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Reading-Growth Estimates for Elementary-School Students Using Curriculum-Based Measurement

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In this study, we examine grade-level growth rates for general education students and students with learning disabilities in grades two to six. In conducting the study, we demonstrate how schools, districts, and state educational agencies can use a combination of Curriculum-Based Measurement and Hierarchical Linear Modeling (HLM) methods to develop growth-rate norms in reading. The participants were made up of 273 general education students and 430 students with learning disabilities. The growth rates for these two groups of students in each grade were estimated using HLM. Within each grade, separate growth rates for subgroups of general education students (i.e., high, average, and low achievers) were estimated. The uses of estimated growth rates for setting year-end goals, monitoring student progress, and evaluating the effectiveness of instructional programs are also discussed.

Key words: reading, growth rates, Curriculum-Based Measurement (CBM), hierarchical linear modeling (HLM)

Introduction

Individual differences in performance levels result in part from differences in the rate of academic skill development over time. Educators have long been interested in assessing student growth over time and identifying the instructional factors that create individual differences in growth. However, their efforts have been hampered by the absence of testing instruments that are able to produce multiple data points over short periods of time and by the lack of statistical methods available to handle these multiple data points adequately. With the advent of Curriculum-Based Measurement (CBM) (Deno, 1985) and Hierarchical Linear Modeling (HLM) (Bryk & Raudenbush, 1987, 1992), however, tools are now available to enable educators to examine individual and group differences in academic skill development in a logistically efficient and technically sound way.

In this study, we demonstrate the combined use of CBM and HLM to examine reading growth rates for students in general education streams as well as students with learning disabilities. It is argued that growth-rate estimates can be used as normative information in the setting of year-end goals, to monitor continuous progress, and to evaluate the effectiveness of instructional programs.

Reading Growth

Reading is defined as the meaningful interpretation of written symbols, which occurs through the interaction between printed words and the reader's language competency, and which includes decoding and comprehension skills (Harris & Sipay, 1985). Reading is a

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fundamental skill that students must acquire if they are to become successful learners in school. As students become older, reading becomes a self-teaching tool, affecting achievement in other subject areas. Reading difficulties are associated with low self-esteem (Castle, 1994), dropping out of school (Simner & Barnes, 1991), and unemployment or low-paying jobs (Caspi, Wright, Moffitt, & Silva, 1998; Condren, 1972). Approximately five to fifteen percent of the school population is estimated to have serious reading difficulties (Cassidy & Gray, 1992; Harris & Sipay, 1985; Kaluger & Kolson, 1978; Kavale & Forness, 1995). In addition, approximately 23 to 45 million adults are thought to be functionally illiterate in the United States, depending on the method of literacy assessment (Cassidy & Gray, 1992).

In response to literacy problems in the United States, in a 1996 radio address, President Clinton declared that the literacy education of children and adults should be a priority of the 21st century (National Institute for Literacy, 1996). In this same address, the President unveiled the "America Reads" initiative, a 2.75 billion dollar program aimed at ensuring that every child is able to read by the end of 3rd grade. The initiative also included literacy education for parents with a child in the 3rd grade.

Teachers are prime agents in the quest for literacy improvement. Research indicates that effective teachers select empirically supported instructional strategies and then continuously modify their instructional methods based on student performance (Fuchs & Fuchs, 1986; Wharton-McDonald, Pressley, Rankin, Mistretta, Yokoi, & Ettenberger, 1997). In other words, effective teachers make data-based instructional decisions. However, systematic monitoring of students' performance for instructional purposes requires that teachers use a technically sound, logistically efficient data collection procedure.

Growth Measures

Historically, educators have used published, standardized achievement tests for measuring student performance in reading. Nevertheless, standardized achievement tests provide information only on relative standings among students at a certain point in time. They do not reveal rates of growth over time or reflect the effectiveness of various instructional interventions as they relate to those growth rates. To evaluate the effects of various instructional interventions on student progress, teachers need access to a measurement instrument that reveals more than students' relative rankings; they need an instrument that reveals the rate at which student performance increases or decreases.

CBM is a technically adequate, logistically efficient data collection system that teachers can use to monitor students' progress during a relatively short time period for instructional purposes (Deno, 1985). As a standardized data-collection procedure, the technical characteristics of CBM include (a) the production of multi-wave data points during a short period of time; (b) technically adequate reliability and validity for progress monitoring (Good & Jefferson, 1998; Marston, 1989; Shin, Deno, & Espin, 2000); (c) sensitivity to small changes in student performance (Marston, Deno, & Tindal, 1983; Marston & Magnusson, 1985; Shin, Deno, & Espin, 2000); and (d) absolute measures of student performance.

