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Effects of Early Writing Intervention Delivered Within a Data-Based Instruction Framework

Pyung-Gang Jung[1], Kristen L. McMaster[1], and Robert C. delMas[1]

Abstract

We examined effects of research-based early writing intervention delivered within a data-based instruction (DBI) framework for children with intensive needs. We randomly assigned 46 students with and without disabilities in Grades 1 to 3 within classrooms to either treatment or control. Treatment students received research-based early writing intervention within a DBI framework for 30 min, 3 times per week, for 12 weeks. Control students received business-as-usual writing instruction. We measured writing performance using curriculum-based measures (CBM) and Woodcock Johnson III Tests of Achievement (WJ III). We found significant treatment effects on CBM outcomes (Hedges g = 0.74 to 1.36). We also found a significant interaction between special education status and condition on the WJ III favoring treatment students with disabilities (Hedges g = 0.45 to 0.70). Findings provide preliminary support for using a combination of research-based intervention and DBI with students with intensive writing needs.

Children at risk or identified with academic disabilities require high-quality, effective intervention to experience success in school. Thus, researchers have made significant investments in the development and evaluation of interventions to improve students' academic performance (Chard et al., 2008; Zumeta, 2015). Although such interventions have benefited many children, a small proportion—approximately 5% of the student population—does not show sufficient response to generally effective research-based approaches (National Center on Intensive Intervention, 2013; Wanzek & Vaughn, 2009). These children likely need more intensive, individualized instruction (D. Fuchs, Fuchs, & Vaughn, 2014; Zumeta, 2015).

Intensive, individualized instruction was intended to be a cornerstone of special education, yet it is not widely implemented in current practice (D. Fuchs, Fuchs, & Stecker, 2010). Thus, D. Fuchs et al. (2010) urged the field to bring the "unique and effective instructional approach . . . known as data-based instruction [DBI] . . . back to the future" (p. 318) of special education. In this article, we describe one attempt to do so by using DBI in combination with research-based intervention to improve outcomes for children who experience difficulties learning to write.

DBI

DBI is a hypothesis-driven, empirical approach to individualizing instruction (Deno & Mirkin, 1977) that entails (a) a systematic process (not a single intervention); (b) an ongoing cycle of

[1]University of Minnesota

Corresponding Author:
Pyung-Gang Jung, University of Minnesota, 56 East River Rd., Minneapolis, MN Minnesota 55455, USA.
E-mail: jungx165@umn.edu

implementation incorporating assessment and intervention; (c) intervention delivered in addition to, or instead of, core instruction and small-group intervention; and (d) implementation for a long period of time (Danielson & Rosenquist, 2014). A series of DBI steps (described in Method section) guides teachers to use data to individualize instruction by determining when and whether instructional changes are needed (Danielson & Rosenquist, 2014; D. Fuchs et al., 2010).

Research shows positive evidence of DBI on teachers' instructional planning and students' performance (Stecker, Fuchs, & Fuchs, 2005). Teachers who used DBI made more frequent instructional changes and identified appropriate targeted skills for students than teachers who did not use DBI (Capizzi & Fuchs, 2005; D. Fuchs, Deno, & Mirkin, 1984; L. Fuchs, Fuchs, & Hamlett, 1989; Stecker & Fuchs, 2000). Further, DBI has resulted in significant academic improvements of students at risk or with disabilities in reading, mathematics, and spelling (see Stecker et al., 2005, for a review). To date, no research has been conducted on DBI in writing.

Need for DBI in Early Writing

Writing skills are essential for school and vocational success (Graham & Perin, 2007). Students with or at risk for disabilities are especially likely to experience difficulty with writing (Graham, Harris, & Larsen, 2001). For example, Salahu-Din, Persky, and Miller (2008) found that, nationally, only 6% of eighth graders with learning disabilities reached proficiency in writing; 46% were below the basic level. For students who struggle with writing, early writing intervention is essential to prevent long-term academic failure (Berninger, Nielson, Abbott, Wijsman, & Raskind, 2008). To provide effective early intervention for students with intensive needs, extensions of DBI research that include a focus on early writing skills are needed. Fortunately, crucial components needed for such research do exist, including early writing intervention and assessment.

Early Writing Intervention

DBI should begin with instruction that targets the specific needs of students with academic difficulties and has evidence of efficacy for improving academic outcomes (Stecker et al., 2005). To target specific early writing needs, researchers have relied on a theoretical model of writing called the *simple view of writing* (Berninger & Amtmann, 2003) that specifies three components of writing: transcription, text generation, and executive functioning (Berninger & Winn, 2006). Each component is constrained by attention and memory. As lower-level writing skills (transcription) become automatic, more cognitive resources are available for higher-level writing skills and cognitive processes (text generation and executive functioning), which should lead to improved overall writing proficiency (e.g., Alves & Limpo, 2015).

To date, no research has been conducted on DBI in writing.

Findings from early writing intervention research support this theoretical model. Specifically, researchers have demonstrated that explicit early writing interventions targeting basic transcription skills (e.g., handwriting and spelling) can lead to improved writing fluency and quality for students identified as at risk or with disabilities (for reviews, see Datchuk & Kubina, 2012; Graham, McKeown, Kiuhara, & Harris, 2012; McMaster, Kunkel, Shin, Jung, & Lembke, in press). Thus, both theory and empirical evidence indicate that intervention focusing on development of transcription skills is crucial to prevent future writing difficulties.

