

A Comprehensive Examination of Preschool Teachers' Implementation Fidelity When Using a Supplemental Language and Literacy Curriculum

Shayne B. Piasta · Laura M. Justice · Anita McGinty ·
Andrew Mashburn · Laura Slocum

Published online: 4 February 2015
© Springer Science+Business Media New York 2015

Abstract

Background Recent curriculum studies raise a number of questions concerning teachers' implementation fidelity, including the extent to which fidelity to multiple curriculum components is achieved and measured and the extent to which fidelity serves as a mechanism for impacting children's learning.

Objective Within the context of a language and literacy curriculum supplement designed for use at scale, we investigated (1) teachers' fidelity across the multiple dimensions identified in the literature (e.g., Dane and Schneider in *Clin Psychol Rev* 18(1):23–45, 1998) and interrelations among these dimensions and (2) associations between measures of fidelity and the language and literacy gains made by children.

Method We examined the fidelity of 74 preschool teachers implementing *Read It Again!*. Multiple measures of adherence, exposure, quality of delivery, and participant

Laura Justice and Anita McGinty are developers of the Read It Again! supplemental curriculum utilized in this study.

S. B. Piasta (✉) · L. M. Justice

Department of Teaching and Learning & Crane Center for Early Childhood Research and Policy,
The Ohio State University, 201 Arps Hall, 1945 North High Street, Columbus, OH 43210, USA
e-mail: piasta.1@osu.edu

A. McGinty

Curry School of Education and Center for Advanced Study of Teaching and Learning, University of
Virginia, Charlottesville, VA, USA

Present Address:

A. McGinty

Core Knowledge Foundation, Charlottesville, VA, USA

A. Mashburn

Department of Psychology, Portland State University, Portland, OR, USA

L. Slocum

Crane Center for Early Childhood Research and Policy, The Ohio State University, Columbus, OH,
USA

responsiveness were collected across the year of implementation, and children's ($n = 295$) language and literacy gains were directly measured.

Results Descriptive statistics demonstrated generally high implementation fidelity across all dimensions. Correlational analyses showed few interrelations among fidelity measures and few associations with child gains.

Conclusions Findings suggest that teachers can exhibit fidelity to multi-componential language and literacy curricula designed for wide-scale use. Findings also support fidelity as a multidimensional construct and suggest that researchers utilize multiple measures to capture both within- and between-teacher variation in fidelity, while also pursuing additional studies to better understand the measurement and functioning of fidelity to inform future work.

Keywords Fidelity · Intervention · Emergent literacy · Implementation · Treatment integrity · Preschool

Introduction

During the last decade, numerous empirical reports have described impacts associated with implementation of language- and literacy-focused practices and programs in preschool settings (Cabell et al. 2011; Christ et al. 2011; Justice and Ezell 2002; Justice et al. 2010b; Landry et al. 2006; Pianta et al. 2008b; Pollard-Durodola et al. 2011). The impetus for such work in part reflects an interest in elevating the quality of language- and literacy-supports within preschool settings, as these are important for improving children's language and literacy skills prior to kindergarten entry. Across such works, impacts of interest include teacher-related factors, such as their implementation of targeted techniques in the classroom (Cabell et al. 2011; Piasta et al. 2010; Wasik and Bond 2001), as well as child-related factors, primarily their development of key language and literacy skills (Justice et al. 2008b; Landry et al. 2006; Pianta et al. 2008b). From a theory-of-change perspective, achieving impacts on teacher-related factors, such as use of specific techniques or materials, is necessary for achieving change on child-related factors (Cabell et al. 2011; Pianta et al. 2008b; Pollard-Durodola et al. 2011; Powell et al. 2010).

Investigations into teacher-related factors that reflect uptake of programs and practices, which for the present purposes we refer to globally as curricula, generally seek to understand the extent to which teachers are able to implement *with fidelity* the various components of a curriculum. This includes, for instance, following a systematic schedule of implementation of lessons or activities, targeting a scope and sequence of teaching objectives, utilizing specific materials and techniques to address these objectives, and monitoring children's progress towards the curriculum objectives. Presumably, all of these components of a curriculum reflect its 'active ingredients,' or the mechanism for bringing about change in both proximal outcomes (e.g., changes in teachers' language and literacy instruction) and more distal outcomes (e.g., children's language and literacy gains). Because implementation of these components is seen as critical to a curriculum's effectiveness, curricula that are considered potential candidates for at-scale use are those in which fidelity of implementation for the key components can be achieved. The purpose of the present study was to conduct an in-depth, comprehensive assessment of preschool teachers' implementation fidelity when adopting a supplemental language and literacy

curriculum. In doing so, we advance the field by documenting the extent to which teachers exhibit fidelity when implementing a curriculum designed for use at scale and contribute to the understanding of implementation fidelity as a construct, through examination of interrelations among proposed dimensions of fidelity and associations with child outcomes. We also provide a model of how implementation, and its various dimensions, can be assessed.

Dimensions of Implementation Fidelity

Fidelity is an essential component of research conducted in applied settings. As a construct, fidelity represents the extent to which the core components of a curriculum are implemented as intended, usually as represented by a theorized gold standard (Hulleman and Cordray 2009). One complication in seeking to document teachers' fidelity is that curriculum implementation requires teachers to show fidelity to many different components. For instance, when implementing a language and literacy curriculum, teachers may be asked to follow a certain scope and sequence, to use specific techniques or materials, and/or to implement given activities along a specific schedule. In addition to following procedures specific to these aspects of implementation, it is generally desired that all of these activities to be implemented in a quality way—that is, for the curriculum to be implemented *well*.

In recognition of this, there have been some efforts to specify various dimensions of fidelity. For instance, some researchers have differentiated between teachers' fidelity to the procedural components of a curriculum and the more dynamic components or processes (e.g., Century et al. 2010; O'Donnell 2008; Odom et al. 2010). Procedural components reflect the static, structural features of a curriculum (sometimes referred to as structural fidelity), whereas the latter refers to the qualitative or dynamic features of a curriculum (sometimes referred to as a process fidelity). Alternatively, Dane and Schneider's (1998) meta-analysis described five separate dimensions of implementation fidelity in their review of interventions designed to prevent behavioral, social, and academic problems among children. These dimensions included *adherence*, *exposure*, *quality of program delivery*, *participant responsiveness*, and *program differentiation*. Using implementation of a language and literacy curriculum as a reference point, adherence refers to the extent to which teachers implement the key program components as manualized in lessons and activities (e.g., adherence to the scope and sequence of instruction, use of specified materials, structure of lesson plans). Exposure, also referred to as dosage and intensity, refers to how much overall contact children have with the curriculum. Quality of delivery refers to qualitative aspects of curriculum implementation, including how well a teacher implements active ingredients of a curriculum. Participant responsiveness refers to the extent to which children receiving the curriculum appear to respond to it in terms of overall participation and enthusiasm (The fifth and final dimension, program differentiation, is not a measure of fidelity per se but rather an index of distinctiveness between classrooms that do and do not utilize a given curriculum).

Although such dimensions continue to shape current thinking concerning implementation fidelity in the broader literature (e.g., Berkel et al. 2011; Durlak 2010; Dusenbury et al. 2003; O'Donnell 2008; Schulte et al. 2009), most studies of preschool language and language curricula do not comprehensively assess all dimensions. Moreover, few studies have empirically investigated the extent to which these theoretical dimensions of fidelity are, indeed, different aspects of implementation. One recent study (Hamre et al. 2010) is an exception, in that multiple (although not all) dimensions of fidelity were measured and

interrelations of these dimensions were examined. Few positive relations among fidelity measures were found, suggesting that teachers who show high levels of fidelity to one aspect of implementation may not show high levels of fidelity to other aspects. Replication of this finding, particularly in a study that comprehensively assesses all dimensions of fidelity, is desirable as it holds practical implications for how implementation fidelity is assessed in intervention research—whether a singular index is sufficient (as it often utilized; e.g., Bierman et al. 2008) or if multiple indices are necessary.

Implementation Fidelity and Children's Learning

Commensurate with the idea of various dimensions of fidelity, it is generally assumed that curricula should be implemented fully (i.e., with high fidelity across multiple dimensions) for the desired impacts to occur with respect to children's learning gains. Presumably, all components of a curriculum reflect the ingredients necessary for bringing about change. If this were the case, and assuming that there is variation in teachers' implementation fidelity, we would expect to see higher levels of implementation fidelity associated with greater learning gains among children exposed to the curriculum (Hulleman and Cordray 2009).

Several recent studies provide support for linkages between implementation fidelity and children's learning gains when exposed to language and literacy curricula in the preschool classroom. For instance, in an evaluation of a comprehensive language-focused curriculum, Justice and colleagues reported positive associations between teachers' use of language-facilitating techniques in the classroom (a process-oriented feature of the curriculum studied) and children's growth in syntactic skills over an academic year (Justice et al. 2008b). However, a more recent study presented mixed findings on this issue. Hamre and colleagues (Hamre et al. 2010) studied prekindergarten teachers' implementation fidelity when using a language and literacy curriculum over an academic year, coupling teacher-completed checklists documenting implementation of procedural components of the curriculum (i.e., dosage) with researcher-conducted observations documenting qualitative aspects of lesson implementation. Interestingly, few measures of implementation fidelity were associated with children's language and literacy gains. In fact, in examining the five fidelity measures with respect to prediction of four child language and literacy outcomes, only three significant relations were observed. Thus, although teachers in this study were heterogeneous in their implementation of the curricula, measures designed to capture this heterogeneity generally did not correlate with children's learning gains and, thus, more research is necessary.

