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A Response-to-Intervention Approach to Decreasing Early Literacy Differences in First Graders From Different Socioeconomic Backgrounds

Evidence for the Intervention Validity of the DIBELS

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Federal legislation mandates that local education agencies provide quality, evidence-based supplemental educational services to struggling learners. Nowhere is this more salient than in underperforming schools serving children from low-income backgrounds who are at risk for developing learning problems. The study described in this article investigated the intervention validity of two measurement tasks from the *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) on the acquisition of early literacy skills of 75 first graders from low-income backgrounds. Results indicate that the DIBELS measures effectively modeled expected student growth and informed instructional planning that ultimately led to increased student outcomes.

Keywords: *DIBELS; early literacy intervention; intervention validity; response to intervention*

Multiple reasons have been suggested to explain the poor academic performance of students from disadvantaged backgrounds. For instance, research studies have shown that the home environments of children from low socioeconomic status (SES) environments are significantly different from children from middle to upper socioeconomic backgrounds in terms of reading materials provided in the home (Marvin & Mirenda, 1993; Neuman & Celano, 2001), parent–child shared literacy experiences (Goldenberg, 1996; Roberts, Jurgens, & Burchinal, 2005; Storch & Whitehurst, 2001), and exposure to language and vocabulary (Hart & Risley, 1995). Similarly, many preschool programs serving children from low SES backgrounds provide limited activities that promote important emergent literacy skills. For example, McGill-Franzen, Lanford, and Adams (2002) indicated that preschools serving children from disadvantaged backgrounds tend to adopt instructional approaches that provide little access to print, few opportunities to participate in literacy-related activities, and little experience listening to or discussing literature. Dickenson and colleagues (Dickenson, 2001; Dickenson & Tabors, 2001) observed classroom environments serving children from low-income homes and concluded that teachers on average read less than 8 minutes per day.

Even when preschool programs show gains in academically related skills, these gains may be lost by the third or fourth grade (Currie & Thomas, 1995; McLoyd, 1998; Snow & Paez, 2004). One plausible explanation for this loss is poor-quality schooling following preschool (Lee & Loeb, 1995; Lupton, 2005). Children who live in low-income communities are more likely to (a) attend a larger school with a larger student-to-teacher ratio (Tajalli & Opheim, 2005) and higher teacher turnover; (b) be taught English, science, and math by a teacher who is not certified in the subject matter (Goldhaber, 2002); and (c) be taught by a teacher with less than 3 years of teaching experience (Lupton, 2005; Nye, Konstantopoulos, & Hedges, 2004; Rowan, Correnti, & Miller, 2002).

It is not surprising, then, that children from low-SES backgrounds are more likely to require remediation to be successful in school than are children from middle- and upper-income homes. In fact, the No Child Left Behind Act of 2001 (NCLB, 2002) requires schools in program improvement (i.e., schools that have failed to meet adequate yearly progress) to provide supplemental educational services to students from low-income homes who do not meet grade-level expectations on state accountability assessments. Yet accountability assessments used to identify students in need of improvement generally do not provide data useful to informing instruction, measuring student progress, and evaluating the effectiveness of supplemental educational services (Elliot & Fuchs, 1997). For low-income students in need of more intense, individualized instruction, such as special education, determining the presence of a disability and eligibility for special education may be challenging. The Individuals with Disabilities Education Improvement Act of 2004 (IDEIA) requires school personnel to rule out exclusionary factors such as inadequate instruction and socioeconomic disadvantage that may account for low academic achievement. Similarly, traditional measures of achievement and intelligence used for special education eligibility fail to provide functional assessment information for program planning, progress monitoring, and program evaluation. That is, the resulting data from these assessments generally are not useful in designing instruction to meet individual students' academic needs. In light of the inclusion of a response-to-intervention (RTI) approach to intervening with struggling learners in the most recent reauthorization of IDEIA and the forthcoming reauthorization of the NCLB with an emphasis on improving the quality of supplemental educational services, local educational agencies need to reconsider the purpose and process of current assessment practices to better serve students and meet the requirements of federal education laws.

