AN EVALUATION AND TRAINING INSTITUTE REPORT

Impact of UPSTART Participation on Nevada Pre-Kindergarteners' School Readiness

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ABOUT EVALUATION AND TRAINING INSTITUTE

Founded in 1974, the Evaluation & Training Institute (ETI) is a non-profit consulting firm, headquartered in Los Angeles, dedicated to working with schools, post-secondary institutions, public agencies, private foundations, community-based organizations, and professional organizations. We specialize in third-party program evaluations covering many fields, including education, literacy, STEM, social services, health and prevention. Many of our evaluations have been instrumental in the development of public policy as well as state and federal legislation. Throughout, our focus is on helping clients improve their programs as well as maintain accountability to funders and oversight committees.

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Abstract

UPSTART is a computer-based program used to develop the school readiness skills of young children in the state of Nevada. Researchers used a randomized control trial design to evaluate the impact of the program in advancing children's early literacy, numeracy, and social-emotional skills. Pre-Kindergarteners in the experimental group were randomly assigned to the UPSTART Reading software, while control group students were assigned to UPSTART Math software. Standardized early literacy and math assessments were administered prior to program commencement and upon completion. Results revealed that there were significant differences in children's mean scores on measures of reading comprehension, letter and word recognition, and phonological processing between those who participated in UPSTART Reading and those in the comparison group, after controlling for pre-test scores and dual language status. Similarly, there were significant differences on measures of math concepts when comparing those who participated in UPSTART Math with those in the Reading group. There were no differences, however, between treatment and control groups on assessments measuring social emotional development. Children who were dual language learners (DLL) scored lower than monolinguistic children on measures of reading comprehension and phonological processing, but there was not an interaction between DLL and treatment status. We additionally found preliminary evidence that UPSTART had a positive impact on the lowest performing students, elevating children out of at-risk for SPED status by the end of the program - translating to a potential return on investment.

Impact of UPSTART Participation on Nevada Pre-Kindergarteners' School Readiness

Preparing children to be successful in school is a complex and evolving process that is optimized when multiple areas of skill development are considered. The importance of formally preparing children for kindergarten is reflected now in 43 states that fund formal prekindergarten programs (Barnett et al., 2018). High quality and accessible early childhood education programs help to address issues of school readiness and serve as a bridge between the family and the K-12 education system. The targeted outcomes of pre-kindergarten are vast and often include a mix of developmental milestones in the cognitive and social domains. Kindergarten teachers today have begun to place value not only on the early academic skills but also on social-emotional readiness such as a child's ability to listen, take turns, and pay attention (Curby et al., 2021). Attending to these skills prior to entering kindergarten will help a child to thrive in their new social setting while also preparing them to learn in a formal setting. Readiness for learning is critical for rising kindergarteners, particularly given the evolving expectations in areas such as literacy and math. In a national survey of teachers, 80% shared that they expected children to adequately grasp reading skills in kindergarten, while only 31% shared this sentiment in 1998 (Bassok et al., 2016). High-quality early childhood education programs can play a critical role in preparing children for success in their K-12 years.

Defining School Readiness

Definitions of school readiness have evolved over the past several decades and continue to change based on growing evidence of the factors that contribute to strong kindergarten outcomes. Early measures of school readiness in the 1980s generally reflected a maturational-developmental perspective (Snow, 2006), which suggested that a child's development was a biological process that developed naturally overtime. This early conceptualization of school readiness viewed the developmental process without acknowledging the contribution of social capital, culture, and home environment. By the 1990s the narrative about school readiness began to shift to acknowledge the role that parents, and communities played in supporting a child's development. In addition, the evolving perspective also included that a child's development was agile and responsive to appropriately calibrated interventions (Zuckerman & Halfon, 2003). The inclusion of the external forces at play in a child's growth changed the paradigm of school readiness and introduced a new complexity for how to best respond and support children within an early childhood educational setting. By the early 2000s, longitudinal evidence from high quality early childhood educational programming helped to solidify the notion that preschool[1] supported school readiness and ultimately led to longer term positive educational outcomes (Yoshikawa et al., 2013). From 2000 to 2019, the Federal appropriation of funds for Head Start increased from just over 5 billion dollars to 10 billion dollars, highlighting the central role that formal subsidized preschool programs play in supporting school readiness across the country (US Department of Health & Human Services: Head Start Facts, 2019).

Building Blocks of School Readiness

High-quality early education settings that use age-appropriate curricula with clearly articulated goals can contribute to improvements in social emotional growth and in academic areas such as early literacy and math so that children have the skills for success at school entry (Phillips et al., 2017).

[1] The terms 'preschool' and 'pre-k' both represent early childhood education and may be interchanged in the literature. The focus of this evaluation is Pre-K, indicating 4- and 5-year-old children in the year just prior to kindergarten.

Early Literacy. Learning to read and comprehend text is one of the most critical skills that school children acquire in their early years. Early literacy skills are also the cornerstone of school readiness research. The development of the foundational skills for literacy begins as young as three years old as children begin to make the connection between letters, sounds and spoken language. The process of learning to read is complex and comprised of a series of fundamental building blocks. The early phases of literacy development from preschool through kindergarten are (1) the alphabetic principle, (2) phonological processing, and (3) emergent reading comprehension. The pathway to reading begins with the development of these early preliteracy skills. Practicing the letter names and sounds during this initial phase serves as an essential foundation for future literacy tasks (Both-de Vries & Bus, 2008; Castles et al., 2009). In fact, research has shown barriers in later reading phases when children did not adequately develop letter naming skills (McBride-Chang (1999). Developing the knowledge of letter names and sounds requires deliberate and direct guidance (Castles, 2018) and has been linked to later reading comprehension success (Peng et al., 2019).

