# FORMATIVE EVALUATION OF ACADEMIC PROGRESS: HOW MUCH GROWTH CAN WE EXPECT?

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Abstract: The purpose of this study was to examine students' weekly rates of academic growth, or slopes of achievement, when Curriculum-Based Measurement (CBM) is conducted repeatedly over 1 year. Using standard CBM procedures in reading, spelling, or math, students in Year 1 (n = 546) were measured once each week; students in Year 2 (n = 2,511) were measured at least monthly. Results provided corroborating data across years and interesting patterns for different types of measures. Findings are discussed in terms of how to use normative slope data to establish appropriate goals for student outcomes. Implications also are discussed in terms of (a) how such norms can be developed for other ongoing assessment systems, (b) developing a technology for the measurement of student change, and (c) developmental theories of academic growth.

In September 1990 the president of the United States convened an historic education summit with the nation's governors at the University of Virginia -- the only time in our country's history that such a summit has been held to discuss issues pertaining to education. In his concluding remarks President Bush discussed the overwhelming need to establish "accountability for outcome-related results." In a related way, Ernest L. Boyer observed, "I think we've gone about as far as we can go in the current reform movement dealing with procedural issues.... Schools [should] be held accountable for outcomes rather than the current situation of heavy state regulation that 'nibbles' them to death over procedures" (see Elliot, 1989).

In response to this recent focus on student outcomes, most states have begun to devise strategies for holding schools more accountable for the achievement of their pupils within general education. New Jersey, for example, has begun to monitor school districts on student outcomes and will issue an annual "School Report Card" to publicize progress and achievement in every school. Governor's commissions in Kansas and Maryland have proposed accreditation systems that would measure student outcomes rather than rely solely on measures of procedural input (Elliot, 1989).

This distinction between procedural and outcome accountability is relevant not only to general education, but also to special services. Since 1975, when The Education for All Handicapped Children Act was passed, the field has witnessed a 15-year focus on procedural compliance (i.e., documenting that services are provided to individuals with disabilities). In 1990, however, in synchrony with the accountability movement within general education, the field began to refocus attention on the question of what students are learning rather than what services are being provided.

## ACCOUNTABILITY, INSTRUCTIONAL PLANNING, AND CURRICULUM-BASED MEASUREMENT

In the 1990s, accountability for both general and special education may be linked less to procedural compliance and tied more to achievement and instruction -- that is measuring student performance, or the lack thereof, and assigning responsibility to districts, schools, and service providers for improving outcomes. In a related way, research has demonstrated the importance of ongoing measurement systems to describe student progress objectively for determining when and how to adjust instructional programs. This research indicates that frequent measurement on curriculum tasks and responsive use of that information in instructional decision making can enhance teacher planning and student outcomes (e.g., Fuchs, Deno, & Mirkin, 1984; Fuchs, Fuchs, Hamlett, & Stecker, 1991; Jones & Krouse, 1988).

Curriculum-Based Measurement (CBM) is one objective, ongoing measurement system designed to account for student outcomes and to enhance instructional planning (Deno, 1985). CBM requires that testing recur frequently over time using a standardized measurement system. Each test is an alternate form representing the year-long curriculum. The assessment information is used to monitor student growth over time and to determine when and how to adjust instructional programs to increase teaching effectiveness.

## STANDARDS FOR FUDGING PROGRESS WITHIN CBM SYSTEMS

In establishing this type of ongoing measurement system to facilitate instructional planning and to accomplish accountability, one essential step is to determine standards for how large weekly rates of improvement should be. Standards for weekly rates of improvement guide teachers' judgments about whether a student's current rate of progress is satisfactory or whether an adjustment in the teaching program is warranted. In this way, standards for weekly rates of improvement facilitate formative evaluation of a student's progress toward a satisfactory outcome at the end of the year. Therefore, in developing ongoing measurement systems that are useful for evaluating student outcomes and for designing successful instructional plans, it is critical for school psychologists to have access to information that will permit them to establish these standards.

Despite the importance of appropriate standards for weekly rates of academic growth, relevant normative information based on large samples of general education students currently is not available. Within CBM, available norms do provide information on student levels and range of performance at different grades, by indexing achievement cross-sectionally. Each student is measured on three samples at one point in time (see Shinn, Tindal, & Stein, 1988). This type of normative information is most useful in formulating social comparisons between students to determine when students are eligible for special service. These levels of performance norms also can be used to estimate end-of-year goals, from which weekly rates of improvement can be interpolated (Fuchs & Shinn, 1989). Unfortunately, this method of establishing weekly rates of growth, based on level norms, does not consider a student's beginning of the year performance: All third graders may have year-end reading goals set at the normatively appropriate level of 125 words read correctly per minute (WCPM). However, for a student with a beginning rate of 75 WCPM, this goal would represent an expected weekly increase of 1.67 WCPM ([125-65] + 30 weeks); for a student with an incoming rate of 25 WCPM, the expected weekly increase would be considerably larger ([125-25+ 30 weeks = 3.33 WCPM). Consequently, relying on cross-sectional normative data can result in varying standards for weekly rates of growth.

An alternative, more direct and perhaps appropriate, method of developing standards for weekly rates of growth is to monitor intraindividual student progress over time and to calculate normative data directly from students' weekly rates of improvement. Within the current educational reform, formative teaching systems such as CBM are most useful for indexing individual student growth over time -- to evaluate an individual's rate of progress and to assist teachers in developing better programs. Therefore, intraindividual norms for student growth, which describe students' weekly rates of improvement over time, appear necessary.

## PURPOSE

The purpose of this study was to provide intraindividual CBM norms for weekly rates of growth, or slopes of achievement. This normative slope information is critical to establish standards for formatively evaluating student growth toward satisfactory outcomes and developing instructional plans. This study makes an important contribution for three reasons. First and most specifically, intraindividual normative slope data should prove useful for CBM practitioners as they monitor student progress and use the information to develop instructional programs. Second and more generally, the methodology used in this study illustrates how other formative evaluation systems may develop norms; thereby, this study contributes to the development of a technology for measuring student change. Third and more theoretically, the resulting data can be interpreted in terms of models of student growth, which can enhance our understanding of human learning.

## METHOD

### Subjects

This database represents two consecutive years of investigation, with two samples of students, using standard CBM procedures in math, spelling, and reading in five school districts in the upper Midwest. The percentage of students receiving free or reduced lunches in these five districts ranged between 33 and 55, and the average normal curve equivalent on widely used, standardized commercial achievement tests was between 47 and 64.

In both studies (Years 1 and 2), every general education teacher within each participating school was included. In the Year 1 study, 24 teacher participants taught Grades 1-6 in three schools; each school participated in one academic area In Year 2, 51 participating teachers taught students in Grades 1-6 in five schools. Teachers in two schools participated in math; teachers in the other three schools, in spelling. In one school, teachers participated in both spelling and reading.

Students enrolled in the target schools participated. In Year 1, 117 students were included in reading, 252 in spelling, and 177 in math. In Year 2, 257 pupils were included in reading, 1,046 in spelling, and 1,208 in math. Any student with a disability, who was mainstreamed for any portion of his or her academic program was included. Numbers and percentages of students by year, area of participation, grade, and handicapped status (i.e., learning disabled or nonhandicapped) are shown in Table 1.

## Ongoing Measurement System: Curriculum-Based Measurement (CBM)

Teachers employed CBM to index pupils' academic progress in reading, spelling, or math from the beginning of October through April. CBM was based on the standard measurement tasks described in the following sections. CBM was conducted at the grade level where the student was placed, so that all first graders were assessed on first-grade curriculum materials, all second graders on second-grade material, etc.[1] In Year 1, every student was measured once each week; in Year 2, at least once each month. In Tables 2-6, the average number of measurements is shown for each type of CBM score at each grade level. During both years, teachers received computer-printed graphs monthly showing each student's scores over time.

Reading measurement procedures. Reading measurement procedures differed across Years 1 and 2. In Year 1, the standard CBM oral reading test was used, where students read aloud from passages. In Year 2, a computerized CBM maze test was employed. The CBM maze measure was adopted in Year 2, because of its feasibility and because of documentation that it can be used to monitor student growth and to help teachers develop more effective instructional programs (e.g., Fuchs, Fuchs, Hamlett, & Ferguson, 1992).

For oral passage reading CBM in Year 1, a teacher, aide, or volunteer administered the test individually according to standard directions. The student read aloud for 1 minute, each time from a different, generic grade-level passage (Deno, Deno, Marston, & Marston, 1987), while the adult marked incorrectly read words (i.e., substitutions, omissions, insertions, and hesitations). Generic passages were employed because different schools used different reading series and because research indicates that the CBM, or general outcome, model of formative teaching can be used successfully with curriculum-specific or generic materials (see Fuchs & Deno, 1991 and Fuchs & Deno, 1993 for discussion). Performance was scored by the testers as number of correctly read words. A coordinator periodically observed test administrations to monitor fidelity to standard procedures. Scores were entered by the data entry clerk into software that stored and organized test information.

