Developments in Curriculum-Based Measurement

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Curriculum-based measurement (CBM) is an approach for assessing the growth of students in basic skills that originated uniquely in special education. A substantial research literature has developed to demonstrate that CBM can be used effectively to gather student performance data to support a wide range of educational decisions. Those decisions include screening to identify, evaluating prereferral interventions, determining eligibility for and placement in remedial and special education programs, formatively evaluating instruction, and evaluating reintegration and inclusion of students in mainstream programs. Beyond those fundamental uses of CBM, recent research has been conducted on using CBM to predict success in high-stakes assessment, to measure growth in content areas in secondary school programs, and to assess growth in early childhood programs. In this article, best practices in CBM are described and empirical support for those practices is identified. Illustrations of the successful uses of CBM to improve educational decision making are provided.

The special characteristics of learners with disabilities have long driven the development of alternative specialized methods for assessing those needs. Perhaps the classic example of this phenomenon is the work of Alfred Binet, who as minister of public instruction in France, worked with Theodore Simon to explore the possibility of using different structured tasks to differentially diagnose and prescribe educational programs for students who might not profit from regular classroom instruction. Although Binet's work subsequently was subverted by other efforts to scale intelligence, it is important to remember that Binet's purpose was to identify more effective programs for educating students rather than excluding them. The innovation in assessment presented in this article, curriculum-based measurement (CBM; Deno, 1985), is also intended to improve educational programs.

Background

CBM was developed to test the effectiveness of a special education intervention model called data-based program modification (DBPM; Deno & Mirkin, 1977). That model was based on the idea that special education teachers could use repeated measurement data to formatively evaluate their instruction and improve their effectiveness. To empirically test teacher use of DBPM, a research and development program was conducted for 6 years through the federally funded University of Minnesota Institute for Research on Learning Disabilities (IRLD).

One result of the IRLD formative evaluation research was the development of a generic set of progress monitoring procedures in reading, spelling, and written expression. Those procedures include specification of (a) the core outcome tasks on which performance should be measured; (b) the stimulus items, the measurement activities, and the scoring performance to produce technically adequate data; and (c) the decision rules used to improve educational programs. Ultimately, a set of criteria was specified that was used to establish the technical adequacy of the measures, the treatment validity or utility of the measures, and the logistical feasibility of the measures (Deno & Fuchs, 1987). Since then, CBM data have been used across a wide range of assessment activities, including screening, prereferral evaluation, placement in remedial and special education programs, formative evaluation, and evaluation of reintegration and inclusion. Recently, research has explored the use of CBM data to predict success on high-stakes assessment and to measure growth in content areas in secondary school programs and in early childhood special education. The remainder of this article addresses the successful uses of CBM to accomplish these purposes.

CBM Characteristics

When the generic procedures for measurement are employed with stimulus materials drawn directly from the instructional materials used by teachers in their classrooms, the approach is referred to as *curriculum-based*. Because evidence has shown that the same procedures can be used successfully with stimulus materials drawn from other sources, the generic procedures have been referred to as *general outcomes measures* (GOMs; L. S. Fuchs & Deno, 1994) or *dynamic indicators of basic skills* (DIBS; Shinn, 1998). In contrast to the term *curriculum-based assessment,* which has been used to refer to a wide range of

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informal assessment procedures, *curriculum-based measurement* refers to a specific set of standard procedures that include the following characteristics.

Technically Adequate

The reliability and validity of CBM have been achieved through using standardized observational procedures for repeatedly sampling performance on core reading, writing, and arithmetic skills. Unlike most informal measures, the psychometric concepts of reliability and validity are primary characteristics of CBM (Good & Jefferson, 1998; Shinn, 1989).

Standard Measurement Tasks ("What to Measure")

The standard tasks identified for use in CBM include reading aloud from text and selecting words deleted from text (maze) in reading, writing word sequences when given a story starter or picture in writing, writing letter sequences from dictation in spelling, and writing correct answers/digits in solving problems in arithmetic.