The Present Study

To sum, recent studies of curriculum implementations focused on improving children's language and literacy skills raise a number of questions about how best to operationalize and measure fidelity as a study construct and serve to identify key gaps in the literature which we sought to address in this study. First, few if any studies have documented the extent to which teachers adopting a new curriculum exhibit fidelity across all proposed fidelity dimensions. Thus, we have little understanding as to the extent to which curricula designed for scale up can be implemented as intended. Second, the available literature raises questions about the theorized relations among various fidelity indices and whether fidelity should be considered one global construct or rather a set of relatively unique indices of implementation. Third, the extant literature is relatively sparse with respect to assessing the specific dimensions of implementation fidelity that are associated with children's gains. From a theoretical perspective, we might presume that careful

measurement of teachers' fidelity to all aspects of a curriculum's implementation would reflect children's exposure to the key ingredients of the curriculum and, in turn, be associated with children's gains in skills targeted by the curriculum.

With these questions in mind, the purpose of the present study was to expand our understanding of implementation fidelity as observed among preschool teachers when implementing a multi-component language and literacy curriculum supplement. Specifically, teachers implemented the 30-week curriculum *Read It Again!* (RIA) for an academic year. As a curriculum supplement, RIA is intended as an add-on to teachers' existing core curricula to target specific language and literacy skills that may not otherwise receive explicit attention. RIA employs many of the key ingredients seen in other language and literacy curricula discussed in the extant literature (Fantuzzo et al. 2011; Landry et al. 2006; Mashburn et al. 2010; Pollard-Durodola et al. 2011), such as a systematic scope and sequence encompassing key areas of language (narrative, vocabulary) and literacy skills (print knowledge, phonological awareness), semi-scripted lessons that support teachers' implementation of this scope and sequence, storybooks as a key material resource, and checklists for monitoring implementation as well as children's learning gains. The theory of change for RIA is presented in Fig. 1. Pilot research featuring a quasi-experimental design showed positive impacts of RIA exposure with respect to children's literacy and language skills (Justice et al. 2010b).

Like other curricula, implementation of RIA's 60 lesson scope and sequence requires teachers to exhibit fidelity not only to static, procedural components (e.g., following the order of activities specified in a lesson, using the identified materials) but also to qualitative aspects and dynamic processes (e.g., ensuring child engagement, differentiating instruction for children who may find the lesson too difficult or too easy). Previous work has provided some evidence regarding teachers' implementation fidelity when using RIA. For example, in a feasibility study (Justice et al. 2010b), Justice and colleagues examined the number of

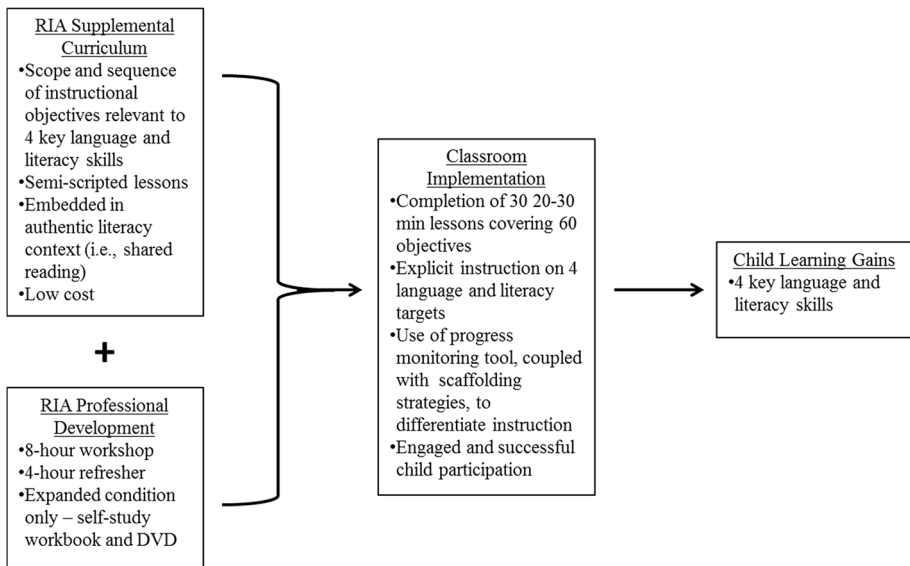


Fig. 1 Theory of change for Read It Again! (RIA). Fidelity when implementing active ingredients, in terms of adherence, exposure, quality of delivery, and participant responsiveness, is expected to facilitate child learning gains

RIA lessons implemented; 11 teachers self-reported implementing an average of 80 % of lessons (48 out of 60). Pentimonti and Justice (2010) examined teachers' implementation of six RIA scaffolding strategies, which represent a key component of RIA and the means by which differentiated instruction is afforded. Scaffolding is based on Vygotsky's theory of instruction (Vygotsky 1978) and refers to the temporary support provided by teachers to assist a child in accomplishing a task that is just beyond what the child could accomplish independently (i.e., a task within the child's zone of proximal development). Authors (2010b) found that teachers implementing RIA lessons only modestly used some of the strategies, and that their self-report of strategy use was not well-calibrated to their observed rate of use (Teachers tended to inflate their rate of use when self-reporting). Neither of these prior studies, nor other works of which we are aware, provides a comprehensive assessment of preschool teachers' fidelity to RIA or other similarly-designed language and literacy curricula with respect to all four dimensions widely used in the literature to describe implementation fidelity (i.e., adherence, exposure, quality of program delivery, participant responsiveness).

Thus, in the present study, we examined implementation fidelity across these four dimensions of fidelity for 74 teachers, all of whom implemented RIA as a part of a multi-state, multi-cohort randomized controlled trial. About one-half of the RIA teachers received modest professional development to support their implementation (a 1-day workshop), whereas the remainder received expanded professional-development opportunities via 12 technology-enhanced self-study modules given evidence that such technology-enhanced, sustained professional development better supports curriculum implementation (e.g., Pianta et al. 2008b). Multiple measures of implementation fidelity aligned with the theory of change (Fig. 1) were captured over the academic year, many of them repeatedly. The data collected thus provide detailed accounts of the extent to which teachers exhibited implementation fidelity across multiple indices, affording the opportunity to deepen our understanding of fidelity across the various dimensions proposed by Dane and Schneider (1998), and to explore associations with the learning gains made by children enrolled in classrooms using RIA. Two specific aims were addressed. First, we examined the extent to which teachers exhibited implementation fidelity across all four dimensions (adherence, exposure, quality of delivery, and participant responsiveness) and possible interrelations among these dimensions. We hypothesized that teachers would exhibit the highest levels of fidelity to procedural aspects (adherence, exposure) as opposed to process-oriented or dynamic aspects (quality of delivery, participant responsiveness), given evidence that procedural fidelity may be achieved quickly and easily (Pence et al. 2008). We also expected significant but small correlations among fidelity dimensions, given the findings of Hamre et al. (2010) and theoretical arguments that such dimensions are related but distinct. Second, we explored the extent to which the dimensions of fidelity were associated with children's language and literacy gains during a year of RIA exposure. Although we anticipated associations among all fidelity measures and child outcomes, we also hypothesized that the process-oriented features of a curriculum might be more influential to children's gains than the procedural components (Hamre et al. 2010; Justice et al. 2008a).

Method

The present study involved correlational analysis of implementation fidelity and child learning data collected as part of a larger, randomized controlled trial of RIA. The larger project involved three cohorts of preschool teachers ($N = 104$) recruited from three states.

Participants

Teachers

Teachers were recruited via a multistep process. Research staff first contacted preschool program directors in designated geographic areas by phone and invited these directors and their teaching staff to learn more about the project; staff then conducted in-person recruitment sessions at programs expressing interest in participating. At the recruitment session, research staff shared additional information concerning RIA and the research project, provided details concerning participation as aligned with approved Institutional Review Board protocols, and distributed printed recruitment and consent materials to teachers. All teachers who met eligibility criteria and voluntarily provided informed consent were selected into the study, with the caveat that only one teacher participate per classroom.

Teachers participated in the project for one academic year: 2008/2009, 2009/2010, or 2010/2011. All teachers met project eligibility criteria such that they were lead or co-lead teachers in Head Start or state-funded preschool programs serving 3-to 5-year old children in rural, Appalachian communities in Ohio, Virginia, or West Virginia. Teachers were consented into the study and randomly assigned to one of three conditions: (1) RIA with a traditional one-day professional development workshop (RIA-T; $n = 35$), (2) RIA with expanded technology-mediated professional development (RIA-E; $n = 39$), or (3) business-as-usual control ($n = 30$). Given the present study's focus on fidelity to RIA, the present study involved only the original 74 teachers recruited and assigned to one of the two RIA conditions, ten of whom withdrew participation at some point during the project ($n = 5$ for each RIA condition). Reasons for withdrawal included moving ($n = 5$), changing classrooms mid-year ($n = 1$), and other reasons ($n = 4$) such as medical issues. In the present work, these ten teachers were included to the extent that relevant data was available so as not to positively bias fidelity estimates (e.g., number of full lessons implemented). The loss of these teachers at various points during the academic year, coupled with instances of occasional failure of teachers to complete or submit data collection forms and infrequent experimenter error (e.g., video equipment failure), account for some variation in sample size across measures. All analyses and results were also replicated with the subsample of original teachers who completed the full project.