For the maze CBM task in Year 2, students completed alternate forms of the test at the computer. Again, generic grade-level passages were employed. These generic passages were 400 words long, told complete stories, and were written to conform to the Fry readability formula (see Fuchs & Fuchs, 1992 for additional description of passages and maze measurement procedure). Students had 2.5 minutes to complete a maze of a 400-word grade-level passage on the screen. The first sentence of the passage was intact; thereafter, every seventh word was deleted and replaced with three choices. Only one choice was semantically correct. Distractors were not auditorally or graphically similar to the correct replacement; they were either the same length or within one letter of the correct replacement. Each maze was edited twice by independent editors to ensure compliance with these requirements. The task required students only to use the space bar and <RETURN> keys. A coordinator periodically observed test administrations to monitor fidelity to standard procedures. Performance was scored as number of correct replacements, and scores were automatically saved and organized.

Spelling measurement procedures. In Years 1 and 2, teachers administered two types of standard CBM spelling tests. One test incorporated randomly selected words from the instructional-level list (i.e., graded test) of the Harris-Jacobson (1972) word list.[2] The second test included words randomly sampled from the Harris-Jacobson word lists, across all six grade levels (i.e., common test). On this common test, all students' tests, regardless of the students' grade level, were identical (i.e., common). For graded and common tests, students took an alternative form of the test each week.

On each standard CBM test, the teacher dictated 20 words at 7-second intervals (total test duration = 2 min, 20 see); students wrote responses on lined, numbered paper. A coordinator periodically observed test administrations to monitor fidelity to standard procedures. A data-entry clerk entered every student's response to every test item into software. This software automatically scored performance as the number of correct letter sequences (LS) and words spelled correctly, and then stored and organized test information. Agreement between the computerized and human scoring has been documented at 99% (see Fuchs, Fuchs, Hamlett, & Allinder, 1991).

Math measurement procedures. During Years 1 and 2, teachers used a standard CBM math procedure; each test was an alternate form representing the type and proportion of problems from the grade-appropriate curriculum. Each CBM test had 25 problems, displayed in random order, encompassing randomly generated numerals. Within grade level, test time was held constant over the year: 45 sees at Grade 1, 1 min at Grade 2, 1.5 min at Grade, 3, 3 min at Grade 4, 5 min at Grade 5, and 6 min at Grade 6. These times increased as the maximum score, or the required number of operations performed and digits written, increased with grade. Teachers administered each test to the class according to standard directions. A coordinator periodically observed test administrations to monitor fidelity to standard procedures. A data-entry clerk entered every student's response to every test item into software, which automatically scored performance as the number of correct digits and problems in answers, and stored and organized test information. Perfect agreement between the computerized and human scoring has been documented (see Fuchs, Fuchs, Hamlett, & Stecker, 1991).

## Data Analysis

Calculation of slope. The primary analysis involved the calculation of slope, or weekly rate of academic progress, for each participant on each datum; in reading, correct words on the oral passage measure and correct replacements on the maze measure; in spelling, correct letter sequences (LS) and correct words on both the graded and common measures; in math, correct digits and correct problems. Slope was calculated as in previous CBM research to permit comparison with earlier studies. Using standard CBM procedures, a least-squares regression was run for each student between scores and calendar days (a real time analysis was used). From this regression, the slope indicates the average increase in score for every subsequent calendar day. To conform to methods employed in previous CBM research, this calendar day slope was converted to a weekly slope of improvement by multiplying by 7 days. Consequently, slope is the average weekly increase in a student's CBM score across the school year.

Analysis of adequacy of linear relationship in modeling progress within 1 academic year. For a subset of up to 56[3] randomly selected students at each grade level (all of whom had at least seven measurements across the school year), a preliminary analysis assessed the extent to which a linear relationship adequately modeled student progress within 1 academic year of development. This analysis was conducted on Years 1 and 2 reading, to describe the oral passage reading and the maze reading measures, and on Year 2 spelling and math data. As slope was calculated for each datum for each of these individuals at every grade level, a quadratic component was included in the analysis to determine whether it contributed to the modeling of student progress.[4] The percentage of students for whom the quadratic term contributed significantly was computed for each datum at every grade level. The percentage of students for whom the linear term significantly contributed also was computed.

Examination of distribution of slopes. After we calculated the individual slopes and estimated the extent to which quadratic and linear relationships modeled student progress, the mean slope and standard deviation were calculated for each datum at every grade. Then, the distribution of the slopes by grade and datum was examined to assess conformity to the normal distribution. Kurtosis and skewness were calculated, and the percentage of distributions for which kurtosis or skewness exceeded two standard errors was computed. The percentage of cases with negative slopes also was calculated.

Analysis of the relationship between slope and grade level. Finally, the effect of grade level on slope was examined by running a one-way analysis of variance (ANOVA) for every datum. The ANOVA employed grade level as the between-subjects factor and incorporated orthogonal polynomial contrasts to determine the extent to which a linear or quadratic relationship modeled student progress across years of development.

## CBM Training

In the summer preceding Year 1, initial training was delivered for 2 days to the districts' special education coordinator, who supervised the project, and to three contact teachers (i.e., one general educator in each participating school). During the first day, a rationale for the project was presented, the measurement procedures were explained and practiced, and methods for interpreting CBM graphs were reviewed. On the second day, measurement and graph reading were practiced again, questions were answered, and each participant was provided scripted materials and procedures with which to train the remaining general educators in her home school.

In the second training phase, which occurred in September of each study year, the scripted training session was conducted at each school by the special education coordinator and that school's contact teacher. This training session included (a) a rationale for the measurement, (b) instruction and practice in administering CBM tests, and (c) instruction and practice in CBM graph reading.

In the third phase, the special education coordinator held monthly inservices each year, at which concerns were discussed, measurement procedures reviewed, and student graphs shared and discussed. Additionally, the contact teacher at each school provided ongoing support and served as the consultant for the project at her school.

# RESULTS AND DISCUSSION

## Reading

In Table 2, the following statistics are presented, by grade level, for words correct on the Year 1 CBM oral passage reading measure and for correct replacements on the Year 2 CBM maze measure: (a) average slopes and standard deviations, (b) percentages of individual student regressions for which the quadratic term significantly contributed to the modeling of student progress, (c) information about the distribution of the slopes across students, and (d) percentages of students with negative slopes. Additionally, in footnotes to these tables, information is presented about results of ANOVAs, testing for the effect of grade level on slope. We discuss these data with respect to three major questions: How well does a linear relationship model student progress within 1 academic year?; How well does the normal distribution characterize the distribution of slopes?; and What is the weekly rate of student progress and to what extent does it vary as a function of grade level?

How well does a linear relationship model student reading progress within 1 academic year? Preliminary analyses assessed the extent to which a linear relationship adequately modeled student progress within one academic year in reading. As the regression between each student's scores and calendar days was computed, a quadratic component was included to determine whether it contributed to the modeling of student progress. Results revealed that, for the CBM oral reading measure and for the CBM maze reading measure, respectively, 0-21% and 19-31% of the relationships had significant quadratic terms. For almost all of these cases, a slightly negatively accelerating pattern of progress was revealed within one academic year. With this pattern, student performance continues to improve over the academic year; however, the amount of that improvement gradually decreases.

For the CBM oral passage reading measure, a linear relationship contributed significantly to the description of student progress for 100%,100%,100%, 86%, 81%, and 24% of the individuals at Grades 16, respectively. For the CBM maze reading measure, a linear relationship satisfactorily contributed to the modeling of progress for 95%, 93%, 80%, 84%, and 70% of the students at Grades 2-6, respectively.

How well does the normal distribution characterize the distribution of slopes? A second set of analyses was conducted to examine the extent to which the distribution of slopes conformed to the normal distribution. As shown in Table 2, distributions of the CBM oral reading slopes appeared normal (i.e., kurtosis and skewness fell within 2 standard errors) for Grades 1,4,5, and 6; the CBM maze slopes were normally distributed for Grades 1, 2, and 6. At Grades 2 and 3 for oral reading and at Grades 3, 4, and 5 for maze, however, kurtosis and skewness exceeded 2 standard errors. At these grades, the distributions were leopkurtic (i.e., more peaked than a normal distribution) and positively skewed with a few extreme positive slopes. The exception was at Grade 4 on the maze measure, where the distribution was negatively skewed, with one extreme negative slope.

What is the weekly rate of student progress and, to what extent, does it vary with grade level? The effect of grade level on CBM reading slopes differed for the two types of measures. For oral passage reading, the ANOVA revealed statistically significant differences in slope as a function of grade. The slopes at Grade 4 were reliably greater than at Grade 6; slopes at Grade 3 were reliably greater than at Grades 5 and 6; slopes at Grade 2 were reliably greater than at every subsequent grade; and slopes at Grade 1 also were reliably greater than at every subsequent grade. Both the linear and the quadratic terms contributed significantly to the relationship; the pattern revealed a negatively decelerating curve. Consequently, across academic years, slopes were positive but the size of that positive slope decreased geometrically with grade.

