Exceptional Children

Vol. 78, No. 1, pp. 7-23.

Early Numeracy Intervention Program for First-Grade Students With Mathematics Difficulties

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ABSTRACT: *The purpose of this study was to determine the effects of an early numeracy preventative Tier 2 intervention on the mathematics performance of first-grade students with mathematics difficulties. Researchers used a pretest-posttest control group design with randomized assignment of 139 students to the Tier 2 treatment condition and 65 students to the comparison condition. Systematic instruction, visual representations of mathematical concepts, purposeful and meaningful practice opportunities, and frequent progress monitoring were used to develop understanding in early numeracy skills and concepts. Researchers used progress-monitoring measures and a standardized assessment measure to test the effects of the intervention. Findings showed that students in the treatment group outperformed students in the comparison group on the progress-monitoring measures of mathematics performance and the measures that focused on whole-number computation. There were no differences between groups on the problem-solving measures.*

With the reauthorization of the Individuals With Disabilities Education Act (IDEA, 2004; Public Law 108-446), states are implementing a response-to-intervention (RTI) process as a way to identify students with learning difficulties at a young age and provide intervention services to prevent future learning disabilities. A multitiered prevention and intervention model that includes universal screening, validated interventions, and ongoing monitoring of student response to instruction is one means for operationalizing RTI to identify those students who are most in need of intensive intervention (Vaughn, Wanzek, & Fletcher, 2007). A multitiered approach to early reading intervention is widely implemented across school districts nationwide (Vaughn, Wanzek, Woodruff, & Linan-Thompson, 2007). Equally important is the development and validation of Tier 2 intervention protocols as part of RTI early mathematics instruction. Educators must have access to validated, preventative early mathematics Tier 2 interventions to implement the RTI model with students who manifest mathematics difficulties.

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EARLY MATHEMATICS TIER 2 INTERVENTION

Recommendations from the National Mathematics Advisory Panel (NMAP; 2008) underscore the importance of providing early intervention that employs effective instructional practices, for at-risk students. For early mathematics interventions, research results are beginning to inform an understanding of the types of instructional practices and intensity of interventions that contribute to mathematics performance. Studies of the effects of Tier 2 mathematics interventions on the mathematics performance of at-risk first-grade students have produced findings that have implications for the design and delivery of interventions. For example, in one study, Bryant, Bryant, Gersten, Scammacca, and Chavez (2008) delivered mathematics intervention in small groups 3 to 4 days per week for 15 min per session for 18 weeks (total of 1,080 min and 72 sessions). The intervention focused on number concepts and operations such as quantity, counting, numerical sequencing, basic facts, and place value concepts. Although students' performance in small groups indicated that they understood the concepts, the study found no significant effect for first-graders (n = 26 Tier 2 students) on the mathematics progress monitoring measures. The authors hypothesized that students did not have sufficient daily time to practice the fundamental numeracy concepts to show significant findings on the fluency measures.

In a follow-up study, Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008) designed a first-grade mathematics intervention that focused on early numeracy concepts and operations, which were similar to those taught in the earlier study. The follow-up study included a longer duration that consisted of 20-min sessions 4 days a week for 23 weeks (total of 1,840 min and 92 sessions); thus, more practice opportunities across the school year were built into the revised intervention as a function of increased intervention time. Results showed a significant effect for Tier 2 intervention for first-grade students (n = 42).

In yet another first-grade study, Fuchs et al. (2005) identified 127 students, from a pool of 564 first graders, as being at risk for mathematics difficulties based on scores from a set of screening measures. The identified students received small group tutoring 3 times per week for 16 weeks with 30 min devoted to numeracy concepts and 10 min to addition and subtraction facts using computer-assisted instruction (CAI; total of 1,440 min for early numeracy intervention and 480 min to develop fact fluency using CAI 48 sessions). Topics for the tutors were almost exclusively related to number concepts and operations. Results showed that at-risk students in the treatment group demonstrated performance that was statistically significantly better than that of the at-risk control group on a standardized measure of concepts and applications and story problems. On the addition and subtraction fact fluency measures and a standardized measure of applied problems, however, the treatment and control at-risk groups scored comparably.

Finally, Fuchs et al. (2006) focused on the efficacy of CAI for developing addition and subtraction fluency. Students worked on the computer on fact retrieval for 50 sessions of 10 min each (total of 500 min) over 18 weeks. The study found a significant effect for addition number combinations on a fact-fluency retrieval but no effect for subtraction fluency or transfer of learning to word problem solving. These authors recommended using a stronger instructional design that focused on formatting problems vertically, including more pictorial representations, and having students practice number combinations with paper-pencil and flash cards to promote transfer from computer to pencil and paper.

PERFORMANCE OF YOUNG STUDENTS WITH A MULTITIERED APPROACH

Continued research is needed to investigate mathematics interventions for struggling students—interventions that consist of the critical features of instructional design, including sufficient time for students to learn early numeracy concepts and operations. The purpose of this study was to determine the effects of an early numeracy preventative Tier 2 intervention on the mathematics performance of first-grade students with mathematics difficulties. We were also interested in determining whether Tier 2 students with mathematics difficulties generalized (transferred) their learning in early numeracy concepts, which we taught, to distal measures (i.e., progress-monitoring measure and a standardized achievement test). The following questions and hypotheses guided our research:

1. Did students receiving the early numeracy Tier 2 intervention demonstrate improved performance on timed progress monitoring measures of early numeracy mathematics, closely aligned to intervention curricula, when compared to students receiving "business as usual" mathematics instruction with no particular intervention? We hypothesized that students in the treatment group would outperform students in the "business as usual" comparison group.
2. Did students receiving the early numeracy Tier 2 intervention demonstrate improved performance on a distal progress monitoring measure of problem solving and mixed whole number computation on a distal standardized measure (problem solving and procedures [mixed whole-number computation]) of mathematics when compared to students receiving "business as usual" mathematics instruction? We hypothesized that students in the treatment group would outperform students in the business-as-usual comparison group on the mixed whole number computation distal measures because our intervention included a strong computation component. We also hypothesized that there would be no differences between groups on the distal problem-solving measures because we did not directly teach the skills and concepts (mathematical ideas; domains) measured on the problem-solving tests.