While teachers' use of CBM alone can lead to improved instructional outcomes (Allinder, 1996; Allinder & Oats, 1997; Fuchs, Deno, & Mirkin, 1984), the use of CBM for instructional purposes could be enhanced by providing standard growth rates for use in instructional decision making. Simple increases in students' reading performance might not be sufficient to guarantee that a current instructional method is effective. Standard growth rates could provide a valuable criterion with which students' current growth rates could be compared, enabling better decision making to take place (Fuchs, Fuchs, Hamlett, Waltz, & Germann, 1993). For example, standard growth rates could be used by educators to help them evaluate the effectiveness of an instructional method (e.g., class wide peer tutoring, direct instruction, strategy instruction). The growth rates associated with the implementation of a particular method could be compared to standard growth rates within a school, district, or state, thus providing educators with the means to determine to what extent the intervention is leading to improved student performance. As a pioneering study, Fuchs et al. (1993) examined the use of grade-level growth rates as standards for ongoing progress monitoring in reading, math, and spelling.

In addition to grade-level growth rates, growth rates for specific subgroups (e.g., students with learning disabilities and high-, average-, and low-achieving students in general education) within each grade would be a useful tool for teachers who are responsible for specific student populations. For example, grade-level growth rates estimated on the basis of students with LD in the school, district or state would be more useful to special education teachers than growth rates based on estimates of the entire population.

In summary, reading is an important skill for students to develop in order to succeed in school and in society. One factor associated with effective reading instruction is the systematic monitoring of student performance. CBM provides teachers with a tool whereby they can systematically monitor student performance and make informed instructional decisions regarding the efficacy of various instructional interventions. Although monitoring student performance in and of itself is important, the use of a monitoring system such as CBM could be enhanced by the addition of normative data related to expected student growth.

In the present study, we examine grade-level growth rates for general education students, including low, average, and high achievers, and for students with learning disabilities. In doing so, we demonstrate a method that schools, districts, and state education agencies (SEAs) can use to determine normative growth rates. Three specific research questions were addressed in this study. First, what are grade-level growth rates for students in general education? Second, what are grade-level growth rates for low, average, and high achievers in general education? Third, what are grade-level growth rates for students with learning disabilities?

Method

Participants and Setting

The first group of participants was comprised of 273 general education students in grades two to six in a large urban elementary school in the Midwest, USA. The breakdown of participants was as follows; 57 second graders (21%), 54 third graders (20%), 62 fourth graders (22%), 52 fifth graders (19%), and 50 sixth graders (18%). Forty-nine percent of the participants were female and 51% were male students. The majority of the participants came from low-income families; 62% received free or reduced lunch programs. The ethnic composition of the sample was 37% European Americans, 37% African Americans, 17% Asian Americans, 7% Hispanics, and 2% Native Americans. The first group of participants took the Metropolitan Achievement Tests-7 (MAT-7) at the beginning of the school year. The average performance levels in reading, mathematics, and language were about or slightly below the national average levels. Scaled scores and normal curve equivalents in these three subject areas by grade level are presented in Table 1.

A second group of participants was made up of 430 students with learning disabilities (LD) in grades three to six from three large urban school districts in the Midwest and the Southeast. These students were identified as having learning disabilities by the school districts based on the criteria of severe discrepancies between achievement and ability, a history of underachievement, an information processing deficit, and exclusion. The grade composition of the LD students was as follows; 107 third graders (25%), 103 fourth graders (24%), 114 fifth graders (27%), and 106

Table 1
Scaled Scores (SS) and Normal Curve Equivalents (NCE) on the MAT-7 for General Education Students

	Reading		Mathematics		Language	
	SS	*NCE*	*SS*	*NCE*	*SS*	*NCE*
Grade 2	533	54	505	40	533	46
Grade 3	577	55	551	51	578	55
Grade 4	582	44	572	49	589	50
Grade 5	600	44	601	52	608	50
Grade 6	614	41	616	48	618	48

sixth graders (24%). Fifty-nine percent of the LD students were male and 41% were female. Information regarding the ethnic composition of the LD participants was not available.