The teachers ranged in age from 22 to 60 years ($M = 39.21$; $SD = 11.08$; 1 unreported). The vast majority of teachers were female (96 %, $n = 71$; 1 unreported) and White/Caucasian (92 %, $n = 68$). Three teachers were Black (4.1 %) and two were multi-racial (2.7 %; 1 unreported); one teacher was Hispanic (1.4 %). Teachers' levels of education varied; their highest degrees obtained included a high school diploma (2.7 %, $n = 2$), associates' degree (34 %, $n = 25$), bachelors' degree (39 %, $n = 29$), or masters' degree (23 %, $n = 17$; 1 unreported). Preschool teaching experience ranged from 0 to 23 years ($M = 8.12$, $SD = 6.07$; 1 unreported). In addition to using RIA as a supplemental language and literacy curriculum, 60 % ($n = 44$) of teachers reported using one or more commercially-available curricula in their classrooms: 46 % used Creative Curriculum, 19 % used Houghton-Mifflin PreK, 14 % used High/Scope, and 8 % used Play on Purpose. Five percent of teachers or fewer reported using a variety of other curricula such as Everyday Math, Opening the World of Learning, DLM Early Childhood Express, Big Math for Little Kids, Sing Spell Read and Write, and Promoting Alternative Thinking Strategies. Notably, the vast majority of these curricula do not have causally-interpretable evidence of impacting the language and literacy skills targeted by RIA (Lonigan et al.

2011; Preschool Curriculum Evaluation Research Consortium 2008). Classroom enrollment ranged from 9 to 40 children ($M = 17.65$, $SD = 4.38$, 2 unreported). Teachers assigned to the RIA-T and RIA-E conditions did not significantly differ on age, gender, race or ethnicity, preschool teaching experience, use of a commercial curriculum, or classroom enrollment ($ps > .164$).

Children

Consent forms were distributed to caregivers of all children in participating teachers' classrooms, with the intention of recruiting approximately five children per teacher to participate in ongoing study assessments. This number was based on a priori power estimates. Participating children were chosen at random from all children whose caregivers provided informed consent and who met the following eligibility criteria: (a) four years of age at time of recruitment, (b) expected to enroll in kindergarten the following year, and (c) able to participate in study assessments (i.e., the child spoke English as a primary language and had no known significant disabilities). In cases in which fewer than six children provided consent or were eligible, all consented, eligible children participated in study assessments. A total of 351 children enrolled in the original 74 RIA classrooms participated in ongoing study assessments ($M = 4.88$ children per classroom, range of 3–5); this sample was reduced to 313 children in 64 classrooms due to teacher withdrawal (as described above).

The present study involved the subsample of 275 children from these 64 classrooms who completed selected study assessments (see “Measures” section) at both the beginning and end of the academic year, allowing for computation of learning gains. The majority of children excluded from the subsample ($n = 25$) did not complete end of year assessments because their families had moved; an additional 13 children had missing data due to other reasons such as absence or dissent. Children included and excluded from this subsample did not significantly differ on gender, age, race, or beginning of year assessment scores, although children who were excluded tended to come from homes of lower socioeconomic status as measured by maternal education and annual family income ($ps < .005$).

Children ranged from 44 to 59 months of age at the beginning of the academic year ($M = 53$ months, $SD = 3.1$). Fifty-two percent were girls. Most were White/Caucasian (83 %), with 3 % Black, 4 % multi-racial, and 10 % other or unreported. One percent were Hispanic or Latino. For 71 % of children's female caregivers, a high school diploma was the highest degree earned; 9 % had an associates' degree, 9 % had a bachelors' degree, and 4 % had a graduate degree (9 % unreported). The median family income was reported as between \$20,001 and \$25,000 per year; 47 % of families had incomes below \$25,000, and 17 % of families had incomes above \$50,000.

Study Procedures

RIA Program and Professional Development

Teachers participating in both RIA conditions (RIA-T or RIA-E) were asked to implement RIA in their classrooms for one full academic year. These teachers received the RIA curricular supplement and associated materials, along with professional development to support its implementation. A brief description of RIA is presented below; additional details are provided in Justice et al. (2010b) and online at <http://ccec.ehe.osu.edu/practice/ccec-curricula/read-it-again-pre-k/> where the curriculum supplement can be downloaded at no cost.

RIA is a 30-week program that targets children's language and literacy skills that are predictive of future reading proficiency and academic success (see National Early Literacy Panel 2008 for review). Materials to implement RIA lessons include 15 inexpensive, commercially-available children's books, common classroom supplies (e.g., markers, paper), and the RIA manual and lesson plans. The theory of change manualized in RIA and also depicted in Fig. 1 specifies three active ingredients: (a) a systematic scope and sequence of instructional objectives, (b) explicit instruction aligned to these objectives embedded within an authentic literacy context (i.e., read-alouds), and (c) monitoring of children's progress towards these objectives and differentiating instruction accordingly. RIA's format and delivery is also expected to incur successful and engaged child participation.

With respect to the first active ingredient, RIA addresses 23 learning objectives for building children's competencies in the domains of Print Knowledge, Phonological Awareness, Vocabulary, and Narrative; these are addressed systematically (progressing from easiest to most difficult) and repeatedly over the duration of the program. Specifically, teachers implement RIA by conducting two RIA lessons per week during whole-class sessions with an anticipated duration of 20–30 min per lesson. Each lesson is tied to one of 15 children's books, which are read repeatedly throughout the program, and uses before-, during, and after-reading activities to target two learning objectives, one from each of two language and literacy domains. For example, Week 1 Lesson 1 addresses one Print Knowledge learning objective (*to recognize that print carries meaning and to distinguish print from pictures*) and one Vocabulary learning objective (*to understand and use words for the names of unfamiliar actions*), whereas Week 1 Lesson 2 addresses one Phonological Awareness learning objective (*to identify when two words share a rhyming pattern*) and one Narrative learning objective (*to identify and describe the setting and characters of a story*).

With respect to the second active ingredient, the 60 RIA lesson plans are soft-scripted, providing the two targeted objectives as well as a sequence of activities with *suggested language* for the teacher to use. The suggested language for teachers provides a mechanism for using explicit instruction to bring about change in children's skills, as aligned to the instructional objectives. Explicit instruction involves directly supporting children's learning via use of clear explanations and demonstrations (see Archer and Hughes 2011). For instance, in the previously referenced RIA Week 1 Lesson 1, which targets children's learning of the difference between print and pictures (a Print Knowledge objective), the lesson opens with the suggested language "The title of the book tells us the name of the story."

With respect to the third active ingredient, RIA includes an informal progress monitoring tool, the Pupil Progress Checklists, which teachers are asked to complete for each child at three points during the program (week 2, week 12, and week 21). Teachers rate each child's competencies on the 23 learning objectives. Teachers' knowledge of individual children's competencies is a vehicle by which they may modify individual lessons to differentiate instruction to meet the needs of children with more limited or advanced skills. To support teachers' use of differentiated instruction, each of the 60 RIA lessons includes a Learners' Ladder, which presents teachers with ideas of how to use three specific high-support scaffolding strategies (i.e., eliciting, reducing choices, co-participation) to make RIA lessons easier for children who need extra help, and three specific low-support strategies (i.e., generalizing, reasoning, predicting) to make RIA lessons more challenging for children who are more advanced in their language and literacy skills (see Pentimonti and Justice 2010).

Teachers participating in the current study were provided with all necessary RIA materials, including the children's books, RIA manual and lesson plans, and Pupil Progress Checklists. All RIA teachers (both RIA-T and RIA-E) attended an 8-h professional development workshop at the beginning of the year (late summer/early fall) provided by research staff trained in RIA. During this workshop, teachers were provided background information on the general content of RIA, as well as all components (e.g., progress-monitoring checklists, differentiation strategies). All RIA teachers also attended a 4-h refresher workshop mid-year (winter). The refresher workshop reviewed key RIA content, with a focus on the differentiation strategies tied to the Learners' Ladders. Note that all teachers were required to attend these workshops as a condition of study participation.

In addition to the professional development workshops noted above, those teachers assigned to the RIA-E condition also received a RIA self-study workbook and DVD. (The DVD maps onto self-study materials available on the internet; however, as not all teachers had access to the internet at the time of the study, they were provided DVDs and a portable player to keep.) These materials are designed to be used in tandem with RIA lessons, to provide teachers with additional information and video exemplars to support implementation. The workbook consists of 12 modules. The first four provide a more in-depth description of the four target domains, whereas the latter eight provided extended opportunities for teachers to learn about and apply the six scaffolding strategies to support children's learning in specific domains. The intent of these modules is to provide teachers with opportunities to integrate these strategies into their practice, and thus the modules contained opportunities for teachers to reflect on how certain strategies would or would not work with specific children in their classrooms. In terms of content, each chapter includes self-study learning objectives, an overview of the chapter topic, relevant terms and background information, and "What's New" sections to introduce new concepts and instructional practices. The chapters also include multiple activities to support teachers' learning by asking teachers to apply what they are learning to their own classroom and prompting teachers to practice skills with their own students. Teachers assigned to the RIA-E condition were asked to complete the self-study professional development activities via the workbook and DVD on a set schedule, with one workbook chapter to be completed about every 2 weeks. At three points during the academic year (beginning, middle, end), research staff visited with RIA-E teachers to document the extent to which self-study materials were being used. Research staff completed a checklist based on teachers' responses to specific questions (e.g., "Have you missed or skipped any RIA-E self-study chapters?") and a review of their workbooks (e.g., for evidence that "Reflect and Apply" activities had been completed and documented). At the end-of-year check point, 100 % of teachers reported using the self-study materials, 92 % reported adhering to the self-study schedule, 14 % reported having skipped or missed a workbook chapter, 91–100 % showed evidence of completing workbook activities, and 62 % showed evidence of fully completing all self-study materials/activities.

