

Using CBM as an Indicator of Decoding, Word Reading, and Comprehension: Do the Relations Change With Grade?

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Abstract. The primary purpose of this study was to assess whether the relation between curriculum-based measurement (CBM) and specific reading skills changes as a function of grade. In addition, this study sought to identify cutscores that correspond with benchmark performance on a variety of reading subskills at Grades 1 through 4. Participants were 310 students, distributed approximately equally across grades, from four schools. Participants were administered CBM reading passages and the Word Attack, Word Identification, and Passage Comprehension subtests from the Woodcock Reading Mastery Test–Revised. Findings indicated that the relation between CBM with decoding, word reading, passage comprehension, basic skills, and total reading-short was strong at each grade level. Benchmarks could not be differentiated for individual reading subskills, but were identified for overall reading competence at each grade level. Implications are drawn for helping school psychologists and other practitioners determine which students need further instructional support in reading.

Reading is the most critical academic skill students will learn and one of the best predictors of overall success in school (Stanovich, 1986) and society (Lyon, 1997). Therefore, reading continues to be a leading topic at the national level (No Child Left Behind; NCLB, 2002) and at the school level. There is no question that teaching all of our students to read by the end of third grade, as mandated under NCLB, is a challenge. To accomplish this task, assessments are needed to help educators efficiently and accurately

screen, diagnose, and monitor the progress of students' reading skills across the early grades.

Although screening, diagnostic, and progress monitoring assessments all provide useful information to help students achieve success in reading, they differ in the amount of information, cost, and time it takes to obtain the information. Screening assessments are meant to be short and efficient. However, this format makes them inappropriate for diagnostic assessment because they do not assess all skills and/or any one particular skill in depth.

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And because screening assessments lack depth and breadth, they do not provide educators with meaningful information that can be linked directly to instructional strategies. Diagnostic assessments, on the other hand, are designed to identify which skills the student has or has not mastered so that an appropriate course of instruction can be determined. Whereas these assessments are more in depth, they are not practical for monitoring student progress because they take longer to administer, provide few if any alternate forms, and are typically expensive to purchase (Fuchs & Fuchs, 1999). Monitoring assessments, by contrast, are designed to be efficient and accurate, provide multiple forms, and be inexpensive to reproduce.

In addition to differences in the amount of information, cost, and efficiency, differences in the criterion validity of these forms of assessment may exist. In fact, the criterion validity of these assessments is rarely compared. Although numerous studies (Deno, Mirkin, & Chiang, 1982; Fuchs & Deno, 1981; Shinn, Good, Knutson, Tilly, & Collins, 1992) have examined the criterion validity of progress-monitoring tools such as curriculum-based measurement (CBM) with respect to commercial assessments such as the Woodcock Reading Mastery Test–Revised (WRMT-R; Woodcock, 1987) few have compared how CBM relates to the subskills assessed on diagnostic assessments and few have examined the adequacy of CBM progress monitoring for different stages of reading development. Therefore, it is unknown if the relation between CBM and specific reading skills such as decoding, word reading, and comprehension changes as a function of reading development (i.e., across grades). This is important because as school psychologists and other educators use CBM to monitor progress, this information could provide additional insight about the specific reading subskills CBM is tapping at different grade levels.

This article reports a study that addressed whether the relation between CBM and specific reading skills changes as a function of reading development (i.e., across grades). Specifically, we investigated if the relation between

CBM is comparably strong with Word Attack, Word Identification, Passage Comprehension, Basic Skills Cluster, and Total Reading–Short on the WRMT-R (1987) as a function of grade (1–4). A second purpose of this study was to identify if CBM cutscores correspond with benchmark performance on these WRMT-R measures. If so, these benchmarks could prove useful for determining who may need further instructional support, while providing evidence that CBM is sensitive at distinguishing among specific reading skills at the various grades.

Numerous studies have reported on the relation between CBM and criterion tests of decoding (e.g., Shinn et al., 1992), word reading (e.g., Shinn et al.; Tindal et al., 1983), and comprehension (e.g., Jenkins & Jewell, 1993; Kranzler, Miller, & Jordan, 1999; Shinn et al.). For example, Shinn et al. looked at the relation between CBM and decoding, word reading, and comprehension with students in general and special education Grades 3 and 5. Decoding was measured using the Word Attack subtest on the Woodcock Reading Mastery Test (Woodcock, 1973). Word Reading was measured using the Test of Written Spelling (Larsen & Hammill, 1976). Comprehension was measured three ways: the Stanford Diagnostic Reading Test (SDRT; Karlsen, Madden, & Gardner, 1975), written retell (Fuchs, Fuchs, & Maxwell, 1988), and cloze (Fuchs et al.). Results indicated that the correlations were higher in Grade 3 on decoding (.69), word reading (.71), and comprehension (.59) (when averaging the correlations on literal and inferential comprehension on the SDRT) than at Grade 5 on decoding (.49), word reading (.69), and comprehension (.58). The research did not, however, test to see if these differences were statistically significant; for word reading and comprehension they do not appear reliably different. Tindal et al. found similar results for students in general education at Grade 6 on the basic skills reading test in the Houghton-Mifflin reading series. The correlation for CBM was .47 with decoding; .66 with comprehension. Similar to Shinn et al., they did not determine if these differences were statistically significant.

Moreover, researchers who have focused only on comprehension and total reading scores have found that the relation between CBM and comprehension decreases with grade. Jenkins and Jewell (1993), for example, looked at the relation between CBM and comprehension skills along with total reading scores on the Gates-MacGinitie Reading Tests (MacGinitie, Kamons, Kowalski, MacGinitie, & McKay, 1978) and the Metropolitan Achievement Test (Prescott, Balow, Hogan, & Farr, 1984). Overall, the correlations for comprehension and total reading showed a negative trend as grade increased. The correlations at Grades 2 and 4 were higher than at Grades 5 and 6 for comprehension, whereas the correlations at Grades 2, 3, and 4 were higher than at Grades 5 and 6 for total reading.

Similar to the results reported by Jenkins and Jewell (1993), Kranzler et al. (1999) reported a negative trend between CBM and comprehension. Kranzler et al. looked at the relation between CBM and reading comprehension on the California Achievement Tests. Results indicated that the correlations were higher at Grade 2 than at Grades 3, 4, and 5. However, these differences were not tested to determine if they were statistically significant.