Another key indicator of literacy acquisition is phonological processing, a child's ability to identify and manipulate segments of language, such as phonemes, rhymes, and syllables (Piasta & Wagner, 2010). As children acquire the basic alphabetic principle, they begin to engage with phonological processing. Emergent readers who demonstrated phonological processing skills, like phonemic blending and segmenting, were found to be significantly more likely to acquire beginning reading skills (Bauserman et al., 2005). Phonological processing has been widely studied and plays an essential early role in literacy development (Burgess, 2006; Dickinson et al., 2003; Kilpatrick, 2015; Lonigan, 2006; McCardle et al., 2001).

The National Early Literacy Panel (NELP) conducted a large-scale meta-analysis of early literacy research and found that emergent literacy skills such as phonological awareness and alphabet knowledge had a clear and consistently strong relationship with later reading skills, in addition to conventional literacy skills such as decoding, oral reading fluency, and comprehension that were also predictors of later achievement (NELP, 2008). Similarly, an analysis of six longitudinal datasets indicated that early language skills such as vocabulary, letter knowledge, and word sounds were a consistent predictor of later reading achievement (Duncan & Magnuson, 2013).

Early Math. Like early literacy, early math skills have been the center of increased attention as a critical component of school readiness. There is a growing body of research that early math skills, like numeral recognition, counting, quantity (more, fewer), shapes, spatial relations, measurement, and patterns are important predictors of later academic achievement (Hardy & Hemmeter, 2019; Jordan et al., 2010). Some research suggests that skills like counting, understanding non-symbolic quantities, and understanding repeating patterns are the biggest predictors of later mathematics knowledge (Fyfe et al., 2019). Research from Duncan et al., (2007) found that early math skills, like knowledge of numbers and ordinality were the most powerful predictors of later learning. In fact, their results suggested that early math skills were a more powerful predictor of later reading achievement, than early reading was of later math achievement. Disparities that exist among math skills at preschool, tend to widen as students' progress through school (Burchinal et al., 2011; Nguyen et al. 2016). These disparities are more prevalent among students from low-income families (Fyfe et al., 2019).

Social-Emotional Skills. In addition to the academic building blocks to school readiness, multiple studies have demonstrated how social-emotional development is also a key component (Raver & Knitzer, 2002; Darling-Churchill & Lippman, 2016). Social-emotional development characterizes a child's capacity to interact with and create relationships with others, including both interpersonal and behavior competencies (Sheridan et al., 2010). Students with strong social and emotional skills are more likely to engage with teachers and peers and experience a positive transition from preschool to kindergarten (Raver & Knitzer, 2002 & Sheridan et al, 2010). Research has linked social and emotional development to later academic success in school. For example, students who enter kindergarten with strong social- emotional competencies are more likely to achieve better grades than children who lack them, because they are more confident and ready to learn. Conversely, young children without these competencies in early elementary school tend to fall behind their peers and perform at lower levels later in school, a trend which may continue if not addressed (Durlak et al., 2011). In the long term, a solid social-emotional skillset contributes to higher graduation rates compared to children who are less ready when they begin kindergarten (Reynolds et al., 2007; Raver & Knitzer, 2002).

Early Education in Nevada

Nevada is one of the states that has prioritized school readiness for young students. The Nevada Early Childhood Advisory Council has defined school readiness as "the intersection of two critical components (1) children's condition to learn based on the five domains of learning, and (2) the school's capacity to meet the needs of all children to prepare them for future school success and the 21st century" (NECAC, 2016). The five domains of learning include, physical development and health, social and emotional development, approaches to learning, language and early literacy development, and cognition and general knowledge. Though school readiness is a top priority for Nevada, only 33% of three- and four-year-olds were enrolled in preschool in 2015. Further, about 23% of students 5 years or younger are below poverty and 65% live in households where all parents are in the workforce (NECAC, 2016). These gaps tend to widen among students in minority groups.

Acknowledging the Gap

Hispanic children, in particular continue to have the lowest levels of preschool enrollment among all race/ethnicity groups in the United States (Hussar et al., 2020). Historically, Hispanic families have underutilized government programs aimed at providing child services to low-income families (Lichter et al., 2015), which indicates they may continue to be underserved despite the opportunity for targeted interventions. While participation in early childhood education has increased for the Hispanic community, there remain significant obstacles and barriers for some groups of families (Lopez et al., 2017; Crosby et al., 2016). Studies suggest that parental employment and nontraditional workday schedules serve as a key barrier to early education access (Crosby & Mendez, 2017). In fact, most publicly funded early childhood programs happen during typical business hours (Crosby, 2018), limiting access to those who do not fit this routine. Given the underrepresentation and reported barriers to early childhood education, an alternative approach to preschool could have a strong and direct benefit on the Hispanic community as they prepare for kindergarten (Turner et al., 2015).

Hispanic dual language learners (DLL) often start kindergarten with lower school readiness than monolingual children, resulting in early disparities between the two groups (Yazejian et al., 2015). If comprehensive school readiness gaps are not addressed, under performance can persist for DLL children into the K-12 system. Barriers in language play a large role in children's ability to acclimate to school and parents' ability to assist their children. There is evidence that while language-minority parents express a strong desire to help their children succeed academically, schools often underutilize or fail to acknowledge this important contribution (August & Shanahan, 2008).

Education Technology for Early Learners

Education technology offers an opportunity for underserved children to receive early education instruction and regardless of diverse home learning environments or existing Pre-K challenges. Technology has become a regular part of everyday life for many young learners and its use is increasing as a social and educational phenomenon (Laidlaw & Wong, 2016). Computer based instruction serves as a beneficial tool in Pre-K curriculum because it often incorporates immediate feedback, visual graphics, and adaptative lesson plans (Macaruso, Hook, & McCabe, 2006; Barron et al., 2011). Further, with computer-based instruction teachers can strike a healthy balance between playful learning and structured lessons and provide individualized programming to meet each child's needs (Rogowsky et al., 2017). Compared to ten years ago, Pre-K aged children today have increased access to technology, like computers, e-tablets, and smartphones (Wartella et al., 2013), which allows for increased access to educational technology programs. In addition, internet access in educational settings increased from 81% to 97% from 2010 to 2018 (NCES, 2018). As access to highspeed internet has expanded, there has been an abundance of educational software programs targeted to young learners, childcare centers, parents, and schools to support the development of children's early literacy and math skills (Wood et al., 2012).

