitoring is recommended for students who are significantly behind their peers (e.g., someone in a tier 3-level intervention), whereas monitoring every other week or monthly may be more appropriate for students who are not as far behind (e.g., someone in a tier 2-level intervention).

Case Study In the area of progress monitoring, because she is providing an intensive tier 3 intervention for these particular students, Mrs. Hammond collects data weekly using one of the CBM measures in writing. She scores the measure and plots each individual data point for each student, by week. She then connects each of the progress monitoring data point for easier visual analysis. The connected line running through all of the student's data points is called a "trendline." This line describes the trend of student performance and can be interpreted relative to the aim or target line (shown in red, Fig.

4.2). This process of analyzing student performance over time is described in step 8.

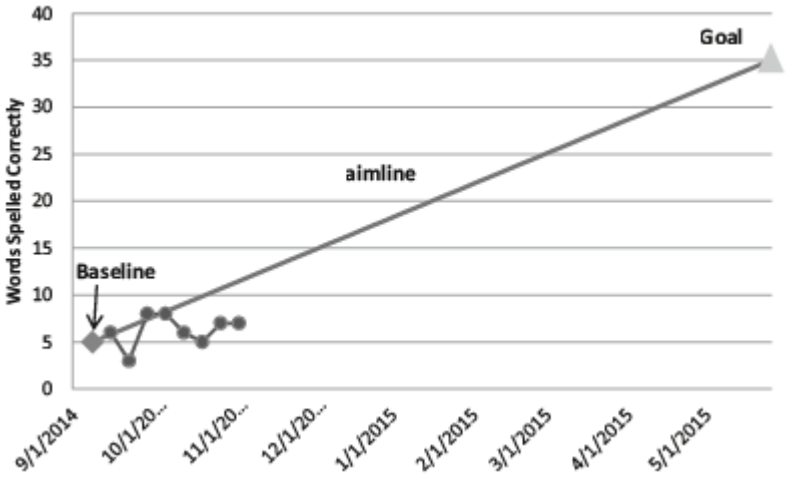

Fig. 4.2 Example progress monitoring with weekly student-level data points plotted and connected

Step 8—Making Ongoing Changes in Instruction Based on Decision-Making Rules Using progress monitoring data, educators can determine if the instructional plan is having the intended effect. The main method for making educational decisions using student progress monitoring data is the trendline rule. There are several methods for determining the trend of student's progress. The National Center for Response to Intervention (NCII, 2014) lists the methods for several of the most com- mon and supported in its glossary of terms available at the following web address: http://www.intensiveintervention.org/ncii-glossary-terms. Recent publications indicate that as many as 12 data points might be necessary to establish a reliable trend line (Ardoin et al., 2013). When the trendline is at or above the aimline, the intervention will be continued and likely faded if progress remains strong. When the student progress (represented by the trendline) is *below* the aimline, consider making a change to the intervention delivery or, in some cases, content.

Case Study Mrs. Hammond uses decision-making rules to make ongoing decisions about intervention effectiveness. She does not want to continue with an intervention if student growth is not observed. For one of her students, Samuel, his data through October 1st indicates that his current trend of data is not

approaching his aimline (see Fig. 4.3). For this reason, Mrs. Hammond decides to make a change for Samuel. She consults with her fellow teachers and her special education consultant to choose an intervention change that is supported by evidence.

For the purposes of this chapter, our focus remains on utilizing CBM measures for screening as specified in step 1.

Using CBM for Screening Decisions

CBM measures embody specific characteristics, including: (a) efficient administration, (b) short duration, (c) technical adequacy, and (d) indicators of academic proficiency. The term *indicator* is used to signify the short duration of the measures as well as their strong relation to other measures of broad academic proficiency in that content area. Utilizing the theories underlying fluency, we can develop brief measures that serve as proxies for overall academic proficiency. Thus, although, a common measure of CBM in reading is the number of words read correctly in 1 min (oral reading fluency), this score serves as a broader indicator of academic proficiency in reading. As mentioned previously, in her 2004 article on the use of CBM measures, L. S. Fuchs described three stages of CBM research: stage 1, technical features of the static score; stage 2, technical features of slope; and stage 3, instructional utility. These stages are important because measures need to be researched and then utilized only for the purpose they were intended and the purposes for which they have been validated. A measure that is appropriate for stage 1 (assessing performance) may not have strong instructional utility. When considering what measure or combination of measures will be utilized for screening decisions for students, one must consider several technical features including: the accuracy of decision-making, predictive validity, and instructional utility of the measures across grades. In certain content areas like early mathematics (see Gersten et al., 2012), a battery of measures might be considered rather than a single measure.