Materials and Procedures

The reading performance of all the participants was assessed by maze probes over the course of an academic year. First, the reading performance of the general education students was tested monthly using generic, grade-level maze probes. Maze probes were developed from grade-level reading materials and were constructed by deleting every seventh word of the passage and replacing it with three alternative choices. One of the alternatives was grammatically and contextually correct, and the other two functioned as distracters. The first sentence of each passage was left intact (see Fuchs & Fuchs, 1992, for details).

The general education students took the maze probes via a computer-based instructional system called Discourse (see Shin, Deno, Robinson, & Marston, 2000, for details). Maze probes were programmed into the Discourse system. Students responded on individual terminals. Each terminal displayed one or two sentences with one or two selection opportunities given to students. Students typed in the first letter of the word to select an answer. Two minutes were given to the students to complete as many selections as possible on the maze probe. At the end of the two minutes, the Discourse system automatically scored and saved student answers in a spreadsheet format. Students did not exhibit any difficulty using the Discourse system because the system had been used in all classrooms for instructional purposes for one year prior to the start of this study.

The number of correct choices in each maze probe was used in the data analysis. The results of recent studies on the technical adequacy of the maze task, based on the measure of *correct choices*, show that the maze measure is technically reliable, sensitive, and valid for modeling growth and estimating growth rates (Fuchs & Fuchs, 1992; Shin, Deno, & Espin, 2000). In addition, in previous research (Fuchs et al., 1993) the measure has been used to reflect reading growth of elementary-school students.

Extant data for students with LD was used in this study. The school districts had collected CBM reading data for students with LD to develop a local normative database on reading performance. The data was collected throughout the school year using generic, grade-level maze probes. Twelve percent of the students had been tested weekly using a computer-programmed maze task; 88% had been tested quarterly in fall, winter, and spring using a paper-and-pencil maze task. The latter group of students had three data points, which is the minimal number of data points for reliable estimation of growth rates (Willet, 1989). We transformed the weekly measures into monthly measures by averaging weekly maze scores within each month. We transformed the data in order to reduce the standard error of estimation and to increase the stability of the growth-rate estimates. The students who were tested weekly were given two and a half minutes to complete the maze probe, whereas the students tested quarterly were given two minutes to complete the maze probe. The influence of these time differences on growth rates was examined prior to conducting analyses of the data for students with LD (see results section).

Results

Growth Rates for General Education Students

Descriptive statistics of monthly maze scores for general education students in each grade are displayed in Table 2. Based on individual students' monthly scores, the average growth rates for each grade were estimated by using Hierarchical Linear Modeling (HLM) (Bryk & Raudenbush, 1987, 1992). In estimating the grade-level growth rates, a linear growth model was adopted on the basis of the findings of previous research, indicating that a linear model better delineates reading-skill development over a short time period (e.g., an academic year) than a logarithmic or quadratic model (Marston, Deno, & Tindal, 1983; Shin, 1999a).

Before grade-level growth rates were estimated, we examined the reliability of the growth rates. Reliability is an index that shows the proportion of observed growth-rate variation among individual students that can be explained reliably by level-two predictors in HLM. The reliability estimate of the linear growth rate (π_{1i}) was .87 in the study, indicating that 87% of the total variance of growth rates could be attributed to the true parameter variance (Bryk & Raudenbush, 1992). The high slope reliability suggests that grade-level growth rates for general education students could

Table 2

Means and Standard Deviations of Monthly Maze Scores for General Education Students in Each Grade

	Nov	Dec	Jan	Feb	March	April	May
Grade 2	1.42	3.04	2.67	2.59	3.27	4.24	4.69
(*n* = 57)	(1.55)	(2.52)	(2.32)	(2.52)	(2.89)	(3.14)	(3.17)
Grade 3	3.81	5.06	6.45	6.60	6.88	8.55	7.71
(*n* = 54)	(3.11)	(2.54)	(3.06)	(3.50)	(3.49)	(3.76)	(4.13)
Grade 4	7.37	9.59	10.24	8.51	11.28	10.26	11.63
(*n* =62)	(3.17)	(3.89)	(4.58)	(4.66)	(4.80)	(5.27)	(5.18)
Grade 5	13.83	15.85	14.15	14.06	17.37	15.85	19.72
(*n* = 52)	(8.23)	(7.27)	(7.68)	(6.33)	(7.35)	(5.77)	(6.25)
Grade 6	14.76	15.65	14.15	13.62	16.83	16.26	16.33
(*n* = 50)	(7.72)	(7.46)	(6.79)	(5.71)	(5.51)	(5.87)	(5.43)

Note. Numbers in parentheses are standard deviations.

be estimated reliably in the present study.