An increasing number of studies suggests that children's later academic achievement can benefit from educational technology. A review of forty-two studies of computer-assisted instruction with beginning readers showed a positive effect on literacy (Blok et al., 2002).

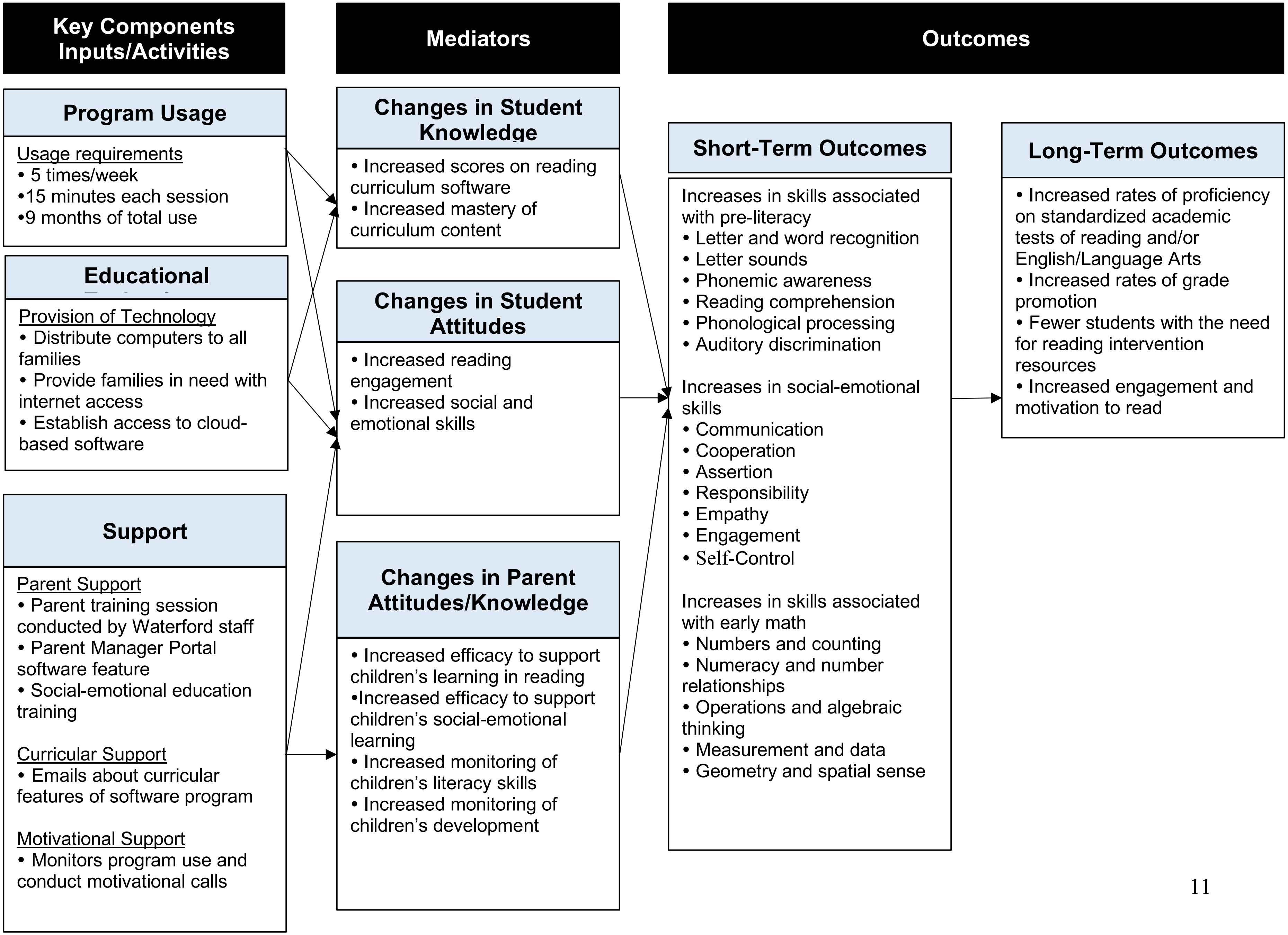
Likewise, researchers found that use of computer technology had a positive effect on mathematics achievement in kindergarten through twelfth grade (Cheung & Slavin, 2013). Work by Abrami et al., (2015) demonstrated that a computer-based reading program had significant positive effects on children's early literacy skills, phonological awareness, listening comprehension, and vocabulary knowledge. Similarly, there was a positive relationship between exposure to educational technology curriculum during preschool and school readiness. These benefits were further enhanced by children's additional computer experience at home (Li et al., 2006).

There is a demonstrated need for high-quality educational technology research, especially in early childhood education, as the number of educational software programs rapidly increases. (Daugherty et al., 2014). However, researchers note that evaluative studies either do not exist prior to the software's release, or there are methodological shortfalls that fail to meet the appropriate standards (Grant et al., 2012; Murphy et al., 2002; Cheung & Slavin, 2011). Moreover, although there are numerous educational software programs to help children prepare for school, there is a lack of research on the impact of computer interventions on different subgroups of students, including dual language learners or households with low socioeconomic status.

Waterford's UPSTART Program

Waterford's UPSTART computer-based program has the potential to offer quality educational curriculum to all young children but particularly to those in need of the most early educational support. These children stand to benefit the most from targeted interventions focused on developing literacy, math, and social emotional skills, all of which are critical for preparing children for kindergarten and setting them up for future long-term success. Given the need for more rigorous research and the potential benefits of computer-based programs for those with the most need, the Evaluation and Training Institute (ETI) partnered with the Waterford Research Institute to study the effects of the UPSTART program on the school readiness skills of pre-kindergarten children living in Nevada. **Figure 1** presents the UPSTART program logic model that guided the current research.

