

EARLY SKILLS AND PREDICTORS OF ACADEMIC SUCCESS

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In the following report, Hanover Research reviews the empirical research base surrounding the impact of early skills on future academic success. This report identifies specific academic and nonacademic early skills necessary for school success, as well as presents evidence to support how districts and schools can effectively assess students' acquisition of key early skills as well as respond to students' needs in order to maximize their learning and success and mitigate any long-term achievement effects.

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

Early skills are gaining currency in the public education sector as educators and policymakers examine ways to close the widening and persistent achievement gap across the country. The pathways for future academic outcomes are often shaped during the early years, as young children learn important skills that serve as the foundation for the development of later academic skills and ultimately, success. Research highlights that children who enter school with specific early skills seem to be more advantaged than their peers in terms of future academic achievement. In 2013, for instance, the American Institutes for Research (AIR) published a comprehensive review of indicators, predictors, and other potential factors associated with high school graduation and postsecondary success.¹ The report highlights that students may demonstrate academic and nonacademic behaviors that are predictive of their educational future as early as elementary school.²

Findings such as the above suggest that educators can monitor a number of early skills to predict academic success or failure at several points in a child’s academic career. Given that early skills are critical to a child’s development, it becomes increasingly important for school districts to examine the relationships of these early skills to later school performance and to proactively identify ways that could support the development of these skills in students who may be susceptible to negative long-term achievement effects.

This report examines the early academic skills related to literacy and mathematics, and considers non-academic skills such as social-emotional and behavioral indicators, that are predictive of students’ later academic success. The following review also highlights how these skills are especially important across specific subgroups, including English language learners and students from low socio-economic backgrounds. In addition, Hanover identifies key assessments that have been proven to be effective for assessing early skills, and presents academic interventions that might mitigate any long-term achievement effects.

To identify studies with the largest impacts, Hanover reviewed a number of online databases of empirical work, including EBSCOHost and ERIC, and examined practice guides developed by the U.S. Department of Education’s What Works Clearinghouse (WWC). In reviewing the literature on early skills, Hanover prioritizes qualitative and quantitative research published in peer-reviewed journals within the last ten years. Studies with large sample sizes and particularly strong implications for practice are emphasized.

¹ “Predictors of Postsecondary Success.” College and Career Readiness and Success Center at American Institutes for Research, 2013.
http://www.ccrscenter.org/sites/default/files/CCRS%20Center_Predictors%20of%20Postsecondary%20Success_final_0.pdf

² Ibid.

To this end, the following report comprises three main sections: **(I) Impact of Early Skills on Future Academic Success; (II) Implications for Assessment;** and **(III), Implications for Instruction.** The following findings offer a general overview of key themes identified in the pertinent literature. Key findings at the beginnings of each section provide a more detailed discussion of these topics.

KEY FINDINGS

THE IMPACT OF EARLY SKILLS

- **Early academic skills related to literacy and math are the most significant predictors of future academic achievement.** Key early literacy predictors for reading and school success include alphabet knowledge, phonological awareness, rapid automatic naming of letters or numbers, rapid automatic naming of objects or colors, writing and phonological memory. Some studies suggest that early math skills measured in Kindergarten, particularly related to counting and number sense, predict reading, math and science achievement in later years.
- **Children’s early non-academic skills, such as social competence and self-regulation, also contribute to school success.** Some studies suggest that early social skills are linked to future literacy achievement. Learning-related skills have been shown to impact reading and math scores as far up as middle school.
- **The impact of early academic skills can vary dependent on gender, socioeconomic status, and English proficiency.** Early literacy skill differences exist between boys and girls and interact with socioeconomic status, with an advantage for girls. Research has demonstrated that children who come from homes in which a language other than English is spoken and who come from a lower socioeconomic status exhibit different language skills and have different educational trajectories than their middle-class peers who come from monolingual English-speaking homes.

IMPLICATIONS FOR ASSESSMENT

- **Instruction and intervention for early skills can be best informed by a comprehensive system of assessments, including both formal and informal assessments.** Universal screening assessments help to identify students who are struggling with both literacy and mathematics skills. To delve deeper into results, teachers or specialists should administer diagnostic assessments to understand why a student is struggling. Periodic progress monitoring assessments can also help teachers identify areas of strengths and need in order to adequately inform instruction.
- **Assessments measuring early literacy skills are comprehensive and assess multiple facets of literacy acquisition.** Literacy assessments generally focus on measuring phonemic and phonological awareness, decoding, vocabulary, and reading comprehension. Many literacy assessments are comprehensive and include various

subtests that have been shown to be highly predictive of elementary students' reading success.

- **Many mathematics assessments can provide teachers with not only substantial information regarding students' skills and knowledge, but also on both the accuracy and rate or efficiency of student performance.** Assessments usually contain multiple subtests that measure particular math concept knowledge and skills. Many assessments require little time to administer and little training for teachers.
- **The best tools for evaluation emotional and/or behavioral skills include those that allow for direct observation of the student and his or her behaviors with teachers, parents, and peers.** Behavioral skills have been found to be significant predictors of students' academic success; therefore, parents and educators need to be constantly observing and monitoring students in early grades to ensure that their social and behavioral skills are developing appropriately. Early intervention for students with poor behavior or social skills is crucial to help students achieve desired outcomes later in their academic careers.

IMPLICATIONS FOR INSTRUCTION

- **Effective early literacy instruction is a complex and multifaceted process that incorporates appropriate materials, experiences, and social support, all of which encourage reading and writing development.** Teachers need to not only teach concepts and skills, but also explicitly teach reading and writing strategies, making sure students have opportunities to apply these skills and strategies to meaningful texts. Struggling students benefit from explicit instruction in key areas such as decoding, fluency, and vocabulary. Effective instruction should also be differentiated and guided by continuous assessment results.
- **Research highlights that literacy instruction and intervention should occur daily to most effectively assist students who are struggling with the development of literacy skills.** Most common literacy interventions provide small group or individual tutoring opportunities and are usually provided as a supplement in addition to regular classroom literacy instruction.
- **Effective mathematics instruction strives for a balance between skills-based instruction and a problem-solving approach.** Interventions targeting early math skills expose students to new concepts incrementally and have multiple opportunities for students to review and practice essential skills over time. In addition, interventions typically include opportunities for students to engage in hands-on activities and active conversations about methods and results.

SECTION I: IMPACT OF EARLY SKILLS ON FUTURE ACADEMIC SUCCESS

In this section, Hanover identifies the early academic (specifically in literacy and mathematics) and non-academic (such as social and emotional competence and learning-related self-regulation) skills that have been found to be predictive of later academic success, specifically at the elementary and middle school levels. Findings in this section are drawn primarily from empirical analyses, and are supplemented by resources provided by national organizations. Figure 1.1 highlights key peer-reviewed empirical studies that investigate the impact of these competencies on future academic success.

KEY FINDINGS

- **Early literacy and math skills have a significant impact on future academic achievement, with variance across gender, socioeconomic status, and English language proficiency.** Studies indicate that these early literacy and math skills can impact future reading, math and content area success. Key early literacy predictors for school success include alphabet knowledge, phonological awareness, rapid automatic naming of letters or numbers, rapid automatic naming of objects or colors, writing and phonological memory. Early counting and number sense skills can also predict reading, math, and science achievement in later years.
- **Although many studies suggest that skills development—and not necessarily socioeconomic or other demographic factors—is a key predictor of student success, some studies that specifically focus on selected student subgroups have demonstrated a marked skills gap among groups of low-socioeconomic or English language learner students.** Research has demonstrated that students from poorer homes tend to fare worse than their peers on measures of oral and comprehension literacy skills—two skillsets that have been demonstrated to significantly predict later academic achievement. Similarly, research suggests that students who enter Kindergarten with lower levels of English proficiency can lag behind their peers in terms of achievement through Grade 4 without adequate interventions or supports.
- **Early years learning-related skills, such as self-regulation and social competence, have also been demonstrated to affect students' future academic trajectories.** Some studies suggest that early social skills are linked to future literacy achievement. Learning-related skills have been shown to impact reading and math scores as far up as middle school.

Figure 1.1: Peer-Reviewed Studies of Early Skills Impacting Later Academic Success

AUTHOR(S) (YEAR)	SAMPLE	RESEARCH QUESTION (S)	FINDING(S)
Literacy Skills Studies			
Hemphill and Tivnan ³ (2008)	<ul style="list-style-type: none"> ▪ 280 students in 30 classrooms across 15 schools between Grades 1 and 3 ▪ 49% African American and 31% Hispanic 	<ul style="list-style-type: none"> ▪ What are the contributions of both early meaning-related and code-related reading skills to low-income children’s literacy achievement across Grades 1-3? ▪ What were the effects of vocabulary on students’ rate of growth in comprehension? 	<ul style="list-style-type: none"> ▪ Measures of language and literacy at the beginning of Grade 1 showed statistically significant relationships with later reading comprehension (Letter-Word Identification=.27; Word Attack=.22; Phonemic Awareness=.28; and Oral Discourse=.21) ▪ Early vocabulary showed the strongest relationship with Grade 3 achievement in reading comprehension (.46) ▪ Growth rates in reading comprehension for most students were very similar, regardless of their initial skill levels in vocabulary
Yesil-Dagli ⁴ (2011)	<ul style="list-style-type: none"> ▪ 2,841 ELL who attended Grade 1 across 291 <i>Reading First</i> schools in Florida during 2004-2005 ▪ 81.5% Hispanic; 88% qualified for Free or Reduced Price Lunch (FRPL) 	<ul style="list-style-type: none"> ▪ Do ELL students’ English letter naming fluency, initial sound fluency, and vocabulary skills vary by their demographic characteristics in Kindergarten? ▪ How do ELL students’ Grade 1 English oral reading fluency initial status and growth vary by their gender, ethnicity, and FRPL eligibility status? ▪ To what extent do initial Kindergarten English letter naming fluency, initial sound fluency, and vocabulary predict Grade 1 English oral reading fluency initial status and growth for ELL students, uniquely and jointly? 	<ul style="list-style-type: none"> ▪ Kindergarten English letter name fluency was the best predictor of oral reading fluency in Grade 1 ▪ Vocabulary skills were the second best predictor of oral fluency in Grade 1 ▪ Male ELL students, ELL students eligible for FRPL, and Hispanic ELL students read fewer words at the beginning of Grade 1 and exhibited a slower growth rate ▪ Asian ELL students had the highest English oral reading fluency scores

³ Hemphill, L. and T. Tivnan. “The Importance of Early Vocabulary for Literacy Achievement in High-Poverty Schools.” *Journal of Education for Students Placed at Risk*, 13, 2008.

⁴ Yesil-Dagli, U. “Predicting ELL Students’ Beginning Grade 1 English Oral Reading Fluency from Initial Kindergarten Vocabulary, Letter Naming, and Phonological Awareness Skills.” *Early Childhood Research Quarterly*, 26, 2011.

AUTHOR(S) (YEAR)	SAMPLE	RESEARCH QUESTION (S)	FINDING(S)
Ford et al. ⁵ (2012)	<ul style="list-style-type: none"> ▪ 2,300 Hispanic Kindergarten students receiving ESL services in 436 Virginia public schools ▪ 49% females; 51% males 	<ul style="list-style-type: none"> ▪ Do Spanish-speaking ELLs in the fall of Kindergarten demonstrate homogeneous early literacy skills or are there distinct patterns of achievement across measures of phonological awareness, alphabet knowledge, and orthography? ▪ If there are distinct profiles, to what extent do they predict literacy achievement at the end of Kindergarten and the beginning of Grade 1? 	<ul style="list-style-type: none"> ▪ Four distinct profiles predictive of spring of Kindergarten and fall of Grade 1 early literacy outcomes ▪ Profiles that included stronger performance on orthographic skills (i.e., alphabet knowledge and phonetic spelling) were associated with greater success on measures of concept of word in text, letter sound knowledge, word reading, and spelling ▪ Fall-K letter-name knowledge was highly correlated with Spring-K and Fall-1st scores
Kieffer and Vukovic ⁶ (2013)	<ul style="list-style-type: none"> ▪ 166 language minority (LM) students and their native English-speaking peers between Grades 1-4 ▪ Two Title I elementary schools in New York City 	<ul style="list-style-type: none"> ▪ How do LM learners compare to their peers and to national norms in their growth trajectories in reading-related skills between Grade 1 and Grade 4? ▪ How do students with specific reading comprehension difficulties and students with word reading difficulties in Grade 4 compare to students without difficulties in their growth trajectories in reading-related skills between Grade 1 and Grade 4? To what extent do these differences, if any, vary by language background? ▪ How sensitive and specific are established Grade 1 component skill measures in predicting reading difficulties in Grade 4 for LM learners, as compared with native English speakers? 	<ul style="list-style-type: none"> ▪ LM students demonstrated weaknesses in vocabulary and oral comprehension ▪ LM students demonstrated strengths in phonological awareness from Grades 1-4 ▪ LM students demonstrated early strengths in letter-word identification, but fell below national norms by Grade 4 ▪ LM students with word reading difficulties demonstrated major weaknesses in vocabulary, oral comprehension, phonological awareness, and working memory ▪ LM students with specific reading comprehension difficulties demonstrated major weaknesses in vocabulary and oral comprehension between Grades 1-4

⁵ Ford, K.L. et al. "Diversity Among Spanish-Speaking English Language Learners: Profiles of Early Literacy Skills in Kindergarten." *Reading and Writing: An Interdisciplinary Journal*, 26, 2012.

⁶ Kieffer, M.J. and R.K. Vukovic. "Growth in Reading-Related Skills of Language Minority Learners and Their Classmates: More Evidence for Early Identification and Intervention." *Reading and Writing: An Interdisciplinary Journal*, 26, 2013.

AUTHOR(S) (YEAR)	SAMPLE	RESEARCH QUESTION (S)	FINDING(S)
Quirk et al. ⁷ (2013)	<ul style="list-style-type: none"> ▪ Sample of 781 Latino/a Kindergarten students in California who were followed until the end of Grade 2 ▪ 48.6% male; 21.8% from migrant families; 76.6% English language learners; 76.6% received free and reduced lunch services; and, 4.4% received Special Education services 	<ul style="list-style-type: none"> ▪ What are the commonly occurring patterns in the underlying dimensions of Latino/a children’s social-emotional/behavioral, physical, and cognitive school readiness? ▪ How do the various school readiness profiles of Latino/a children relate to their academic achievement at the end of Grade 2? 	<ul style="list-style-type: none"> ▪ Gender was the only significant difference among the top two readiness classes, with girls less likely to be in the lower of these two classes ▪ Children in bottom three readiness classes were less likely to have had preschool experience and had significantly lower levels of English proficiency ▪ Class membership significantly associated with scores on the Grade 2 California Standards Test ▪ Top two readiness classes had reading fluency rates near or above national benchmark at the end of Grade 2
Lee and Al Otaiba ⁸ (2015)	<ul style="list-style-type: none"> ▪ 462 kindergarten students from 10 public elementary schools ▪ Approximately 60% African American; 55% male; 69% eligible for Free or Reduced Lunch (FRL) 	<ul style="list-style-type: none"> ▪ Are the indicators of alphabet knowledge, phonological awareness, and spelling measured in the same way for boys ineligible for FRL, girls ineligible for FRL, boys eligible for FRL, and girls eligible for FRL? ▪ Are the early literacy latent constructs generalizable across these groups? ▪ Do the interrelations of the latent factors of early literacy skills vary across the four groups namely, boys ineligible for FRL, girls ineligible for FRL, boys eligible for FRL, and girls eligible for FRL? ▪ Are the factor structures of the latent factors more strongly correlated in one group than another? ▪ What are the factor mean differences in early literacy skills between boys ineligible for FRL, girls ineligible for FRL, boys eligible for FRL, and girls eligible for FRL? 	<ul style="list-style-type: none"> ▪ Multiple-group confirmatory factor analysis ▪ Boys and girls from high-poverty households performed significantly lower than girls from low-poverty households in alphabet knowledge, phonological awareness, and spelling ▪ Boys from high-poverty households scored 4.57 points lower in alphabet knowledge ($p < .05$); 2.05 points lower in phonological awareness ($p < .001$); and, 4.41 points lower in spelling ($p < .001$) ▪ Girls from low-poverty households performed better than boys from low-poverty households in alphabet knowledge (6.26 points; $p < .01$) ▪ Girls outperformed the boys in alphabet knowledge (5.45 points, $p < .01$) and spelling (1.78 points, $p < .05$)

⁷ Quirk, M., K. Nylund-Gibson, and M. Furlong. “Exploring Patterns of Latino/a Children’s School Readiness at Kindergarten Entry and Their Relations with Grade 2 Achievement.” *Early Childhood Research Quarterly*, 28, 2013.