Prescriptive Stimulus Materials

Because the materials used for assessment in CBM may be obtained from the instructional materials used by the local school, specifications are provided for materials selection (e.g., Shinn, 1989). Key factors in this selection process are the representativeness and equivalence of the stimulus materials. Both factors are addressed to increase the utility of the procedures for making instructional decisions.

Administration and Scoring ("How to Measure")

CBM procedures include specification of sample duration, administration, student directions, and scoring procedures. Combining the prescriptive selection of stimulus materials with standardization of the procedures is necessary to ensure sufficient reliability and utility of the data for individual and group comparisons across time. Standardization also enables summarization of group data for developing local norms and for general descriptions of program effects across students (Shinn, 1995).

Performance Sampling

In CBM, academic performance is sampled through the use of direct observation procedures. All CBM scores are obtained by counting the number of correct and incorrect responses made in a fixed time period. In reading, for example, the most commonly used measure requires a student to read aloud from a text for 1 minute and have an observer count the number of correctly and incorrectly pronounced words.

Multiple Equivalent Samples

One of the most distinctive and important features of CBM is that performance is repeatedly sampled across time. The repeated observations of performance are structured so that students respond to different but equivalent stimulus materials that are drawn from the same general source. For example, on the first occasion in measuring reading proficiency, students are asked to read aloud for 1 minute from a text passage that they have not previously read. On the next occasion, the students read again from the same book, but from a different, unfamiliar, and equally difficult text passage. In this way, task difficulty is held constant and inferences can be drawn regarding the generalizability of student proficiency at reading comparable, but unfamiliar, text.

Time Efficient

CBM is designed for efficiency. Multiple performance sampling requires that measures be short. CBM performance samples are 1 to 3 minutes in duration, depending on the skill being measured and the number of samples necessary to maximize reliability.

Easy to Teach

Another logistical consideration in using CBM is the ease with which professionals, paraprofessionals, and parents can learn to use the procedures in such a way that the data are reliable.

Common Uses

The original purpose of CBM was to enable teachers to formatively evaluate their instruction. What follows is a summary, beginning with the more common and older applications of CBM and progressing to recent applications.

Improving Individual Instructional Programs

The formative evaluation model based on CBM is represented graphically in Figure 1. As can be seen in the figure, individual student performance during an initial baseline phase is plotted and a goal is established. A progress line connecting the initial level and the goal depicts the rate of improvement necessary for the student to achieve the goal. The vertical lines on the graph indicate the point at which a change is made in the student's program. At each point, judgments are made regarding the effectiveness of the instruction being provided. This systematic approach to setting goals, monitoring growth, changing programs, and evaluating the effects of changes is the formative evaluation model. Research on the achievement effects of using this approach has revealed that the students of teachers who use systematic formative evaluation based