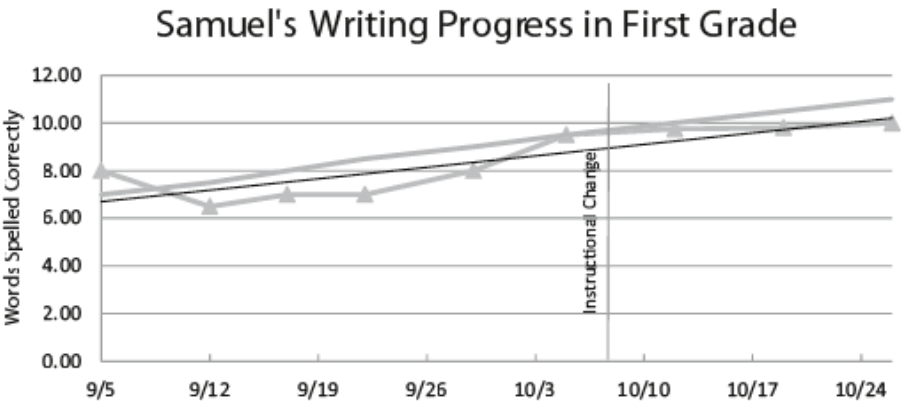

Fig. 4.3 Progress monitoring graph for Samuel. *Solid line* indicates the aimline; the *line* specified by the data points (i.e., *triangles*) is Samuel's trendline of progress. The *vertical line* on the graph represents the point at which Mrs. Hammond's intervention change was made

Other Features that May Impact Screening Decisions

Once an appropriate measure is selected that maps on to our desired educational decision, other factors must be considered. The importance of classification accuracy is a critical component of any screener (Gersten, 2012; Johnson, Jenkins, & Petscher, 2010; Kovaleski, Vanderheyden, & Shapiro, 2013; Smolkowski et al., Chap. 8, this volume). Classification accuracy refers to how accurately a measure can be utilized to predict a decision regarding future student performance. For instance, classification accuracy might be calculated to determine how likely a student would be to pass or fail a high-stakes assessment in the spring based on initial performance on a CBM during fall screening. Sensitivity, specificity, and the area under the receiver operating characteristic (ROC) curve are some of the statistics used to estimate the accuracy of a given screening measure, and is only interpretable for given associated set of cut points, in terms of correctly identifying students at one point in time as at at-risk or on track for outcomes measured at a later time. Sensitivity (i.e., the true positive fraction) describes how acutely a particular cut point on a screening measure identifies children as at-risk who end up failing the outcome measure; sensitivity is not interpretable without knowing the corresponding value of specificity for that same cut point. *Specificity* (i.e., 1-false positive fraction), on the other hand, refers to the degree to which a given cut point on specific screening measure rules out students who are not at risk for failing the outcome measure; a screener that is specific reduces the number of students who are

identified erroneously as needing additional instructional support. There are trade-offs between sensitivity and specificity (i.e., as one increases the other decreases) and, depending on how accurate the screener is overall, the differences between sensitivity and specificity can be quite large. A book published in 2013 by Kovaleski and colleagues, *Identification of Students with Learning Disabilities Utilizing RTI,* provides a comprehensive overview of how classification accuracy can be improved and utilized for high-stakes decision- making and details how schools could use CBM screening data in a multitiered system to make classification decisions regarding students who might be in need of additional intervention. The goal for schools would be to maximize the number of students correctly identified. Utilizing a complementary process of screening and then a few weeks of follow-up progress monitoring to confirm or disconfirm the screening decision can be effective in enhancing classification accuracy.