Measures

Measures for the present study were selected from the larger, parent-project battery to assess aspects of teachers' fidelity of implementation and children's learning gains. Fidelity of implementation was characterized as in Dane and Schneider (1998) and subsequent works (e.g., O'Donnell 2008) to include the four specific dimensions referenced previously: adherence, exposure, quality of delivery, and participant responsiveness. The

first author takes responsibility for the integrity of these data as well as for the data analyses reported subsequently.

Adherence

Adherence refers to the extent to which teachers implement program components as manualized. In the current study, three measures of adherence were utilized. Teachers' *adherence to the general RIA lesson components* was measured via Fidelity Observation Checklists. The observation checklist included nine items basic to all RIA lessons (e.g., Was the teacher using the correct book? Did the teacher use all the necessary RIA materials listed in the lesson? Were implementation notes completed?). Research staff completed observation checklists live during RIA lessons at the beginning, middle, and end of the academic year. Each item was scored dichotomously (yes = 1, no = 0), with item scores averaged per teacher to give the proportion of general RIA lesson components implemented.

Teachers' *adherence to the specific components of a given RIA lesson* was measured via Lesson Implementation Checklists that were specific to a given lesson. Key components for each RIA lesson were identified a priori, with ten specific components identified for each lesson (five components per each of two objectives). The implementation checklist for Lesson 9, for example, included items such as (a) Did the teacher discuss the concept that words and/or print convey meaning (objective 1)?, (b) Did the teacher point to the words as reads? (c) Did the teacher address all four target vocabulary words (objective 2)? and (d) Did the teacher intentionally use prepositional words (those listed or others) during the discussion of letter locations? Research staff coded lesson implementation checklists from videos of RIA lessons from the beginning, middle, and end of the year. Each of the 10 items was scored dichotomously (yes = 1, no = 0), with these scores averaged per teacher to give the proportion of specific RIA lesson components implemented.

The *proportion of RIA Pupil Progress Checklists completed* constituted the third measure of teachers' adherence, assessing the extent to which this component of RIA was implemented. Per the manual, teachers were to complete Pupil Progress Checklists during weeks 2, 12, and 21 of the curriculum. Completed checklists were collected by research staff, and the total proportion completed at each time point was calculated and used as a variable in analyses.

Exposure

Exposure refers to the amount of the program that was implemented and experienced by participants, in terms of number and duration of sessions. In the current study, four measures of exposure were derived from RIA Lesson Implementation Notes, which were provided to teachers as part of their RIA manual. (Note that these are different than the Lesson Implementation Checklists, used by research staff to assess adherence to specific lessons.) Teachers were asked to complete an Implementation Note after each RIA lesson, on which they reported the date on which the lesson and each activity/objective was implemented and the length of the lesson in minutes (additional information regarding children's engagement and success during the lesson was also reported and are discussed as measures of participant responsiveness). Research staff visited each classroom six times across the year to collect these implementation notes and computed the (a) *number of full lessons implemented*, (b) *number of activities/objectives completed*, (c) *average lesson duration*, and (d) *total implementation time*.

Quality of Delivery

Quality of delivery refers to aspects of implementation beyond what is prescribed by the program and includes “the manner in which the [teacher] delivers the program using the techniques, processes, or methods prescribed” (O’Donnell 2008, p. 34). In the current study, quality of delivery was assessed via two observational measures.

The Explicit Language and Literacy Instruction Techniques coding scheme (ELLIT; McGinty et al. 2011) captured the manner in which teachers delivered one of the key RIA components, namely their use of *explicit language and literacy instruction* to target each of the four language and literacy RIA targets (i.e., phonological awareness, print knowledge, vocabulary, narrative) during an RIA lesson. Research staff coded ELLIT from a video-taped RIA lesson implemented in the middle of the academic year using a 30-s time-sampling technique; such time-sampling-based coding has been successfully used in other studies (e.g., Pianta et al. 2008a; Piasta et al. 2012). For each 30-s interval of the lesson, staff indicated whether any of the teacher’s extra-textual talk (i.e., talk beyond reading the text of the book) used one or more explicit instructional strategies to refer to one or more of the RIA targets. Four explicit instructional strategies, defined as the way that teachers support children’s learning, were examined: (a) identify/orient, which is when a teacher identifies or orients a child to a particular target (e.g., “Who is the character in this book?” or “This is the word *clambering*.”), (b) elaborate, which is when a teacher provides additional information about a target (e.g., requesting or providing definitions, examples, information about key features, attributes, or categories of words or concepts, dramatizing words or concepts; “The title tells us what the story is about” or “Show me what it would look like if we ‘clambered’ over to the library corner.”), (c) generalize, which is when a teachers helps children make connections between concepts and their own lives (e.g., “How many syllables are in your name, Cassandra?” or “Remember when the fire alarm went off the other day? We all *clambered* out of the room!”), and (d) analyze/reason, which is when teachers help children consider material in an abstract way (e.g., asking how or why questions and providing these explanations, comparing and contrasting, integrating and synthesizing, making predictions; “Which word has more letters—bug or banana?” or “Why do you think he was *clambering* into the basket?”).

Each of the four strategies could be coded for any of the RIA targets (e.g., print knowledge, vocabulary) during a given 30-s interval. For example, if a teacher asked what sound children heard at the beginning of a word, that teacher would be coded as targeting phonological awareness via an identify/orient strategy during that interval. If within that same interval, the teacher also asked which students’ names began with that same sound, the teacher would also be coded as targeting phonological awareness via a generalize strategy. Moreover, if the teacher also identified the sound as corresponding to a specific letter during the same 30-s interval, the teacher would additionally be coded as targeting print knowledge via an identify/orient strategy. ELLIT scores were computed by tallying the number of instructional strategies implemented across all intervals for a given RIA target. Double-coded using a randomly-selected 20 % of videos indicated high inter-rater reliability, with intraclass correlations greater than .91 for each RIA target.

As the second measure of quality of delivery, we assessed how well teachers delivered another key component of the curriculum, *use of scaffolding strategies*. The Scaffolding Coding Checklist (SCC; Justice et al. 2009) captured the extent to which teachers employed the six scaffolding strategies featured in the Learners’ Ladders of RIA lessons (i.e., eliciting, reducing choices, co-participation, generalizing, reasoning, and predicting). Research staff coded SCC from videotapes of RIA lessons from the beginning, middle, and

end of the academic year. Staff reviewed each extra-textual utterance made by teachers during RIA lessons and indicated whether any of the six scaffolding strategies were used to support children's learning. Each utterance could only be coded for a single strategy. SCC scores were computed by tallying the number of scaffolding strategies implemented across the RIA lesson. Double-coding using a randomly-selected 20 % of videos indicated high inter-rater reliability, with an intraclass correlation of .80. Additional information concerning this coding scheme is presented in Pentimonti and colleagues (2013).

Participant Responsiveness

Participant responsiveness refers to the extent to which those receiving a program respond to its content. In the current study, two measures of participant responsiveness were utilized, both of which were derived from the RIA Lesson Implementation Notes described above; recall that these were completed by teachers after each RIA lesson. For each lesson, teachers used a 3-point Likert scale (high, medium/variable, low) to rate the extent of (a) *child engagement* during the lesson and (b) *child success* with the lesson. Teachers' ratings across lessons were averaged for each of these measures, with scores close to 2 representing high engagement/success and scores close to 0 representing low engagement/success.

Child Learning Gains

Children participating in study assessments completed a large battery of direct measures in the fall and spring of preschool. All measures were individually administered by trained research staff in a quiet location at children's preschool centers. In the present study, one measure aligned to each of the four RIA target areas (print knowledge, phonological awareness, vocabulary, narrative) was selected from this larger battery a priori for purposes of exploring associations between implementation fidelity and child learning gains. Print knowledge, phonological awareness, and vocabulary were measured using the Print Knowledge, Phonological Awareness, and Definitional Vocabulary subtests, respectively, of the Test of Preschool Early Literacy (TOPEL; Lonigan et al. 2007). The Print Knowledge subtest of the TOPEL involves asking a child to demonstrate knowledge of book and print concepts, letter names, and letter sounds. The Phonological Awareness subtest involves asking a child to demonstrate the ability to manipulate (i.e., delete and blend) sounds in words, at the syllable and individual phoneme levels. The Definitional Vocabulary subtest is a measure of expressive language and involves asking a child to name and describe important features of pictured objects. These three subtests are standardized measures with adequate psychometric properties; reported Cronbach alphas range from .86 to .96 and test–retest correlations range from .81 to .89. Narrative was measured using the Narrative Assessment Protocol (Justice et al. 2010a). This measure involves eliciting a story retelling from a child and analyzing it for inclusion of lexical and syntactic forms. Psychometric qualities of this measure are adequate (Justice et al. 2010a), to include concurrent validity based on correlations with established measures of general language ability as well as high internal consistency ($\alpha = .83$) and inter-rater agreement (average item-level agreement = 83 %). For each of these measures, children's raw scores in the fall and spring of the academic year were computed as indicated in the respective administration manual. These raw scores were used to calculate gain scores (spring score minus fall score) for each individual child. The gain scores of children enrolled in the same

Table 1 Classroom language and literacy learning gains

Measure	<i>n</i> ^a	<i>M</i>	<i>SD</i>	Minimum	Maximum
Print knowledge	64	10.65	4.67	1.00	24.25
Phonological awareness	64	3.32	3.05	−3.20	11.00
Vocabulary	64	6.66	3.35	0.00	14.50
Narrative	64	2.53	3.65	−6.00	11.00

^a Number of classrooms for which average learning gains could be computed

classroom were then averaged to create the classroom-level gain scores used in analyses; descriptives for these classroom gain scores are presented in Table 1.