The within-individual model used in this analysis was,

$$Y_{ti} = \pi_{0i} + \pi_{1i} \times Month + r_{ti}$$

where Y_{ti} is the monthly score at time *t* for individual *i*, π_{0i} the intercept indicating the initial status for individual *i*, and π_{1i} the linear growth rate for individual *i*, and r_{1i} the prediction error. The grade was entered as a dummy variable and used as a level-two predictor in the between-individual model, as follows:

$$\pi_{1i} = \beta_{10} + \beta_{11} \times Gr2 + \beta_{12} \times Gr3 + \beta_{13} \times Gr4 + \beta_{14} \times Gr5 + u_{1i},$$

where β_{10} is the intercept representing the mean growth rate for the reference group (i.e., grade six in this equation), β_{11}, β_{12}, β_{13}, and β_{14} are the partial regression coefficients representing mean differences in growth rates between grade six and grades two, three, four, and five, respectively, and u_{1i} is the random effect when the effect of level-two variables is controlled.

Table 3 shows the estimates of the fixed effects (i.e., level-two variables) for the linear growth term. Grade six showed an increase of .33 correct choices per month (β_{10}) on the maze task. The growth rates for the other grades were computed by adding the growth rate of grade six to a partial regression coefficient of each grade indicating a mean growth-rate difference from grade six. For example, the growth rate for grade two (.45) was computed by adding the partial regression coefficient β_{11} (.12) to the growth rate of grade six (.33). In addition to the grade-level growth rate for

Table 3

Fixed Effects Model for Estimating Grade-Level Growth Rates for General Education Students with Grade Six as a Reference Group

Fixed effect	Coefficient	Standard error	*t* value	*p* value
β_{10} (Grade 6)	.33	.09	3.64	.00
β_{11} (Grade 2 – Grade 6)	.12	.13	.99	.33
β_{12} (Grade 3 – Grade 6)	.35	.13	2.77	.01
β_{13} (Grade 4 – Grade 6)	.29	.12	2.18	.03
β_{14} (Grade 5 – Grade 6)	.27	.13	2.19	.03

Table 4

Monthly Growth Rates and Standard Error of Estimation for General Education Students in Each Grade

	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
Growth rate	.45	.68	.62	.60	.33
Standard error	.09	.09	.08	.09	.09

each grade, the standard error of estimation was estimated by using a level-two model where each grade was alternately specified as a reference group (see Table 4).

Although grade six showed the lowest increase among grades, the estimated growth rate was statistically significant (see Table 3), which indicates a significant increase of reading proficiency had occurred for grade six over the course of a school year. Table 3 also shows the statistical differences in estimated mean growth rates between grades. The growth rate for grade six, which was the lowest, was significantly lower than those for grades three to five ($p < .05$); however, no significant difference was found between grades six and two. Considering standard error of estimation for grades two to five (see Table 4), grade two had a significantly lower mean growth rate than that seen for grades three and four. There were no additional differences between grades.

Growth Rates for Subgroups of General Education Students

General education students in each grade were classified into three subgroups (i.e., low, average, and high achievers) based on normal curve equivalents (NCE) of the reading subtest of the Metropolitan Achievement Tests-7 administered at the beginning of the school year. Students

Table 5

Monthly Growth Rates for Low-, Average-, and High-Achieving General Education Students in Each Grade

Grade	Group	Mean	Standard error	*SD*	*n*
Grade 2[a]	Low	.30	.07	.28	14
	Average	.41	.06	.33	30
	High	.91	.15	.34	5
Grade 3[b]	Low	.18	.09	.30	12
	Average	.79	.09	.47	25
	High	.83	.12	.43	12
Grade 4	Low	.43	.14	.59	18
	Average	.58	.13	.67	29
	High	.73	.16	.39	6
Grade 5	Low	.56	.23	1.02	20
	Average	.45	.22	.96	20
	High	.69	.21	.62	9
Grade 6	Low	.48	.22	.85	15
	Average	.29	.14	.72	25
	High	.05	.30	.78	7

a. The high-achieving group showed a significantly higher mean growth rate than did the low- and average-achieving groups ($p < .01$).

b. The high- and average-achieving groups showed significantly higher mean growth rates than did the low-achieving group ($p < .01$).

scoring less than 33 NCE were classified as low achievers, students having NCE between 34 and 66 as average achievers, and students having higher than 67 NCE as high achievers. The growth rates for these subgroups were computed by averaging individual students' growth rates within each group, estimated by the Empirical Bayse procedure in HLM (Bryk & Raudenbush, 1992). Table 5 shows the mean growth rates for these three groups in each grade.