In stark contrast, the ANOVA revealed no relation between slope and grade level for the Year 2 maze slopes. No significant difference occurred between slopes at any two grades. These contrasting findings for oral passage reading and maze slopes are important both for assisting practitioners in setting appropriate weekly rates of progress and, as proposed by Potter and Wamre (1990), for exploring and understanding models of reading development.

In terms of establishing appropriate weekly rates of improvement when monitoring progress with oral passage reading, the student's grade level of functioning must be considered. Findings indicate that for first graders, an improvement of 2 words per week may represent a realistic slope. On the other hand, given research indicating the importance of ambitious goals to enhance student achievement (e.g., Fuchs, Fuchs, & Hamlett, 1989), an improvement of approximately 3 words per week (i.e., 2.10 plus one standard deviation of .80) may represent an appropriately ambitious standard for weekly growth. This may be especially true for students with disabilities who must decrease discrepancies between their performance and that of their peers. Realistic and ambitious standards for weekly growth, respectively, are 1.5 and 2.0 words per week at Grade 2; 1.0 and 1.5 words per week at Grade 3; .85 and 1.1 words per week at Grade 4; .5 and .8 words per week at Grade 5; and .3 and .65 words per week at Grade 6.

When establishing appropriate weekly rates of improvement for monitoring student progress with the maze measurement procedure, however, the student's grade level is of no consequence: A realistic target for weekly improvement appears to be approximately .39 (i.e., the grand mean across grade level); an ambitious target, .84 (i.e., the grand mean plus one pooled within group standard deviation).

These contrasting patterns in slope for the two CBM measures, as a function of grade, are also interesting for understanding models of reading development. Developmental models of reading (e.g., Chall, 1983; LaBerge & Samuels, 1974; Perfetti & Lesgold, 1979) assume that reading entails component skills, each of which is sufficient for a time, but then new skills must be achieved for reading proficiency to increase. These components begin with letter-sound recognition and proceed sequentially to decoding, fluency, comprehension, and the ability to integrate and synthesize material (see Potter & Wamre, 1990).

As indexed by CBM passage reading, students make their most dramatic growth in the early grades, with slopes of 2 words per week at Grade 1 and slopes between .85 and 1.5 words per week at Grades through 4. By Grades 5 and 6, however, slope for general education students' oral passage reading drops to one-half word per week and less. This inverse relation between slope and grade for oral passage reading fits within developmental reading theory. Research clearly indicates that the CBM oral passage reading measure can be used as a global indicator of reading, to index student proficiency across the multiple component skills of reading, including comprehension (e.g., Deno, Mirkin, & Chiang, 1982; Fuchs, Fuchs, & Maxwell, 1988; Shinn, 1989). Nevertheless, oral passage reading most directly requires the earlier component skills proposed by developmental reading theorists: decoding and fluency. According to theory, greater growth on tests directly requiring decoding and fluency should be, and indeed was, manifest as earlier reading stages in the earlier grades.

By contrast, the CBM maze task may more directly require not only decoding and fluency, but also comprehension: To score well on the maze (or to index improvement over time), students must decode text, proceed fluently, and understand the content for successful blank restoration. Developmental theory would predict that this more comprehensive set of component skills required by the maze would result in more similar rates of growth over the grades. This predicted pattern actually was demonstrated in the current study. Our findings are related to and supported by those reported and discussed by (a) Jenkins and Jewell (1990) in their correlational comparison of CBM measures of oral passage reading and maze and (b) Shinn and colleagues (1992) in their construct validity analysis of reading measures.

## Spelling

Data for spelling correct letter sequences and words are shown for the common and the graded measures: Year 1 results appear in Table 3; Year 2 results, in Table 4. The following statistics are presented by grade level: (a) average slopes and standard deviations, (b) percentages of individual student regressions for which the quadratic term significantly contributed to the modeling of student progress, (c) information about the distribution of the slopes across students, and (d) percentages of students with negative slopes. In footnotes to these tables, information also is presented about results of ANOVA, testing for the effect of grade level on slope.

How well does a linear relationship model student progress within 1 academic year? Preliminary analyses, assessing the extent to which a linear relationship adequately modeled student progress within one academic year, revealed that, for the Year 2 graded measure the quadratic term significantly contributed to the modeling of student growth for 2-13% of the individuals when LS was the score and for 4-21% of the students when correct words was the score (see Table 4 for percentages by grade). For the common measure in Year 2, percentages ranged between 4 and 16 both for LS and words correct (see Table 4). As with the reading slopes, for almost all cases, these curvilinear relationships indicated slightly negatively accelerating patterns across one academic year. A linear relationship contributed significantly to the modeling of student progress for the following percentages at Grades 2-6, respectively 70, 50, 24, 28, and 48 for the graded LS score; 67, 25, 32, 19, and 19 for the grades words score; 89, 83, 66, 43, and 45 for the common LS score; and 59, 41, 20, 13, and 21 for the common words score.

How well does the normal distribution characterize the distribution of slopes! Distributions of the Year 1 slopes appeared normal for approximately 40% of the grades (i.e., kurtosis and skewness fell within 2 standard errors). Only 20-40% of the Year 2 distributions appeared to conform to normality (see Table 4). In all cases, when kurtosis exceeded 2 standard errors, the distribution was lepokurtic (i.e., more peaked than a normal distribution). With respect to skewness, distributions that exceeded 2 standard errors were, in all but two cases, positively skewed with a few extreme positive slopes. Despite that many spelling slope distributions failed to conform to normal distributions, distortion from normality, both in terms of kurtosis and skewness, was not extensive.

What is the weekly rate of student progress and, to what extent, does it vary with grade level? A significant relation between grade and CBM spelling slopes (see ANOVA results in footnotes to Tables 3 and 4) existed for both years, for the graded and common measures, and for the letter sequences and correct words scores. In all but one case (i.e., the Year 1 correct words score for the common measure), both the linear and the quadratic terms contributed significantly to the modeling of the relationship between slope and grade level.

For the primary CBM spelling index (i.e., LS scores on the graded tests), slopes ranged from .21 in Grade 6 to 1.08 in Grade 2 during Year 1; from .46 in Grade 6 to .92 in Grade 2 during Year 2. Follow-up tests to the ANOVA indicated that, for Year 1, the slope of growth was comparable at Grades 5 and 6, but that the Grade 4 slope was reliably greater than slopes at Grades 5 and 6. In a similar way, the slope at Grade 3 was reliably greater than at all subsequent grades, and the Grade 2 slope also was reliably greater than at every higher grade. For Year 2, reliable differences were identical to those found at Year 1, with the exception that the Grades 5 and 6 slopes also were statistically significantly different.

As these findings reveal, LS slope on the graded measure decreased reliably and geometrically with grade level, indicating that students make their most dramatic spelling growth in the early grades and that, although their growth continues, the amount of that growth trails off steadily over time. This inverse relation between LS slope and grade level for the graded CBM spelling test was also evident in the pattern of slopes for the common CBM spelling test (sampling words across Grades 1-6). Corroborating information across years and across types of CBM spelling tests increases confidence in reliability of findings.

Interestingly, the inverse relation between LS slope and grade level also is consonant with theories of developmental spelling growth. These theories propose that children advance through discernable stages of spelling (Henderson, 1980). Most children proceed relatively quickly through the first three stages (i.e., nonphonetic, preconventional phonetic, and conventional phonetic stages) and enter the final stage (i.e., morphemic spelling) by third grade (Beers & Henderson, 1977; Morris, Nelson, & Perney, 1986). This theory suggests that progress occurs relatively quickly during the first 2 to 3 years and then, as students enter the morphemic spelling stage, progress slows. This proposed pattern is mirrored in the pattern of CBM spelling slopes shown in Tables 3 and 4.

In terms of expectations for weekly rates of improvement, at least when monitoring progress on the Harris-Jacobson graded word lists, it appears that realistic and ambitious targets are approximately 1 word and 1.5 words per week at Grade 2; .65 and 1.0 word at Grade 3; .45 and .85 word at Grade 4; .3 and .65 word at Grades 5 and 6.

On a different note, findings reveal a pattern of higher slopes for the LS than for the words score. LS award credit for parts of words spelling correctly. These higher slopes for scores that award partial credit should make LS a more sensitive index of growth, which detects student improvement sooner than would scores requiring students to improve in units of whole words correct (see Deno, 1985 for discussion). Of course, because spelling words, rather than parts of words, is valued in society, it may be important to monitor number of words spelled correctly periodically, perhaps at monthly intervals, to ensure that students' word spelling is improving gradually, along with LS.