Results

Aim 1: Examination of Implementation Fidelity and Interrelations Among Dimensions

The first research aim was addressed using descriptive statistics and correlations. The means, standard deviations, and ranges for the measures of implementation fidelity are presented in Table 2. Notably, preliminary analyses were conducted to compare teachers assigned to RIA-T versus RIA-E conditions; there were no significant differences between conditions on any measure of implementation fidelity (comparisons available from the first author upon request) and thus all results are presented collapsed across condition.

With respect to adherence, teachers tended to exhibit high fidelity to general RIA lesson components, with over 90 % of general components implemented across lessons delivered at the beginning, middle, and end of the year. These variables were negatively skewed, with 82–92 % of teachers, respectively, exhibiting at least 80 % fidelity across these measures and time points. Implementation of RIA components specific to each lesson was lower, with an average of 76–82 % fidelity across the three time points. Implementation of these components was also slightly negatively skewed but also more variable, with 54–70 % of teachers exhibiting at least 80 % fidelity across time points. With respect to the Pupil Progress Checklists, teachers completed these at high rates at each of three time points (90–93 % completion rates).

For exposure, teachers delivered an average of 44 out of the 60 RIA lessons and 89 out of 120 RIA activities/objectives. Four percent of teachers delivered all 60 lessons (and thus completed all activities/objectives), 44 % delivered 50–59 lessons, 29 % delivered 40–49 lessons, and 22 % delivered fewer than 40 lessons. Fifty-three percent of teachers completed at least 80 % of the activities/objectives, and all but 10 teachers completed at least 50 % of the objectives. The average duration of an RIA lesson was 24 min, which is consistent with the anticipated duration of 20–30 min. Fifty-four percent of teachers averaged 20–30 min per lesson, with 14 % of teachers averaging more time per lesson, and 31 % of teachers averaging less time. Although the anticipated total implementation time for all 60 lessons was between 1,200 and 1,800 min, or 20–30 h across the year, only 23 % of teachers fell within this range. One teacher spent more time implementing, 36 % of teachers spent between 15 and 19 h implementing, 19 % spent between 10 and 14 h implementing, and 21 % spent less than 10 h implementing.

Considering quality of delivery, all teachers explicitly targeted print knowledge and narrative during the RIA lesson. Vocabulary and phonological awareness, however, were

Table 2 Implementation fidelity across all RIA teachers

Fidelity measure	<i>n</i>	<i>M</i>	Mode	<i>SD</i>	Observed		Possible range ^a
					Minimum	Maximum	
<i>Adherence</i>							
General RIA components							
Time 1	74	0.91	1.00	0.16	0.00	1.00	0–1
Time 2	68	0.92	1.00	0.11	0.50	1.00	0–1
Time 3	66	0.90	0.89	0.09	0.67	1.00	0–1
Specific RIA components							
Time 1	73	0.76	0.80	0.18	0.20	1.00	0–1
Time 2	67	0.82	1.00	0.18	0.30	1.00	0–1
Time 3	65	0.76	1.00	0.21	0.10	1.00	0–1
Pupil progress checklists completed							
Time 1	71	0.93	1.00	0.24	0.00	1.00	0–1
Time 2	71	0.91	1.00	0.28	0.00	1.00	0–1
Time 3	71	0.90	1.00	0.28	0.00	1.00	0–1
<i>Exposure</i>							
Full lessons implemented	72	44.18	54.00	15.20	0.00	60.00	0–60
Activities/objectives completed	72	88.82	106.00	30.45	0.00	120.00	0–12
Lesson duration	70	23.55	32.50	5.64	12.45	34.49	
Total implementation time	70	932.17	975.00	446.29	65.00	1912.00	
<i>Quality of delivery</i>							
Explicit language and literacy instruction							
Phonological awareness	63	7.33	0.00	10.83	0.00	43.00	
Print knowledge	63	21.86	10.00	17.81	2.00	134.00	
Vocabulary	63	6.62	0.00	8.69	0.00	29.00	
Narrative	63	33.83	9.00	18.60	2.00	85.00	
Scaffolding strategies use							
Time 1	73	11.08	5.00	7.15	1.00	28.00	
Time 2	67	11.24	8.00	8.91	0.00	39.00	
Time 3	66	15.47	13.00	8.63	0.00	37.00	
<i>Participant responsiveness</i>							
Child engagement	70	1.51	1.50	0.27	0.73	2.00	0–2
Child success	70	1.38	1.63	0.27	0.69	1.97	0–2

^a Variables for which the possible range is not specified had minimums of 0 but no maximums

targeted to a lesser extent. Although 77 and 54 % of teachers provided some vocabulary and phonological awareness instruction, respectively, these variables were positively skewed. With respect to use of scaffolding strategies, the vast majority of teachers used these during lessons; only 1 teacher did not use scaffolding strategies at two of the assessment points. At the beginning and middle of the year, most teachers tended to use between 3 and 20 scaffolding strategies during a lesson; by the end of the year, the tendency was to use between 6 and 24 such strategies.

With respect to participant responsiveness, teachers indicated that children in their classrooms tended to be engaged and experience success with the RIA lessons. Only 6 %

of teachers indicated that their students' average levels of engagement or success were low, with all other teachers indicating student engagement and success as moderate to high.

Prior to exploring bivariate correlations among measures or conducting any further analyses, outliers were identified and adjusted to within the median plus or minus two interquartile ranges (Tabachnick and Fidell 1996). Adjusting for outliers brought skew and kurtosis values for all variables to within generally acceptable ranges (<1.16), thus no further transformations were performed. Given the lack of variability for Pupil Progress Checklists completed, these variables were dichotomized into teachers who completed all checklists (1) versus those who did not (0). Results for these variables ought to be interpreted cautiously, however, given the close to 90/10 split and few teachers who did not complete all checklists (Tabachnick and Fidell 1996). Bivariate correlations among the measures are presented in Table 3. In general, measures of fidelity that were collected more than once tended to show small to moderate associations across time. Moreover, although various aspects of fidelity were correlated, patterns suggesting strong within- or across-dimension associations did not emerge.

Aim 2: Associations with Children's Language and Literacy Gains

The second research aim was largely exploratory in nature and examined correlations between teachers' implementation fidelity and the average language and literacy gains of children enrolled in their classrooms. Prior to analyses, composites were created for those fidelity measures completed at multiple time points. Fidelity scores from the beginning, middle, and end of the academic year were averaged to create composites for adherence to general components of RIA lessons, adherence to specific components of RIA lessons, and use of scaffolding strategies. A dichotomous composite was computed to indicate whether all (1) or only some (0) of the Pupil Progress Checklists were completed across the year. Results were identical regardless of whether outlier-adjusted or unadjusted variables were used.

Correlations between fidelity measures and children's learning gains are presented in Table 4. Gains were not associated with any measures of adherence or participant responsiveness. Gains on print knowledge and phonological awareness, however, were associated with some measures of exposure and quality of delivery. Greater print knowledge gains tended to be made in those classrooms whose teachers spent more time on RIA lessons and utilized more scaffolding strategies. (Greater gains also tended to be made in classrooms whose teachers provided greater amounts of explicit narrative instruction during RIA lessons.) Greater use of scaffolding strategies were also associated with greater phonological awareness gains.

Discussion

Over the last decade, numerous studies have presented results of language and literacy curriculum implementations with respect to impacts on teachers' practices in the classroom as well as children's language and literacy skills (e.g., Assel et al. 2007; Bierman et al. 2008; Fantuzzo et al. 2011; Hamre et al. 2010; Justice et al. 2008b, 2010b; Landry et al. 2006). Assessment of teachers' implementation fidelity has been included in these studies as a feature of study methodology, given its status as a quality indicator for efficacy trials (Odom et al. 2010) and its influence in determining whether a curriculum can be used at-scale (O'Donnell 2008). Fidelity indices have also been included in these studies as an

Table 3 Bivariate correlations among fidelity measures

	2	3	4	5	6	7	8	9	10	11	12
1. General RIA components, Time 1	0.33**	0.36**	0.23*	0.30*	0.21	0.29*	0.16	0.23	0.27*	0.25*	-0.13
2. General RIA components, Time 2		0.34**	-0.01	0.43**	0.16	0.06	0.01	-0.02	0.23	0.22	-0.18
3. General RIA components, Time 3			0.10	0.30*	0.42**	0.11	0.13	0.16	0.18	0.15	0.01
4. Specific RIA components, Time 1				0.42**	0.37**	-0.05	0.01	0.00	0.01	-0.01	-0.09
5. Specific RIA components, Time 2					0.47**	-0.02	-0.01	-0.10	0.14	0.12	-0.15
6. Specific RIA components, Time 3						0.16	0.15	0.11	0.05	0.00	0.04
7. Pupil progress checklists completed, Time 1							0.48**	0.34**	0.34**	0.34**	0.04
8. Pupil progress checklists completed, Time 2								0.77**	0.62**	0.61**	0.20
9. Pupil progress checklists completed, Time 3									0.46**	0.45**	0.09
10. Full lessons implemented										0.99**	0.16
11. Activities/objectives completed											0.16
12. Lesson duration											
13. Total implementation time											
14. Explicit instruction: phonological awareness											
15. Explicit instruction: print knowledge											
16. Explicit instruction: vocabulary											
17. Explicit instruction: narrative											
18. Scaffolding strategies, Time 1											
19. Scaffolding strategies, Time 2											
20. Scaffolding strategies, Time 3											
21. Child engagement											
22. Child success											