METHOD

Participants and Research Design

Sampling Procedures, Risk Assessment, and Power Analyses. Two main considerations drove sample selection: (a) maintaining sufficient power and (b) reliably assessing risk. Of the initial pool of students (N = 771), the lowest 35% (n = 269) was identified as being "at risk" based on an initial administration of the Texas Early Mathematics Inventories-Progress Monitoring measures (TEMI-PM; University of Texas System & Texas Education Agency, 2007b; refer to the "Measures" section of this article for further details about this test) in the fall (September). Of the 269 students, 31 were omitted from consideration because of disabilities. Students with disabilities were omitted from the sample because the intervention did not provide the level of individualized, intensive instruction that is often required to help these students master mathematics concepts and skills.

For the remaining students (n = 238), we administered four additional TEMI-PM probes (alternate forms of the original measure used for student selection) over a 3-week period to determine whether there were false positives among the initial pool of students. False positives are a particular concern given the generally "chaotic" nature of early achievement and the increased possibility of falsely identifying students as being "at risk" when they were merely distracted, anxious, or unfamiliar with the testing protocols.

Growth modeling (with continuous outcomes and auto-correlated residuals) was used to estimate case-level factor scores for intercept and slope for each of the 238 cases using PLUS 4.1 (preliminary analyses suggested a statistically significant positive trend in scores over time, on average; thus, a growth model approach was preferred over a confirmatory factor model). We conceptualized intercept as the last of the four additional TEMI-PM measures (beyond the TEMI-PM used to initially identify the lowest 35%). Estimated time 4 scores were used to make final sample selection. The cut score was selected based on the probabilities of diagnostic accuracy (i.e., likelihood ratio [LR]) derived using receiver operator curve (ROC) analysis. Using this procedure, we found 14 students to be false positives and eliminated them from the sample.

A concern with accuracy and the need to maintain an adequate sample size both influenced our sampling strategy. Preliminary power analyses suggested a sample size of 240, with 160 in the treatment condition and 80 in the comparison group. The initial pool of eligible students was only 238, so our strategy was to identify students who clearly were *not* at risk, based on their estimated score at time 4 and a conservative risk threshold (LR: negative of .70). The final sample (n = 224: 151 treatment and 73 control) identified for treatment and control conditions was associated with a minimal detectable effect size of approximately .40, assuming .80 power and 45 instructional groups with five students in each group. Simple random assignment of students to condition was completed using a random number generator in Statistical Analysis Software. The research design was a pretest-posttest control group design.

Setting and Demographics. Students in this study attended 10 elementary schools in a suburban central Texas community. Like any school district, the geographic location of the schools influenced the demographic characteristics of the student population. Our schools included diverse student populations where some schools had larger percentages of students who received free or reduced-price lunch; these were the schools in which we typically had more students qualifying for the intervention and thus more intervention groups of students. The number of intervention groups ranged from 2 (three schools) to 6 (two schools). We had 3 groups in three schools, 4 groups in one school, and 5 groups in another school. We obtained demographic characteristics of the sample from the school district. For the treatment group, 50.4% of the students were classified as economically disadvantaged based on free or reduced-price lunch data. For the comparison group, 52.3%% were considered economically disadvantaged. In the treatment group, 43.9% of the students were male and 56.1% were female: 26.6% were African American, 33.0% were Hispanic, 36.6% were White, and 3.6% were Asian/Pacific Islander. In the comparison group, 55.4% of the students were male and 44.6% were female: 21.5% were African American, 40.0% were Hispanic, 32.3% were White, and 6.2% were Asian/Pacific Islander.

Attrition. At the end of the school year, the sample included 204 first-grade students. Twenty-one students (Treatment = 12 treatment [13% of the treatment group] and 9 comparison [8% of the comparison group]) moved away from the district for various reasons during the academic year, leaving 204 students: 65 students in the comparison group and 139 students in the treatment group. The demographic percentages shown in Table 1 are for the postattrition sample.

MEASURES

Screening and Progress Monitoring Measures. Our screening and progress-monitoring measure, the TEMI-PM, includes four group-administered subtests. Magnitude Comparisons (MCs) assesses a student's ability to differentiate the smaller value of two numerals displayed side by side. For first-grade students, numerals range from zero through 99, with difficulty increasing as students move through items. On Number Sequences (NSs), respondents are presented with two numerals and a blank space indicating the missing third numeral (e.g., ___ 18 19). The number of correctly identified missing numbers represents the raw score. Place value (PV) uses a format similar to that used in many early math textbooks (e.g., Addison-Wesley Scott Foresman). Students are presented with figures depicting tens and ones (e.g., the number 34 is represented by three vertical stacks of 10 squares and four single squares) and asked

TABLE 1

Demographic Characteristics for the Treatment and Comparison Groups

Characteristic	*Treatment* (n = *139)*	*Comparison* (n = *65)*
Ethnicity		
African American	26.6%	21.5%
Asian	3.6%	6.2%
Native American	—	—
Hispanic	33%	40%
White	36.6%	32.3%
Gender		
Male	43.9%	55.4%
Female	56.1%	44.6%
ELL		
Yes	5%	9.2%
No	94.9%	90.8%
Free/Reduced-Price Lunch		
Neither	49.6%	47.7%
Free/reduced-price lunch	50.4%	52.3%

Note. ELL = English language learner.

to select their response from four options. Addition/Subtraction Combinations (ASCs) addresses young students' knowledge of addition and subtraction facts from zero through 18. Items appear eight to a row, with five rows in all. Each row contains four addition problems and four subtraction problems. For all of the subtests, students have 2 min to write answers to as many items as possible. The number of correct responses represents the raw score. More complete descriptions of the measures, along with evidence of their reliability and validity, can be found in Bryant, Bryant, Gersten, Scammacca, and Chavez (2008) or Bryant, Bryant, Gersten, Scammacca, Funk et al. (2008).

Outcome Measures. We administered the Stanford Achievement Test-Tenth Edition (SAT-10; Pearson, 2003) as one of the distal outcome measures to all students. The mathematics portion of the SAT-10 includes the Mathematics Problem Solving (MPS) and Mathematics Procedures (MP) subtests in Grade 1 with items that assess numeration, numerical sequencing, measurement, statistics, problem solving, and computation. A composite score (Total Mathematics) is also available. In the fall, students in Grade 1 are administered the Stanford Early School Achievement Test 2 level, and in the spring, students are administered the Primary-1 level. In the current study, the SAT-10 mathematics subtests yielded internal consistency reliability coefficients that exceeded .80. The total score internal consistency reliability coefficient exceeded .90.