Figure 1. UPSTART Program Logic Model



The principal component of UPSTART is an in-home computer-based school readiness software program that provides pre-kindergarten children with reading, math and science curriculum, and social emotional learning with the main focus on reading instruction. The program is focused on promoting mastery of early literacy skills, with optional curriculum to support math and science learning. The program prepares young children for entry into school by providing an individualized learning experience through a lesson sequencer that adapts to each child's skill level. Based on student performance, the sequencer will run remedial activities to reteach and practice skills again or advance to another objective if students are mastering concepts. Content is delivered online through lessons that adapt to a child's skill level, using multimedia, digital books, songs, and other online activities. Recommended usage of the school readiness software is to use the Reading program for 15 minutes a day, 5 days a week.

The UPSTART Reading program is designed to use research-based best practices for early literacy instruction, based on early guidelines outlined by the National Reading Panel (2008). These guidelines emphasize phonemic awareness, phonics, fluency, comprehension, and vocabulary. The UPSTART Reading curriculum aims to lay the foundation for skilled reading by emphasizing precursor skills related to decoding and comprehension, two processes that are the hallmark of reading fluency (Hoover & Gough, 1990). **Table 1** showcases the reading domains and skills taught by UPSTART Reading at the first level[2] of the curriculum: phonics, comprehension/vocabulary, language concepts, and phonological awareness.

[2] Level One is the beginning point of the curriculum where the preschool child begins as a nonreader and is introduced to skills designed to teach the child to read. Levels range from one to three and the child is tested at the beginning of the program and placed in a level based on his or her performance.

Table 1. UPSTART Reading Program Domains and Skills

UPSTART Reading Domains	Level 1 Reading Skill
Phonics Systematically builds from not reading to confident reading at 90 words a minute	• Recognize *A* through Z, and *a* through *z* • Learn 10 letter sounds and 20 sight words to read 10 leveled readers • Spell child's name
Comprehension/Vocabulary Develops vocabulary and critical thinking skills through rich reading experiences	• Read along and understand nursery rhymes • Read along and understand alliterative books • Learn 255 target vocabulary words
Language Concepts Introduces concepts of written language (from letters and pictures to basic grammar)	• Understand print (left-to-right, letters, pictures, words, text) • Develop oral language skills (colors, shapes, numbers, sizes, etc.)
Phonological Awareness Develops awareness of individual sounds in words	• Break words into individual sounds (cat to (/k/ /a/ /t/) • Blend individual sounds into words (/k/ /a/ /t/ to cat) • Change a sound in a word to make a new word (cat to bat)

Beyond early literacy skill development, the UPSTART program support model and curriculum were also designed to enhance young children's emotional development. Social and emotional learning (SEL) was built directly into both the software learning sequence and the parent engagement curriculum. Social-emotional learning skills were taught to children through modeled behavior in video activities and books and covered content areas that aligned to the Collaborative for Academic, Social, and Emotional Learning (CASEL) core competencies. Social skill content areas included in UPSTART focus on Self Concept and Independence, Emotional Functioning, Social Awareness, and Social Skills.

Methods

The current UPSTART evaluation in Nevada targeted several research questions. The primary confirmatory study was on the program's impact on literacy and social emotional skill development, with an exploratory study of math concepts development to determine if the control condition resulted in benefits to math achievement. We also conducted an exploratory return on investment study based on our operational definition of risk of special education classification, and potential cost savings by mitigating these risks. Given the population in the state of Nevada, we also explored how the UPSTART program impacted both dual language and monolinguistic pre-kindergarteners. Questions that guided our research are presented below.

Research Questions and Hypothesis

We designed a randomized control-trial (RCT) experiment to test our primary research questions, which included the following confirmatory contrasts between treatment and control students:

1. Did pre-kindergarten children randomly assigned to receive the UPSTART Reading (treatment condition) software program during their Pre-K year have higher scores than their counterparts assigned to the UPSTART Math/Science (control condition) program on the following measures of school readiness that focus on emerging literacy and social-emotional development:
    a. Phonological processing,
    b. Letter and word recognition,
    c. Reading comprehension, and
    d. Social emotional development.

We hypothesized that if the UPSTART Reading program has no effect on improving literacy and social school readiness skills, then we would expect children who participated in UPSTART Reading (treatment group) to perform at the same level as children who received the Math/Science program (control group) on measures of literacy and social skill development. Conversely, if UPSTART Reading influences early literacy and social skills, then children in UPSTART Reading should perform significantly better than the comparison group on measure of early literacy and social-emotional development.

2. How did the UPSTART Reading program differentially impact students who are dual language learners (Spanish home language; vs. monolinguistic children with English as their home language) across the above areas of inquiry?

We also tested the following exploratory research questions:

3. Did pre-kindergarten children randomly assigned to receive the UPSTART Math software program during their Pre-K year have higher scores than their counterparts assigned to the UPSTART Reading program on measures of emerging math concepts and applications?
4. What proportion of students identified as the lowest performers on literacy assessments at the start of the Pre-K year (i.e., at-risk for needing resources beyond general education in kindergarten) moved out of the risk classification by the end of the Pre-K year? And what is the potential return on investment for providing UPSTART reading intervention to this population of students?

Participants

During a two-year period, the UPSTART program was offered to families in Nevada living in or near the major cities of Las Vegas, North Las Vegas, Henderson, and Reno. The program was offered to age-eligible English-speaking children and Dual-Language Learners (DLL)[3]. ETI recruited evaluation participants through a screening and eligibility[4] process to evaluate the effectiveness of the program. The evaluation sample of children were enrolled in the UPSTART program during the 2019-2020 program year (Cohort 1) or the 2020-2021 program year (Cohort 2). ETI administered assessments to both cohorts before and after each one participated in the UPSTART program. The cohorts were then combined and analyzed for this Pre-K impact analysis.