Table 3 continued

	13	14	15	16	17	18	19	20	21	22
1. General RIA components, Time 1	0.08	-0.10	-0.03	0.11	0.01	0.20	0.03	0.07	0.17	0.14
2. General RIA components, Time 2	-0.02	-0.14	0.14	0.15	0.05	0.08	0.04	0.24*	0.15	0.19
3. General RIA components, Time 3	-0.05	-0.15	0.11	-0.02	0.06	-0.15	-0.07	0.15	0.25*	0.22
4. Specific RIA components, Time 1	-0.04	0.19	-0.16	-0.13	-0.03	0.11	0.01	0.07	-0.08	-0.12
5. Specific RIA components, Time 2	-0.11	0.08	0.07	0.03	0.08	-0.01	0.17	0.25*	0.11	0.09
6. Specific RIA components, Time 3	-0.04	0.18	-0.19	-0.14	0.17	-0.14	0.03	0.12	0.17	0.14
7. Pupil progress checklists completed, Time 1	0.18	0.19	-0.25*	-0.14	0.16	0.05	0.04	-0.04	0.28*	0.28*
8. Pupil progress checklists completed, Time 2	0.43**	0.13	-0.08	-0.09	-0.12	0.02	-0.07	-0.12	0.16	0.09
9. Pupil progress checklists completed, Time 3	0.30*	-0.01	0.06	0.09	-0.22	-0.08	-0.10	-0.11	0.07	0.01
10. Full lessons implemented	0.70**	0.23	0.04	0.19	0.00	0.17	0.08	0.19	0.17	0.14
11. Activities/objectives completed	0.69**	0.22	0.05	0.21	0.02	0.18	0.10	0.20	0.17	0.13
12. Lesson duration	0.45**	0.13	-0.13	0.18	0.02	-0.04	0.23	0.15	0.10	0.12
13. Total implementation time		0.30*	-0.02	0.07	0.14	0.16	0.12	0.15	0.19	0.12
14. Explicit instruction: phonological awareness			-0.11	-0.18	0.27*	0.09	0.29*	0.24	0.20	0.05
15. Explicit instruction: print knowledge				0.45**	-0.20	-0.05	0.08	0.16	0.03	0.09
16. Explicit instruction: vocabulary					-0.37**	0.08	0.49**	0.27*	0.01	0.06
17. Explicit instruction: narrative						0.15	0.09	0.19	0.11	0.09
18. Scaffolding strategies, Time 1							0.15	0.29*	-0.13	-0.21
19. Scaffolding strategies, Time 2								0.44**	-0.02	0.00
20. Scaffolding strategies, Time 3									-0.02	-0.07
21. Child engagement										0.72**
22. Child success										

Results are presented for analyses of variables adjusted for outliers; the same overall pattern of results was found when using unadjusted variables. A similar pattern of results was also found when analyses were limited to the subsample of teachers who completed the full study, although associations involving full lessons implemented and activities/objectives completed were slightly attenuated due to the lesser variability on these measures in the subsample

* $p < .05$; ** $p < .001$

Table 4 Bivariate correlations between fidelity measures and child language and literacy learning gains

	Print knowledge	Phonological awareness	Vocabulary	Narrative
<i>Adherence</i>				
General RIA lesson components ($n = 64$)	0.098	0.198	−0.157	−0.195
Specific RIA lesson components ($n = 64$)	0.001	0.150	−0.055	−0.169
Pupil progress checklists completed ($n = 63$)	0.052	0.012	0.084	−0.170
<i>Exposure</i>				
Full lessons implemented ($n = 62$)	0.136	0.057	−0.197	−0.001
Activities/objectives completed ($n = 62$)	0.142	0.041	−0.193	−0.007
Lesson duration ($n = 61$)	0.365*	−0.204	0.017	−0.028
Total implementation time ($n = 61$)	0.213	0.015	−0.171	−0.161
<i>Quality of delivery</i>				
Explicit language and literacy instruction ($n = 60$)				
Phonological awareness	0.009	0.073	−0.019	−0.178
Print knowledge	−0.154	−0.082	0.139	0.048
Vocabulary	0.040	0.048	0.097	0.126
Narrative	0.305*	0.118	−0.034	−0.226
Scaffolding strategies use ($n = 64$)	0.253*	0.327**	−0.018	−0.159
<i>Participant responsiveness</i>				
Child engagement ($n = 61$)	0.016	−0.083	−0.214	−0.040
Child success ($n = 61$)	−0.020	−0.036	−0.163	−0.022

Results are presented for analyses of variables adjusted for outliers. The same pattern of results was found when using unadjusted variables

* $p < .05$; ** $p < .01$

outcome measure, given that teachers' achievement of fidelity to key components of curriculum is conceived as an important mechanism for improving children's skills (Hamre et al. 2010). Despite its ubiquity within the early-childhood intervention literature, however, few empirical investigations have comprehensively examined implementation fidelity as a targeted construct of interest. The present study was designed to fill this important gap in the literature, and to improve our understanding of implementation fidelity when pre-school teachers utilize a structured supplemental language and literacy curriculum over an academic year.

Before turning to discussion of our major findings, we first review the curriculum-implementation requirements requested of teachers in this study. Similar to those described in other recent works (Assel et al. 2007; Bierman et al. 2008; Hamre et al. 2010; Pianta et al. 2008b; Powell et al. 2010), teachers received professional development workshops (with some receiving extended technology-mediated modules) and all required materials to implement a supplemental language and literacy curriculum over the academic year, including lesson plans and 15 children's storybooks. Teachers followed an explicit scope and sequence of instruction, delivering 60 soft-scripted lessons plans at a rate of two lessons per week, embedded explicit talk about four targeted areas of development (phonological awareness, print knowledge, vocabulary, narrative) into these lessons, and used six

scaffolding strategies to differentiate delivery of lessons for individual students. Teachers also maintained notes regarding each lesson (reporting, for instance, on children's engagement during lessons) and completed pupil progress-monitoring checklists. Thus, although the curriculum itself may seem relatively straightforward compared to some of the more comprehensive and integrated curricula described recently in the literature (Bierman et al. 2008; Fantuzzo et al. 2011), teachers' implementation requirements were relatively complex. Such complexity argues for consideration and capture of varied indices of adherence, exposure, quality of delivery, and participant responsiveness, particularly as a means of further understanding the extent to which implementation may "scale up." To this end, this curriculum study provided an excellent opportunity to learn more about the construct of implementation fidelity and to explore teachers' achievement of fidelity across four separate dimensions (Dane and Schneider 1998; O'Donnell 2008) and the relations between fidelity and children's learning gains.

Findings of the present study that warrant elaboration are as follows. First, teachers showed relatively high levels of implementation fidelity over the academic year, encompassing measures of adherence, exposure, quality of delivery, and participant responsiveness. Adherence to the general format of lessons (for which teachers were observed to implement about 90 % of lesson components) and the more specific features of lessons (for which teachers implemented more than 70 % of lesson components) was high at the initial time-point and was maintained over the academic year. The same was also true with respect to exposure. Two-third of the teachers implemented at least two-thirds of the lessons (at least 40 over the 30-week implementation period) and they addressed, on average, 74 % of the objectives in the scope and sequence (89/120 activities/objectives). Lessons lasted an average of 24 min, which is within the targeted range, per lesson, of 20–30 min. Overall, teachers' total implementation time was 932 min, which falls somewhat short of the target of 1200–1800 min. Teachers' implementation of dynamic components of the intervention (providing explicit language and literacy instruction and using scaffolding strategies to differentiate instruction) was more variable but also interpreted as relatively high: About 70 30-s intervals of lessons featured explicit talk about language and literacy, and teachers used more than 11 scaffolding strategies per session. Given the overall high levels of fidelity exhibited, the results should therefore be interpreted to show that preschool teachers can enact multiple and varied components of a supplemental language and literacy curriculum designed for scale up, including fidelity to both procedural and process-oriented aspects, and maintain these components over an academic year.

Notably, although overall implementation fidelity was high, teachers showed greater fidelity to some aspects than others, and not necessarily along a strict procedural versus process dichotomy. Higher fidelity for general lesson component adherence, Pupil Progress Checklists completion, and activities/objectives completion is unsurprising as all such aspects were relatively straightforward and directly specified in lesson plans and/or the RIA manual. Moreover, general lesson components, in particular, applied to all lessons thereby affording teachers a good deal of practice in implementing these components. The specific components of lessons, on the other hand, required teachers to implement discrete elements particular to each individual lesson, a more challenging task necessitating that teachers understand the nuances of each lesson and its content. Implementation required that teachers rely on their own understandings and professional skills to implement these specific components, given that the lessons were semi-scripted and did not demand that teachers address the components in pre-specified ways. The latter may also explain the greater variability in teachers' quality of delivery, in terms of how well teachers

incorporated the core components of RIA (i.e., explicit language and literacy instruction, scaffolding strategies). Again, although the RIA language and literacy targets and scaffolding strategies were detailed in the manual and evident throughout lesson plans, lessons plans did not necessarily dictate how or when to implement these components. As a final point related to levels of implementation fidelity, teachers appeared to better implement explicit instruction on print knowledge and narrative as compared to phonological awareness and vocabulary. This finding was not an artifact of lessons and objectives selected for ELLIT coding, as objectives pertaining to each of the four key RIA target were equally represented in videos coded for this measure. Some evidence suggests that preschool teachers find the concept of phonological awareness particularly difficult, demonstrating lower phonological awareness knowledge themselves (Crim et al. 2008; Cunningham et al. 2009). A recent study also suggests that, within the context of typical practice, teachers of preschool-aged children afford considerably more opportunities to learn about print, books, and comprehension than phonological awareness or vocabulary (Yeager Pelatti et al. 2014). Thus, providing instruction on print knowledge and narrative may have been easier or more natural for teachers implementing RIA than providing instruction on phonological awareness or vocabulary.