Early Writing Assessment

A fundamental assumption of DBI is that although research-based interventions may benefit many students, a teacher can only hypothesize that a given approach will be effective for an individual student and must collect ongoing assessment data to determine intervention effects for that student (Deno & Mirkin, 1977). Curriculum-based measurement (CBM; Deno, 1985) has unique features that meet this need. First, CBM is a "general outcome measurement" approach (L. Fuchs & Deno, 1991), in that it provides an index of overall academic proficiency. Second, CBM has been demonstrated to produce reliable and valid scores (see reviews by Foegen, Jiban, & Deno, 2007; McMaster & Espin, 2007; Wayman, Wallace, Wiley, Ticha, & Espin, 2007). Third, CBM is characterized by standardized administration and scoring procedures, multiple forms with equivalent difficulties, and time efficiency (Stecker et al., 2005).

CBM in writing (CBM-W) has evidence of producing reliable scores that serve as valid indicators of students' early writing performance and are sensitive to growth over time (McMaster, Ritchey, & Lembke, 2011). Specifically, Word Dictation (a word-level task) and Picture Word (a sentence-level task) have been demonstrated to be appropriate for monitoring children's early writing progress (Lembke, Deno, & Hall, 2003; McMaster, Du, et al., 2011). An important next step is to determine whether, when teachers use CBM-W for individualized instructional decision making, student outcomes improve.

Purpose and Research Questions

As we have described, researchers have provided promising evidence supporting (a) the use of DBI, (b) the implementation of early writing interventions focusing on transcription, and (c) the use of CBM-W to obtain reliable, valid early writing assessment data. In this study, we combined these three components to examine the effects of early writing intervention delivered within a DBI framework, using CBM-W data for ongoing instructional decision making. In doing so, we intended to shed light on whether DBI, which has been shown to improve student outcomes in reading, math, and spelling, would also show promise in writing.

Thus, we examined the effects of research-based early writing intervention delivered within a DBI framework for children with intensive needs. Because many children in early elementary grades have not yet been identified with disabilities (Berninger et al., 2006), we included students at risk as well as those already identified with disabilities. In addition, to provide further evidence regarding the effects of transcription interventions on overall writing skills, we examined the effects of intervention on both basic and more complex writing skills.

Specific research questions included the following:

1. What are the effects of research-based early writing intervention delivered within a DBI framework for students in Grades 1 to 3 at risk or identified with disabilities?
2. Do effects vary by (a) special education status and (b) type of writing skills as measured by CBM-W and a standardized writing measure?

We hypothesized that students who received research-based early writing intervention with DBI would outperform control students in their writing achievement, on both basic and more complex writing skills, given theoretical and empirical evidence indicating that transcription skills can lead to improved overall writing proficiency (Datchuk & Kubina, 2012; Graham et al., 2012; McMaster et al., in press).

Method

Our study took place in three elementary schools in a large, urban midwestern district. Three general education teachers and four special education teachers from seven classrooms agreed to participate. Teachers nominated students who they believed were in need of intensive, individualized writing intervention ($n = 66$). Students who had parental consent and assented to participate ($n = 50$) were screened using CBM-W Picture Word and Woodcock-Johnson III Tests of Achievement (WJ III; Woodcock, Mather, & McGrew, 2001) writing subtests (Spelling, Writing Fluency, and Writing Samples).

Students were initially deemed eligible for the study if their CBM-W median score was below 15 correct word sequences (CWS), a cut score with evidence of classification accuracy (Jung & McMaster, 2012). This cut score yielded a sample of $n = 41$. To maximize the number of students who might benefit from the intervention, two additional screening criteria were applied to students whose median score was greater than 15 CWS. First, students were included if their score on the WJ III Spelling subtest was below one standard deviation of the normative mean ($n = 5$). Because the intervention was designed to improve transcription skills, the Spelling subtest was the focus; however, eligible students also showed low performance on WJ III Writing Fluency and Writing Samples (below the 8th and 2nd percentile ranks, respectively). Second, students were included if they generated simple, repetitive sentences (e.g., "I have a dog," "I have a lamp") on more than than 50% of their CBM-W sentences ($n = 2$). These additional criteria yielded a final sample of $n = 48$.

Of the 48 participants, 29 were students with disabilities receiving special education services, and 19 were designated "at risk" (low performing in writing but not identified with disabilities). Students receiving special education services represented a wide range of disability categories (see Table 1) and, according to their special education teachers, had intensive needs related to writing development. The largest-represented category was "students needing alternative programming" (SNAP). Students identified as SNAP have significant academic needs and are identified through a problem-solving model, which the participating district has used since the early 1990s as an alternative to the traditional IQ–achievement discrepancy approach to identifying students with learning disabilities (Marston, Muyskens, Lau, & Canter, 2003). In this approach (which has served as a model for some contemporary response-to-intervention approaches), students are identified as needing special education services based on their responsiveness to increasingly intensive and individualized intervention, as indicated by progress-monitoring data. All students with disabilities in this study were receiving individualized academic instruction in a resource room or self-contained special education classroom. Students identified as at risk received literacy instruction in the general education classroom at the time of this study.

All participants were assigned randomly within classroom to treatment or control. Two treatment students did not complete the study (described in Attrition under Results). Thus, complete data were available for 46 students (27 with disabilities and 19 at risk). Demographic information is presented in Table 1. There were no statistically significant differences between conditions on any of the demographic variables.