Differences in growth rates between the subgroups of general education students within each grade were investigated by using ANOVA with Tukey's Honestly Significant Difference (HSD) as a post-hoc method. In grade two, the growth rate for high achievers was significantly higher than those for low and average achievers (F (2, 46) = 7.16, p < .01). In grade three, the growth rates for high and average achievers were also significantly higher than the growth rate for low achievers (F (2, 46) = 9.89, p < .01). Significant group differences, however, were not identified in grades four to six (F (2, 50) = .29, p > .05 for grade four, F (2, 46) = .21, p > .05 for grade five, and F (2, 44) = .75, p > .05 for grade six, respectively).

Growth Rates for Students with Learning Disabilities

Descriptive statistics of monthly maze scores for students with LD in each grade are displayed in Table 6. Before grade-level growth rates were estimated, the effect of testing-time difference (i.e., 2 minutes versus 2.5 minutes) on the estimation of growth rates was examined. To conduct this analysis, the testing time was used as a level-two predictor, explaining the inter-individual differences in growth rates among students with LD (i.e., $\pi_{1i} = \beta_{10} + \beta_{11} \times Time + u_{1i}$). The results of the analysis show that the testing-time difference was not significantly related to individual differences in growth rates (β_{11} = .06, t = .26, p > .05).

As in the analysis for the general education students, a linear growth model was used to estimate the grade-level growth rates for students with LD as a within-individual model:

$$Y_{ti} = \pi_{0i} + \pi_{1i} \times Month + r_{ti} \,.$$

In the case of the individual model, the grade was coded into a dummy variable and used as a level-two predictor with grade six as a reference group, as follows:

$$\pi_{1i} = \beta_{10} + \beta_{11} \times Gr3 + \beta_{12} \times Gr4 + \beta_{13} \times Gr5 + u_{1i} \,.$$

The reliability estimate of the linear growth rate was .45, indicating that 45% of the total variance of the linear growth rate could be attributed to the true parameter variance (Bryk & Raudenbush, 1987, 1992). This result suggested that the grade-level growth rates for students with LD were estimated less reliably than those for the general education students. The low slope reliability for the students with LD could be attributed in part to the limited number of data points (i.e., three) for most participating students (Bryk & Raudenbush, 1992; Willet, 1989).

The mean growth rate estimated for grade six was an increase of .61 correct choices per month (β_{10}) on the maze task, which was the second highest among the grades (see Table 7). As in the computation of grade-level growth rates

Table 6

Means and Standard Deviations of Monthly Maze Scores for Students with Learning Disabilities in Each Grade

	Nov	Dec	Jan	Feb	March	April	May
Grade 3	3.64	3.22	4.99	4.36	7.08	7.42	4.88
(n = 107)	(4.32)	(3.35)	(3.86)	(3.39)	(2.75)	(4.41)	(4.08)
Grade 4	3.22	4.56	5.44	4.51	6.33	6.25	4.92
(n =103)	(2.99)	(3.76)	(3.33)	(3.37)	(4.41)	(3.36)	(3.65)
Grade 5	5.61	5.83	4.17	7.70	4.00	7.80	9.84
(n = 114)	(4.21)	(1.72)	(3.37)	(4.81)	(4.29)	(6.69)	(5.32)
Grade 6	7.03	12.00	8.67	7.79	14.80	10.83	9.43
(n = 106)	(5.08)	(5.48)	(6.59)	(4.45)	(5.36)	(5.04)	(4.81)

Note. Numbers in parentheses are standard deviations.

