

Synthesis of IES Research on Early Intervention and Early Childhood Education

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Disclaimer

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The professional engagements reported by each panel member that appear most closely associated with the panel conclusions are noted below.

Dr. Diamond is Professor in the Department of Human Development and Family Studies at Purdue University. Her expertise centers in professional development interventions with early childhood teachers. She has served as the Co-PI for two IES grants related to the use of on-site and distance coaching in professional development with teachers of at-risk preschool children (R305M040167 and R305B070605). No conflicts of interest are present.

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Executive Summary

Synthesis of IES Research on Early Intervention and Early Childhood Education

The purpose of this synthesis is to describe what we have learned from research grants on early intervention and childhood education funded by the Institute of Education Sciences (IES) National Center for Education Research and National Center for Special Education Research and published in peer-reviewed outlets through June 2010. This synthesis is not intended to be the typical research review, which provides a broad overview of research in a field. Rather, it looks across the projects that IES funded to determine what has been learned and to suggest to the field avenues for further research to support improvements in early childhood education in our country.

It is important to contextualize this report. Soon after it was founded, IES launched a broad range of research programs to better understand the links between early childhood education, early intervention, and children's learning and development; develop more powerful interventions for improving child outcomes; rigorously test the impact of programs, practices, and policies on child outcomes; and develop and validate assessment measures for use with young children. Among these research programs are those that focus on improving developmental outcomes and school readiness for young children with or at risk for disabilities. In the synthesis report accompanying this Summary, we give special attention to summarizing what has been learned about early childhood classrooms as contexts for development and learning, the kinds of instructional practices and curricula that appear to be efficacious for enhancing children's development and learning, and approaches for improving teachers' and other practitioners' (e.g., speech, occupational, or physical therapists) instruction, given hypothesized linkages between instructional quality, instructional effectiveness and children's learning.

To support the development of this report, IES identified its research grants relevant to the topic and gathered the peer-reviewed journal articles and chapters produced under these grants. IES staff consulted with its grantees to confirm that all peer-reviewed articles emerging from these projects and published or in-press by June 2010 were identified. The articles and chapters were then provided to a panel that included four nationally-recognized experts in early childhood education. Through several conference calls, panel members decided on the focus and organizing themes for the synthesis. The written report reflects their expert judgment as to the contributions of the reviewed articles and chapters toward advancing knowledge and practice in early childhood education.

The panel identified a number of notable contributions of IES-funded research projects to understanding early childhood education and interventions intended to improve early education. These contributions reflect four areas of inquiry by IES-supported researchers: research related to early childhood classroom environments and general instructional practices; research related to educational practices designed to impact children's academic and social outcomes; research

related to measuring young children's skills and learning; and research related to professional development for early educators.

Below, we provide a summary of contributions to the knowledge base in early childhood education and intervention produced by IES-funded research across these four focal areas.

Research related to early childhood classroom environments and general instructional practices

A considerable volume of work supported by IES research investments has focused on improving understanding of teaching and learning as it occurs in early childhood programs; such work is important for helping us to identify those features of classrooms that are reliably associated with children's achievements. IES-supported research has furthered our understanding of early childhood classroom environments and general instructional practices by making the following seven contributions to the literature.

First, IES-supported research shows that there are critical associations between features of pre-kindergarten classrooms, such as the quality of teacher-child interactions and the nature of teachers' feedback to children, and positive children's outcomes. For instance, the extent to which teachers are observed providing emotional support to children in their classroom is positively associated with children's growth in social competence. Second, research findings show that parents' and teachers' support for children's learning contributes to young children's outcomes. As an example, one study showed that the extent to which parents were involved in their children's schooling and their perceptions about their children's teacher were related to their children's academic and social competence. Third, research findings show that participation in higher-quality classroom environments is associated with improved learning outcomes for young children. IES-supported research found that children within classrooms characterized by relatively high levels of emotional support and instructional support show greater growth over an academic year on measures of academic and social development. Fourth, IES-supported research indicates that children enrolled in early education settings exhibit great variability in their skills and risk factors. Such work may be important for considering how early instruction can be differentiated to meet the diverse needs of children with early education settings. Fifth, IES-supported work demonstrates that there is a need to improve characteristics of the classroom language environment. This work suggests that children in preschool classrooms may be exposed to few exemplars of advanced linguistic content, such as challenging questions, which may inhibit language-development opportunities. Sixth, and relatedly, studies show that the content of early childhood education may be relatively constrained with respect to provision of math- and science-oriented instruction; in turn, children's potential for increasing their knowledge of math and science concepts within the preschool classroom may be limited. Seventh, IES-supported work shows that the composition of preschool classrooms may influence children's learning. Optimal classrooms may be those in which children have the opportunity to learn from peers with advanced skills, as suggested in one study.

Research related to educational practices designed to impact children's academic and social outcomes

In the field of early childhood education, teaching professionals are pressed to use research-based practices, particularly in the areas of language, literacy, mathematics, cognition, and social skills. For this to occur, there must be a body of work identifying those practices that are likely to have positive impacts on children's development if applied in the classroom. This work might be directed towards developing and testing new, innovative practices targeting certain areas of learning (e.g., math, science), or it might be directed towards documenting the effects of commonly used practices or curricula. A substantial volume of IES-supported work contributes to developing and testing new or accepted practices, resulting in 13 separate contributions to the literature noted in this report. These contributions fall into three focal areas.

First, IES-supported work identified specific practices that teachers can use to improve children's language, literacy, mathematics, cognitive (i.e., abstract reasoning), and social skills. For instance, researchers identified specific ways that teachers can read books to children to improve literacy skills, and specific types of activities (e.g., board games) that teachers can use to improve mathematic skills. At the same time, researchers also identified some commonly used programs that appear to have little impact on children's skills. Second, some IES-supported work focused specifically on developing and testing practices that may be used with special populations of children, such as those at-risk for reading difficulty, those with problem behaviors, and those with sensory disabilities (e.g., hearing loss). This work is important for supporting the development of all children in the classroom and appropriately differentiating instructional approaches. Third, IES-supported work examined the use of tiered approaches to supporting instruction, commonly referred to as response-to-intervention (RtI). For instance, study findings show that RtI may be an appropriate approach for supporting children's early math development.

Research related to measuring young children's skills and learning

The development of valid and reliable measures of children's skills and learning, for use by educators or members of the research community, is an important scientific pursuit. For instance, research examining the association between specific features of classroom environments, such as the quality of instruction, and children's language development must validly and reliably represent the classroom environment and children's learning in some way. IES-supported researchers made three notable contributions related to the measurement of children's skills and learning.

First, research findings show that some measures commonly used in the early childhood community may not provide reliable information about children's skills. Such findings show the importance of conducting ongoing evaluations of measures commonly used, and also point to the need for new measures to be developed that provide reliable information. To this end, a second contribution of note is that IES-supported research generated new tools that can reliably and

validly describe children's growth and learning in key areas. These include screening tests that can reliably show which children may benefit from supplemental or specialized interventions in reading. Third, research has focused on the use of progress monitoring and data-based decision making tools that might improve teachers' instructional practice. This line of research considers how dynamic tools that monitor children's growth over time can be used by teachers to individualize instruction in key areas.

Research related to professional development for early educators

A growing volume of work, including work supported by IES, is systematically identifying how professional development may be used to improve instruction in early childhood settings. The need for improvement is warranted not only based on descriptive evaluations of the need for improved quality of instruction in many early education settings, but also to ensure that early childhood educators have access to the most up-to-date information about effective practices and programs. As IES-supported researchers continue to expand what is known about early childhood, this knowledge must be shared in effective ways with educators. This report identified three ways in which IES-supported research contributed to what is known about professional development for early educators.

First, study findings show that classroom instruction can be improved by providing professional development to teachers. Improvements in instruction may be seen in general measures of the instructional environment or in more focal ways, such as teachers' use of assessment data to design individual instruction. Second, and as importantly, study results show that professional development impacts are seen not only in what teachers do in their classrooms but also in what children are learning. As an example, children's literacy development benefits when teachers receive professional development coursework focused on improving their literacy instruction. Third, IES-supported work made important contributions to showing how technology can be used as a mechanism for the professional development of teachers. Technology provides a mechanism for helping teachers observe their own practices (via video analysis), for working distally with coaches, and for monitoring children's progress using hand-held digital technologies.

The research, practice, and policy communities have learned a lot about effective educational practices through IES-supported research. For instance, this body of work identified specific practices that teachers can use to improve children's learning in key areas, and has also identified effective ways to support teachers through professional development.

The authors of this report also assert that there is much more that needs to be learned to ensure that early education settings are as effective as they can be as the entry point for many children to arrive into formal schooling. For instance, there is a great need for improved understanding of the most effective ways to intervene with children who live in very challenging circumstances or who are learning multiple languages at once. Moreover, there is still a pressing need to learn more about the practices and curricula commonly employed in early education settings,

particularly the conditions under which these are most effective. Many of the practices studied in IES-supported work likely work in some settings, but not all, and for some children, but not all. In our view, important questions for early education research include:

What are the crucial features of high quality early childhood education? More evidence is needed about the relationship between specific features of classroom quality and children’s development and learning in specific domains. We know little about minimum thresholds of classroom quality that are necessary to optimize learning. Research is needed that will help us identify when and what kinds of investments in quality improvement are likely to have the biggest impact on children’s learning and development.

Which instruction is most effective for which children and under what circumstances? More evidence is needed about aspects of effective instruction for young children, including children with significant learning needs. What are the most effective and efficient approaches for improving children’s attention and self-regulation, and promoting their language, literacy, mathematics, and science learning to establish the foundations for success in the elementary grades? What adaptations are needed so that instruction is effective for every child? Also, many important issues remain to be addressed about effective and efficient interventions with children who demonstrate learning difficulties. In addition to the continued development of effective, individualized interventions, further attention is needed to the development of assessment tools that can be used quickly and reliably to monitor preschool children’s progress in academic and social learning domains, and which can sensitively and specifically identify future academic risks.

How do we effectively and efficiently support teachers in improving their instruction? While we have learned a lot about effective instructional practices, we know much less about effective strategies for helping teachers to improve the quality of their classrooms and the instruction that they provide. This remains an important target for future research.

Research in early education and early intervention, supported by IES, has made substantial and significant contributions to our understanding of effective practices for enhancing the learning and development of our youngest and most vulnerable citizens. Importantly, much of this work is ongoing and is not included in this report. In the next decade, due in part to these IES-supported efforts, our understanding of early childhood education will expand exponentially. In our opinion, it is important that periodic compilations of these accumulating findings, such as that presented here, are undertaken; this is important for cataloging advances in what we are learning as well as areas in which we must continue to improve our understanding. Rigorous research that addresses important questions about approaches for promoting children’s development and learning can provide educators (and other public consumers of education) with important guidance regarding the scientific bases for practices and policies currently in place, or under consideration for adoption.

Preamble from the Institute of Education Sciences

In 1999, the National Research Council published a report on the state of education research in the United States. The panel concluded,

One striking fact is that the complex world of education—unlike defense, health care, or industrial production—does not rest on a strong research base. In no other field are personal experience and ideology so frequently relied on to make policy choices, and in no other field is the research base so inadequate and little used.

National Research Council (1999, p. 1)

Three years later with the passage of the Education Sciences Reform Act of 2002, Congress established the Institute of Education Sciences (IES) and charged it with supporting rigorous, scientifically valid research that is relevant to education practice and policy. To meet this charge, IES established long-term programs of research that focused on topics of importance to education practitioners and leaders (e.g., reading, teacher quality, education systems), clearly specified methodological requirements for projects, and established a scientific peer review system for reviewing grant proposals.

Since 2002, IES' National Center for Education Research has funded a broad range of work targeted toward providing solutions to the education problems in our nation. In 2006, IES' National Center for Special Education Research began funding a comprehensive program of special education research designed to expand the knowledge and understanding of infants, toddlers and children with or at risk for disabilities. In both IES Centers, the funds are provided for exploratory research, development of education interventions, development and validation of measurement instruments, and evaluation of the impact of interventions. Exploratory research examines the relations between education outcomes and malleable factors (i.e., factors that can be changed, such as child behaviors, teacher practices, school management strategies), as well as the mediators and moderators of those relations. Exploratory research can inform the development of new education interventions or identify those interventions that are associated with better education outcomes and should be rigorously evaluated. Development and innovation projects are intended to create potent and robust interventions that may be effective for improving education outcomes. Development research is important because we have not yet solved old problems (e.g., closing achievement gaps), and we continue to face new challenges and opportunities (e.g., integrating new technologies into education systems). In addition to developing interventions, IES supports research to develop and validate measurement instruments, including screening tools, progress monitoring instruments, measures of child outcomes, and assessments of teachers' and administrators' knowledge and skills.

A critical component of IES research has been rigorous evaluation of the impact of programs, practices, and policies on education outcomes. Education has always produced new ideas, new innovations, and new approaches, but as in any field, new is not always better. Historically education research has not rigorously tested whether programs and policies actually produce

positive effects on education outcomes. The research enterprise has not provided education leaders and practitioners with scientifically valid information on which interventions appear to be effective in achieving their intended goals, which need more work to become more potent or more robust, and which appear ineffective and should perhaps be discarded. Since its inception, IES has been committed to supporting rigorous experimental and quasi-experimental evaluations to answer the questions of what works, for whom it works, under what conditions it works, and why something does or does not work. This document is an effort to take stock of what we have learned thus far.

IES Research Syntheses

As part of our assessment of the work that IES is doing, we are asking panels of eminent scholars to review peer-reviewed journal articles and chapters that are products of IES-funded research grants on a specific topic (e.g., reading, early childhood). These papers include empirical studies as well as theoretical pieces. The task for each panel of scholars is to synthesize what we have learned from IES-funded research on their topic and to summarize the results for a general audience that includes policymakers and other stakeholders. The syntheses are not intended to be typical research reviews, which provide a grand overview of research in a field. Rather, the task is to look across the projects that IES has funded to determine what has been learned and where empirical and theoretical progress has been made as a result of IES funding, and to provide suggestions to further research to improve education in our country.

The first step involved in producing an IES research synthesis is to select a topic. Topics are determined by IES staff members who review the overall research portfolio to identify topics that include multiple projects that have been completed and from which peer-reviewed articles and book chapters have already been published. A panel chair is then selected who is a nationally recognized researcher in the topic area. Next, IES staff works with the chair to identify a small number of panelists to co-author the research synthesis. These are people the chair believes are nationally recognized experts in the topic area, and are, in many cases, themselves recipients of IES grants. IES then identifies the research grants that are relevant to the topic and gathers the peer-reviewed journal articles and chapters that were produced under these grants relevant to the topic being reviewed. IES staff consults with grantees when appropriate in order to ascertain the relevance of the funded project to the topic of the synthesis and to confirm that all peer-reviewed articles emerging from these projects are included. The articles and chapters are then provided to the panel. The panel meets several times, either in person or in conference calls, to discuss the focus of the synthesis and to identify organizing questions or themes. The panel is given a relatively short deadline of 4 to 6 months to produce a draft document. Under the broad question of what has been learned from IES-supported research, the panel reviews the published research and organizes the synthesis under topics or questions that reflect the work that has been published. The panel also may include non-IES research in the synthesis, to provide the background or context for the IES-sponsored research or to describe the work on which IES research builds. The expert panel interacts with and receives feedback from IES staff during the

development of the research synthesis. However, the panel uses their collective expertise to determine the foci of the written report, and the synthesis reflects the panel members' expert judgment as to the strength of the evidence presented in the published work and the contribution of the reviewed articles and chapters to the synthesis topic. The panel members are the authors of the synthesis and thus responsible for the final product.