Measures

We chose Picture Word for screening, pre- and posttesting, and monitoring progress as it has shown sufficient technical adequacy in terms of reliability, validity, and sensitivity to growth (McMaster, Du, et al., 2011). Each prompt consists of nine words with three words per page. Students generate as many sentences as possible using words presented with pictures for 3 min. Writing samples are scored using total words written (WW), words spelled correctly (WSC), CWS (the total number of adjacent, correctly spelled words that are grammatically correct within the context of the sample; Videen, Deno, & Marston, 1982), and correct minus incorrect word sequences (CIWS). Alternate-form reliabilities have been reported to be moderate to strong ($r = .44$ to $.79$), and criterion validity has ranged between $r = .23$ and $r = .54$ with the Test of Written Language (Hammill & Larsen, 1996; McMaster, Du, et al., 2011; McMaster, Du, & Pétursdóttir, 2009).

We used WJ III (Woodcock et al., 2001) Spelling, Writing Fluency, and Writing Samples subtests for pre- and posttest. For Spelling, students write letters or words that the examiner dictates. Items are scored as 1 if correct and 0 if incorrect. Writing Fluency requires students to generate sentences quickly and accurately

Table 1. Student Demographics.

Variable	Treatment (n = 22)		Control (n = 24)			
	n	%	n	%	χ^2	p
Age					4.61	.20
6 years	4	18.2	5	20.8		
7 years	7	31.8	13	54.2		
8 years	7	31.8	2	8.3		
9 years	4	18.2	4	16.7		
Sex					0.55	.46
Male	16	72.7	15	62.5		
Female	6	27.3	9	37.5		
Ethnicity					2.65	.62
American Indian	1	4.5	0	0.0		
African American	14	63.6	14	58.3		
Asian	2	9.1	1	4.2		
Hispanic	1	4.5	3	12.5		
White	4	18.2	6	25.0		
FRL					0.46	.50
No FRL	2	9.1	1	4.2		
Receives FRL	20	90.9	23	95.8		
SPED					0.00	.96
No IEP	9	40.9	10	41.7		
Has IEP	13	59.1	14	58.3		
Disability Categories					5.07	.65
ASD	4	30.8	4	28.6		
SNAP	6	46.2	5	35.7		
S/LI	1	7.6	0	0.0		
OHD	1	7.6	3	21.4		
PI	0	0.0	1	7.1		
DCD-MM	0	0.0	1	7.1		
EBD	1	7.6	0	0.0		
ELL status					0.95	.33
Non-ELL	15	68.2	13	54.2		
ELL	7	31.8	11	45.8		
Home language					5.96	.54
Arabic	0	0.0	1	4.2		
Amharic	1	4.5	0	0.0		
English	14	63.5	13	54.2		
Hmong	1	4.5	1	4.2		
Nepali	1	4.5	0	0.0		
Spanish	1	4.5	3	12.5		
Somali	3	13.6	6	25.0		
Tigrinya	1	4.5	0	0.0		

Note. FRL = free or reduced-price lunch; SPED = special education status; IEP = individualized education program; ASD = autism spectrum disorder; SNAP = student needing alternative programming; S/LI = specific language impairment; OHD = other health disabilities; PI = physical impairment; DCD-MM = developmental cognitive disabilities: mild to moderate; EBD = emotional and behavioral disabilities; ELL = English language learner.

within 7 min in response to a picture stimulus and three words. Each sentence is scored 1 for being a complete and "reasonable sentence" (Mather & Woodcock, 2001, p. 52) that includes the three words or 0 for not meeting these criteria. For Writing Samples, students write words or sentences in response to a picture or a verbal stimulus. Scores range from 0 to 2 based on scoring criteria described in the examiner's manual (Mather & Woodcock, 2001).

An aggregated score of the three writing subtests yields a Broad Written Language cluster, representing a comprehensive measure of written language achievement. The raw scores of each subtest and the aggregated score were converted to *W* scores using the WJ III Compuscore and Profiles Program (Schrank & Woodcock, 2001). Reported median reliability coefficients are $r = .89$ for Spelling, $r = .86$ for Writing Fluency, $r = .84$ for Writing Samples, and $r = .94$ for the Broad Written Language cluster (Mather & Woodcock, 2001).

Fidelity of DBI was assessed using a modified version of the Accuracy of Implementation Rating Scales (AIRS; D. Fuchs et al., 1984), focusing on administering, scoring, and graphing CBM-W and using CBM-W outcomes. Fidelity of early writing intervention was checked using writing intervention checklists developed by the first author. On both checklists, each item was rated as 1 (observed) or 0 (not observed), along with observation notes.

Early Writing Intervention

We adapted the research-based early writing intervention from the Center on Accelerating Student Learning (CASL) handwriting and spelling program. (Graham & Harris, 1999, 2006). The CASL manual includes seven handwriting and spelling activities supported by research (Graham, Harris, & Chorzempa, 2002; Graham, Harris, & Fink, 2000), described subsequently.

During Phonics Warm-Up, students identified sounds and locations (beginning, middle, end) of target letters in words. The instructor would say, "The first sound of [apple] is /a/. What sound? What letter makes the /a/ sound?" During Alphabet Practice, students practiced writing letters and words with the letters. The instructor modeled writing each target letter by tracing it with a finger. Students traced and copied the letters and then wrote the letters from memory.