The Texas Early Mathematics Inventories-Outcome (TEMI-O; University of Texas System & Texas Education Agency, 2007a) is a group-administered problem-solving and whole-number computation measure. The TEMI-O was considered to be a distal outcome measure because it assesses all of the state's standards for first-grade instruction (our intervention focused only on the number and operation standards). The TEMI-O is composed of two subtests: Mathematics Problem Solving (MPS) and Mathematics Computation (MC). The MPS contains 39 items that assess number, operation, and quantitative reasoning; patterns, relationships, and algebraic thinking; geometry and spatial reasoning; measurement; probability and statistics; and underlying processes and mathematical tools. Teachers read aloud the stimulus item prompts, one at a time. The last response choice for each item is "Not Shown," which increases the complexity of the item. The MC subtest contains

30 items that assess whole-number computation skills. Students are given 25 min to complete the items. The TEMI-O Total Score reliability, as estimated using coefficient alpha, was .86 for Form A, .90 for Form B, and .92 for Form C. Examination of concurrent criterion-related validity was conducted by correlating TEMI-O Total Scores with the Total Scores obtained by students on the SAT-10 and by estimates of student mathematics abilities, as rated by their teachers. The coefficient for the SAT-10 and Form A for the TEMI-O Total Score was .61; teacher ratings correlated with TEMI-O Total Scores at .61. Both coefficients reflect positively on the validity of the TEMI-O scores.

We used the TEMI-PM as the proximal fluency progress-monitoring measure to answer research Question 1 because of the assessment's alignment with the interventions and the first-grade curriculum in the school district. To answer research Question 2, we used the SAT-10 and the TEMI-O as distal outcome measures because they assess mathematical problem solving, which we did not directly teach, and mixed whole-number computation. Although we taught whole-number computation, we did not assess these skills in a mixed format.

PROCEDURES

Assessment Procedures

Screening and Benchmark Testing. The TEMI-PM (screening) and TEMI-O were administered in the fall (September), winter (February), and spring (May) by 50 first-grade classroom teachers to intact classrooms of students who returned signed, affirmative permission slips, in line with Institutional Review Board (IRBs) procedures. Testing occurred over 3 consecutive days; each session lasted approximately 45 min. We used the TEMI-PM as the initial screening measure to identify students who scored below the 35th percentile. To this pool of students (N = 238), the project staff administered four additional alternate forms of the TEMI-PM probes to continue the identification process. The project staff administered the SAT-10 to intact classes in May. The test was administered across 2 days, with the Mathematics Procedures subtest given the first day and the Mathematics Problem Solving given the next day.

Training. For the research team, the project and assessment coordinators conducted a half-day training session on all measures. Administration procedures for each of the measures were presented and modeled. The research team had time to practice the administration procedures under the direction of the project coordinators. The research team included two full-time intervention coordinators and five graduate research assistants (GRAs) who were doctoral and master's students in the Department of Special Education; all of the GRAs held teaching credentials or were completing a teaching certification program. This research team was also responsible for conducting the intervention. The purpose of this training was to ensure that the staff was prepared to train the classroom teachers and to conduct observations of assessment fidelity.

For the 50 first-grade classroom teachers, the two intervention coordinators provided a 1-hr training. Teachers were provided with materials for conducting the assessments and with "prompt" materials (e.g., tips for administration) to ensure fidelity of test administration. Training sessions occurred at the beginning of the academic year, with 1-hr refresher trainings conducted after school or during preparatory periods before test administration in the winter and spring.

Fidelity of Assessment Administration. First-grade classroom teachers administered the TEMI-PM and TEMI-O assessments over 3 days in the fall, winter, and spring of the academic year. For each of the 3 days of testing, the research team conducted fidelity checks by randomly choosing 10 of the 50 first-grade teachers (total n = 30) for observations. Interrater agreement results for teacher fidelity were 91.7% in the fall, 97.2% in the winter, and 97.2% in the spring.

Early Numeracy Intervention: Treatment Procedures

Intervention Training. At the beginning of the academic year, the principal investigator provided a 3-hr training on the intervention lessons and accompanying instructional materials. This training consisted of an explanation of the content and review and modeling of systematic instruction. Following this training, the research team practiced the lessons with one another. Before intervention, the tutors taught a lesson and received feedback from experienced tutors who were using the same lessons with a group of students. Throughout the school year, training sessions were conducted before each intervention unit (seven total sessions).

Description of the Intervention. The early numeracy intervention program focused on number and operation mathematical ideas, including problem solving, that were drawn from prominent sources on mathematics instruction (e.g., Clements & Sarama, 2009; *Curriculum Focal Points for Prekindergarten Through Grade 8 Mathematics,* National Council of Teachers of Mathematics, NCTM, 2006; NMAP, 2008; National Research Council, NRC, 2009). Our goal was to help young students engage in activities to promote conceptual, strategic, and procedural knowledge development for number and operation concepts and skills. We included activities that related to counting (e.g., counting sequence, counting principles), and number knowledge and relationships (e.g., comparing the magnitude of numbers and quantity and ordering or sequencing numbers). We also included activities that focused on partitioning and grouping of tens and units (e.g., part-whole, compose and decompose numbers), which prepare students for work in place value and the base-10 system in later school years. Finally, early numeracy instruction should also include activities to help students develop a conceptual understanding of addition and subtraction and the mathematical properties that can be used to solve arithmetic combinations. To that end, we provided numerous opportunities for students to learn about combining and separating sets and working with basic facts (e.g., part-part-whole; fact families; related facts). See Table 2 for more information about the mathematical ideas taught in the intervention.