Before it can be published, the research synthesis is subjected to rigorous external peer review through the IES Standards and Review Office, which is responsible for independent review of IES publications. The panel then responds to the peer-reviewer comments and makes appropriate revisions.

The focus of the present synthesis reflects the Institute's emphasis on research on programs, practices, and policies intended to improve school readiness for children who are at risk for later school failure (through the National Center for Education Research or NCER) and on research that contributes to the improvement of developmental outcomes and school readiness of infants, toddlers, and young children (from birth through age 5) with disabilities or at risk for disabilities (through the National Center for Special Education Research or NCSER). IES has funded research on early childhood education since 2002 through NCER and since 2006 through NCSER. NCER funded 66 early childhood research projects between 2002-2010, including those funded under the Early Learning Programs and Policies and other program areas (e.g., Mathematics and Science, Teacher Quality). Also included in this number is a Research and Development Center on Early Childhood Education. NCSER funded 34 Early Intervention and Early Learning in Special Education research projects between 2006-2010, including a Research and Development Center for Response to Intervention in Early Childhood.

In reading this synthesis, readers should remember that it is not intended to be an overview of the existing research in early childhood education. Panel members were only asked to review those published articles or book chapters that had emerged from IES-funded projects. Specifically, the panel was asked to review articles from peer-reviewed journals and book chapters from funded projects that were published or in press as of June 30, 2010. Thus, there is a great deal of ongoing research that is not represented in this synthesis because some grants are not yet at the stage in the research process where findings are in and summarized for publication. Note also that reports of IES-funded research that have not been subjected to the peer-review process in publication, such as conference proceedings and technical reports, are not included in this review. Appendix A lists the projects and publications that were reviewed for this synthesis.

Given panel members were only asked to review those peer-reviewed articles and book chapters that emerged from IES-funded projects available at the time this synthesis was written, there likely are peer-reviewed articles or book chapters emerging from ongoing IES-funded research relevant to the synthesis topic. IES plans to include these articles and book chapters in future updates of this synthesis.

CONTEXT AND ORGANIZATION OF THIS REPORT

At the beginning of this century, we knew that early education and intervention programs had the potential to provide long-term benefits, including school success and high-school completion, to young children, particularly those experiencing risk. Evidence for these successful outcomes came primarily from studies of model demonstration programs conducted in the 1960s and 1970s, such as the Abecedarian Project and High Scope/Perry Preschool.¹ In Abecedarian, children were enrolled as infants and randomly assigned to either an intervention group that received services for 6 to 8 hours a day, 5 days per week, and 50 weeks per year or to a control group receiving nutritional supplements and parent counseling. Intervention continued through the first 3 primary grades, with a resource teacher working with each child and family to support their regular schooling.² Abecedarian was an intensive, long-term intervention, which does not reflect typical practice in contemporary early childhood programs. Perry Preschool included half-day sessions 5 days a week for 2 academic years along with weekly home visits by the teachers to involve mothers and their children in educational activities at home.³ Although the classroom component is similar to current early childhood interventions, it was a model demonstration program delivered by highly trained teachers, and the evaluation was limited to 123 low-income, African American children, who had low IQ scores (70-85, falling within the range of mild to moderate intellectual disability as conceptualized at that time). Results of evaluations such as these provided evidence that early intervention had the potential to improve developmental and learning outcomes for some children.

Years after these model demonstration programs ended, the implications of their findings for designing and understanding the impacts of contemporary early childhood education programs are unclear. In the United States at the beginning of the 21st century, young children are more likely to be poor, more children are learning English in addition to their home language, and more children are identified as having developmental delays than at the time of the Abecedarian and Perry Preschool projects. In the 21st century, mothers of preschool children are more likely to be employed; children are more likely to spend substantial amounts of time in center-based care and education programs; and many of their early childhood teachers do not have 4-year college degrees or early childhood teaching licenses. Early childhood programs serve a much broader range of young children than did the Abecedarian, Perry Preschool, or Head Start programs in the 1960s and 1970s.⁴

Today, many early childhood programs serve children who are identified to be at risk for adverse educational outcomes in the short- or the longer-term. In fact, some programs serve only children exhibiting risk. The term “at risk” as used here and elsewhere in this report refers to a child

¹ Nores et al. (2005); Campbell et al. (2001).

² Campbell et al. (2002).

³ Schweinhart (2004).

⁴ Frey (2011); Hernandez (1995); LoCasale-Crouch et al.(2007).

exhibiting an elevated risk for adverse educational outcomes due to presence of some factor in his or her life; these are called “risk factors.” Factors typically associated with elevated risks for adverse educational outcomes include being raised in low-income household, being raised in a home in which a language other than English is spoken, and having a developmental disability, such as intellectual disability, language impairment, autism spectrum disorder, or hearing loss. Many of the children who exhibit these and other risk factors are already behind their more advantaged peers when they enter kindergarten in their language, literacy, mathematical, cognitive, or social skills.⁵ Importantly, as shown in a number of IES-supported studies,⁶ there are significant individual differences among young children in their language, literacy, mathematical knowledge, cognition, and social competence and lags in these areas present significant risks to children’s future academic and social success.⁷ Put simply, children who have well-developed language, literacy, mathematics, cognitive, and social skills at entrance to primary schooling are on a positive trajectory for short- and long-term success as compared to children with under-developed skills. At the same time, young children who exhibit delays in language, literacy, mathematics, cognitive, and social skills, due to presence of risk factors described previously, typically face elevated risks for secondary delays or disabilities as well as future academic and social difficulties.⁸ To the extent possible and when such information is available within a given report, we describe the specific risk factors identified for children included in the research reported in this synthesis.

A primary purpose of early childhood education and interventions is to promote children’s acquisition of knowledge and skills linked to later social competence and academic success.⁹ In this context, IES launched a broad range of research programs to better understand the links between early childhood education, early intervention, and children’s learning and development; develop more powerful interventions for improving child outcomes; rigorously test the impact of programs, practices, and policies on child outcomes; and develop and validate assessment measures for use with young children. Among these research programs are those that focus on improving developmental outcomes and school readiness for young children with or at risk for disabilities. In this report, we give special attention to summarizing what has been learned about early childhood classrooms as contexts for development and learning, the kinds of instructional practices and curricula that appear to be efficacious for enhancing children’s development and learning, the ways in which children’s skills and learning can be reliably and validly documented, and approaches for improving teachers’ and other practitioners’ (e.g., speech,

⁵ Denton Flanagan and McPhee (2009); Denton and West (2002); Markowitz et al. (2006).

⁶ Glenn-Applegate et al. (2010); Greene, Pashak, and Romero (2009); Pashak et al. (2007); Pashak, Cooke, and Hendricks (2006); Pence et al. (2010); Siegler and Ramani (2009); Conroy et al. (2009); Perlman and Fantuzzo (2010).

⁷ Cabell et al. (2011); Duncan et al. (2007); Mashburn et al. (2008).

⁸ Jordan et al. (2006); Justice, Bowles et al. (2009).

⁹ Powell, Diamond et al. (2008); Mashburn and Pianta (2010).

occupational, or physical therapists) instruction, given hypothesized linkages between instructional quality, instructional effectiveness and children's learning.

Scope of the research synthesis. For this research synthesis, we examined peer-reviewed journal articles and chapters that were products of early childhood research projects funded by the Institute of Education Sciences from 2002 through 2008.¹⁰ These papers included both empirical studies as well as theoretical pieces. (Appendix A provides a list of all of the projects and publications included in our review.) Our task was to synthesize what has been learned thus far through IES early childhood research grant activities. This is not a typical synthesis intended to provide a grand overview of research in a field, nor is it a meta-analysis that quantitatively synthesizes a specific body of work. Rather, our task was to look across the range of projects that IES has funded to determine what has been learned and where progress has been made as a result of IES funding, and to provide suggestions for further research in early childhood education.

EARLY CHILDHOOD CLASSROOM ENVIRONMENTS AND GENERAL INSTRUCTIONAL PRACTICES

Scientific research that aims to identify features of young children's experience that enhance their learning and that has been supported by the Institute has had two broad foci: children's experiences with teachers and peers in early childhood classrooms, and teachers' instruction. The first section of this synthesis examines research that has addressed questions related to features of early childhood classroom environments and instructional practices (including curricula) implemented with an entire class or individual children, including how they relate to young children's academic and social competence outcomes.

Much of the current research that examines the ways in which features of early childhood classrooms are related to children's development and learning has been influenced by the bioecological model of development proposed by Bronfenbrenner and his colleagues.¹¹ This model proposes that development takes place through reciprocal interactions between a developing child and the individuals and objects in the child's environment. Within this framework, environmental characteristics of early childhood settings (e.g., class size, child-teacher ratio, teachers' credentials) may affect (moderate) the strength of associations between adult-child interactions (in this case, instructionally and emotionally supportive teacher-child interactions) and children's development and learning. Operating from this theoretical

¹⁰ Because most IES funded research projects are 3 to 4 years in length, projects funded in 2006-2008 may be only beginning to disseminate results through peer-reviewed articles and chapters. This is especially noteworthy given IES only began funding research projects addressing interventions for children with or at-risk for disabilities in 2006.

¹¹ Bronfenbrenner and Ceci (1994); Bronfenbrenner and Morris (2006).

framework has led researchers to examine associations among classroom, teachers, and child characteristics; teacher-child interactions; and young children's development and learning.

Features of Early Childhood Classrooms

Background: One step toward improving early childhood education is to understand how teaching and learning occur in early childhood programs in order to identify those features that are reliably associated with developmental outcomes. This is particularly important given that trends in immigration and birth rates over the last 50 years mean that the U.S. population is substantially more diverse than at the time the first model early childhood intervention programs were initiated in the 1960s. Today, the preschool population is more heterogeneous than in the past, as recent Census data indicate that about one-half of all children under five years of age are from racial or ethnic minority groups (U.S. Census, 2010). In fact, a majority of children enrolled in publicly supported early childhood classrooms are poor children of color. Additionally, one in four preschool children has a parent who was born outside the United States, and one of four children under age 6 lives in a household in which a language other than English is spoken. Preschool programs in most states include substantial numbers of children who speak a language other than English in the home.¹² Moreover, in recent years there has been a substantial expansion of economic inequality, with increasingly larger proportions of children living in poverty; in 2009, almost one of every four preschool children lived in a family with income below the Federal poverty level.¹³ With respect to young children with disabilities, in 2009, 348,604 infants and toddlers (birth through age 2) and 731,754 preschool-age children (ages 3 through 5) were enrolled in early intervention and preschool programs under the Individuals with Disabilities Education Act, and 6.7 percent of preschool children with disabilities were identified as limited English proficient.¹⁴

¹² National Center for Education Statistics (2004).

¹³ Frey (2011); Hernandez (1995); Annie E. Casey Foundation (2010).

¹⁴ U.S. Department of Education, Office of Special Education Programs, Data Analysis System (DANS), OMB #1820-0557: "Infants and Toddlers Receiving Early Intervention Services in Accordance with Part C," 2009. Data updated as of July 15, 2010 and OMB #1820-0043: "Children with Disabilities Receiving Special Education Under Part B of the Individuals with Disabilities Education Act," 2009. Data updated as of July 15, 2010.

Contributions from IES-Supported Research

Contribution 1. There are critical associations between features of pre-kindergarten¹⁵ classrooms, such as the quality of teacher-child interactions and the nature of teachers' feedback to children, and positive children's outcomes. Researchers at the National Research and Development Center on Early Childhood Development and Education have examined associations among measurable features of pre-kindergarten classrooms and children's outcomes.¹⁶ Data collected in state-funded pre-kindergarten classrooms in 11 states with well-established¹⁷ programs provide evidence that the quality of children's interactions with teachers, the nature of their experiences with peers, and the instructional focus of the classrooms are among the most critical features of classrooms for improving children's outcomes.¹⁸ Mashburn and his colleagues found significant associations between teachers' use of specific instructional strategies to promote children's higher-order thinking and creativity (e.g., talking about ideas, reasoning about future events), the provision of feedback to children about their ideas and their work, and children's academic and language competence gains. The quality of teachers' emotional support for children (e.g., sensitivity to children's needs, effective use of behavior support strategies) was positively associated with children's social competence. In all of these analyses, teacher-child interactions that reflected higher levels of instructional quality and emotional support were associated with better child outcomes.¹⁹ In contrast, most infrastructure and program design features (i.e., structural features such as class size, child-to-teacher ratio and teacher credentials) were not directly related to children's academic and social outcomes. These authors suggest that structural features create the conditions in which high quality teacher-child interactions occur.²⁰ This suggestion is supported by a study completed as part of an IES-supported professional development project. Investigators found significant associations between Head Start teachers' education, their book-reading practices, and growth in vocabulary of children enrolled in their classrooms over the school year. Teachers with more years of education and training in early childhood were more likely to use specific strategies (e.g., talking about the meaning of words in the book) that, in turn, were associated with greater gains in children's vocabulary.²¹

¹⁵ Throughout this report, we use the term pre-kindergarten to refer to programs for 4-year old children, typically funded by states; early childhood programs refer more broadly to early education programs in local communities and school districts and includes Head Start. Inclusive programs are those that include children with disabilities and children without identified disabilities, while early education and care refers to full-day programs with a dual focus on early childhood education and care that supports parents' employment.

¹⁶ This research has been supported by multiple funding sources, including IES.

¹⁷ This research was conducted in state-funded programs in operation for several years; the 11 states included in these studies served approximately 80 percent of children in the US who attended state pre-k programs at the time; Burchinal et al. (2010).

¹⁸ Mashburn and Pianta (2010).

¹⁹ Mashburn et al. (2008).

²⁰ Mashburn et al. (2008).

²¹ Gerde and Powell (2009).

Contribution 2. Parents' and teachers' support for children's learning is associated with positive outcomes for young children. Two studies offer evidence that collaborations between teachers and parents, and positive teacher-parent relationships, are associated with children's academic and social competence. In a study involving correlational analyses, parents' and teachers' support for children's learning was associated with positive outcomes for children in state-funded pre-kindergarten programs in six states.²² In a separate study, Powell and his colleagues examined two dimensions of parent-school relationships, parental involvement at school and parents' perceptions of teachers' responsiveness to them and to their children in a study conducted in 13 pre-kindergarten classrooms in one urban school district. They found that parents' school involvement and parents' perceptions of the responsiveness of their child's teacher were related to children's academic and social competence.²³

Contribution 3. Higher-quality classroom environments are associated with improved learning outcomes for children. Given that there is variability among classrooms in terms of their level of quality, one critical question addressed in a recent study²⁴ is whether it is possible to identify a critical threshold of instructional quality and teacher-child supportive interactions. The study was designed to determine whether it is possible to identify either a threshold of quality below which little learning occurs or a different threshold above which there is little association between additional increases in quality and improved child learning. Two measures of classroom quality were examined: the level of emotional support (e.g., teachers' enthusiasm, enjoyment and respect during interactions with children, use of effective behavior support strategies) and the level of instructional support (i.e., teachers' instruction related to concept development). These investigators found that whereas teachers' instructional support predicted some child outcomes, there was a substantially stronger association between instructional support and children's language, reading, and math outcomes in classrooms in which teachers provided a higher quality of instructional support. Similar results were found for teachers' emotional support, with stronger associations between emotional support and children's social competence in classrooms with higher levels of emotional support. These findings are not consistent with a "good-enough" threshold of quality, above which improvements in classroom quality are unrelated to improvements in child learning. Rather, these results suggest that improving the quality of emotional *and* instructional support in the classroom is related to social and academic gains for children.