Although no single model describes an RTI approach to service delivery, generally (a) empirically validated curriculum and instruction at the schoolwide and individual student levels are provided, (b) student progress is systematically and repeatedly measured to evaluate the effects of intervention, and (c) instruction is modified, as needed, based on student progress-monitoring data (Fuchs, Mock, Morgan, & Young, 2003). If a student fails to make adequate progress after the implementation of increasingly individualized and intensive instructional services, school personnel may be confident in ruling out the effects of poor instruction and socioeconomic disadvantage, and any other relevant causes, and deduce that the child may have a disability and requires special education services. However, several important measurement considerations come into play when using an RTI service delivery approach. In addition to utilizing assessment tools with established reliability and validity, evidence also must be available regarding the measures' intervention validity or effectiveness in evaluating intervention outcomes and informing intervention planning that, ultimately, lead to improved student learning.

In a recent report by the U.S. Department of Education, National Center on Student Progress Monitoring (2006), seven standards of technical adequacy critical to progress monitoring measures were identified:

1. Availability of alternate forms,
2. Specification of rates of improvement,
3. Specification of benchmarks and/or goal setting,
4. Sensitivity to small increments in learning,
5. Improvement in teacher planning and student learning,
6. Established reliability, and
7. Validity.

One of the most widely cited and empirically validated progress monitoring tools is the *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS; Good & Kaminski, 1996). In addition to meeting reliability and validity standards, most DIBELS tasks possess alternate forms, specify rates of improvement and benchmarks, are sensitive to small changes in learning, and improve teacher planning and student learning (U.S. Department of Education, National Center on Student Progress Monitoring, 2006). In this article, results are reported from a study utilizing two DIBELS tasks (i.e., Phoneme Segmentation Fluency [PSF] and Nonsense Word Fluency [NWF]) to measure the effects of literacy instruction on the acquisition of early literacy skills for first graders from low-SES backgrounds. The purpose of this study was to examine the intervention validity of the DIBELS PSF measure. Thus, results are interpreted in relation to the capability of the DIBELS PSF task to model learning, inform instruction, and document intervention effects that lead to increased student outcomes.

Method

Participants

A total of 75 first-grade students from three elementary schools in a small city in the Pacific Northwest participated in the study. Selection criteria for participants were based on the percentage of students receiving free or reduced-price lunch in each school. Demographic information for each participating school is summarized in Table 1. School 1 served as the low-SES intervention and control site where students from three first-grade classrooms were randomly assigned to either an experimental group receiving early literacy instruction (ELI) or a control group. One of two classrooms from School 2 and all three classrooms from School 3 participated as a high-SES comparison group.

Dependent Measures

DIBELS PSF and NWF tasks were used to monitor the acquisition of literacy skills and estimate the slope of learning for all study participants. On the PSF task, the student is verbally presented a series of three- and four-phoneme words and asked to provide the individual sounds in each word. For example, a student is asked to identify

Table 1
School District Demographics by Participating School

Demographics[a]	School 1	School 2	School 3
Total number of first graders	65	44	62
Number of participating first graders	50	15	10
% of students eligible to receive free or reduced price lunch	58	3	28
Ethnicity (%)			
Asian or Pacific Islander	1	4	1
African American	2	1	1
Native American	4	1	1
Hispanic	5	1	5
White	88	93	92

a. Based on information reported by participating school districts.

the sounds in the word *cat*, with the correct response being /c/ /a/ /t/. Immediately after the student responds, another three- or four-phoneme word is presented. The number of correct phonemes produced in 1 minute is the final score. Twelve alternate forms of the PSF measure were used in the study. The alternate-form reliability of a single probe for this task is .88, with a multiple probe (e.g., three probes) reliability of .96 (Good, Gruba, & Kaminski, 2002). The concurrent criterion-related validity with the *Woodcock-Johnson Psycho-Educational Battery Total Reading* cluster score is .54, and with the Metropolitan Readiness Test it is .65. The predictive criterion-related validity for the PSF measure is .62 with the *Metropolitan Readiness Test* and .68 with the *Stanford Diagnostic Reading Test*.

The NWF measure was used to measure participating children's emerging alphabetic principle skills at the start and conclusion of the study. On the NWF measure, the student is presented an 8.5 in. × 11 in. sheet of paper with randomly ordered vowel–consonant and consonant–vowel–consonant nonsense words (e.g., *tob*, *siv*, *ov*) and asked to produce aloud the sounds of each letter in the word or read the whole word. For example, for the stimulus word *tup*, the correct response would be /t/ /u/ /p/, or "tup." The total number of correct letter–sounds produced in 1 minute is the final score. Two alternate forms of the NWF task were used in the study. The alternate-form reliability is .92 for a single probe for this task, and it is .98 for multiple probes (e.g., three probes; Good, Gruba, et al., 2002). The concurrent criterion-related validity of the NWF task is .59 with the PSF task, and predictive criterion-related validity is .66 with the *Woodcock-Johnson Psycho-Educational Battery Total Reading* cluster score and .82 with *Oral Reading Fluency* measures (Good, Gruba, et al., 2002).