This recent work in classification accuracy highlights the movement toward greater precision in decision-making utilizing CBM. Initial development of CBM focused on decisions that an individual teacher might make about a small group of students. A teacher would examine recent data values that had been collected and would apply a decision rule like the "three below, six above rule" (see Deno & Mirkin, 1982) where if three weekly data points were below the goal line (see Fig. 4.1), an intervention change would be needed, but if six weekly data points were *above* the goal line, it would be a time to raise the goal for the student. As the use of CBM morphed from individual teacher decision-making to decision-making for larger groups of students (utilizing normative data), the need for greater accuracy emerged. CBM essentially transitioned from serving as a key measure in an individualized, instructionally driven model for special education teachers, to being utilized across general education for universal screening, to serve as a key component in special education *eligibility* decision-making as part of an RTI model. As another part of universal screening, CBM is utilized to predict performance on high-stakes tests (cf. McGlinchey & Hixson, 2004). Prediction of performance within a year or across years allows schools to better divert resources to students or groups of students who might fail if intervention is not provided. Thus, screening serves as an important technique to identify

students at risk early, while there is still time to intervene. For CBM screening, the higher the stakes of the decision, the more important precision in decision-making becomes. For instance, making a decision about student placement in special education is extremely high stakes and CBM screening data is one piece of data to aid that process. Precise decision-making is necessary when utilizing CBM data for this purpose, where a student's placement will be substantially influenced. A lower stakes decision that still requires specificity, but not to the same degree as special education evaluation, might be determination of small-group intervention activities for a low-performing classroom based on CBM screening data. The good news is that educators can find greater detail and more specificity on these issues in resources such as the book by Kovaleski et al. (2013) and in the chapters contained in this volume (i.e., Burns et al., Chap. 5; Smolkowski et al., Chap. 8; Espin & Deno, Chap. 13).

Potential CBM Screening Measures

Next, discussion of the various measures available for screening will be provided. See Table 4.1 for a table of fluency-based CBMs in reading, math, writing, and other content areas that span the grade levels from early elementary through high school. The reader is also encouraged to access the Progress Monitoring and Screening Tools Charts assembled by the National Center on Intensive Intervention (NCII) and the National Center on RTI (NCRTI) respectively (see http://www.intensiveintervention.org/chart/progress-monitoring and http://www.rti4success.org/ resources/tools-charts/screening-tools-chart) for additional information regarding the technical adequacy of the fluency-based CBMs discussed below. These charts are updated annually with new screening measures as well as with evolving information for existing tools.

Reading In the area of reading, typical measures utilized for screening in early literacy (i.e., pre-K through early grade 1) include letter naming, letter sound naming, phoneme segmentation, nonsense word fluency, and word identification fluency. Each measure is individually administered for 1 min and the number of correct responses is totaled and graphed. In the area of elementary literacy (i.e., grades 1–5), common CBM

measures include oral reading fluency and maze. Oral reading fluency measures are individually administered for 1 min and the number of words read correctly in that minute is graphed. The maze task is group administered and the time for the task varies from 1 to 3 min depending on the students' grade level (e.g., earlier grade levels tend to have longer time to engage the task) and the specific test publisher. Students read a passage to themselves where every seventh word (approximately) is deleted and replaced by three choices: the correct word and two distractors. As students read the passage, they circle the word that they feel makes the most sense in the context of the passage. The number of correct choices selected by the student is the score that is graphed. As students improve in their fluency on these tasks, an increase in academic achievement should also be noted.

Knowledge of letter names has been identified as one of the best predictors of later reading acquisition and growth (Stage, Sheppard, Davidson, & Browning, 2001). The letter naming fluency (LNF) CBM is a measure of students' ability to correctly name in 1 min a selection of random lowercase and uppercase letters. Each probe provides students with a randomly ordered list of letters and requires students to reproduce the letter name associated with each letter. The ability to accurately recognize and name different letters has been linked to later word reading ability as one must easily be able to recognize letters and sounds in order to use grapheme-phoneme knowledge to decode words (Stage et al., 2001).

CBMs in letter-sound naming (LSN) require students to produce the phonological sound of the presented letter. Students are given a list of 26 letters presented in random order and asked to say the sound that the letter makes. As the student reads off the list provided, the administrator marks errors on a corresponding score sheet (Fuchs & Fuchs, n.d.). Students receive one point for each correct letter sound.

Phoneme Segmentation CBM presents students with words containing approximately four phonemes. They must accurately pronounce each phoneme of the word presented. Students are timed for 1 min, whereas the administrator marks errors on a corresponding score sheet (Fuchs & Fuchs). Students receive one point for each phoneme pronounced correctly.