There were 11 units of instruction; each unit included 8 days of lessons. Each instructional day included a warm-up and two scripted lessons. The warm-up was 3 min and consisted of fluency activities on previously taught skills (e.g., reading and writing numerals within a certain range, practicing addition and subtraction facts). Each of the two daily lessons was 10 min in length. Time was allowed to transition between lessons after independent practice for the lesson. The lessons focused on developing conceptual knowledge by the teacher's "thinking aloud" to demonstrate how to solve problems and by the teacher and students' using concrete (e.g., base-ten models, connecting cubes) and visual representations (e.g., number lines, ten frames, hundreds charts, fact cards) to model problems and show relationships (Gersten, Chard et al., 2009). Students also learned specific cognitive strategies (e.g., count on, doubles + 1, make 10 + more, fact families) as a way to solve different types of problems more efficiently (Clements & Sarama, 2009; Woodward, 2006).

The instructional design of the lessons included the critical features of systematic intervention that have been validated in numerous studies with struggling students (e.g., Swanson, Hoskyn, & Lee, 1999). The features included a teaching routine consisting of modeling, guided practice, and independent practice (progress monitoring); error correction procedures; pacing; opportunities for meaningful practice (e.g., with visual representations); examples; and review. Daily progress monitoring was conducted where students were given a short amount of time to work independently to solve problems that were the focus of instruction. Number correct and incorrect were entered into a daily check-up sheet and examined to determine student progress. At the conclusion of each unit, a unit check was conducted on representative items across the lessons taught in the unit. These data were graphed for examination of student response to the intervention.

Behavior Management System. The behavior management system was an interdependent group-oriented contingency system (Litow & Pumroy, 1975); that is, all of the students of the tutoring group had to meet the criterion (i.e., be "Math Ready") of the contingency before earning reinforcement (Cooper, Heron, & Heward, 2007). Math Ready consisted of five behaviors: eyes on the teacher, listening, ready to learn, mouth quiet (no off-task talking), and hands on table. The expected behaviors were taught to students at the beginning of the year and reviewed after breaks (e.g., winter break). Students were expected to demonstrate these behaviors at the

TABLE 2

Early Numeracy Curriculum

- Counting: rote, Counting up/back
- Number recognition and writing: 0–99
- Comparing and grouping numbers
- Number relationships of more, less
- Relationships of 1 and 2 more than/less than
- Part-part-whole relationships (e.g., ways to represent numbers)
- Numeric sequencing (ordering)
- Making and counting: Groups of tens and ones
- Using base-ten (2 tens, 6 ones) and standard language (26) to describe place value
- Reading and writing numbers to represent base-ten models
- Counting and decomposition strategies (e.g., addition: count on [+ 1, + 2, +3], doubles [6 + 6] doubles + 1 [6 + 5], make 10 + more [9 + 5]; subtraction: count back/down [–1, –2, –3]); fact families
- Properties of addition (commutativity and associativity)

beginning of the day's lessons and during the lessons, as appropriate (e.g., obviously, "hands on table" was not expected while students were engaged in activities). The math tutor used 5 to 10 marbles to intermittently reinforce the group when they were exhibiting Math Ready behaviors during the day's lessons. If the students earned all of the marbles, they were rewarded with stickers and small items such as pencils or pencil erasers. Students were reminded to be Math Ready at the beginning of each day's lessons and during transitions (e.g., between lessons, during materials distribution).

Tutoring Program. Tutoring sessions occurred 4 days per week for 25 min per session across 19 weeks (total of 1,900 min and 76 sessions). Small groups of three to five students at each of the 10 schools were formed based on the beginning-of-the-year scores from the TEMI-PM assessment and teachers' schedules. Students who qualified for the treatment condition were pulled from one to six classes per school. Thus, tutoring groups were formed based as much as possible on assessment results but also on classroom teachers' schedules. However, due to scheduling issues in individual classrooms, some groups had to change to accommodate teachers' requests (these changes occurred two to four times during the year depending on the school). Other changes in groups occurred during the year due to behavior concerns and ability levels (these changes occurred two to five times). A trained tutor from the research team delivered the intervention daily in whatever setting each school could find for small group daily intervention. Thus, tutoring occurred in a classroom, in a library, on a stage, and in the book room.

Fidelity of Treatment Implementation and Nature of Comparison Services

Fidelity of Implementation. Each tutor was observed for three sessions during the 19-week intervention to assess the quality (i.e., fidelity) of specific implementation performance indicators. Quality of Implementation (QoI) indicators included the degree to which tutors did the following:

- Followed the scripted lessons (e.g., modeling, guided practice, independent practice).
- Implemented the features of explicit, systematic instruction (e.g., pacing, error correction).
- Managed student behavior (e.g., use of reinforcers and redirection).
- Managed the lesson (e.g., use of timer, smooth transitions between booster lessons).

Performance indicators were rated on a zero to 3 point scale, in which zero = Not at All, 1 = Rarely, 2 = Some of the Time, and 3 = Most of the Time. Results were shared with the tutors and areas in need of further training and recommendations for improved performance were discussed. Results on the QoI showed average ratings exceeding 2.5 in all areas, with no single rating of < 2.0. The majority of ratings were 3.0. These results across tutors show that there was a high degree of fidelity in the implementation of the booster lessons.

Observations of Teachers of the Comparison Condition. A research consultant for the project conducted the observations of the general education teachers. Our consultant was trained on the intervention and was highly skilled in behavior management. One first-grade teacher at each of the nine campuses was randomly selected for the classroom observation of "business as usual" (BAU) intervention for the comparison groups. Teachers at the 10th school chose not to participate in this aspect of the study. Observations occurred from 30 min to 1 hr, depending on the length of each teacher's lesson.

We used an observation rating scale for data-collection purposes, ranging from 3 for Most of the Time to zero for Not at All. We specifically chose items for data collection that aligned with items chosen for the fidelity observation of the treatment tutors so that we could compare results on similar indicators across the conditions. The scale included sections on teacher behavior for intervention, instruction, progress monitoring, student behavior management, and lesson management. Results on the QoI showed the following mean scores: (a) overall math instruction: 1.56, (b) teaching the lesson: 2.33, (c) implementing instructional procedures: 2.51, (d) monitoring student progress: 2.43, (e) managing student behavior: 2.09, and (f) managing the lesson: 2.78. Thus, comparatively speaking, tutors in the treatment condition demonstrated higher ratings than teachers in the comparison condition on indicators of instruction and management that are crucial for intervention work.