The results from these studies indicate that CBM may be measuring different reading subskills at different grade levels. However, this remains unclear. Jenkins and Jewell (1993) and Kranzler et al. (1999) do not report on the relation between CBM and decoding or word reading. In the same way, Shinn et al. (1992) and Tindal et al. (1983) did not provide information on the relation between CBM and decoding, word reading, and comprehension across the early grades. Without this information, it is unclear if CBM is appropriate for monitoring specific reading skills like decoding, word reading, and comprehension as reading develops across grades. In a decision-making model, this information would aid school psychologists in understanding what specific reading subskills are being assessed at the different grade levels. If CBM does assess different reading subskills across grades, this could have implications for interventions as well as what type of additional assessments might be

recommended to further diagnose or assess students' reading skills.

To compare CBM with specific reading skills (e.g., decoding, word reading, and comprehension) across grades, it is important to understand how these subskills develop over time. Chall's (1983) developmental model is helpful because it includes the grades focused on in the current study and provides a series of three stages that can be compared to each other. In Stage 1 (Grades K–2), the reader continues to develop an understanding of the phoneme-grapheme relation that helps students learn that individual letters and groups of letters comprise different sounds (i.e., decoding). In Stage 2 (Grades 2–3), the reader continues practicing decoding words but develops automatic word recognition and starts to read with fluency. In Stage 3 (Grades 4–8), the focus moves away from decoding and is centered more on comprehension. Not surprisingly, instruction often mirrors these stages.

Although studies have looked at the relation between CBM and specific reading skills at individual grades or across grades, the research base does not address the utility of CBM as an indicator of each of these subskills (i.e., decoding, word reading, and comprehension) at various grades. Another related question concerns the utility of identifying CBM cutscores that correspond with some benchmarks of competence. For example, can one identify a CBM score at Grade 1 that is strongly associated with competent decoding and below which, remediation should occur? Various studies have examined whether using CBM by itself or in conjunction with other measures can be used to screen students for future poor academic performance including success or failure on high stakes testing (Sibley, Biwer, & Hesch, 2001) or broad reading benchmarks at subsequent grades (Good, Simmons, & Kame'enui, 2001; Sibley et al.; Stage, 2001). However, no studies have examined whether CBM cutscores can be identified to assess benchmarks of mastery on norm-referenced tests of decoding, word reading, and comprehension. This information could aid school psychologists in making decisions about which CBM cutscores to use to determine who needs

further instruction on specific reading subskills as well as being informative as to who is on track for developing these skills.

This study contributes to the existing literature on CBM in two important ways. First, we assessed whether the relation between CBM and specific reading skills as measured on the WRMT-R (Woodcock, 1987; i.e., Word Attack, Word Identification, Passage Comprehension, Basic Skills Cluster, and Total Reading–Short) changes as a function of grade. Second, we examined the utility of CBM cutscores as benchmarks of mastery on Word Attack, Word Identification, Passage Comprehension, Basic Skills Cluster, and Total Reading–Short on the WRMT-R at Grades 1 through 4. The WRMT-R was chosen for this study because it provides an index of decoding (Word Attack), word reading (Word Identification), and comprehension (Passage Comprehension), which this study focused on as well as providing an index of general reading ability (i.e., Basic Skills Cluster and Total Reading–Short). The WRMT-R also has good psychometric properties with concurrent validity coefficients ranging from .63 to .86, and the split-half reliability coefficients ranging from .91 to .98 across Word Attack, Word Identification, and Passage Comprehension. An additional reason for using the WRMT-R is its wide use in research studies, which allows comparisons between our results and those of other studies. However, one potential downside to using this assessment is the possibility of having a floor effect in the lower grades. This occurs due to a lack of adequate items at the lower end of the range indicating that the assessment may be less sensitive for measuring skills for early grades (i.e., Grade 1) or for older students with fewer skills.

Method

Participants

Participants were 310 English-speaking students in a southeastern metropolitan area in 16 classrooms (four at each grade, first through fourth) in four schools. The principal in each school was initially contacted and permission was given to solicit first through fourth grade teachers for participation in this study. The first

author met with the teachers in the four schools to discuss their participation in the study. Those who agreed sent home consent forms with every English-speaking student in their class. Every student who returned a consent form participated in the study. The teachers resent consent forms home until we obtained approximately 80 students at each of the four grade levels. On average we assessed 18 students in each of the 16 classrooms.

The percentage of students receiving free or reduced lunch at each of these four schools was 81.8, 42.4, 41.2, and 34.4. See Table 1 for demographics. Chi-square tests applied to sex, race, and special education status revealed no statistically significant relation with grade.

Measures

CBM. Eight CBM reading passages, two at each grade, were administered at students' grade-appropriate level. These passages were developed by Fuchs and Fuchs (1992); they are generic (i.e., not from the student's classroom curriculum, but developed to represent grade level text). Fuchs and Deno (1994) demonstrated generic passages are as effective as curriculum-specific passages for monitoring student progress in reading. The average of the number of words read correctly in 1 minute across the two passages was used as the CBM score. Words read correctly are those pronounced accurately while reading the passage. Repetitions and self-corrections within 3 seconds are counted as correct. Errors are substitutions, omissions, and hesitations (more than 3 seconds).

The test-retest reliability on the CBM passages used in this study was assessed using a random sample of approximately 30 students at each grade. These students were retested during a third session, with at least 1 week but not more than 3 weeks between test-retest sessions. Test-retest reliability for the CBM passages used at first grade was .96 ($n = 29$); at second grade, .97, ($n = 30$); at third grade, .93 ($n = 30$); and at fourth grade .92 ($n = 29$). In terms of CBM validity, Fuchs, Fuchs, and Maxwell (1988) demonstrated that CBM has good criterion validity with reading comprehension on the Stanford Achievement Test,

Table 1
Demographic Information for Students by Grade Level

	Grade				(df)	χ^2_a
	1 (N = 74)	2 (N = 81)	3 (N = 79)	4 (N = 76)		
Sex					(3)	.95
Male	42 (57%)	45 (56%)	42 (53%)	40 (53%)		
Female	32 (43%)	36 (44%)	37 (47%)	36 (47%)		
Race					(6)	.07
African American	30 (40%)	30 (37%)	44 (56%)	37 (49%)		
Caucasian	36 (49%)	45 (56%)	31 (39%)	38 (50%)		
Other	8 (11%)	6 (7%)	4 (5%)	1 (1%)		
Special Education Status					(3)	.528
Yes	4 (5%)	8 (10%)	9 (11%)	9 (12%)		

*None of these χ^2 values were statistically significant.

with a correlation coefficient of .91. In addition, Deno et al. (1982) demonstrated strong criterion validity between CBM and reading comprehension using the cloze technique. At third grade, they found a correlation of .86; at sixth grade, .87.