During Word Building, students generated words by adding a letter to the beginning of rimes. The instructor modeled how to make a real word using a rime on a card (e.g., *at*) by adding a letter in front of the rime. After modeling, students made as many real words as possible. During Word Study, students studied spelling words through five steps: (a) Say the word and its letters, (b) say the word and letters from memory without looking, (c) say the letters again, (d) write the word from memory, and (e) check to see if the word is correct.

During Alphabet Rockets, students copied sentences with accuracy and fluency. Students wrote the sentence, which included target letters covered in Alphabet Practice, as many times as possible for 3 min. During Writing, students wrote a story based on a story prompt using handwriting and spelling skills practiced so far. Last, during Word Sort, the instructor demonstrated how to categorize words by target features, showed how to check, and then had students state a rule for the patterns observed. Students then sorted the words.

The writing activities were delivered over three sessions and then repeated with new content. Session 1 included Phonics Warm-up (5 min), Word Building (15 min), and Alphabet Rockets (7 min). Session 2 included Alphabet Practice (7 min), Word Study (10 min), and Writing (10 min). Session 3 included Word Sort (27 min). At first, tutors delivered each writing activity for the prescribed time (as indicated in parentheses after each activity) to all students but could then adjust time spent on each activity based on students' individual needs after collecting at least eight CBM-W data points (and by following the DBI steps described in the following paragraph). Regardless of how much time was spent on specific activities, intervention sessions were delivered for a total of 30 min per session.

DBI Steps

The first author trained three undergraduate and two graduate tutors to implement the following eight DBI steps (Deno & Mirkin, 1977; McMaster et al., 2014). Step 1 was "establish present level of performance." Tutors administered and scored three CBM-W prompts and graphed the median baseline score. Step 2 was "set an ambitious long-term goal." Tutors multiplied the total number of intervention weeks by the weekly growth rates expected for typically developing students (0.5 to 1.0 CWS per week; McMaster, Du, et al., 2011), and added the baseline score. Then, they drew a goal line from baseline to the long-term goal on the graph.

Step 3 was "implement high-quality instruction with fidelity." Tutors implemented the early writing intervention activities described previously. Step 4 was "monitor student progress toward the goal." CBM-W progress monitoring data were collected twice weekly. Tutors added a trend line representing the student's growth rate after collecting eight data points (as recommended by McMaster, Du, et al., 2011). Step 5 was "use decision rules to evaluate student progress and instructional effectiveness." Tutors made instructional decisions by comparing the trend line to the goal line. If the trend line was steeper than the goal line, they increased the goal. If the trend line matched the goal line, they kept the intervention as is. If the trend line was less steep than the goal line, they changed instruction by implementing Steps 6 and 7.

For Step 6, "generate hypotheses to individualize instruction," tutors synthesized information from various sources, including CBM-W samples and observation notes. They made systematic decisions using a data-based decision- rubric (available from the first author), which includes a series of questions that guide tutors to consider possible reasons for insufficient progress and select appropriate changes. They could change the setting and format (e.g., by rearranging the learning environment or redistributing instructional time across activities), delivery (e.g., by making intervention more explicit), or content (e.g., by changing target letters, sounds, or words). More information about the frequency and types of changes that tutors made are in the Procedures section. Step 7 was "make instructional changes based on hypotheses." Tutors recorded changes on a form titled "Changes in Instructional Plan" (CIP). Step 8 was "repeat Steps 4 through 7."

Treatment Condition

Treatment students received intervention in small groups of three to four students. The intervention was delivered by trained tutors, 30 min per session, three times per week, for 12 weeks, during students' regular writing instruction schedules (thus supplanting their usual writing instruction).

Control Condition

Students in the control condition received business-as-usual writing instruction. The first author and three university researchers conducted direct classroom observations of writing instruction delivered by the seven teachers to control students. These observations captured characteristics of writing instruction identified by Coker and Ritchey (2010), including grouping, writing focus, writing levels (e.g., word, sentence, or passage levels), and type of teacher and student responses. Control students received varying types of writing instruction depending on their educational service settings. Students with disabilities ($n = 14$) typically received writing instruction individually or in small groups by special education teachers, focusing on transcription skills at the word and sentence levels. Students identified as at risk ($n = 10$) typically received whole-class instruction by general education teachers, focusing on text generation skills at the passage level, in a "writer's workshop" format. According to observers, writing instruction in both special education and general education settings was less explicit and less targeted to specific writing components than was treatment writing instruction.

The first author also engaged in e-mail exchanges and met with teachers to obtain more information about writing assessment and instructional decision-making practices. General education teachers reported that they rarely monitored student writing progress. Rather, they kept students' writing samples and sent them home at the end of the term.

Special education teachers reported monitoring progress using CBM-W story prompts once every 2 to 4 weeks depending on writing objectives in the student's individualized education program; however, they did not use CBM-W data for ongoing instructional decision making. At the end of the study, the first author contacted all teachers to offer to share study findings and provide intervention training.

Procedures

Five doctoral students majoring in educational psychology or curriculum and instruction collected screening and pre- and posttest data. Most examiners were blinded to condition except for a few instances when scheduling issues prevented blinded administration. Before administration began, the first author provided a 1-hr training and checked fidelity of CBM-W and WJ III administration using the AIRS and checklists of essential administration components. Fidelity was 100% for both measures. Because treatment students were exposed to CBM-W frequently (twice per week) during the 12 weeks, control students also were administered CBM-W twice to address the possibility of practice effects of progress monitoring.