Table 7

Fixed Effects Model for Grade-Level Growth Rates for Students with Learning Disabilities with Grade Six as a Reference Group

Fixed effect	Coefficient	Standard error	*t* value	*p* value
β_{10} (Grade 6)	.61	.08	7.63	.00
β_{11} (Grade 3 – Grade 6)	-.46	.11	4.12	.00
β_{12} (Grade 4 – Grade 6)	-.39	.11	3.45	.00
β_{13} (Grade 5 – Grade 6)	.12	.11	1.11	.27

Table 8

Monthly Growth Rates and Standard Error of Estimation for Students with Learning Disabilities in Each Grade

	Grade 3	Grade 4	Grade 5	Grade 6
Growth rate	.15	.22	.73	.61
Standard error	.08	.08	.08	.08

for general education students, mean growth rates for the other grades were obtained by adding the growth rate of grade six to a partial regression coefficient of each grade. In addition to each grade’s mean growth rate, the standard error of estimation was estimated by using a level-two model, alternately specifying each grade as a reference group (see Table 8).

The grade differences in terms of growth-rate estimates were also examined using HLM. The results of this analysis show that the mean growth rate for grade six was significantly higher than those for grades three and four, but that it was not statistically different from the growth rate for grade five (see Table 7). Considering standard errors of estimation for grades three to five (see Table 8), grade five had a significantly higher mean growth rate than those for grades three and four, but grades three and four were not statistically different from each other.

Discussion

The purpose of our study was to examine grade-level growth rates for students in general and special education and to demonstrate a method that could be used by schools, districts, or states to establish normative growth rates. We addressed three research questions in our study: (1) What are the grade-level growth rates for students in general education? (2) What are the grade-level growth rates for low, average and high achievers in general education? (3) What are the grade-level growth rates for students with learning disabilities?

The mean growth rates in our study for general education students in grades two to six were .45, .68, .62, .60, and .33 increases per month on the maze task. For students with LD, the mean growth rates in grades three to six were .15, .22, .74, and .61, respectively. The growth rates for high-, average-, and low-achieving students in general education were also estimated. The growth rates for these groups were: .30, .41, and .91 in grade two, .18, .79, and .83 in grade three, .43, .58, and .73 in grade four, .56, .45, and .69 in grade five, and .48, .29, and .05 in grade six, respectively.

What is perhaps more interesting than the absolute growth rates themselves are the patterns of growth rates within and across the various groups. For example, with respect to the growth rates of the high, average, and low achievers in general education, differences appear to exist with regard to peak developmental periods. High achievers grew faster in grades two and three (i.e., .91 and .83 increases per month, respectively), whereas average achievers developed reading proficiency more rapidly in grade three (i.e., .79 increases per month). In contrast, low achievers did not show rapid increases of reading proficiency at any point. Their growth rates increased from low to moderate amounts in grade four, but, unlike the other groups of general education students, no rapid increase of growth rates occurred across grades. These differences in developmental patterns of reading proficiency might be evidence of a defining characteristic of the three groups of students, although this hypothesis must be examined in a longitudinal rather than cross-sectional study.

It is also interesting to compare the growth rates of students with LD and the low achievers in the general education group. The data obtained in this study reveals that the pattern of change in grade-level growth rates for students with LD and for low achievers is similar. Moreover, growth rates in each grade for these two groups are statistically compatible, considering standard error of estimation of growth rates. This similarity in growth rates was confirmed in a subsequent study (Shin, 1999b) where differences in initial reading status were also found. Initial level differences combined with similar rates of reading growth, results in a pattern whereby students with LD grow at the same rate as low-achieving general education students during the elementary-school years, but at a lower level of performance. This picture of reading performance and growth for student with LD and low-achieving students corroborates previous research findings that learning disability applies to a distinct group of students having the most severe, continuous learning problems (Kavale, Fuchs, & Scruggs, 1994).

In our study, we wished to not only examine the growth rates of the students in our sample, but also to demonstrate how schools, districts, and state educational agencies could use CBM in combination with HLM procedures to develop local norms of standard growth rates. Technically speaking, the results of this current and previous studies (Shin, Deno, & Espin, 2000) indicate that the maze measure utilized in this study can be used to produce reliable estimates of growth both in general and special education. Although it would be recommended that data be collected on a monthly basis in order to obtain more reliable estimates of growth, even the use of only three data points produced reliable growth estimates.

How practical and realistic is it for schools, districts, or SEAs to collect data on a monthly basis? We believe that it is both practical and realistic, although it is clear that resources must be devoted to such efforts. In our study, the majority of the CBM data was collected and scored via a computer system, making data collection efforts relatively simple and efficient. Even without the use of a computer, the maze is a relatively easy measure to administer and score. It can be administered to large groups and in a short period of time. Despite these advantages, however, time and resources are needed to collect data on a monthly basis from a representative sample of students. We would argue that the time and resources devoted to this end represent a worthwhile allocation of such time and resources. The normative growth rates established within a school, district, or SEA could provide educators with the means to set realistic long-range goals against which to monitor student progress, and evaluate systematically the effects of instructional interventions, some of which themselves may be quite costly.

