Is it Working?: An Overview of Curriculum Based Measurement and its Uses for Assessing Instructional, Intervention, or Program Effectiveness

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Presented here is an overview of Curriculum Based Measurement (CBM) – a standardized process of obtaining data regarding a student's acquisition of skills in reading, writing, math, and spelling. A review of research that has utilized CBM in its efforts to define effective teaching strategies also is offered. Overall, the goal of this discussion is to orient professionals working with students in and outside of the school setting to a model of assessment that is gaining wide acceptance in data based decision making.
Keywords: CBM, PSM, RtI, DIBELS

The field of education often is not associated with rigorous lines of scientific inquiry – until recently (Shavelson & Towne, 2002; Sweet, 2004) when the National Research Council asserted that current educational practices must be put to the test of clinical rigor as their impact on student outcomes is investigated (Snow, Burns, & Griffin, 1998). At the same time, the National Institute of Child Health and Human Development identified students' academic failure as a national public health problem (c.f., Reyna, 2004). Specifically, their proclamation calls for the elimination of practices that have found comfort in classrooms due to their appeal, intuitive feel, or alignment with philosophical beliefs rather than through data-based processes that support their use in educating students (Reyna, 2004; Sweet, 2004).

The No Child Left Behind Act (NCLB, 2001) and Individuals with Disability Education Improvement Act (IDEIA, 2004) have further shaped educational goals with requirements that students' academic experiences be enriched with high quality and research-based instructional strategies. The end goal is that all students regardless of their race, gender, socioeconomic status, or identified disabilities must reach levels of proficiency in core academic areas – notably reading. Attainment of these goals is determined by student performance on state-level tests. Thus, it becomes evident that students off track for meeting these goals must be identified early; at a point before the gap between expected outcomes and observed skills broadens. For these students, data must be used to identify why their learning trajectories are not progressing in the desired directions. A desired outcome of this analysis would produce hypotheses that link skill gaps to alterable instructional/environmental variables that lead directly to intervention (National Association of State Directors of Special Education - NASDSE, 2006). Within a Problem Solving Model (PSM), this analysis utilizes data to guide and evaluate decision making that seeks to remove barriers impeding learning. Importantly, within this model, frequent (e.g., weekly) monitoring of students' responses to instructional modifications must occur (Fuchs & Fuchs, 2004) with changes to ineffective strategies made. Also known as Response to Intervention (RtI), the overarching goal of this dynamic cycle of data collection and evaluation is to identify changes in rates of skill attainment based on modified instruction or environmental conditions (NASDSE, 2006). Problem solving and RtI are becoming central tenets in the field of education (NASDSE, 2006).

An apparent need entwined in this approach is a metric for monitoring student skill acquisition in basic academic domains. Tools for collecting these data must, first, be sensitive to small changes in skill acquisition. Additionally, frequent administration of these indices must not confound future data (i.e., practice or carryover effects). Notably, these assessments must be quick and easy to administer. Indeed, General Outcome Measurement systems such as those structured from a students' instructional framework, i.e., Curriculum Based Measurement (CBM), address all these needs.

Purpose of Article

The purpose of this article is two-fold. First, it provides a general overview of CBM. Second, it presents a review of not only how CBM can support decision making in the educational setting but also how it monitors student(s) response to instruction, intervention, and program implementation.

Overview of CBM

Curriculum Based Measurement (CBM) reflects a systematic set of procedures through which data regarding student skill development in basic areas of achievement are obtained. Assessed by fluency metrics that assess students' command and accuracy at math computation, reading of connected text, and writing serve as central domains in its application in the educational setting.

CBM was developed by Stan Deno at the University of Minnesota's Institute for Research on Learning Disabilities during the mid 1970's. Originally developed as a metric to examine the rates of growth in students participating in special education (Stecker, Fuchs, & Fuchs, 2005), its current applications have broadened to both formative and summative assessments of student skill acquisition. Research by Shinn (1989) provides solid validation for CBM's role in monitoring student progress and making subsequent educational decisions about instructional content and strategies.

CBM in Educational and Research Settings

An overview of CBM tools utilized within school and research settings is presented next. Data derived from these measures provide general indicators of basic skill acquisition. Conceptually, CBM is similar to a thermometer. Concretely, CBM not only monitors students' progress but also to highlights students whose skills fall in ranges that portend of limited future success. Scores that deviate well below typical performance warrant further investigation to determine the cause of the divergence. Next, identifying where and why the problem is present follows and may include CBM to identify possible gaps in precursor and foundational skills. In general, CBM indices provide ongoing monitoring of skills, and thus formative and summative evaluation, of the impact of instruction, intervention, or program implementation.