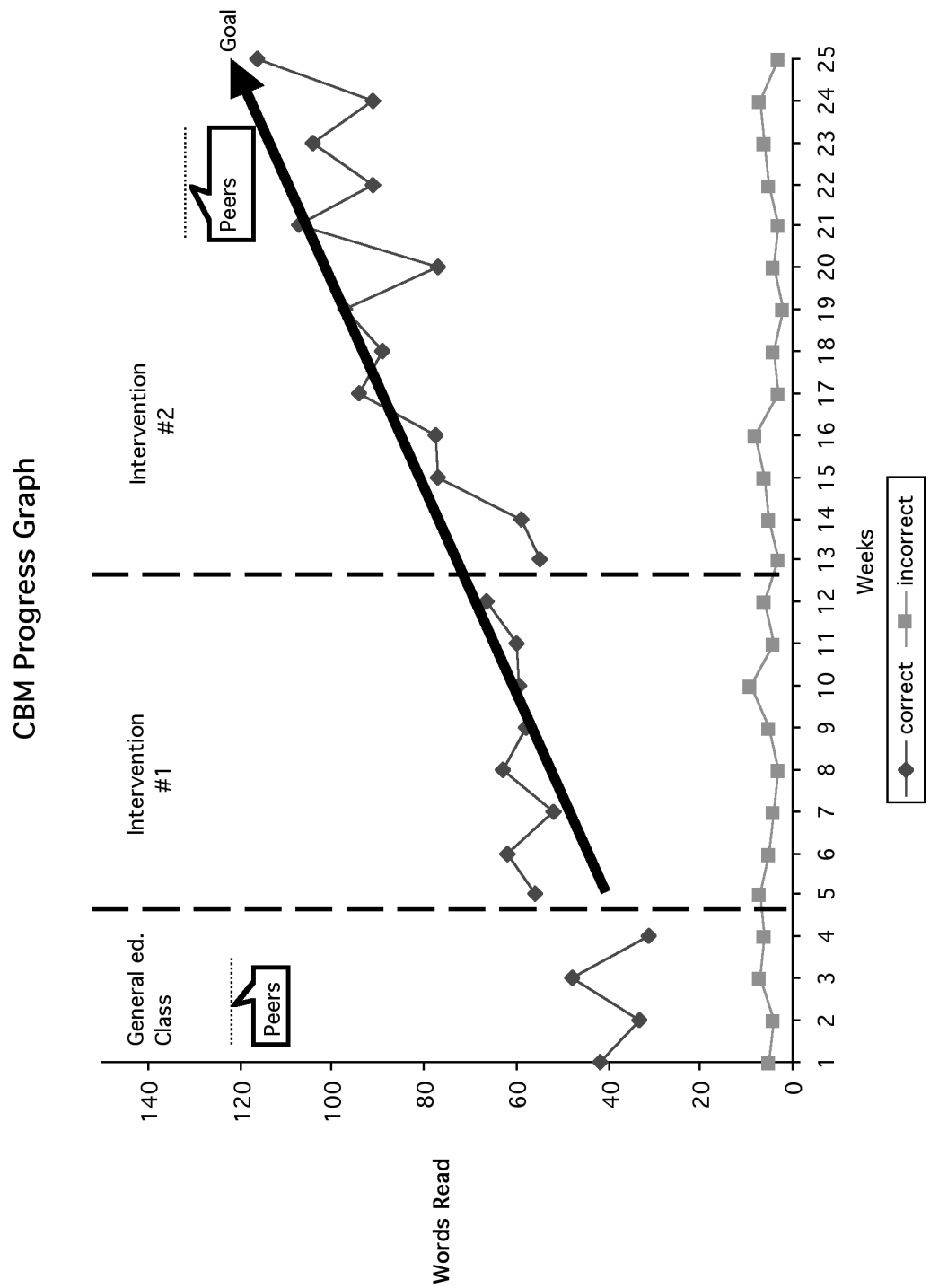

FIGURE 1. CBM progress graph.

on CBM have greater achievement rates (L. S. Fuchs, Deno, & Mirkin, 1984).

Predicting Performance on Important Criteria

Teachers' effective use of formative evaluation to increase achievement requires that CBM data be closely associated with a wide range of criteria important to making educational decisions (Good & Jefferson, 1998; Marston, 1989). All of the measures used in CBM possess relatively high-criterion validity coefficients (L. S. Fuchs, Fuchs, & Maxwell, 1988; Marston, 1989). For that reason, CBM data can be used not only to evaluate instruction but also to classify age and grade developmental status (Deno, 1985; Shinn, 2002), predict and improve on teacher judgments regarding student proficiency (Marston, Mirkin, & Deno, 1984), discriminate between students achieving typically and those in compensatory programs (Marston, & Magnusson, 1988), and predict who will succeed on high-stakes tests (Good, Simmons, & Kameenui, 2001). Recent research efforts have been successfully directed toward establishing reasonable growth standards for purposes of setting both individual and program standards (Deno, Fuchs, Marston, & Shin, 2001).

Enhancing Teacher Instructional Planning

Several related outcomes are also produced through a formative evaluation model based on CBM. In L. S. Fuchs, Deno, and Mirkin's (1984) study, near the end of the school year, teachers of reading were asked whether they could identify their students' reading goals. It is not surprising but important to note that those teachers using CBM in formative evaluation were more accurate in identifying their students' goals. In a related study, when teachers used CBM within a formative evaluation model, it significantly affected both the frequency and quality of the instructional changes they made as they responded to unsatisfactory student progress (L. S. Fuchs, Fuchs, Hamlett, & Stecker, 1991; Fuchs, Fuchs, & Hamlett, 1993).