Contribution 4. The children enrolled in early education settings show great variability in their skills and risk factors. In addition to showing that there are substantial differences among classrooms in their level of quality (e.g., level of emotional and instructional support), IES-supported research has shown also that the children within early education classrooms are highly

²² Barbarin et al. (2010).

²³ Powell, Son, et al. (2010).

²⁴ Burchinal et al. (2010).

diverse in their skill levels. Often, preschool programs that prioritize the enrollment of children experiencing a variety of factors that may put them at risk for poor developmental or academic outcomes view these children as a single “at-risk” group. Research funded by IES provides additional evidence to a large existing body of research suggesting that this group is not a homogeneous one.²⁵ In this study, investigators examined variability in the emergent literacy and early language skills of a group of 492 preschool children participating in public programs that targeted enrollment to children at risk, such as children residing in low-income households. Using a person-centered approach to analyses, Cabell and her colleagues identified five different profiles that characterized children’s early literacy and language competence. Two profiles, which characterized nearly 50 percent of the children, were associated with relatively low levels of language and literacy skill, whereas children in the other three profiles had average or above-average skills. Follow-up at kindergarten showed that children whose preschool profiles were characterized by low levels of language and literacy skills continued to demonstrate lower levels of reading skill than did the children whose preschool profiles were characterized by higher language and literacy skills. This study highlights the variability in both oral language (children’s understanding and use of language to communicate ideas) and literacy skills (such as alphabet knowledge) in children participating in subsidized preschool programs. As well, it provides evidence that, although a minority, some low-income children enter preschool with age-appropriate language and literacy skills, with age-level performance continuing through kindergarten.

Additional research has helped to highlight the fact that some young children are decidedly at risk for poor social and academic outcomes. In an IES-supported correlational study of all second-grade children in one large urban district, Fantuzzo and his colleagues found that 12 percent of second graders had experienced documented abuse or maltreatment, and 8 percent of children had been homeless.²⁶ Most of these children experienced maltreatment or homelessness as an infant, toddler, or preschooler. Study findings showed that children who were homeless when they were younger than 3 years of age were especially vulnerable to exhibiting lower levels of academic achievement and poor social skills in the early primary grades. There was a significant relationship between children’s history of maltreatment and homelessness during the early childhood years and rates of school absence (more maltreatment and homelessness were associated with higher absenteeism). This is noteworthy, given evidence from a separate IES-supported study, about the potential risks associated with school absence; higher levels of attendance are associated with higher rates of learning. In fact, investigators found that about two-thirds of children’s learning gains during the school year were associated with the time they

²⁵ Cabell et al. (2011).

²⁶ Perlman and Fantuzzo (2010).

spent in school.²⁷ Thus, events that interfere with children's school attendance, such as homelessness, may compound children's risk for school learning difficulties.

Classroom Instructional Practices and Children's Learning

Background. Although there is scientific evidence that links the quality of teachers' instruction with children's learning, there is substantial variability in the quality of early childhood programs with respect to the quality of teachers' instruction. Recent studies suggest that many children who are at risk, particularly children who are poor or who are learning English as a second language, attend classrooms that are of mediocre quality. Additionally, descriptive analyses of state-funded pre-kindergarten in 11 states with well-established programs suggest that children are engaged in learning activities for slightly more than half of the school day.²⁸ The rest of the school day is devoted to other activities including outdoor play, meals, hygiene, and naps.²⁹ While important in a young child's day, these activities are typically not used as times for explicit teaching of important curricular content. Consequently, evidence suggests that not all early childhood classrooms maximize children's learning to the extent that is possible based on findings from analysis of high-quality classrooms.³⁰

Approaches to teaching young children have been heavily influenced by theoretical perspectives emphasizing that children learn through active engagement with individuals and materials rather than through teacher-directed instruction. These perspectives assumed that children learned through play and that the teacher's role was to prepare an attractive environment and to respond to children's interests. Although professional organizations in early childhood currently acknowledge the importance of intentionality in instruction and of children's engagement in both child-initiated and teacher-directed activities for promoting learning, many children still attend classrooms that are organized to promote learning through play activities that each child chooses.³¹ Yet, this type of classroom organization is associated with smaller learning gains over the school year when compared to classrooms that include teacher-directed learning.³²

IES-supported investigators have found that children make substantially greater gains when they are enrolled in classrooms where teachers planned activities that they taught to groups of children and provided support to children as they were learning difficult skills.³³ Yet, in a study in an urban pre-kindergarten program, IES-supported researchers also found that teachers made infrequent use of group learning formats.³⁴

²⁷ Fitzpatrick, Hustedt, and Grissmer (2011).

²⁸ Early et al. (2009).

²⁹ Chien et al. (2010).

³⁰ Early et al. (2009); Magnuson et al. (2004).

³¹ NAEYC (1986, 1997, 2009).

³² Mashburn et al. (2008); Powell and Diamond (2011).

³³ Chien et al. (2010).

³⁴ Powell, Burchinal, et al. (2008).

Many early childhood classrooms do not provide adequate supports to foster children's development of language, literacy, mathematics, and cognitive skills and socially competent behaviors. Put simply, results of studies conducted to date show that children within early childhood classrooms participate in very few of the types of interactions that have been demonstrated to support or accelerate development and learning.³⁵ This situation stems from three circumstances: the classroom language environment, the content of instruction, and children's peer group.

Contributions from IES-Supported Research.

Contribution 5. There is a need to improve characteristics of the classroom language environment. A number of IES-supported studies have examined the classroom environment in programs serving children at risk. The results of these studies provide evidence that teachers' language is generally constrained in its focus, such that it contains relatively few explicit exemplars of advanced linguistic content (e.g., teachers do not typically engage in frequent conversations with children, connecting their actions and those of students through language), literacy principles (e.g., teachers do not typically use terms and strategies that make clear the relationship between oral or written language and the names of specific units or tasks such as letter, rhyme, sound), and cognitive concepts (e.g., teachers do not typically use abstract vocabulary and concepts in conversations with children), even in the context of emotionally supportive interactions.³⁶ For example, one in-depth study of children's exposure to cognitively challenging questions examined 1,680 teacher questions that occurred across a range of instructional activities in 14 pre-kindergarten classrooms. Of these questions, only one in ten were cognitively complex, despite the documented importance of this type of question for advancing children's language and cognitive skills.³⁷ In this regard, identifying effective means for elevating and sustaining the quality of teacher-child instructional interactions that emphasize children's language, literacy, social, and cognitive development is a critical avenue for education research and has featured prominently in much of the IES-supported early childhood research activity.³⁸

Contribution 6. The content of early childhood education may be relatively constrained with respect to provision of math- and science-oriented instruction. IES-supported research suggests that there is very little instruction in mathematics and science occurring within early childhood classrooms. Most preschool teachers limit mathematics instruction to naming common shapes and counting up to relatively small numbers (e.g., 10 or 20).³⁹ This focus is much more restricted than what preschoolers can learn, as shown by preschool programs in other countries⁴⁰

³⁵ Early et al. (2009); Mashburn et al. (2008).

³⁶ Burchinal et al. (2010); Mashburn et al. (2008); Massey et al. (2008); Pence, Justice, and Wiggins (2008).

³⁷ Massey et al. (2008).

³⁸ Justice, Cottone et al. (2008); Powell, Diamond, and Koehler (2010); Powell, Diamond, et al. (2010).

³⁹ Ginsburg, Lee, and Boyd (2008).

⁴⁰ Ertle et al.(2008).

and by intervention research focused on early mathematics and funded through IES.⁴¹ Findings from this intervention research will be discussed later in this report.

Contribution 7. Classroom composition likely influences children’s learning in early education settings. Children’s exposure to peers who may themselves provide salient exemplars of advanced linguistic, literacy, cognitive and social skills appears to be constrained in many programs for preschoolers at risk, despite the fact that peer-to-peer interactions are an important and unique source of learning within early childhood classrooms.⁴² In many preschool classrooms, particularly those funded by public streams (e.g., state-funded pre-kindergarten, early childhood special education, Head Start), children’s eligibility to participate is based on the presence of risk factors, often attributable to disability or poverty. Research supported by IES has found that this results in a significant reduction in the level of language, literacy, cognitive and social skills to which children within a given classroom are exposed during interactions with their peers. For instance, one study of 610 children enrolled in 88 Head Start classrooms reported that children’s mean standard score on a well-validated measure of vocabulary was 83 ($SD = 16$), substantially below the normative mean of 100.⁴³ Although this is not particularly surprising, given that such programs target participation based on risk, it also requires acknowledgement of the fact that children within early childhood classrooms spend their days interacting with classmates who may well exhibit significant lags in language, literacy, cognitive and social skills. Moreover, children who exhibit less-developed skills in language, as an example, may benefit very little from enrollment in classrooms in which their classmates also exhibit less-developed skills.⁴⁴

⁴¹ Clements and Sarama (2007); Starkey, Klein, and Wakeley (2004).

⁴² Mashburn et al. (2008).

⁴³ Powell, Diamond et al. (2010).

⁴⁴ Justice et al. (2011).

EDUCATIONAL PRACTICES DESIGNED TO IMPACT CHILDREN'S ACADEMIC AND SOCIAL OUTCOMES

In the field of early childhood education (and education more broadly), teaching professionals are pressed to utilize research-based practices, particularly in the areas of language, literacy, mathematics and cognition. These efforts are grounded in a scientific literature showing there to be strong continuity in children's skills from the preschool years forward: that is, language and literacy skills observed among preschool children are consistently correlated with later achievements in reading, including both decoding and comprehension.⁴⁵ As well, there is a growing emphasis on effective instructional practices for children who are at risk, including the use of research-based intensive, targeted interventions to develop skills, including early literacy and social skills.⁴⁶

Early childhood classrooms are unique within the broader context of schooling. The activities in which children engage, the instructional targets addressed, and the pedagogical training and background knowledge of teachers all differ in qualitative ways from those of the later primary grades. For instance, in preschool classrooms children spend about one-third of their classroom time in free-choice activities; academically oriented instruction is under-emphasized relative to supporting children's social-emotional development; and many teachers have not received four years of higher education or participated in university-based teacher preparation programs.⁴⁷ Consequently, it is important to recognize that research results based on work conducted in primary classrooms cannot be readily generalized to early childhood classrooms.

IES has focused explicitly on identifying early childhood education practices associated with improvements in children's learning and development, including research on cognition and learning. Of the contributions of IES-supported research on cognition and learning, specific instructional strategies, curricula, and assessments are presented in the next sections.

Cognitive Development

Background: One of IES' initial research programs supported the application of recent advances in cognitive developmental research to educational practices that will improve children's learning outcomes. These efforts have led to the development of focused interventions that target foundational skills for young children's learning. For example, cognitive developmental theory and research identify important abstract reasoning skills that are related to children's learning in mathematics and literacy. Although it was once thought that abstract reasoning skills would not benefit from instruction,⁴⁸ subsequent research has suggested that they

⁴⁵ Storch and Whitehurst (2002).

⁴⁶ Snyder, McLaughlin, and Denney (2011).

⁴⁷ Early et al. (2009); NAEYC (2003); Powell, Diamond et al. (2008).

⁴⁸ Piaget (1952).

might be malleable.⁴⁹ These findings have led to experimental studies, supported by IES, which examine the effects of teaching abstract reasoning for children's learning.

Contributions from IES-Supported Research

Contribution 8. Children's abstract reasoning skills can be improved through specialized activities. In IES-supported research, Pasnak and his colleagues tested approaches for improving young children's abstract reasoning skills, such as the oddity principle (the oddity principle refers to a child's ability to identify when one item in a set differs from the others on the basis of some dimension, such as size or color or shape). Such cognitive skills provide a critical foundation for children's learning in mathematics and literacy and can be taught to young children who have not yet acquired these skills. In an intervention study designed to test this hypothesis, 380 kindergarten children who did not understand these abstract principles were randomly assigned to an experimental condition in which they were taught these skills using specially-designed games, or to a control group.⁵⁰ Children in the experimental condition performed significantly better than those in the control group on a task assessing abstract reasoning skills. Not only did children in the treatment group learn abstract-reasoning skills, their development of these skills was associated with substantial gains in reading and mathematics performance. This study and other studies conducted by Pasnak and his colleagues suggest that at the start of kindergarten, children who do not understand these abstract reasoning skills and are directly taught them are better able to benefit from concurrent instruction in literacy and mathematics.⁵¹ Although such findings are promising, future research must consider the extent to which these benefits extend into the future grades.

Language and Literacy Development

Background. The focus of language and literacy instruction in preschool classrooms is influenced by theoretical perspectives, particularly the *Simple View of Reading*,⁵² that link skilled and fluent reading to two distinct sets of processes: decoding skills and language-comprehension skills. To lay a foundation for children to achieve skilled and fluent reading in the primary grades, young children need to develop precursor skills related to decoding (e.g., phonological awareness, letter knowledge, concepts about print) and to language-comprehension success (e.g., vocabulary, drawing inferences, listening comprehension). In an effort to promote teachers' explicit attention to building these reading foundations, the majority of states have adopted standards governing academic content in early childhood programs that reflect these important foundational competencies.⁵³

⁴⁹ Gelman (1969).

⁵⁰ There were three different control conditions: (1) an active control condition in which children received additional instruction in numeracy; (2) an active control condition in which children received additional literacy instruction; and (3) a control condition in which children engaged in art activities; Pasnak et al. (2009).

⁵¹ Pasnak et al. (2007); Pasnak et al. (2009).

⁵² Hoover and Gough (1990).

⁵³ Barnett et al. (2009).

Instruction for young children who are at high risk for difficulty with learning to read has been response-to-intervention (RtI). Within RtI frameworks, decisions about changing or intensifying instruction are based on children's responses to evidence-based interventions that are implemented with integrity. With respect to instructional focus, intentional instruction associated with a high-quality "core" curriculum is provided to all young children and typically is characterized as core or universal instruction. Interventions associated with secondary (supplemental) and tertiary (individualized) levels of an RtI framework generally are distinguished by differential intensity and specificity of instructional approaches. In most RtI frameworks, targeted or supplemental interventions typically are provided to small groups of children (estimated to be 15-20 percent of young children in a classroom or program) who receive supplemental instruction beyond that which is typically provided. Tertiary or individualized interventions involve isolating and systematically manipulating instructional or environmental variables based on individual children's learning needs. If an effective core curriculum and supplemental interventions are implemented with fidelity, estimates are that only 5 percent of children in a classroom or program will need intensive individualized interventions.⁵⁴

In the context of turning education practice into a research-based enterprise, IES has emphasized the importance of conducting rigorous tests of curricula and instructional strategies that support children's development of critical skills for early reading. Contributions of IES-sponsored research focused on curricula, and instructional strategies are presented below.

Contributions of IES-Supported Research

Contribution 9. There is a need to differentiate more- and less-effective curricula that support children's early reading. Research has focused on the development and evaluation of curricula that have attempted to *manualize* what are believed to be "active ingredients" of high-quality language and literacy instruction. Today, there are far more curricula available and in use than have been evaluated scientifically for their impacts on children. Moreover, evaluations of curricula in use by programs and teachers have often failed to show positive main (unmoderated) effects on children's language, literacy, and cognitive development.⁵⁵ For example, in a randomized controlled trial study of two different literacy curricula (Doors to Discovery,⁵⁶ Let's Begin with the Letter People⁵⁷) implemented in three preschool settings, Assel and his colleagues found no significant effects of these curricula, compared with business as usual instruction, across all settings.⁵⁸ However, perhaps the most well-known effort to evaluate the impacts of curricula was the Preschool Curriculum Evaluation Research initiative, which involved a 12-site evaluation of 14 planned variations of early childhood language, literacy, and/or cognitive

⁵⁴ Harn, Kame'enui, and Simmons (2007).