Independent Variables

Two independent variables were examined in this study: (a) SES status of students' families and (b) instructional program.

SES. Parents of participating students completed a brief family survey regarding family income, education, and occupation to describe and verify group differences in SES. The *Nam-Powers Socio-Economic Status Scores* measurement system (Nam & Terrie, 1993) was used to form an SES composite based on the survey information. The Nam-Powers uses occupational scores derived from 1990 U.S. Census Bureau information on (a) the median educational and income levels of occupations and (b) the number of persons engaged in each occupation. Income and education scores were derived from 1981 U.S. Census Bureau information. Mean occupation, income, and education scores for each group in the study were calculated.

Instructional program. Instruction consisted of two conditions: ELI and math instruction (MI). Instruction was delivered over 10 consecutive weeks in addition to the reading and MI implemented in each participating classroom. Participants in the ELI group received explicit ELI 4 days a week for 20 to 25 minutes per day based on the *Phonemic Awareness in Young Children* instructional program (Adams, Foorman, Lundberg, & Beeler, 1997). Specific skills targeted in daily lessons included detection of initial and final phonemes, phoneme segmentation and blending, phoneme counting, adding and subtracting initial and final phonemes, and letter–sound correspondence. Daily lessons were scripted and organized around the principles of effective instructional design (Simmons, Kame'enui, Coyne, & Chard, 2006), including signaling, precorrection, concrete representations, introduction of a limited number of phonetically similar new phonemes and letter–sounds in each lesson, daily practice across a range of examples, and cumulative review. Instructional groupings and skill emphases were modified based on weekly individual progress monitoring data. The researcher met weekly with intervention implementers to share progress-monitoring data and modify instruction as needed. Approximately 80% of instructional activities were spent on increasing onset recognition, phoneme segmentation, and blending skills. Skills in letter–sound correspondence accounted for approximately 20% of instructional effort. Six groups of 3 to 7 children composed the ELI group.

Participants in the MI comparison condition received early math skills instruction 4 days a week for 20 to 25 minutes per day using the *Connecting Math Concepts, Level A* (Engelmann, Carnine, Kelly, & Engelmann,

1996) program. Providing beginning MI gave children in the comparison condition the opportunity to acquire important math skills while participating in the study as controls. In addition, instructional effects could be attributed to the implemented reading-focused instruction and not to the additional time, energy, and attention the children in the ELI group received. Three groups of 4 to 12 children composed the MI condition.

Procedure

The study was conducted over 12 weeks at the beginning of the school year in September. Data were collected on all participating children at both the intervention and comparison school sites. Prior to the start of the intervention (Week 1), all participants were administered the PSF and NWF tasks. During the intervention phase (Weeks 2 to 11), the early literacy skills of all participants were measured weekly using an alternate PSF probe. Weekly PSF data were used for grouping and guiding instructional activities only for those children in the ELI condition. At the end of the intervention phase (Week 12), all participants were administered one alternate PSF and NWF probes.

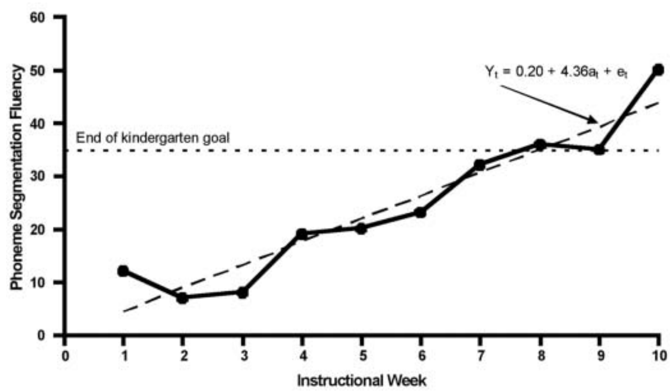
Training of Interventionist and Data Collectors

Six graduate students in school psychology were trained prior to the start of the study to deliver early literacy or beginning MI. Each graduate student had experience working with young children, and five of the six graduate students had received training and completed practicums in delivering scientifically based reading instruction. The interventionists were observed daily during the early phase of the study and twice weekly during the later part of the study to ensure fidelity of treatment. Data collectors responsible for administering the PSF and NWF tasks were trained during two 2-hr sessions that included demonstrating and practicing the administration and scoring of the measures. Data collectors consisted of five graduate students in school psychology and one person in the community trained in education and psychology. Reliability of scoring was determined by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. Interobserver agreement for all measures prior to data collection was 90% to 100%, and follow-up interobserver agreement at Week 5 remained above 90%.