Anecdotally, the BAU did not contain any well-defined treatment for Tier 2 students. Rather, the research consultant noted a variety of groupings and instructional materials (e.g., manipulatives, worksheets). For example, it was noted that most of the teachers used small-group instruction to work with the comparison students. Group size varied from pairs of students, to small groups of three to five students, to larger groups of seven or more. No explicit, systematic mathematics instruction was observed with the struggling students; rather, the teachers focused on completing the whole-class assignment in a smaller group, through centers, or by reviewing for upcoming assessments. One teacher provided packets of work that were differentiated, based on students' academic levels, and another teacher paired higher-performing students with lower-performing students. Instructional pacing varied across teachers; students sometimes appeared disengaged in the smaller groups when the pacing was slower. Some students in the classroom did not behave appropriately while the teacher worked with the small groups of students. The research consultant noted some high-quality whole-class core instruction and some use of small-group instruction.

In examining the intervention approaches conducted by the tutors in the treatment condition and the teachers in the comparison condition, some obvious differences between the conditions could be viewed as "value added" for the intervention condition. First, our intervention consistently included structured lessons with systematic instruction, scripted lessons to promote pacing, and carefully sequenced lessons. We employed a concrete-semi-concrete-abstract procedure to help build conceptual knowledge, including the use of visual representations, which are supported in the literature as important components of instruction (Gersten, Beckmann et al., 2009). Our intervention provided multiple practice opportunities, which is sorely lacking in the general education classroom, and another critical factor of systematic instruction. During the observations, we did not see evidence of systematic instruction, which is well documented as an essential component of instruction for struggling students. Also, we conducted progress monitoring (independent practice) as part of every lesson. Although the general education teachers did incorporate checking for understanding, in some cases, into instruction, our progress monitoring was systematic, including self-correcting (error correction) by students.

RESULTS

All variables were within normal limits based on a review of normal probability plots by Chambers, Cleveland, Kleiner, and Tukey (1983). Table 3 shows descriptive statistics for fall and spring results on the TEMI-PM and the TEMI-O. No significant differences were found between groups in the fall on the TEMI-PM and TEMI-O. Table 4 shows means and standard deviations for the two groups for the SAT-10, which was administered only in the spring. Estimates of clustering due to school or tutor suggested minimal effects.

TABLE 3

Means and Standard Deviations for Fall and Spring Results on the TEMI-PM and TEMI-O

Group	*TEMI-PM MC*		*TEMI-PM PV*		*TEMI-PM ASC*		*TEMI-PM NS*		*TEMI-PM TS*		*TEMI-O MPS*		*TEMI-O MComp*		*TEMI-O TS*	
	Fall	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*	*Fall*	*Spring*
Comparison																
Mean	13.78	33.14	4.78	15.78	2.45	13.81	5.656	15.89	26.67	78.62	17.86	27.07	7.33	16.62	25.19	43.70
Std. Dev.	6.569	7.60	1.972	4.46	1.754	5.882	3.656	5.22	9.350	17.670	5.003	5.848	3.137	5.821	6.796	10.348
Treatment																
Mean	13.27	34.50	4.57	17.79	2.10	17.44	5.439	18.81	25.39	88.76	17.10	26.75	7.31	19.00	24.42	45.76
Std. Dev.	7.399	7.77	1.968	5.42	1.902	6.847	3.711	6.63	9.750	21.264	4.986	5.856	3.05	5.245	6.548	9.796

Note. Std. Dev. = standard deviation; TEMI-PM = Texas Early Mathematics Inventories-Progress Monitoring; MC = Magnitude Comparisons subtest; PV = Place Value subtest; ASC = Addition/Subtraction Combinations subtest; NS = Number Sequences subtest; TS = Total Score; TEMI-O = Texas Early Mathematics Inventories-Outcome; MPS = Mathematics Problem Solving subtest; MComp = Mathematics Computation subtest.

TABLE 4

Means and Standard Deviations for Spring Scores on the SAT-10

	Comparison Group			Treatment Group		
Measure	N	M	SD	N	M	SD
SAT-10 MPS	64	88.75	11.16	139	89.61	11.58
SAT-10 MP	64	92.56	13.59	139	95.70	13.24
SAT-10 TS	64	89.84	11.75	139	91.61	11.95

Note. SAT-10 = Stanford Achievement Test-Tenth Edition; MPS = Mathematics Problem Solving subtest; MP = Mathematics Procedures subtest; TS = Total Score.

Accordingly, the data were analyzed as a single-level model.

A series of analyses of covariance (ANCOVA) with the TEMI-PM fall Total Score as the covariate was used to evaluate statistical differences between groups and to maximize power of the design. The increased Type I error rate associated with multiple comparisons was addressed using the Benjamini-Hochberg (1995) correction, which controls for false discovery rate.

Two procedures were conducted, one to evaluate statistical significance of the eight noncomposite scores (i.e., TEMI-PM: MC, NS, PV, and ASC; SAT-10: MPS and MP; TEMI-O: computation and problem solving) and the other to evaluate group difference on the composite scores of the TEMI-PM Total Score, TEMI-O Total Score, and SAT-10 Total Score (because composite scores are the sum of two or more noncomposite measures, the procedures were separated to maintain independence of observations). Benjamini-Hochberg does not produce a new *p*-value. Instead, it indicates whether a given finding is significant at the specified level after correcting for multiple comparisons according to $p_i' = i\alpha/M$, where i is the rank of p_i, the original *p*-value, M is the total number of findings within the domain, and α is the target *p*-value.

Assumptions regarding homogeneity of regression were evaluated for all outcomes. There were no violations. We calculated Hedges g (g^*) for small sample sizes. Differences in adjusted posttest means were standardized using the pooled within-groups standard deviation (Hedges & Olkin, 1985).

Results for research Question 1 showed statistically significant differences (adjusted for Type 1 error based on Benjamini-Hochberg with M = 8 and $\alpha = .05$) in favor of the treatment group on the Addition and Subtraction Combinations ($p = < .0001$; $g^* = .55$), Place Value ($p = < .002$; $g^* = .39$), Number Sequences ($p = < .00001$; $g^* = .47$), and the TEMI-PM Total Score ($p < .01$; $g^* = .50$). No differences were found on the Magnitude Comparisons subtest ($p = .16$; $g^* = .18$).