⁵⁵ Gunn, Smolkowski, and Vadasy (2011); Justice, Mashburn et al. (2008).

⁵⁶ Wright Group, McGraw Hill (2001).

⁵⁷ Abrams & Company (2000).

⁵⁸ Assel et al. (2007).

curricula against business-as-usual (BAU) classroom conditions (a math curriculum, discussed in a later section, was also included). Third-party contractors assessed classroom instructional quality, as well as child achievements in language, literacy, and social competence, across all curricula studied. Twelve of the 14 curricula yielded no consistent positive impacts on children's language, literacy, or social skills as compared to BAU instruction. Moreover, for the most part, teachers' implementation of these curricula was not associated with higher levels of classroom instructional quality. For instance, on a measure examining the quality of oral-language instruction, implementation of only one of the 14 curricula studied appeared to positively and significantly affect this aspect of instruction.⁵⁹

These findings, coupled with other experimental studies supported by IES that have failed to show positive impacts of curriculum implementation,⁶⁰ suggest that many early childhood curricula inadequately represent the “active ingredients” of classroom instruction that are needed to bring about positive impacts on children's language, literacy, social, or cognitive skills, or fail to include specific approaches that are effective for improving children's learning. As Clements⁶¹ has noted, many curricula were developed through market research rather than through formative design research to identify the critical ingredients of a curriculum. In addition, little is known regarding the “threshold” of implementation of these active ingredients that is needed for a given curriculum to achieve its desired effects. Although studies often find beneficial curricular effects for children whose teachers accurately implement language, literacy, and cognitive curricula, such effects might actually reflect unmeasured variables that relate to teachers' implementation (e.g., teacher motivation). There is a substantial need for research, particularly of an experimental nature, that isolates these active ingredients and identifies thresholds of curriculum implementation needed to achieve positive impacts for children.⁶²

Contribution 10. Teachers' can support children's early reading skills through read-alouds. Within early childhood classrooms, particularly as compared to the primary grades, children may spend less than half the school day in teacher-led instructional activities.⁶³ Rather, children may spend a good deal of time in naturalistic child-initiated interactions with peers and adults in their classrooms. Importantly, such interactions can be explicitly structured to promote children's learning.⁶⁴ In recent years, researchers have directed considerable effort towards identifying ways to incorporate specific instructional strategies within naturalistic activities to more effectively promote children's language and literacy development. One such routine receiving considerable attention is that of the read-aloud.⁶⁵

⁵⁹ Preschool Curriculum Evaluation Research Consortium (2008).

⁶⁰ Gunn, Smolkowski, and Vadasy (2011).

⁶¹ Clements (2007).

⁶² Hamre et al. (2010).

⁶³ Chien et al. (2010); Early et al. (2009).

⁶⁴ Justice et al. (2011); Mashburn et al. (2008).

⁶⁵ Hamre et al. (2010); Justice, McGinty et al. (2010); Piasta et al. (2010); Pollard-Durodola et al. (2010).

Teacher-child read-alouds, as implemented with small groups of children or with the entire class, are a ubiquitous part of the early childhood classroom. To this end, IES-supported researchers have sought to improve the benefits children experience from read-aloud participation by identifying ways to explicitly incorporate attention to pre-reading and comprehension skills within this naturalistic routine. These studies are described below, along with IES-supported research that has focused on increasing instruction on print knowledge within book reading. Teachers learn strategies to engage young children in print-focused conversations about features of words, names of letters, and concepts about print during read-alouds.⁶⁶

One recent study involved an experimental design in which 59 preschool teachers were randomly assigned to complete a 30-week read-aloud intervention involving 120 reading sessions total; teachers in an experimental group ($n = 31$) were taught to embed print-focused conversations into every session, whereas those in the comparison group ($n = 28$) read using their normal reading style. Print-related skills (e.g., alphabet knowledge, name-writing ability) were examined before and after the intervention for 379 children randomly sampled from the classrooms. Study findings showed that children in classrooms whose teachers were taught to use print-focused conversations received a significant boost in early literacy skills⁶⁷ and, more importantly, these early boosts endured through the end of first-grade, as shown on standardized measures of word recognition, spelling, and reading comprehension.⁶⁸

A second line of research has focused on increasing children's oral language comprehension and production (important reading-comprehension precursors) during read-alouds by having teachers engage children in discussions about the meanings of novel words contained in books, particularly words that represent challenging concepts or may be unfamiliar.⁶⁹ Investigators examined the effects of a program designed to teach science and social studies vocabulary through shared book reading with low-income preschool children. Twenty-one preschool teachers were randomly assigned to implement the vocabulary-enriching book reading intervention ($n = 13$) or maintain their prevailing practices ($n = 8$). Children participated in small-group reading sessions using a total of 36 different science and social studies books (informational texts and fictional works) in which their teachers embedded explicit discussion and elaboration of a small set of relatively challenging words (e.g., earth, cities). Assessments of vocabulary growth over the 18-week instructional period for 163 preschoolers sampled from the participating classrooms showed that the book-based vocabulary program significantly improved children's learning of targeted vocabulary words and also had significant effects on a

⁶⁶ Justice et al. (2009, 2010); Piasta et al. (2010).

⁶⁷ Justice et al. (2009, 2010).

⁶⁸ Piasta et al. (2010).

⁶⁹ Coyne, McCoach and Kapp (2007); Pollard-Durodola et al. (2010).

standardized measure of receptive vocabulary.⁷⁰ The time period over which benefits continue is unknown.

Contribution 11. Supplemental literacy instruction can be beneficial for children who are at risk for reading difficulty. Several IES-funded projects have examined the efficacy of targeted supplemental instruction for improving the early reading skills of children at risk for reading difficulty. Working from the *Simple View of Reading*, in which decoding and language-comprehension skills are viewed as critical to achievement of skilled reading, one intervention focuses on providing children with explicit reading instruction (*Early Reading Intervention*)⁷¹ whereas a separate intervention targets vocabulary.⁷²

The *Early Reading Intervention* was designed to teach decoding skills to kindergarten children identified as at risk for reading difficulty (based on performance close to or below the 30th percentile on a compilation of pre-reading measures, such as letter naming and phonological awareness). The kindergarten classrooms in which participating children were enrolled were randomly assigned to one of two supplemental reading intervention conditions: (a) school-determined intervention or (b) explicit, code-based reading instruction (*Early Reading Intervention*). These interventions were provided in addition to the daily reading instruction provided to all children. Children in both experimental conditions received supplementary reading instruction in small groups for 30 minutes each day for 21 weeks. In this study, which examined the relative effects of these two targeted interventions, findings showed statistically significant effects in favor of the supplemental *Early Reading Intervention* when compared to the school-determined intervention. Intervention impacts were larger for outcome measures that aligned with the explicit, code-based supplemental reading instruction (alphabet knowledge, letter sound knowledge, phonemic awareness, word attack) than for comprehension measures. Importantly, scores on the majority of outcome measures showed that after intervention ended, two to four times more children who received the school-determined intervention remained at significant risk for reading difficulties (performance < 15th percentile), as compared to children receiving the *Early Reading Intervention*. Given that both experimental groups received a supplemental reading intervention, this latter finding suggests that children most at risk for reading failure benefit substantially from supplemental reading intervention that focuses on code-based instruction and includes detailed lessons and a clear and systematic scope and sequence of learning activities.

Coyne and colleagues have targeted the language comprehension skills of at-risk kindergarten and first-grade children in a series of studies conducted under two separate IES-funded projects. In one study conducted in these projects, the researchers examined the effects of targeted vocabulary interventions on early reading outcomes of kindergarten and first-grade children most

⁷⁰ Gonzalez et al. (2011).

⁷¹ Simmons et al. (2011).

⁷² Coyne, McCoach, and Kapp (2007); Loftus et al. (2010).

at risk for language and literacy difficulties. Informed by earlier research indicating that direct vocabulary instruction is most effective when it provides explanations of target words along with additional opportunities for children to actively engage with these words, this vocabulary intervention provided targeted and explicit instruction in small groups of students (six or fewer) in addition to the core vocabulary instruction in the kindergarten classroom.⁷³ A more recent study of this intervention conducted by Loftus and colleagues involved 43 kindergarten children from three classrooms in one elementary school, a subset of whom ($n = 20$) were identified as at risk on the basis of vocabulary scores; the study employed a within-subjects experimental design with two factors (condition and time).⁷⁴ Classroom-based vocabulary instruction was provided to all children, and small-group, supplemental vocabulary intervention was provided for the 20 at-risk students. As was the case with Simmons and colleagues' *Early Reading Intervention*, this vocabulary intervention was provided in addition to the reading instruction in the kindergarten classroom. Findings showed that the students identified as at risk and who received supplemental intervention made significantly greater gains in understanding words targeted in the intervention as compared to words included only in classroom-based instruction. This supplemental instruction helped to reduce the word knowledge gap between at-risk children and their peers.

These studies contribute to a growing body of research focused on evaluating key instructional components of class-wide and supplemental reading interventions for children at risk for reading problems. Also, they contribute to the application of response-to-intervention frameworks focused on literacy instruction for preschool and kindergarten children who are at risk or have experienced difficulty learning to read.

Contribution 12. Young children who are deaf or hard of hearing require specialized supports to develop language and literacy skills. Children who are deaf or hard of hearing (DHH) are at risk for significant reading disabilities, although there are now better long-term prognoses due to technological advances with cochlear implants and early detection of hearing loss through universal hearing screening programs.⁷⁵ As part of an IES-funded project, investigators characterized the nature, variability, and rate of growth in emergent literacy skills for young children with hearing loss and who have speech perception.⁷⁶ Trained examiners administered a battery of measures assessing phonological awareness, alphabet knowledge, and vocabulary to 44 young children with hearing loss and speech perception who were enrolled in self-contained preschool, kindergarten, or first-grade classrooms. Children's performance on measures of letter-word identification, passage comprehension, and picture vocabulary was close to, but below, the average score for children their age, although there was substantially more variability in children's performance than seen in children with normal hearing. In contrast, children's

⁷³ Coyne, McCoach, and Kapp (2007); Loftus et al. (2010).

⁷⁴ Children at-risk were low income and were enrolled in a school in which a large majority of fourth-graders failed to meet state reading standards.

⁷⁵ Vermeulen et al. (2007).

⁷⁶ Easterbrooks et al. (2008).

performance on a measure of phonological (letter-sound) awareness was substantially below the average score of the normative (hearing) group. Findings from this study also showed these children's assessed early literacy skills were related to one another in ways similar to children with typical hearing.⁷⁷ These results provide evidence that children with significant hearing loss and speech perception have more difficulty with pre-reading skills requiring letter-sound understanding than do children with normal hearing.

The results of this study were used to inform the development of an emergent literacy curriculum for pre-kindergarten children with hearing loss. This curriculum, *Foundations for Literacy*,⁷⁸ provides instruction in both decoding (e.g., letters, sounds) and language comprehension. Unlike curricula for hearing children, this curriculum includes multimodality support (e.g., visual and tactile as well as auditory cues) for children's learning.⁷⁹ As part of the work related to the development and evaluation of the *Foundations for Literacy* curriculum, investigators conducted two studies to examine strategies for building the alphabetic principle in young children who are deaf or hard of hearing. The first study was designed to examine a semantic association strategy for teaching sound-letter correspondence (e.g., letter /m/ is associated with sound *mmm* through a story in which a child is eating ice cream and says *mmm – that's good*) as part of a 35-minutes-per-day intervention program for 8-9 weeks. The second study assessed the effect of the semantic association strategy when it was embedded in the 60 minutes a day *Foundations for Literacy* curriculum over 6 weeks. Single-case experimental research designs (multiple-probe across sound-letter correspondences) were used in both studies to evaluate functional relationships between the intervention and acquisition of sound-letter correspondences for individual children.⁸⁰ Five preschool children (three with cochlear implants) participated in the first study, and five pre-kindergarten children (all with cochlear implants) participated in the second study. Findings from both demonstrated that preschool children who are deaf or hard of hearing with some speech perception learned sound-letter correspondences using the semantic association strategy included in the *Foundations for Literacy* curriculum. These studies are among the first to be conducted that focus on instruction of sound-letter correspondences for preschool children who are deaf or hard of hearing. Further evaluations of this curriculum and its instructional components are in progress.

Contribution 13. Children with problem behaviors may benefit from particular types of reading instruction. Young children who display significant problem behaviors are also at risk for

⁷⁷ Easterbrooks et al. (2008).

⁷⁸ Lederberg et al. (2009).

⁷⁹ Bergeron et al. (2009).

⁸⁰ Single-case designs are experimental methods to evaluate the impact of interventions with small numbers of participants. If, across cases, children's responses are clear and consistent, a functional relationship is said to exist between the intervention and the response. More detail on these designs can be found at http://ies.ed.gov/ncee/wwc/pdf/reference_resources/wwc_scd.pdf.

academic problems. To date, limited research has been conducted related to efficacious early literacy and reading interventions for young children with co-existing problem behaviors and academic skills deficits. As part of an IES-funded research project, investigators examined associations between different types of problem behaviors and kindergarten reading outcomes of children identified as being at risk for reading difficulty.⁸¹ They sought to determine the extent to which explicit, code-based reading instruction involving phonemic and alphabetic skills moderated the relations between children's problem behaviors and academic problems. The investigators hypothesized that relationships between problem behavior and reading outcomes would vary by type of behavior problem (e.g., hyperactivity, aggression, anxiety), and that hyperactivity and aggression would be more commonly associated with poorer reading outcomes. In this study, 206 children identified as at risk for reading difficulty received either an explicit, code-based reading instruction intervention or a school-determined reading intervention. Fifteen of the 112 children in the explicit, code-based reading instruction group and 9 of the 94 children in the school-determined intervention group were receiving special education services. While students were selected on the basis of reading risk, investigators collected information on children's problem behaviors that allowed them also to examine associations between children's behavior problems and reading difficulties. Children in both experimental conditions received supplementary reading instruction in small groups for 30 minutes per day for 21 weeks.

As noted earlier in this report, children who received the explicit, code-based reading instruction (*Early Reading Intervention*) made statistically significant gains on measures of alphabetic, phonemic, and untimed decoding skills.⁸² In the Hagan-Burke et al. study, researchers showed there to be statistically significant associations between problem behavior and reading: as a group, children with problem behaviors had lower reading performance than their peers. Interaction analyses showed the explicit, code-based reading program moderated the negative association between externalizing problem behavior with children's alphabet knowledge, phonemic blending skills, and word reading. This type of reading program also moderated the negative association between hyperactivity with children's alphabet knowledge and phonemic blending. No moderator effects were found for internalizing problem behavior and associations with end-of-kindergarten reading outcomes. This study supports the need for further development and evaluation of instructional programs for children at risk for reading difficulty with co-existing problem behaviors.

⁸¹ Hagan-Burke et al. (2011).

⁸² Simmons et al. (2011).