Research participants were 550 pre-kindergarteners randomly selected from out of 1,367 families enrolled in the UPSTART program (the research sample was roughly 40% of the total program group size at the start of testing). Pre-kindergarteners were randomly assigned to the UPSTART Reading program (N = 272; English = 142 and DLL = 130) and to UPSTART Math (N = 278; English = 143 and DLL = 135). Random assignment was done after families completed baseline assessments.

Measures

Evaluation participants were administered early literacy and math subscales from the Kaufman Test of Educational Achievement, Third Edition (KTEA-3, 2014): Letter and Word Recognition, Reading Comprehension, Phonological Processing and Math Concepts and Applications[5]. Parents completed the Social Skills Improvement System Rating Scales (Gresham & Elliot, 2008), which were based on their child's behavior during the previous two months prior to the assessment. The SSIS subscales assessed: Communication, Cooperation, Assertion,

[3] Age-eligible children are children entering kindergarten in either the Fall 2020 (Cohort 1) or Fall 2021 (Cohort 2).
[4] Program families were excluded from the evaluation if their child was not proficient in English or had a diagnosed learning disability.
[5] The KTEA Math subscale was added in Spring 2020 as an exploratory extension of our original research study; Cohort 1 has math posttest scores only.

Responsibility, Empathy, Engagement, and Self-Control. **Table 2** presents the domains of interest, along with the corresponding subscales used to measure children's abilities.

Table 2. Domains by Instrument Subscale

Domain	Instrument	Subscale
Letter & Word Recognition (LWR) Child identifies a specified letter name or letter sound, identifies regular words that can be sounded out by grapheme-phoneme correspondence rules, identifies irregular sight words[6].	KTEA-3	Letter & Word Recognition
Reading Comprehension (RC) Child derives meaning from printed symbols or familiar signs, matches words with pictures, and responds to command items or passages that test both their ability to read and understanding of what is written.	KTEA-3	Reading Comprehension
Phonological Processing (PP) Child listens to and manipulates whole words, word parts, and sounds, identifies rhyming and non-rhyming words, and holds phonological information in working memory and is able to retrieve that information.	KTEA-3	Blending Rhyming Sound Matching Segmenting Deleting Sounds
Math Concepts & Applications (MCA) Child responds to basic concepts such as number identification, shape identification, and varying quantities.	KTEA-3	Math Concepts & Applications
Social Skills Parents respond to questions regarding their child's social skills across several subscales	SSIS-RS	Communication Cooperation Assertion Responsibility Empathy Engagement Self-Control Composite

Children's *Letter & Word Recognition* was assessed with a 51-item scale ranging from 0 to 51. *Reading Comprehension* was measured using a 35-item scale ranging from 0-35. *Phonological Processing* was measured using a 50-item scale that is the composite score of five subscales: Blending (score range: 0-10), Rhyming (0-8), Sound Matching (0-6), Deleting Sounds

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[6] High-frequency words that are generally learned first – e.g., "on, was, that, etc."

(0-11), and Segmenting (0-15). *Math Concepts and Applications* was measured with an 87-item scale ranging from 0-87. Once raw scores were calculated for each domain, they were converted to standard scores[7].

The SSIS instrument included seven subscales for measuring different constructs within social-emotional development and a composite score for measuring children's global social skills. The SSIS consisted of 46 items with a total possible score of 0-138 for the instrument (each item having a possible score of 0-3). Four SSIS subscales, *Communication*, *Assertion*, *Engagement,* and *Self-control* were assessed with seven-items and a scale ranging from 0 to 21, respectively. *Cooperation, Responsibility,* and *Empathy* were measured with six-items each, and a scale ranging from 0-18. The seven SSIS subscale raw scores were converted to their corresponding benchmark level (Below Average, Average, Above Average). The SSIS composite raw score was converted to a standard score and its corresponding benchmark level. Conversions for both subscale scores and the SSIS composite were calculated using a set of age-based norms.

Design and Procedures

An intent-to-treat randomized control trial design was used (diagrammed in **Figure 2**) and included pre- and post-program early literacy and math measures administered to a group of treatment children (UPSTART Reading) and a group of control children (UPSTART Math), who were randomly assigned to their condition prior to baseline assessment and entry into the UPSTART program. Children and families in the treatment group received curriculum designed to support social emotional development (SED), a feature that was not implemented with the control group.

[7] Phonological Processing subscales were not associated with standard scores and were analyzed as raw scores.

Figure 2. The Evaluation Design of the Pre-Kindergarten Study

Summer 2019 & 2020			Summer 2020 & 2021	
Pre-Test	Random Assignment	UPSTART Reading and SEL **Treatment**	Post-Test	Kindergarten
Pre-Test		UPSTART Math **Control**	Post-Test	

Children were recruited to participate in the evaluation in the summer of 2019 (Cohort 1) and in the summer of 2020 (Cohort 2). Children in both groups completed their respective programs over an eight-month period and post-program assessments were conducted after the UPSTART program was completed in summer 2020 (Cohort 1) and summer 2021 (Cohort 2), just before the children entered kindergarten.

Assessments were individually administered to children by trained test administrators. Due to social distancing, closures and travel restrictions as a result of the pandemic, all test administration after Cohort 1's pretest transitioned to a virtual/online platform[8]. The assessments were conducted using remote testing procedures developed to address the health and safety regulations (see **Appendix A** for more details). The entire assessment procedure was completed in 30-40 minutes on average and was collected during the same period and with identical procedures for both the treatment and control groups.

Data Analytic Approach

We examined children's baseline characteristics to confirm that treatment and control groups were equivalent at the start of Pre-K on factors that may influence school readiness skills, such as pre-test achievement scores and demographic factors and found no statistically significant differences.

[8] Baseline tests for Cohort 1 were administered at central locations within the local community (e.g., hotel conference rooms, libraries, community centers).

We conducted a series of linear regression models for each outcome variable to control for factors that may influence predicted outcome scores. Prior knowledge and dual language status were both controlled for in the regression models presented below. Hedges' g effect sizes were calculated to illustrate the magnitude of the difference between the two conditions and compare the strength of the impacts across measures. The baseline and outcome assessments used to study the impact of UPSTART were identical, and age adjusted scores were used for all regression models.