Results

Hierarchical linear modeling (HLM) was used to examine the effects of data-based ELI on the acquisition

Figure 1
Ordinary Least Squares Growth Trajectory for Participant 104 Based on 10 Repeated Assessments Over 10 Weeks of Instruction



of early literacy skills using the PSF measure. HLM procedures provided an estimate of each child's slope of learning of early literacy skills over the duration of the intervention, allowing a between-groups comparison of children's acquisition of early literacy skills. Data analysis was conducted using the HLM/2L program (Bryk, Raudenbush, & Condon, 1996). A growth trajectory for each participating student in the study was specified using a Level 1, within-person model. Under a linear individual growth model, a growth curve was fit for each student (i) as follows:

$$Y_{ti} = \pi_{0i} + \pi_{1i}a_{ti} + e_{ti}$$

Here, Y_{ti} is the PSF score for individual i at a particular time t. For student i, initial status or growth trajectory intercept is represented by π_{0i} and his or her rate of acquisition or slope is π_{1i}. The intercept was set at the student's preintervention baseline performance. Intervention week for person i at time t is a_{ti}, and e_{ti} is random error. For example, for Participant 104, the estimated Level 1 model displayed in Figure 1 is

$$Y_t = 0.20 + 4.36a_t + e_t$$

Participant 104, who started with very low phoneme segmentation skills, obtained a rate of acquisition 4.36 phonemes per week with the implemented intervention.

Descriptive statistics for the predictor variables, growth trajectory intercepts, and slopes for each group are provided in Table 2. The low-SES intervention group and low-SES control group were not significantly different on

Table 2
Descriptive Statistics for Predictor Variables and Growth Parameters

	Low-SES Intervention[a]				Low-SES Control[b]				High-SES Comparison[c]			
Variable	*M*	*SD*	Min.	Max.	*M*	*SD*	Min.	Max.	*M*	*SD*	Min.	Max.
Initial PSF	17.12**	12.69	0	48	21.58**	16.02	0	58	35.68	15.76	3	61
Initial NWF	15.54*	11.20	0	52	14.83*	10.52	0	35	27.56	18.73	0	97
SES	56.78**	18.82	11	96	59.29**	22.13	16	95	83.44	10.16	49	96
Growth intercept	22.04	15.68	7.10	50.73	24.23	15.12	–3.27	45.13	39.11	13.99	2.11	57.86
Slope of growth	3.33	1.52	0.44	5.46	1.23	1.80	–1.10	4.44	1.53	1.49	–0.68	4.93

Note: SES = socioeconomic status; PSF = Phoneme Segmentation Fluency; NWF = Nonsense Word Fluency. Growth trajectory parameters are based on ordinary least squares estimates.
a. $n = 26$.
b. $n = 24$.
c. $n = 25$.
*$p < .05$. **$p < .01$.

any of the predictor variables, including initial PSF and NWF, and SES. Thus, random assignment of students within each class was effective in creating similar groups. Both low-SES groups were significantly different from the high-SES control group on SES level as measured by each school's report of students receiving free and reduced price lunch and initial PSF and NWF, indicating that there were clear differences in literacy and economic status between the low- and high-SES groups.