## Math

The following statistics are presented, by grade level, for digits and problem scores, in Table 5 for Year 1 and in Table 6 for Year 2: (a) average slopes and standard deviations, (b) percentages of individual student regressions for which the quadratic term significantly contributed to the modeling of student progress, (c) information about the distribution of the slopes across students, and (d) percentages of students with negative slopes. See footnotes to these tables for results of ANOVAs, testing for the effect of grade level on slope.

How well does a linear relationship model student progress within 1 academic year? For the digits score, analyses indicated that the quadratic term significantly contributed to the modeling of student growth for 0-15% of the individuals in Year 2. For the problems datum, the quadratic term significantly contributed to the modeling of progress for 412% of the students in Year 2 (see Table 6). Again, for almost all cases, these curvilinear relationships revealed a negatively accelerating pattern across one academic year. The linear term significantly contributed to the modeling of progress for the following percentages of students at Grades 1-6, respectively: 84, 60, 98, 75, 60, and 38 for digits, and 92, 64, 89, 84, 61, and 45 for problems.

How well does the normal distribution characterize the distribution of slopes? Distributions of the Year 1 slope (see Table 5) were normal for approximately half the grades (i.e., kurtosis and skewness fell within 2 standard errors). As shown in Table 6, with the larger sample sizes of Year 2, most distributions appeared to conform to normality. In all cases, when kurtosis exceeded 2 standard errors, the distribution was lepokurtic (i.e., more peaked than a normal distribution). With respect to skewness, distributions that exceeded 2 standard errors were, in all but one case, positively skewed with a few extreme positive slopes.

What is the weekly rate of student progress and, to what extent does it vary with grade level? CBM math slopes for the digits correct scores (i.e., the primary CBM math score) ranged from .20 at Grade 2 to .77 at Grade 4 during Year 1; from .28 at Grade 2 to .74 at Grade 5 during Year 2. As described in the footnotes to Tables 6 and 6, in both years, ANOVAs revealed statistically significant differences in slope as a function of grade.

For Year 1 slopes, a linear relationship existed between the digits slope and grade level; Grade 2 slopes were reliably lower than Grade 3, 6, and 1 slopes, which in turn were reliably lower than Grade 4 and 5 slopes. For the Year 2 slopes, both the linear and quadratic terms were statistically significant; Grade 1, 2, and 3 slopes were reliably lower than Grade 6 slopes, which in turn were reliably lower than Grade 4 and 5 slopes.

Consequently, across the samples in both data collection years, patterns in the slopes for digits were similar. Two notable exceptions were (a) the significant quadratic relationship revealed in Year 2, but not Year 1, and (b) the apparently higher Year 1 first-grade slopes compared to those in Year 2. Given the larger sample size for the Year 2 data, greater confidence should be placed in the figures shown in Table 6.

As indicated by these preliminary norms, therefore, a weekly increase of .30 digits seems to represent a realistic CBM weekly rate of improvement for Grades 1, 2, and 3; .45 digits for Grade 6; and .70 to .75 digits for Grades 4 and 5. Adding one standard deviation to the average slopes shown in Table 6, CBM practitioners may employ the following targets for establishing more ambitious weekly rates of growth for their students: at Grades 1, 2, and 3, .50; at Grade 6, 1.00; at Grades 4 and 5, 1.15 to 1.20.

Although number of problems correct typically is not employed in the ongoing measurement of progress within CBM methodology, some comment with respect to this secondary score appears warranted. It is interesting to note that, except at Grade 1, slopes consistently were higher for digits than problems. Comparable slopes for digits and problems at Grade 1 are expected because Grade 1 problems typically require only 1-digit answers. However, with higher grades, especially after Grade 3, the number of digits required per problem increases --hence, the increasing discrepancies between slopes for digits and problems scores. These larger slopes for digits support the use of digits as the primary CBM datum: As Deno (1985) noted, higher slopes are a desirable feature of ongoing measurement systems, because higher slopes makes student growth easier to detect. When, due to higher slopes, student change (or lack thereof) becomes evident sooner, ongoing measurement systems are more useful for instructional decision making and more satisfying for pupils and teachers.

# CONCLUSIONS

Results must be interpreted in light of two serious limitations. First, because data were collected in one rural region, performance may be unrepresentative of more suburban or urban areas, of other regions of the country, or even of other rural districts in the same region. Future studies addressing the extent of variability across (and even within) districts should clarify whether a need exists to develop district- (or school-) specific norms for weekly rates of growth or whether norms based on large samples, representative of the greater population, will suffice. Second, because alternative materials from which to sample testing stimuli were not contrasted in this study, we do not know whether findings would generalize to other curricula. Clearly, additional research investigating such comparisons are required. Pending future studies with other types of samples and using other curricula, current norms for weekly rates of student improvement can be considered only preliminary.

Within the constraints of these limitations, the current study does provide important preliminary information (a) to help establish guidelines for formatively evaluating student progress when implementing CBM, (b) to provide a methodology to develop similar guidelines for other formative teaching systems and to measure and study student change, and (c) to increase our understanding of theoretical models of academic growth.

## Establishing Guidelines for Formatively Evaluating Progress with CBM

Results provide estimates for designating realistic and appropriately ambitious weekly rates of growth when formatively evaluating student progress with CBM. These estimates, derived primarily from general education samples (but including small numbers of mainstreamed students with disabilities), can be used within both general and special education settings.

## Special education

To illustrate how this type of normative information can be used within special education settings, we briefly describe a case study about a sixth-grade student who is receiving instruction in a special education resource room and is working on the fifth-grade math curriculum this year. The CBM system is designed to mirror this curriculum: Each 25-item parallel test requires the student to complete every type of problem to be taught during the year. The student takes two parallel forms of the test each week. The primary CBM summary of performance is a graph showing the student's total test scores (i.e., number of digits correct) over time (see Figure 1).

On his first three CBM tests sampling the fifth-grade mathematics curriculum, the student earned CBM scores of 37, 29, and 24 digits correct. Using a baseline 29 digits correct (i.e., the median of his first three scores), the school psychologist could consult norms for weekly rates of growth to determine that, based on a general education sample including 21% handicapped pupils, fifth graders typically improve approximately. 75 digits per week (see Table 6). The school psychologist realizes, however, that this special education student must improve upon the typical rate of progress in order to reduce the discrepancy between his performance and that of his peers. Consequently, instead of using the more typical growth standard of .75 digits improvement per week, the school psychologist employs the more ambitious criterion of 1.2 digits per week (i.e.,.75 plus one standard deviation, .45). Because 26 weeks remain in the academic year, the year-end goal then is set at 61 ([1.2 x 26 weeks] + a baseline of 29). This weekly rate of improvement is depicted on the student's graph with a broken diagonal line.

The teacher and school psychologist can use this CBM structure to evaluate the student's progress in the 95th-grade curriculum and to plan his instructional program. When the student's rate of growth exceeds 1.2 digits per week, the goal is increased. As shown in Figure 1, however, the student's rate of growth is less the desired criterion of 1.2 digits per week: The solid line superimposed over the last 10 scores indicates that the actual rate of growth is less than the desired rate, reflected in the broken diagonal line. Consequently, the teacher adjusts the teaching program to try to effect better growth (see message at the bottom of the graph suggesting a teaching change). In consultation with the school psychologist, the teacher relies on information about the instruction provided, about the student, and about the CBM database to determine how to adjust the student's program.

The CBM database also can be used to account for student outcomes. Between November and May (26 weeks), the student progressed from 29 to 75 digits correct on the Grade 5 curriculum, representing a weekly increase of over 1.5 digits. This slope of 1.5 digits compares favorably to the student's prespecial education slope of .75 for the mainstream 95th-grade class working in the Grade 5 curriculum.

## General education

In general education CBM implementations (e.g., Fuchs, 1992), every student in the class is measured once each week on the grade-appropriate curriculum. This general education CBM database can be used to identify students who are experiencing difficulty with the curriculum early in the year, when their weekly rates of growth fall below normative targets for growth. These students can be identified for special attention within general education. Sometimes, students who suffer difficulties represent a small portion of the general education class; other times, larger portions of the class experience problems.

When small subgroups of a class (i.e., one-three pupils) are identified as problematic, the CBM norms can be used in a similar manner as described within special education settings: to carefully track the individual's rate of growth and determine when goals can be increased and when individual adjustments in instructional programs are warranted. When larger groups of a classroom are involved, however, focusing on individual students to determine differentiated instruction can be logistically difficult. In such cases, the CBM database can be used to help teachers target their large- and small-group instruction to meet the needs of all students in the class more effectively. Additionally, the combination of CBM with classwide peer tutoring represents one strategy for providing differentiated instruction within the context of general education (see Fuchs, 1992 for description of general education CBM applications).