⁸ Lee, J.A.C. and S. Al Otaiba. “Socioeconomic and Gender Group Differences in Early Literacy Skills: A Multiple-Group Confirmatory Analysis Approach.” *Educational Research and Evaluation*, 21:1, 2015.

AUTHOR(S) (YEAR)	SAMPLE	RESEARCH QUESTION (S)	FINDING(S)
Mathematics Skills Studies			
Duncan et al. ⁹ (2007)	<ul style="list-style-type: none"> ▪ Six longitudinal data sets ▪ Most came from the nationally representative sample from <i>The Early Childhood Longitudinal Study-Kindergarten Cohort</i> (21,260) and <i>The 1970 British Birth Cohort Study</i> (10,000) 	<ul style="list-style-type: none"> ▪ How are school-entry academic, attention, and socioemotional skills associated with later school achievement? ▪ Are there differences in associations by gender and family socioeconomic status? 	<ul style="list-style-type: none"> ▪ Across all six studies, the strongest predictors of later achievement are school entry math, reading, and attention skills ▪ Early math skills have the greatest predictive power, followed by reading and then attention skills ▪ Measures of socioemotional behaviors were insignificant predictors of later academic performance ▪ Gender and socioeconomic status did not impact patterns of associations
Jordan et al. ¹⁰ (2009)	<ul style="list-style-type: none"> ▪ 378 Kindergarten students; 56% minority; 33% low-income ▪ 196 Grade 3 students; 45% minority; 23% low-income ▪ Six schools in a public school district in Delaware 	<ul style="list-style-type: none"> ▪ Does level of number competence in Kindergarten predict level of mathematics performance after Grade 1? ▪ Does level of Kindergarten number competence predict rate of achievement in mathematics between Grades 1 and 3? ▪ Does rate of growth in early number competence predict later mathematics level and growth? 	<ul style="list-style-type: none"> ▪ A sequential process growth curve model showed that Kindergarten number competence predicted rate of growth in mathematics achievement between Grades 1 and 3 ▪ Kindergarten number competence predicted mathematics achievement level through Grade 3 ▪ Rate of growth in early number competence predicted mathematics performance level in Grade 3

⁹ Duncan, G.J. et al. "School Readiness and Later Achievement." *Developmental Psychology*, 43:6, 2007.

¹⁰ Jordan, N.C. et al. "Early Math Matters: Kindergarten Number Competence and Later Mathematics Outcomes." *Developmental Psychology*, 45:3, 2009.

AUTHOR(S) (YEAR)	SAMPLE	RESEARCH QUESTION (S)	FINDING(S)
<p>Claessens and Engel¹¹ (2013)</p>	<ul style="list-style-type: none"> ▪ Data from the <i>Early Childhood Longitudinal Study-Kindergarten Cohort</i> ▪ Sample of 7,655 children who were in Kindergarten in 1998-1999 and followed through Grade 8 	<ul style="list-style-type: none"> ▪ What is the relationship between measures of school-entry mathematics skill sets and subsequent success in school? ▪ How do early math skills relate to reading, math and science achievement, as well as grade retention through elementary and middle school? ▪ Which aspects of early mathematics knowledge are most important for later success? ▪ How does this vary across children at risk of school failure? 	<ul style="list-style-type: none"> ▪ Early math skills predict reading, math and science achievement as well as grade retention from Kindergarten through Grade 8 ▪ Kindergarten math skills in pattern recognition, measurement, and advanced number are more predictive of eighth grade outcomes overall and for subgroups who enter school with low math skills
<p>Watts et al.¹² (2014)</p>	<ul style="list-style-type: none"> ▪ Data from National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD) ▪ Participants recruited at birth from 10 different urban and rural areas in the United States ▪ Data set includes 1,364 children 	<ul style="list-style-type: none"> ▪ To what extent is preschool mathematics proficiency associated with high school mathematics achievement? ▪ What is the association between early grade growth in mathematical knowledge and later mathematics achievement? 	<ul style="list-style-type: none"> ▪ 54-month mathematical ability had the strongest correlation with age 15 mathematics achievement ▪ Strong correlation between Grade 1 competencies and adolescent mathematics achievement ▪ Preschool mathematics predicted adolescent mathematics achievement ▪ Growth in mathematics ability between age 54 months and Grade 1 is strong predictor of adolescent mathematics achievement
Behavior/Non-Academic Skills Studies			

¹¹ Claessens, A. and M. Engel. "How Important Is Where You Start? Early Mathematics Knowledge and Later School Success." *Teachers College Record*, 115:6, 2013.

¹² Watts, T.W. et al. "What's Past Is Prologue: Relations Between Early Mathematics Knowledge and High School Achievement." *Educational Researcher*, 43:7, 2014.

AUTHOR(S) (YEAR)	SAMPLE	RESEARCH QUESTION (S)	FINDING(S)
McClelland et al. ¹³ (2006)	<ul style="list-style-type: none"> ▪ 538 children in North Carolina between Kindergarten and Grade 6 ▪ 51% Caucasian; 49% African-American 	<ul style="list-style-type: none"> ▪ Do Kindergarten learning-related skills (including self-regulation and social competence) predict initial levels and growth in reading and math skills between Kindergarten and Grade 6? ▪ How do the reading and math skills of children rated as having low levels of learning-related skills compare with their higher-rated peers from Kindergarten to the end of Grade 6? 	<ul style="list-style-type: none"> ▪ Learning-related skills had a unique effect on children’s reading (correlations ranged from .38 to .50, $ps<.05$) and math (.41 to .49, $ps<.05$) scores between Kindergarten and Grade 6 ▪ Learning-related skills predicted growth in reading and math between Kindergarten and Grade 2 ▪ Children with poor learning-related skills performed lower than their peers on measures of reading and math between Kindergarten and Grade 6, with the gap widening between Kindergarten and Grade 2
Walker and Henderson ¹⁴ (2012)	<ul style="list-style-type: none"> ▪ 1, 117 children from <i>National Institute of Child Health and Human Development Study of Early Child Care</i> ▪ 82% White; 12% African American 	<ul style="list-style-type: none"> ▪ Are children’s social problem solving skills (SPS) a mechanism through which temperament influences later academic achievement? ▪ Does sex moderate these associations? 	<ul style="list-style-type: none"> ▪ High ratings of inhibitory control in preschool predicted better academic skills in kindergarten and Grade 1 ▪ The effect of shyness on academic skills was mediated through social problem-solving competence ▪ The nature and quality of shy children’s social interactions in the classroom influence their academic skills

¹³ McClelland, M.M., A.C. Acock, and F.J. Morrison. “The Impact of Kindergarten Learning-Related Skills on Academic Trajectories at the End of Elementary School.” *Early Childhood Research Quarterly*, 21, 2006.

¹⁴ Walker, O.L. and H.A. Henderson. “Temperament and Social Problem Solving Competence in Preschool: Influences on Academic Skills in Early Elementary School.” *Social Development*, 21:4, 2012.

ACADEMIC SKILLS

The academic skills that children develop early in their lives help establish the foundation for later competence and proficiency. Research suggests that early literacy and math skills are significant predictors of children's subsequent academic achievement.¹⁵ The following subsections outline the specific literacy and mathematics skills that have been demonstrated to be predictive of future academic success.

LITERACY SKILLS

A large body of empirical evidence demonstrates that early literacy skills have lasting impacts on students' academic careers. Literacy incorporates a variety of foundational skills and understandings about written and spoken language as systems of communicating meaning. **Early literacy is defined as "the most comprehensive yet concise description of the knowledge, skills, and dispositions that precede learning to read and write in the primary grades (K–3)."**¹⁶ Early literacy development is therefore critical because as children begin formal literacy instruction, "their entry into full literacy instruction is supported by knowledge of letters and letter-sound correspondences, by experience with a range of types of print, and by vocabulary, syntactic, and discourse abilities involved in understanding text."¹⁷

At the turn of the century, The National Reading Panel (NRP) of the National Institute of Child Health and Development (NICHD) identified five areas that are necessary for literacy development: phonemic awareness, phonics, fluency, vocabulary, and comprehension.¹⁸ Numerous studies have found that many of the fundamental skills associated with these five areas are predictive of later reading achievement and are therefore, important targets for intervention. In 2008, for example, the National Early Literacy Panel (NELP) synthesized research on the development of early literacy skills in children ages zero to five. The report identified six key predictors for reading and school success, including **alphabet knowledge, phonological awareness, rapid automatic naming of letters or numbers, rapid automatic naming of objects or colors, writing and phonological memory.**

The report also highlighted five early literacy skills that are moderately predictive of later literacy achievement, including **concepts about print, print knowledge, reading readiness, oral language and visual processing.**¹⁹ According to the NELP report, these "five skills are usually more predictive of literacy achievement at the end of Kindergarten or beginning of Grade 1."²⁰ Additional research supports the importance of **phonological awareness,**

¹⁵ Duncan et al., Op. cit.

¹⁶ Roskos, K.A., J.F. Christie, and D.J. Richgels. "The Essentials of Early Literacy Instruction." National Association for the Education of Young Children, 2003. p. 2. <http://www.naeyc.org/files/yc/file/200303/Essentials.pdf>

¹⁷ Hemphill and Tivnan, Op. cit., p.428

¹⁸ Brown, C.S. "Language and Literacy Development in the Early Years: Foundational Skills That Support Emergent Readers." *The Language and Literacy Spectrum*, 24, 2014.

¹⁹ Ibid.

²⁰ Ibid., p. 36.

alphabet knowledge, and orthographic knowledge as predictors of literacy development.²¹ These fundamental early skills serve as building blocks for development of subsequent skills.

Evidence from longitudinal studies suggest that various early literacy skills can impact later academic achievement across content areas. The National Early Literacy Panel indicates that **vocabulary skills** in the early elementary school years, for example, are strong predictors of later reading achievement.²² One study by Hemphill and Tivnan used a sample of several hundred low-income children across 16 urban elementary schools that were implementing literacy interventions to examine Grade 1 predictors of literacy development.²³ Results indicated that beginning-of-first-grade **letter-word identification and word attack skills** were the most important predictors of reading comprehension at the end of Grade 1. On the other hand, vocabulary was the best predictor of reading comprehension at the end of second and Grade 3s. Most importantly, vocabulary scores remained an important predictor while the predictive power of early print-related and phonemic awareness skills diminished over time.²⁴ In addition, **early reading and pre-reading skills** were related to math abilities in elementary school, even after family background and sociodemographic factors were controlled²⁵ and Kindergarten reading, in particular, predicted math achievement in first, third and Grade 5.²⁶

While literacy skills may have a direct effect on learning, some evidence suggests that reading proficiency in early elementary school can also impact learning in indirect way. For instance, one study examined the relationship between social skills and literacy and found that poor literacy skills in Grade 1 and Grade 3 “predicted relatively high aggressive behavior in Grade 3 and Grade 5.”²⁷

Similarly, using longitudinal data from the national Early Childhood Longitudinal Study-Kindergarten Cohort, Cooper et al. examined the impact of Kindergarten reading and social skills on academic success in elementary school.²⁸ Results suggest that Kindergarten reading and social skills were associated with fifth-grade academic success in both math and reading even after the researchers controlled for other predictors of achievement, such as gender, minority status, household income and current social skills. More specifically, children with “a combination of low/average reading skills and higher levels of social skills performed better on later academic assessments than children with similar reading skills but lower levels of social skills during Kindergarten.”²⁹ On the other hand, children who were very strong early readers still performed similarly on the Grade 5 academic outcomes regardless of their level

²¹ Ford et al., Op. cit.

²² “Developing Early Literacy: Report of the National Early Literacy Panel.” National Institute of Literacy, 2008.
<http://lincs.ed.gov/publications/pdf/NELPReport09.pdf>

²³ Hemphill and Tivnan, Op. cit.

²⁴ Ibid.

²⁵ Duncan et al., Op. cit.

²⁶ Claessens, A., G.J. Duncan, and M. Engel. “Kindergarten Skills and Grade 5 Achievement: Evidence from the ECLS-K.” *Economics of Education Review*, 28:4.

²⁷ Miles, S.B. and D. Stipek. “Contemporaneous and Longitudinal Associations Between Social Behavior and Literacy Achievement in a Sample of Low-Income Elementary School Children.” *Child Development*, 77:1, 2006. p.103.

²⁸ Cooper, B.R. et al. “Patterns of Early Reading and Social Skills Associated with Academic Success in Elementary School.” *Early Education and Development*, 25, 2014.

²⁹ Ibid. p. 1257.

of social skills.³⁰ These findings suggest that a **combined focus on the development of literacy and social skills** is most likely to benefit *all* children, regardless of their background, and provide lasting impacts through elementary school and beyond.

SKILLS ACQUISITION FOR SPECIFIC SUBGROUPS

Research has demonstrated that English literacy skills acquisition varies across subgroups. Studies highlight, for example, that **early literacy skill differences exist between boys and girls and interact with socioeconomic status**. For example, a 2015 study by Lee and Al Otaiba, found that both boys and girls from high-poverty households performed significantly lower than the girls from low-poverty households in alphabet knowledge, phonological awareness, and spelling.³¹ Additionally, there was a female advantage among children from low-poverty households in alphabet knowledge and among children from high-poverty households in alphabet knowledge and spelling.³²

Another study highlights that children from low socioeconomic homes show lower levels of oral language skills on measures of language processing, language comprehension, and language production from infancy through high school than children from more advantage settings.³³ Hoff highlights, “children’s oral language skills prior to reading instruction, including vocabulary, grammar, and narrative abilities, have been found to predict future reading success.”³⁴

The impact of early literacy skills on academic outcomes also varies for English language learners (ELLs). A study conducted by Yesil-Dagli that investigated the predictive role of English letter naming fluency, initial sound fluency, and vocabulary skills at Kindergarten entry for Grade 1 English oral reading fluency found that Kindergarten **English letter naming fluency** was the best predictor and **vocabulary skills** were the second best predictors of oral reading fluency in the Grade 1, followed by initial sound fluency among ELL students.³⁵ On average, “male ELL students compared to female ELL students, ELL students eligible for free or reduced price lunch eligibility (FRPL) compared to those not eligible for FRPL, and Hispanic ELL students compared to White ELL students read fewer words at the beginning of the Grade 1 and showed a slower growth rate.”³⁶

In addition, a 2013 study by Ford et al. explored the variance in literacy development among 2,300 Hispanic Kindergarteners who were receiving English as a Second Language (ESL) services at the beginning of the school year.³⁷ More specifically, the study examined the patterns of achievement across measures of phonological awareness, alphabet knowledge,

³⁰ Ibid.