Math and Science Development

Background. When children enter kindergarten, they already show significant individual differences in their mathematical knowledge, and these early differences have large and lasting consequences. Children's initial skill levels predict their later learning in many domains,⁸³ but the relation between early math knowledge and future math achievement is particularly strong and persistent; in fact, it is roughly twice as strong as the relation between early and later reading achievement, which in turn is stronger than the relation in other domains (such as attentional control and emotional regulation).⁸⁴

Children from low-income families begin school with much less mathematical knowledge than their classmates from middle- or high-income households, and over the course of schooling, they fall steadily further behind.⁸⁵ Again, similar differences among students from different economic backgrounds are present in other subject areas, but the differences in mathematical knowledge tend to be especially large.⁸⁶ In an attempt to reduce or eliminate gaps in mathematical knowledge at kindergarten entry among children from different backgrounds and with different abilities, IES has funded a number of research projects that test the effects of preschool mathematics and science interventions in controlled, rigorous ways. The contribution of these efforts is described below.

Contributions of IES-Supported Research

Contribution 14. Teachers' use of structured curricula can improve young children's math achievement. Several math-oriented early childhood curricula have been developed with IES support (*Building Blocks*,⁸⁷ *Pre-K Mathematics*,⁸⁸ and *Big Math for Little Kids*⁸⁹), two of which have been subjected to direct testing of child impacts (*Building Blocks* and *Pre-K Mathematics*). These curricula are aimed at improving the mathematical skills of preschoolers from low-income backgrounds, and studies of the first two of the named interventions demonstrate that children from low-income backgrounds can become considerably more proficient in math if given appropriate instructional support of the types described below.

Building Blocks, one of the preschool curricula shown to increase children's mathematical knowledge, features small-group and whole-group activities, computer games, and family activities to be done at home. The curriculum provides experience with a wide variety of aspects of mathematics, including numbers, patterns and geometry for at least 1 hour per week for 26 weeks. One distinctive feature of the curriculum is that it explicitly takes into account typical learning trajectories, based on research evidence of typical developmental sequences, such that

⁸³ Bransford, Brown, and Cocking (1999).

⁸⁴ Duncan et al. (2007).

⁸⁵ Jordan et al. (2006).

⁸⁶ Case, Griffin, and Kelly (1999).

⁸⁷ Clements and Sarama (2007); Clements et al. (2011).

⁸⁸ Klein et al. (2008).

⁸⁹ Ertle et al. (2008).

activities become more difficult as children's mathematical thinking advances. The curriculum helps teachers to understand the developmental changes that typically occur in children's thinking about mathematical concepts.⁹⁰ Another distinctive feature of *Building Blocks* is that it relies heavily on computer software as a means of conveying mathematical content and engaging children's interest.

In a randomized trial, children in 35 preschool classrooms serving lower- and middle-class children received one of three approaches: *Building Blocks*, another research-based preschool mathematics curriculum, or the curriculum used in that classroom the previous year. Children who received the *Building Blocks* curriculum improved their math skills significantly more than children in the two comparison conditions.⁹¹ In a larger study funded by IES that involved 106 classrooms and more than 1300 students, similarly large and significant changes in mathematical competence were obtained for children receiving this curriculum.⁹²

A major part of *Building Blocks* involves teacher training. In one test of the curriculum, teachers received 34 hours of group training plus 16 hours of in-class coaching.⁹³ In another test, teachers were given 75 hours of out of class training, as well as 13 hours of in-class mentoring.⁹⁴ This large amount of teacher training seems to be essential for the successful implementation of the curriculum because, in the absence of careful guidance, teachers tend to modify research-based curricula in ways that make them less effective.⁹⁵

Another successful, large-scale preschool mathematics curriculum is *Pre-K Mathematics*. As does *Building Blocks*, it combines school-based activities with activities for parents and children to do at home. In the school-based part of the intervention, children participate in small-group activities for 20 minutes twice a week throughout the school year. Home activities link to the small-group activities in school; parents are provided with manipulative toys (e.g., linking blocks) to use in each activity and are given instructions on how to perform them.

The *Pre-K Mathematics* curriculum is based on the NCTM (National Council of Teachers of Mathematics) standards for pre-K to Grade 2. It includes units on seven basic mathematics topics: 1) Enumeration and number sense; 2) Arithmetic reasoning; 3) Spatial sense; 4) Geometric reasoning; 5) Patterns and units construction; 6) Non-standard measurement; and 7) Logical relations. Teachers are provided two extended professional development activities: a 5-day summer workshop prior to the school year and a 4-day winter workshop during the year that the teachers are using the curriculum. To improve implementation of the home-based part of the curriculum, parents and their children attend three home mathematics classes over the course of

⁹⁰ Sarama and Clements (2002).

⁹¹ Clements and Sarama (2008).

⁹² Clements et al. (2011).

⁹³ Clements and Sarama (2008).

⁹⁴ Clements et al. (2011).

⁹⁵ Griffin (2007); Griffin and Case (1997).

the year. Parents are also given materials and curriculum guidance sheets for conducting activities at home with their preschoolers.

Two large studies demonstrated that combining aspects of the *Pre-K Mathematics* curriculum with the computer software component of *Building Blocks* led to large gains in children's mathematical knowledge, as compared to control classrooms that continued using the same curricula used in the classroom the previous year.⁹⁶ These studies also showed that parents regularly used the materials that were sent home and that teachers effectively implemented the combined program.

Contribution 15. Targeted interventions can significantly improve young children's number sense. IES-supported studies have been important to identifying interventions that improve young children's number sense. Understanding these interventions (and their impacts on children's skills) requires understanding the type of "number sense" that was pursued in each one. This is due to theoretical differences within the field, such that the meaning of number sense and the goals pursued in these interventions have varied more than the shared term "number sense" would suggest.

Siegler and colleagues define number sense as the ability to translate accurately among alternative representations of numerical magnitudes.⁹⁷ For example, seeing people in an audience and estimating the number of people involves translating a visual representation (the visual image of the people in the audience) into a numerical representation (a number that approximates the audience size). Similarly, hearing a gong ring a number of times and estimating how many times it has rung involves translation between auditory and numerical representations; experiencing the passage of time and estimating how many minutes have passed involves a translation between temporal and numerical representations.

A large amount of evidence involving both children⁹⁸ and adults⁹⁹ indicates that people represent knowledge of numerical magnitudes as a horizontally-oriented mental number line, in which number symbols (e.g., "4") are associated with non-verbal representations of quantity (e.g., visual images of 4 candies or 4 coins, or auditory images of 4 tones). In cultures in which the writing system proceeds from left to right, so does the mental number line, with small numbers on the left and large ones on the right. Siegler and colleagues' research has shown that the accuracy with which children can translate numbers into spatial positions on physical number

⁹⁶ Klein et al. (2008); Sarama et al. (2008).

⁹⁷ Booth and Siegler (2006); Opfer and Siegler (2004); Ramani and Siegler (2008); Siegler and Ramani (2008, 2009).

⁹⁸ Case and Okamoto (1996).

⁹⁹ Dehaene (1997).

lines is closely related to children's arithmetic proficiency, their memory for numbers, their estimation skills, and their overall mathematics achievement.¹⁰⁰

Based on these findings, these investigators created a numerical board game, *The Great Race*, consisting of 10 squares arranged from left to right, with "1" in the leftmost square, "2" in the square immediately to the right, and so on (similar to the popular board game *Chutes and Ladders*). The goal of the intervention was to improve children's ability to translate between numerical and non-numerical representations, with a focus on children from low-income backgrounds. In a study of impacts of this board game, each child played the game with an adult for four 15-20 minute sessions over a 2-week period. Children in a control group played a game that was identical, except that it did not include numbers in the squares; children in that group would spin a color and recite the colors through which their token passed on the way to the color (e.g., saying "red, blue.")

Theoretically, playing this board game was expected to help children gain a sense of numerical magnitudes because playing it provides several cues to each number's size. The larger the number, the greater the distance that the child's token has traveled from the origin, the more physical movements of the token the child has made, the more number words the child has said and heard, and the longer the time period since the game began. These visual, kinesthetic, auditory, and temporal cues were expected to create a broad-based, multimodal sense of numerical magnitudes (from 1-10).

As was theorized, playing *The Great Race* produced substantial, significant gains in children's numerical knowledge. The preschoolers, all from low-income backgrounds, became significantly more accurate in number line estimation, in choosing which of two numbers was bigger, in reading numbers, and in counting, as compared to those playing the control (color) game. In addition, playing the numerical board game also improved children's ability to solve arithmetic problems.¹⁰¹ In fact, children who played the numerical board game outperformed those children playing the color board game on five types of numerical knowledge. The resemblance of the board game to the hypothesized mental number line was important in producing these gains; playing a game that was identical except for the numbers being arranged in a circle, less similar to the mental number line, did not produce as much learning. The gains from playing the linear board game proved to be stable over at least a two-month period.

Contribution 16. Response to intervention may be applicable to supporting early math development in children at risk. Some IES-supported investigators have used a Response to Intervention (RtI) approach to helping young children gain number sense.¹⁰² RtI approaches

¹⁰⁰ Booth and Siegler (2006); Opfer and Siegler (2004); Siegler and Booth (2004); Thompson and Siegler, (2010).

¹⁰¹ Ramani and Siegler (2008); Siegler and Ramani (2008,2009).

¹⁰² Chard et al. (2008); Chard et al. (2005); Chard, Ketterlin-Geller, and Jitendra (2008); Clarke, Baker, and Chard (2008).

include both assessment and instructional components. The assessment component is aimed at identifying children in need of special assistance; the instructional component is aimed at preventing difficulties from arising, remedying difficulties that do arise, and providing the tools teachers need for instruction and progress monitoring. The overall goal is to prevent small, relatively tractable early problems from becoming large, intractable, later ones. RtI is generally thought of as comprising three stages of instruction that are intensified at the secondary and tertiary levels based on children's response (or lack thereof) to lower-tier interventions.

Clarke and his colleagues defined number sense in a considerably broader way than did Siegler and his colleagues. Their definition included understanding of numerical magnitudes (like Siegler et al.), but also counting, identifying written numerals, writing numbers, and arithmetic. Consistent with this emphasis, the part of their *Early Learning in Mathematics* (ELM) curriculum aimed at improving number sense focused on one-to-one correspondence, efficient counting strategies, and how to decompose numbers, add one to a number, and solve simple addition and subtraction story problems.¹⁰³

The focus of this research was on young children considered at risk for poor mathematics achievement; these children were identified as those whose initial test scores were below the 40th percentile on a standardized test of mathematics knowledge (the *Test of Early Mathematics Ability* or TEMA¹⁰⁴). The instruction provided to children via the ELM curriculum emphasized systematic and explicit teaching of strategies, encouraging children to think aloud, depicting problems graphically, collaborative learning, and providing formative assessment data to teachers. The ELM curriculum was shown to improve kindergartners' numerical knowledge more than a business-as-usual control group. Moreover, students identified as at risk based on their mathematics knowledge showed greater gains than other students considered not to be at risk.¹⁰⁵

Contribution 17. Young children may require a lengthy period of instruction to learn some key math concepts. Another group of IES-supported investigators reported results of a constructivist intervention aimed at improving children's number sense. In line with general theoretical assumptions of constructivist approaches, this number-sense intervention emphasizes the importance of children discovering rules, regularities, and relations for themselves, rather than directly teaching these rules, regularities, and relations to children.¹⁰⁶ This intervention was based on a very broad view of number sense that included proficiency at one-to-one matching of two sets of objects, recognizing written numerals, reciting the counting string, counting objects, ordering numerical magnitudes, non-verbal and verbal addition and subtraction, and estimation of sums and differences.

¹⁰³ Clarke et al. (2011).

¹⁰⁴ Ginsburgh and Baroody (1990).

¹⁰⁵ Chard, Ketterlin-Geller, and Jitendra (2008).

¹⁰⁶ Baroody, Eiland, and Thompson (2009).

A study involving 80 children identified as at risk for school learning problems was conducted to evaluate this curriculum. The children attended preschool programs that prioritized participation of children with a documentable risk factor, including children from low-income households, children acquiring English as a second language, and children with various disabilities (e.g., speech-language disorder) or health-related risk conditions (e.g., premature birth).

The children received a core curriculum aimed at teaching the skills included in their definition of number sense, after which the children received one of four 10-week (30 sessions) interventions aimed at improving mental arithmetic: (a) semi-structured discovery learning (practice with identifying the number after N , in the hope that children would induce the rule that the number after N is $N+1$); (b) structured discovery learning (the semi-structured learning procedures plus presentation of the corresponding $N+1$ problem, and the corresponding $N+0$ problem); (c) structured discovery learning plus statement of the rule “When we add one, the answer is the number after the other number”; or (d) haphazard practice with randomly sequenced problems in which children are asked about which number comes after N , the answer to $N+1$, and the answer to $N+0$.

Overall achievement of children exposed to the core curriculum improved relative to national norms of the test. However, the four approaches to arithmetic instruction did not differ in their impacts on children’s mathematics skills. All were sometimes effective in helping children learn that adding 0 to a number meant that the answer was the other (original) number, but none were very effective in teaching children that adding 1 meant that the answer was one greater than the other number. Investigators concluded that improving the arithmetic understanding of children at risk requires a lengthier period of instruction than the year of instruction that the preschoolers received.

Contribution 18. There are significant relations between mathematics difficulties in kindergarten and the primary grades. IES-supported research involving secondary analyses of the large and nationally representative data set from the Early Childhood Longitudinal Study (ECLS-K) was conducted to explore mathematics outcomes for children with or at risk for disabilities. A primary aim of this work was to identify whether specific types of early mathematics instruction were associated with better outcomes. As part of this study, researchers examined 5-year growth trajectories from kindergarten through fifth grade, and found that children who displayed persistent mathematics difficulties in kindergarten (delays evident on a mathematics skills assessment administered in both fall and spring of the kindergarten year) had the lowest subsequent mathematics skills growth rates when compared to the mathematics growth trajectories of children who did not evidence persistent delays in kindergarten.¹⁰⁷ Study authors noted that findings supported a cumulative growth model (in which children’s learning in

¹⁰⁷ Morgan, Farkas and Wu (2009).

mathematics reflects their earlier understandings) rather than a lag model (in which instruction in important mathematics concepts allows children to catch-up with their more advanced peers). Findings also suggest that kindergarten children with persistent delays in mathematics may be candidates for intensive early intervention in preschool and kindergarten, so as to avoid failing to become proficient in mathematics skills during their elementary school years.¹⁰⁸

Contribution 19. Science and literacy instruction can be integrated in ways that improves children's motivation towards science. Although young children's early literacy and mathematics competence has been a primary focus of IES-funded research projects, one project has combined literacy and science teaching in to enhance kindergarten children's understanding of science and their motivation for engaging in science activities. This project was initiated in the face of evidence that teachers spend much less time teaching science concepts than they do teaching either literacy or math in the early grades. Researchers evaluated the effects of an inquiry-focused approach to teaching science concepts, implemented in four kindergarten classrooms in one public school. Science learning outcomes of children in these intervention classrooms were compared to outcomes for children in kindergarten classrooms in a different public school within the same district.¹⁰⁹ Children in intervention classrooms made statistically significant gains in understanding scientific processes and life science concepts, relative to students in comparison classrooms. The children also came to believe that they were competent in learning science. Both boys and girls were motivated to engage in scientific inquiry and understanding of scientific topics.¹¹⁰ This investigation provides preliminary evidence that an instructional approach that integrates scientific inquiry and literacy activities promotes both boys' and girls' learning and motivation for engaging in science.