Woodcock Reading Mastery Test-Revised Word Attack. The WRMT-R (Woodcock, 1987) Word Attack subtest was used as an index of students' decoding skill and to determine the relation with CBM across grades. This subtest requires the student to read nonsense words in isolation and provides a standard score with a mean of 100 and standard deviation of 15. The split-half reliability of this subtest is .94 at first grade; .91 at third grade. Concurrent validity with the Woodcock-Johnson Psycho-Educational Battery total reading score is .69 at first grade; .68 at third grade.

Woodcock Reading Mastery Test-Revised Word Identification. The WRMT-R (Woodcock, 1987) Word Identification subtest was used as an index of students' word reading skill and to determine the relation with CBM across grades. This subtest requires the student to read words in isolation and provides a standard score with a mean of 100 and standard deviation of 15. The split-half reliability of this subtest is .98 at first grade; .97 at third grade. Concurrent validity with the Woodcock-Johnson Psycho-Educational Battery total reading score is .82 at first grade; .86 at third grade.

Woodcock Reading Mastery Test-Revised Passage Comprehension. The Passage Comprehension subtest of the WRMT-R (Woodcock, 1987) was used as an index of students' comprehension skill and to determine the relation with CBM across grades. This

subtest requires the student to read a sentence or sentences and supply one word that has been deleted. It provides a standard score with a mean of 100 and standard deviation of 15. The split-half reliability of this subtest is .94 at first grade; .92 at third grade. Concurrent validity with the Woodcock-Johnson Psycho-Educational Battery total reading score is .63 at first grade; .71 at third grade.

Woodcock Reading Mastery Test-Revised Basic Skills. The Basic Skills score on the WRMT-R (Woodcock, 1987) was used as an index of students' overall word reading ability and to determine the relation with CBM across grades. This score comprises the Word Identification and Word Attack subtests. It provides an overall index of word reading ability as it relates to decoding nonsense words and reading real words. It provides a standard score with a mean of 100 and standard deviation of 15. The split-half reliability of this subtest is .98 at first grade; .97 at third grade. Technical data for concurrent validity are not provided for basic skills.

Woodcock Reading Mastery Test-Revised Total Reading-Short. The Total Reading-Short score on the WRMT-R (Woodcock, 1987) was used as an index of students' overall reading ability and to determine the relation with CBM across grades. This score comprises the Word Identification and Passage Comprehension subtests. It provides an overall index of reading ability as it relates to word reading and comprehension. It provides a standard score with a mean of 100 and standard deviation of 15. The split-half reliability of this subtest is .98 at first grade; .97 at third grade. Although concurrent validity is provided for Total Reading, no correlations were provided for Total Reading-Short.

Procedure

Training. Seven research assistants were trained over several days on the administration of CBM and the three subtests of the WRMT-R (Woodcock, 1987). Training was accomplished by using audiotapes of students tested earlier that year on CBM, Word Attack, Word Identification, and Passage Comprehension.

The training was carried out in four steps. First, the research assistants reviewed the administration and scoring procedures for CBM and the three subtests of the WRMT-R. Second, in a group, the research assistants listened to three audiotapes and scored student responses. Third, the seven research assistants' scores were compared to the original scores and percentage agreement was calculated using the formula for simple agreement (number of agreements divided by number of agreements plus number of disagreements multiplied by 100). Fourth, discrepancies in scoring and pronunciation of words were discussed and clarified. This last step was repeated until each research assistant demonstrated 100% agreement on CBM passages and a minimum of 95% agreement on the three subtests of the WRMT-R.

The assessments were administered over two sessions during the last 2 months of the regular school year, with between 2 and 18 school days between the two sessions. Each session was tape recorded and this recording was later used to determine accuracy of scoring. The first session included one CBM passage at the student's grade level and the Word Identification and Word Attack subtests of the WRMT-R (Woodcock, 1987). The second session included a second CBM passage at the student's grade level and Passage Comprehension of the WRMT-R.

Scoring. To determine the scoring accuracy of the research assistants, the first author initially established agreement with one research assistant. This was accomplished by having the first author and research assistant listen to 20 random audiotapes and score the responses of the students. The percentage agreement was calculated using the formula for simple agreement. The initial agreement between the first author and the research assistant was 99% for CBM, 98% for Word Identification, 95% for Word Attack, and 99% for Passage Comprehension of the WRMT-R (Woodcock, 1987). (Agreement was not relevant for Basic Skills because it is a combination of Word Identification and Word Attack, or for Total Reading-Short because it is a combination of Word Identification and Passage Comprehension.)

Once agreement between the first author and the research assistant was established, classrooms for all seven research assistants were divided and 20% of the students tested in each classroom were rescored by the first author and the one research assistant by listening to the audiotapes. The rescored protocol was then compared with the original scores obtained by the research assistant working with that class. The percentage agreement, calculated using the formula for simple agreement, across all seven of the research assistants was .99 for CBM passages, .99 for Word Identification, .96 for Word Attack, and .99 for Passage Comprehension of the WRMT-R (Woodcock, 1987).

Data Analysis

The distribution for each measure first was inspected to ensure normality, which is essential for using parametric statistics (e.g., correlations, *t* tests). This was accomplished by visual inspection and use of the Kolmogorov-Smirnov test of normality to check for any distributions that were significantly skewed. Distributions that reached significance of .05 were reexpressed using Tukey's ladder of reexpression (Tukey, 1977). Based on this procedure, the following variables were reexpressed: CBM at Grade 1, Word Attack at Grade 4, Word Identification at Grades 3 and 4, Passage Comprehension at Grade 4, Basic Skills Cluster at Grades 3 and 4, and Total Reading-Short at Grades 2, 3, and 4. The reexpressed variables were used in all analyses.

For each grade, correlations were calculated between the average of two CBM scores and the total raw scores on the following subtests of the WRMT-R (Woodcock, 1987): (a) Word Attack, (b) Word Identification (c) Passage Comprehension, (d) Basic Skills Cluster, and (e) Total Reading-Short. The differences in the correlations between CBM and the subtests on the WRMT-R were then examined *across* the grades using the formula for independent samples:

$$Z = \frac{(z_1 - z_2) - 0}{\sigma} \quad z_1 = z_2 = \frac{1}{\sqrt{N_1 - 3}} + \frac{1}{\sqrt{N_2 - 3}} \quad (\text{Blalock, 1960}).$$

Zero is used in the above formula to test the null hypothesis that the two population correlations are identical (Blalock, 1960). The other way the correlations were examined was to conduct *within* grade comparisons using the following formula for dependent samples:

$$t = \frac{(r_w - r_c) \sqrt{(N - 3)(1 + r_c)}}{\sqrt{2(1 - r_{w,2} - r_{c,2} - r_{w,2} + 2r_{w,c}r_{c,w})}} \quad (\text{Blalock, 1960}).$$

The formula for independent samples was used because the comparison was conducted across grade levels where each student was represented only once, making the samples independent of each other. On the other hand, the formula for dependent samples was used because the comparison was conducted within each grade level where the students were represented in each variable, meaning the sample comprised the same students, and, therefore, was dependent.