Developing Norms

CBM can be used to develop norms for decision making when the same CBMs are administered to normative peer samples. In Figure 1, individual performance can be compared to the average of peer performance, which is represented by the line well above the target student's level during baseline and at the end of the year. This reference is important because it reveals the magnitude of the difference between the performances of individual students and those of their peers with the same stimulus materials. Teachers can create their own peer reference by sampling the performance of other students in the same classroom. Because CBM is standardized, it has also been effectively used to create school and district norms. When local norms are created, peer references are more broadly representative of students in the same grade, in the same school, or across schools within a district (Marston & Magnusson, 1988; Shinn, 2002). Using CBM to create local norms has been especially useful in urban school districts where concerns exist regarding the degree to which the norms of commercially available standardized tests reflect the rapidly changing diversity of student populations.

Increasing Ease of Communication

Although the effectiveness of CBM in increasing both teacher and student awareness of goals has already been discussed, it is important to point out that the CBM graph, with its multiple references, creates opportunities for clearer communication. It has now become common practice for teachers to use the CBM data in parent conferences and at multidisciplinary team meetings to provide a framework for communicating individual student status. Professional educators and parents can easily use the CBM graph because little or no interpretation of the scores is necessary (Shinn, Habedank, & Good, 1993). This contrasts sharply with the complexities related to communicating the results of commercially available standardized test scores. A simple illustration of both the ease and effectiveness of communicating about CBM data can be found in the results of the teacher planning study mentioned earlier (i.e., Fuchs, Deno, & Mirkin, 1984). In that study, students as well as teachers were asked whether they knew their annual reading goals and were asked to specify those goals. Those students whose teachers were using CBM and formative evaluation not only expressed that they knew those goals but also were able to accurately specify their target reading scores.

Screening to Identify Students Academically at Risk

An increasingly common use of CBM is to screen students who are at risk for academic failure. As mentioned previously, because CBM procedures are standardized, they can be used to compare individual performance to that of the group. The use of local norms is common for this purpose, but norms are not required. In a study by Deno, Reschly-Anderson, Lembke, Zorka, and Callender (2002), all of the students in a large urban elementary school were given three standard CBM maze passages and their performance was aggregated within and across grades. The lowest 20% of the students on the CBM maze (multiple-choice cloze) measure in each grade were considered highly at risk and were required to undergo progress monitoring every other week with the more conventional CBM oral reading measure. Identification of high-risk students has now become commonplace among schools practicing CBM (Marston & Magnusson, 1988).

Evaluating Classroom Prereferral Interventions

The cost and the consequences of special education are recurring issues in the literature of special education. Of particular concern is the possibility that some students are being referred for and placed in special education when they would succeed in general class programs with greater accommodation by classroom teachers. One approach to addressing this issue is to require classroom teachers to conduct prereferral interventions, to establish that such accommodations are insufficient. A problem with this approach has been that little useful data have been available to appraise the effects of those prereferral data. Because CBM data are sensitive to the effects of program changes over relatively short time periods, they can be used to aid in the evaluation of prereferral interventions. The use of CBM in evaluating prereferral interventions is the first component of the Problem Solving Model (Deno, 1989) that has been implemented at both the state and district levels (Shinn, 1995; Tilly & Grimes, 1998). The Problem Solving Model enables general and special educators to collaborate in the early stages of child study to determine with some validity that the problems of skill development faced by a student are more than "instructional failures." Documentation stating that the problem is not readily solvable by the classroom teacher becomes the basis for special education eligibility assessment.