We additionally examined the impacts of UPSTART on the lowest performing students at pretest to see if the program could help mitigate their risk status by the end of the program. This was an exploratory and descriptive analysis only.

Statistical Analysis

We defined the following variables for each pre-kindergarten child in multiple linear regressions to estimate the impact of UPSTART reading on our outcome variables of interest: Y_{ij} is the child's score on post-test measures of letter and word recognition, reading comprehension, phonological processing, match concepts and applications, and social skills; Treatment (T_{ij}) is an indicator for whether the child received the intervention (Treatment = 1 if the student was randomly assigned to the UPSTART Reading treatment intervention, Treatment = 0 if the child was randomly assigned to the UPSTART Math control condition); $Y^{Pre}{}_{ij}$ is the child's score on pre-test measures (pre-test covariate); $Y^{DLL}{}_{ij}$ is an indicator of a child's dual language learner status (DLL = 1 if the child speaks Spanish in the home and is also learning English, DLL=0 if the child is monolinguistic). One possible linear regression model that uses these variables is the following:

$$Y_{ij} = \beta_0 + \beta_1(T_{ij}) + \beta_2(Y^{Pre}{}_{ij}) + \beta_3(Y^{DLL}{}_{ij}) + \varepsilon_{ij}$$

The βs in Eq. 1 are regression coefficients that describe the relationship between each variable and the pre-kindergartner's post-test score:

- β_0 is the intercept;
- β_1 is the expected increase in the post-test score for pre-kindergarteners who participated in the UPSTART Reading intervention relative to students who did not receive the intervention;
- β_2 is the effect of pre-test data; and,
- β_3 is the effect of dual language learner (DLL) status

We explored covariate interactions between Treatment (β_1) and DLL (β_3) to determine if treatment effects were significantly different for DLL students.

Results

Baseline Equivalence

Using independent samples *t*-tests, we established equivalence between the treatment and control group on pre-test measures of achievement. Mean differences are presented, along with *t*-values, significance levels and effect sizes.

Table 3 presents pre-test mean scores on the early constructs of interest[9]- reading comprehension, letter and word recognition, phonological processing, math concepts and social skills constructs. Initial results from *t*-tests indicate that there were no significant pre-program differences between children assigned to treatment and control conditions on any subscale, indicating comparable levels of early literacy, math and social emotional skills between the two experimental groups prior to beginning the UPSTART program.

Table 3. Baseline Equivalence of Treatment-Control Groups by Construct

Subscale	*N*	Mean	*SD*	Pre-test *t*-value	Difference	St. Difference[10]
Reading Comprehension						
Reading	272	101.53	15.84	-0.142	0.19	0.887
Math	278	101.34	15.12			
Letter and Word Recognition						
Reading	272	97.09	16.85	-0.5524	0.78	0.5809
Math	278	96.32	16.07			
Phonological Processing						
Reading	272	92.03	12.12	0.0553	-0.06	0.9559
Math	278	92.09	13.50			
Math Concepts and Applications						
Reading	156	97.08	16.89	-0.7184	1.35	0.4731
Math	149	95.73	15.76			
Social-Emotional (RS)						
Reading	270	104.89	12.20	-0.3269	0.35	0.7439
Math	277	104.54	12.63			

Note. *p<0.05; ** p<0.01

[9] Math Concepts and Applications was not administered at the pre-test for Cohort 1; therefore, baseline equivalence could only be established for Cohort 2.
[10] Hedges' *g* Effect Size: Treatment minus control divided by pooled standard deviation.

Table 4 presents the baseline equivalence of participant characteristics using Fisher's Exact test. There were no significant differences between the treatment and control conditions for any of the demographic characteristics.

Table 4. Baseline Equivalence of Treatment-Control Groups by Participant Characteristic

	N	Percent	*p-value*
Female			
Reading	132	48.35	1.000
Math	135	48.56	
White			
Reading	71	26.10	0.566
Math	79	28.42	
DLL Status			
Reading	130	47.76	0.865
Math	135	48.56	
Over 200% Poverty			
Reading	122	50.21	0.587
Math	127	52.70	

Note. *p<0.05; ** p<0.01

Program Impacts on Outcome Variables

Ordinary least squares (OLS) multiple regression models were conducted to examine the relationship between the three confirmatory literacy achievement outcome variables (reading comprehension, letter and word recognition, and phonological processing) and social skills outcomes. In addition, OLS was used to conduct an exploratory analysis of possible math achievement benefits from being randomly assigned to the control group. Potential covariates were included in the OLS models, including treatment status, baseline achievement scores at pre-test, and a dichotomous variable for dual language learners (DLL). The predicted mean scores from the regression models were presented, as well as Hedges' g effect sizes to illustrate the magnitude of the difference between the two conditions for all statistically significant findings. Summaries of results are presented by outcome variable.

Reading Comprehension. Participation in the treatment condition (UPSTART Reading) had a significant impact on children's reading comprehension skills (β = 0.19, p = 0.00; **Table 5**). Controlling for pre-test scores and DLL status, UPSTART Reading students outperformed their control group peers by 6.28 points on our measure of reading comprehension.

Children from both treatment and control conditions who were dual language learners tended to score significantly lower on Reading Comprehension outcome measures than their monolinguist counterparts, holding all else constant (β = -0.08, p = 0.03). There were no significant interactions between DLL and non-DLL treatment children (β = -0.05, p = 0.47), which indicates that the effect of using UPSTART Reading was the same among DLL and non-DLL treatment children.