Nonsense word fluency is a first-grade dynamic indicators of basic literacy skills (DIBELS) measure (Good & Kaminski, 2002). Students are given 1 min to read through a list of pseudo-words that primarily follow the consonant-vowel-consonant (CVC) pattern. Credit is earned in one of two ways: (1) by saying each individual sound in the pseudo-word, or (2) by blending the sounds into a word (Fuchs, Fuchs, & Compton, 2004). Thus, the final NWF score is the number of sounds produced correctly, with up to three sounds per pseudo-word, as well as the total number of CVC words that were decoded completely and correctly. NWF therefore provides both an index of letter-sound correspondence and the ability to blend letters into words using the most common sounds for each letter (Fuchs, Fuchs, & Compton, 2004).

Word identification fluency (WIF) is a 1-min timed CBM for first-grade students that requires reading from a list of approximately 50 high-frequency words (Fuchs & Fuchs, www.studentprogress.org). On the scoring sheet, the administrator awards the student 1 point for reading a word completely and correctly and a 0 for an incorrect response, which could include an error on any part of the word. At the end of 1 min, the administrator circles the last word the student read, and tallies and then graphs the number of words read correctly. This score represents automatic word recognition, which is essential for reading proficiency (Fuchs, Fuchs, & Compton, 2004).

Content Areas CBMs in the area of vocabulary matching for secondary students have also been researched as both indicators of performance and progress in social studies and science (see Espin, Shin, & Busch, 2005; Espin, Busch, Shin, & Kruschwitz, 2001; special issue of *Assessment for Effective Intervention* on content area measurement 38, Lembke, E.). These studies have examined both student-read and administrator-read forms. Student-read forms contain 22 vocabulary terms with two distractors printed on the left side of a page and listed alphabetically. Twenty definitions were provided on the right side of the same page; each definition was reworked to contain 15 words or fewer. Vocabulary terms were chosen at random from a social studies textbook and from teachers' lectures. Vocabulary-matching probes were administered for 5 min. Students were expected to read both the vocabulary terms and the definitions and to match each term with its respective definition. Administrator-read probes were developed from the

same list of vocabulary words, but the form students received only contained the vocabulary terms. Administrators read the definitions aloud, one at a time, to students, who were asked to identify the term that best matched the definition read. Probes were administered for 5 min with a 15-s interval between each item. Students received one point for each vocabulary term matched correctly. Espin, Shin, and Busch (2005) found that student-read probes produced reliable and valid growth trajectories and exhibited sufficient sensitivity to growth over time.

Mathematics In mathematics, the most common measures at the elementary level have traditionally been computation or concepts and applications measures (see Foegen et al., 2007 for a detailed review). These measures require students to complete simple arithmetic or applied mathematics problems. In early numeracy development (i.e., kindergarten through grade 1), CBMs in oral counting, number identification, quantity discrimination, and missing number are commonly used. These measures capture early numeracy skills that are believed to be related to later mathematical proficiency and understanding and are based on the principle of number sense (Clarke et al., Chap. 3, this volume; Clarke & Shinn, 2004). CBMs for secondary math instruction in the area of Algebra have also been developed and are discussed at the end of this subsection.

The oral counting CBM requires students to count out loud starting at one and going as far as they can in 1 min. No student materials are required; the administrator records the student's progress on a scoring sheet, placing a bracket after the last number that the student states. The final score is determined as the number of correct values, in a sequence, that the student was able to say. This value is recorded and graphed. Only numbers counted in sequence are counted as correct. Numbers not counted in sequence, and numbers provided to the student after a brief hesitation (e.g., 3 s) are scored as incorrect (Clarke & Shinn, 2004).

Number identification is another early numeracy CBM that requires students to verbally identify, or name, numbers between 1 and 20 that are presented in random order. Students are provided with a form that contains a table of numbers and are asked to read the numbers aloud, reading from left to right

across rows. Numbers correctly identified are scored as correct; numbers misidentified or numbers that are skipped are marked as incorrect. Students pausing for 3 or more seconds are prompted by the administrator to move onto the next number. The number of correctly identified numbers is recorded and graphed (Clarke & Shinn, 2004).