Materials for using CBM (administrator directions, student and examiner probes, scoring directions, and norms or risk level benchmarks) are available from many resources. Most popular are websites where electronic copies are available (e.g., http://dibels.uoregon.edu/ and http://www.aimsweb.com). In particular, the first website contains CBM targeting early literacy skills as assessed with the Dynamic Indicators of Basic Early Literacy Skills (DIBELS); whereas the later website includes CBM that targets reading (fluency and comprehension), basic math calculation, spelling, and writing. Also included on the *AIMSweb* site are alternate early literacy, numeracy, and Spanish language adaptations of the basic measures. Access to these materials is offered for either no charge (DIBELS) or a minimal price. Research examining psychometric properties of the measures also are accessible on these sites.

Reading. As noted throughout the National Reading Panel's (NRP) 2000 report, the general concept of reading, or the skills at deriving meaning from connected text, rest upon a successful acquisition of five basic skills: phonemic awareness, phonics, reading fluency, comprehension, and vocabulary. In light of this, assessment to determine and monitor children's acquisition of these components is needed. A popular system of CBM for monitoring early reading skills is DIBELS indices (Good, Kamininski, Simmons, & Kame'enui, 2001; Kamininski & Good, 1996). Five subtests (i.e., Letter Naming Fluency, Initial Sounds Fluency, Nonsense Word Fluency, and Oral Reading Fluency) are found within DIBELS with each subtest targeting dimensions of the five components of reading. A wealth of research documents the reliability and validity of DIBELS as screening and progress monitoring tools (e.g., Good & Jefferson, 1998; Good, Kamininski, Simmons, & Kame'enui, 2001). A review of commonly employed avenues of CBM in reading is offered next. Early literacy as assessed with DIBELS measures starts this overview.

Letter Naming Fluency (LNF), one of the first DIBELS subtests that is administered to kindergarten aged students, assesses early phonics skills. During LNF, students are presented with a page of randomly ordered upper and lower-case letters of the alphabet. Directions prompt students to identify as many as of the letters as they can within one minute. Hesitations of three seconds are followed by the examiner's cue for the student to focus on the next letter. The total number of letters identified correctly in the one minute interval becomes the LNF score. Strong predictive relationships have been documented between rapid letter naming (LNF) and reading fluency and comprehension three years later (e.g., Good, Simmons, & Kame'enui, 2001: Torgesen, Wagner, & Rashotte, 1994).

A second DIBELS subtest commonly administered to students in kindergarten and first grade is Initial Sound Fluency (ISF). In contrast to LNF, however, ISF provides a snapshot of emerging phonemic awareness, which has been identified as a critical steppingstone to later reading achievement (Adams, 1998; National Reading Panel, 2000). Tasks within ISF ask students to identify and produce initial sounds in words depicted in pictures presented. Rather than measuring fluency with which students accomplish this task, ISF measures a student's "think time" across the prescribed number of tasks. As with other DIBELS subtests, strong psychometric properties have been documented (Good, Simmons, Kame'enui, Kaminski, & Wallin, 2002).

Nonsense Word Fluency (NWF), also a DIBELS subtest, presents students with a series of made up words that they are asked to read as if they were real words. Additional prompts direct students to perform this task quickly and accurately. The number of sounds students produce correctly during the one minute timed session becomes their NWF score. Typically, NWF is administered to second grade students or during the spring semester of first grade. Researchers such as Hintze, Ryan, and Stoner (2003) and Good, Simmons, Kame'enui, Kaminski, and Wallin, (2002) offer detailed findings documenting strong reliability and validity of the NWF subtest.