Is it possible to use the growth rates found here in this study as reliable standards? It is cautiously suggested that the grade-level growth rates reported in this study could be used by urban school districts as standards for monitoring student progress, setting year-end goals, and evaluating program effectiveness. It is also suggested that the normative growth rates would be more useful to evaluate group performance rather than individual students' performance levels due to the individual differences of students.

It is believed, however, that the growth rates reported in this study should be considered to be *minimum* standards. Our reasons for arguing this are twofold. First, specially designed reading programs were not delivered to the participants in our study. If special programs were to be implemented, higher standards (e.g., perhaps one to two standard errors of estimation higher) might be expected than those reported here. Future research could examine how much growth can be expected when certain types of educational programs (e.g., classwide peer tutoring strategies as discussed by Fuchs, Fuchs, Mathes, & Simmons, 1997; Phillips, Hamlett, Fuchs, & Fuchs, 1993) are provided to students. A second reason that growth rates estimated in the study should be considered minimum standards is that general education students in grades four to six in this study showed lower levels of reading performance than the national norm groups on the MAT-7 reading test.

One limitation in the present study is the restricted range of response opportunities on the maze task given to high-achieving students in grade six. These high achievers showed very high performance levels on the maze task with no significant growth over a school year (i.e., .05 increase per month). The ceiling effect for these students might have had a confounding effect upon estimating the mean growth rate for grade six in general education in this study. To assess reading-proficiency development for upper-grade students in general education more precisely, one may need to increase response opportunities (e.g., more than 24 selection opportunities) or decrease the testing time (e.g., less than two minutes).

Conclusion

In this study, a combination of CBM and HLM methods were used to examine grade-level growth rates for low-, average-, and high-achieving students in general education, and for students with learning disabilities. The implications of our research are four-fold. First, the study contributes to the knowledge base regarding reading growth-rates for elementary-school students with and without learning disabilities, and serves to broaden the generalizability of existent research outcomes through its replication and extension of other empirical findings (e.g., Fuchs et al., 1993). Second, the pattern of change in grade-level growth rates for students with LD suggests the need for intensive instructional support systems and procedures to be provided as early as possible. Students in the early grades who show especially slow growth rates can be considered at risk of experiencing severe academic difficulties; educational services should be provided as soon as possible to these students. Third, the grade-level growth rates reported in this study could be used as provisional standards by school districts that have a similar student compositions and similar instructional service delivery models to this study. Finally, this study demonstrates methods that can be used by schools, districts, and SEAs to develop normative growth rates in order to enhance instructional decision making and monitoring student growth and progress. The extent to which the use of such normative growth rates is effective in decision making has yet to be examined.

References

Allinder, R. M. (1996). When some is not better than none: Effects of differential Implementation of curriculum-based measurement. *Exceptional Children, 62*, 525-535.

Allinder, R. M., & Oats, R. G. (1997). Effects of acceptability on teachers' implementation of curriculum-based measurement and students achievement in mathematics computation. *Remedial and Special Education, 18,* 113-120.

Bryk, A. S., & Raudenbush, S. W. (1987). Application of hierarchical linear models to assessing change. *Psychological Bulletin, 101,* 147-158.

Bryk, A. S., & Raudenbush, S. W. (1992). *Hierarchical linear models*. Newsbury Park, CA: Sage.

Caspi, A., Wright, B. R. E., Moffitt, T. E., & Silva, P. A. (1998). Early failure in the labor market: Childhood and adolescent predictors of unemployment in the transition to adulthood. *American Sociological Review, 63,* 424-451.

Cassidy J., & Gray, M. A. (1992). United States. In J. Hladczuk & W. Etler (Eds.), *International handbook of reading education* (pp. 413-436). Westport, CT: Greenwood.

Castle, M. (1994). Promoting the disabled reader's self-esteem. *Reading and_Writing Quarterly: Overcoming Learning Difficulties, 10*, 159-170.

Condren, R. J. (1972). Characteristics of the chronically unemployed in relation to reading retardation. *Dissertation Abstracts International, 33*, 2788-2789.

Deno, L. S. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children, 52*, 219-232.