Quantity discrimination asks students to, when presented with two numbers, verbally state which is larger. Numbers are randomly paired and appear side by side in separate boxes. Students are asked to work from left to right across rows identifying the larger number. Boxes in which the student correctly identified the larger number are scored as correct. When students select the smaller number, state an incorrect answer, or hesitate for more than 3 s, an error is marked. As with other CBMs, when the student hesitates for at least 3 s, he or she is prompted by the administrator to move onto the next pair. The number of correctly discriminated pairs is totaled and then recorded (Clarke & Shinn, 2004).

Missing number measures ask students to identify a missing number within a sequence of three, with the missing number appearing at either the initial, medial, or final position. The three-string sequences are presented in individual boxes, and students complete the task with paper and pencil. Students need to correctly identify the missing number in the sequence to receive credit for the response. Responses are scored as incorrect if the student either names the incorrect number or skips a problem. Students who hesitate for at least 3 s are directed by the administrator to move onto the next sequence (Clarke & Shinn, 2004).

Computation CBM assess students' basic computation skills in single, mixed, or multi-step addition, subtraction, multiplication, and division (Lembke & Stecker, 2007). This CBM is group administered for 2–3 min (Fuchs, Fuchs, & Zumeta, 2008). Students receive credit for correctly identified digits when completing each problem; thus, partial credit is possible for more advanced items with two or more digits in the final answer.

Concepts and application measures assess students' skills with completing mathematical problems in an applied context. Included domains in these measures vary by grade level, but can include counting, number concepts, number naming, measurement, money, grid reading, charts, graphs,

fractions, decimals, applied computation, word problems, quantity discrimination, temperature, etc. (Fuchs, Fuchs, & Zumeta, 2008; Lembke & Stecker, 2007). Often math concepts and application measures include multiple digits or words in their complete answers. Students receive credit for the number of blanks completed correctly, allowing them to earn partial credit for their responses.

CBM probes in Algebra, part of Project AAIMS (see http://www.education.ia- state.edu/c_i/aaims/), have been identified and include four different probes. The basic skills algebra probes contain 60 items and are designed to test a student's basic algebra performance in areas including, but not limited to, solving simple equations, combining like terms, applying the distributive property, working with integers, and working with proportions. (Johnson, Gallow, & Allenger, 2013; Foegen & Morri- son, 2010). The basic skills probes are group administered and students have 5 min to complete as many items as they can. Students earn credit (1 point) for each correctly answered problem (60 points maximum); the total number correct are then tallied and graphed (Foegen & Morrison, 2010; Foegen, Olson, & Impecoven-Lind, 2008).

Beyond basic skills, the algebra foundations CBM is group administered for 5 min and assesses student performance across the following domains: (a) variables and expressions, (b) integers, (c) exponents, (d) order of operations, (e) graphing,

(f) solving simple equations, (g) extending patterns in data tables, (h) writing a word phrase for expressions, and (i) graphing expressions. Students earn credit (1 point) for each correct item (50 points maximum; Foegen & Morrison, 2010; Foegen, Olson, & Impecoven-Lind, 2008).

The third AAIMS measure, content analysis, is a multiple-choice CBM that covers numerous algebraic concepts (e.g., solving equations, evaluating expressions, solving linear systems, calculating slope, simplifying expressions with exponents; Foegen & Morrison, 2010; Foegen, Olson, & Impecoven-Lind, 2008). Each problem is worth a total of 3 points. Students earn full credit by circling the correct choice. Partial credit is awarded for showing work using a rubric-based key. Scores are the total sum of points across all problems. Students are provided 7 min to complete as many items as they can (Foegen, Olson, & Impecoven-Lind, 2008).

The final algebra measure is translations. This task requires students to explore numerical relations in multiple formats (e.g., data tables, graphs, equations; Foe- gen, Olson, & Impecoven-Lind, 2008). Students are required to correctly identify matches across the multiple formats. The algebra measures are currently under further development through federal grant work conducted by Foegen and colleagues (see http://www.education.iastate.edu/c_i/aaims/).