Reducing Bias in Assessment

The Problem Solving Model using CBM has attracted attention as a means for reducing bias in the assessment process. Because teachers typically are the source of referrals to special education, their validity as "tests" of student success in the classroom is an issue that has been examined using CBM (Shinn, Tindal, & Spira, 1987). Indeed, in one big city school system, the Office of Civil Rights joined forces with the district to examine whether the CBM data used as part of the Problem Solving Model could diminish the likelihood of minority students being inappropriately placed in special education (Minneapolis Public Schools, 2001). Data from that school district revealed that after implementation of the model, the proportion of non-White students referred for and placed in special education did not substantially change, but it became more likely that problems were addressed through general education classroom intervention than through special education placement. In addition, students who were placed in special education demonstrated lower achievement test scores than they had prior to the introduction of the Problem Solving Model.

Offering Alternative Special Education Identification Procedures

There has been widespread dissatisfaction with traditional approaches to identifying students for special education that rely on standardized tests of ability, achievement, or both (Reschly, 1988). Despite this dissatisfaction, few alternatives have been offered to replace these procedures. Over the past 20 years, the use of CBM within a systematic decision framework has been explored as a basis for developing alternative identification procedures (Marston & Magnusson, 1988; Marston, Mirkin, & Deno, 1984; Shinn, 1989). Recently, the use of CBM to test students' responsiveness to treatment (L. S. Fuchs & Fuchs, 1998) has gained favor within policy-making groups. For example, the responsiveness to treatment approach has been recommended by the President's Commission on Excellence in Special Education (2002) as an alternative to traditional standardized testing for identifying students with learning disabilities. That approach is an extension of prereferral evaluation and the Problem Solving Model to evaluate increased levels of intensity in instructional intervention, and it relies on CBM. For example, if a student fails to increase his or her rate of growth in response to several general education classroom interventions, that student might be considered as eligible for special education. This alternative approach to eligibility determination rooted in the Problem Solving Model has created an entirely different perspective of the concept of disability (Tilly, Reschly, & Grimes, 1999).

Recommending and Evaluating Inclusion

As increased emphasis has been placed on inclusion of students with disabilities in general education classrooms, and as laws and regulations have required schools to ensure access to the general education curriculum, the need to evaluate the effects of these changes on the academic development of students with disabilities has increased. CBM has proved to be a very useful tool for those accountable for the progress of students with disabilities as they seek to provide education for these students in the mainstream curriculum. The general strategy employed when using CBM to evaluate inclusion has been to collect data before and after integration into general education instruction and then to continue monitoring student progress to ensure that reintegration of students is occurring responsibly (D. Fuchs, Roberts, Fuchs, & Bowers, 1996; Powell-Smith & Stewart, 1998). The results of the research in this area provide clear evidence that both special educators and classroom teachers can use CBM to provide ongoing documentation of student progress and to signal the need for increased intensification of instruction when inclusive programs are unsuccessful.

Predicting Performance on High-Stakes Assessment

Perhaps no other aspects of contemporary education are receiving greater attention than accountability and high-stakes assessment. At federal and state levels, pressure is being applied to schools to "step up" to the challenge of reform movements rooted in testing. Schools are being placed on "pro-

bation" and being threatened with the prospect of reconstitution (i.e., disbursement and replacement of the existing school staff). In this environment, the annual high-stakes summative evaluations have become a kind of Sword of Damocles hanging over the heads of teachers and administrators everywhere. Whatever one might think about this approach to improving education, one rational response has been to seek progress-monitoring data that enable school staff members to formatively evaluate programs and revise them when they appear to be unsuccessful in helping students pass the annual high-stakes tests. The criterion validity of CBM data has become the basis for making judgments about whether students will achieve mandated levels of performance on benchmark tests. In a variety of studies, high correlations (.65–.85) have been obtained between CBM scores for reading and math and performance on high-stakes assessments (cf. Deno et al., 2002; Good, Simmons, & Kameenui, 2001; Muyskens & Marston, 2002).