Additionally, predictive discriminant analysis (PDA), a type of discriminant function analysis (Huberty, 1994), was used to determine how well CBM could predict student mastery versus nonmastery on the following WRMT-R (Woodcock, 1987) subtests: (a) Word Attack, (b) Word Identification, (c) Passage Comprehension, (d) Basic Skills Cluster, and (e) Total Reading-Short. PDA is used when the primary question of interest is dealing with the accuracy of predicting group membership. In this study, PDA was employed at each grade level to determine the accuracy at which CBM can be used to identify student status (mastery/nonmastery) on each reading skill.

To use PDA in this way, mastery criteria for distinguishing mastery from nonmastery must first be identified. A standard score of 85 was used as the benchmark for mastery and below 85 as nonmastery for Grades 2, 3, and 4. A standard score of 90 was used for these grades because it is one standard deviation below the mean and represents the low end of average based on the distribution for this instrument. However, for Grade 1 a standard score of 90 was used as the benchmark for mastery and below 90 as nonmastery. A stan-

standard score of 90 was chosen because this study indicates that at first grade the WRMT-R (Woodcock, 1987) is not as sensitive as it is at later grades at distinguishing between students who have and have not mastered basic reading skills. For example, only a small percentage of students in first grade (an average of 3.6% across measures), scored below 85 on Word Attack, Word Identification, or Passage Comprehension as compared to 6% in second grade, 10% in third grade, and 13% in fourth grade. To ensure there was optimal opportunity to distinguish between these two groups it was determined that a higher standard score at first grade would aid in making meaningful distinctions between those students who had mastered these skills and those who had not. By using a standard score of 90, we were able to look at 7% of first graders who scored below 90 compared to 3.6% who scored below 85.

In addition, to analyze the impact of false negatives (i.e., those students who did not master the skill but were predicted as having mastered the skill) and false positives (i.e., those students who had mastered the skill but

were predicted as not having mastered the skill), the sensitivity and specificity indices provided by PDA were examined for each of the three reading skills (i.e., decoding, word identification, and comprehension). The sensitivity index is influenced by false negatives (sensitivity = true positives / [true positives + false negatives]) and provides an index of how well the criteria identified students who have not mastered these skills (i.e., true positives). On the other hand, the specificity index is influenced by false positives (specificity = true negatives / [true negatives + false positives]) and provides an index of how well the criteria identified students who have mastered these skills (i.e., true negatives).

Although the information provided by the PDA is valuable from a psychometric standpoint, it does not provide the CBM cutscore for determining the benchmark associated with mastery versus nonmastery. The cutscore used by PDA, however, can be determined by plotting the CBM and the WRMT-R (Woodcock, 1987) data on a scatterplot. The values provided by PDA that equate to the number of true

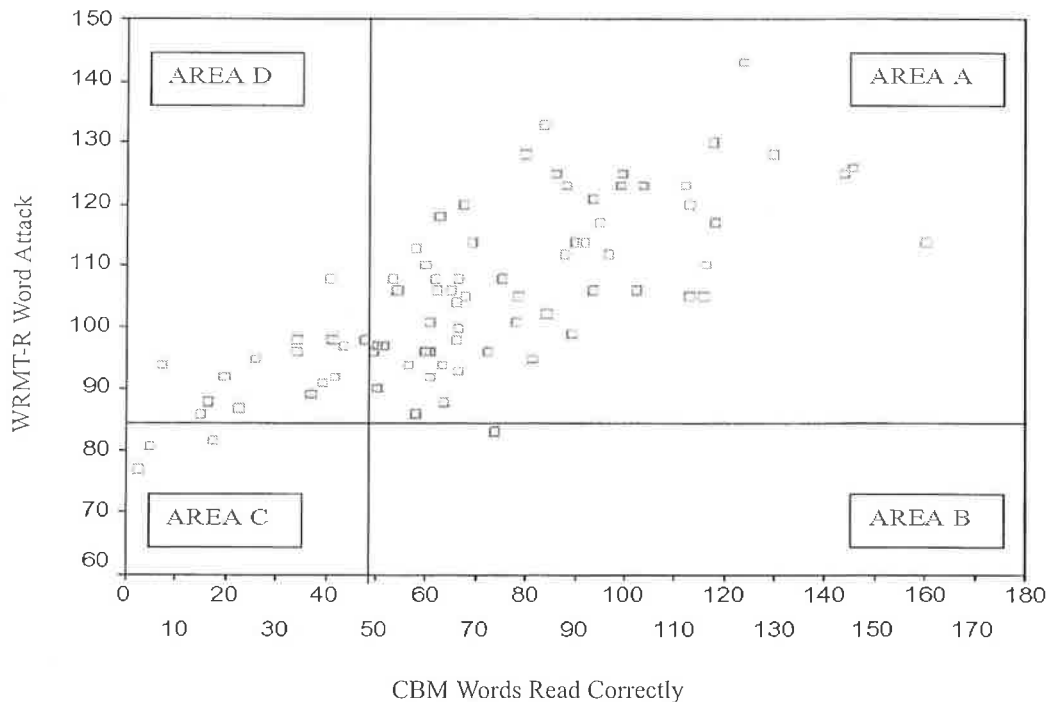


Figure 1. Example of benchmark interpretable areas of applying PDA data to determine second grade CBM cutscore on word attack (WRMT-R).

positives, true negatives, false positives, and false negatives can then be overlaid onto a scatterplot.

Figure 1 provides an example of the scatterplot for second-grade students using the results from PDA for CBM and Word Attack on the WRMT-R (Woodcock, 1987). The horizontal line drawn through the scatterplot represents the standard score on the WRMT-R. The vertical line drawn through the scatterplot represents the CBM cutscore used to divide the group into true and false positives and true and false negatives based on the PDA data. Area A represents students whose CBM and Word Attack subtest score are both sufficiently high, indicating they are on-track for reading (i.e., true negatives). Area B represents students whose CBM score is sufficiently high but whose Word Attack subtest score is too low, indicating they may need assistance with decoding (i.e., false negatives). Area C represents students whose CBM and Word Attack subtest scores are both sufficiently low, indicating they may need assistance with both decoding and reading fluency (i.e., true positives). Area D represents students whose Word Attack subtest score is sufficiently high but whose CBM score is too low, indicating they may need assistance with reading fluency (i.e., false positives). This procedure was used for each reading skill in Grades 1, 2, 3, and 4.