³¹ Lee and Al Otaiba, Op. cit.

³² Ibid.

³³ Hoff, E. “Interpreting the Early Trajectories of Children from Low-SES and Language Minority Homes: Implications for Closing the Achievement Gap.” *Developmental Psychology*, 49:1, 2013.

³⁴ Ibid. p.6.

³⁵ Yesil-Dagli, Op. cit.

³⁶ Ibid.p.15.

³⁷ Ford et al., Op. cit.

and orthography. Using cluster analysis with results from the Phonological Awareness Literacy Screening (PALS), the authors discovered four distinct profiles that were associated with literacy outcomes at the end of Kindergarten and the beginning of 1st grade. Results highlight that although the ELL sample scored lower across all measures of early literacy, there was much variability in their skills. Specifically, “the two clusters that were associated with greater success on later measures of concept of word in text and a composite measure of letter sound knowledge, word reading, and spelling, were the two that included stronger performance on alphabet knowledge and phonetic spelling, the two tasks that measured orthographic knowledge.”³⁸

Similarly, a study by Kieffer and Vukovic suggests that children who enter Kindergarten with limited proficiency in English continue to lag behind their peers in terms of reading achievement through Grade 4.³⁹ Another study by Quirk et al. followed 1069 predominantly Latino/a children from Kindergarten entry through the end of Grade 2.⁴⁰ They found that school readiness, including cognitive, social-emotional/behavioral, and physical skills at Kindergarten entry predicted students’ phonological awareness midway through Kindergarten and reading fluency at the end of Grade 1.⁴¹ These findings suggest that students with low scores on early literacy measures have a more difficult time catching up to their peers without adequate support.

MATHEMATICS SKILLS

Given that mathematics proficiency requires students to possess various detailed skills, it is critical for educators to identify the basic early skills that are most predictive of future school success. A meta-analysis conducted by Duncan et al. examined the influence of children’s early skills in reading, math, attention and social-emotional functioning to later reading and math achievement using data from six longitudinal school readiness databases and demonstrated that early math skills were the strongest predictor of students’ math abilities in later years.⁴² Controlling for IQ, family income, gender, temperament, type of previous educational experience, and whether children came from single or two-parent households, the study found that the **mastery of school-entry math concepts** was the strongest predictor of future academic success. Further, not only were early math skills critical to future math achievement, but they were also as predictive of future reading achievement as early reading skills.⁴³

Studies demonstrate that early number competence can predict conventional mathematics outcomes in school. The ability to “**identify numbers, discriminate between quantities, and identify missing numbers in sequences** at the end of Kindergarten is a strong predictor of mathematics outcomes at the end of Grade 1.”⁴⁴ One study examined children’s number

³⁸ Ibid. p.907.

³⁹ Kieffer and Vukovic, Op. cit.

⁴⁰ Quirk, Nylund-Gibson, and Furlong, Op. cit.

⁴¹ Ibid.

⁴² Duncan et al., Op. cit.

⁴³ Ibid. p. 1439.

⁴⁴ Jordan et al., Op. cit. p. 851.

competencies, or understanding the meaning of numbers and number relationships, from the beginning of Kindergarten to the middle of Grade 1 in relation to their mathematics achievement from the end of Grade 1 to the end of Grade 3.⁴⁵ According to Jordan et al., number competencies refer to the “ability to apprehend the value of small quantities immediately, make judgements about numbers and their magnitudes, grasp counting principles, and join and separate sets.”⁴⁶ Results indicated that there was a strong and significant relationship between early number competence and later mathematics achievement. Not only did Kindergarten number competence predict achievement level through Grade 3, it also predicted rate of growth in mathematics achievement between first and Grade 3s.⁴⁷

Evidence also suggests that general mathematics achievement measured around Kindergarten entry is highly predictive of subsequent mathematics achievement, even through adolescence. Claessens and Engel conducted secondary analysis using data from the Early Childhood Longitudinal Study-Kindergarten Cohort to explore how early math skills relate to achievement from Kindergarten to Grade 8 across reading, math, and science test score outcomes, as well as grade retention and teacher-reported academic achievement.⁴⁸ Results indicated that early math skills predict reading, math and science achievement as well as grade retention from Kindergarten through Grade 8. In addition, results highlight that Kindergarten math skills in **pattern recognition, measurement, and advanced numbers** are most predictive of eighth grade outcomes.⁴⁹ More specifically, a child’s “ability to read all one-digit numerals, count beyond 10, recognize a sequence of patterns, and use nonstandard units of length to compare objects is the most consistent and important predictor of later achievement test scores in both reading and math across elementary school.”⁵⁰ Research also indicates that **number sense and counting** measured in preschool or Kindergarten predict later elementary school math achievement test scores.⁵¹

One study highlights how early gains in mathematics ability is predictive of adolescent mathematics achievement. Watts et al. investigated the predictive power of early gains in mathematics achievement using multisite longitudinal data.⁵² The authors found that “preschool mathematics ability predicts mathematics achievement through age 15, even after accounting for early reading, cognitive skills, and family and child characteristics.”⁵³ The study also demonstrates that growth in mathematical ability between age 54 months and Grade 1 is an even stronger predictor of mathematics achievement in adolescence.⁵⁴

⁴⁵ Ibid.

⁴⁶ Ibid. p. 850.

⁴⁷ Ibid.

⁴⁸ Claessens and Engel, Op. cit.

⁴⁹ Ibid.

⁵⁰ Ibid. p.27

⁵¹ Ibid.

⁵² Watts et al., Op. cit.

⁵³ Ibid. p. 352.

⁵⁴ Ibid.

NON-ACADEMIC SKILLS

Children’s learning-related non-academic skills can also contribute to early school success. A study by McClelland et al. examined the relationship between Kindergarten learning-related skills, which included **social competence and self-regulation**, to reading and math success in 538 children between Kindergarten and Grade 6.⁵⁵ Results indicated that learning-related skills affected children’s reading and math scores between Kindergarten and Grade 6, with low learning-related skills contributing to lower performance in both reading and math. In addition, learning-related skills in Kindergarten predicted growth in reading and math between Kindergarten and Grade 2.⁵⁶

Temperamental reactivity (e.g., shyness, anger, and sadness) has also been shown to be negatively associated with academic achievement.⁵⁷ Shy children, for instance, may perform similarly to their peers of academic performance during early elementary school, but begin to lag behind their peers over time. On the other hand, effortful control is positively associated with achievement.⁵⁸ In a 2012 study, Walker and Henderson examined whether social problem-solving competence is a mechanism through which temperament influences later academic skills and whether these associations were comparable for boys and girls using data from the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD).⁵⁹ The results indicated that the effect of shyness on academic skills was mediated through social problem-solving competence when controlling for inhibitory control, suggesting that the nature and quality of shy children’s social interactions in the classroom influence their academic skills.⁶⁰ Walker and Henderson note that, “inhibitory control is concurrently and longitudinally related to early math and reading achievement in preschool and early elementary school, even after controlling for various demographic characteristics and/or prior achievement.”⁶¹ This research suggests that the link between early social skills, such as self-regulation and interpersonal skills, and future academic success is critical and warrants further investigation.

There is also evidence to suggest that **cognitive control**, or children’s ability to shift behavior in response to changing environmental demands, contributes to academic success. This skill improves rapidly between the preschool and elementary school years. One study revealed that cognitive control predicted children’s academic performance on math and school-based assessments.⁶² Studies also highlight that shifting skills are related to mathematical skills in school-age children and that shifting ability predicts both reading and math performance in

⁵⁵ McClelland, Acock, and Morrison, Op. cit.

⁵⁶ Ibid.

⁵⁷ Walker and Henderson, Op. cit.

⁵⁸ Ibid.

⁵⁹ Ibid.

⁶⁰ Ibid.

⁶¹ Ibid. p.763.

⁶² Coldren, J.T. “Cognitive Control Predicts Academic Achievement in Kindergarten Children.” *Mind, Brain and Education*, 7:1, 2013.

each of the three primary grades.⁶³ This line of research attests to the role that mental flexibility and control plays in education.

Finally, studies suggest that **fine motor skills** are significant predictors of math and reading achievement in Kindergarten and Grade 1.⁶⁴ Dinehart and Manfra examined whether the fine motor skills of over 3,000 preschoolers predicted their academic achievement in Grade 2. Results indicated that fine motor writing skills in preschool were consistently stronger predictors of reading and math achievement than fine motor manipulation tasks.⁶⁵ In addition, Puranik and Al Otaiba found that handwriting significantly contributed to written composition proficiency in kindergartners.⁶⁶

⁶³ Ibid.

⁶⁴ Dinehart, L.H. "Handwriting in Early Childhood Education: Current Research and Future Implications." *Journal of Early Childhood Literacy*, 15:1, 2015.

⁶⁵ Dinehart, L.H. and L. Manfra. "Association Between Early Fine Motor Development and Later Math Achievement in Early Elementary School." *Early Education and Development*, 24:2, 2013.

⁶⁶ Puranik, C. and S. Al Otaiba. "Examining the Contribution of Handwriting and Spelling to Written Expression in Kindergarten Children." *Reading and Writing: An Interdisciplinary Journal*, 25:7, 2012.

SECTION II: IMPLICATIONS FOR ASSESSMENT

In addition to understanding and identifying early skills that are predictive of future academic success, school districts may also choose to implement early assessments to measure students' acquisition of important early skills. Assessing early skills is the first step of a proactive process to help provide adequate support for students. Employing a variety of literacy, math, and emotional/behavioral assessments, including diagnostic assessments, can support student success by facilitating differentiated instruction.

In the following section, Hanover describes a variety of research-based literacy, math and emotional/behavioral assessment tools that have been shown to be effective for students in the early years.

KEY FINDINGS

- **A comprehensive system including formal and informal assessments can be used to inform instruction and intervention for struggling students.** Universal screening assessments can be used to flag students that are behind. Diagnostic assessments can then be administered to understand why a student is struggling. Periodic progress monitoring assessments provide information on how a student's performance is or is not improving. Information from all these assessments can help teachers identify areas of strengths and need in order to adequately inform instruction.
- **Assessments of early literacy and early math skills are comprehensive in nature and are often composed of a variety of subtests.** Studies suggest that curriculum-based measurement and computer-adapted tests are effective ways to screen and progress monitor students for early literacy and math skills. Assessments can vary in terms of length, format, and time required to administer.
- **The evidence surrounding the assessment of emotional or behavioral skills demonstrates that these skills are best assessed using a combination of tools.** Teacher or parent observations and surveys are common modes of assessing socio-emotional and behavioral skills in the early years. Studies suggest that measures of socio-emotional and behavioral constructs can be used with students to help teachers track their development over time. When linked with academic tests, these assessments can help teachers to develop appropriate Individualized Education Plans for struggling students.

A SYSTEMATIC APPROACH TO ASSESSMENTS

Assessments of literacy and math growth provide vital information to teachers and administrators. They can allow educators to monitor the success of programs as well as the success of individual students in an effort to provide adequate interventions. The Center on Instruction recommends that **when selecting assessments, educators should be mindful of**

the purpose each assessment will serve. This includes thinking about what decisions will be made based on the assessment data and by whom.⁶⁷

Ideally, schools should have a system of assessments in place that collects an assortment of data. Primarily, schools need to employ **summative assessments** that measure end-of-year performance and the extent to which students meet or exceed state-level standards.⁶⁸ In addition, schools should have a variety of assessments used to monitor student progress throughout the year.⁶⁹ **Progress monitoring assessments**, broadly defined, “regularly assess students in specific academic and behavioral areas in order to determine the efficacy of and inform instruction or intervention.”⁷⁰ These may be classroom-based formative assessments, which allow teachers to collect ongoing data about student performance. Furthermore, **benchmark assessments** can be utilized to compare student or school performance to a standard or average performance and are increasingly used to make predictions about the ability of students to pass end-of-year standardized assessments.⁷¹

In addition to these more comprehensive assessments, schools may choose to employ **universal screeners** and **diagnostic assessments** as a way to evaluate when students may benefit from interventions.⁷² Universal screening tests are “quick, low-cost, [and] repeatable,” and are administered to all students.⁷³ These assessments are typically offered at the beginning of the year and are used to identify students who need some form of intervention or support in order to meet grade-level standards. More targeted diagnostic assessments may follow this screening to gather more information on what skills a student is struggling with and how instruction can be specialized to meet the student’s needs.⁷⁴

Diagnostic assessments can be formal or informal. Formal diagnostic assessments are typically more standardized measures. They measure a range of skills and compare a student’s performance to a larger sample of students. On the other hand, informal diagnostic measures may be similar to classroom-based formative assessments. For instance, a teacher can ask a student to perform a reading task, which can offer sophisticated insight into both a student’s strengths and weaknesses and the strategies a student is or is not using.⁷⁵

While there is overlap between some of the uses of diagnostic assessments and progress monitoring or universal screening, **diagnostic assessments specifically “aid educators in understanding the causes for student performance,” providing more insight on the**

⁶⁷ Torgesen, J. and D. Houston Miller. “Assessments to Guide Adolescent Literacy Instruction.” Center on Instruction, 2009. p. 13. <http://www.centeroninstruction.org/files/Assessment%20Guide.pdf>

⁶⁸ “Elementary Assessments: Universal Screening, Diagnostic, & Progress Monitoring.” The State Education Resource Center of Connecticut. p. 1. http://www.sde.ct.gov/sde/lib/sde/pdf/curriculum/cali/elementary_assessments_4-9-12.pdf

⁶⁹ Ibid.

⁷⁰ Ibid., p.2.

⁷¹ Torgesen and Houston Miller, Op. cit., p. 44.

⁷² “Elementary Assessments: Universal Screening, Diagnostic, & Progress Monitoring,” Op. cit., p. 1.

⁷³ Ibid. p. 2.

⁷⁴ Ibid.

⁷⁵ Torgesen and Houston Miller, Op. cit., p. 49.

strengths and weaknesses that may explain a student’s performance on a universal screening assessment.⁷⁶ Overall, diagnostic information is precise about a student’s strengths and weaknesses and readily available so teachers can take immediate action. Summative, end-of-year assessments are typically not good diagnostic assessments. In addition to providing little specific information about a student’s process or skills beyond a basic proficiency level, the results are typically not available until the next school year, when the student has already moved onto a new grade and new teachers.⁷⁷

Figure 2.1 highlights the characteristics of universal, diagnostic, and progress monitoring assessments.

Figure 2.1: Characteristics of Assessment Types as Identified in the Professional Literature

ASSESSMENT TYPE	CHARACTERISTICS
Universal Screening Assessments	<ul style="list-style-type: none"> ▪ Accessible to all students ▪ Assess critical skills and concepts ▪ Brief, easy to administer and score ▪ Given to all students (i.e. within a district, school, grade-level, course) ▪ Quick turn-around time (1-3 days) of aggregated and disaggregated data to classroom teachers ▪ Repeatable, reliable, and valid
Diagnostic Screening Assessments	<ul style="list-style-type: none"> ▪ Given to selected students ▪ Aid educators in understanding causes of student performance ▪ Information gathered is used to plan, modify, and differentiate instruction ▪ Reliable and valid
Progress Monitoring Assessments	<ul style="list-style-type: none"> ▪ Administered at regular intervals, with increasing frequency as the intensity of the intervention increases ▪ Rates of improvement are specified ▪ Reliable and valid ▪ Sensitive to improvement/small increments of growth ▪ Sufficient number of alternative forms of equal difficulty

Source: State Education Resource Center of Connecticut⁷⁸

LITERACY ASSESSMENTS

Literacy instruction in the early years should take into account the diversity of student abilities and needs. The use of a variety of screeners and diagnostic assessments can be used not only to provide insight into student performance, but also to help make decisions about placement

⁷⁶ “Elementary Assessments: Universal Screening, Diagnostic, & Progress Monitoring,” Op. cit. p. 2.