On research Question 2, there were statistically significant differences on TEMI-O Computation ($p = .001$; $g^* = .44$) and on SAT-10 Mathematics Procedures ($p = .05$; $g^* = .23$), though this latter difference was not statistically significant after Benjamini-Hochberg adjustment for Type I error. There were no statistically significant differences on TEMI-O Problem Solving ($p = .99$; $g^* = -.05$) or on the SAT-10 Mathematics Problem Solving subtest ($p = .32$; $g^* = .07$). Groups differed on the TEMI-O Total Score at $p = .05$ ($g^* = .21$); however, this difference did not meet the requirements for significance after controlling for Type I error (M = 3, $\alpha = .05$). Differences on the SAT-10 Total Score ($p = .14$; $g^* = .15$) were not statistically significant (see Table 5).

DISCUSSION

This experimental study sought to determine whether an intervention provided in first grade to students demonstrating overall low early numeracy and computation performance would be associated with improved outcomes, compared with students randomized to a comparison condition. We hypothesized that students in the treatment condition would outperform comparison students on the TEMI-PM Total Score (proximal measure). Findings revealed that students in the

TABLE 5

Posttest Results by Outcome Measure for the Comparison and Treatment Groups

	Adjusted Posttest Means				
Measure	*Comparison Group (n = 64)*	*Treatment Group (n = 139)*	*F*	*Adjusted Sig.*	*Hedges' g (g^*)*
SAT-10 Mathematics Procedures	92.19	95.87	3.65	.05	.23
SAT-10 Mathematics Problem Solving	88.27	89.83	1.01	.32	.07
SAT-10 Total Score	89.39	91.82	2.19	.14	.15
TEMI-O Mathematics Computation	16.46	19.15	12.11	< .01	.44
TEMI-O Mathematics Problem Solving	26.87	26.85	0.00	.99	–.05
TEMI-O Total Score	43.35	46.10	3.82	.05	.21
TEMI-PM Magnitude Comparisons	32.99	34.62	2.02	.16	.18
TEMI-PM Number Sequences	15.70	18.98	13.78	< .01	.47
TEMI-PM Place Value	15.62	17.88	9.72	< .01	.39
TEMI-PM Addition Subtraction Combinations	13.68	17.58	16.34	< .01	.55
TEMI-PM Total Score	78.00	89.1	14.94	< .01	.50

Note. SAT-10 = Stanford Achievement Test-Tenth Edition; TEMI-O = Texas Early Mathematics Inventories-Outcome; TEMI-PM = Texas Early Mathematics Inventories-Progress Monitoring; partial eta-squared is an effect-size estimator based on the proportion of total variation attributable to the factor, excluding other factors from the total nonerror variation; Hedges' g is a standardized mean difference estimator with the variance estimate corrected for bias.

treatment condition outperformed comparison students by .5 of a standard deviation and demonstrated statistically significantly higher scores than comparison students on the TEMI-PM Total Score and three of the four subtests (there were no differences between groups on the Magnitude Comparisons subtest). Thus, these findings confirm our hypothesis. This is educationally significant and clinically meaningful per the guidelines provided by the Institute of Education Sciences What Works Clearinghouse (http://ies.ed.gov/ncee/wwc/pdf/wwc_version1_standards.pdf).

On closer scrutiny of the TEMI-PM subtest scores, we found significant effects for PV in favor of the treatment group. The findings are encouraging with respect to the effects of intervention activities designed to teach relationships of tens and ones, particularly because no significant effects were detected on the PV subtest results in an earlier study (Bryant, Bryant, Gersten, Scammacca, Funk et al., 2008).

Additionally, we were interested in examining how students in the treatment condition performed on arithmetic combinations (i.e., basic facts) because automatic retrieval of arithmetic combinations has been identified as a hallmark of mathematics difficulties (Bryant, Bryant, & Hammill, 2000; Bryant, Bryant, Williams, Kim, & Shin, in press; Geary, 2004; Gersten, Jordan, & Flojo, 2005; Siegler, 2007). Fluency development was incorporated into daily practice and warm-up activities. The positive effects ($g^* = .55$) for the ASC subtest of the TEMI-PM suggest that compared to the comparison group, the activities proved beneficial.

Finally, we were disappointed by the results on the Magnitude Comparisons subtest of the TEMI-PM, which is an area that warrants closer examination. Compatible number pairs (e.g., 32 and 46: the digit in the ones place in the smaller numeral is less than the digit in the ones place in the larger numeral [2 < 6 and 32 < 46]) and incompatible number pairs (e.g., 63 and 57: the digit in the ones place in the smaller numeral is greater than the digit in the ones place in the larger numeral [7 > 3 but 57 < 63]) could have been a contributing factor to slowing response time if students were not paying attention to the value of each digit. For example, Nuerk, Kaufmann, Zoppoth, and Willmes (2004) and Nuerk, Weger, and Willmes (2001) hypothesized that students with mathematics difficulties may exhibit slow response rates when examining decade-unit incompatibility to discriminate quantities. Their research on the compatibility effect included students only as young as second grade; thus, we do not know how this unit-decade compatibility effect is manifested in younger students. Also, the subtest contained pairs of numbers close to each other on the number line (e.g., 34 and 38) and pairs of numbers further apart (e.g., 22 and 68). The ability to more accurately and quickly discriminate quantitative differences between two numerals with larger distances between them is called the distance effect (Dehaene, Dupoux, & Mehler, 1990; Nuerk et al., 2004). Conceivably, students with mathematics difficulties may have more problems discriminating quantities that are close to each other on the number line.

We also hypothesized that students in the treatment condition would outperform comparison students on the SAT-10 Mathematics Procedures subtest and the TEMI-O Mathematics Computation subtest because these subtests were more closely aligned with our basic facts and mixed whole-number computation lessons. Although findings for the SAT-10 Mathematics Procedures were not significant when adjusting for Type I error, the effect size was ($g^* = .23$) and the p value from the ANCOVA was .05. Also, the TEMI-O Mathematics Computation subtest had a treatment effect of $g^* = .44$. These findings are educationally significant, and our hypothesis was confirmed.

Our findings are similar to those of other studies (Fuchs et al., 2006; Fuchs, Fuchs, & Hollenbeck, 2007) that demonstrated significant findings for a preventative first-grade tutoring program with a strong number, operation, and quantitative reasoning component. Compared to our previous studies, we would argue that the increased length of the tutoring sessions (daily and total time); the features of carefully constructed problems with multiple, visual representations; and the purposeful and meaningful practice (e.g., review) contributed to the overall effects found in this study on the TEMI-PM, the SAT-10 Mathematics Procedures, and the TEMI-O Computation subtests.