Results

Scores on CBM and WRMT-R

Means and standard deviations for CBM and the WRMT-R (Woodcock, 1987) along with the correlation coefficients between CBM and (a) Word Attack (decoding), (b) Word Identification (word reading), (c) Passage Comprehension (comprehension), (d) Basic Skills, and (e) Total Reading-Short (total reading) for each grade are displayed in Table 2. Results indicated that the relation between CBM and decoding, word reading, comprehension, basic skills, and total reading on the WRMT-R were all strong at each grade level. The differences were also tested among the correlations *across* grades and *within* grades for CBM and (a) decoding, (b) word reading, (c) comprehension,

(d) basic skills cluster, and (e) total reading. These results varied based on whether the comparison was being made across or within grades as well as for specific skills (i.e., decoding, word reading, and comprehension).

The results for comparisons *across* grades indicated that the relation between CBM and decoding was generally higher in Grades 2 and 3 than Grades 1 and 4 and that the relation between CBM and word reading was stronger at Grades 1, 2, and 3 compared to Grade 4. In contrast, results comparing CBM and comprehension indicated no difference across the grades. The comparisons between CBM and basic skills as well as total reading, however, tended to favor Grades 1, 2, and 3 over Grade 4. Although these results provide information about the relation of CBM with specific reading skills across these grades it is also important to look at the relation between CBM and these specific reading skills within each of the grades tested.

The results for comparisons *within* each grade indicated that at Grades 1 and 3, CBM had a stronger relation with word reading than with decoding or comprehension. By contrast, there was no difference in relation between CBM with decoding, word reading, and comprehension at second grade, whereas at fourth grade, a stronger relation emerged between CBM and comprehension over decoding and word reading. The relation between CBM and basic skills appeared to be stronger than the relation between CBM and decoding or comprehension at grades 1 and 2, and CBM and decoding at Grades 3 and 4. Finally, the relation between CBM and total reading appeared to be stronger than the relation between CBM and all other skills at Grades 1, 2, 3, and 4. This information is provided in Tables 3 and 4 as a summary of the *Z* scores and *t* scores.

Predictive Discriminant Analysis and Cutscores

PDA was used to provide scores for hit rates, sensitivity, and specificity for (a) decoding, (b) word reading, (c) comprehension, (d) basic skills, and (e) total reading for each of the four grades (see Table 5). The hit rate provides an overall indication of how well CBM

Table 2
 Means, Standard Deviations, and Correlation Between CBM, Decoding, Word Reading, Comprehension, Basic Skills,
 and Total Reading-Short on the WRMT-R

	Grade											
	1			2			3			4		
	<i>M</i>	<i>SD</i>	<i>r</i>	<i>M</i>	<i>SD</i>	<i>r</i>	<i>M</i>	<i>SD</i>	<i>r</i>	<i>M</i>	<i>SD</i>	<i>r</i>
CBM	38.7	29.83	-	70.7	33.48	-	97.7	39.26	-	110.7	35.70	-
Decoding	109.50	13.08	.71**	105.1	13.87	.82**	102.3	14.19	.82**	98.7	10.85	.72**
Word Reading	111.51	12.86	.91**	103.5	12.28	.88**	102	13.54	.88**	98.1	11.27	.73**
Comprehension	106	11.77	.79**	102.9	12.11	.83**	101.3	13.16	.84**	98.4	12.99	.82**
Basic Skills	110.8	12.74	.86**	104.8	14.54	.89**	102.8	15.71	.87**	98.6	12.16	.78**
Total Reading	109.4	12.41	.90**	104.2	13.62	.91**	102.1	14.26	.91**	98	12.06	.83**

** $p < .01$.

Table 3
Z Scores for the Correlations Across Grades Between CBM and Decoding, Word Reading, Comprehension, Basic Skills, and Total Reading-Short on the WRMT-R

	Grades					
	1 v. 2	1 v. 3	1 v. 4	2 v. 3	2 v. 4	3 v. 4
Decoding	1.68*	1.73*	.10	-	2.19*	1.62
	(.71/.82)	(.71/.82)	(.71/.72)	(.82/.82)	(.82/.72)	(.82/.72)
Word Reading	1.07	1.01	3.59***	-	2.60**	2.63**
	(.91/.88)	(.91/.88)	(.91/.73)	(.88/.88)	(.88/.73)	(.88/.73)
Comprehension	.62	.77	.53	.16	.07	.23
	(.79/.83)	(.79/.84)	(.79/.82)	(.83/.84)	(.83/.82)	(.84/.82)
Basic Skills	.74	.18	1.53	.56	2.32**	1.75*
	(.86/.89)	(.86/.87)	(.86/.78)	(.89/.87)	(.89/.78)	(.87/.78)
Total Reading	.16	.16	1.70*	-	1.91*	1.90*
	(.90/.91)	(.90/.91)	(.90/.83)	(.91/.91)	(.91/.83)	(.91/.83)

* $p < .05$, ** $p < .01$, *** $p < .001$.

Correlations are provided in the parentheses. Z scores were not calculated when correlations were identical as indicated by -.

predicted student success on each of the specific reading skills. Therefore, the higher the percentage, the better CBM was at identifying true negatives (i.e., those that scored high on both CBM and the WRMT-R) and true positives (i.e., those that scored low on both CBM and the WRMT-R). The sensitivity index indicates how well CBM identified those students who did not master the specific reading skills, whereas the specificity index indicates how well CBM identified those students who did master the specific reading skills. In this way the hit rate is viewed as a general guideline of how well CBM distinguishes between students who have and have not mastered these specific reading skills. The sensitivity and specificity indices, however, provide further understanding of how well CBM distinguishes between students who may require further assistance (i.e., sensitivity index) on these specific read-

ing skills from those that do *not* require further assistance (i.e., specificity index).

The hit rate results for CBM and decoding, word reading, comprehension, basic skills, and total reading indicated that CBM did a good job of distinguishing students' mastery versus nonmastery in each of these areas at Grades 1, 2, 3, and 4. Moreover, the sensitivity and specificity index indicated that CBM also did a good job of correctly identifying students who scored below a standard score of 90 at Grade 1 and 85 at Grades 2 through 4 on each reading subskills as well as basic skills and total reading.