Social-Emotional Competence

Background. There are compelling rationales for the conduct of early childhood education research focused on young children's social-emotional competence and the prevention and amelioration of problem behavior. A national survey study conducted by Gilliam and Golan found expulsion rates due to behavioral concerns for preschool children in state-subsidized programs (6.67 per 1,000 children) to be greater than those of elementary or secondary students.¹¹¹ Estimates of the prevalence of challenging behavior in preschool children range from 10 to 15 percent of the population; data from the Early Childhood Longitudinal Study – Kindergarten (ECLS-K) indicate that teachers report 10 percent of children begin kindergarten with persistent problem behavior.¹¹² For young children with disabilities or those with other risk factors, including living in poverty, prevalence estimates are higher, with one study suggesting

¹⁰⁸ Morgan, Farkas, and Wu (2009).

¹⁰⁹ Samarapungavan, Mantzicopoulos, and Patrick (2008).

¹¹⁰ Mantzicopoulos, Samarapungavan, and Patrick (2008); Mantzicopoulos and Patrick (2010); Patrick, Mantzicopoulos, and Samarapungavan (2009).

¹¹¹ Gilliam and Golan (2006).

¹¹² Denton, Germino-Hausken, and West (2000).

that between 10-23 percent of young children enrolled in Head Start exhibited persistent problem behaviors.¹¹³ Without early prevention and intervention, social, emotional, and behavioral challenges are likely to persist or worsen beyond the early childhood years and lead to negative outcomes, including poor academic achievement, problems with socialization, and mental health concerns.¹¹⁴

Several comprehensive frameworks that organize evidence-based practices designed to support young children's social competence and to prevent or address challenging behavior have been described in the literature. Examples include the *Intervention Hierarchy for Promoting Young Children's Peer Interaction* and the *Teaching Pyramid* framework.¹¹⁵ The Intervention Hierarchy, for instance, provides a comprehensive set of guiding principles for organizing classroom instruction and interventions to promote children's social competence; it is largely a framework for organizing the numerous interventions available. These frameworks, as well as the evidence-based practices associated with them (e.g., provision of explicit social-skills training to children) have been the basis for interventions developed and evaluated as part of IES-supported research. Strategies associated with the frameworks can be used universally with all children and with increased specificity and intensity for children at risk, children with disabilities, or children with targeted social skills needs or persistent challenging behavior. Interventions developed using these frameworks include universal practices for all children, more specific and intensive interventions for young children who need additional social and behavioral supports, and individualized interventions for children who demonstrate significant deficits in social competence and persistent challenging behavior.

IES-supported investigators have developed an intervention known as *Best in Class* that organizes teaching practices designed to increase children's engagement, prevent problem behavior, and improve the classroom learning environment. The strategies are designed to modify teacher-child interaction patterns and improve child social-emotional and learning outcomes. The strategies included in the *Best in Class* intervention include (a) pre-correction of problem behaviors¹¹⁶ coupled with close supervision and monitoring; (b) increased instructional pacing and opportunities for children to respond; (c) increased rates of praise by teachers; and (d) provision of feedback, error correction, and progress monitoring.¹¹⁷

Referenced previously, another intervention developed with IES support was the *Teaching Pyramid* intervention; this is designed to promote children's social-emotional competence and

¹¹³ Kupersmidt, Bryant, and Willoughby (2000).

¹¹⁴ Dunlap et al. (2006).

¹¹⁵ Brown, Odom, and Conroy (2001); Hemmeter, Ostrosky, and Fox (2006).

¹¹⁶ Pre-correction is a strategy teachers use to prevent or interrupt problem behaviors, particularly those that are predictable and thus preventable. This strategy involves identifying antecedents of specific problem behaviors (e.g., the transition between activities) and then employing specific strategies to prevent these behaviors from occurring (e.g., use of visual schedules).

¹¹⁷ Conroy et al. (2008); Sutherland et al. (2010).

address challenging behavior in young children using an RtI framework. Thus, *Teaching Pyramid* practices are organized as universal, secondary, and tertiary interventions with detailed descriptions of research-based practices that should be implemented at each level of the framework. Universal practices include fostering responsive and positive relationships and interactions and the provision of high-quality learning environments. Secondary interventions focus on explicit instruction in social skills and emotional regulation. Tertiary interventions include the implementation and evaluation of individualized, comprehensive, function-based, positive behavior support plans for children with persistent challenging behavior.¹¹⁸ These interventions (*Best in Class*, *Teaching Pyramid*) are currently under evaluation in IES-supported studies.

Contributions of IES-Supported Research

Contribution 20. There is a need for validated practices and policies that help teachers to effectively improve children’s social-emotional competence. IES-supported research has provided evidence regarding the need to develop and test interventions, such as *Best in Class*, that can help teachers to improve children’s social-emotional competence and prevent challenging behavior. In a recent study of six Head Start programs in the Midwest, researchers found that only one-half provided instruction designed to support children’s social-emotional competence, and five of six programs had no systematic policies and procedures to support children with persistent challenging behavior.¹¹⁹ Although preliminary and limited to a small number of programs, this study suggests that early childhood programs may lack policies and procedures for supporting children with the most persistent challenging behavior. This is a concern, given earlier evidence that young children with problem behaviors are more likely to be expelled from preschool than from elementary school.

Within the *Intervention Hierarchy*, *Best in Class*, and the *Teaching Pyramid* frameworks, establishing an engaging and positive classroom environment has been identified as foundational for supporting young children’s learning and development and preventing challenging behavior. Researchers have identified dimensions of positive classroom climate (e.g., positive and responsive teacher-child interactions, use of praise and feedback, instructional pacing) and are currently examining whether teachers’ effective use of practices related to these dimensions is associated with changes in children’s engagement, social competence, challenging behavior, and learning.¹²⁰

As part of validating *Teaching Pyramid* intervention practices, IES-supported investigators conducted a single-case experimental study using a multiple probe design with four participants to examine the effects of a brief 30-minute training and e-mail feedback on teachers’ use of

¹¹⁸ Fox and Hemmeter (2009).

¹¹⁹ Quesenberry, Hemmeter, and Ostrosky (2011).

¹²⁰ Pianta et al. (2008); Conroy et al. (2009).

descriptive praise (that is, praise linked with a specific behavior).¹²¹ Findings showed that all teachers increased their use of descriptive praise during intervention, and that teachers continued their use of this practice above baseline levels after the intervention ended. Investigators also showed that teachers' increased use of descriptive praise during large-group classroom activities was associated with decreases in class-wide challenging behavior.

Studies focused on a specific practice or intervention, such as praise, expand the knowledge base about which practices should be included in frameworks such as the *Intervention Hierarchy* or *Teaching Pyramid*. At the same time, IES is supporting ongoing lines of research to evaluate social competence, behavior, and learning outcomes for preschool children with and without disabilities when teachers implement universal, targeted, and individualized practices associated with these comprehensive frameworks.

MEASURING YOUNG CHILDREN'S SKILLS AND LEARNING

Background. Much of the IES-supported research discussed thus far necessarily involves measurement of children's skills and learning as part of the scientific pursuit; for instance, research examining the association between features of classroom environments and children's learning must validly and reliably represent children's learning in some way. It might be tempting to assume that researchers have an array of well-validated tools at their disposal to measure children's learning across the areas of development discussed in this report (e.g., language, literacy, mathematics, social). On the contrary, research identifying valid and reliable ways to measure children's skills and capture their learning over time is greatly needed. At the same time, there is a need to develop tools that can be readily used within everyday educational settings by teachers and other practitioners; oftentimes, researchers use tools to measure children's skills that would be unwieldy if adopted by practitioners. If research findings are to be translated into everyday practice, and these research findings involve measurement of children's skills, we need tools that practitioners can adopt. For instance, one IES-supported study showed that kindergarteners' fine-motor skills were significantly related to children's academic achievement in later elementary grades.¹²² Other investigators have also found that preschool children's writing skills (specifically, children's use of letters when writing their name) were related to their literacy development, also suggesting that it might be important to attend to children's fine-motor skills.¹²³ However, such findings would be difficult to generalize into educational settings unless there are tools that practitioners can adopt that capture these constructs (e.g., provide a way to measure children's fine-motor skills).

¹²¹ Hemmeter et al. (2011).

¹²² LeBoeuf, Fantuzzo, and Lopez (2010); Grissmer et al. (2011).

¹²³ Diamond, Gerde, and Powell (2008).

There are, in general, few tools that provide fine-grained assessment of infant, toddler, or preschool children's social competence or of their learning in areas related to the development of early academic skills in such areas as language, literacy, mathematics and science.¹²⁴ Direct, individual child assessment is time-consuming and costly, and the routine use of standardized assessment measures with young children has been challenged because results of assessments with young children are typically less reliable than with older children and adolescents. There also are concerns that traditional individualized direct assessment approaches may not be developmentally appropriate for young children who have limited attention to adult-directed activities and who might be wary of unfamiliar adults (i.e., such as an examiner).¹²⁵ Additional concerns are that some assessments may not be valid when used with children who are different from the normative sample on characteristics such as race, home language, or disability.¹²⁶ As can be seen, there is a substantial need for research focused on developing tools that can be used to measure young children's skills.

Contributions of IES-Supported Research

Contribution 21. Some commonly used assessments may not yield reliable scores and thus should be used cautiously. Sometimes, measurement research can show that commonly used measures might not be serving their intended purposes. In fact, results of research conducted by Fantuzzo and his colleagues suggest that some commonly used assessment tools might not yield the same pattern of results for different groups of young children. In the conduct of an evaluation study, these researchers asked whether the *Child Behavior Checklist*,¹²⁷ a commonly employed indicator of behavior problems, yielded valid scores when used with a diverse sample of low-income preschool children.¹²⁸ Their analyses provided no confirmation for the Externalizing and Internalizing behavior dimensions reported by the scale developers. Exploratory analyses suggested that a majority of clinical behavior problems included on the CBCL occurred very rarely in this sample of children. Because the behavior dimensions were not reliable in this sample, it suggests that the use of this measure to evaluate the presence or absence of effects associated with programmatic interventions might be incorrect if this instrument is used in studies involving samples of low-income children from diverse backgrounds.

Contribution 22. New tools are available that provide valid and reliable ways to assess children's language and literacy skills. An emerging body of accompanying work has focused on developing sensitive means for measuring children's language, literacy, and cognitive growth within the context of enhanced classroom instruction and delivery of specific programs and

¹²⁴ National Early Literacy Panel (2008); National Research Council (2008).

¹²⁵ Division for Early Childhood (2007); National Association for the Education of Young Children and National Association of Early Childhood Specialists in State Departments of Education (2003).

¹²⁶ National Research Council (2008).

¹²⁷ Achenbach and Rescorla (2000).

¹²⁸ LeBoeuf, Fantuzzo, and Lopez (2010).

curricula.¹²⁹ For instance, IES-supported researchers have sought to determine whether teacher reports (e.g., teacher completion of surveys) can be reliably used to document children's language and literacy skills as an alternative to direct assessment. Similarly, IES-supported researchers¹³⁰ have studied the diagnostic sensitivity of low-cost language and literacy screening tools for assessing children's skills. These ongoing efforts concerning assessment of children's language, literacy, and cognitive skills warrant mention because research designed to assess the impacts of specific instructional approaches (i.e., efficacy trials) requires access to psychometrically sound and accessible measures of language, literacy, and cognition.

Screening instruments is an area addressed in IES-supported studies; these have involved comparing three types of screening approaches for efficiently identifying kindergarteners at risk for reading disabilities. Investigators conducted two studies focused on the use of a dynamic screening assessment focused on phonological awareness to predict risk for reading disabilities in kindergarten children.¹³¹ In the first study, the predictive validity of a dynamic assessment on which children are provided with feedback and instruction as part of the assessment session (Dynamic Screening of Phonological Awareness¹³²) was compared to the predictive validity of a static version of the same instrument (*Static Deletion Test*).¹³³ In the second study, the predictive validity of the dynamic screening assessment was compared to a commonly used progress monitoring screening measure, the *DIBELS Initial Sound Fluency*.¹³⁴ Results from both studies showed the dynamic screening assessment contributed minimally but uniquely to the prediction of end-of-year reading achievement outcomes focused on word identification and word attack beyond the static and progress monitoring measures.

Other investigators¹³⁵ have compared the classification accuracy of two emergent literacy screening measures, the *Get Ready to Read! Screening Tool-Revised* (GRTR-R)¹³⁶ and the alliteration, rhyming, and picture naming tasks, part of the *Get It, Got It, Go!* individual growth and development indicators (IGDIs).¹³⁷ The criterion measure used to evaluate classification accuracy was the *Test of Preschool Early Literacy*.¹³⁸ Findings demonstrated that the GRTR-R generally yielded more accurate classification of children into at-risk or not-at-risk groups than did the IGDIs. When considering specific domains of early literacy, the GRTR-R and IGDI screening measures were more accurate in predicting children's *Test of Preschool Early Literacy* print knowledge scores than their *Test of Preschool Early Literacy* scores related to vocabulary

¹²⁹ Cabell et al. (2009); Justice, Bowles et al. (2010); Wilson and Lonigan (2010).

¹³⁰ Justice, Bowles et al. (2010); Wilson and Lonigan (2010).

¹³¹ Both studies are reported in Bridges and Catts, 2011.

¹³² Bridges and Catts (2008).

¹³³ Bridges and Catts (2011).

¹³⁴ Kaminski and Good (1996).

¹³⁵ Wilson and Lonigan (2010).

¹³⁶ Whitehurst and Lonigan (2001).

¹³⁷ Missall and McConnell (2004).

¹³⁸ Lonigan et al. (2007).

and phonological awareness. Findings from this study support the use of the GRTR-R and to a lesser extent the IGDIs as screening instruments that hold promise for correctly identifying young children at risk for later reading difficulties, although none of the screening tools identify children's weaknesses or strengths across specific early literacy domains.¹³⁹

Contribution 23. Progress monitoring and data-based decision making tools might improve instructional practices. As important as it is for practitioners to have access to tools that yield reliable and valid scores to measure young children's skills across various areas, it is also necessary for practitioners to be able to use these tools effectively—to monitor children's progress over time and to make important decisions about children's status, such as whether a child exhibits a disability. IES-supported investigators have developed and are validating a web-based clinical decision support system known as MOD (Making Online Decisions). The MOD is a support tool for early interventionists, similar to the progress monitoring and decision making tools developed and validated for use in preschool and primary grades. The MOD system guides service providers through decision-making processes informed by progress monitoring data, the provider's professional judgment, and information from the child's parent or primary caregiver. Research is currently being conducted to evaluate whether the MOD system influences providers' decision-making behavior when progress monitoring measures indicate infants and toddlers are performing below expected levels on early communication skill indicators. This research is also determining if changes in service providers' behavior are associated with improved early communication for infants and toddlers.¹⁴⁰

PROFESSIONAL DEVELOPMENT FOR EARLY EDUCATORS

IES-supported research has made important contributions to developing and identifying effectively ways to provide professional development to educators. Professional development interventions include those that are directed to helping teachers implement a new curriculum, improve instructional practices, or improve instruction within a specific domain.¹⁴¹ The expectation is that increasing teachers' use of research-based instructional practices, with fidelity, promotes more effective learning by children enrolled in their classrooms. Professional development interventions with pre-kindergarten teachers represent promising strategies for improving academic and social outcomes of young children at risk.¹⁴²

¹³⁹ Wilson and Lonigan (2010).

¹⁴⁰ Buzhardt et al. (2010).

¹⁴¹ We acknowledge that any study that utilizes an intervention with teachers must, by its very nature, include professional development. The corpus of work that is discussed in this section of the report focuses only on those studies that had as their aim the evaluation of the effects of specific PD intervention components on specific elements of instruction. It is qualitatively different from PD designed to help teachers implement a curriculum or intervention practice with fidelity.