A related, noteworthy aspect of the research and development in this area has been the movement from computing simple correlations to identifying criterion levels of performance on the CBMs that teachers can use as targets for performance. Evidence has accumulated, for example, regarding the relationship between CBM reading scores and pass rates on state assessments. Students reading at least 40 words correctly in 1 minute by the end of first grade are on a trajectory to succeed in learning to read, and students reading more than 110 words correctly in 1 minute by the beginning of third grade are most likely to pass their state assessments in Oregon (Good et al., 2001). Eighth-grade students who can read at least 145 words from local newspaper passages correctly in 1 minute are almost certain to pass the *Minnesota Basic Skills Test* in reading (Muyskens & Marston, 2002). Preliminary research has been, and continues to be, conducted to identify criterion levels of performance on the CBM maze and math measures, as well.

Measuring Growth in Secondary School Programs and Content Areas

CBM was developed initially to help teachers at the elementary school level increase the achievement of students struggling to learn basic skills in reading, writing, and arithmetic. As development in those areas has proceeded, teachers in secondary school programs have become interested in the application of similar formative evaluation approaches with their students. For that reason, technical work has proceeded on establishing CBM progress monitoring methods for assessing student growth both in advanced academic skills and in content area learning (Espin, Scierka, Skare, & Halvorson, 1999; Espin & Tindal, 1998). The technical developments in using CBM methods to assess growth in reading and writing at the secondary level have generated outcomes that appear both promising and tentative. In general, attempts to establish the criterion validity of the same reading and writing measures that have been used at the elementary level have revealed that those measures do correlate with important criteria (e.g., test scores, grade point average, teacher judgment), but the correlations are not as strong as for elementary students. One exception involves a recent study conducted by Muyskens and Marston (2002) in which correlations were high for students in eighth grade. That research was conducted with middle school students, rather than high school students, so it is possible that further studies will identify those upper levels of competence for which ordinary CBMs will be effective.

Assessing English Language Learning Students

A particular problem confronting schools in the United States is the dramatically increasing proportion of students whose first language is not English and who are still learning to speak English while they are learning to read and write in English. Commercially available standardized tests have not been useful because they have not included the full range of languages represented among English language learning (ELL) students within their norm samples. More significant, many achievement tests draw heavily on background knowledge of the American culture in structuring questions. Among other problems that exist because of the lack of technically adequate procedures is how to distinguish ELL students who are having difficulty learning because of their lack of proficiency in English from ELL students whose struggles also stem from special disabilities.

Several studies have explored the use of CBM to overcome the problems of assessing ELL students and to monitor their growth in mainstream classrooms. Baker and colleagues (i.e., Baker & Good, 1995; Baker, Plasencia-Peinado, & Lezcano-Lytle, 1998) have focused primarily on using the CBM reading scores of Spanish-speaking ELL students to evaluate their progress in general education programs. That research establishes levels of reliability and validity for the CBM procedures with ELL students in both their native and English languages that are comparable to those of native speakers of English. Furthermore, longitudinal analyses have revealed that students who begin with comparable proficiency in English often acquire English language skills at very different rates. The apparent technical adequacy of CBM has led at least one urban school system to use CBM procedures for developing norms across reading, writing, and arithmetic on their ELL students (M. Robinson, personal communication). CBM also has been used to predict differences in the success rates of middle school ELL students on state assessments as a function of their level of reading proficiency (Muyskens & Marston, 2002). In addition, research has been conducted using CBM with students in countries where languages other than English are spoken. The evidence from this body of research indicates that the procedures and tasks to be used for measurement need to be consistent with formal differences in the language. For example, oral reading can be used to measure growth in other phonetic

languages, such as Korean, but the maze procedure appears to be more appropriate for measuring growth in an iconic language, such as Chinese (Yeh, 1992).

Predicting Success in Early Childhood Education

The criterion validity of CBM oral reading scores has been sufficiently established to become an important criterion for establishing the predictive validity of prereading measures and the effectiveness of early literacy interventions. With the ascendant interest in the role played by phonological skills in learning to read, the utility of scores from measures of phonological skill has been established by examining their accuracy in predicting beginning oral reading scores (Kaminski & Good, 1996). As cited in Good, Simmons, and Kameenui (2001), evidence has developed that CBM oral reading performance at the end of first grade is a significant indication of subsequent reading success. Research in this area has established important linkages among measures of phonological skill in kindergarten, oral reading performance in Grades 1 through 3, and success on state assessments.