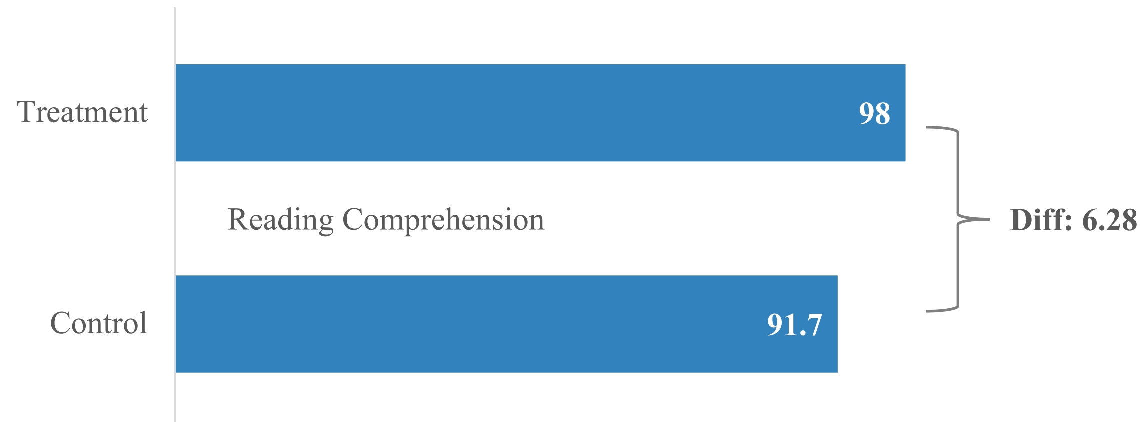
Table 5. Regression Summary of Predictors of Reading Comprehension (N=550)

Variable	*B*	*SE B*	β
(Constant)	43.23	4.52	
Reading Treatment	6.28	1.27	0.19**
Pre-Test	0.49	0.04	0.45**
DLL	-2.74	1.23	-0.08*
Treatment*DLL	-1.87	2.56	-0.05
R^2	.27		
F	70.10**		
*Note. *p<0.05; ** p<0.01*			

The predicted mean standard scores for reading comprehension are presented for the treatment and control group in **Figure 3**. The UPSTART Reading treatment group had an average predicted mean score of 98 points, which is 6.28 points higher than the control group's score of 91.7 points.

A Hedges' g effect size of 0.44 was calculated to contextualize the magnitude of the treatment and control differences for the reading comprehension outcome. According to What Works Clearinghouse standards (4.1; 2020), "effect sizes of 0.25 standard deviations or larger are considered to be substantively important." The difference between the treatment and control condition on reading comprehension was meaningful based on the WWC effect size benchmark.

Figure 3. Predicted Treatment and Control Reading Comprehension Mean Scores at Post-Test



Phonological Processing. Results displayed in **Table 6** indicate that after controlling for pre-test score and DLL status, random assignment to UPSTART Reading had a significant impact on children's phonological processing ability, $\beta = 0.11$, $p = 0.003$. The UPSTART Reading treatment group had an average predicted mean score of 90.9 points, which is 3.6 points higher than the control group's score of 87.3 points. A Hedges' g effect size of 0.26 was calculated to contextualize the magnitude of the treatment and control differences for the phonological processing outcome.

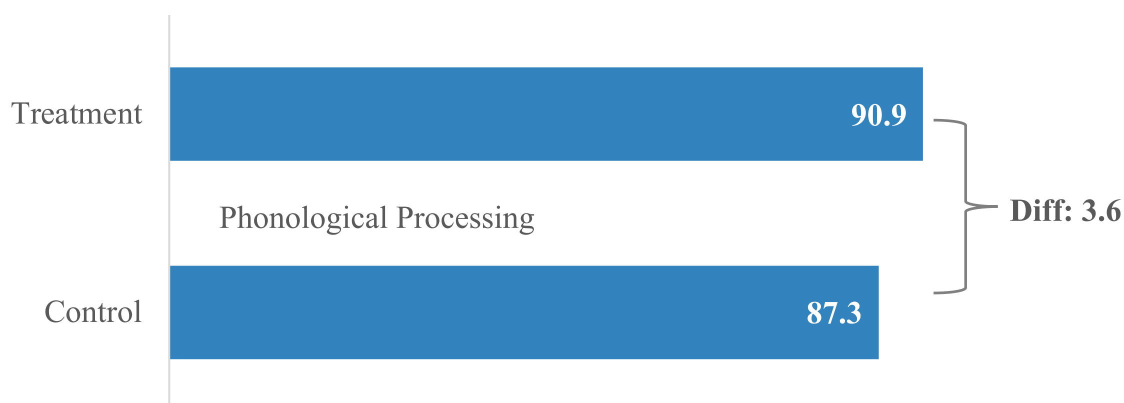
Dual language learner status was a significant predictor in the model and reveals that DLL children in both treatment and control groups scored lower compared to non-DLL children on phonological processing ($\beta = -0.13$, $p = 0.001$). There were no significant interaction effects between DLL status and treatment status ($\beta = 0.03$, $p = 0.651$), which shows that the UPSTART reading treatment has a similar impact on phonological processing for DLL and non-DLL treatment children.

Table 6. Regression Analysis of Predictors of Phonological Processing (N=550)

Variable	*B*	*SE B*	*β*
(Constant)	26.29	4.72	
Reading Treatment	3.53	1.18	.11**
Pre-Test	0.68	.05	0.53**
DLL	-4.18	1.22	-0.13*
Treatment*DLL	1.08	2.37	0.03
R^2	.35		
F	98.33**		
Note. *p<0.05; ** p<0.01			

Figure 4 presents the treatment and control group predicted mean standard phonological processing scores and the mean score difference between both groups at post-test.

Figure 4. Predicted Treatment and Control Phonological Processing Post-Test Mean Scores



See **Appendix B** for more detail on the individual phonological processing subscales.

Letter and Word Recognition. UPSTART Reading had a significant impact on children's letter and word recognition (LWR) skills (β = 0.75, p = 0.000) after controlling for pre-test scores and DLL status.

No significant differences in LWR standard scores were found between DLL and non-DLL children (in both treatment and control groups; β = 0.01, p = 0.11). The interaction between treatment and DLL was not significant in the model, revealing that among students in the treatment condition, DLL and non-DLL children had similar responses to the intervention (β = 0.08, p = 0.11).