In addition, CBM cutscores for each of the reading skills were determined using the PDA classification results overlaid on a scatterplot (see Table 6). These cutscores provide a guideline as to how many words read correctly per minute correspond with student

Table 4
***t* Scores for the Correlations Within Grades Between CBM and Decoding,
 Word Reading, Comprehension, Basic Skills, and Total
 Reading—Short on the WRMT-R**

	Grade			
	1	2	3	4
Decoding & Word Reading	8.35*** (.71/.91)	-1.94 (.82/.88)	2.07* (.82/.88)	.39 (.72/.73)
Decoding & Comprehension	1.79 (.71/.79)	.17 (.82/.83)	.29 (.82/.84)	2.29* (.72/.82)
Decoding & Basic Skills	10.40*** (.71/.86)	3.94*** (.82/.89)	2.26* (.82/.87)	2.44* (.72/.78)
Decoding & Total Reading	7.60*** (.71/.90)	3.70*** (.82/.91)	3.31** (.82/.91)	3.23** (.72/.83)
Word Reading & Comprehension	4.22*** (.91/.79)	1.87 (.88/.83)	1.44 (.88/.84)	2.07* (.73/.82)
Word Reading & Basic Skills	5.30*** (.91/.86)	.91 (.88/.89)	1.02 (.88/.87)	2.00* (.73/.78)
Word Reading & Total Reading	.86 (.91/.90)	1.77 (.88/.91)	2.59* (.88/.91)	5.30** (.73/.83)
Comprehension & Basic Skills	1.99* (.79/.86)	2.45* (.83/.89)	.96 (.84/.87)	1.21 (.82/.78)
Comprehension & Total Reading	6.39*** (.79/.90)	4.54*** (.83/.91)	3.33** (.84/.91)	.41 (.82/.83)
Basic Skills & Total Reading	2.97** (.86/.90)	1.26 (.89/.91)	2.54* (.87/.91)	2.88** (.78/.83)

* $p < .05$. ** $p < .01$. *** $p < .001$.

Correlations are provided in the parentheses.

Table 5

**Hit Rates, Sensitivity, and Specificity Indices for CBM Predicting Mastery/
Nonmastery of Decoding, Word Reading, Comprehension, Basic Skills
Cluster, and Total Reading-Short on the WRMT-R**

Reading Skill	TP	FN	TN	FP	Hit Rate (%)	Sensitivity (%)	Specificity (%)
Grade 1 (Based on 90 Standard Score)							
Decoding	4	1	42	27	62.2	80	60.9
Word Reading	1	0	44	29	60.8	100	60.3
Comprehension	8	2	42	22	67.6	80	65.6
Basic Skills	3	0	57	14	81.1	100	80.3
Total Reading	5	1	45	23	67.6	83.3	66.2
Grade 2 (Based on 85 Standard Score)							
Decoding	3	1	62	15	80.2	75.0	80.5
Word Reading	4	0	65	12	85.2	100	84.4
Comprehension	4	2	57	18	75.3	66.7	76.0
Basic Skills	5	0	65	11	86.4	100	85.5
Total Reading	6	0	65	10	87.7	100	86.7
Grade 3 (Based on 85 Standard Score)							
Decoding	8	1	58	12	83.5	88.9	82.9
Word Reading	7	0	65	7	91.1	100	90.3
Comprehension	6	0	67	6	92.4	100	91.8
Basic Skills	8	0	65	6	92.4	100	91.5
Total Reading	6	0	67	6	92.4	100	91.8
Grade 4 (Based on 85 Standard Score)							
Decoding	6	2	57	10	84	75	85.1
Word Reading	8	1	59	7	89.3	88.9	89.4
Comprehension	7	3	55	10	82.7	70	84.6
Basic Skills	8	1	59	7	89.3	88.9	89.4
Total Reading	7	1	59	8	88	87.5	88.1

Note. TP = true positive; FN = false negatives; TN = true negatives; FP = false positives.

$$\text{Hit rate} = \frac{TP + TN}{N}; \text{ sensitivity} = \frac{TP}{TP + FN}; \text{ specificity} = \frac{TN}{TN + FP}$$

Table 6
CBM Cutscores for Decoding, Word Reading, Comprehension, Basic Skills,
and Total Reading—Short on the WRMT-R

Reading Skill	Grade			
	1	2	3	4
Decoding	19	50	72	89
Word Reading	19	44	65	86
Comprehension	19	54	63	91
Basic Skills	16	44	65	86
Total Reading	19	44	63	86

success on each of these specific reading skills at Grade Levels 1 through 4. Results indicated that as students increased in grade, so did the CBM score that corresponded with mastery on these specific skills. Generally speaking, the difference between Grades 1 and 2 corresponded with an increase of about 28 words read correctly, whereas the difference between Grades 2 and 3 and Grades 3 and 4 both correspond with an increase of about 20 words read correctly. At Grade 1, similar cutscores were identified for decoding, word reading, comprehension, basic skills, and total reading. However, for Grades 2, 3, and 4, the cutscores for each of these skills differed. For example, the cutscores for second grade differed from each other by 0 and 10 words read correctly on CBM. At third grade the difference between the cutscores for these skills ranged between 2 and 9, and fourth grade ranged between 0 and 5.

Discussion

In the past, research comparing CBM with assessments of specific reading skills has focused on one or two skills, mainly comprehension, across grades (e.g., Jenkins & Jewell, 1993; Kranzler, Miller, & Jordan, 1999; Shinn et al., 1992; Tindal et al., 1983). This study expands this prior work by exploring CBM as an index of specific reading skills, such as decoding, word reading, comprehension, basic skills cluster, and total reading on the

WRMT-R (Woodcock, 1987) across Grades 1 through 4. In addition, CBM cutscores were identified that correspond with benchmark performance on these WRMT-R measures at each of these grades.

This information adds to the literature by providing information of specific reading subskills associated with CBM across Grades 1 through 4. Specifically, this information is helpful in a decision-making model as it could provide a better understanding of CBM related to specific reading subskills across the grades. This information could aid school psychologists and other educators in making decisions about which CBM cutscores to use to determine who needs further instruction on specific reading subskills as well as indicating who is on track for developing these skills.

CBM Progress Monitoring by Grade

Although *across* and *within* grade comparisons were calculated between CBM and each of these reading subskills, the focus of this discussion is on decoding, word reading, and comprehension. The reason for focusing on these three skills is that they lend themselves to instructional practices, whereas basic skills and total reading are more global composites for which instructional implications are less clear.

Comparisons across grades. To determine whether CBM is adequate for monitoring specific reading skills at Grades 1 through

4, we examined the correlations *across* and *within* grades in light of Chall's (1983) model of reading. Similar to Shinn et al. (1992), who reported the relation between CBM and decoding to be higher in third and fifth grade, our comparisons across grades indicated the relation between CBM and decoding was generally higher in Grades 2 and 3 than Grades 1 and 4. The results for Grades 2 and 3 support Chall's first stage that purports instruction for students who are acquiring initial reading skill focus more on decoding. However, first grade did not show the strongest relation with decoding as would be expected according to Chall's model. One reason for this may be a floor effect on the WRMT-R, with too few items at the lower end to obtain a good estimate of students' ability to decode nonsense words. Evidence for this is provided by the range of raw scores for decoding (0 to 37), compared to word reading (10 to 72) and comprehension (3 to 36).