Writing CBM in writing originally involved story prompts to which students responded for 3–5 min and were scored for number of words written (WW), words spelled correctly (WSC), and correct word sequences (CWS, which accounts for spelling and grammar; Videen, Deno, & Marston, 1982). These measures have yielded reliable and valid indices of writing proficiency for students in grades 2 and up (see McMaster & Espin, 2007 for a review). Recently, researchers have extended writing CBMs to provide indicators of students' early writing proficiency with evidence of reliability, validity, and sensitivity to growth made over short-time periods (e.g., Coker & Ritchey, 2010; Lembke, Deno, & Hall, 2003; Hampton, Lembke, & Summers, 2010; McMaster, Du, & Petursdottir, 2009; McMaster, Du, Yeo, Deno, Parker, & Ellis, 2011; Parker, McMaster, Medhanie, & Silberglitt, 2011).

CBM for beginning writers has included tasks designed to capture transcription and text generation to reflect early writing development at the word, sentence, and discourse levels of language and has included scaffolding (in the form of verbal, picture, or written prompts) to support young writers' developing self-regulatory skills. The tasks are timed to gauge production fluency, which is a strong predictor of overall writing quality (e.g., Berninger & Swanson, 1994) most likely because fluency in lower-order processes frees up cognitive resources for higher-order processes (Berninger & Amtmann, 2003; McCutchen, 2006). These tasks have included dictation, sentence writing, and story writing. The writing subsection of Table 4.2 provides a summary of research on CBM for beginning writers, highlighting measures that have been established as having adequate reliability, validity, and utility for monitoring progress over time across early elementary grades. Three CBM tasks that are well established in terms of reliability, validity, and capacity to show growth in short-time periods are word dictation, picture-word

prompts, and story prompts. These measures offer teachers a selection of tools that can be utilized at the word, sentence, and discourse levels based on the grade and skill level of their students.

Word dictation (WD), a measure designed to capture students' transcription skills at the word level, is administered individually. WD requires students to write words dictated by the examiner. Words (approximately 20–40) used in these probes may come from high-frequency word lists designed to address students' knowledge of various spelling patterns (e.g., VC, CVC, VCe, etc.), grade-level spelling texts, or unit-specific words.

Picture word (PW) prompts are group administered and are designed to capture students' transcription and text generation skills at the sentence level. Each prompt contains a series of pictures with the corresponding name below the picture. Stu- dents are asked to compose a sentence about the picture and the names of each picture may be read aloud to students prior to administration.

Story prompts (SP), also group administered, are designed to capture students' transcription and text generation skills at the paragraph or discourse level. Each prompt contains a story starter surrounding a topic that reflects the experiences of students attending the US public schools. They contain simple vocabulary and a simple sentence structure. Students are presented with the story prompt and asked to think about their story for 30 s before responding. Elementary aged students are then asked to write independently for 3 min. Secondary level students may write for 5 or 7 min, but the time of administration must remain constant across the academic year.

Issues for Consideration, Including Limitations of the Use of CBM for Screening Decisions

Face Validity and Fluency Educators should use CBMs strategically, realizing that these measures are important for quick screening but other measures may need to be brought to bear in cases where students are identified as needing additional support. In this way, multiple skills in a content area are assessed in order to gain a more robust picture of student ability and draw reasonable conclusions about his or her overall performance. For example, assessing oral reading fluency or letter identification provides one piece of information about a

student's reading ability, but additional measures of reading comprehension as well as diagnostic measures to investigate types of errors made are necessary to make sound instructional decisions for students. Educators should use CBMs with an eye toward interpreting results carefully and within the confines of what the task requires students to do.

Students with Speech and Language Impairments In general, when administering CBMs that require a verbal response to students with speech and language impairments, educators must score and interpret assessment results with caution. Students should not be penalized for errors of production if those errors are a direct result of their speech impairment. Likewise, educators should be careful when interpreting CBM results for students with language impairments, as they may be slower to process directions and give responses. CBM results can provide information about a student's performance, but should not be the only piece of data used to make educational decisions regarding classroom performance for students with speech and language impairments. In addition, consideration should be given to the individual needs of students and whether fluency-based assessments accurately capture students' performance and progress, keeping in mind that in some cases, a fluency-based measure is not appropriate.

For students with speech difficulties, the person administering the fluency CBM should be familiar with the student's speech patterns and be able to correctly score his/her responses. It may be necessary for the school or district's speech-language pathologist to participate in testing or to serve as a second scorer. Additionally, students with a fluency impairment (i.e., a student who stutters) may be accurate in his/her oral reading fluency but may read slowly. These students may have a low rate of words read per minute (WPM) as a result of their dysfluency, not as a result of a true reading deficit. It is important to consider this when making educational decisions and grouping students by ability, as an oral reading fluency CBM may not be the best representation of the reading level of a student who has difficulties or disabilities with respect to speech production.