¹⁴² Powell and Diamond (2011).

Background. Research on adult learning has highlighted the importance of four different elements for professional development to be effective for improving teacher-related outcomes. It: (a) is learner-centered, building on individual teachers' strengths and needs; (b) addresses important content knowledge; (c) provides individuals with opportunities to test their understanding by trying things out and receiving feedback; and (d) occurs within a collaborative environment.¹⁴³ This framework highlights the importance of individualized work with teachers that focuses on content knowledge and effective pedagogy within an identified domain (e.g., literacy, mathematics) as critical for professional development. There is substantial evidence that brief workshops are ineffective in promoting lasting changes in instruction, a result consistent with this perspective on professional development and adult learning.¹⁴⁴

In large part, the interest in improving professional development for teachers is that it will benefit children in their classrooms. To this end, there is a general expectation that when a professional development intervention leads to improvements in teachers' instruction, children will also benefit. Children's learning is only indirectly targeted by interventions directed toward teachers, however, and immediate benefits to children's learning might be difficult to detect. As an example, Mashburn and his colleagues recently reported on the impact of a professional development intervention targeting teachers' language and literacy instruction on children's outcomes. Teachers in this study received language and literacy activities and access to a video library of best practices, or these resources plus consultation. The investigators found an association between teachers' participation in the consultancy condition and children's gains on a measure of receptive language skills. Such findings suggest that professional development of teachers can affect children. The professional development interventions that have been funded by IES reflect attention to targeted, individualized work with teachers (e.g., through individualized coaching, mentoring or consultation) to promote pedagogical content knowledge, provide opportunities for teachers to try out new approaches to instruction and to receive feedback on their teaching.¹⁴⁵ Professional development interventions that promote teachers' use of effective approaches for teaching important academic and social skills with fidelity and use data to make informed decisions about instruction for individual children are expected to promote children's learning by improving teachers' instruction.

Contributions of IES-Supported Research

Contribution 24. Classroom instruction can be improved by providing professional development to teachers. IES has supported research that develops and evaluates interventions to improve teaching of important language and literacy skills. Although somewhat different in scope and implementation, each of these projects uses individualized coaching or mentoring

¹⁴³ Bransford, Brown, and Cocking (1999).

¹⁴⁴ Zaslow et al. (2011).

¹⁴⁵ We use the terms used by study authors (coaching, mentoring, consultation) to describe their work with teachers in providing "individualized and sustained work ... that provides guidance and feedback on implementation of evidence-based practices in their own classrooms" (Powell, Diamond et al., 2010, p. 301).

from a more experienced individual and, in some cases, feedback on children's learning, to help teachers learn to use more effective strategies for teaching critical early literacy skills in their own classrooms. Results tend to suggest that coaching improves teachers' instruction when compared with teachers who do not receive coaching.

In an intervention with public school pre-kindergarten teachers (all of whom held teaching licenses), Pianta and colleagues asked teachers to videotape themselves and to upload the videotape to a secure website. School districts in this study were randomly assigned to one of two types of intervention: Web-only or Web plus Consultation. In the Web-only condition, teachers received curricular materials and had access to exemplars of good practice through videotapes available on a secure website. Teachers in the Consultation condition had access to all of the materials and resources available to Web-only teachers and, in addition, received Consultation support over the course of the year. Teachers in the Consultation condition videotaped their implementation of an instructional activity. Teachers sent the videotape to the consultant who provided written feedback to teachers. Teachers and consultants met on-line in a video-chat to discuss the feedback. The study authors concluded that teachers in this intervention made gains in the sensitivity of their interactions with students and provided better language supports to students compared to teachers who did not receive consultation support.¹⁴⁶ The authors also reported that children whose teachers participated in the Consultation condition made greater gains in receptive language skills compared to those in the Web-only condition. However, such findings should be considered cautiously, as the randomization of teachers to the two intervention conditions was done at the level of the district but analyses of children's outcome were conducted at the (teacher) classroom level. This analytical approach limits the strength of the finding.

A different group of investigators examined two approaches to coaching, one of which relied on distance technology, for helping Head Start teachers, many of whom had neither a 4-year college degree nor a teaching license, improve the way they teach important literacy and language skills. In this randomized controlled trial study, teachers were assigned to receive either face-to-face coaching in their own classrooms or coaching through the use of video-based distance technologies similar to those used by Pianta and his colleagues; there was also a wait-list control group. These investigators found that teachers who received either coaching intervention made significant improvements in their classroom's literacy environment compared with teachers in the wait-list control group who had not received the intervention. Teachers in both intervention groups also showed significant improvements in their instruction of letters and words. Teachers in both coaching groups improved their teaching relative to teachers who did not receive coaching, but there were no meaningful differences between the two coaching groups.¹⁴⁷ Effects

¹⁴⁶ Pianta et al. (2008).

¹⁴⁷ Powell, Diamond et al. (2010).

of this approach to professional development on children's learning of literacy and language skills are discussed in the next section.

In another study of professional development of teachers, Landry and her colleagues examined the effects of mentor coaching in combination with two different approaches to monitoring children's learning for improving teachers' instruction. Participating schools were randomly assigned to one of five groups that included a business-as-usual control group and one of four intervention groups created by crossing two levels of mentoring (none, in-class) and two types of progress-monitoring tools (individual child reports linked to curriculum and instructional objectives using a handheld personal digital assistant/PDA, paper and pencil reports). A professional development training course, referred to as eCIRCLE, provided the curricular framework that guided teachers' classroom instruction. The effectiveness of these intervention approaches was evaluated with teachers in four different states, including licensed teachers in state-funded pre-kindergarten programs and Head Start teachers. The authors concluded that overall teaching quality, as well as teachers' instruction focused on phonological awareness and writing skills, were improved for teachers in all of the interventions, compared to other teachers who received none of the interventions. Mentor coaching in combination with progress monitoring using a PDA resulted in the strongest intervention effects across these groups of teachers.¹⁴⁸

A slightly different approach is one in which a mentor works with a group of teachers in a "community of practice" to improve teachers' instruction. In a recent quasi-experimental study of a "community of practice" approach for improving instruction for Spanish-speaking children who were learning English, investigators found this intervention led to improvements in teachers' use of literacy activities provided in English (but not in Spanish).¹⁴⁹

Recent work conducted by Hemmeter and colleagues has examined the use of performance feedback delivered electronically to support teachers' use of descriptive praise and feedback for enhancing learning for preschool children with or at risk for disabilities. In their work, investigators examined concomitant relations between teachers' effective use of descriptive praise and children's classroom engagement and challenging behavior in a single-subject, multiple-probe across participants' experimental study with four preschool teachers. Findings demonstrated that brief training with performance feedback delivered via electronic mail was associated with increases over baseline levels in teachers' use of descriptive praise and some reductions in children's challenging behavior.¹⁵⁰

Contribution 25. Improving teachers' instruction through professional development can improve children's learning and development. At the time of this report, two IES-supported

¹⁴⁸ Landry et al. (2009).

¹⁴⁹ Buysse, Castro, and Peisner-Feinberg (2010).

¹⁵⁰ Hemmeter et al. (2011).

studies focused on examining impacts of professional development interventions on teachers' use of research-based instructional practices had also reported evidence on the effectiveness of the professional development intervention in improving children's learning outcomes.¹⁵¹ In their randomized controlled trial study, discussed in the previous section, Powell and his colleagues found that when teachers participated in a one-semester professional development intervention targeting phonological awareness and language comprehension, children in their classrooms made significantly greater gains on measures of letter knowledge, blending of sounds, understanding of print, and writing compared with children enrolled in control classrooms.¹⁵² However, they found no effect of the intervention on children's vocabulary skills or understanding of initial sounds.

Landry and her colleagues' research, also referenced in the prior section, used a randomized controlled trial design to compare the effects of different levels of progress monitoring and mentor coaching with a control condition, on children's learning. Results were mixed and varied as a function of program site (state). Specifically, there was no overall effect of the intervention on children's oral language; children in two of the four states showed improved print awareness and letter knowledge, although the effects of specific intervention elements were inconsistent (e.g., mentoring was important in one state but not another); and, in all four states, children whose teachers were in the no-mentoring, PDA group made greater gains in phonological awareness than did children in the control group.¹⁵³ Thus, while these investigators provide evidence that the professional development intervention led to improvements in instructional quality focused on phonological awareness, writing, and print and letter knowledge, results for children were mixed, with patterns of effects varying across sites and across the content of instruction.

An important issue requiring further research is that of understanding how, and whether, different approaches to professional development with teachers affect children's learning in different ways (or at all). That is, is it more effective to provide professional development focused on (a) improving teachers' knowledge about instruction and children's learning within a content area such as mathematics, or (b) teachers' beliefs or motivations about the importance of teaching specific content for children's success in the primary grades, or (c) changing teachers' practices so that they provide more effective instructional and emotional support to the children in their class.

Contribution 26. Technology can play an important role in designing effective professional development. In two of the professional development projects discussed in the previous sections, short videotaped movies of effective teaching provided an additional approach to

¹⁵¹ Landry et al. (2009); Powell, Diamond et al. (2010).

¹⁵² Powell, Diamond et al. (2010).

¹⁵³ Landry et al. (2009).

helping teachers learn new ways to teach literacy skills.¹⁵⁴ Pianta and his colleagues found that teachers who received mentoring through consultation were more likely than non-mentored teachers to view the video movies on their own. Powell and his colleagues found that teachers who had access to videotape exemplars of best practices varied widely in the extent to which they viewed videotapes on their own. When teachers viewed the videotapes, it was most likely to be outside of work hours. Such work contributes to expanding the field's understanding of how and to what extent technology might be used to support teachers' development, particularly their adoption of new practices.

Technology has also been used to provide feedback to teachers on aspects of their instruction, including linking comments from a literacy coach with videotapes of a teacher's instruction.¹⁵⁵ Approaches to providing feedback through electronic mail have also been examined.¹⁵⁶ Finally, investigators found that including a PDA that provided teachers with immediate feedback on children's learning and identified the next concepts to be taught, as coupled with the support of a mentor coach, had generally positive effects on quality of language and literacy instruction; in turn, some positive impacts on children's language and literacy skills were also observed, although results were mixed. As technology is used increasingly for professional development with teachers, research is needed to examine the role of technology in promoting teachers' use of effective teaching strategies.

SUMMARY AND CONCLUSIONS

A primary purpose of early childhood education is to promote children's acquisition of knowledge and skills linked to later social competence and academic success. Although early childhood education programs are concerned with supporting the early development and learning of all children, they can be particularly important for closing the gap in early skills among children experiencing risk factors relative to more-advantaged children. That is, children who are poor, children who speak a language other than English at home, and children with identified disabilities or at risk for developing disabilities perform at lower levels than their more advantaged peers on many measures of academic and social competence when they enter kindergarten. They are on a trajectory that may result in short- and long-term school failure. These are also the children who are the majority of participants in publicly supported early childhood classrooms and early intervention programs.

Through IES-funded research, we are gaining a better understanding of how early childhood programs can function to support learning for children who exhibit risk factors, including children with disabilities. As has been seen in this report, IES-supported research has focused on

¹⁵⁴ Pianta et al. (2008); Powell, Diamond, and Koehler (2010).

¹⁵⁵ Mashburn and Pianta (2010); Powell, Diamond, and Koehler (2010).

¹⁵⁶ Hemmeter et al. (2011).

a number of different intervention topics, including identifying curricula and instructional strategies that promote young children's academic and social competence. In addition, rigorous research studies of early childhood curricula have made clear that many are no more effective than business-as-usual practices for improving children's learning.

Fortunately, there are many noteworthy exceptions. Among the approaches that have been shown to be more effective than business as usual are IES-supported studies of a literacy curriculum for children who are deaf or hard of hearing and curricula that are effective in promoting children's understanding of important mathematical concepts. Equally important is research that has led to the identification of specific instructional strategies for improving children's learning of targeted, foundational skills in early literacy, science and mathematics. IES-funded research also is investigating the effectiveness of RtI frameworks that support the development and learning of children with or at risk for disabilities, and children with low levels of achievement (primarily in reading). Results of such work can help educators understand the scientific bases of RtI applications in early education classrooms. Finally, IES-funded research has added to our understanding of professional development interventions that support teachers' use of effective instruction and advance children's learning of important academic and social skills.

While we have learned a great deal about effective educational practices through IES-supported research, the field of early childhood education and intervention still has far to go toward identifying the most effective ways to intervene with children who are at risk for school learning problems, have specific educational needs, live in different circumstances, and attend a range of early education and intervention programs. We are still far from answering the second-generation questions of what works, for whom, and under what circumstances.¹⁵⁷ In our view, important questions for education research include those related to:

The quality of early childhood education and intervention for all children. For example, we need more evidence about the ways in which specific features of classroom quality are related to children's development and learning in specific domains. Are there minimum thresholds of quality (teachers' instruction and support for children) below which little learning occurs? How does quality of instruction relate to quality of teacher-child relationships (e.g., is there a synergistic association such that good quality in one domain leverages quality in another)? How are quality thresholds applicable across varied types of program (e.g., publicly supported programs such as state-funded pre-K, community based early care and learning center) and locales? What interventions are effective for improving early childhood classroom quality? Where will investment in quality improvements have the biggest impact on children's learning and development?

Key characteristics of effective instruction. Substantial efforts have focused on developing effective instruction of important early learning objectives, particularly for children who are at

¹⁵⁷ Guralnick (1997).

risk. Yet, we are far from knowing the most effective and efficient approaches for engaging children in learning to support their development of attention and self-regulation; at the same time, there is a great need to know how best to promote children's development of language, literacy, mathematics and science knowledge, all of which are foundations for continued success in the elementary grades. Children who are at risk frequently fall behind their more advantaged peers with few or no risk factors on measures of social and academic competence when they enter preschool at ages three and four. Thus, focusing on efficient as well as effective educational practices will be critical in closing achievement gaps.

Intensive instruction for children with significant learning needs. In addition to focusing on issues related to classroom-wide quality, many important issues remain when children continue to demonstrate difficulties learning. For example, while response-to-intervention approaches have been used effectively to support elementary school children's learning, they are only beginning to be used in early childhood programs. Particularly given substantial organizational differences, it is not a straightforward task to apply elementary school practices to early childhood classroom settings. Further attention to the development of assessment tools that can be used quickly and reliably to monitor preschool children's progress in academic and social learning domains is needed, as is the continued development of effective, individualized interventions that can be implemented in group settings by teachers and at home by family members.

Improving teaching practices. We have learned a lot about effective instructional practices that promote children's development and learning, and about elements of high-quality teaching. We know much less, however, about effective strategies for helping teachers to improve the quality of their classrooms and of the instruction that they provide. Individualized coaching or mentoring has been identified as an effective way for helping teachers learn new and effective teaching practices, yet we know little about elements of effective coaching. For example, is coaching more effective when it is provided by a colleague from one's own school (mentor-teacher) than when it is provided by a coach from the outside? How frequently should the coach consult with the teacher, and how much coaching is needed to effect reliable, lasting changes in teachers' instructional practices? How effective are communities of practice (i.e., groups of teachers) in promoting changes in teaching, relative to individualized coaching? What technologies are effective in supporting teachers' learning and use of new, more effective instruction?

Research in early education and early intervention, supported by IES, has made substantial and significant contributions to our understanding of effective practices for enhancing the learning and development of our youngest and most vulnerable citizens. Rigorous research that addresses important questions about approaches for promoting children's development and learning can provide educators (and other public consumers of education) with important guidance regarding the scientific bases for practices and policies currently in place, or under consideration for adoption. The present summary provides an initial summary of major contributions to date of IES-supported research; additional IES-supported research relevant to early childhood education

is underway and will provide additional guidance regarding effective practices and policies for early education.