In contrast, the comparisons across grades for CBM and word reading were clearer. Similar to Shinn et al. (1992) who reported a stronger relation between CBM and word reading for third grade over fifth grade, our comparisons across grades indicated the relation between CBM and word reading was higher at Grades 1, 2, and 3 compared to Grade 4. These results support Chall's second stage (1983), indicating that students move from decoding words to reading words as whole units to aid the development of reading fluency.

Interestingly, comparisons across grades for CBM and comprehension revealed no difference among the grades. Although this finding is similar to reports by Shinn et al. (1992), findings contrast those reported by Jenkins and Jewell (1993) and Kranzler et al. (1999), where correlations with comprehension decreased with grade. In relation to Chall's third stage of reading, one would expect the correlations between CBM and comprehension to increase with grade if students were in fact focusing more on comprehension and less on decoding and word reading. However, CBM may be measuring comprehension more consistently across the grades because comprehension re-

quires quick and accurate reading (LaBerge & Samuels, 1974; Perfetti, 1995). This implies that comprehension is mediated by how quickly and accurately one can decode and read words in text, regardless of grade. Because CBM is an indicator of ability to read words quickly and accurately in text, it stands to reason that it would measure comprehension similarly across the grades. Another way to look at the relation between CBM and decoding, word reading, and comprehension is within grade.

Comparisons within grades. In addition to analyzing the data across grades, we explored the relation between CBM and decoding, word reading, and comprehension *within* grade. Although numerous studies have examined the relation between CBM and reading skills across grades, we did not identify any studies that looked at the relation within grades. This information could provide a better understanding of the relation between CBM and specific reading skills at different grade levels. Moreover, it may help clarify how CBM fits into a developmental model of reading like the one proposed by Chall (1983).

In terms of Chall's (1983) stages, one might expect to find the relation with CBM and decoding to be stronger in Grades 1 and 2, with word reading to be strongest at Grade 3, and comprehension strongest at Grade 4. However, our results indicated that the relation between CBM and word reading was strongest at Grade 1 (over decoding and comprehension), and there was no difference between these skills at Grade 2. Interestingly, these findings do not align with Chall's first stage, but instead align more closely with Stages 2 and 3. In comparison, at Grade 3, results did align with Chall's Stage 2. At Grade 4, results aligned with Chall's Stage 3. To explore this further, we address each grade separately in relation to Chall's stages.

At first and second grade one would expect decoding to be more closely associated with CBM based on a developmental model of reading like Chall's (1983); however, results did not corroborate that. One reason we did not find this pattern with first-grade may be related to a floor effect with the decoding mea-

sure. Evidence for this is provided by looking at the percentage (14%) of first-grade students who answered fewer than three questions on the decoding subtest. This seems to indicate that the first-grade students did not have an opportunity to demonstrate their skills related to decoding. It is possible that another decoding measure with more items for beginning readers would yield different results.

Unlike first grade where word reading had a stronger relation with CBM than decoding or comprehension, there was no difference at second grade between these skills. In relation to Chall's (1983) stages, we had expected but did not find a stronger relation between CBM and decoding. One reason for this lack of a difference between CBM and these subskills is that these subskills (i.e., decoding, word reading, and comprehension) are developing at comparable rates. In second grade, students may begin to synthesize these subskills as instruction becomes more balanced across these three areas of reading. However, by third grade, we might expect to find students reading words more automatically while relying less on decoding.

In fact, at Grade 3, results indicated that the relation between CBM and word reading was strong for decoding, but not stronger than comprehension. These results generally align with Chall's (1983) second stage of reading that focuses on word reading. This shift away from decoding implies that students can read words automatically without having to focus on the individual sounds of the letters. However, this stage would also imply that the student is continuing to build this skill so that it becomes more automatic leaving mental energy for comprehension (LaBerge & Samuels, 1974). Viewed this way, it seems reasonable that word reading would receive more focus than decoding but not comprehension at third grade.

Chall's (1983) third stage focuses on comprehension at Grades 4 and above. This aligns with our finding that at fourth grade CBM had a stronger relationship with comprehension than decoding and word reading. It seems reasonable that by fourth grade students have acquired the necessary skills to read

words quickly and accurately, therefore allowing them to spend the majority of their mental energy on comprehending what they read rather than struggling with individual words or parts of words.

These results provide school psychologists and other practitioners with evidence that although CBM is strongly related to decoding, word reading, and comprehension as assessed on the WRMT-R (Woodcock, 1987) at Grades 1 through 4, CBM may be tapping different skills across the grades. These different skills seem to align with the focus of instruction at each of these grades, mirroring to some degree the stages of reading proposed by Chall (1983). However, other methods exist for determining if CBM is an adequate index of each of these individual reading skills, including the calculation of hit rates, sensitivity, and specificity indices provided by PDA.

Hit Rates, Sensitivity, Specificity, and Cutscores for CBM on the WRMT-R

The hit rates for CBM and decoding, word reading, comprehension, basic skills, and total reading on the WRMT-R (Woodcock, 1987) provides further evidence that CBM is strongly related to these reading subskills, making it an appropriate tool for indexing reading competence across Grades 1 through 4. Similarly, the sensitivity and specificity index indicates that CBM also identified students who scored below a standard score of 90 at Grade 1 and 85 at Grades 2 through 4 on each reading subskill, as well as basic skills and total reading. This provides further support that CBM is a good index of these individual reading skills across these grades.

The hit rates along with the sensitivity and specificity index do not, however, provide evidence of the CBM score that can be used to reflect mastery versus nonmastery on the reading subskills. In relation to a problem-solving model, this information would help school psychologists and others by providing a CBM cutscore that would help differentiate students who are on track from those who may need further instructional support. To determine which students may need instructional assistance, we obtained CBM cutscores that corre-

sponded with mastery versus nonmastery for decoding, word reading, comprehension, basic skills, and total reading. Not surprisingly, the CBM cutscores increased as grade increased. This indicates that students' ability to read accurately and quickly should continue to improve as they move up in grades. As accuracy and rate increase, so do the underlying skills that are used to support reading in text such as decoding, word reading, and comprehension. Interestingly, at first and fourth grades, there was little difference between the cutscores CBM identified for mastery on decoding, word reading, and comprehension. By contrast, at second and third grades, there was a larger discrepancy between the cutscores identified with CBM on decoding, word reading, and comprehension.