⁷⁷ Gong, B. “Using Balanced Assessment Systems to Improve Student Learning and School Capacity: An Introduction.” Council of Chief State School Officers, 2010. p. 15.
<http://www.ccsso.org/Documents/Balanced%20Assessment%20Systems%20GONG.pdf>

⁷⁸ Bullets adapted from: “Elementary Assessments: Universal Screening, Diagnostic, & Progress Monitoring,” Op. cit.

in appropriate interventions.⁷⁹ An effective reading program should ideally include assessments of all necessary literacy skills and concepts.⁸⁰

Below, Figure 2.2 presents an overview of evidence-based studies that highlight the use of literacy assessments that evaluate early literacy skills. In many of these studies, the researchers address the validity and reliability of the assessment tools, while also discussing how these assessments have been used to measure student’s literacy growth and achievement.

Figure 2.2: Empirical Studies of Early Literacy Assessments

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	ASSESSMENT MEASURES	CONCLUSIONS
Han et al. (2014) ⁸¹	<ul style="list-style-type: none"> ▪ 179 students in three Head Start centers ▪ 66% of sample are from non-English speaking homes 	<ul style="list-style-type: none"> ▪ Students were assessed two times over the academic year in order to find the link between time in a program and changes in literacy score ▪ <i>Peabody Picture Vocabulary Test-IV</i> used to measure receptive vocabulary ▪ <i>Test of Preschool Early Literacy</i> used for vocabulary and phonological awareness subtests ▪ <i>Phonological Awareness Early Literacy Screening- PreK (PALS)</i> used for print awareness and letter knowledge subtests 	<ul style="list-style-type: none"> ▪ Assessment measures can effectively measure children’s receptiveness to vocabulary knowledge, particularly EL students ▪ Researchers were able to use assessments to determine the effects of time in a program on student literacy rates ▪ Letter naming, letter sound, print awareness, and phonological awareness are all relatively easily measureable elements of early literacy skills development using pre- and post-tests over the course of the year

⁷⁹ Ibid.

⁸⁰ Denton, C.A. “Classroom Reading Instruction That Supports Struggling Readers: Key Components for Effective Teaching.” RTI Action Network: A Program of the National Center for Learning Disabilities. <http://www.rtinetwork.org/essential/tieredinstruction/tier1/effectiveteaching>

⁸¹ Han, M. et al. “Development of Early English Language and Literacy Skills Among Spanish-Speaking Children: Does Preschool Make a Difference?” *Early Child Development and Care*, 184:4, April 2014. https://www.researchgate.net/publication/263689495_

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	ASSESSMENT MEASURES	CONCLUSIONS
Scheffel et al. (2012) ⁸²	<ul style="list-style-type: none"> ▪ 2,649 elementary students ▪ 29.7% identified as English language learners (ELLs) ▪ Included high proportion of minority students: 61.3% Hispanic; 50.7% identified as Limited English Proficient (LEP) ▪ About 75% of total sample was eligible for Free and Reduced Lunch 	<ul style="list-style-type: none"> ▪ Students were assessed three times a year over a three-year period ▪ The <i>Dynamic Indicators of Basic Early Literacy Skills</i> (DIBELS) was used to measure phonological awareness, the alphabetic principle, and text fluency ▪ A number of DIBELS subtests assess more specific elements of early literacy skills, including: initial sound, phonemic segmentation, nonsense word, and oral reading fluencies ▪ Researchers examined the effectiveness of the DIBELS subtests in predicting student success in reading comprehension by Grade 3 	<ul style="list-style-type: none"> ▪ The DIBELS subtest scores had either a “moderately strong” or “strong” correlation with students’ end-of-year literacy assessments ▪ Thus, various measures of fluency observed throughout the year via DIBELS can predict changes in early literacy skills ▪ The predictive capabilities of the subtests were equally strong for EL and non-EL students ▪ The most variable association was between the DIBELS oral reading fluency test and state literacy assessments ▪ The DIBELS assessment better predicts students who are at “low risk” than those who are “at risk”
McBride et al. (2010) ⁸³	<ul style="list-style-type: none"> ▪ 633 K-2 students in eight schools across seven states ▪ Included minority students: 14% Black; 7% Hispanic ▪ Included low-income students: 29% eligible for Free and Reduced Lunch; 20% Title I 	<ul style="list-style-type: none"> ▪ Researchers tested the validity and cost effectiveness of four early reading assessments ▪ The <i>Dynamic Indicators of Basic Early Literacy Skills</i> (DIBELS) is used to screen and monitor emergent readers three times each year ▪ <i>STAR Early Literacy</i> (SEL) is an adaptive test that includes items from seven literacy domains; does not measure fluency ▪ <i>Group Reading Assessment and Diagnostic Evaluation</i> (GRADE) is a group-administered, computer-adaptive test; does not measure fluency ▪ The <i>Texas Primary Reading Inventory</i> (TPRI) is a screening and inventory tools composed of grade-level subtests 	<ul style="list-style-type: none"> ▪ For all literacy components (phonemic awareness, phonics, vocabulary, comprehension, and fluency), correlations between subtests were high and comparable ▪ STAR Early Literacy is most cost- and time-effective (neither requiring a full class period to administer nor high levels of teacher oversight) ▪ Data reveal that tests of fluency, vocabulary, comprehension, and word reading generally measure the same skills – suggesting that separate subtests for each may not be necessary

⁸² Scheffel, D., D. Lefly, and J. Houser. “The Predictive Utility of DIBELS Reading Assessment for Reading Comprehension Among Grade 3 English Language Learners and English Speaking Children.” *Reading Improvement*, 49:3, September 2012. Accessed via EBSCOHost.

⁸³ McBride, J. et al. “Technical Adequacy and Cost Benefit of Four Measures of Early Literacy.” *Canadian Journal of School Psychology*, 25:2, June 2010. Accessed via ProQuest.

There are a multitude of early literacy assessments, with each one assessing students' outcomes in one or a combination of the following five literacy areas: **phonemic awareness, phonics, fluency, vocabulary, and comprehension**.⁸⁴ Researchers highlight, however, that "vocabulary is the component skill that is most commonly assessed due to it being a relatively straightforward process."⁸⁵ The research suggests that there are many common methods of assessing these various facets of early literacy.

In terms of assessing oral language, for instance, evidence suggests that most measures involve extensive retelling or production of stories and explanations, which could be indicative of both comprehension and production of language. Phonological awareness, meanwhile, is typically assessed by having students "segment spoken words into syllables, onset and rime or individual phonemes."⁸⁶ Studies also highlight that an effective way to assess a student's alphabetic knowledge is through rapid automatic naming of letters, which involves asking the student to name the items as quickly as possible and tracking the time it took to complete the task.⁸⁷ In addition, Vanderwood, Linklater, and Healy suggest that there is a significant relation between nonsense word fluency in Grade 1 and various reading outcomes in Grade 3. The researchers propose that nonsense word fluency could be used to identify those students who performed successfully on the Grade 3 outcome measures with a high degree of accuracy.⁸⁸ Thus, schools can implement individual literacy assessments that target any number of different indicators of early skills development, depending on resources and internal capabilities.

However, data generally support the use of early literacy assessments that contain a battery of tests used to more comprehensively measure early literacy skills. For example, Han and colleagues assessed students' literacy development across four key skills: letter naming, letter sound, print awareness, and phonological awareness. Together, the researchers concluded that "both groups [i.e., EL and non-EL] demonstrated strong development in their ability to attend to and manipulate the sounds of the language, print awareness knowledge, and ability to name letters of the alphabet and to produce the sounds associated with letters of the alphabet."⁸⁹ This highlights the interrelated nature of many fundamental literacy skills, and the typical need to assess them conjointly in young students.

One commonly cited assessment in the literature is the Dynamic Indicators of Basic Early Literacy Skills (DIBELS). Indeed, Scheffel and colleagues found that DIBELS assessment scores are reliable indicators of early literacy skills development, and in particular, "can be used to classify English Language Learners who are at risk for reading failure."⁹⁰ DIBELS indicators

⁸⁴ McBride et al., Op. cit.

⁸⁵ Hill, S. "Towards Ecologically Valid Assessment in Early Literacy." *Early Child Development and Care*, 181:2, February 2011.p. 167.

https://www.researchgate.net/publication/254229516_Towards_ecologically_valid_assessment_in_early_literacy

⁸⁶ Ibid. p. 168.

⁸⁷ Ibid.

⁸⁸ Vanderwood, M.L., D. Linklater, and K. Healy. "Predictive Accuracy of Nonsense Word Fluency for English Language Learners." *School Psychology Review*, 37:1, 2008. Accessed via ProQuest.

⁸⁹ Han et al., Op. cit., p. 13.

⁹⁰ Scheffel, Lefly, and Houser, Op. cit., p. 90.

(Figure 2.3) have been shown to be highly predictive of elementary students’ overall reading success.⁹¹ The assessment’s K-6 indicators are designed to measure phonological awareness, the alphabetic principle, and fluency. **The distinction of its use of indicators is critical, since this feature distinguishes it from other literacy assessments.**⁹² The assessment includes seven short, one-minute measures.

Figure 2.3: Overview of DIBELS Measures

CORE COMPONENTS OF READING	DIBELS INDICATOR
Phonemic Awareness	<ul style="list-style-type: none"> ▪ Initial sound fluency ▪ Phoneme segmentation fluency
Alphabetic Principle and Phonics	<ul style="list-style-type: none"> ▪ Nonsense word fluency ▪ Oral reading fluency
Accuracy and Fluency with Connected Text	<ul style="list-style-type: none"> ▪ Oral reading fluency
Comprehension	<ul style="list-style-type: none"> ▪ At least through Grade 3: ▪ A combination of oral reading fluency and retell fluency
Vocabulary and Oral Language	<ul style="list-style-type: none"> ▪ Word use fluency

Source: Literacy Connect⁹³

One study by Scheffel and colleagues examined the effectiveness of various subtests of DIBELS in predicting student success on the standardized reading measure at the end of Grade 3. The researchers were also interested in whether this effectiveness is consistent for native speakers and EL students. For over 2,000 elementary school students’ in Grades 1 through 3, DIBELS results were matched to their state standardized reading assessment score. Results indicated that the relationship between the DIBELS tests and the state standardized reading assessment scores were at least “moderately strong” for both ELs and non-ELs.⁹⁴ Another study by McBride and colleagues evaluated the usefulness, reliability, validity, and cost effectiveness of four early literacy measures, including DIBELS. They found that results on the DIBELS subtests were correlated with other early literacy measures.⁹⁵

However, DIBELS’s overall utility has also received criticism. One of the primary criticisms of DIBELS is that “it is not an adequate indicator of reading comprehension.”⁹⁶ This is due to the DIBELS Oral Reading Fluency (ORF) subtest, in which students orally read passages and fluency is determined based on the number of words read correctly in one minute. Critics suggest that the task emphasizes speed, rather than comprehension, as students may read the words

⁹² “DIBELS Data System.” Literacy Connects. <http://literacyconnects.org/img/2013/03/DIBELS-and-what-they-measure.pdf>

⁹³ Ibid.

⁹⁴ Scheffel, Lefly, and Houser, Op. cit. p. 83.

⁹⁵ McBride et al., Op. cit.

⁹⁶ Riedel, B.W. “The Relation Between DIBELS, Reading Comprehension, and Vocabulary in Urban First-Grade Students.” *Reading Research Quarterly*, 42:4, October 2007. p. 549. Accessed via ProQuest.

quickly but not derive meaning from the text.⁹⁷ Yet, Riedel conducted a study to examine the relationship between DIBELS and reading comprehension at the end of Grade 1 and Grade 2. He found that the ORF subtest was a better predictor of comprehension than the remaining subtests. In fact, use of other subtests in combination with ORF “did not substantially improve predictive power beyond that provided by ORF alone.”⁹⁸ He also found that vocabulary was an important factor in the equation, as students with better vocabulary had satisfactory ORF scores and comprehension.⁹⁹ These data conclude that the DIBELS assessment is a viable instrument to evaluate and track early literacy skills.

Another common way to assess early literacy skills is through the use of a computer-administered adaptive test such as STAR Early Literacy. A computer-adapted test continually adjusts the difficulty of the questions based on the student’s previous response.¹⁰⁰ STAR Early Literacy is used as a diagnostic assessment of early literacy skills for PreK-3 students. Students are assessed in three domains and ten sub-domains (Figure 2.4). This assessment is most commonly used to screen students for their literacy achievement level, and can also be used to monitor student growth throughout the year. Students typically complete the entire assessment in 15 to 20 minutes. Each student receives a scaled score, which can be useful in comparing performance over time and across grades.¹⁰¹

Figure 2.4: Domains Measured on STAR Early Literacy Assessment

WORD FACILITY AND SKILL	COMPREHENSION STRATEGIES AND CONSTRUCTING MEANING	NUMBERS AND OPERATIONS
<ul style="list-style-type: none"> ▪ Alphabetic principle ▪ Concept of word ▪ Visual discrimination ▪ Phonemic awareness ▪ Phonics ▪ Structural analysis ▪ Vocabulary 	<ul style="list-style-type: none"> ▪ Sentence-level comprehension ▪ Paragraph-level comprehension 	<ul style="list-style-type: none"> ▪ Early numeracy

Source: Renaissance Learning¹⁰²

Studies conducted by the publishers, Renaissance Learning, demonstrate reliability and validity of the tool.¹⁰³ Those studies suggest that the tool can predict future academic performance on an independent measure of reading comprehension, STAR Reading.¹⁰⁴ A study by McBride and colleagues also found that STAR Early Literacy was the most cost

⁹⁷ Ibid. p. 549.

⁹⁸ Ibid. p. 547.

⁹⁹ Ibid.

¹⁰⁰ “Parent’s Guide to STAR Assessments: Questions and Answers.” Renaissance Learning. <http://doc.renlearn.com/KMNet/R0054872491706A8.pdf>

¹⁰¹ Ibid.

¹⁰² Ibid.

¹⁰³ McBride et al., Op. cit. p. 192.