Second, there were relatively low correlations among measures of implementation fidelity collected from the participating teachers. This was true when looking across theorized constructs (e.g., relations between measures of adherence and exposure), within a construct (e.g., relations between various measures of adherence), and even over time (e.g., the relations between a measure of adherence at time 1 and time 2). Although such findings seem surprising, as we might expect a teacher to show similar levels of fidelity for all aspects of implementation—that is, for a teacher to be a generally good or not-so-good implementer—prior literature has also showed relatively low correlations across some measures of fidelity, such as exposure (dosage) and adherence (Pianta et al. 2008b). Justice and colleagues examined fidelity of implementation for 135 preschool teachers who used a supplemental language and literacy curriculum for an academic year, and found virtually no relations between indices of implementation procedures versus processes of the curriculum (Justice et al. 2008a). Interestingly, from a pragmatic standpoint, such findings suggest that a teacher who shows high levels of fidelity to one component of a curriculum does not necessarily show high levels of fidelity to another component. From a more theoretical perspective, the present findings also support the importance of viewing implementation fidelity as a multi-dimensional construct, as has been referenced in both the educational literature and in the health sciences (Dane and Schneider 1998; Domitrovich et al. 2010; O'Donnell 2008). An important implication of this conceptualization is that researchers should seek to capture implementation fidelity across various indices reflecting adherence, exposure, quality of delivery, and participant responsiveness. The relatively low inter-correlations between variables presumably mapping to a single dimension of fidelity (e.g., adherence to the general content of RIA lessons and adherence to the specific content of RIA lessons, $r = .23$ at Time 1 observations) also suggests that multiple indicators of each dimension may be necessary to fully capture implementation of a given dimension. Notably, although restricted range might be cited as an explanation for low correlations involving certain measures of adherence (e.g., general RIA components at Time 2 and Time 3), other measures and time points for adherence showed greater variability, and measures of exposure, quality of delivery, and participant responsiveness were less likely to be affected by restriction of range.

Third, there were very limited relations observed among indices of implementation fidelity and children's gains in language and literacy skills. Although somewhat

unexpected, few studies of preschool language and literacy curricula have explicitly linked heightened implementation fidelity to heightened child outcomes (cf. Hamre et al. 2010) and our findings are somewhat aligned with indications that process-oriented aspects of fidelity (e.g., use of scaffolding strategies) are most likely to be associated with child gains (Hamre et al. 2010; Justice et al. 2008a). We offer two possible reasons for the lack of correspondence between implementation fidelity and children's gains. First, it is possible that thresholds operate with respect to implementation fidelity, such that increases in implementation fidelity above a certain threshold do not lead to corresponding improvements in children's skills. Research on classroom quality, which could be conceived as an indicator of implementation fidelity in which classroom quality is a curricular focus, suggests that such thresholds do exist (Burchinal et al. 2010). Second, it is also possible that there is an interdependence among the various dimensions of implementation fidelity, such that no one dimension exerts a unique impact on children's skills but rather it is the interplay among the dimensions that matter. As an example, McGinty and colleagues showed an interdependence between measures of adherence and exposure when predicting children's gains from an early-literacy program used by their preschool teachers (McGinty et al. 2011). Although an assessment of the interactions among fidelity indices was beyond the scope of this study, our findings suggest that this may be an interesting avenue to pursue in future research on implementation fidelity.

We recognize that there are limitations of this study, the most important of which include the following. First, the teachers in this study implemented a single curriculum supplement. This may affect the generalizability of our results to understanding implementation fidelity more generally. We encourage other researchers to take on comprehensive evaluations of curriculum fidelity to bolster our understanding of this important construct. Relatedly, it is unclear how results may generalize to other cultural contexts (e.g., beyond preschool settings in the United States). Second, some of our measures of implementation fidelity involved teacher report, including all measures of participant responsiveness. Social desirability as well as inaccurate memories can negatively affect the validity of self-reported data. Future research should adopt, whenever possible, more direct measures of implementation fidelity. Third, our study cannot directly ascertain why teachers exhibited particular levels of fidelity (e.g., the role of prior knowledge or additional professional development activities not specific to the curriculum); this would be an important avenue for future research. Last, our work was largely exploratory, given the relative dearth of relevant research on this topic, and our sample size was too small to allow for some advanced statistical modeling techniques. We view this as a first foray into an important and under-studied aspect of curriculum and intervention research, and hope our results provide a springboard for future work. Exciting future investigations of implementation fidelity might incorporate larger samples to use person-centered approaches for examining profiles of teachers with respect to fidelity, or more definitely examine the dimensionality of fidelity with respect to adherence, exposure, quality of delivery, and participant responsiveness. As a whole, research on fidelity will undoubtedly move the field forward as we strive to more effectively integrate research and practice concerning curriculum implementation.

Acknowledgments This research was supported by Grant R305A080459 from the Institute of Education Sciences. The opinions expressed are those of the authors and do not necessarily represent views of the Institute or the U.S. Department of Education. We would like to thank the research team and the many administrators, teachers, and children without whom this study would not have been possible.

Conflict of interest The authors declare that they have no conflict of interest. Although two of the authors are also developers of Read It Again!, the supplemental curriculum is made freely available on the internet and is not commercially published; the developers thus have no financial ties to the curriculum.

Ethical Standards The research was conducted in a manner that complied with Human Subjects Protections, as approved by investigators' respective Internal Review Boards. All participants provided informed consent.

References

- Archer, A., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient teaching*. New York, NY: Guilford Press.
- Assel, M., Landry, S., Swank, P., & Gunnewig, S. (2007). An evaluation of curriculum, setting, and mentoring on the performance of children enrolled in pre-kindergarten. *Reading and Writing*, 20(5), 463–494. doi:[10.1007/s11145-006-9039-5](https://doi.org/10.1007/s11145-006-9039-5).
- Berkel, C., Mauricio, A., Schoenfelder, E., & Sandler, I. (2011). Putting the pieces together: An integrated model of program implementation. *Prevention Science*, 12(1), 23–33. doi:[10.1007/s11121-010-0186-1](https://doi.org/10.1007/s11121-010-0186-1).
- Bierman, K. L., Domitrovich, C. E., Nix, R. L., Gest, S. D., Welsh, J. A., Greenberg, M. T., & Gill, S. (2008). Promoting academic and social-emotional school readiness: The Head Start REDI program. *Child Development*, 79(6), 1802–1817. doi:[10.1111/j.1467-8624.2008.01227.x](https://doi.org/10.1111/j.1467-8624.2008.01227.x).
- Burchinal, M., Vandergrift, N., Pianta, R., & Mashburn, A. (2010). Threshold analysis of association between child care quality and child outcomes for low-income children in pre-kindergarten programs. *Early Childhood Research Quarterly*, 25(2), 166–176.
- Cabell, S. Q., Justice, L. M., Piasta, S. B., Curenton, S. M., Wiggins, A., Pence Turnbull, K. L., & Petscher, Y. (2011). The impact of teacher responsivity education on preschoolers' language and literacy skills. *American Journal of Speech-Language Pathology*, 20, 315–330. doi:[10.1044/1058-0360\(2011/10-0104](https://doi.org/10.1044/1058-0360(2011/10-0104).
- Century, J., Rudnick, M., & Freeman, C. (2010). A framework for measuring fidelity of implementation: A foundation for shared language and accumulation of knowledge. *American Journal of Evaluation*, 31(2), 199–218. doi:[10.1177/1098214010366173](https://doi.org/10.1177/1098214010366173).
- Christ, T., Wang, X. C., & Chiu, M. M. (2011). Using story dictation to support young children's vocabulary development: Outcomes and process. *Early Childhood Research Quarterly*, 26(1), 30–41. doi:[10.1016/j.ecresq.2010.06.002](https://doi.org/10.1016/j.ecresq.2010.06.002).
- Crim, C., Hawkins, J., Thornton, J., Rosof, H. B., Copley, J., & Thomas, E. (2008). Early childhood educators' knowledge of early literacy development. *Issues in Teacher Education*, 17(1), 17–30.
- Cunningham, A. E., Zibulsky, J., & Callahan, M. D. (2009). Starting small: Building preschool teacher knowledge that supports early literacy development. *Reading and Writing: An Interdisciplinary Journal*, 22(4), 287–510.
- Dane, A. V., & Schneider, B. H. (1998). Program integrity in primary and early secondary prevention: Are implementation effects out of control? *Clinical Psychology Review*, 18(1), 23–45.
- Domitrovich, C. E., Gest, S. D., Jones, D., Gill, S., & DeRousie, R. M. S. (2010). Implementation quality: Lessons learned in the context of the Head Start REDI trial. *Early Childhood Research Quarterly*, 25(3), 284–298. doi:[10.1016/j.ecresq.2010.04.001](https://doi.org/10.1016/j.ecresq.2010.04.001).
- Durlak, J. A. (2010). The importance of doing well in whatever you do: A commentary on the special section, "Implementation research in early childhood education". *Early Childhood Research Quarterly*, 25(3), 348–357. doi:[10.1016/j.ecresq.2010.03.003](https://doi.org/10.1016/j.ecresq.2010.03.003).
- Dusenbury, L., Brannigan, R., Falco, M., & Hansen, W. B. (2003). A review of research on fidelity of implementation: Implications for drug abuse prevention in school settings. *Health Education Research*, 18(2), 237–256.
- Fantuzzo, J. W., Gadsden, V. L., & McDermott, P. A. (2011). An integrated curriculum to improve mathematics, language, and literacy for Head Start children. *American Educational Research Journal*, 48(3), 763–793. doi:[10.3102/0002831210385446](https://doi.org/10.3102/0002831210385446).
- Hamre, B. K., Justice, L. M., Pianta, R. C., Kilday, C., Sweeney, B., Downer, J. T., & Leach, A. (2010). Implementation fidelity of MyTeachingPartner literacy and language activities: Association with preschoolers' language and literacy growth. *Early Childhood Research Quarterly*, 25(3), 329–347. doi:[10.1016/j.ecresq.2009.07.002](https://doi.org/10.1016/j.ecresq.2009.07.002).