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Appendix A

IES-Supported Research Projects and related Publications included in this Synthesis

Principal Investigator: Scott Baker

Institution: Pacific Institutes for Research

Project: *Early Learning in Mathematics: Efficacy in Kindergarten Classrooms*
(R305A080114)

Clarke, B., Smolkowski, K., Baker, S., Fien, H., and Chard, D. (2011). The Impact of a Comprehensive Tier 1 Kindergarten Curriculum on the Achievement of Students At-Risk in Mathematics. *Elementary School Journal, 111*, 561-584.

Principal Investigator: Arthur Baroody

Institution: University of Illinois, Urbana-Champaign

Project: *Developing an Intervention to Foster Early Number Sense and Skill*
(R305K050082)

Project: *Fostering Fluency With Basic Addition and Subtraction* (R305A080479)

Baroody, A.J. (2011). Chapter 2--Learning: A Framework. In F. Fennell (Ed.), *Achieving Fluency: Special Education and Mathematic*. Reston, VA: National Council of Teachers of Mathematics.

Baroody, A.J., Bajwa, N.P., and Eiland, M. (2009). Why Can't Johnny Remember the Basic Facts? *Developmental Disabilities Research Reviews, 15*(1), 69-79.

Baroody, A.J., Eiland, M., and Thompson, B. (2009). Fostering At-Risk Preschoolers' Number Sense. *Early Education and Development, 20*(1), 80-120.

Baroody, A.J., Feil, Y., and Johnson, A.R. (2007). An Alternative Reconceptualization of Procedural and Conceptual Knowledge. *Journal for Research in Mathematics Education, 38*(2), 115-131.

Baroody, A.J., and Li, X. (2009). Mathematics Instruction That Makes Sense for 2 to 5 Year olds. In E.L. Essa and M.M. Burnham (Eds.), *Informing our Practice: Useful Research on Young Children's Development* (pp. 119–135). Washington, DC: The National Association for the Education of Young Children.

Baroody, A.J., and Varma, S. (2011). The Active Construction View of Basic Number Fact Knowledge: New Directions for Cognitive Neuroscience. In J. Baek, A.E. Kelly, and L. Kalbfleisch (Eds.), *Neuropsychology and Mathematics Education*.

Principal Investigator: Virginia Buysee

Institution: University of North Carolina, Chapel Hill

Project: *Improving Teacher Quality to Address the Language and Literacy Skills of Latino Children in Pre-Kindergarten Programs (R305M040032)*

Buysee, V., Castro, D.C., and Peisner-Feinberg, E. (2010). Effects of a Professional Development Program on Classroom Practices and Outcomes for Latino Dual Language Learners. *Early Childhood Research Quarterly*, 25(1), 94-206.

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Principal Investigator: Hugh Catts

Institution: University of Kansas

Project: *Early Identification of Children with Reading Disabilities Within an RTI Framework (R324A080118)*

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Principal Investigator: Bette Chambers

Institution: Success For All Foundation

Project: *Randomized Evaluation of Curiosity Corner with Follow-up into SFA and Control Elementary Programs* (R305J030138)

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Principal Investigator: David Chard

Institution: University of Oregon

Project: *Early Learning in Mathematics: A Prevention Approach* (R305K040081)

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Principal Investigator: Douglas Clements

Institution: University at Buffalo, SUNY

Project: *Scaling up TRIAD: Teaching Early Mathematics for Understanding with Trajectories and Technologies* (R305K050157)

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Principal Investigator: Margaret Clements

Institution: Education Development Center, Inc.

Project: *Examination of the Impact of Big Math for Little Kids (BMLK) on Pre-K and Kindergarten Students' Learning of Math* (R305K040001)

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Principal Investigator: Maureen Conroy

Institution: Virginia Commonwealth University

Project: *Promoting Social, Emotional, and Behavioral Competence in Young High-Risk Children: A Preventative Classroom-Based Early Intervention Model* (R324A080074)

Conroy, M.A., Sutherland, K.S., Haydon, T., Stormont, M., and Harmon, J. (2008). Preventing and Ameliorating Young Children's Chronic Problem Behaviors: An Ecological Classroom-Based Approach. *Psychology in the Schools*, 46(1), 3-17.

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Principal Investigator: Michael Coyne

Institution: University of Connecticut

Project: *Project VITAL: Vocabulary Intervention Targeting At-risk Learners* (R305G030250)

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Principal Investigator: Michael Coyne

Institution: University of Connecticut

Project: *Project IVI: Intensifying Vocabulary Intervention for Kindergarten Students at-Risk of Learning Disabilities* (R324L060026)

Loftus, S., Coyne, M.D., McCoach, D.B., Zipoli, R., Kapp, S., and Pullen, P. (2010). Effects of a Supplemental Vocabulary Intervention on the Word Knowledge of Kindergarten Students At-Risk for Language and Literacy Difficulties. *Learning Disabilities Research & Practice, 25*(3), 124-136.

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Principal Investigator: Anne Cunningham

Institution: University of California, Berkeley

Project: A Longitudinal Study of the Effectiveness of a Pre-K Multisensory Literacy Curriculum (R305J030037)

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Principal Investigator: John Fantuzzo

Institution: Trustees of the University of Pennsylvania

Project: *Kids Integrated Data System (KIDS): An Evidence-Based System for Enhancing Educational Proficiency and Social Adjustment* (R305A080309)

LeBoeuf, W.A., Fantuzzo, J.W. and Lopez, M.L. (2010). Measurement and Population Miss-fits: A Case Study on the Importance of Using Appropriate Measures to Evaluate Early Childhood Interventions. *Applied Developmental Science*, 14(1) 45-53.

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Principal Investigator: Dale Farran

Institution: Vanderbilt University

Project: *Focus in the Early Childhood Curricula: Helping Children Transition to School* (R305J020020)

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Principal Investigator: Cheryl Fountain

Institution: University of North Florida

Project: *Evaluation of the Early Literacy and Learning Model (ELLM): A Curriculum and Instruction Support System (R305J020040)*

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Principal Investigator: Jorge Gonzalez

Institution: Texas A&M University

Project: *Project Words of Oral Reading and Language Development (R305G050121)*

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Principal Investigator: Charles Greenwood

Institution: University of Kansas

Project: *The Infancy Preschool Early Literacy Connection: Validation Studies of the Early Communication (ECI) Indicator of Growth and Development (R324A070085)*

Buzhardt, J., Greenwood, C., Walker, D., Carta, J., Terry, B. and Garrett, M. (2010). A Web-Based tool to support Data-Based Early Intervention Decision Making. *Topics in Early Childhood Special Education*, 29(4), 201-213.

Principal Investigator: Barbara Gunn

Institution: Oregon Research Institute

Project: *Evaluating the Efficacy of Read Well Kindergarten* (R305F05080)

Gunn, B.K., Smolkowski, K., and Vadasy, P. (2011). Evaluating the Effectiveness of *Read Well Kindergarten*. *Journal of Research on Educational Effectiveness*, 4(1), 53-86.

Principal Investigator: Mary Louise Hemmeter

Institution: Vanderbilt University

Project: *Examining the Potential Efficacy of a Classroom Wide Model for Promoting Social Emotional Development and Addressing Challenging Behavior in Preschool Children With and Without Disabilities* (R324A070212)

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Principal Investigator: Laura Justice

Institution: University of Virginia

Project: *Evaluation of the Language-Focused Curriculum* (R305J030084)

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Principal Investigator: Laura Justice

Institution: University of Virginia

Project: *Print Referencing Efficacy* (R305G050005 (original award number R305G050057))

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Principal Investigator: Laura Justice

Institution: Ohio State University

Project: *Efficacy of Read It Again! In Rural Preschool Settings* (R305A080459)

Pentimonti, J., Zucker, T., and Justice, L.M. (2010). Informational Text use in Preschool Classroom Read-Alouds. *The Reading Teacher*, 63(8), 656-665.

Principal Investigator: Laura Justice

Institution: University of Virginia

Project: *Efficacy of Conversational Responsiveness Preschool Language Intervention* (R305F050006)

Cabell, S., Justice, L.M., Konold, T., and McGinty, A. (2011). Profiles of Emergent Literacy Skills Among Preschool Children Who Are At-Risk for Academic Difficulties. *Early Childhood Research Quarterly*, 26(1), 1-14.

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Principal Investigator: Richard Lambert

Institution: University of North Carolina at Charlotte

Project: *Evaluation of the Effects of Creative Curriculum on Classroom Quality and Child Outcomes in Head Start (R305J020039)*

Preschool Curriculum Evaluation Research Consortium (2008). *Effects of Preschool Curriculum Programs on School Readiness* (NCER 2008-2009). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. Washington, DC: U.S. Government Printing Office.

Principal Investigator: Susan Landry

Institution: University of Texas Health Science Center at Houston

Project: *Scaling Up a Language and Literacy Development Program at the Pre-Kindergarten Level (R305W020002)*

Landry, S.H., Anthony, J.L., Swank, P.R., and Monseque-Bailey, P. (2009). Effectiveness of Comprehensive Professional Development for Teachers of At-Risk Preschoolers. *Journal of Educational Psychology, 101*(2): 448-465.

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Principal Investigator: Susan Landry

Institution: University of Texas Health Science Center at Houston

Project: *Evaluation of Pre-Kindergarten Curricula in Head Start and Public School Settings (R305J020014)*

Assel, M.A., Landry, S.H., Swank, P.R., and Gunnewig, S. (2007). An Evaluation of Curriculum, Setting, and Mentoring on the Performance of Children Enrolled in Pre-Kindergarten. *Reading and Writing: An Interdisciplinary Journal, 20*(5), 463-494.

Principal Investigator: Amy Lederberg

Institution: Georgia State University

Project: *Improving Deaf Preschoolers' Literacy Skills* (R324E060035)

Bergeron, J.P., Lederberg, A.R., Easterbrooks, S.R., Miller, E.M., and Connor, C.M. (2009). Building the Alphabetic Principle in Young Children Who Are Deaf or Hard of Hearing. *The Volta Review*, 109(2-3), 87-119.

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Principal Investigator: Christopher Lonigan

Institution: Florida State University

Project: *Evaluating the Effectiveness of Preschool Literacy Curriculum for Children At-Risk* (R305J030093)

Preschool Curriculum Evaluation Research Consortium. (2008). *Effects of Preschool Curriculum Programs on School Readiness* (NCER 2008-2009). U.S. Department of Education, National Center for Education Research. Washington, DC: U.S. Government Printing Office.

Principal Investigator: Christopher Lonigan

Institution: Florida State University

Project: *A Randomized Trial of Preschool Instructional Strategies to Improve School Performance and Reduce Use of Special Education* (R324E060086)

Wilson, S.B. and Lonigan, C.J. (2010). Identifying Preschool Children At-Risk of Later Reading Difficulties: Evaluation of Two Emergent Literacy Screening Tools. *Journal of Learning Disabilities*, 43(1), 62-76.

Principal Investigator: Gayle Luze

Institution: Iowa State University

Project: *The Infancy Preschool Early Literacy Connection: Validation Studies of the Early Communication (ECI) Indicator of Growth and Development (R324A070248)*

Luze, G.J. and Hughes, K. (2008). Using Individual Growth and Development Indicators to Assess Child and Program Outcomes. *Young Exceptional Children*, 12(1), 31-41.

Principal Investigator: Panayota Mantzicopoulos

Institution: Purdue University

Project: *The Scientific Literacy Project: Enhancing Young Children's Scientific Literacy through Reading and Inquiry-Centered Adult-Child Dialogue (R305K050038)*

Mantzicopoulos, P., and Patrick, H. (2010). "The See-Saw is a Machine That Goes Up and Down": Young Children's Narrative Responses to Science-Related Informational Text. *Early Education and Development*, 21(3), 412-444.

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Principal Investigator: Paul Morgan

Institution: Pennsylvania State University

Project: *Instructional Effects on Achievement Growth of Children with Learning Difficulties in Mathematics* (R324A070270)

Morgan, P.L., Farkas, G., and Wu, Q. (2009). Five-Year Growth Trajectories of Kindergarten Children With Learning Difficulties in Mathematics. *Journal of Learning Disabilities*, 42(4), 306-321.

Principal Investigator: Helen Neville

Institution: University of Oregon

Project: *Training Attention in Preschool: Effects on Neurocognitive Functions and School Performance* (R305B070018)

Stevens, C., Lauinger, B. and Neville, H. (2009). Differences in the Neural Mechanisms of Selective Attention in Children From Different Socioeconomic Backgrounds: An Event-Related Brain Potential Study. *Developmental Science* 12(4), 634-646.

Principal Investigator: Robert Pasnak

Institution: George Mason University

Project: *Increasing Learning by Promoting Early Abstract Thought* (R305H030031) *An Economical Improvement in Literacy and Numeracy* (R305B07542)

Greene, M.R., Pasnak, R., and Romero, S. (2009). A Time Lag Analysis of Temporal Relations Between Motivation, Academic Achievement, and Two Cognitive Abilities. *Early Education and Development*, 20(5), 799-825.

Kidd, J.K. Pasnak, R., Gadzichowski, M., Ferral-Like, M., and Gallington, D. (2008). Enhancing Early Numeracy by Promoting the Abstract Thought Involved in the Oddity Principle, Seriation, and Conservation. *Journal of Advanced Academics*, 19(2), 164-200.

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Principal Investigator: Robert Pianta

Institution: University of Virginia

Project: *National Research and Development Center on Early Childhood Development and Education* (R305A060021)

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Principal Investigator: Douglas Powell

Institution: Purdue University

Project: *Impact of the Project Approach on Children's School Readiness and School Achievement (R305J020027)*

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Principal Investigator: Douglas Powell

Institution: Purdue University

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Principal Investigator: Jeff Priest

Institution: University of New Hampshire

Project: *Granite Ladders: An Evaluation of an Early Literacy Curriculum for New Hampshire's Preschoolers* (R305J020051)

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Principal Investigator: Robert Siegler

Institution: Carnegie Mellon University

Project: *Using Cognitive Analyses to Improve Children's Math and Science Learning* (R305H020060)

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Principal Investigator: Deborah Simmons

Institution: Texas A&M Research Foundation

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Principal Investigator: Patricia Snyder

Institution: University of Florida

Project: *Impact of Professional Development on Preschool Teachers’ Use of Embedded-Instruction Practices (R324A070008)*

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Principal Investigator: Prentice Starkey

Institution: University of California, Berkeley

Project: *A Longitudinal Study of the Effects of a Pre-Kindergarten Mathematics Curriculum on Low-Income Children's Mathematical Knowledge* (R305J020026)

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Principal Investigator: Kathy Thornburg

Institution: University of Missouri

Project: *Project Construct: A Catalyst for Early Achievement* (R305J030103)

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Principal Investigator: Patricia Vadasy

Institution: Washington Research Institute

Project: *Efficacy of Sound Partners Supplemental Tutoring for ELL Students, Grades K-1 (R305A070324)*

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Principal Investigator: M. Jeanne Wilcox

Institution: Arizona State University

Project: *Development of an IFSP Form and Process to Maximize Learning Opportunities for Young Children with Disabilities (R324B070033)*

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Principal Investigator: M. Jeanne Wilcox

Institution: Arizona State University

Project: *The Development and Efficacy of a Curriculum-Based Language and Early Literacy Intervention for Preschool Children with Developmental Disabilities (R324E060023)*

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