¹⁰⁴ Ibid.

effective tool (compared to three other instruments, including DIBELS) because it took the least amount of teacher time and energy to administer and score.¹⁰⁵

Finally, data support the use of the Phonological Awareness Early Literacy Screening (PALS) instrument to track students’ early literacy skill development. The PALS assessments are most commonly used as screening, diagnostic and progress monitoring tools. The PALS Pre-K assessment is a phonological awareness and literacy screener that measures preschoolers’ knowledge of early literacy skills in the fall and spring of their Pre-K year. It is meant to help teachers tailor instruction to meet the needs of individual students. A continuation of the assessment is the PALS-K assessment, which is offered in Kindergarten, and the PALS 1-3 assessment for students in Grades 1 through 3. The PALS-K assessment contains six required tasks and one optional task (Figure 2.5). PALS is individually administered, although a few tasks can be conducted in small groups.¹⁰⁶ PALS also offers online score entry and reporting that supports teacher planning and instruction.¹⁰⁷

Figure 2.5: Skills Measured on PALS-K Assessments

SKILL(S) MEASURED	REQUIRED TASK
Rhyme Awareness	<ul style="list-style-type: none"> ▪ From three pictures, students identify the picture that rhymes with the target picture ▪ There are 10 items for this task
Beginning Sound Awareness	<ul style="list-style-type: none"> ▪ From three pictures, students identify pictures that have the same beginning sound as the target picture ▪ There are 10 items for this task
Alphabet Knowledge	<ul style="list-style-type: none"> ▪ Students name the 26 lower-case letters of the alphabet
Letter Sounds	<ul style="list-style-type: none"> ▪ Students produce the letter sounds of 23 upper-case letters of the alphabet ▪ Students produce the three consonant digraphs (ch, sh, th)
Spelling	<ul style="list-style-type: none"> ▪ Students spell five consonant-vowel-consonant words
Concept of Word	<ul style="list-style-type: none"> ▪ Students are taught a rhyme in advance of assessing their concept of word ▪ A students' concept of word is assessed using a picture sheet of the rhyme, as well as pointing and word identification in the context of a small book format and then in a word list
Word Recognition in Isolation (optional)	<ul style="list-style-type: none"> ▪ Students identify a list of words at the Preprimary, Primary, and First-Grade level

Source: Wisconsin Department of Public Instruction¹⁰⁸

¹⁰⁵ Ibid.

¹⁰⁶ "PALS: Information for Educators." Wisconsin Department of Public Instruction. <http://dpi.wi.gov/sites/default/files/imce/assessment/pdf/PALS%20Brochure%20Educators%20Final.pdf>

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

A study by Han and colleagues suggests that the Peabody Picture Vocabulary Test-IV, the Test of Preschool Early Literacy, and PALS-PreK are all effective in measuring the early vocabulary and phonological awareness skills of Spanish-speaking ELs, as they showed significant gains across all measures. Both ELs and non-ELs in the study also made significant progress on letter naming, letter sound, and print awareness. One thing to note, however, is that the length of time in the program was a factor in how much gains the students made over time.¹⁰⁹

MATHEMATICS ASSESSMENTS

Providing differentiated and accessible mathematics instruction in the early years serves as a vital foundation to future mathematics learning. Such high-quality classroom practice, however, requires careful attention to the types of assessments needed to effectively monitor student progress and carefully plan adequate instruction. As with literacy instruction, the use of a combination of screeners, diagnostic assessments and progress monitoring tools can provide insight into student performance and help teachers and administrators make decisions about placement in appropriate interventions.¹¹⁰

Below, Figure 2.6 presents an overview of evidence-based studies that highlight the use of mathematics assessments that target early math skills. In many of these studies, the researchers address the validity and reliability of the assessment tools, while also discussing how these assessments have been used to measure development of early math skills. It is important to note, however, that research on early math assessments is relatively slim compared to research on early literacy assessments.

¹⁰⁹ Han et al., Op. cit.

¹¹⁰ "Elementary Assessments: Universal Screening, Diagnostic, & Progress Monitoring," Op. cit.

Figure 2.6: Empirical Studies of Early Mathematics Assessments

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	ASSESSMENT MEASURES	CONCLUSIONS
Shapiro et al. (2015) ¹¹¹	<ul style="list-style-type: none"> ▪ 250 students in Grades 3 through 5 ▪ Data collected across two elementary schools ▪ Large proportion of Hispanics and low-income students 	<ul style="list-style-type: none"> ▪ Researchers compared the use of a Computer Adaptive Test (<i>STAR-Math</i>) and a Curriculum-Based Measurement (<i>CBM</i>, <i>AIMSweb Math Computation</i>, and <i>AIMSweb Math Concepts/Applications</i>) in assessing early math skills ▪ Instruments were administered once a month across a seven-month period 	<ul style="list-style-type: none"> ▪ <i>STAR-Math</i> across all grades and <i>AIMSweb M-CAP</i> in Grades 3 and 5 linked to linear growth patterns ▪ Predictive validity was strongest between <i>STAR-Math</i> Grade 3 and 4 student outcomes ▪ This suggests that both computer adaptive tests and curriculum-based measurements can be used to assess both short- and long-term math skills development in the early grades
Keller-Margulis et al. (2008) ¹¹²	<ul style="list-style-type: none"> ▪ 1,477 students in Grades 2-5 across six elementary schools in one district ▪ District composed of large populations of Hispanic (31%) and low-income students (33%) 	<ul style="list-style-type: none"> ▪ Data were collected three times throughout the year over two-week periods to test the validity of Curriculum-Based Measurement tools ▪ Two math skills were assessed: math computation (<i>Monitoring Basic Skills Progress—Math Computation</i>) and math concepts and applications (<i>Monitoring Basic Skills Progress—Math Concepts and Applications</i>) ▪ M-COMP requires students to complete 25 mixed operations problems ▪ M-CAP requires students to complete 18-24 problems in the areas of counting, number concepts, names of numbers, measurement, charts, money, fractions, and word problems, depending on grade level 	<ul style="list-style-type: none"> ▪ Researchers found evidence of the long-term diagnostic accuracy of Curriculum-Based Measurements and performance on state-wide assessments ▪ Math Curriculum-Based Measurement benchmarks correlated with performance on both achievement measures one to two years later ▪ Math computation growth related to performance on the statewide achievement test ▪ Math assessments in the early grades may require different expectations than reading tests because in these grades, math is not additive (branching off into different areas) so student expectations may change throughout the year

Research on mathematics assessments suggests that curriculum-based measurement (CBM) is an effective way to screen and progress monitor students for early math skills in elementary school. Evidence also indicates that “CBM have acceptable levels of diagnostic accuracy in predicting student performance on state tests of mathematics performance.”¹¹³ Two most commonly used CBM measures for math are Math Computation (M-COMP), which assesses math computational skills, and Math Concepts and Application (M-CAP), which

¹¹¹ Shapiro, E.S., M.S. Dennis, and Q. Fu. “Comparing Computer Adaptive and Curriculum-Based Measures of Math in Progress Monitoring.” *School Psychology Quarterly*, 30:4, December 2015. Accessed via EBSCOHost.

¹¹² Keller-Margulis, M.A., E.S. Shapiro, and J.M. Hintze. “Long-Term Diagnostic Accuracy of Curriculum-Based Measures in Reading and Mathematics.” *School Psychology Review*, 37:3, September 2008. Accessed via EBSCOHost.

¹¹³ Shapiro, E.S. and S.N. Gebhardt. “Comparing Computer-Adaptive and Curriculum-Based Measurement Methods of Assessment.” *School Psychology Review*, 41:3, September 2012. p.296. Accessed via EBSCOHost.

assesses mathematical concepts and applications across grade level objectives.¹¹⁴ These types of CBM-based assessment tools have a number of applications in early skills monitoring across both mainstream and special education classrooms; indeed, the uses of these instruments include “not only assessment for instructional placement and progress monitoring, but also careening and eligibility determinations. Extensive research has provided evidence of the solid technical characteristics of CBM.”¹¹⁵

Published by Pearson, M-COMP is a paper-pencil test that measures all basic operations for students in Grades 1 through 5, as well as decimals and fractions for students in Grade 4. The content is based on grade-level objectives (Figure 2.7). There are approximately 30 to 40 questions for each grade level. In terms of administration, the measure can be given individually or in small groups. Students are asked to complete as many problems as possible in eight minutes. Scores are calculated based on the number of correct responses, which each question allotted a certain amount of points.¹¹⁶

Figure 2.7: Domains Assessed by Grade Level on M-COMP Instrument

DOMAIN	GRADE LEVEL							
	1	2	3	4	5	6	7	8
Size of Numbers	✓	✓						
Column Addition	✓	✓	✓					
Basic Facts	✓	✓	✓	✓	✓	✓		
Complex Computation	✓	✓	✓	✓	✓	✓	✓	
Decimals				✓	✓	✓	✓	✓
Fractions				✓	✓	✓	✓	✓
Conversions					✓	✓	✓	✓
Percentages					✓	✓	✓	✓
Integers						✓	✓	✓
Expressions						✓		
Reductions						✓	✓	
Equations							✓	✓
Exponents							✓	✓

Source: Pearson¹¹⁷

There is also evidence to suggest that computer-adapted measures are effective as screeners and progress monitoring tools. STAR Math, for instance, is a computer-adaptive assessment that measures students’ mathematics abilities in Grades 1 through 12, although it can be used with Kindergarten students as well. It is most commonly used to identify students’ instructional

¹¹⁴ Ibid.

¹¹⁵ Keller-Margulis, Shapiro, and Hintze, Op. cit., p. 374.

¹¹⁶ “Mathematics Computation Administration Scoring Guide.” Pearson, 2012. http://www.aimsweb.com/wp-content/uploads/mcomp_admin_scoring-guide_2.01.pdf

¹¹⁷ Adapted from: “Math Computation.” Pearson. <http://www.aimsweb.com/assessments/features/assessments/math-computation>

math levels and compare their math achievement to that of students across the country.¹¹⁸ The assessment measures skills across eight mathematical strands: numeration concepts, computation processes, word problems, estimation, data analysis and statistics, geometry, measurement, and algebra. The STAR Math assessment consists of 24 multiple-choice questions. Overall, the content covered in the questions represents the standards and objectives most commonly addressed in math curricula across the United States.¹¹⁹

Given that it is adaptive, “the difficulty of items is adjusted automatically to reflect the skill level of the student.”¹²⁰ It can be administered individually or to groups of students in less than 15 minutes. What is unique about STAR Math is that it offers several accommodations for students with disabilities through accessibility options already built into the computer’s operative system. Teachers and paraprofessionals can administer the test after participating in a required training, which often takes less than an hour. Since scoring is automated by the system itself, it does not require any additional time. STAR Math scaled scores range from 1 to 1,400, and grade-equivalent, percentile and normal curve equivalent scores are derived from the scaled scores and the student’s current grade level.¹²¹

A research study conducted by Shapiro, Dennis and Fu compared the use of STAR-Math with CBMs in mathematics. They investigated “the degree to which slope or rate of change predicted student outcomes on the annual state assessment of mathematics.”¹²² They assessed 250 students in Grades 3 to 5 once per month over a seven-month period. Results indicated that STAR-Math showed primarily linear growth patterns across all three grades. Results also suggest that STAR-Math had a better predictive validity in terms for outcomes on the annual state assessment for students in Grades 3 and 4.¹²³

Support for CBMs in math is also portrayed through another study by Keller-Margulis, Shapiro and Hintze, which examined the relationship between benchmark data and rate of growth in mathematics across the year. In terms of measuring mathematics computation, for instance, students in Grades 1 through 5 were given Monitoring Basic Skills Progress—Math Computation probes. These probes are timed (between two to five minutes) and include 25 questions to solve. Students were also given the Monitoring Basic Skills Progress—Math Concepts and Applications, which includes 18 to 24 problems depending on grade level. These probes take approximately six to eight minutes to complete. Each problem required between one and three responses, and varied in type (e.g., fill-in blanks, multiple choice). Results indicated that math benchmark data was correlated with performance on achievement measures one to two years later. In addition, math computation growth was also correlated with scores on the annual achievement test.¹²⁴

¹¹⁸ “STAR Math.” Center on Response to Intervention at American Institutes for Research.

<http://www.rti4success.org/star-math#rel>

¹¹⁹ “Getting the Most out of STAR Math: Using Data to Inform Instruction and Intervention.” Renaissance Learning, 2010. p. 4. <http://doc.renlearn.com/KMNet/R004454309GKBFA7.pdf>

¹²⁰ “STAR Math,” Op. cit.

¹²¹ Ibid.

¹²² Shapiro, Dennis, and Fu, Op. cit. p. 470.

¹²³ Ibid.

¹²⁴ Keller-Margulis, Shapiro, and Hintze, Op. cit.

EMOTIONAL AND BEHAVIORAL ASSESSMENTS

Below, Figure 2.8 presents an overview of evidence-based studies that highlight the use of emotional/behavioral assessments that measure early non-academic skills.

Figure 2.8: Empirical Studies of Early Emotional/Behavioral Assessments

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	ASSESSMENT MEASURES	CONCLUSIONS
De Feyter and Winsler (2009) ¹²⁵	<ul style="list-style-type: none"> ▪ Subsample from Miami School Readiness Project ▪ 2,194 low-income Pre-K students ▪ Immigrant status was important- 89% of first generation immigrants were Latino 	<ul style="list-style-type: none"> ▪ <i>Devereux Early Childhood Assessment (DECA)</i> measured children’s socio-emotional strengths and behavior problems ▪ Uses a resilience framework ▪ Teachers report on the frequency of children’s behaviors by rating them on four subscales: initiative, self-control, attachment/closeness with adults, and behavioral concerns 	<ul style="list-style-type: none"> ▪ First-generation immigrants showed more advanced development and fewer behavioral concerns ▪ Effect size for the difference between first-generation and non-immigrant children was $d=0.36$ (socio-emotional skills) ▪ Suggests that teacher-reported measures of non-academic skills can reliably predict emotional strengths and weaknesses
DiStefano and Kamphaus (2008) ¹²⁶	<ul style="list-style-type: none"> ▪ 162 students (6-8 years old) ▪ 55% African American 	<ul style="list-style-type: none"> ▪ Researchers measured the patterns of behavioral adjustment and change in the first years of elementary school ▪ <i>Behavioral Assessment System for Children (BASC)</i> measured externalizing behaviors, internalizing behaviors, and adaptive skills ▪ Teachers completed the BASC for each child at the beginning of the school year ▪ Classroom grades in reading, math, social skills, and work habits were also collected, as well as data from school archival records on behavioral infractions 	<ul style="list-style-type: none"> ▪ Assessment helped identify students as either low or average risk ▪ Behavioral development followed linear trajectory, with decrease in the measured construct over time ▪ Students at risk showed lower test scores and grades ▪ BASC allows teachers to see the link between academic and non-academic outcomes, which can be used to develop Individualized Education Plans

The evidence surrounding the assessment of emotional or behavioral skills, such as cognitive control and self-regulation, demonstrates that these skills are most commonly assessed through the use of **teacher or parent observations or surveys**. For instance, Child Trends recommends the use of a teacher survey to assess a student’s self-control, social competence and persistence.¹²⁷

¹²⁵ De Feyter, J.J. and A. Winsler. “The Early Developmental Competencies and School Readiness of Low-Income, Immigrant Children: Influences of Generation, Race/Ethnicity, and National Origins.” *Early Childhood Research Quarterly*, 24, July 2009. <http://winslerlab.gmu.edu/pubs/Defeyer2009.pdf>

¹²⁶ DiStefano, C. and R.W. Kamphaus. “Latent Growth Curve Modeling of Child Behavior in Elementary School.” *Research in the Schools*, 15:1, March 2008. Accessed via EBSCOHost.