Students with language impairments may read fluently but may in fact struggle with comprehension and vocabulary of a

CBM passage. Educators must be sure to assess the comprehension of students with language impairments and use data from reading fluency and comprehension measures to determine the need for reading interventions.

In all content areas, including mathematics and writing, students with language impairments may struggle to understand and correctly follow the directions for a CBM task, especially the first time the assessment is given. Every effort must be taken to ensure that CBM results reflect the student's ability in that content area and not the deficits created by their language impairment. Although administration directions are standardized to allow for comparison of results across peers, it may be necessary to repeat or even reword the task directions, depending on the age of the student and the severity of the language impairment. If directions were altered in any way, educators must interpret results carefully and avoid making peer comparisons (e.g., avoid comparing scores collected in that manner to established criterion-referenced goals or benchmarks). Rather, in cases where the standardization of the assessment is lost, only within-individual comparisons can be made (e.g., comparing a student's current performance to her past performance given consistent breaks in standardization between the two administrations). Educators should use several different, and sometimes individualized, assessments to make educational and intervention decisions for students with language impairments.

Future Research

Using CBM fluency data for universal screening can provide a snapshot of a student's academic proficiency in reading, mathematics, writing, and other content areas. Although these tasks have demonstrated adequate reliability and validity and provide a general indication of a student's academic health as it relates to broader academic skills in each of these areas, future research surrounding the use of fluency measures is needed in many areas. Consistent with previous sections of this chapter, issues related to future research are also broken down by skill and content areas.

Reading Although research in CBM in reading is well documented, many areas remain open for future research. Specifically, research might address ways to map reading rates

to productive reading strategies, text type (e.g., narrative vs. expository), level of text difficulty for secondary students, as well as the kinds of qualitative data that can be extracted from fluency measures "to help teachers generate diagnostically useful performance profiles," including linking diagnostic information to instructional recommendations, and exploring methods for assessing prosody and its impact on reading competence (Fuchs, Fuchs, Hosp, & Jenkins, 2001, p. 252).

Mathematics In early mathematics, we need more research regarding whether a single mathematical indicator can be utilized across multiple grade levels to track student progress and growth over time *or* whether multiple measures of early mathematical fluency are required for assessing progress (Clarke & Shinn, 2004). At the secondary level, more research is needed surrounding the technical adequacy of CBM in advanced mathematics, such as algebra or geometry, along with the "instructional utility" (Calhoon, 2008, p. 237) of these measures for teachers making instructional decisions. Future research might also explore the criterion validity of M-CBM and high-stakes assessments, as well as the criterion and predictive validity of multiple-skill M-CBMs (measures with several types of mathematics tasks on one probe) (Christ & Vining, 2006).

Writing What defines fluency and how to define fluency in writing continues to remain an area for future research. Though quantitative scoring indices have primarily been utilized throughout the early research in this area (Coker & Ritchey, 2010) in which researchers have demonstrated that simple, countable indices of writing such as WW, WSC, and CWS are reliable and valid (Deno, Marston, Mir- kin, Lowry, Sindelar, & Jenkins, 1982; Deno, Mirkin, & Marston, 1982; Videen, Deno, & Marston, 1982), the validity of these writing indices have not remained stable across grade level. Furthermore, relatively little work explores alternative scoring indices in writing or the use of qualitative writing indices. Whether such scoring (both quantitative and qualitative) is consistent with the indices that teachers value most must also be considered (Gansle, Noell, VanDerHeyden, Naquin, & Slider, 2002).

Content Areas In the content areas of social studies and science, CBM vocabulary assessments offer promise, however, relatively little work exists in this area. Although research has begun to address how vocabulary assessments might be used

for making placement decisions, identifying discrepancies in student performance and progress, and determining need for intervention (Espin, Busch, Shin, & Kruschwitz, 2001; Espin, Shin, & Busch, 2005), additional empirical research is needed. Research is also needed in using vocabulary-matching measures as progress-monitoring measures, on how CBM in vocabulary influences teacher decision-making, and on student achievement in the content areas (Espin, Busch, Shin, & Kruschwitz, 2001; Espin, Shin, & Busch, 2005).