We also examined whether treatment students would outperform comparison students on the distal measure of mathematics problem solving on the SAT-10 and the TEMI-O. There were no statistical differences between groups on either of these measures on problem solving, as predicted. We did not anticipate between-group differences because our curriculum did not directly teach problem solving in the manner in which it was measured on either subtest. Thus, our hypothesis about no significant differences between groups was also confirmed.

By the end of first grade, 45% of treatment students and 22% of comparison students were no longer at risk for mathematics difficulties.

Next, we examined the findings from yet another perspective. In addition to statistical and practical effects, we were interested in measuring clinical effects (Thompson, 2002). For the purposes of this study, we defined clinical effects as the percentage of students who moved out of the risk category, based on their end-of-year mathematics scores. By the end of first grade, 45% of treatment students and 22% of comparison students were no longer at risk for mathematics difficulties, as determined by the results on the spring TEMI-PM. We were pleased with the percentage of students who were eligible to exit Tier 2 intervention and the apparent effect of the intervention to reduce the percentage of students with mathematics difficulties. The risk status of these students in the fall of the following year remains to be determined. It is important to determine whether the effects of the preventative first-grade tutoring for the "responders" to the intervention were maintained in subsequent years, as the demands of the mathematics curriculum increase (Fuchs et al., 2005). Additionally, it is important to identify how the remaining 55% of the Tier 2 students with at-risk status at the conclusion of the academic year fared the following year.

Finally, we thought it was important to examine campus-level factors that affect intervention research. We anecdotally examined whether a preventative mathematics intervention would be feasible to implement within the real-world context of schooling and whether schools and teachers would accommodate the time for the intervention from their daily instructional schedule. In each of our 10 schools, we formed tutoring groups that included students from different first-grade classes. We needed to work closely with teachers to identify mutually agreed-on times when we could pull students from their classes, which was somewhat challenging. We found in our next study, however, that working with central office administration, the principals, and the teachers in the spring of the year before the implementation of tutoring was a reasonable solution to the scheduling challenges.

In sum, the findings indicate that students who participated in the intervention compared to students from the same classes and schools who did not participate, performed statistically significantly better on the progress monitoring measure (i.e., TEMI-PM) closely aligned with the intervention and the progress monitoring distal measure (i.e., Mathematics Computation of the TEMI-O), with less robust findings for the SAT-10. Moreover, the percentage of treatment students compared to comparison students who were no longer eligible for Tier 2 intervention suggests that interventions can potentially reduce the number of students at risk for mathematics difficulties by the end of first grade.

Limitations

The implementation of the Tier 2 intervention program by our research staff on a pullout basis was a limitation of this study. When the goal is to validate an intervention, trained research staff must be responsible for implementation. Studies are needed, however, in which general education teachers and interventionists conduct the intervention to determine the practicality of the program and the effect on students' mathematics performance. Scaling up research to classroom teachers and interventionists to provide Tier 2 intervention must be conducted and replicated to help us learn what makes sense for classroom implementation.

Future Research

Future research studies are warranted in several areas. First, most multitiered models are based on the premise that students in Tier 2 intervention have participated in a rigorous, research-based Tier 1 program and that these students are at risk for reasons other than poor classroom instruction. Studies are needed to document the nature and effects of Tier 1 mathematics instruction for young students. Certainly future research that examines the effectiveness of Tier 2 interventions within the context of robust Tier 1 instruction is needed.

Second, studies are needed to further examine the unit-decade compatibility and distance effects with younger students to determine the developmental nature of these numerical representations. It is conceivable that more instructional attention needs to be provided to those students who have slow response rates in discerning and understanding differences in quantities.

Third, longitudinal studies are warranted to examine the mathematics performance of students who previously received Tier 2 intervention in first grade. It is important to follow students who exited from Tier 2 in first grade, students who remained in Tier 2, and students who qualified for Tier 3 in second and subsequent grades to determine the effects of intervention and whether mathematics difficulties continue.

Educational Implications

In the absence of widespread, evidence-based Tier 2 mathematics interventions for young struggling students, we think that schools can begin to take steps to provide services to those whose needs require immediate help. First-grade teachers should conduct systematic progress monitoring on essential mathematical ideas that they are responsible for teaching. Information about progress-monitoring tools can be found, for example, at the National Center on Response to Intervention's web site (www.rti4success.org/). Also, according to the findings from this study and others (e.g., Fuchs et al., 2005), small-group instruction is a necessary component of early mathematics intervention.

General education teachers or mathematics interventionists could conduct the intervention with supported coaching, as needed. We found in other studies (e.g., Bryant, Roberts, & Bryant, 2010) that general education teachers, for the most part, value support as they try to implement Tier 2 interventions that are new for them.

Information about progress-monitoring tools can be found at the website of the National Center on Response to Intervention (www.rti4success.org/).

Finally, our Tier 2 first-grade mathematics intervention involved an increased amount of instructional time, compared to our earlier studies; mathematical models (e.g., visual representations); activities to support student engagement; and systematic instruction to develop conceptual knowledge and procedural fluency and automaticity. Overall, findings from this study support the use of these intervention procedures to help young, at-risk students improve their mathematical performance.

REFERENCES

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of Royal Statistical Society Service, B, 57,* 289–300.

Bryant, D. P., Bryant, B. R., Gersten, R., Scammacca, N., & Chavez, M. (2008). Mathematics intervention for first- and second-grade students with mathematics difficulties: The effects of Tier 2 intervention delivered as booster lessons. *Remedial and Special Education, 29,* 20–32. doi: 10.1177/0741932507309712

Bryant, D. P., Bryant, B. R., Gersten, R., Scammacca, N., Funk, C., Winter, A., . . . Shih, M., & Pool, C. (2008). The effects of Tier 2 intervention on first-grade mathematics performance of first-grade students who are at risk for mathematics difficulties. *Learning Disability Quarterly, 31,* 47–63. doi: 10.2307/20528817

Bryant, D. P., Bryant, B. R., & Hammill, D. D. (2000). Characteristic behaviors of students with learning disabilities who have teacher-identified math weaknesses. *Journal of Learning Disabilities, 33,* 168–177, 199. doi: 10.1177/002221940003300205

Bryant, D. P., Bryant, B. R., Williams, J., Kim, S. A., & Shin, M. (in press). Strategies for improving student outcomes in mathematics computation. In D. Chard, M. Tankersley, & B. Cook (Eds.), *Effective practices in special education.* Boston, MA: Pearson.