Although there were slight differences in the CBM cutscores for decoding, word reading, and comprehension on the WRMT-R (Woodcock, 1987) at second and third grades, these differences do not appear sufficiently large to make meaningful distinctions among the three subskills. Instead, it may be more appropriate to use the cutscores for basic reading and/or total reading because they provide an estimate of overall reading competence. In a problem-solving model, school psychologists and other practitioners may use the CBM cutscores to identify students who require more intensive instruction in reading as well as students who may require further diagnostic testing to determine the areas in which they need assistance. However, caution should be used with these cutscores until further research is conducted that replicates similar findings. If these findings were found across several studies, it would provide support for using CBM cutscores as an indication of specific or overall reading ability as compared to a norm-referenced test.

Limitations and Implications for Future Research

Given the following study limitations, caution should be taken in interpreting findings. First, it is difficult to draw conclusions without replication and the use of other criterion measures of decoding, word reading, com-

prehension, and overall reading competence. Future research should explore if similar results occur when using other norm-referenced reading tests and should look at higher grades (e.g., 5 through 8). Second, the measures were administered only once and were not randomized to control for a possible order effect. Future studies are warranted to assess these skills multiple times throughout the year and to randomize the order in which the measures are administered. Third, by using the mean of two CBM passages instead of the median across three CBM passages, the scores may not provide the best representation of students' skills. Future studies could examine this by administering three CBM passages and then comparing the results between the mean of the first two passages versus the median of all three passages. Fourth, although the population included students with disabilities, the numbers were not large enough to conduct separate analyses. Future research should explore if students with disabilities show similar patterns of findings.

Conclusion

Reading is one of the most critical academic skills students learn. This, combined with the attention reading is currently receiving at the national level, indicates the importance of finding assessments that allow educators to efficiently and accurately screen, diagnose, and monitor the progress of students' reading skills across the early grades. Results from this study provide school psychologists and other practitioners with further evidence that CBM is appropriate for monitoring specific reading subskills, such as decoding, word reading, comprehension, and for tracking more global reading competence (e.g., basic skills and total reading). In addition, CBM cutscores at each grade level may assist practitioners in identifying students who need more intensive instruction in reading in general, and students who require diagnostic testing to determine the subskills on which to focus that instruction.

References

- Blalock, H. M., Jr. (1960). *Social statistics* (2nd ed.). New York: McGraw-Hill.

- Chall, J. S. (1983). *Stages of reading development*. New York: McGraw-Hill.
- Deno, S. L., Mirkin, P. K., & Chiang, B. (1982). Identifying valid measures of reading. *Exceptional Children*, 49, 36-45.
- Fuchs, L. S., & Deno, S. L. (1981). *The relationship between curriculum-based mastery measures and standardized achievement tests in reading* (Research Report No. 57). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities. (ERIC Document Reproduction Service No. ED212662)
- Fuchs, L. S., & Deno, S. L. (1994). Must instructionally useful performance assessment be based in the curriculum? *Exceptional Children*, 61, 15-24.
- Fuchs, L. S., & Fuchs, D. (1992). Identifying a measure for monitoring student reading progress. *School Psychology Review*, 21, 45-58.
- Fuchs, L. S., & Fuchs, D. (1999). Monitoring student progress toward the development of reading competence: A review of three forms of classroom-based assessment. *School Psychology Review*, 28, 659-671.
- Fuchs, L. S., Fuchs, D., & Maxwell, L. (1988). The validity of informal reading comprehension measures. *Remedial and Special Education*, 9(2), 20-28.
- Good, R. H., Simmons, D. C., & Kame'enui, E. J. (2001). The importance and decision-making utility of a continuum of fluency-based indicators of foundational reading skills for third-grade high-stakes outcomes. *Scientific Studies of Reading*, 5, 257-288.
- Huberty, C. J. (1994). *Applied discriminant analysis*. New York: Wiley.
- Jenkins, J. R., & Jewell, M. (1993). Examining the validity of two measures for formative teaching: Reading aloud and maze. *Exceptional Children*, 59, 421-432.
- Karlsen, B., Madden, R., & Gardner, E. F. (1975). Stanford Diagnostic Reading Test. San Antonio, TX: Psychological Corporation.
- Kranzler, J. H., Miller, M. D., & Jordan, L. (1999). An examination of racial/ethnic and gender bias on curriculum-based measurement of reading. *School Psychology Quarterly*, 14, 327-342.
- LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology*, 6, 293-323.
- Larsen, S., & Hammill, D. (1976). Test of Written Spelling. Austin, TX: PRO-ED.
- Lyon, G. R. (1997, July). *Statement on reading*. Report presented before the committee on Education and the Workforce, U.S. House of Representatives, Washington, DC.
- MacGinitie, W. H., Kamons, J., Kowalski, R. L., MacGinitie, R. K., & McKay, T. (1978). *Gates-MacGinitie Reading Tests* (2nd ed.). Chicago: Riverside.
- No Child Left Behind Act. (2002). *20 U.S.C. 6301 et. Seq. (Statute)*.
- Perfetti, C. A. (1995). Cognitive research can inform reading education. *Journal of Research in Reading*, 18, 106-115.
- Prescott, G. A., Balow, I. H., Hogan, T. P., & Farr, R. C. (1984). *Metropolitan Achievement Tests*. San Antonio, TX: The Psychological Corporation.
- Shinn, M. R., Good, R. H., Knutson, N., Tilly, W. D., & Collins, V. L. (1992). Curriculum-based measurement of oral reading fluency: A confirmatory analysis of its relation to reading. *School Psychology Review*, 21, 459-479.
- Sibley, D., Biwer, D., & Hesch, A. (2001, April). *Establishing curriculum-based measurement oral reading fluency performance standards to predict success on local and state tests of reading achievement*. Paper presented at the annual conference of the National Association of School Psychologists, Washington, DC.
- Stage, S. A. (2001). Program evaluation using hierarchical linear modeling with curriculum-based measurement reading probes. *School Psychology Quarterly*, 16, 91-112.
- Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly*, 21, 360-406.
- Tindal, G., Fuchs, L. S., Fuchs, D., Shinn, M. R., Deno, S. L., & Germann, G. (1983). *The technical adequacy of a basal reading series mastery test: The Scott-Foresman reading program* (Research Report No. 128). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities. (ERIC Document Reproduction Service No. ED236199)
- Tukey, J. W. (1977). *Exploratory data analysis*. Reading, MA: Addison Wesley.
- Woodcock, R. M. (1973). *Woodcock Reading Mastery Tests*. Circle Pines, MN: American Guidance Corp.
- Woodcock, R. M. (1987). *Woodcock Reading Mastery Test-Revised*. Circle Pines, MN: American Guidance Corp.

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