Moreover, fluency tasks in the above outlined areas share many similar challenges that necessitate future research. Although research must continue across all of Fuchs' (2004) stages given the varying depths of the extant literature in the different areas, specific attention is needed in stage 3. Namely, as Espin, Shin, and Busch (2005) noted above, fluency CBMs must explore the effect of both screening and progress monitoring on teachers' instructional practices and student performance (see also Foegen & Morrison, 2010, regarding the effect of teacher use of CBM on student progress), as well as on special education decision-making. As Fuchs (2004) adds, incorporating teacher and student feedback loops for designing "instruction- ally informative diagnostic profiles" as supplements to graphing, may improve "CBMs instructional utility" (p. 191). If the goal is that use of CBM will result in improved outcomes for students, research must ensure that teachers know how to use and interpret CBM scores to inform their instruction. Similarly, teachers must perceive the data obtained through the use of CBM as useful, what Calhoon[1] (2008) calls the "acceptability or utility" (p. 237) of CBM. Acceptability can be particularly difficult at the middle and high-school levels where teachers' caseloads often exceed 100–180 students (Calhoon, 2008). The unique needs of secondary teachers and students must be examined, as certain CBM measures and scoring techniques may not be appropriate for adolescent learners, failing to adequately capture their individual progress.

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[1] Although Calhoon talks specifically of the struggles in mathematics, these concerns must be recognized across content classes at the secondary level.

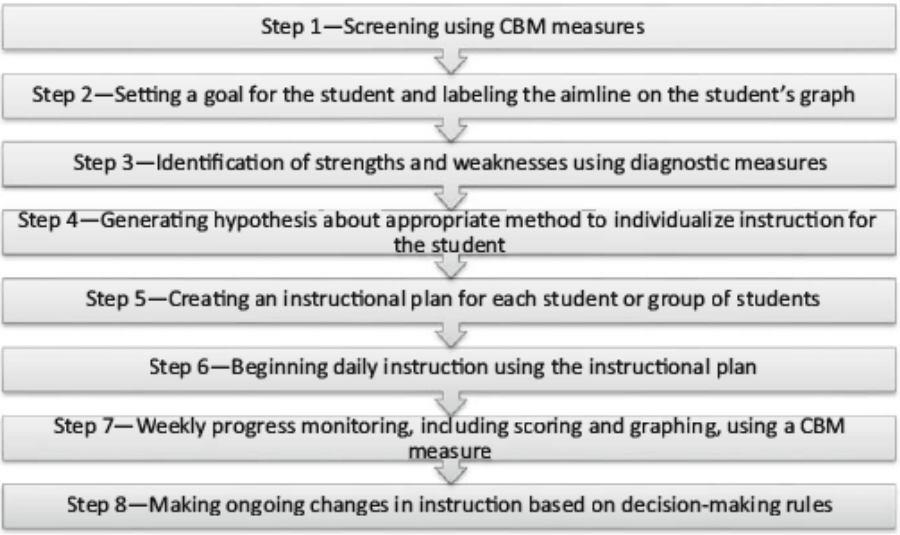

Fig. 4.4 Steps in a data-based model for decision-making using CBM

Furthermore, the movement toward multiple-skill CBM measures over single- skill measures, has been supported, as adequate growth over time in the latter may not be sufficient for demonstrating broader knowledge in the content domain (Fuchs, 2004). Fuchs (2004) also suggests that long-term progress monitoring using single-skill measures may too narrowly restrict teachers' instructional focus.

Finally, while Tindal and Parker (1991) recommend "embed[ding] assessment within a decision-making framework" (p. 218) for writing, such a recommendation is also important for the other fluency measures. Situating and supporting instructional, intervention, and placement recommendations within and with data-based decisions is central to identifying what to measure, how to improve performance, and how to document student growth to ensure that the decisions being made accurately reflects student need (Tindal & Parker, 1991; See Fig. 4.4 for specific steps). As fluency is a complex construct, research must continue to explore the many nuances of what it means to be fluent in reading, mathematics, writing, and the con- tent areas across grade levels and across ability levels of students. Unfortunately, such measures will only be useful to the extent that they are properly used, interpreted, and provide valuable instructional recommendations for teachers. Though the current research demonstrates great promise, much work remains.

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