Scoring. The examiners scored CBM-W after participating in a 1-hr training. First, they scored a common CBM-W set together, compared their scores, and discussed and resolved discrepancies. After each scorer reached the reliability criterion of 80% with the first author, who had met the reliability criterion of 90% with a special education professor who had extensive scoring experience, a blinded package of writing samples was distributed to each scorer. The first author compared 20% of each scorer's writing samples with her own and calculated interrater agreement (number of agreements divided by agreements plus disagreements and multiplied by 100). Interrater agreement ranged from 91.43% to 100% for all scoring procedures.

The WJ III Spelling subtest was scored by the first author, and then 20% of the scored subtests was checked by another scorer for interscorer reliability. To score Writing Fluency and Writing Samples subtests, the first author provided a 1-hr training to a doctoral student in special education. The interrater agreement procedure was conducted in a similar way to CBM-W scoring. Mean interrater agreement was 100% for Spelling and Writing Fluency and 90.29% for Writing Samples (range = 85.74% to 92.86%).

Tutor training. Six undergraduate and graduate students studying educational psychology, curriculum and instruction, or psychology served as tutors and participated in three training workshops. At the first workshop, tutors learned the overall structure of the early writing intervention activities and materials. The second workshop covered CBM-W administration, scoring, and graphing. The third workshop provided a study overview and explained DBI steps, including applying data-based decision rules.

Fidelity of implementation. Fidelity of implementation was assessed for both writing intervention and DBI twice: 4 weeks after DBI began and then 4 weeks later, when tutors made their first instructional decisions. Fidelity of writing intervention was checked twice using the writing intervention checklist for all seven writing activities for each tutor. Every tutor audio-recorded intervention sessions comprising all writing activities. Tutors were notified that if fidelity was below 80%, they would be asked to audio-record their sessions again after receiving corrective feedback from the first author. At both fidelity checks, however, fidelity was high, so additional checks were not necessary. Average writing intervention fidelity was 93.62 % at the first fidelity check (range = 88.89% to 100%) and 98.66% at the second check (range = 83.33% to 95.24%). A total of 36 out of 216 intervention sessions (17%) were checked.

DBI fidelity was checked twice using the AIRS in the areas of CBM administering, scoring, and graphing. The first author collected additional materials, including audio-recorded CBM-W administration files, CBM-W graphs, scored CBM-W prompts, and CIPs from tutors.

The first author listened to the audio files to check CBM-W administration. CBM-W scoring was checked by comparing the writing prompts scored by each tutor to the same prompts scored by the first author. CBM-W graphs and CIPs were examined to determine whether tutors made timely and appropriate instructional decisions. To be "timely and appropriate," tutors had to document instructional decisions and rationales on the CIP after eight data points, and the timing of the decision had to match the graphed data. An instructional change was deemed appropriate if the tutor provided a reasonable rationale based on CBM-W data, writing samples, and observations. For example, if the trend line was less steep than the goal line, indicating the need for instructional change, tutors could determine the students' needs based on CBM-W samples (e.g., if students consistently misspelled "long *a*" words, content changes would be an appropriate change) or could follow guidelines provided for making changes to setting, format, or delivery on the data-based decision making rubric. Average DBI fidelity was 95.68% at the first check (range = 90.90% to 100%) and 95.67% at the second check (range = 82.86% to 100%).

Two raters discussed rating criteria for each item on the writing intervention checklist and the AIRS, listened to an audio-recorded session together, compared ratings, and discussed discrepancies. After reaching the criterion of 80% interrater agreement, the raters checked fidelity independently. Percentage interrater agreement (agreements divided by agreements plus disagreements and multiplied by 100) was 98.56% for writing intervention and 99.33% for DBI.

Documenting instructional decisions. Tutors documented all instructional decisions based on CBM-W data on CIP forms. They made 47 instructional decisions in total across students, averaging about two decisions per student (range = 0 to 4). They made 19 goal increases (40.43%) and five decisions to keep the intervention as is (10.64%). They made 23 instructional changes (48.94%), including 11 changes to setting and format by rearranging the order or length of writing activities or by adding a motivational plan (47.83%), eight delivery changes by explaining the activity and its purpose more explicitly to the student or by providing immediate corrective feedback (34.78%), and four content changes by selecting target letters and words that were better matched to students' needs (17.39%).

Ongoing support. All tutors participated in weekly 1-hr group meetings, in which they discussed issues that arose during the week. Each tutor presented his or her student's progress monitoring graph and discussed possible factors affecting the student's performance and what to change. The first author also checked in with each tutor weekly (for about 30 min) to ensure each tutor was keeping track of students' progress and implementing DBI as intended.

Data Analysis

A mixed (two between, one within) repeated-measures multivariate analysis of variance (RM-MANOVA; Tabachnick & Fidell, 2007) was conducted using posttest scores of both dependent measures (CBM-W and WJ III). Because treatment students received intervention in small groups, we calculated intraclass correlations (ICCs) for each dependent variable to identify any cluster effects. No statistically significant ICCs were found (all $ps > .05$) with most ICC values less than .005 (range = .003 to .17). Thus, we used student as the unit of analysis.