- Hulleman, C. S., & Cordray, D. S. (2009). Moving from the lab to the field: The role of fidelity and achieved relative intervention strength. *Journal of Research on Educational Effectiveness*, 2(1), 88–110. doi:[10.1080/19345740802539325](https://doi.org/10.1080/19345740802539325).
- Justice, L. M., Bowles, R., Pence, K., & Gosse, C. (2010a). A scalable tool for assessing children's language abilities within a narrative context: The NAP (Narrative Assessment Protocol). *Early Childhood Research Quarterly*, 25(2), 218–234.
- Justice, L. M., & Ezell, H. K. (2002). Use of storybook reading to increase print awareness in at-risk children. *American Journal of Speech-Language Pathology*, 11(1), 17–29.
- Justice, L. M., Mashburn, A. J., Hamre, B. K., & Pianta, R. C. (2008a). Quality of language and literacy instruction in preschool classrooms serving at-risk pupils. *Early Childhood Research Quarterly*, 23(1), 51–68. doi:[10.1016/j.ecresq.2007.09.004](https://doi.org/10.1016/j.ecresq.2007.09.004).
- Justice, L. M., Mashburn, A., Pence, K. L., & Wiggins, A. (2008b). Experimental evaluation of a preschool language curriculum: Influence on children's expressive language skills. *Journal of Speech, Language, and Hearing Research*, 51(4), 983–1001.
- Justice, L. M., McGinty, A. S., Cabell, S. Q., Kilday, C. R., Knighton, K., & Huffman, G. (2010b). Language and literacy curriculum supplement for preschoolers who are academically at risk: A feasibility study. *Language, Speech, and Hearing Services in the Schools*, 41(2), 161–178. doi:[10.1044/0161-1461\(2009/08-0058](https://doi.org/10.1044/0161-1461(2009/08-0058).
- Justice, L. M., Pentimonti, J. M., Sofka, A. E., & McGinty, A. S. (2009). *Scaffolding Coding Checklist coding manual*. Columbus, OH: The Ohio State University.
- Landry, S. H., Swank, P. R., Smith, K. E., Assel, M. A., & Gunnewig, S. B. (2006). Enhancing early literacy skills for preschool children: Bringing a professional development model to scale. *Journal of Learning Disabilities*, 39(4), 306–324.
- Lonigan, C. J., Farver, J., Phillips, B., & Clancy-Menchetti, J. (2011). Promoting the development of preschool children's emergent literacy skills: A randomized evaluation of a literacy-focused curriculum and two professional development models. *Reading and Writing*, 24(3), 305–337. doi:[10.1007/s11145-009-9214-6](https://doi.org/10.1007/s11145-009-9214-6).
- Lonigan, C. J., Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (2007). *Test of preschool early literacy*. Austin, TX: Pro-Ed.
- Mashburn, A. J., Downer, J. T., Hamre, B. K., Justice, L. M., & Pianta, R. C. (2010). Consultation for teachers and children's language and literacy development during pre-kindergarten. *Applied Developmental Science*, 14(4), 179–196.
- McGinty, A. S., Breit-Smith, A., Fan, X., Justice, L. M., & Kaderavek, J. N. (2011). Does intensity matter? Preschoolers' print knowledge development within a classroom-based intervention. *Early Childhood Research Quarterly*, 26, 255–267. doi:[10.1016/j.ecresq.2011.02.002](https://doi.org/10.1016/j.ecresq.2011.02.002).
- McGinty, A. S., Petit, L., Gosse, C., Pentimonti, J. M., & Justice, L. M. (2011). *Explicit Language and Literacy Instruction Techniques coding manual*. Charlottesville, VA: University of Virginia.
- National Early Literacy Panel. (2008). *Developing early literacy*. Washington, D. C.: National Institute for Literacy.
- O'Donnell, C. L. (2008). Defining, conceptualizing, and measuring fidelity of implementation and its relationship to outcomes in K-12 curriculum intervention research. *Review of Educational Research*, 78(1), 33–84. doi:[10.3102/0034654307313793](https://doi.org/10.3102/0034654307313793).
- Odom, S. L., Fleming, K., Diamond, K., Lieber, J., Hanson, M., Butera, G., & Marquis, J. (2010). Examining different forms of implementation and in early childhood curriculum research. *Early Childhood Research Quarterly*, 25(3), 314–328. doi:[10.1016/j.ecresq.2010.03.001](https://doi.org/10.1016/j.ecresq.2010.03.001).
- Pence, K. L., Justice, L. M., & Wiggins, A. K. (2008). Preschool teachers' fidelity in implementing a comprehensive language-rich curriculum. *Language, Speech, and Hearing Services in Schools*, 39(3), 329–341.
- Pentimonti, J. M., & Justice, L. (2010). Teachers' use of scaffolding strategies during read alouds in the preschool classroom. *Early Childhood Education Journal*, 37(4), 241–248. doi:[10.1007/s10643-009-0348-6](https://doi.org/10.1007/s10643-009-0348-6).
- Pentimonti, J. M., Justice, L. M., McGinty, A. S., Slocum, L., & O'Connell, A. A. (2013). Teachers use of the dynamic features of a curriculum supplement. Manuscript in preparation.
- Pianta, R. C., Belsky, J., Vandergrift, N., Houts, R., & Morrison, F. J. (2008a). Classroom effects on children's achievement trajectories in elementary school. *American Educational Research Journal*, 45(2), 365–397.
- Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008b). Effects of web-mediated professional development resources on teacher-child interactions in pre-kindergarten classrooms. *Early Childhood Research Quarterly*, 23(4), 431–451.

- Piasta, S. B., Dynia, J. M., Justice, L. M., Pentimonti, J. M., Kaderavek, J. N., & Schatschneider, C. (2010). Impact of professional development on preschool teachers' print references during shared reading: A latent growth curve analysis. *Journal of Research on Educational Effectiveness*, 3, 343–380.
- Piasta, S. B., Justice, L. M., Cabell, S. Q., Wiggins, A. K., Pence Turnbull, K., & Curenton, S. M. (2012). Impact of professional development on preschool teachers' conversational responsiveness and children's linguistic productivity and complexity. *Early Childhood Research Quarterly*, 27, 387–400. doi:[10.1016/j.ecresq.2012.01.001](https://doi.org/10.1016/j.ecresq.2012.01.001).
- Pollard-Durodola, S. D., Gonzalez, J. E., Simmons, D. C., Kwok, O., Taylor, A. B., Davis, M. J., & Simmons, L. (2011). The effects of an intensive shared book-reading intervention for preschool children at risk for vocabulary delay. *Exceptional Children*, 77(2), 161–183.
- Powell, D. R., Diamond, K. E., Burchinal, M. R., & Koehler, M. J. (2010). Effects of an early literacy professional development intervention on Head Start teachers and children. *Journal of Educational Psychology*, 102(2), 299–312. doi:[10.1037/a0017763](https://doi.org/10.1037/a0017763).
- Preschool Curriculum Evaluation Research Consortium. (2008). *Effects of preschool curriculum programs on school readiness: Report from the Preschool Curriculum Evaluation Research Initiative*. Washington, D.C.: Institute of Education Sciences.
- Schulte, A. C., Easton, J. E., & Parker, J. (2009). Advances in treatment integrity research: Multidisciplinary perspectives on the conceptualization, measurement, and enhancement of treatment integrity. *School Psychology Review*, 38(4), 460–475.
- Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics* (3rd ed.). New York: HarperCollins.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wasik, B. A., & Bond, M. A. (2001). Beyond the pages of a book: Interactive book reading and language development in preschool classrooms. *Journal of Educational Psychology*, 93(2), 243.
- Yeager Pelatti, C., Piasta, S. B., Justice, L. M., & O'Connell, A. A. (2014). Language- and literacy-learning opportunities in early childhood classrooms: Children's typical experiences and within-classroom variability. *Early Childhood Research Quarterly*, 29(4), 445–456. doi:[10.1016/j.ecresq.2014.05.004](https://doi.org/10.1016/j.ecresq.2014.05.004).