The mean slope of growth for each group is reported in Table 2, and the growth trajectories for each group are illustrated in Figure 2. The mean slope represents the average increase in phoneme segmentation skills per week for each group. The low-SES intervention and control groups possessed similar initial phonological awareness skills, and neither group had achieved the kindergarten goal of 35 to 45 phonemes per minute on the PSF task (Good, Simmons, Kame'enui, Kaminski, & Wallin, 2002) at the beginning of the intervention. As expected, participants in the high-SES comparison group had met and, on average, surpassed the end-of-kindergarten goal on the PSF task at the beginning of first grade. During intervention, the rates of acquisition of phonological awareness skills for participants in the low-SES control group and high-SES comparison group were similar. This result was expected because participants in the high-SES comparison group began the study already possessing PSF goal levels, as hypothesized based on previous research supporting the premise that children from middle- to higher-SES communities are more academically prepared than are children from lower SES communities. Similarly, participants in the low-SES control group possessed low PSF skills at the beginning of the study and, because they did not receive explicit instruction in this skill, continued to have lower PSF skills at the end of the study. The rate of acquisition of phonological awareness skills (as measured by DIBELS PSF) for students in the low-SES intervention group was more than double the growth rates of the control and comparison conditions. Thus, the PSF task was effective in modeling growth of phonological awareness for children receiving data-based ELI. As indicated, children in the high-SES comparison group had achieved sufficient phonological awareness skill at the beginning of first grade prior to intervention; thus, little to no acquisition of phonological awareness was expected, and the PSF task successfully measured this outcome. For children in the low-SES control group who did not receive the ELI, a flat slope on PSF was indicative of these students not reaching outcome levels of phonological awareness predictive of reading success.

ANCOVA was used to examine the impact of the implemented ELI and subsequent growth in alphabetic skills as measured by the NWF task. Participants' initial NWF skills were used as a covariate to adjust NWF posttest scores. Results on NWF pre- and posttest intervention scores are displayed in Table 3. Because of a nonsignificant interaction effect, a full model was used to test the effects of group on NWF posttest skills. A significant effect was present for NWF at pretest, $F(1, 71) = 94.98$, $p < .01$, indicating that pretest performance on the NWF measure was related to posttest performance. Main effects for group were examined indicating a significant group effect on NWF posttest scores, $F(2, 71) = 3.26$, $p = .05$, and moderate to large effect size .084. However, planned comparisons showed no significant differences between the low SES intervention group and low SES control group, $p = .49$. Significant differences were not found between the low-SES intervention group and high-SES comparison groups, $p = .064$. As shown in Table 4, adjusted NWF posttest scores for the two low-SES groups

Figure 2
Growth Trajectories for Higher SES Comparison Group, Lower SES Control Group, and Lower SES Intervention Group

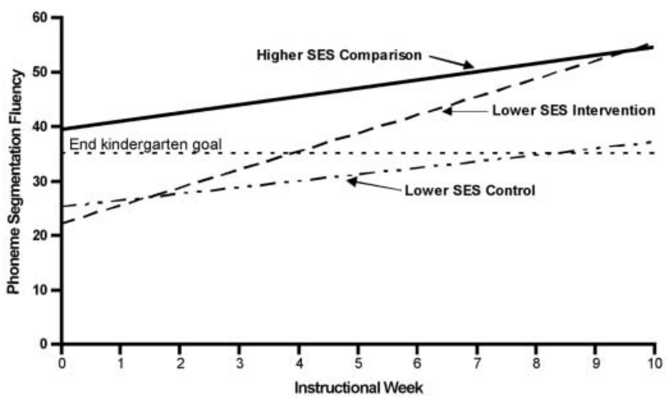


Table 3
Analysis of Covariance of Nonsense Word Fluency (NWF) Posttest Scores

Source	*df*	SS	MS	*F*
NWF pre	1	8949.85	8949.85	93.14
Group	2	730.89	365.45	3.80**
Low-SES intervention vs. low-SES control[a]	1	97.44	97.44	1.01
Low-SES intervention + low-SES control vs. high-SES control[b]	1	649.75	649.75	6.76*
Error	70	6726.30	96.09	
Total	73	15914.99		

Note: SS = sum of squares; MS = mean square; SES = socioeconomic status.
a. Contrast 1 planned comparison is between the low-SES intervention and low-SES control conditions.
b. Contrast 2 planned comparison is between the low-SES intervention and control conditions and the high-SES control condition.
$^*p < .05$. $^{**}p < .01$.

were similar and estimated to be higher than the high-SES group mean because of both groups' growth in letter–sound correspondence, as measured by the NWF task. However, because participants' skills in letter–sound correspondence, or alphabetic principle, in both the experimental and control groups increased, conclusions regarding the effectiveness of the NWF task to detect learning because of the implemented early literacy intervention are tentative. Alternative explanations regarding the absence of intervention effects on alphabet principle skills as measured by the NWF task are provided in the discussion.