The degree to which students read fluently strongly predicts later reading success (Adams, 1998; National Reading Panel, 2000; Snow, Burns, & Griffin, 1998). Oral Reading Fluency (ORF) is the DIBELS subtest that monitors oral reading fluency. During ORF, a student is asked to read aloud from a 150-400 (grade or instructional level appropriate) word passage. As the student reads for one minute, an examiner marks any words read incorrectly. The total number of words read correctly per minute serves as the ORF score. Notably, student performance on ORF successfully predicted student performance on third grade high stakes state level reading tests in Florida with a correlation of .74 documented (Buck & Torgesen, 2003). Similar findings were documented in Colorado (Shaw & Shaw, 2003) and Ohio (Vander Meer, Lentz, & Stollar, 2005). Test-retest reliabilities (ranging from .92 to .97) also can be reviewed in Tindal, Martson, and Deno's (1983) work. Meanwhile, Good and Jefferson (1998) provide a review of validity studies where coefficients ranged from .52 to .91.

The acquisition of skills that enable students to derive meaning from written text reflects the ultimate objective for reading instruction (Adams, 1998; National Reading Panel, 2000; Snow, Burns, & Griffin, 1998). The *AIMSweb* Maze task (www.aimsweb.com; Shinn & Shinn, 2002) is an example of CBM that monitors reading comprehension. Directions for the Maze task ask students to read silently from a passage presented. Embedded within this activity is a cloze task where every seventh word across the passage is replaced with three possible word choices; only one of the word choices makes sense given the story offered. Readers must circle the correct word. Three minutes are provided after which the number of correctly circled responses becomes the Maze score. Research conducted Shin, Deno, and

Espin (2000) and Martson and Deno (1981) provide documentation of the validity, reliability, and sensitivity of the Maze task for monitoring growth in reading comprehension.

Mathematics. One popular model of CBM in math (M-CBM) taps students' fluency with basic math skills. During the administration of M-CBM, students are presented with probes containing either single or mixed skill calculation problems (Shinn, 2004). Directions inform students to complete as many of the problems as possible within the prescribed time limit. Time limits vary based on grade level but vary between two to four minutes with younger students in first through third grades are provided with two minutes to complete math probes presented (Shinn, 2004). The number of digits correct (DC) in students' answers becomes the M-CBM score. Students completing M-CBM are directed to try each item; however, they are allowed to draw an "X" through any problems that they are not aware of how to complete. As with other CBM indices, strong documentation of the internal consistency (Fuchs, Fuchs, & Hamlett, 1994), test-retest, and interscoring agreement (Tindel, et al., 1983) of M-CBM have been offered.

Spelling. Curriculum Based Measures of spelling (S-CBM) closely parallel typical spelling test procedures where students are asked to write dictated words on a lined paper. The rate of presented words is standardized – one word dictated every ten seconds for first and second grade students and one word dictated every seven seconds for students in third through eighth grades. Overall, a total of 17 words are presented. Scoring reflects the number of correct letter sequences (CLS) or Words Spelled Correctly (WSC) in students' responses. Test-rest reliability is offered by Martson (1982), Shinn (1989), and Tindal, et al (1988). For example, Martson (1982) documents strong reliability for administration of parallel form one week apart (CLS = .83, WSC = .85).

Written expression. Assessment of students' writing skills is obtained with CBM in Written Expression (WE-CBM; Powell-Smith & Shinn, 2004). During this task students are asked to continue writing about a story for which a starting prompt has been provided orally. Specifically, students are asked to think (for one minute) about what they are going to write after which they are asked to begin writing for three minutes. Three general scores are obtained: the total number of words written (TWW), the number of words spelled correctly (WSC), and the number of correct word sequences (CWS). In most need of additional explanation is the CWS score, which is derived from counting the number of adjacent words pairs that are accurate in their spelling, grammar, punctuation, and syntax. Interested readers are directed to work by Videen, Deno, & Martson (1982), Martson (1982), and Parker, Tindal, & Hasbrouk (1991) for a review of validity studies that defined correlations between WE-CBM scoring and scoring derived from the Test of Written Language, the Language subtest from the SAT, and teacher holistic judgments, respectively.

CBM Used to Evaluate and Drive Instruction

One critical focus for CBM is to drive the focus of instruction so that areas in need of additional attention are highlighted and the effectiveness of instructional strategies are evaluated (Deno, 1997). Teachers using CBM data to inform their practices develop more specific and realistic goals for their students and modify their instructional approaches more frequently in response to data obtained than do teachers utilizing alternate avenues for monitoring student performance (Fuchs, Fuchs, Hamlett, Phillips, & Bentz, 1994). Outcome evaluation following professional development directed at the use of R-CBM shows that subsequent to training, teachers are more invested in assessing the impact of their instruction on their students (Fuchs, Deno, Mirkin, 1984); effect sizes of .70 are found following this dynamic relationship between on-going progress monitoring and instructional modifications (Fuchs, 1989).