Condition (treatment vs. control) and special education status (at risk vs. with disabilities) were between-subjects factors for both measures. Type of scoring procedures (WW, WSC, CWS, and CIWS) and subtests (Spelling, Writing Fluency, and Writing Samples) represented within-subjects factors for CBM-W and WJ III, respectively. This type of repeated-measures analysis is sometimes referred to as profile analysis (Maxwell & Delaney, 2004). RM-MANOVA includes both between- and within-subjects sources of variance in the analysis, providing a better model of the multivariate structure of the data and reducing error variance estimates

Table 2. Descriptive Statistics for CBM-W Scores of Student Participants.

	Students at risk					Students with disabilities				
	Treatment (n = 9)		Control (n = 10)		ES	Treatment (n = 13)		Control (n = 14)		ES
Measure	Pretest	Posttest[a]	Pretest	Posttest[a]	Pretest/ posttest[b]	Pretest	Posttest[a]	Pretest	Posttest[a]	Pretest/ posttest[b]
CBM-W: WW					0.47/0.80					0.54/0.74
M	18.30	28.65	14.63	22.40		16.00	25.99	11.38	19.74	
SD	6.47		8.22			9.07		7.34		
Skewness	1.09		−0.03			0.94		0.67		
Kurtosis	1.77		−0.41			0.42		−0.77		
CBM-W: WSC										0.83/0.72
M	14.78	25.59	12.07	19.75	0.34/0.74	14.13	23.74	7.33	17.90	
SD	6.56		8.28			8.54		7.31		
Skewness	1.47		0.29			0.98		0.86		
Kurtosis	3.29		0.04			1.32		−0.43		
CBM-W: CWS					0.11/1.31					0.75/1.28
M	10.48	23.04	9.60	13.84		10.72	22.37	5.26	13.17	
SD	8.19		7.62			7.62		6.36		
Skewness	1.91		0.51			0.73		1.41		
Kurtosis	4.42		−0.31			−0.52		0.89		
CBM-W: CIWS					−0.28/1.33					0.92/1.41
M	−1.55	9.91	1.00	−2.08		1.38	9.76	−6.29	−2.23	
SD	9.59		7.60			6.66		9.46		
Skewness	1.39		0.27			0.11		0.18		
Kurtosis	3.30		−0.04			−0.63		−0.35		

Note. CBM-W = curriculum-based measures in writing; WW = words written; WSC = words spelled correctly; CWS = correct word sequences; CIWS = correct minus incorrect word sequences; ES = effect size (Hedges' *g*) for data-based instruction–control. [a]Adjusted posttest means after controlling for pretest scores on each dependent variable. [b]Hedges' *g* based on the difference between the adjusted posttest means divided by the pooled standard deviations of pretest scores.

compared to conducting an individual ANOVA for each dependent variable. The design allows for examination of differential treatment effects across different scoring procedures (CBM-W) or subtests (WJ III) that compose a measure. Standardized residual scores for each CBM-W metric and for each WJ III subtest (*W* scores), which place all of the measures on the same scale, were used for the analysis. Significant multivariate results were followed up with univariate independent one-way analyses of variance. To estimate practical importance of treatment effects, effect sizes were calculated using Hedges' *g* (Hedges & Olkin, 1985).

Results

Tables 2 and 3 present descriptive statistics by special education status and condition, including means, standard deviations, skewness, kurtosis, and effect sizes for each dependent measure. Pretest descriptive statistics are based on raw scores, whereas posttest descriptive statistics are based on estimated means adjusted for pretest scores. Hedges' *g* was calculated by differences between the estimated posttest means between conditions divided by the pooled standard deviations of pretest scores.

Attrition

Two treatment students did not complete the entire posttest. One student left the study after receiving intervention for 1 week, due to a conflict with the school schedule, so we had neither CBM-W nor WJ III data for him. The other student was not able to complete CBM-W because he was absent on the day it was administered and was not available for makeups. Fewer than 5% of students in the sample had missing data, and they were

Table 3. Descriptive Statistics for the WJ III *W* Scores of Student Participants.

	Students at risk					Students with disabilities				
	Treatment (*n* = 9)		Control (*n* = 10)		ES	Treatment (*n* = 13)		Control (*n* = 14)		ES
Measure	Pretest	Posttest[a]	Pretest	Posttest[a]	Pretest/posttest[b]	Pretest	Posttest[a]	Pretest	Posttest[a]	Pretest/posttest[b]
WJ III: Spelling					−0.23/0.33					1.16/0.45
M	443.22	453.99	447.40	448.10		443.20	445.77	419.00	436.29	
SD	21.04		13.15			16.82		23.45		
Skewness	−1.41		0.54			−1.03		0.47		
Kurtosis	2.45		−0.48			1.04		0.61		
WJ III: Writing Fluency					1.78/−0.89					0.91/0.68
M	466.67	466.52	447.40	473.92		466.10	468.97	461.10	465.32	
SD	5.68		13.15			6.91		2.77		
Skewness	0.48		0.54			1.39		2.92		
Kurtosis	−0.99		3.41			1.00		9.05		
WJ III: Writing Samples					−0.24/−0.14					0.68/0.70
M	451.00	461.88	457.60	465.61		449.60	464.14	428.4	442.09	
SD	33.00		17.64			25.08		34.84		
Skewness	−2.75		−0.75			−1.08		−0.44		
Kurtosis	7.87		1.63			0.88		−0.54		

Note. WJ III = Woodcock-Johnson III Tests of Achievement; ES = effect size (Hedges' g) for data-based instruction–control. [a]Adjusted posttest means after controlling for pretest scores on each dependent variable. [b]Hedges' *g* based on the difference between the adjusted posttest means divided by the pooled standard deviations of pretest scores.

missing in a random pattern, indicating that proceeding with the analyses was appropriate (Tabachnick & Fidell, 2007).