Table 4
Nonsense Word Fluency (NWF) Means, Standard Deviations, and Adjusted Means by Group

Measure	Low-SES Intervention Group	Low-SES Control Group	High-SES Control Group
n	26	24	25
NWF pre			
M	15.54	15.43	27.56
SD	11.20	10.33	18.73
NWF post			
M	31.69	33.08	35.96
Adjusted *M*[a]	34.93	37.75	29.55
SD	13.07	13.87	18.25

a. Adjusted means are adjusting for each student's initial NWF score.

Discussion

The research literature has consistently reported that children from low-SES backgrounds typically have lower achievement and, consequently, require supplemental instructional services to meet grade-level standards. Formative assessment instruments are needed to inform intervention planning and provide service providers (e.g., school personnel, local education agencies, state and federal departments of education) with reliable and valid data regarding the effectiveness of their efforts. The findings of this study support the conclusion that utilizing the PSF task from the DIBELS measurement system to inform instructional planning resulted in increased phoneme segmentation skills, a phonological awareness skill important to learning to read. Children who received the data-based ELI had a positive slope of learning of phoneme segmentation skills and by the end of the intervention possessed skills similar to those of the high-SES comparison group. Notably, 96% of the students receiving the ELI attained goal outcome levels on the PSF task, compared to 64% of children in the low-SES group who did not receive the ELI. Not surprising, some students acquired phoneme segmentation skills regardless of direct intervention. However, growth, as measured by the PSF task, was not as steep or pervasive as that of children who received the robust and data-based early literacy intervention. Thus, the PSF task effectively modeled expected growth of students at risk for learning problems who received intervention (e.g., ELI group) and those who did not receive intervention (e.g., MI control group) and students who were not considered at-risk and did not receive intervention (e.g., high-SES comparison group).

When examining the effectiveness of the NWF task in measuring growth in alphabetic principle skills, both low-SES groups showed gains in alphabetic principle skills at the end of the intervention. One possible explanation for this outcome is the minimal amount of intervention time (20%) devoted to instruction in alphabetic principle skills. The difference in exposure to letter–sound instruction between the two low-SES groups was small and likely did not have a significant impact on the alphabetic principle skills of children in the intervention group. Another explanation may be that the children in these two groups were receiving concentrated instruction in alphabetic principle skills in their general classroom program. If that was the case, the NWF task effectively measured growth in this area for both groups. It is evident from the NWF pretest data that both low-SES groups scored significantly below recommended levels of letter–sound correspondence as measured by the NWF tool; thus, it is likely that beginning reading instruction included a significant amount of instruction in alphabetic principle.

Because of study limitations, results should be interpreted with consideration of threats to external and internal validity. Participants in this study were predominately White and English speaking, residing in a small city. Thus, participants may not be representative of, and conclusions may not generalize to, persons from non-White ethnic and racial backgrounds who are non–English speaking. Although participants in this study were purposely chosen based on their SES and statistical procedures confirmed that significant SES differences were evident between the low- and high-SES participants, children in the low-SES groups may not have adequately represented all children from low-SES backgrounds. Family questionnaires revealed that some low-SES participants lived in middle-income homes, with at least one parent completing 1 or 2 years of college. Thus, the low-SES groups may not well represent children from disadvantaged backgrounds who are of primary concern for narrowing the achievement gap. Future studies should include participants from similar low SES levels and different ethnic, racial, and linguistic backgrounds to more adequately reflect all children from lower SES environments.

Implications of the study's findings on educational practice are that a technology exists for monitoring, informing, and evaluating the effectiveness of implemented interventions targeting important early literacy skills, and utilizing these data results in increased student outcomes. Specifically, evidence for the intervention validity of the DIBELS PSF task is compelling with regard to utilizing PSF data to inform instructional content. Whether similar results would have occurred if PSF data were not used to inform instruction is not known. Thus, future research is needed to explicitly examine whether using PSF data for program planning purposes compared to not using PSF data with children receiving early literacy interventions results in increased literacy skills. However, considering recent legislation mandating the provision of effective supplemental services and an emphasis on a RTI approach to intervening with struggling learners, local education agencies are in need of reliable and valid formative evaluation tools to implement and monitor federally funded programs and services. Thus, based on the study's findings, the DIBELS PSF measure appears to effectively and efficiently monitor student progress, and the utilization of these data led to increased student outcomes.

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