Bryant, D. P., Roberts, G., Bryant, B. R., DiAndreth-Elkins, L. (2011). Tier 2 for K–2 early numeracy number sense interventions for kindergarten and first-grade students with mathematics difficulties. In R. Gersten & B. Newman-Gonchar (Eds.), *RtI mathematics book* (pp. 65–83). Baltimore, MD: Brookes.

Chambers, J., Cleveland, W., Kleiner, B., & Tukey, P. (1983). *Graphical methods for data analysis.* Pacific Grove: CA. Wadsworth & Brooks/Cole.

Clements, D. H., & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach.* New York, NY: Routledge.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied behavior analysis* (2nd ed.). Columbus, OH: Merrill.

Dehaene, S., Dupoux, E., & Mehler, J. (1990). Is numerical comparison digital? Analogical and symbolic effects in two-digit number comparison. *Journal of Experimental Psychology: Homan Perception and Performance, 16,* 626–641. doi: 10.1037/0096-1523.16.3.626

Fuchs, L. S., Compton, D. L., Fuchs, D., Paulsen, K., Bryant, J. D., & Hamlett, C. L. (2005). The prevention, identification, and cognitive determinants of math difficulty. *Journal of Educational Psychology, 97,* 493–513. doi: 10.1037/0022-0663.97.3.493

Fuchs, L. S., Fuchs, D., Hamlet, C. L., Powell, S. R., Capizzi, A. M., & Seethaler, P. M. (2006). The effects of computer-assisted instruction on number combination skill in at-risk first graders. *Journal of Learning Disabilities, 39,* 467–475. doi: 10.1177/00222194060390050701

Fuchs, L. S., Fuchs, D., & Hollenbeck, K. N. (2007). Extending responsiveness to intervention to mathematics at first and third grades. *Learning Disabilities Research & Practice, 22,* 13–24. doi: 1031111/j.1540-5826.2007.00227.x

Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of Learning Disabilities, 37,* 4–15. doi: 10.1177/00222194040370010201

Gersten, R., Beckmann, S., Clarke, B., Foegen, A., Marsh, L., Star, J. R., & Witzel, B. (2009). *Assisting students struggling with mathematics: Response to intervention (RtI) for elementary and middle schools* (NCEE 2009-4060). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of

Education. Retrieved from http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Gersten, R., Chard, D., Jayanthi, M., Baker, S., Morphy, P., & Flojo, J. (2009). Mathematics instruction for students with learning disabilities: A meta-analysis of instructional components. *Review of Educational Research, 79,* 1202–1242. doi: 10.1177/00222194050380040301

Gersten, R., Jordan, N. C., & Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *Journal of Learning Disabilities, 38,* 293–304. doi: 10.1177/00222194050380040301

Hedges, L. V., & Olkin, I. (1985). *Statistical methods in meta-analysis.* Orlando, FL: Academic Press.

Litow, L., & Pumroy, D. K. (1975). A brief review of classroom group-oriented contingencies. *Journal of Applied Behavior Analysis, 8,* 341–347. doi: 10.1901/jaba.1975.8-341

National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics: A quest for coherence.* Reston, VA: Author.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education. Retrieved from http://www2.ed.gov/about/bdscomm/list/mathpanel/index.html

National Research Council. (2009). *Mathematic learning in early childhood: Paths toward excellence and equity.* Washington, DC: Author.

Nuerk, H. C., Kaufmann, L., Zoppoth, S., & Willmes, K. (2004). On the development of the mental number line: More or less or never holistic with increasing age? *Developmental Psychology, 40,* 1,199–1,211. doi: 10.1037/0012-1649.40.6.1199

Nuerk, H. C., Weger, U. W., & Willmes, K. (2001). Decade breaks in the mental number line? Putting the tens and unites back into different bins. *Cognition, 82,* B25–B33. doi: 10.1016/S0010-0277(01)00142-1

Pearson Education. (2003). Stanford achievement test–tenth edition. Boston, MA: Author.

Siegler, R. S. (2007). Cognitive variability. *Developmental Science, 10,* 104–109. doi: 10.1111/j.1467-7687.3007.00571.x

Swanson, H. L., Hoskyn, M., & Lee, C. (1999). *Interventions for students with learning disabilities: A meta-analysis of treatment outcomes.* New York, NY: Guilford Press.

Thompson, B. (2002). Statistical, practical, and clinical: How many kinds of significance do counselors need to consider? *Journal of Counseling and Development, 80,* 64–71.

University of Texas System & Texas Education Agency. (2007a). Texas early mathematics inventories-outcome. Austin, TX: Authors.

University of Texas System & Texas Education Agency. (2007b). Texas early mathematics inventories-progress monitoring. Austin, TX: Authors.

Vaughn, S., Wanzek, J., & Fletcher, J. M. (2007). Multiple tiers of intervention: A framework for prevention and identification of students with reading/learning disabilities: In B. M. Taylor & J. Ysseldyke (Eds.), *Educational instruction for struggling readers, K–6* (pp. 173–195). New York, NY: Teachers College Press.

Vaughn, S., Wanzek, J., Woodruff, A. L., & Linan-Thompson, S. (2007). Prevention and early identification of students with reading disabilities: A research review of the three-tier model. In D. H. Haager, S. Vaughn, & J. K. Klingner (Eds.), *Validated reading practices for three tiers of intervention* (pp. 11–28). Baltimore, MD: Brookes.

Woodward, J. (2006). Developing automaticity in multiplication facts: Integrating strategy instruction with timed practice drills. *Learning Disability Quarterly, 29,* 269–289. Retrieved from http://www.jstor.org/stable/30035554

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This work was supported by the U.S. Department of Education, Institute of Education Sciences grant R324B070164. No official endorsement should be inferred.

Manuscript submitted June 2010; accepted December 2010.

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