To examine whether the analyses were sensitive to the two missing posttest cases at pretest, RM-MANOVAs were conducted with the two students included and excluded, with treatment condition and special education status as the between-subjects factors and type of scoring procedures (WW, WSC, CWS, and CIWS) or type of subtests (Spelling, Writing Fluency, and Writing Samples) as within-subjects factors. The RM-MANOVA indicated the analyses were not sensitive to the inclusion of the missing data for CBM-W but were sensitive for the WJ III, suggesting it would be appropriate to exclude the two students from the final analysis (statistical results are available from the first author on request). The two students were excluded from the final analyses, resulting in a total sample size of 46 students.

Pretreatment Differences

RM-MANOVAs showed no statistically significant mean differences between conditions on students' writing performance on CBM-W, $F(1, 42) = 2.855$, $p = .099$, or the WJ III, $F(1, 42) = 2.17$, $p = .148$, at pretest. However, treatment students showed consistently higher means compared to controls, with effect sizes (computed using pretest raw scores from CBM-W and the WJ III) greater than 0.25 for all but three of the variables (see Tables 2 and 3), thus not satisfying baseline equivalence (What Works Clearinghouse, 2014). To control for pretreatment differences, a regression adjustment was applied for all dependent variables. First, a regression model was built for each measure with the respective pretest scores as the independent variable and posttest scores as the dependent variable. Then, we used standardized residuals from each model, which removes variance accounting for pretest scores from posttest scores, as the dependent variables in the RM-MANOVAs.

Effects of DBI on Writing Performance

We conducted a RM-MANOVA with condition (treatment vs. control) and special education status (at risk vs. with disabilities) as between-subjects factors and type of scoring procedure (WW, WSC, CWS, and CIWS) as the within-subjects factor to examine treatment effects

Table 4. Results of RM-MANOVA on CBM-W and the WJ III Performance.

Effect	SS	*df*	Wilks's Λ	*F*	*p*
CBM-W					
Between subjects					
Treatment	3.857	1	—	5.293	.026
SPED	0.071	1	—	0.097	.757
Treatment × SPED	2.014	1	—	2.764	.104
Error	0.729	42			
Within subjects					
Scoring type	—	3, 40	.999	0.020	.996
Scoring Type × Treatment	—	3, 40	.907	1.370	.266
Scoring Type × SPED	—	3, 40	.936	0.909	.445
Scoring Type × Treatment × SPED	—	3, 40	.933	0.956	.423
WJ III					
Between subjects					
Treatment	0.483	1	—	1.422	.240
SPED	2.773	1	—	8.162	.007
Treatment × SPED	2.204	1	—	6.487	.015
Error	14.271	42			
Within subjects					
Subtest type	—	2, 41	.999	0.018	.982
Subtest Type × Treatment	—	2, 41	.884	2.696	.079
Subtest Type × SPED	—	2, 41	.991	0.179	.837
Subtest Type × Treatment × SPED	—	2, 41	.907	2.106	.135

Note. RM-MANOVA = repeated-measures analyses of variance; CBM-W = curriculum-based measures in writing; WJ III = Woodcock-Johnson III Tests of Achievement; SPED = special education status; SS = sums of squares.

on students' writing performance measured by CBM-W. Results, presented in Table 4, revealed a significant main effect of condition favoring the treatment. Because the interaction was not statistically significant, a regression equation for each CBM-W measure was fitted that included the respective pretest measure and only the main effects for condition and special education status as predictor variables. Posttest means were then estimated using the respective regression models, holding the pretest measure constant at the mean. The magnitude of the effect size based on estimated posttest means was large for all four scoring procedures (g= 0.78, 0.74, 1.23, and 1.36, respectively). Main effects of special education status and type of scoring procedures were not statistically significant, and there were no significant two- or three-way interactions.

An RM-MANOVA with condition and special education status as between-subjects factors and type of subtest (Spelling, Writing Fluency, and Writing Samples) as the within-subjects factor was conducted to examine treatment effects on students' writing achievement as measured by the WJ III. Results, shown in Table 4, revealed no reliable main effect of condition. The RM-MANOVA revealed a statistically significant main effect of special education status favoring at-risk students and a significant Condition × Special Education Status interaction. A regression equation for each WJ III subtest was fitted that included the respective pretest measure, main effects for condition and special education status, and the interaction as predictor variables. Posttest means were then estimated using the respective regression models, holding the pretest measure constant at the mean. The special education status effect size based on estimated posttest means was small to medium for all three subtests (g= 0.46, 0.50, and 0.37, respectively).

To examine the nature of the interaction, follow-up independent t tests were conducted with condition as the independent variable and the average of the three standardized residual WJ III writing subtest scores as the dependent variable for students at risk and with disabilities separately. Significance of the results was determined using the Holm-Bonferroni adjustment (Holm, 1979). No statistically significant mean difference was found between conditions for students at risk, $t(17) = -0.78$, $p = .45$. A reliable mean difference favoring the treatment group was found for students with disabilities, $t(25) = 3.25$, $p = .003$, with a medium to large effect size based on estimated posttest means for all three WJ III subtests (see Table 3).