¹²⁷ “Measuring Elementary School Students’ Social and Emotional Skills.” Child Trends, 2014. <file:///C:/Users/mewaida/Desktop/SocialEmotional/2014-37CombinedMeasuresApproachandTablepdf1.pdf>

The research-based literature indicates the usefulness of tracking a student's change in behavioral development over time. One study by DiStefano and Kamphaus examined students' behavioral changes in the early elementary school years using the Behavioral Assessment System for Children (BASC).¹²⁸ Developed by Reynolds and Kamphaus, BASC is a set of rating scales and forms that help to assess the behaviors and emotions of children and adolescents. Scales included in the assessment system are the Teaching Rating Scale (TRS), Parent Rating Scales (PRS), Self-Report of Personality (SRP), Student Observation System (SOS), and Structured Developmental History (SDH). More specifically, the TRS measures student's adaptive and problem behaviors in the preschool setting or elementary school setting. Teachers rate specific behaviors on a four-point scale of frequency, from "Never" to "Almost Always." This tool, which contains between 100 and 139 items depending on age range, takes between 10-20 minutes to complete.¹²⁹

In their study, DiStefano and Kamphaus found that students' behavioral development could be measured using BASC and that students' development followed a linear trajectory. In this study, researchers used cluster analyses to group students as either "low risk" or "average risk" based on assessment results. The BASC assessment revealed a decrease in students' externalizing behaviors between Grades 1 and 3, regardless of the group into which students were originally placed. Conversely, the assessment found that students' adaptive skills decreased over time in both groups, indicating that as students get older, they may—for various reasons, including peer pressure and developmental changes—take advantage of more opportunities to act out or misbehave.¹³⁰ These findings led researchers to conclude that parents and teachers could use these measures of social skills to "be aware of [developmental changes in students] and encourage students to learn and foster good social skills and behaviors early in the school career to carry through to later grades."¹³¹

Studies also suggest that measures of socio-emotional and behavioral constructs can also be used with low-income and minority students to help teachers track their development over time. De Feyter and Winsler, for instance, examined the early developmental competencies of low-income preschool children, many of whom were either first- or second-generation immigrants. Teachers assessed children's socio-emotional skills, such as initiative, self-control, attachment with adults and behavioral concerns, using the Devereux Early Childhood Assessment (DECA).¹³² The DECA is a nationally-normed comprehensive assessment that measures protective factors in children ages two to five years old. The assessment can be completed in 10 minutes by parents or teachers. What is unique about the DECA is that it focuses on a resilience perspective of child development, evaluating the frequency of 27 positive behaviors exhibited by preschoolers (Figure 2.9).¹³³

¹²⁸ DiStefano and Kamphaus, Op. cit.

¹²⁹ "Behavioral Assessment System for Children, Second Edition (BASC-2)." Pearson.
<http://www.pearsonclinical.com/education/products/100000658/behavior-assessment-system-for-children-second-edition-basc-2.html#tab-scoring>

¹³⁰ DiStefano and Kamphaus, Op. cit., p. 35.

¹³¹ Ibid.

¹³² De Feyter and Winsler, Op. cit.

¹³³ "The Devereux Early Childhood Assessment (DECA) Kit." Kaplan Early Learning.
<https://www.kaplanco.com/product/41009/the-devereux-early-childhood-assessment-deca-kit-1st-edition?c=17%7CEA1000>

Figure 2.9: Measures in the DECA Assessment

Initiative: The child’s ability to use independent thought and action to meet his or her needs.	
<ul style="list-style-type: none"> ▪ Do things for himself/herself ▪ Keep trying when unsuccessful (act persistent) ▪ Ask other children to play with him/her ▪ Try or ask to try new things or activities ▪ Start or organize play with other children ▪ Participate actively in make-believe play 	<ul style="list-style-type: none"> ▪ Try different ways to solve a problem ▪ Focus his/her attention or concentrate on a task or activity ▪ Choose to do a task that was challenging ▪ Say positive things about the future (act optimistic) ▪ Make decisions for himself/herself
Self-Control: The child’s ability to experience a range of feelings and express them using the words and actions that society considers appropriate.	
<ul style="list-style-type: none"> ▪ Control his/her anger ▪ Show patience ▪ Share with other children ▪ Calm himself/herself down when upset 	<ul style="list-style-type: none"> ▪ Listen to or respect others ▪ Accept another choice when his/her first choice was unavailable ▪ Handle frustration well ▪ Cooperate with others
Attachment: The mutual, strong, and long-lasting relationship between a child and significant adults such as parents, family members, and teachers.	
<ul style="list-style-type: none"> ▪ Act in a way that made adults smile or show interest in him/her ▪ Respond positively to adult comforting when upset ▪ Trust familiar adults and believe what they say ▪ Show affection for familiar adults 	<ul style="list-style-type: none"> ▪ Ask adults to play with or read to him/her ▪ Seek help from children/adults when necessary ▪ Show an interest in what children/adults are doing ▪ Act happy or excited when parent/guardian returns

Source: Center for Resilient Children¹³⁴

In their study, De Feyter and Winsler found that there is variability in students’ school readiness based on assessment results. For instance, results from DECA indicated that compared to non-immigrant children, first- and second-generation immigrant children exhibited more advanced socio-emotional skills and behavior. According to the teachers, students’ behaviors improved over time. There were also generational differences for Latino children, as non-immigrant children exhibited more behavioral concerns.¹³⁵ This study highlights the importance of using assessment tools that measure early non-academic skills to develop a solid and comprehensive understanding of school readiness patterns of minority children from a strengths-based perspective.

¹³⁴ Adapted from: “The Devereux Early Childhood Assessment (DECA).” Center for Resilient Children. <http://www.centerforresilientchildren.org/wp-content/uploads/DECA-Preschool-Program-First-Edition-Protective-Factor-Def-and-items.pdf>

¹³⁵ De Feyter and Winsler, Op. cit., p. 16.

SECTION III: IMPLICATIONS FOR INSTRUCTION

Data gleaned from literacy and mathematics assessments in the early school years should be used to inform classroom instruction and identify students in need of further instructional interventions. In the National Research Council's (NRC) landmark report, *Preventing Reading Difficulties in Young Children*, Snow, Burns, and Griffin highlight that most reading difficulties or struggles can actually be prevented through effective instruction and interventions in the preschool years and in the early elementary school years.¹³⁶ It is therefore critical for educators to use effective instructional techniques and interventions to respond to the various needs of students in their classrooms and address any gaps in learning that might potentially lead to negative long-term consequences in future years.

In the following section, Hanover describes the essential components of effective literacy, math, and emotional/behavioral interventions that have been shown to be effective for students in the early years.

KEY FINDINGS

- **Daily, guided literacy activities that explicitly impart reading and comprehension strategies are essential to helping students develop early literacy skills.** Notably, research suggests that these activities are equally effective in whole-class, small-group, or one-on-one settings. A promising reading strategy is for the teacher to prompt students before, during, and after guided reading to promote vocabulary and comprehension. In this way, literacy activities are formalized around a specific and consistent format. This guided practice can include teacher-student and student-student groupings.
- **Hands-on math activities reinforce math lessons and help students connect math to everyday activities.** This helps to make math less formal, and provides young students with concrete examples of abstract concepts; thus, teachers should connect math ideas with physical representations as often as possible to effectively develop early skills. Students should be encouraged to communicate using math terms to describe the world around them. Informal tools—such as fingers, tally marks, and blocks—are often more effective than traditional math instruments.
- **Teachers should use dedicated practice to help children develop emotional and behavioral skills at a young age.** This includes direct instruction, modeled behaviors, and most importantly, role-playing. Children develop these nonacademic skills by observing them in practice. Teachers are encouraged to develop prompts and hypothetical situations in which students can practice coping strategies with one another. Lessons can discuss anger management, or social and communication skills. The classroom environment must also promote health emotional and behavioral expressions.

¹³⁶ Snow, C., M.S. Burns, and P. Griffin. "Preventing Reading Difficulties in Young Children." National Research Council, 1998. <http://files.eric.ed.gov/fulltext/ED416465.pdf>

LITERACY INSTRUCTION

Below, Figure 3.1 presents an overview of six evidenced-based studies that assess instructional practices and interventions that target early literacy skill development. In many of these studies, researchers compare students from different socio-economic backgrounds and evaluate effect sizes based on these differences. These comparisons serve as a proxy for the importance of access to early skill development, given the traditional gaps in performance between low- and middle-/high-income students. Thus, these approaches provide some possible pathways for schools to help foster early skill development among students who lag behind their peers in preprimary and early primary schools.

Figure 3.1: Empirical Studies of Early Literacy Skill Interventions

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Baker et al. (2013) ¹³⁷	<ul style="list-style-type: none"> ▪ 225 Grade 1 students in majority low-income schools ▪ Roughly one-fourth were at language risk, and roughly 10% were at literacy risk 	<ul style="list-style-type: none"> ▪ Researchers examined the impact of a <i>Reading Aloud</i> intervention over a 19-week period, using books that teachers commonly read ▪ Narrative and expository texts were integrated in with these common texts ▪ Each unit included six lessons, each lasting 30 minutes ▪ Lessons divided into before (identifying book type; highlighting key vocabulary), during (story and grammar elements; discussions and comprehension), and after (summarizing and retelling with partners) reading activities 	<ul style="list-style-type: none"> ▪ The whole-class read aloud program proved effective both for at-risk and not-at-risk students by allowing teachers to explicitly teach ways to better understand texts ▪ The dedicated read aloud program most significantly improved vocabulary (d=0.93) and narrative retell (d=0.42) outcomes ▪ There was a smaller impact on listening comprehension (d=0.16) and expository retell (d=0.28)
Gilbert et al. (2013) ¹³⁸	<ul style="list-style-type: none"> ▪ 649 struggling Grade 1 readers ▪ Roughly have attended schools where 95% of students came from low-income families 	<ul style="list-style-type: none"> ▪ Students were screened multiple times throughout the school year to determine their risk status ▪ Tier 2 supports included small-group tutoring, while Tier 3 supports included additional small-group or one-on-one tutoring (30 minutes) 	<ul style="list-style-type: none"> ▪ Tutoring was effective in increasing the development of at-risk Grade 1 students, although with a modest effect size (d=0.19) ▪ Single-year multi-tier intervention did not prevent later difficulties – this suggests that supplemental preventive programs may need to span multiple years to prevent future struggles

¹³⁷ Baker, S.K. et al. "An Evaluation of an Explicit Read Aloud Intervention Taught in Whole-Classroom Formats in First Grade." *The Elementary School Journal*, 113:3, March 2013. Accessed via EBSCOHost.

¹³⁸ Gilbert, J.K. et al. "Efficacy of a First-Grade Responsiveness-to-Intervention Prevention Model for Struggling Readers." *Reading Research Quarterly*, April 2013. Accessed via EBSCOHost.

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Vadasy and Sanders (2012) ¹³⁹	<ul style="list-style-type: none"> ▪ 180 Grade 1 students tracked over two years ▪ Both EL and non-EL students participated ▪ Large population of low-income students (40%) 	<ul style="list-style-type: none"> ▪ Para-educator tutors spent 30 minutes a day, four days a week working with students using scripted lessons ▪ 20 minutes for phonics activities, 10 minutes for scaffolding students’ oral reading practice ▪ Students received individual phonics instruction in English (e.g., letter-sound correspondences, spelling, irregular words, etc.) 	<ul style="list-style-type: none"> ▪ Two years after the intervention, positive effects were maintained on word reading (d=0.45), spelling (d=0.36), and to a lesser extent, reading comprehension (d=0.24) ▪ Effects were smaller over time for EL students, particularly in spelling ▪ Initial word reading proficiency in Grade 1 is highly predictive of reading outcomes by the end of Grade 3
Duff, Hayiou-Thomas, and Hulme (2011) ¹⁴⁰	<ul style="list-style-type: none"> ▪ 26 age 6 students with reading difficulties in the United Kingdom 	<ul style="list-style-type: none"> ▪ Students participated in a 10-week supplementary reading program, which alternated daily between group and individual sessions (20 minutes) ▪ Group sessions included letter/word identification training, phonological awareness activities, and group storytelling ▪ Individual sessions included reading easy and instructional books alone, and reading a more difficult text in shared reading 	<ul style="list-style-type: none"> ▪ Students made significantly greater gains in early word reading (d=0.37), phoneme awareness (d=0.71), and spelling (d=0.61) than non-intervention peers ▪ Effects persisted six months later ▪ Despite gains, intervention students continued to underperform peers, although the gap had narrowed significantly
Chambers et al. (2011) ¹⁴¹	<ul style="list-style-type: none"> ▪ Lowest 50% of Grade 1 and 2 students were identified as potentially in need of tutoring ▪ 33 high-poverty schools ▪ High populations of minority students: 64% Black and 24% Hispanic 	<ul style="list-style-type: none"> ▪ Students received Tier 2 computer-assisted tutoring in small groups (Team Alphie; six children per group) and one-to-one tutoring ▪ Team Alphie combines cooperative learning, computer-assisted instruction, embedded multimedia, and tutoring ▪ Pair-learning activities are emphasized ▪ Daily 45-minute lessons in phonemic awareness, phonics, fluency, vocabulary, and comprehension 	<ul style="list-style-type: none"> ▪ Students using Team Alphie scored higher than their peers in traditional tutoring on reading posttests in Grade 1 (d=0.28) and Grade 2 (d=0.21) ▪ Schools using the computer-assisted software were able to tutor many more students than peer schools, making this a potentially cost- and time-saving intervention

¹³⁹ Vadasy, P.F. and E.A. Sanders. “Two-Year Follow-Up of a Code-Oriented Intervention for Lower-Skilled First-Graders: The Influence of Language Status and Word Reading Skills on Third Grade Literacy Outcomes.” *Reading & Writing*, 26:6, July 2012. Accessed via EBSCOHost.

¹⁴⁰ Duff, F.J. “Evaluating the Effectiveness of a Phonologically Based Reading Intervention for Struggling Readers with Varying Language Profiles.” *Reading & Writing*, 25:3, January 2011. Accessed via EBSCOHost.

¹⁴¹ Chambers, B. et al. “Small-Group, Computer-Assisted Tutoring to Improve Reading Outcomes for Struggling First and Second Graders.” *The Elementary School Journal*, 111:4, June 2011. Accessed via EBSCOHost.

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Amendum, Vernon-Feagans, and Ginsberg (2011) ¹⁴²	<ul style="list-style-type: none"> ▪ 364 Kindergarten and Grade 1 students from eight schools ▪ Minority student populations at these schools ranged from 57% to 98%; low-income status ranged from 57% to 78% 	<ul style="list-style-type: none"> ▪ Intervention literacy coaches connected with classroom teachers via distance technology to provide real-time guidance and support ▪ The intervention model stressed the centrality of reading comprehension, and highlights the interconnectedness of word identification, fluency, vocabulary, and comprehension 	<ul style="list-style-type: none"> ▪ Intervention students outperformed their struggling peers on all reading outcomes between the fall and spring posttests: word attack (d=0.52); letter-word identification (d=0.52); passage comprehension (d=0.72); and spelling of sounds (d=0.40) ▪ The results show that struggling young readers benefit from specific focused interventions

In early childhood education classrooms, many of the studies that discuss early literacy skills development assess students’ outcomes in a variety of indicators such as comprehension, letter and word identification, spelling, and reading abilities. This highlights the range of skills that literacy teachers must consider when providing instruction to young children, which accounts for much of the need for targeted and purposeful pedagogy in these early education classrooms. Indeed, early intervention approaches for children at-risk for reading difficulties can reduce the risk of future problems and establish a solid, foundational knowledgebase that will serve them in later schooling. In one study, for instance, Vadasy and Sanders found that children who had received dedicated 30-minute blocks of literacy instruction in Grade 1 showed continued positive outcomes two years later.¹⁴³

The body of empirical research suggests that the most effective way to develop early literacy skills is to dedicate time each day for explicitly guided reading activities. This can manifest in whole-class, small-group, or one-on-one work, provided that students are receiving dedicated instruction in one or more core elements of literacy foundations. For example, Baker and colleagues found that whole-class, guided read-alouds improved the comprehension and vocabulary outcomes for both low-risk and high-risk students compared to their peers using traditional methods. In their model, teachers lead before-, during-, and after-reading discussions that explicitly teach comprehension strategies to young students. This before, during, and after method is supported by the U.S. Department of Education for imparting foundational reading skills to children in Kindergarten through Grade 3.¹⁴⁴ The lessons were based on four main principles:

¹⁴² Amendum, S.J., L. Vernon-Fergans, and M.C. Ginsberg. “The Effectiveness of a Technologically Facilitated Classroom-Based Early Reading Intervention.” *The Elementary School Journal*, 112:1, September 2011. [http://www.targetedreadingintervention.org/sites/targetedreadingintervention.org/files/documents/The%20Effectiveness%20of%20a%20Technologically%20Facilitated%20Classroom-Based%20Early%20Reading%20Intervention%20\(2011\).pdf](http://www.targetedreadingintervention.org/sites/targetedreadingintervention.org/files/documents/The%20Effectiveness%20of%20a%20Technologically%20Facilitated%20Classroom-Based%20Early%20Reading%20Intervention%20(2011).pdf)

¹⁴³ Vadasy and Sanders, Op. cit., p. 836.