Frequency of Use

At least two studies have been conducted to examine the factors that can function as barriers to CBM implementation (Wesson, Deno, & King, 1984; Yell, Deno, & Marston, 1992). More than 15 years ago, Wesson et al. (1984) found that nearly 85% of the 300 teachers surveyed reported they were aware of direct and frequent measurement of student progress; yet, only half of those familiar with the procedures were using them. In Yell et al.'s (1992) study, only teachers using CBM were surveyed. Teachers in both studies consistently identified time as the single most important barrier to implementing the measurement procedures. An interesting related finding was that teachers using CBM estimated that it took less than 10% of their instructional time to conduct the measurement. Nevertheless, given the time constraints under which teachers operate, they seem, inevitably, to believe that any additional activity cannot be accommodated into their daily schedule.

A Uniquely Special Education Development

CBM is a procedure that was developed by special educators for special educators. Having said that, it is important to recognize that related work both in and outside of special education served as a basis for CBM and supported the use of CBM in general education. All CBM procedures involve the direct observation of behavior and use the single case analytical procedures that are characteristic of applied behavior analysis (ABA; Deno, 1997). ABA is a system developed for use with any behavior in any setting; thus, much of the work of ABA has addressed behavior in the mainstream of ordinary life. In that sense, CBM is, in part, based on procedures derived from sources outside of special education. At the same time, the most extensive applications of ABA have been in special education, and the early applications of ABA to academic instruction occurred most often within special education (e.g., Lovitt, 1976).

The use of CBM to measure growth in reading has relied extensively on time-limited samples of oral reading. In the general literature of reading development, the speed with which students are able to translate text into spoken language is viewed as one of the most significant characteristics of skillful reading (Adams, 1990). In addition, psychologists interested in the study of reading have long viewed automatic responding as an essential element in reading comprehension (Laberge & Samuels, 1974). Although *oral reading fluency* is not always defined in terms of speed and accuracy of word recognition, that use of the term is so widespread that the recommendations from the National Reading Panel (2000) regarding fluency have been interpreted to mean speed and accuracy of oral reading. However oral reading fluency is defined, the current broad interest in this subject has contributed to the rapid dissemination of CBM reading procedures. As continued research on the relationship between rapid and accurate reading of words and comprehension reveals the close connection between these key elements of reading (L. S. Fuchs, Fuchs, Hosp, & Jenkins, 2001; Jenkins, Fuchs, von den Broek, Espin, & Deno, 2002), CBM is likely to become an ever-increasing source of interest from special and general educators alike. Whether similar accelerated interest in CBM will occur for other basic skills remains to be seen.

The most effective uses of CBM in the formative evaluation of individual student programs almost certainly occur in settings where individual (special) education teachers have the time and skills to respond to the charted progress of individual students. Special educators designed the formative evaluation model that has been demonstrably effective in improving the achievement of individual students for use in special education. Initially, this meant evaluating the success of teachers at accelerating the progress of their special education students in the mainstream curriculum. As caseload limits for special educators have been raised or eliminated, and as inclusive education has received more attention, teachers have had less time and too many students to use CBM effectively in formative evaluation.

The shift, then, has been to use CBM to support general educators' efforts to accommodate the increased diversity in classrooms produced, in part, by inclusion of students with disabilities (L. S. Fuchs, Fuchs, Hamlett, Phillips, & Bentz, 1994). CBM has proven to be a useful tool for this purpose. L. S. Fuchs and Fuchs (1998) provided an interesting and important illustration of the efforts required to tailor CBM for use in the general education classroom. Their work clearly demonstrates the effort that must be made to effect CBM im-

plementation with teachers who are working with large groups of students in general education classrooms. Even as those efforts are successful, it is unlikely that CBM with large groups can contribute to improved student achievement to the degree that it does when used to tailor individual student programs. In those settings where special education is organized for individual students, the unique contributions of CBM most certainly will be the greatest.

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