Discussion

Students at risk or with disabilities who received early writing intervention within a DBI framework showed significantly higher writing performance on CBM-W, but not on the WJ III, compared to controls. Thus, our hypothesis that treatment students would outperform control students was partially supported. These findings corroborate previous DBI research in other academic areas—specifically, reading, mathematics, and spelling (Capizzi & Fuchs, 2005; D. Fuchs et al., 1984; L. Fuchs et al., 1989; Stecker & Fuchs, 2000; Wesson, 1990).

One or more combinations of factors may have contributed to improved CBM-W outcomes. Tutors (a) implemented research-based early writing intervention three times per week while (b) monitoring students' progress using CBM-W twice per week and (c) using the DBI framework to evaluate instructional effectiveness and make individualized decisions. All three features are supported by previous research for enhancing students' academic achievement (Berninger et al., 1997, 1998; Graham et al., 2000, 2002; Stecker et al., 2005). Findings of this study support the use of these assessment, intervention, and decision-making components as a package to improve student outcomes in writing. However, given apparent pretest differences favoring treatment students, these findings should be interpreted with caution even though we controlled the pretreatment differences statistically.

Differential Effects of DBI

Whereas results indicate that students benefited from the treatment regardless of special education status on CBM-W, a statistically significant difference between conditions on the WJ III measures was found only for those receiving special education services. Thus, findings support the implementation of early writing intervention within a DBI framework for improving overall writing performance in terms of transcription skills (specifically, handwriting and spelling) as well as quantity and quality of writing for students receiving special education services.

Students with disabilities might have experienced significant benefits compared to those at risk because intervention focusing on transcription might have been better aligned to their specific needs. A focus on transcription may not have been sufficient for students at risk; in fact, tutors expressed the need for more text generation activities for students at risk. In addition, at-risk control students may have experienced benefits from writing instruction by general education teachers, which focused more on text generation skills, leading to higher writing performance than among those at risk who received treatment.

There was no differential effect of treatment depending on CBM-W scoring procedures or the WJ III subtests. In addition, no significant three-way interaction (Condition × Scoring Procedure × Special Education Status) was found. Students with intensive early writing needs appeared to improve both basic and more complex writing skills.

Limitations and Directions for Future Research

Several features of the current study limit generalizable conclusions that can be drawn from the findings. First, as mentioned previously, although there were no reliable between-group pretreatment differences, treatment students showed a pattern of higher mean performance levels compared to controls. We statistically controlled for preexisting group differences, but those differences or others related to them but not measured in our analysis could have influenced the results. Future researchers should consider assigning student participants into conditions randomly after matching them on important variables, including dependent variables or other characteristics (Gersten et al., 2005). Second, a relatively small sample of students from three schools participated; replication of this research with larger, more diverse samples is warranted.

Students at risk or with disabilities who received early writing intervention within a DBI framework showed significantly higher writing performance on CBM-W, but not on the WJ III, compared to controls.

Third, it is unclear which dimensions of the treatment contributed to enhanced writing performance given that it was delivered as an instructional package. Further research is needed to identify the "active ingredients"—in other words, which of the assessment, intervention, and DBI components are necessary and sufficient to lead to improved student outcomes. It may be that receiving research-based early writing intervention was sufficient to improve student outcomes. However, the decision-making component of DBI, which prompts an instructional change when students are not making sufficient progress, likely led to even greater growth, at least for some students, serving as the most crucial component. On average, tutors made about two instructional changes per student, suggesting that the standard intervention was not sufficient for all students.

Additional research is needed to examine the effects of DBI on quality of writing. Four CBM-W scoring procedures used in this study represent quantitative aspects of writing. The WJ III Writing Samples subtest assessed students' writing quality but was limited to sentence-level writing. Because quality is a important aspect of written expression, future researchers should consider measuring students' writing quality. Given tutors' comments about the need for more text generation activities, researchers should also consider including a broader range of writing activities in future early writing intervention studies. In addition, this study provides promising evidence of DBI in early writing delivered by trained tutors; a logical next step would be to investigate the effects of this approach delivered by in-service teachers in schools.

Implications for Practice

Given that individualized instruction is an essential feature of special education (D. Fuchs et al., 2010), DBI may serve as an effective framework to teach students with disabilities who have specific needs in writing. Teachers should consider explicitly teaching transcription skills for struggling beginning writers using research-based interventions. In this study, students received a research-based early writing intervention that comprised a variety of handwriting and spelling activities, which likely contributed to students' improved writing performance. However, research-based intervention may not be sufficient for all students all of the time. In this study, data indicated the need for multiple instructional decisions, about 90% of which were to either increase a student's goal or change instruction. We strongly recommend that teachers collect ongoing progress-monitoring data and use those data to make instructional decisions based on students' responsiveness to intervention.

Conclusion

Previous studies have supported the benefits of DBI for improving students' performance in reading, mathematics, and spelling. This study extends the DBI literature by providing preliminary promising evidence of early writing intervention delivered within a DBI framework. In particular, this approach appeared to be more effective for students receiving special education services, at least with the types of early writing activities included in this study. Further, this study shows the importance of research-based early writing intervention focusing on handwriting and spelling. Finally, this study adds to the literature that supports a systematic approach to individualizing intervention, which is essential to providing students with disabilities the *special* education that they need to be successful in school and later life.

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