Fuchs, L. S., Deno, S. L., & Mirkin, P. K. (1984). The effects of frequent curriculum-based measurement and evaluation on pedagogy, student achievement, and student awareness of learning. *American Educational Research Journal, 21*, 449-460.

Fuchs, L. S., & Fuchs, D. (1986). Effect of systematic formative evaluation: A meta-analysis. *Exceptional Children, 53*, 199-208.

Fuchs, L. S., & Fuchs, D. (1992). Identifying a measure for monitoring student reading progress. *School Psychology Review, 21*, 45-48.

Fuchs, L. S., & Fuchs, D. (1999). Monitoring student progress toward the development of reading competence: A review of three forms of classroom-based assessment. *School Psychology Review, 28*, 659-671.

Fuchs, L. S., Fuchs, D., Hamlett, C. L., Waltz, L., & Germann, G. (1993). Formative evaluation of academic progress: How much growth can we expect? *School Psychology Review, 22*, 27-48.

Fuchs, D., Fuchs, L. S., Mathes, P. G., & Simmons, D. C. (1997). Peer-assisted learning strategies: Making classrooms more responsive to diversity. *American Educational Research Journal, 34*, 174-206.

Good, R. H., & Jefferson, G. (1998). Contemporary perspectives on curriculum-based measurement validity. In M. R. Shinn (Ed.), *Advanced applications of curriculum-based measurement* (pp.61-88). New York: Guilford.

Harris, A. J., & Sipay, E. R. (1985). *How to increase reading ability: A guide to developmental and remedial methods*. New York: Longman.

Kaluger, G., & Kolson, C. J. (1978). *Reading and learning disabilities* (2nd ed.) Columbus, OH: Merrill.

Kavale, K. A., & Forness, S. R. (1995). *The nature of learning disabilities: Critical elements of diagnosis and classification*. Mahwah, NJ: Erlbaum.

Kavale, K. A., Fuchs, D., & Scruggs, T. E. (1994). Setting the record straight on learning disability and low achievement: Implications for policymaking. *Learning Disabilities Research & Practice, 9*, 70-77.

Marston, D. (1989). A curriculum-based measurement approach to assessing academic performance: What it is and why it is. In M. R. Shinn (Ed.), *Curriculum-based measurement: Assessing special children* (pp. 18- 78). New York: Guilford.

Marston, D., Deno, S. L., & Tindal, G. (1983). *A comparison of standardized achievement tests and direct measurement techniques in measuring pupil progress* (Research Report No. 126). Minneapolis, MN: University of Minnesota, Institute for Research on Learning Disabilities.

Marston, D., & Magnusson, D. (1985). Implementing curriculum-based measurement in special and regular education settings. *Exceptional Children, 52*, 266-276.

National Institute for Literacy (1996). President's radio address emphasizes literacy as a priority for the 21st century. *Policy Update*.

Phillips, N. B., Hamlett, C. L., Fuchs, L. S., & Fuchs, D. (1993). Combining classwide curriculum-based measurement and peer tutoring to help general educators provide adaptive education. *Learning Disabilities Research & Practice, 8*, 148-156.

Shin, J. (1999a). *Reading-skill development and instructional practices facilitating reading growth for students with and without learning disabilities: A one-year longitudinal study*. Unpublished Doctoral Dissertation, University of Minnesota, Minneapolis.

Shin, J. (1999b). Differences in reading-skill development between low-achieving students and students with learning disabilities. *Korean Journal of Special Education, 34*, 277-295.

Shin, J., Deno, S. L., & Espin, C. A. (2000). Technical adequacy of the maze task for curriculum-based measurement of reading growth. *The Journal of Special Education, 34*, 140-153.

Shin, J., Deno, S. L., Robinson, S. L., & Marston, D. (2000). Predicting classroom achievement from active responding on a computer-based classwide instructional system. *Remedial and Special Education, 21*, 53-60.

Simner, M. L., & Barnes, M. J. (1991). Relationship between first-grade marks and the high school dropout problem. *Journal of School Psychology, 29*, 331-335.

Wharton-McDonald, R., Rankin, J., Mistretta, J., Yokoi, L., & Ettenberger, S. (1997). Effective primary-grades literacy instruction = Balanced literacy instruction. *The Reading Teacher, 50*, 518-521.

Willet, J. B. (1989). Some results on reliability for the longitudinal measurement of change: Implications for the design of studies of individual growth. *Educational and Psychological Measurement, 49*, 587-603.

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