Finally, the CBM database can be used to describe and account for student outcomes. By comparing individual weekly rates of growth to normative rates of improvement, judgments about the adequacy of individual progress can be formulated. In a related way, the average rate of growth for a classroom can be compared to normative information to evaluate the quality of the overall instructional program within the classroom.

## Providing a Methodology for Other Formative Teaching Systems and Contributing to a Technology for the Measurement of Change

With respect to the second purpose, this study offers a methodology that researchers may use to develop similar norms for other formative teaching systems. Within the current educational reform movement, which stresses accountability for student outcomes, information about appropriate standards for judging student progress is critical. With formative teaching systems (as illustrated above for CBM), information is provided on an ongoing basis, so that service providers can use measurement not only for end-of-year summative decisions about the adequacy of student growth, but also for formative decision making to enhance those outcomes. Norms that provide realistic standards for evaluating growth are necessary for making these summative, as well as formative, decisions about the adequacy of individual, class, school, or district outcomes.

The current study also contributes to the development of technology for measuring student change, as it offers an illustrative methodology by which normative information for other formative teaching systems can be developed. With formative teaching systems, such as CBM, student performance is measured repeatedly (i.e., 1-2 times per week) on equivalent tests representing the year-long curriculum. These measurements, therefore, are comparable at any two points in time during the academic year; consequently, weekly rates of growth can be computed. The traditional approach of district level, annual, one-shot testing on commercial standardized achievement tests provides limited information with which to describe change or to formulate improvements in instructional plans. By contrast, the method for describing student change presented in this article is novel and useful; it represents a potentially important contribution to a technology of measuring pupil progress, which can be used in a formative way to improve instruction and learning outcomes.

## Enhancing Understanding of Human Growth and Development

Results of the current study were discussed in terms of models of student development of academic proficiency. Spelling and reading findings support developmental theories of student growth, where students acquire important component skills relatively quickly in the early grades.

A final set of comments, about the extent to which a linear relationship adequately models student progress, also relates to our understanding of human development. In this discussion, it is important to remember that within-year analyses were conducted at the individual student level, with regressions predicting student scores from calendar weeks. By contrast, the across-year analyses were conducted at the group level, with ANOVAs assessing the relationship between grade and slope. Consequently, the analyses are not parallel. Although the current methodology does permit comparison between within- and across-year patterns of growth, future research might formulate these comparisons longitudinally, so that both the within- and across-year analyses could be run analogously, tracking the same students within and across grades.

The current set of analyses indicated that, for most students, reading and math progress made during one academic year can be characterized as increasing in linear fashion with time. For this majority of individuals, a linear regression both describes and predicts progress adequately. This finding enhances our understanding of how students develop academically, suggesting that progress occurs additively within the framework of a single academic year. These results also increase confidence in the standard CBM data-evaluation methods, which rely on regression or quarter-intersect (i.e., straight) liens to (a) describe current rates of progress, (b) predict desired rates of progress, and (c) determine when student progress is satisfactory or when a need for instructional adjustment exists (see Fuchs, Hamlett, & Fuchs, 1990 for a description of these data-evaluation methods and see Figure 1 for the application of these straight lines).

It is important to note, however, that for some students (0-31%, depending on academic area, datum, and grade), progress within one academic year was characterized by a negatively accelerating pattern. Fitting a linear function (or a straight line) to a negatively accelerating curve would result in underestimating student progress early in the year and overestimating student progress at the end of the year. Moreover, for Grade 6 oral passage reading and for Grade 6 math (as well as for many spelling grade levels), the linear relationship did not contribute significantly to the modeling of student progress for more than 60% of general education students. CBM practitioners should be mindful of the possibility that an individual student's progress may not, in fact, be characterized by a straight line -- especially for oral passage reading at Grade 6, for math at Grade 6, and for spelling. For these individuals, standard CBM methods for evaluating progress may not be adequate.

These results also bear on the long-standing question about whether equal interval or semilogarithmic graph paper is more suitable for displaying student progress over one academic year (see Marston, 1988 for related discussion). Equal interval paper assumes a linear relationship between time and score; semilogarithmic paper assumes a positively accelerating learning curve. The finding that a linear function adequately models student progress within an academic year for the great majority of individuals in reading and math supports the use of equal interval graph paper for displaying reading and math progress with CBM. It also helps explain

Marston's (1988) finding that students' reading scores graphed on equal interval paper predicted outcome scores better than scores graphed on six-cycle paper. The related finding (i.e., when a linear relationship does not characterize progress, a negatively accelerating curve best approximates growth) also seriously questions the use of semilogarithmic graph paper to display progress --at least for use with a measurement approach, such as CBM, that samples material from the entire year's curriculum and focuses on student progress toward end-of-year goals.

Although a linear relationship adequately modeled reading and math growth within an academic year, a linear relationship did not adequately model academic growth across years in school. This was true for all measures in all academic areas, except the CBM maze measure for which weekly rates of growth were comparable regardless of time in school. Consequently, it appears that, over years in school, academic proficiency continues to increase (i.e., students exhibit positive slopes) -- at least when progress is indexed on measures of basic skills such as spelling words, reading aloud text, and conducting operations on numbers. The magnitude of that improvement, however, gradually decreases, probably as learning of the basics is acquired and attention becomes refocused on more complex domains of study not reflected in the measures employed in this study, except for the maze. This gradual deceleration may explain why, at Grade 6 for math and oral passage reading, but not for maze, the linear relationship applied to individual student regressions no longer modeled growth. Future research investigating the tenability of these hypotheses should not only enhance our understanding of models of human development but also contribute to a technology of measuring student change.

## FOOTNOTES

*[1] All students within a class were monitored on the same, grade-appropriate materials. This uniform approach to measurement level frequently is adopted when CBM is used in general education to increase feasibility. Teachers did, however, set individual goals, specifying the desired performance by the end of the year on the grade-appropriate material and used the database to monitor student growth. They occasionally did make instructional adjustments based on the ongoing assessment information.*

*[2] The Harris-Jacobson word list includes high frequency vocabulary across reading curricula. This word list was selected because the participating school districts did not employ a spelling program. The computerized CBM spelling program can be adapted for use with any curriculum.*

*[3] When n exceeded 50 at a grade level, 50 cases were selected randomly for this analysis. When $n < 50$, all cases with at least seven measurements were employed.*

*[4] Although the use of a quadratic term in a polynomial regression is acceptable for evaluating the curvilinear nature of individual student progress within a year, please note that this would not be the procedure of choice for predicting performance beyond the range of data.*

**TABLE 1**

**Numbers of Student Participants in Years 1 and 2 by Area, Grade, and Handicapped Status [a]**

**Table Legend:**

**A = Nonhandicapped**
**B = Handicapped**

| Year/Grade | | Math A | | Math B | | Spelling A | | Spelling B | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Year 1** | | | | | | | | | | |
| Grade | 1 | 17 | (94) | 1 | ( 6) | -- | (--) | -- | (--) | [b] |
| | 2 | 42 | (98) | 1 | ( 6) | 59 | (97) | 2 | ( 3) | |
| | 3 | 22 | (92) | 2 | ( 8) | 34 | (92) | 3 | ( 8) | |
| | 4 | 20 | (95) | 1 | ( 5) | 56 | (92) | 5 | ( 8) | |
| | 5 | 42 | (93) | 3 | ( 7) | 48 | (96) | 2 | ( 4) | |
| | 6 | 22 | (92) | 2 | ( 8) | 39 | (93) | 4 | ( 7) | |
| Total | | 167 | (94) | 10 | ( 6) | 236 | (94) | 16 | ( 6) | |
| **Year 2** | | | | | | | | | | |
| Grade | 1 | 183 | (95) | 10 | ( 5) | -- | (--) | -- | (--) | [b] |
| | 2 | 180 | (95) | 8 | ( 5) | 181 | (95) | 9 | ( 5) | |
| | 3 | 169 | (86) | 26 | ( 14) | 195 | (86) | 32 | (14) | |
| | 4 | 172 | (89) | 22 | ( 11) | 172 | (89) | 22 | (11) | |
| | 5 | 180 | (79) | 47 | ( 21) | 179 | (79) | 48 | (21) | |
| | 6 | 176 | (84) | 35 | ( 16) | 175 | (84) | 33 | (16) | |
| Total | | 1060 | (88) | 148 | ( 12) | 902 | (86) | 144 | (14) | |

| Year/Grade | | Reading A | | Reading B | |
|---|---|---|---|---|---|
| **Year 1** | | | | | |
| Grade | 1 | 18 | (95) | 1 | ( 5) |
| | 2 | 23 | (92) | 2 | ( 8) |
| | 3 | 11 | (79) | 3 | (21) |
| | 4 | 15 | (94) | 1 | ( 6) |
| | 5 | 15 | (75) | 5 | (25) |
| | 6 | 21 | (88) | 2 | (12) |
| Total | | 103 | (88) | 14 | (12) |
| **Year 2** | | | | | |
| Grade | 1 | 13 | (93) | 1 | ( 7) |
| | 2 | 43 | (94) | 3 | ( 6) |
| | 3 | 44 | (85) | 8 | (15) |
| | 4 | 34 | (89) | 4 | (11) |
| | 5 | 46 | (81) | 11 | (19) |
| | 6 | 40 | (89) | 5 | (11) |
| Total | | 225 | (88) | 32 | (12) |

[a] Percentage are shown in parentheses.
[b] In spelling, only a small number of first-grade students participated. Therefore, they are not included.