Research by Fuchs, Fuchs, Hamlett, Phillips, and Bentz, (1994) offers applied insight and findings examining teacher use of M-CBM to monitor the impact of classroom instruction. Of interest, they examined the effect on student achievement following provision of M-CBM data to second through fifth grade teachers. Fuchs et al., (1994) also investigated the impact that the providing teachers with feedback and instructional recommendations with CBM data had on students' math achievement. A second group of teachers and their students served as a comparison group. After 25 weeks, outcomes provided support for the use of CBM as a critical avenue of feedback regarding teaching effectiveness. Specifically, students of teachers who had received CBM data and instructional recommendations demonstrated greater gains in computational assessments than did students whose teachers did not receive this information. Observation and interviews with teachers revealed that teachers not only reviewed but also implemented the instructional recommendations derived from CBM data. Average and low average achieving students benefited most from the CBM and instructional recommendations as data revealed larger monthly gains for these students than for struggling students. Importantly, gains were noted in skill fluency for all students regardless of their levels of achievement.

Research also has looked at the use of CBM in the development and refinement of Individual Education Plans (IEPs) for students receiving special education services (Codding, Skowron, & Pace, 2005). Driven by findings from Smith (1990) that found notable inconsistencies between assessment data and annual achievement goals on IEPs as well as by observations and qualitative notes that described teachers as passive recipients of assessment data (Domscheit-Chaleff, 1996), Codding and colleagues trained teachers not only to interpret CBM data but also to translate these data into objective and measurable goals for monitoring students' skills. During Codding, Skowron, and Pace's study, three special education teachers were trained and provided consultation addressing: writing observable and measurable objectives; identifying instructional reading levels for students; and calculating annual goals based on research-based expected levels of progress (Fuchs, Fuchs, Hamlett, Walz, & Germann, 1993). A thirteen item checklist was completed across this study and attended to items such as: the correct use of CBM data to identify students' instructional levels in reading; and the presence of operationally defined behaviors in reading that included information regarding the learner, target behavior (e.g., reading comprehension, reading fluency), conditions under which the student was to perform the behavior (e.g., when presented with a third grade ORF DIBELS probe), and the criterion for success (will read 75 words correctly per minute with five or fewer mistakes). Positive outcomes of the training/consultation model were found. Initially, baseline data indicated compliance with an average of 28% of these steps. Subsequent to this training, however, 86-100% of steps were completed.

Indeed, this review has highlighted the importance that training teachers to understand and subsequently use CBM to inform instruction holds. Our attention now will be directed toward an alternate use of CBM – as an avenue to monitor students' growth following changes in school-wide curriculum and infusion of new processes for allocating instructional resources. This approach will be examined at the student, class (small group), and district level.

CBM as a Measure of Response to Curriculum and Process Modifications

Greenwood, Tapia, Abbott, and Walton (2003) utilized ORF CBM to investigate how school-wide implementation of a large, multi-year dissemination of evidence based instructional strategies in reading to elementary teachers impacted the acquisition of early literacy and reading fluency rates of students. Cohorts of children from kindergarten through fifth grade served as the focal point. Numerous measures were employed to assess this impact; however, critical areas of concern targeted reading fluency. Specifically, DIBELS ORF data were gathered four times a year from the entire student body with selected students monitored more frequently. Across the three year implementation, outcomes derived from Hierarchical Linear Modeling highlighted the greatest impact (as measured by ORF rates) among students identified as average or low-risk learners – average and low-risk students made the highest monthly gains over time than did students identified as being at high risk for reading failure. High risk students also evidenced growth over time – a finding that parallels Fuchs et al., (1994).

From another perspective, research conducted by VanDerHeyden and Burns (2005) utilized CBM to monitor students' skills in mathematics following implementation of problem solving model process. Specifically, this project utilized CBM to identify children whose levels of skill development indicated a need for instructional modification with CBM data used to drive resource allocation. CBM data collected across the school year documented significant improvement in mathematics skills upon implementation of a data-based decision model framed within a problem solving model. This process for assigning resource allocation based on CBM data also gained additional support as noted in students' gains in Stanford-9 mathematics testing.