¹⁴⁴ Foorman, B. et al. “Foundational Skills to Support Reading for Understanding in Kindergarten Through 3rd Grade.” Institute of Education Sciences, U.S. Department of Education, July 2016. p. 12. http://ies.ed.gov/ncee/wwc/Docs/practiceguide/wwc_foundationalreading_070516.pdf

- Lessons were organized around a model, lead, test approach to provide step-by-step demonstrations of the comprehension strategies and decision-making processes they wanted students to use to comprehend texts.
- Read aloud lesson content was sequenced to become more complex over time, to build strategically on previous skills and strategies learned, and to require greater responsibility on the part of the students to understand text.
- Teachers and students engaged in frequent interactions about texts.
- Teachers provided extensive feedback to students, affirming their responses and addressing aspects of students' responses they wanted to highlight and extend.¹⁴⁵

Teachers used a variety of evidenced-based components of comprehension instruction throughout the read-aloud activities across all stages (i.e., before, during, and after) to ensure that students across all skill levels would benefit from the practice. These seven components are:

- **Comprehension monitoring:** Teachers explained and demonstrated the importance of understanding what the text was about. During reading, they paused in strategic places to address difficult words in context, to make inferences, and to summarize text
- **Cooperative learning:** Students were taught a specific approach for working with a partner (i.e., a book buddy). In each lesson, students worked together on text retells and other comprehension activities.
- **Graphic and semantic organizers:** Teachers used specific visual organizers for narrative texts and information texts. The narrative text organizer focused on story grammar elements and the information text organizer focused the K-W-L format and three strategic questions associated with learning about animals.
- **Story structure:** Students were taught the difference between narrative texts and information texts. Each unit focused on one information text and one narrative text and each lesson began with a discussion of ways to determine text type.
- **Question answering:** Teachers asked strategically placed questions throughout the lesson. Teachers also learned generic questioning approaches they could use to clarify student responses, elicit more elaborate responses, and extend discussions.
- **Question generation:** Teachers taught students basic questions they should ask (a) about narrative texts and expository texts, (b) to figure out word meanings when listening to texts, and (c) to predict what a text might be about before reading it and what might come next during reading.
- **Summarization:** Students were taught a systematic process for retelling/summarizing narrative texts and information texts.¹⁴⁶

¹⁴⁵ Bullet points adapted from: Baker et al., Op. cit., pp. 335–336.

¹⁴⁶ Bullet points taken verbatim from: Ibid., p. 335.

The dedicated Grade 1 read-aloud intervention, which was standardized across classrooms to limit differences between teacher practices in traditional settings, supported students' early literacy development by formalizing the read-aloud protocols and ensuring that teachers devoted time at multiple stages to devote to targeted instruction. According to the researchers, "the intervention was organized around the concept of explicit instruction where teachers assisted students in developing strong representations of text by using approaches to comprehension supported by the National Reading Panel."¹⁴⁷ This study highlights the efficacy of dedicated whole-class approaches to reducing the literacy skills gap in early grades.

However, **data suggest that these approaches are equally as effective in smaller settings, with small-group and individual activities benefiting low-performing students.** In one study, for example, Duff, Hayiou-Thomas, and Hulme discovered that small-group and individual instruction in literacy skills positively impacted young students who were struggling in literacy lessons. These results persisted over six months, implying that guided reading instruction affirmatively influences the literacy skills gap. In the intervention, students alternated between daily small group work with two other students and individual sessions, each lasting 20 minutes. In group sessions, teachers led students through specific letter and word identification training, phonological awareness activities, and group narration and storytelling. In the individual sessions, teachers lead student reading across both familiar and unfamiliar topics.¹⁴⁸ Again, these findings show that students can develop fundamental literacy skills provided they receive guided and explicit instruction in comprehension strategies.

The Institute of Education Sciences (IES) advocates for this explicit, guided literacy practice in the early grades. For example, they propose that schools "teach beginning readers complex grammatical structures and key elements of narrative language during whole-class or small-group lessons."¹⁴⁹ According to the IES, schools can develop early reading skills in students from Kindergarten to Grade 3 in four key ways:

- Teach students academic language skills, including use of inferential and narrative language and vocabulary knowledge;
- Develop awareness of the segments of sounds in speech and how they link to letters;
- Teach students to decode words, analyze word parts, and write and recognize words; and
- Ensure that each student reads connected text every day to support reading accuracy, fluency, and comprehension.¹⁵⁰

¹⁴⁷ Ibid., p. 350.

¹⁴⁸ Duff, Hayiou-Thomas, and Hulme, Op. cit., pp. 627–628.

¹⁴⁹ Foorman et al., Op. cit., p. 10.

¹⁵⁰ Bullet points adapted from: Ibid., p. 2.

MATH INSTRUCTION

Figure 3.2 presents some key research-based studies that examine the effectiveness of various early math interventions that can reduce the skills gap in young students. Similar to the literacy skill development studies, many of these evaluations compare outcomes between students from different socio-economic backgrounds. This again serves as a proxy for the early skills gap, and can highlight ways for schools to ensure that young students receive needed math skills instruction to avoid long-term deficiencies.

Figure 3.2: Empirical Studies of Early Math Skill Interventions

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Ramani and Siegler (2011) ¹⁵¹	<ul style="list-style-type: none"> ▪ 112 preschool students from low- and middle-income families ▪ Low-income students attended Head Start programs 	<ul style="list-style-type: none"> ▪ Children participated in five sessions, each with session asking children to complete different tasks ▪ Conditions included linear board and circular board games, which measured: counting, number line estimation, numerical magnitude comparison, and numerical identification 	<ul style="list-style-type: none"> ▪ Children with less initial knowledge generally learned more, and children from low-income backgrounds often improved relative to their middle-income peers ▪ Low-income children gained in number line estimation (d=0.86), numerical magnitude estimation (d=0.53), numerical identification (d=0.51), and arithmetic (d=0.83) ▪ Middle-income children also gained, although to a lesser extent, in number line estimation (d=0.36), numerical identification (d=0.29), and notably, arithmetic (d=1.12)
Clements et al. (2011) ¹⁵²	<ul style="list-style-type: none"> ▪ 1,375 preschool students in low-resource communities ▪ High minority population (55% Black and 20% Hispanic) ▪ 85% qualified for free- or reduced-price lunch 	<ul style="list-style-type: none"> ▪ Researchers implemented <i>Building Blocks</i> curriculum that highlights communicating, reasoning, representing, and problem solving ▪ Children encouraged to mathematize their everyday activity (e.g., art, songs, puzzles) ▪ A variety of activities including whole group, small group, centers, and computer centers 	<ul style="list-style-type: none"> ▪ <i>Building Block</i> students learned more math than their peers (d=0.72) ▪ The intervention is believed to be equally effective regardless of a class’s socio-economic or language makeup ▪ Teachers were able to develop richer classroom environments for math (i.e., a math-centered culture)

¹⁵¹ Ramani, G.B. and R.S. Siegler. “Reducing the Gap in Numerical Knowledge Between Low- and Middle-Income Preschoolers.” *Journal of Applied Developmental Psychology*, 32, April 2011. <http://www.psy.cmu.edu/~siegler/RamaniSiegler2011.pdf>

¹⁵² Clements, D.H. et al. “Mathematics Learned by Young Children in an Intervention Based on Learning Trajectories: A Large-Scale Cluster Randomized Trial.” *Journal for Research in Mathematics Education*, 42:2, 2011. https://www.researchgate.net/publication/258933028_Mathematics_Learned_by_Young_Children_in_an_Intervention_Based_on_Learning_Trajectories_A_Large-Scale_Cluster_Randomized_Trial

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Dyson, Jordan, and Glutting (2011) ¹⁵³	<ul style="list-style-type: none"> ▪ 121 low-income Kindergarten students from five schools (between 79% and 95% free- and reduced-price lunch) ▪ High minority population (55% Black and 37% Hispanic) 	<ul style="list-style-type: none"> ▪ Intervention targeted whole number concepts related to counting, comparing, and manipulating sets ▪ Teachers used consistent representations (chips, dots, and fingers) and centered on activities on a number list from 1 to 10 ▪ Students received small group, 30 minute sessions for three days a week 	<ul style="list-style-type: none"> ▪ Intervention students outperformed peers on a standardized math test immediately following the study (d=0.30) ▪ Students showed marginal gains in indicators of math fluency including: number recognition (d=0.32), story problems (d=0.32), and number combinations (d=0.18) ▪ Intervention effects held six weeks after the experiment, suggesting that gains can occur over a relatively short time
Agodini and Harris (2010) ¹⁵⁴	<ul style="list-style-type: none"> ▪ Data collected from a sample of 39 schools ▪ Schools had 26% Black and 20% Hispanic students, and three-quarters where Title I eligible 	<ul style="list-style-type: none"> ▪ Researchers tested the validity of four math interventions ▪ <i>Investigations</i> is a K-5 curriculum that is based on a student-centered approach, highlighting communicating about math and solving problems in multiple ways ▪ <i>Math Expressions</i> (K-5) uses teacher-directed and student-centered instruction, providing student with effective procedures while promoting natural solution methods ▪ <i>Saxon</i> (K-4) uses scripted lessons to lead multisensory approaches for explicit instruction, hands-on activities, conversations about math, and practice ▪ <i>SFAW</i> (PK-6) uses a consistent daily lesson structure in explicit instruction and pictorial and abstract representations 	<ul style="list-style-type: none"> ▪ Results show that the math curriculum used in Grade 1 classrooms can have an impact on later student performance ▪ <i>Math Expressions</i> (d=0.24-0.30) and <i>Saxon</i> (d=0.24-0.30) students showed higher performance by nine to 12 percentile points than students in <i>Investigations</i> or <i>SFAW</i> ▪ These results were consistent across 15 student subgroups ▪ The curriculum differentials for teachers were large (d=0.31-0.42), suggesting that curriculum content matters in Grade 1

¹⁵³ Dyson, N.I., N.C. Jordan, and J. Glutting. "A Number Series Intervention for Low-Income Kindergartners At-Risk for Mathematics Difficulties." *Journal of Learning Disabilities*, 46:2, June 2011. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3566272/>

¹⁵⁴ Agodini, R. and B. Harris. "An Experimental Evaluation of Four Elementary School Math Curricula." *Journal of Research on Educational Effectiveness*, 3:3, July 2010. Accessed via EBSCOHost.

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Clements and Sarama (2007) ¹⁵⁵	<ul style="list-style-type: none"> ▪ 68 students from two low-income preschools ▪ Most students receive free- or reduced-price lunch (74%), and 58% identify as Black 	<ul style="list-style-type: none"> ▪ Researchers also implemented <i>Building Blocks</i> curriculum 	<ul style="list-style-type: none"> ▪ Researchers observed highly significant effect sizes between treatment and control students ▪ Students improved in number test (d=0.85) and geometry, measurement, and pattern recognition (d=1.47) ▪ Significant gains were also observed in subitizing, sequencing, shape identification, and composition of shapes

The studies above highlight the important role that early math skills can play in student success. According to researchers, for instance, “if children leave Kindergarten with weak number competencies, they enter [Grade 1] at a disadvantage and may never catch up to those who started with good number competencies.”¹⁵⁶ Most of the identified studies assess students’ familiarity with a range of math competencies, such as shape and number recognition, arithmetic, and number estimation. Many of these foundational skills serve as the basis for subsequent math instruction, and students who are struggling with these early skills will face difficulties in math in later schooling.

One of the most effective characteristics of early math skills development is the inclusion of hands-on activities to reinforce math lessons. Indeed, several of the interventions evaluated in the above studies incorporate strategic physical and sensorial activities into math lessons so that young students can connect concepts with physical representations. For example, Ramani and Siegler discovered that board games in preschool classrooms helped these children develop mastery of early math competencies. Moreover, these effects were largest for students who originally scored lower on pretests and those who came from less affluent households. The researchers guided students through two games: a linear board game and a circular board game (Figure 3.3). They concluded that “engaging in informal numerical activities can play a critical role in children’s early numerical development. Preschoolers from both lower and higher income backgrounds are interested in math-related activities, and they engage in similar amounts of math-related play at preschool when similar resources are available.”¹⁵⁷

¹⁵⁵ Clements, D.H. and J. Sarama. “Effects of Preschool Mathematics Curriculum: Summative Research on the Building Blocks Project.” *Journal for Research in Mathematics Education*, 38:2, 2007.
<http://www.du.edu/marsico/institute/media/documents/effectsofapreschoolmathematicscurric.pdf>

¹⁵⁶ Clements et al., Op. cit.

¹⁵⁷ Ramani and Seigler, Op. cit, p. 157.

Figure 3.3: Hands-On Games Used to Reinforce Early Math Skills

LINEAR BOARD GAME	CIRCULAR BOARD GAME
<p>The board used in the linear board game included 10 different colored squares of equal size, arranged in a horizontal array. Each square contained one number, with the numbers increasing consecutively from left to right.</p> <p>At the beginning of each session, the experimenter told the child that they would take turns spinning the spinner and that whoever reached the end first would win. Then the experimenter said that on each turn, the player who spun the spinner would move her or his token the number of spaces indicated on the spinner. The experimenter also told the child to say the numbers on the spaces through which the token moved. Thus, children who were on the square with a 3 and spun a 2 would say, “4, 5” as they moved. If a child erred or could not name the numbers, the experimenter correctly named them and then had the child repeat the numbers while moving the token.</p>	<p>The only difference between the linear and circular conditions involved the game boards. There were two circular boards, each divided into 12 wedges. Ten of the wedges, those located approximately at the locations of 2:00 through 10:00 on an analog clock, included the numbers 1–10 ordered consecutively. On one board, the numbers increased clockwise; on the other, the numbers increased counterclockwise.</p> <p>The procedure followed in the circular board condition was identical to that in the linear board condition. Half of the children in this condition played the clockwise version of the game and the other half played the counterclockwise version. The number of games played and time spent playing did not differ between the linear and circular board conditions.</p>

Source: Ramani and Siegler; “Reducing the Gap in Numerical Knowledge Between Low- and Middle-Income Preschoolers”¹⁵⁸

In another study, where researchers compared four early math skill interventions, Agodini and Harris concluded that the *Saxon* math intervention—which stressed hands-on and sensorial strategies—was one of the most effective approaches to increasing early proficiency in math. The other three studies highlighted other aspects of instruction, such as different problem-solving techniques or pictorial representations. Uniquely, *Saxon* “uses a multisensory approach with explicit instruction, hands-on activities, mathematical conversations, and practice.”¹⁵⁹ These sensorial activities permit teachers to build competencies over time, as opposed to teaching discrete concepts individually. Each *Saxon* lesson comprises five daily activities: morning routines; fact practice; an explicit lesson; guided class practice; and homework.¹⁶⁰ The developmental progression espoused by the *Saxon* program is further supported by the U.S. Department of Education for young students’ math skills development:

- First, provide opportunities for children to practice recognizing the total number of objects in small collections and labelling them with a number word without needed to count them.