**TABLE 2**

**Slope Information for Years 1 and 2 in Reading**

**Table Legend:**

**I - n**
**II - M**
**III - (SD)**
**IV - Kurtosis**
**V - ($se_k$)**
**VI - Skewness**
**VII - ($se_s$)**
**VIII - Min**
**IX - Max**
**X - % Neg.**
**XI - % Quad.**

| Variable/Grade | | I | Number Scores II | Number Scores III | Slope (b) [a] II | Slope (b) [a] III |
|---|---|---|---|---|---|---|
| **Year 1** | | | | | | |
| **Number Correct: Oral Passage Reading** | | | | | | |
| Grade | 1 | 19 | 13.59 | (6.13) | 2.10 | ( .80) |
| | 2 | 25 | 27.92 | (5.03) | 1.46 | ( .69) |
| | 3 | 14 | 29.79 | ( .58) | 1.08 | ( .52) |
| | 4 | 16 | 28.75 | (1.34) | .84 | ( .30) |
| | 5 | 20 | 28.80 | (1.24) | .49 | ( .28) |
| | 6 | 23 | 27.74 | (1.96) | .32 | ( .33) |
| **Year 2** | | | | | | |
| **Number Correct: Replacement-Maze** | | | | | | |
| Grade | 1 | 14 | 7.14 | (3.48) | 34 | ( .39) |
| | 2 | 51 | 24.73 | (4.46) | 39 | ( .24) |
| | 3 | 52 | 13.69 | (5.27) | 47 | ( .37) |
| | 4 | 38 | 17.24 | (6.11) | 38 | ( .32) |
| | 5 | 57 | 18.49 | (4.94) | 36 | ( .23) |
| | 6 | 45 | 15.16 | (6.74) | 27 | ( .25) |

| Variable/Grade | | Distribution of Slopes IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|
| **Year 1** | | | | | | |
| **Number Correct-Oral Passage Reading** | | | | | | |
| Grade | 1 | 1.04 | (1.01) | .88 | ( .52) | .35 |
| | 2 | 6.93 | ( .90) | 2.34 | ( .46) | .71 |
| | 3 | 2.57 | (1.15) | 1.39 | ( .60) | .43 |
| | 4 | -1.12 | (1.09) | .43 | ( .56) | .47 |
| | 5 | .31 | ( .99) | .71 | ( .51) | .04 |
| | 6 | - .45 | ( .94) | .06 | ( .48) | -.22 |

**TABLE 2 (Continued)**

| Variable/Grade | | Distribution of Slopes IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|
| **Year 2** | | | | | | |
| **Number Correct: Replacement-Maze** | | | | | | |
| Grade | 1 | - .19 | (1.15) | - .89 | ( .60) | -.44 |
| | 2 | .78 | ( .66) | .48 | ( .33) | .04 |
| | 3 | 5.13 | ( .65) | 1.70 | ( .33) | -.06 |
| | 4 | 4.34 | ( .76) | -1.09 | ( .39) | -.82 |
| | 5 | 1.25 | ( .62) | .92 | ( .32) | -.06 |
| | 6 | - .98 | ( .70) | .02 | ( .35) | -.18 |

| Variable/Grade | | Distribution of Slopes IX | X | XI |
|---|---|---|---|---|
| **Year 1** | | | | |
| **Number Correct: Oral Passage Reading** | | | | |
| Grade | 1 | 4.94 | 0.0 | 0 |
| | 2 | 4.00 | 0.0 | 21 |
| | 3 | 2.43 | 0.0 | 0 |
| | 4 | 1.41 | 0.0 | 7 |
| | 5 | 1.12 | 0.0 | 6 |
| | 6 | .97 | 17.4 | 5 |
| **Year 2** | | | | |
| **Number Correct Replacement: Maze** | | | | |
| Grade | 1 | .82 | 21.4 | --[b] |
| | 2 | 1.48 | 0.0 | 29 |
| | 3 | 2.01 | 1.9 | 26 |
| | 4 | .94 | 7.9 | 31 |
| | 5 | 1.11 | 3.5 | 20 |
| | 6 | .76 | 22.2 | 19 |

[a] For oral passage reading, the one-way ANOVA for the effect of grade produced a significant $F(5,111)$ value of 31.08, $p < .001$; the $F(1,111)$ for the linear trend was 151.83, $p > .001$ and for the quadratic trend, $F(1,111) = 4.73$, $p < .005$. Student-Newman-Keuls revealed that 6 = 5; 6<4<3<2<1. For maze, the ANOVA revealed no significant relation between slope and grade, $F(5,250) = .18$, ns.

[b] Given the low n and the relatively few measurement points for maze at Grade 1, we did not run the Quadratic intraindividual analysis.

**TABLE 3**

**Slope Information for Year 1 in Spelling**

**Table Legend:**

**I - n**
**II - M**
**III - (SD)**
**IV - Kurtosis**
**V - ($se_k$)**
**VI - Skewness**
**VII - ($se_s$)**
**VIII - Min**
**IX - Max**
**X - % Negative**

| Variable/Grade | | I | Number Scores II | Number Scores III | Slope (b) [a] II | Slope (b) [a] III |
|---|---|---|---|---|---|---|
| **Graded LS** | | | | | | |
| Graded | 2 | 61 | 27.70 | (3.57) | 1.08 | ( .43) |
| | 3 | 37 | 28.92 | (2.38) | .70 | ( .43) |
| | 4 | 61 | 26.13 | (4.79) | .43 | ( .34) |
| | 5 | 50 | 27.02 | (2.68) | .23 | ( .33) |
| | 6 | 43 | 26.67 | (4.68) | .21 | ( .94) |
| **Graded Words** | | | | | | |
| Graded | 2 | 61 | 27.70 | (3.57) | .21 | ( .09) |
| | 3 | 37 | 28.92 | (2.38) | .11 | ( .08) |
| | 4 | 61 | 26.13 | (4.79) | .08 | ( .09) |
| | 5 | 50 | 27.02 | (2.68) | .06 | ( .05) |
| | 6 | 43 | 26.67 | (4.68) | .05 | ( .07) |
| **Common LS** | | | | | | |
| Graded | 2 | 61 | 27.70 | (3.57) | 1.03 | ( .35) |
| | 3 | 37 | 28.92 | (2.38) | .74 | ( .39) |
| | 4 | 61 | 26.13 | (4.79) | .35 | ( .32) |
| | 5 | 50 | 27.02 | (2.68) | .22 | ( .27) |
| | 6 | 43 | 26.67 | (4.68) | .26 | ( .21) |
| **Common Words** | | | | | | |
| Graded | 2 | 61 | 27.70 | (3.57) | .14 | ( .06) |
| | 3 | 37 | 28.92 | (2.38) | .11 | ( .07) |
| | 4 | 61 | 26.13 | (4.79) | .05 | ( .08) |
| | 5 | 50 | 27.02 | (2.68) | .05 | ( .06) |
| | 6 | 43 | 26.67 | (4.68) | .07 | ( .10) |

**TABLE 3 (Continued)**

| Variable/Grade | | Distribution of Slopes IV | V | VI | VII | VIII | IX | X |
|---|---|---|---|---|---|---|---|---|
| **Graded LS** | | | | | | | | |
| Graded | 2 | .98 | ( .60) | .65 | ( .31) | .29 | 2.44 | 0.0 |
| | 3 | - .34 | ( .76) | .35 | ( .39) | - .22 | 1.63 | 2.7 |
| | 4 | 4.83 | ( .60) | -1.22 | ( .31) | 1.22 | 1.44 | 1.6 |
| | 5 | 1.93 | ( .66) | .03 | ( .34) | .76 | 1.11 | 16.0 |
| | 6 | 9.17 | ( .71) | -6.12 | ( .36) | -5.68 | .85 | 4.7 |
| **Graded Words** | | | | | | | | |
| Graded | 2 | .44 | ( .60) | .24 | ( .31) | .07 | .50 | 0.0 |
| | 3 | .83 | ( .76) | .60 | ( .39) | - .07 | .32 | 5.4 |
| | 4 | 3.46 | ( .60) | -2.57 | ( .31) | - .37 | .29 | 3.3 |
| | 5 | 1.73 | ( .66) | - .54 | ( .34) | - .09 | .18 | 12.0 |
| | 6 | 3.57 | ( .71) | -4.22 | ( .36) | - .32 | .15 | 4.7 |
| **Common LS** | | | | | | | | |
| Graded | 2 | .62 | ( .60) | .30 | ( .31) | .04 | 1.90 | 0.0 |
| | 3 | - .76 | ( .76) | .03 | ( .39) | - .13 | 1.45 | 2.7 |
| | 4 | 2.04 | ( .60) | -1.24 | ( .31) | -1.08 | 1.13 | 4.9 |
| | 5 | 3.44 | ( .66) | 2.82 | ( .34) | - .21 | 1.58 | 12.0 |
| | 6 | 2.34 | ( .71) | 1.39 | ( .36) | - .05 | .92 | 7.0 |
| **Common Words** | | | | | | | | |
| Graded | 2 | -1.05 | ( .60) | - .07 | ( .31) | .01 | .25 | 0.0 |
| | 3 | .30 | ( .76) | - .15 | ( .39) | - .07 | .27 | 5.4 |
| | 4 | 3.57 | ( .60) | -2.05 | ( .31) | - .24 | .16 | 11.5 |
| | 5 | 2.74 | ( .66) | .97 | ( .34) | - .09 | .30 | 12.0 |
| | 6 | 6.72 | ( .71) | 4.64 | ( .36) | - .03 | .64 | 11.6 |