As can be seen, CBM's qualities also align with accountability requirements as enmeshed in No Child Left Behind legislation (NCLB, 2001). Notably, Fuchs and Fuchs (2004) have addressed this issue and paved a pathway along which CBM data could serve as indices documenting Annual Yearly Progress (AYP) for students across kindergarten through sixth grade. Application of CBM as an index of AYP is forthcoming.

CBM as an Evaluation of Intervention Effectiveness

When evaluating the impact that intervention efforts have upon academic achievement, our focus can be directed at success (or lack of) across individuals or small groups of students. Although actual use of CBM data to monitor student progress remains the same, the unit of analysis is based on the question posed, for example, "What impact does this strategy have for this 9 year old, retained 3rd grade minority student from a household with limited financial resources?" In comparison, when looking at intervention impact on a larger group of students our question might be as follows: "In general, what impact does provision of phonological awareness training have upon the rates of literacy skill acquisition in a group of kindergarten students who have been identified by DIBELS assessment to be at high risk for later reading failure?" The following presents research efforts using CBM to answer these types of questions.

Intervention impact on reading fluency was examined by Begeny and Silber (2006) as they monitored third and fourth grade students' rates of reading fluency following exposure to an intervention package that contained two or more intervention procedures (repeated reading, listening passage preview, word list training, and isolated word practice). Utilizing an alternating treatment design during the 9-12 minute sessions, students were exposed to at least two of these strategies three days a week across the four weeks of intervention. Presentation of the intervention strategies utilized an alternating treatment design across the 9-12 minute sessions. In addition to examining overall impact, the relationship between immediate and retained gains was explored – again with CBM ORF. Outcomes found a strong basis for the use of more than one intervention component at a time which aligns with previous research findings (e.g., Daly, Martens, Dool, & Hintze, 1998; Eckert, Ardoin, Daisey, Scarola, 2000). Notably, the greatest gains were noted after implementation of the package consisting of listening passage preview (Rose, 1984), repeated readings (Chard, Vaughn, & Tyler, 2002), and word list training (Levy, Abellow, & Lysynchuk, 1997). Additional findings suggested the presence of a priming effect; data collected at the end of the intervention session were noted to have lower reliability than data collected two days after the intervention session.

Effects on reading fluency also were examined in Faila and Sheridan's (2003) examination of Paired Reading. Within this study that employed ORF measures as the outcome metric, a sample of three students (i.e., two third and one fourth grade) and their parents participated in a training that prepared them to engage in paired reading activities at home for four nights a week across four weeks. Instructional level reading materials were provided for the at-home sessions. To evaluate the impact of this intervention, ORF CBM were administered to students two times a week across the four week intervention timeframe. An additional comparison sample of peers identified as average readers by the classroom teacher also participated in biweekly data collection. Overall findings supported the efficacy of this strategy for two of the three students with moderate to large effect sizes reported for students who participated in the Paired Reading activity with their parents.

CBM also serves as a strong metric in summative evaluation following program implementation. Notably, as school districts modify their teaching strategies (e.g., time allotment for a subject, use of a pacing calendar, or application of strategies from professional development initiatives), classroom structure such as reduced class sizes or less diverse student populations (e.g., single gender classrooms), or overall curriculum adoption, they must carefully attend to the impact that these modifications have upon student learning. In one such study, Stage (2001) employed ORF CBM to examine the impact that struggling first grade readers attendance in a 26 day summer school program had upon their rates of reading fluency. Outcomes documented significant growth in oral reading fluency by the end of the summer program. Specifically, these struggling students, whose ORF scores at the end of first grade fell at or below the 25th percentiles, now increased to the 50th percentiles. Interestingly, this review offered a glimpse of the application of CBM in a formative and summative evaluation role with student progress monitored across the summer as well as before and after participation in the reading program.

Discussion

As can be noted, CBM has gained strong footing as a metric for monitoring student academic progress – particularly during the elementary years of schooling. Given this, it is critical that all individuals who work with children understand its use in the school setting as both a screening instrument that identifies risk levels associated with individual students and as a metric that monitors students' acquisition of skills. Specifically, this discussion was aimed at increasing practitioners' awareness and understanding of progress monitoring and screening tools upon which student achievement can be assessed. It is hoped that this discussion has increased the knowledge of all who work with children; thus opening channels of communication so that precious energies can be directed toward identifying what works best for *all* kids.

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