¹⁵⁸ Adapted from: *Ibid.*, pp. 148–149.

¹⁵⁹ Agodini and Harris, *Op. cit.*, p. 207.

¹⁶⁰ *Ibid.*

- Next, promote accurate one-to-one counting as a means of identifying the total number of items in a collection.
- Once children can recognize or count collections, provide opportunities for children to use number words and counting to compare quantities.
- Encourage children to label collections with number words and numerals.
- Once children develop these fundamental number skills, encourage them to solve basic problems.¹⁶¹

These strategies equally incorporate physical and hands-on methods to develop early comfort with math (e.g., tangible objects in small collections).

An equally important factor in early math skills development is encouraging young students to mathematize their everyday life. Teachers can support early math skills by fostering a classroom environment in which children can describe math ideas in their surroundings. This reflects many of the same benefits of using hands-on activities in early elementary classrooms. For young children, especially, experts posit that “children should use informal tools such as their fingers, tally marks, or other concrete objects to represent math ideas [...] Once children are comfortable using math informally, teacher can help them link their informal knowledge to more abstract math concepts.”¹⁶² By using these informal methods, young students learn that math concepts exist in everyday situations. Figure 3.4 shows examples of how teachers can instruct information representations of math concepts in a way that encourages children to mathematize their surroundings.

Figure 3.4: Using Informal Representations of Math Using Everyday Objects

CONCEPT	INFORMAL REPRESENTATION	TEACHING THE CONCEPT
Whole Number	“Three”	Collections of blocks, dots, tally marks, fingers, or other countable objects can represent numerals. For example, when playing a game, use blocks to represent children’s scores so everyone can track each player’s score.
Equal	“Same number as” or “Same as”	Provide opportunities for children to begin to recognize that collections that have the same number when counted are equal. For example, a collection of four plates is the same number as a collection of four cups.
Unequal	“More than” or “fewer than”	Point out that a collection is more (or fewer) than another if it requires a longer (or shorter) count. For example, seven is more than six because it requires counting beyond six.
Addition	“And” or “More”	Start with a collection and add more items to make it larger. For example, start with three crayons and add one more. Then ask, “How many?”

¹⁶¹ Bullet points taken verbatim from: Frye, D. et al. “Teaching Math to Young Children: A Practice Guide.” Institute of Education Sciences, U.S. Department of Education, November 2013. p. 1.
http://ies.ed.gov/ncee/wwc/Docs/practiceguide/early_math_pg_111313.pdf

¹⁶² Frye et al., Op. cit., p. 42.

CONCEPT	INFORMAL REPRESENTATION	TEACHING THE CONCEPT
Subtraction	“Take away” or “Fewer”	Start with a collection and take away some items to make it smaller. For example, start with three crayons and take away one. Then ask, “How many?”

Source: Institute of Education Sciences¹⁶³

In one empirical study, Clements and colleagues tested the validity of the *Building Blocks* curriculum for more than 1,300 preschool students. The curriculum instructed teachers to guide students to “extend and mathematize their everyday activities, from block building to art to songs to puzzles, through sequenced, explicit activities.”¹⁶⁴ Most activities conveyed communication, reasoning, representing, and problem solving skills as well, underscoring the importance of communication in math for young children. Data from the study revealed that teachers that promoted the *Building Blocks* method were able to foster a “richer classroom environment” for math and children in treatment classrooms outscored their peers in math test scores (effect size of $d=0.72$).¹⁶⁵ Teachers in treatment classrooms were thus able to encourage children to mathematize everyday objects and activities, promoting skills for children to both think and talk about math.

EMOTIONAL AND BEHAVIORAL SKILLS

Finally, Figure 3.5 presents the empirical evidence that addresses nonacademic skills development during early childhood education, namely emotional and behavioral competencies. Although many of these outcomes are more difficult to measure empirically, these studies largely use teacher and student responses to evaluate changes in behavior and attitudes toward learning.

Figure 3.5: Empirical Studies of Early Emotional and Behavioral Skill Interventions

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Daunic et al. (2012) ¹⁶⁶	<ul style="list-style-type: none"> 1,296 students across 14 schools and 87 classrooms 	<ul style="list-style-type: none"> Researchers tested the effects of Tools for Getting Along (TFGA), a social problem-solving, universally-delivered curriculum designed to reduce the developmental risk of emotional or behavioral problems Lessons focus on step-by-step problem solving strategy to use in emotionally charged situation (role-play lessons) Data collected using teacher and student self-reported data 	<ul style="list-style-type: none"> Students in TFGA had more positive approach to problem solving and a more rational problem-solving style Students with initially lower baseline scores improved significantly on measures of problem-solving behavior and pro-social behaviors

¹⁶³ Adapted from: Ibid., p. 43.

¹⁶⁴ Clements et al., Op. cit., p. 132.

¹⁶⁵ Ibid., p. 153.

¹⁶⁶ Daunic, A.P. et al. “Reducing Developmental Risk for Emotional/Behavioral Problems: A Randomized Controlled Trial Examining the Tools for Getting Along Curriculum.” *Journal of School Psychology*, 50, 2012. <http://fulltext.study/download/363760.pdf>

AUTHOR(S) YEAR	DEMOGRAPHIC CHARACTERISTICS	COMPONENTS OF INTERVENTION	OUTCOMES
Carter et al. (2011) ¹⁶⁷	<ul style="list-style-type: none"> ▪ Meta-analysis of 81 studies ▪ Data from 16,426 students 	<ul style="list-style-type: none"> ▪ Studies addressed self-determination elements or outcome measures (e.g., self-efficacy, problem solving) ▪ Researchers wanted to examine the link between self-determination and improved educational and post-school outcomes for children with or at risk of emotional or behavioral disorders ▪ Reviewed school-based intervention studies 	<ul style="list-style-type: none"> ▪ Fostering students' self-determined behavior is a core element of successful efforts – self-management and self-regulation in particular ▪ Researchers also recommend a greater emphasis on promoting self-awareness and self-knowledge
Webster-Stratton, Reid, and Stoolmiller (2008) ¹⁶⁸	<ul style="list-style-type: none"> ▪ 120 Head Start classrooms and 14 elementary schools ▪ All schools had diverse low-income populations (59% free- or reduced-price lunch) 	<ul style="list-style-type: none"> ▪ Researchers tested the effects of the Incredible Years (IY) Child Training curriculum, an early school-based preventative model ▪ Teachers were trained in the IY curriculum and on how to use effective classroom management (e.g., promoting pro-social behaviors, emotional literacy, increase parental involvement) ▪ The IY curriculum stresses social learning behaviors such as videotape modeling, role-play and practice of targeted skills, and reinforcement of target behaviors ▪ Students segmented into moderate- and high-risk groups for social problem solving behaviors 	<ul style="list-style-type: none"> ▪ Intervention teachers used more positive classroom management strategies across five teaching styles: warmth/affectionate (d=0.51), inconsistent/permissive (d=0.63), harsh/critical (d=0.67), social/ emotional teacher (d=0.96), and effective discipline (d=1.24) ▪ Students showed more social competence and emotional self-regulation, and also had fewer conduct problems than similar peers ▪ Teachers and students reported significant improvements in classroom atmosphere (d=1.03) ▪ Intervention increased the parent-teacher bond (d=0.57) ▪ Students from classrooms with very low initial levels of school readiness and high conduct problems disproportionately benefitted

Experts acknowledge the need to identify social, emotional, and behavioral issues in young children, and the benefits that this early detection and skill development can have on long-term outcomes. Beyond academic benefits, solid foundations in emotional and behavioral skills can lead to healthy development and overall wellness later in life.¹⁶⁹ The Center for the Study of Social Policy asserts that strategies for promoting social, emotional, and behavioral

¹⁶⁷ Carter, E.W. et al. "Self-Determination Interventions for Students with and at Risk for Emotional and Behavioral Disorders: Mapping the Knowledge Base." *Behavioral Disorders*, 36:2, February 2011. Accessed via ProQuest.

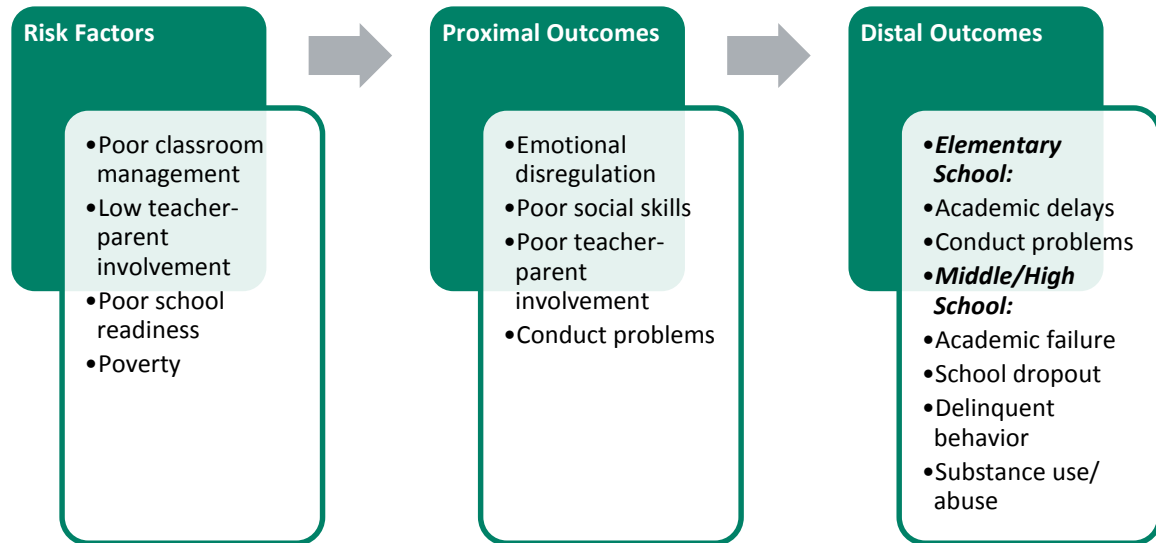
¹⁶⁸ Webster-Stratton, C., M.J. Reid, and M. Stoolmiller. "Preventing Conduct Problems and Improving School Readiness: Evaluation of the Incredible Years Teacher and Child Training Programs in High-Risk Schools." *Journal of Child Psychology and Psychiatry*, 49:5, January 2008. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2735210/>

¹⁶⁹ "Results-Based Public Policy Strategies for Promoting Children's Social, Emotional, and Behavioral Health." The Center for the Study of Social Policy, March 2012. p. 2. <http://www.cssp.org/policy/papers/Promote-Childrens-Social-Emotional-and-Behavioral-Health.pdf>

health need to be promoted during early childhood education, for example, to prevent long-lasting issues. This includes developing “initiatives to increase understanding of early social and emotional development” and integrating “social and emotional development into existing programs and services.”¹⁷⁰ Moreover, the Economic Policy Institute believes that “non-cognitive skills should be an explicit pillar of education policy.”¹⁷¹

The empirical studies identified above similarly highlight the importance of early skill development in emotional and behavioral contexts to improve children’s experiences in school. These interventions can help to mitigate risk factors, which can lead to both short- and long-term negative outcomes such as asocial behavior, conduct problems, academic delays in later elementary school, and school dropout in secondary school (Figure 3.6).

Figure 3.6: Risk Factors and Consequences of Poor Emotional/Behavioral Skill Development



Source: Webster-Stratton, Reid, and Stoolmiller; “Preventing Conduct Problems and Improving School Readiness”¹⁷²

Teachers can foster the development of key emotional and behavioral skills by helping students to develop strategies for handling difficult situations. Most often, this can be accomplished through practice (i.e., role-play), where teachers and students assume roles and work through hypothetical situations. Daunic and colleagues revealed the effectiveness of this strategy in their research studying the *Tools for Getting Along (TFGA)* intervention. The *TFGA* curriculum uses social information processing—through direct instruction, teacher modeling, and role-playing—to help children overcome any emotional or behavioral risk factors. The model’s six steps include:

- Encoding of external and internal cues;

¹⁷⁰ Ibid., p. 7.

¹⁷¹ Garcia, E. “The Need to Address Noncognitive Skills in the Education Policy Agenda.” Economic Policy Institute, December 2014. <http://www.epi.org/publication/the-need-to-address-noncognitive-skills-in-the-education-policy-agenda/#epi-toc-14>

¹⁷² Adapted from: Webster-Stratton, Reid, and Stoolmiller, Op. cit.

- Cue interpretation and mental representation;
- Clarification or selection of a goal;
- Response access or construction;
- Response decision; and
- Behavioral reenactment.¹⁷³

The curriculum is grounded on the evidence-based assertion that “when cognitively based interventions that promote successful emotional and behavioral development are implemented at a universal (i.e., class-wide) level, **students with emerging destructive or maladaptive behaviors are able to observe and be supported by the problem-solving strategies of socially appropriate peers.**”¹⁷⁴ *TFGA*, in this way, imparted coping skills to young children, many of who lacked foundational skills in handling emotional or behavioral difficulties. Daunic and colleagues noted that after participating in the intervention, students demonstrated lower levels of proactive aggression and self-reported anger, as well as lower rates of expressing anger.¹⁷⁵

Similarly, Webster-Stratton, Reid, and Stoolmiller found that children who practiced social skills and observed model behavior were more likely to demonstrate higher levels of emotional and behavioral self-regulation. In their study, the researchers tested the effectiveness of the *Incredible Years (IY)* program Dina Dinosaur Social Skills and Problem Solving Curriculum. This intervention led 30 classroom lessons in seven units: learning school rules; how to be successful in school; emotional literacy, empathy, and perspective taking; interpersonal problem solving; anger management; social skills; and communication skills. Each lesson consisted of 20 minute large-group time and 20 minutes of small-group skill practice activities. These activities, notably, included “games to stimulate group discussion, cooperation, and skill building.”¹⁷⁶ This study further underlines the benefits of role-play and practice in fostering the development of emotional and behavioral skills.

Beyond this skill practice, **it is important to modify the learning environment to decrease problem behaviors and encourage health emotional/behavioral expression.** Importantly, this means removing potential triggers that can result from “a mismatch between the classroom setting or academic demands and students’ strengths, preferences, or skills.”¹⁷⁷ In many ways, this puts the onus on teachers to ensure that classrooms are reflective of health behaviors. To do this, educators can implement classroom management practices that:

¹⁷³ Bullet points adapted from: Daunic et al., Op. cit., p. 151.

¹⁷⁴ Ibid. Emphasis added.

¹⁷⁵ Ibid., p. 161.

¹⁷⁶ Webster-Stratton, Reid, and Stoolmiller, Op. cit.

¹⁷⁷ Epstein, M. et al. “Reducing Behavior Problems in the Elementary School Classroom.” Institute of Education Sciences, U.S. Department of Education, September 2008. p. 22.

http://ies.ed.gov/ncee/wwc/Docs/PracticeGuide/behavior_pg_092308.pdf

- Establish an orderly and positive classroom environment by teaching and reinforcing rules and routines;
- Reinforce the appropriate behavior of individuals and groups of students;
- Practice instructional principles that incorporate presentation of new materials with modeling and practice;
- Offer a variety of activities and materials at a pace and level of difficulty appropriate to the range of student abilities in class; and
- Encourage collaborative peer support (peep tutoring) as an instructional strategy.¹⁷⁸

¹⁷⁸ Bullet points taken verbatim from: *Ibid.*, pp. 22–23.

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