[a] For graded LS, the one-way ANOVA for the effect of grade produced a significant $F(4,247)$ value of 26.34, $p < .001$; the $F(1,247)$ for the linear trend was 86.82, $p < .001$ and for the quadratic trend, $F(1,247) = 8.08$, $p < .005$. Student-Newman-Keuls revealed that $6 = 5<4<3<2$. For graded words, ANOVA indicated a significant $F(4,247)$ value of 64.96, $p < .001$; the $F(1,247)$ for the linear trend was 172.71, $p < .001$ and for the quadratic trend, $F(1,247) = 43.11$, $p < .001$. Student-Newman-Keuls revealed $6 = 5 = 4<3<2$. For common LS, ANOVA indicated a significant $F(4,247)$ value of 68.05, $p < .001$; the $F(1,247)$ for the linear trend was 20.59, $p < .001$ and for the quadratic trend, $F(1,247) = 32.48$, $p < .001$. Student-Newman-Keuls revealed $5 = 6 = 4<3<2$. For common words, ANOVA indicated a significant $F(4,247)$ value of 17.22, $p < .001$; the $F(1,247)$ for the linear trend was 38.06, $p < .001$ and for the quadratic trend, $F(1,247) = 18.06$. Student-Newman-Keuls revealed $4 = 5 = 6<3<2$.

**TABLE 4**

**Slope Information for Year 2 in Spelling**

**Table Legend:**

**I - n**
**II - M**
**III - (SD)**
**IV - Kurtosis**
**V - ($se_k$)**
**VI - Skewness**
**VII - ($se_s$)**
**VIII - Min**
**IX - Max**
**X - % Neg.**
**XI - % Quad.**

| Variable/Grade | | I | Number Scores II | Number Scores III | Slope (b) [a] II | Slope (b) [a] III |
|---|---|---|---|---|---|---|
| **Graded LS** | | | | | | |
| Grade | 2 | 190 | 11.91 | (8.39) | .92 | ( .48) |
| | 3 | 227 | 11.61 | (8.00) | .57 | ( .34) |
| | 4 | 194 | 10.74 | (7.31) | .48 | ( .50) |
| | 5 | 227 | 11.09 | (7.65) | .41 | ( .41) |
| | 6 | 208 | 11.23 | (7.60) | .46 | ( .31) |
| **Graded Words** | | | | | | |
| Grade | 2 | 190 | 11.91 | (8.39) | .17 | ( .10) |
| | 3 | 227 | 11.61 | (8.00) | .11 | ( .09) |
| | 4 | 194 | 10.74 | (7.31) | .09 | ( .07) |
| | 5 | 227 | 11.09 | (7.65) | .06 | ( .07) |
| | 6 | 208 | 11.23 | (7.60) | .09 | ( .09) |
| **Common LS** | | | | | | |
| Grade | 2 | 190 | 7.40 | ( .97) | .88 | ( .51) |
| | 3 | 227 | 7.37 | ( .88) | .54 | ( .39) |
| | 4 | 194 | 7.43 | ( .89) | .40 | ( .34) |
| | 5 | 227 | 7.43 | ( .93) | .30 | ( .29) |
| | 6 | 208 | 7.40 | (1.00) | .22 | ( .21) |
| **Common Words** | | | | | | |
| Grade | 2 | 190 | 7.40 | ( .97) | .12 | ( .08) |
| | 3 | 227 | 7.37 | ( .88) | .09 | ( .09) |
| | 4 | 194 | 7.43 | ( .89) | .07 | ( .08) |
| | 5 | 227 | 7.43 | ( .93) | .06 | ( .07) |
| | 6 | 208 | 7.40 | (1.00) | .04 | ( .08) |

**TABLE 4 (Continued)**

| Variable/Grade | | Distribution of Slopes IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|
| **Graded LS** | | | | | | |
| Grade | 2 | 1.82 | ( .35) | - .38 | ( .18) | - .79 |
| | 3 | 1.43 | ( .32) | .46 | ( .16) | - .67 |
| | 4 | .48 | ( .34) | .29 | ( .17) | - .76 |
| | 5 | 1.44 | ( .32) | .71 | ( .16) | - .43 |
| | 6 | 3.91 | ( .33) | .72 | ( .16) | - .23 |
| **Graded Words** | | | | | | |
| Grade | 2 | .93 | ( .35) | - .31 | ( .18) | - .19 |
| | 3 | 1.21 | ( .32) | - .02 | ( .16) | - .23 |
| | 4 | .14 | ( .34) | - .03 | ( .17) | - .12 |
| | 5 | 2.95 | ( .32) | .75 | ( .16) | - .25 |
| | 6 | 4.32 | ( .33) | 1.45 | ( .16) | - .08 |
| **Common LS** | | | | | | |
| Grade | 2 | .29 | ( .35) | - .17 | ( .18) | - .82 |
| | 3 | 1.55 | ( .32) | - .27 | ( .16) | -1.05 |
| | 4 | .48 | ( .34) | .60 | ( .17) | - .42 |
| | 5 | 2.40 | ( .32) | .19 | ( .16) | - .81 |
| | 6 | 3.57 | ( .33) | .77 | ( .16) | - .65 |
| **Common Words** | | | | | | |
| Grade | 2 | 1.02 | ( .35) | .55 | ( .18) | - .06 |
| | 3 | 1.27 | ( .32) | - .59 | ( .16) | - .27 |
| | 4 | 2.83 | ( .34) | .10 | ( .17) | - .19 |
| | 5 | .87 | ( .32) | .25 | ( .16) | - .15 |
| | 6 | .31 | ( .33) | - .14 | ( .16) | - .18 |

| Variable/Grade | | Distribution of Slopes IX | X | XI |
|---|---|---|---|---|
| **Graded LS** | | | | |
| Grade | 2 | 2.12 | 1.6 | 8 |
| | 3 | 1.79 | 1.8 | 2 |
| | 4 | 1.32 | 16.9 | 6 |
| | 5 | 1.65 | 13.9 | 4 |
| | 6 | 2.07 | 1.9 | 13 |
| **Graded Words** | | | | |
| Grade | 2 | .43 | 3.2 | 21 |
| | 3 | .32 | 5.3 | 4 |
| | 4 | .62 | 7.8 | 6 |
| | 5 | .53 | 17.3 | 11 |
| | 6 | .71 | 8.2 | 7 |

**TABLE 4 (Continued)**

| **Variable/Grade** | | **Distribution of Slopes** IX | X | XI |
|---|---|---|---|---|
| **Common LS** | | | | |
| Grade | 2 | 2.04 | 4.7 | 16 |
| | 3 | 1.81 | 6.6 | 7 |
| | 4 | 1.43 | 7.3 | 8 |
| | 5 | 1.23 | 8.5 | 4 |
| | 6 | 1.53 | 10.1 | 11 |
| **Common Words** | | | | |
| Grade | 2 | .46 | 4.7 | 14 |
| | 3 | .31 | 11.9 | 7 |
| | 4 | .39 | 10.9 | 14 |
| | 5 | .35 | 18.8 | 4 |
| | 6 | .25 | 19.7 | 16 |

[a] For graded LS, the one-way ANOVA for the effect of grade produced a significant F (4,1041) value of 93.26, p < .001; the F (1,1041) value for the linear trend was 168.98, p < .001 and for the quadratic trend, F (1,1041) = 197.27, p < .001. Student-Newman-Keuls revealed that 4 = 6<5<3<2. For graded words, ANOVA indicated a significant F (4,1041) value of 50.84, p < .001; the F (1,1041) for the linear trend was 137.91, p < .001 and for the quadratic trend, F (1,1041) = 56.03, p < .001. Student-Newman-Keuls revealed 5<6 = 4 = 3<2. For common LS, ANOVA indicated a significant F (1,1041) value of 100.86, p < .001; the F (1,1041) for the linear trend was 375.26, p < .001 and for the quadratic trend, F (1,1041) = 33.23, p < .001. Student-Newman-Keuls revealed 6<5<4<3<2. For common words, ANOVA indicated a significant f (4,1041) value of 31.47, p < .001; the F (1,1041) for the linear trend was 125.05, p < .001 and for the quadratic trend, .51, ns. Student-Newman-Keuls revealed 6<5 = 4<3<2.

**TABLE 5**

**Slope Information for Year 1 in Math**

**Table Legend:**

**I - n**
**II - M**
**III - (SD)**
**IV - Kurtosis**
**V - ($se_k$)**
**VI - Skewness**
**VII - ($se_s$)**
**VIII - Min**
**IX - Max**
**X - % Negative**

| **Variable/Grade** | | **I** | **Number Scores** II | III | **Slope (b) [a]** II | III |
|---|---|---|---|---|---|---|
| **Digits** | | | | | | |
| Grade | 1 | 18 | 29.00 | (2.57) | .53 | ( .10) |
| | 2 | 43 | 29.49 | (1.67) | .20 | ( .11) |
| | 3 | 24 | 28.92 | (2.92) | .42 | ( .26) |
| | 4 | 21 | 29.48 | (2.62) | .77 | ( .31) |
| | 5 | 45 | 28.20 | (3.80) | .70 | ( .31) |
| | 6 | 26 | 27.15 | (3.91) | .48 | ( .38) |

**TABLE 5 (Continued)**

| Variable/Grade | | I | Number Scores II | III | Slope (b) [a] II | III |
|---|---|---|---|---|---|---|
| **Problems** | | | | | | |
| Grade | 1 | 18 | 29.00 | (2.57) | .50 | ( .49) |
| | 2 | 43 | 29.49 | (1.67) | .14 | ( .09) |
| | 3 | 24 | 28.92 | (2.92) | .31 | ( .15) |
| | 4 | 21 | 29.48 | (2.62) | .34 | ( .13) |
| | 5 | 45 | 28.20 | (3.80) | .20 | ( .09) |
| | 6 | 26 | 27.15 | (3.91) | .09 | ( .08) |

| Variable/Grade | | IV | V | Distribution of Slopes VI | VII | VIII | IX | X |
|---|---|---|---|---|---|---|---|---|
| **Digits** | | | | | | | | |
| Graded | 1 | .46 | (1.04) | .51 | ( .54) | .36 | .74 | 0.0 |
| | 2 | .53 | ( .71) | - .42 | ( .36) | - .13 | .48 | 7.0 |
| | 3 | -1.17 | ( .92) | .11 | ( .47) | - .01 | .88 | 4.2 |
| | 4 | .64 | ( .97) | - .92 | ( .50) | .05 | 1.29 | 0.0 |
| | 5 | 2.38 | ( .70) | 1.13 | ( .35) | - .04 | 2.35 | 2.2 |
| | 6 | .17 | ( .89) | .60 | ( .46) | - .15 | 1.40 | 7.7 |
| **Problems** | | | | | | | | |
| Graded | 1 | 3.19 | (1.04) | 1.11 | ( .54) | .27 | 2.43 | 0.0 |
| | 2 | .79 | ( .71) | - .32 | ( .36) | - .12 | .36 | 7.0 |
| | 3 | - .19 | ( .92) | .27 | ( .47) | .06 | .59 | 4.2 |
| | 4 | .64 | ( .97) | -1.10 | ( .50) | .04 | .50 | 0.0 |
| | 5 | - .06 | ( .70) | .60 | ( .35) | - .02 | .48 | 2.2 |
| | 6 | .89 | ( .89) | .64 | ( .46) | - .07 | .28 | 7.7 |

[a] For digits, the one-way ANOVA for the effect of grade produced a significant $F (5,171)$ value of 19.38, $p < .001$; the $F (1,171)$ for the linear trend was 31.38, $p < .001$ and for the quadratic trend, $F (1,170) = 1.34$ ns. Student-Newman Keuls revealed that 2<3 = 6 = 1<4 = 5. For problems, ANOVA indicated a significant $F (5,171)$ value of 14.93 $p < .001$; the $F (1,171)$ for the linear trend was 31.88, $p < .001$ and for the quadratic trend, $F (1,171) = .01$, ns. Student-Newman-Keuls revealed that 6 = 2<5<4 = 3<1.

**TABLE 6**

**Slope Information for Years 2 in Math**
**Table Legend:**

I - n
II - M
III - (SD)
IV - Kurtosis
V - ($se_k$)
VI - Skewness
VII - ($se_s$)
VIII - Min
IX - Max
X - % Neg.
XI - % Quad.

| Variable/Grade | | I | Number Scores II | Number Scores III | Slope (b) [a] II | Slope (b) [a] III |
|---|---|---|---|---|---|---|
| **Digits** | | | | | | |
| Grade | 1 | 193 | 15.73 | (6.84) | .34 | ( .19) |
| | 2 | 188 | 15.12 | (8.66) | .28 | ( .20) |
| | 3 | 195 | 13.30 | (8.21) | .30 | ( .23) |
| | 4 | 194 | 16.63 | (9.52) | .69 | ( .46) |
| | 5 | 227 | 14.85 | (9.37) | .74 | ( .44) |
| | 6 | 211 | 14.15 | (8.73) | .42 | ( .49) |
| **Problems** | | | | | | |
| Grade | 1 | 193 | 15.73 | (6.84) | .26 | ( .14) |
| | 2 | 188 | 15.12 | (8.66) | .14 | ( .12) |
| | 3 | 195 | 13.30 | (8.21) | .24 | ( .12) |
| | 4 | 194 | 16.63 | (9.52) | .25 | ( .17) |
| | 5 | 227 | 14.85 | (9.37) | .23 | ( .17) |
| | 6 | 211 | 14.15 | (8.73) | .13 | ( .13) |

| Variable/Grade | | Distribution of Slopes IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|
| **Digits** | | | | | | |
| Grade | 1 | .79 | ( .35) | .52 | ( .18) | - .22 |
| | 2 | .67 | ( .35) | .63 | ( .18) | - .15 |
| | 3 | 2.68 | ( .35) | 1.23 | ( .17) | - .16 |
| | 4 | - .69 | ( .35) | - .13 | ( .18) | - .56 |
| | 5 | .75 | ( .32) | - .11 | ( .16) | - .76 |
| | 6 | .31 | ( .33) | .29 | ( .17) | - .88 |
| **Problems** | | | | | | |
| Grade | 1 | 1.63 | ( .35) | 1.03 | ( .18) | - .08 |
| | 2 | - .24 | ( .35) | .20 | ( .18) | - .13 |
| | 3 | 2.76 | ( .35) | 1.55 | ( .17) | - .01 |
| | 4 | - .93 | ( .35) | - .06 | ( .18) | - .11 |
| | 5 | .56 | ( .32) | - .10 | ( .16) | - .25 |
| | 6 | 1.50 | ( .33) | .34 | ( .17) | - .29 |

**TABLE 6 (Continued)**

| **Variable/Grade** | | **Distribution of Slopes IX** | **X** | **XI** |
|---|---|---|---|---|
| **Digits** | | | | |
| Grade | 1 | 1.00 | 1.6 | 2 |
| | 2 | .97 | 5.9 | 11 |
| | 3 | 1.65 | 6.2 | 7 |
| | 4 | 1.72 | 6.7 | 0 |
| | 5 | 2.21 | 4.8 | 15 |
| | 6 | 2.07 | 19.9 | 9 |
| **Problems** | | | | |
| Grade | 1 | 1.00 | 1.6 | 4 |
| | 2 | .46 | 11.2 | 11 |
| | 3 | .99 | 0.0 | 4 |
| | 4 | .62 | 4.1 | 7 |
| | 5 | .65 | 4.4 | 12 |
| | 6 | .70 | 12.8 | 4 |

[a] For digits, the one-way ANOVA for the effect of grade produced a significant $F(5,1202)$ value of 62.54, $p < .001$; the $F(1,1202)$ for the linear trend was 97.91, $p < .001$ and for the quadratic trend, $F(1,1202) = 24.41$, $p < .001$. Student-Newman Keuls revealed that $2 = 3 = 1 < 6 < 4 = 5$. For problems, ANOVA indicated a significant $F(5,1202)$ value of 39.65, $p < .001$; the $F(1,1202)$ for the linear trend was 24.51, $p < .001$ and for the quadratic trend, 23.04, $p < .001$. Student-Newman-Keuls revealed that $6 = 2 < 5 = 3 = 4 < 1$.

GRAPH: FIGURE 1. CBM display of student progress on Grade 5 curriculum.

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