Table 7. Regression Analysis of Predictors of Letter and Word Recognition (N=550)

Variable	*B*	*SE B*	β
(Constant)	14.43	3.32	
Reading Treatment	4.82	1.02	0.14**
Pre-Test	0.80	.03	0.75**
DLL	0.31	1.04	.01
Treatment*DLL	3.22	2.03	0.08
R^2	.57		
F	244.70**		
Note. *p<0.05; ** p<0.01			

The impact of UPSTART Reading on Letter and Word Recognition was significant and meaningful based on the WWC effect size benchmark. The predicted post-test mean scores for children in the UPSTART Reading group was 97.36, compared to 92.54 for the control group (a difference of 4.82, **Figure 5**). The Hedges' g effect size was 0.42, which is greater than the WWC effect size benchmark of 0.25.

Figure 5. Predicted Treatment and Control Letter and Word Recognition Post-Test Mean Scores

Math: *Exploratory Analysis*. The focus of our research was on literacy outcomes, but since the control group received a math program, we conducted an exploratory study of how students in treatment and control groups compared on a measure of math. The study was conducted on a sub-set of the RCT sample and included cases with complete pre-test and post-test measures of math. We hypothesized that control group students, who received UPSTART Math during their Pre-K year, would score higher on a measure of math than students in the treatment condition who received UPSTART Reading. The regression analyses displayed in **Table 8** show that UPSTART Reading had a significant negative influence on children's ability to identify numbers, shapes, and varying quantities. In other words, children who used UPSTART math (i.e., the control group) benefited by outperforming their Reading group peers on math concepts and applications (β = -0.16, p = 0.00).

There were no significant differences in how DLL and non-DLL treatment students responded to the intervention (β = 0.04, p = 0.35) based on regression results modelling the interaction between treatment and DLL status.

Table 8. Regression Analysis of Predictors of Math (N=226)

Variable	*B*	*SE B*	*β*
(Constant)	44.42	4.42	
Reading Treatment	-4.92	1.31	-0.16**
Pre-Test	.61	.04	.65**
DLL	-1.27	1.37	-0.04
Treatment*DLL	1.79	2.63	0.04
R^2	.46		
F	81.82		
Note. *p<0.05; ** p<0.01			

Figure 6 reveals a five-point difference between the treatment and control group predicted mean scores at post-test on math concepts and applications. Children in UPSTART Math scored 102.35 points, while children in UPSTART Reading scored 97.42 points on measures of math concepts and applications. The difference in scores was meaningful based on a Hedges' g effect size of 0.44, which is greater than the WWC standard benchmark of 0.25.

Figure 6. Predicted Treatment and Control Math Post-Test Mean Scores

Social Emotional Development. Results of the regression analysis did not confirm the hypothesis that participation in UPSTART had an impact on pre-kindergarten children's social emotional development skills based on the social skills composite measure. The treatment condition was not a significant predictor in the regression model, $\beta = -0.03$, $p = 0.49$ (**Table 9**).

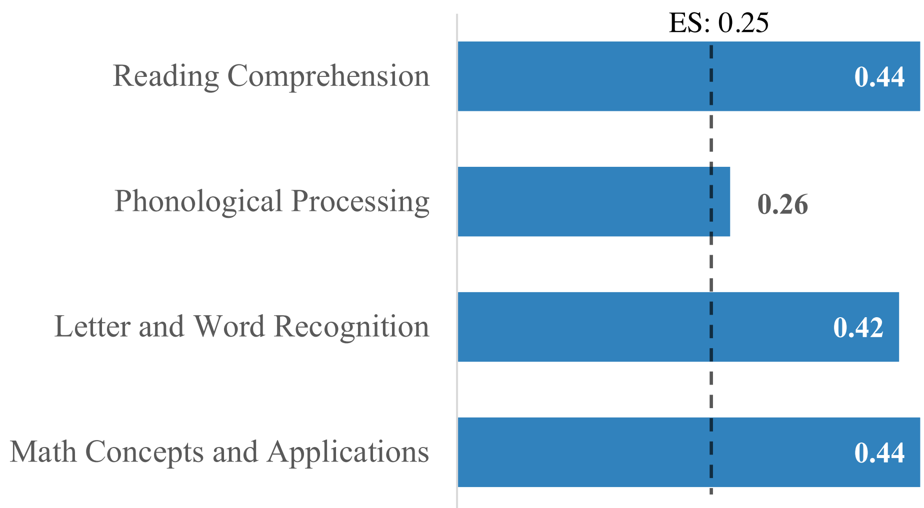
In addition, there were no significant differences between DLL and monolinguistic children on the social-emotional development composite ($\beta = -0.068$, $p = 0.230$) and the interaction between treatment and DLL status was not significant ($\beta = 0.015$, $p = 0.867$). These findings indicate that dual language learners were not impacted differently than monolinguistic children, regardless of which condition they were in (see **Appendix C** for more detail on the individual subscales).

Table 9. Regression Analysis of Predictors of Social Emotional Development (N=550)

Variable	*B*	*SE B*	β
(Constant)	49.19	4.53	
Reading Treatment	-0.72	1.03	-0.04
Pre-Test	0.45	0.04	0.00**
DLL	.98	1.21	0.04
Treatment*DLL	-.94	1.72	0.03
R^2	.37		
F	100.57		
Note. *p<0.05; ** p<0.01			

Effect Sizes. The effect size estimates are presented in **Figure 7** and show the magnitude of the average performance differences in standard deviation units between the treatment group and the control group on subscales with statistically significant regression results. Effect sizes were calculated based on the adjusted mean difference between the treatment and control groups divided by the unadjusted pooled standard deviation. The adjusted mean difference between the two groups for measures of reading and social emotional development were derived from the linear regression analysis and controlled for prior knowledge and DLL status. The effect size for math was generated from regression results that did not control for prior knowledge.

Figure 7. Effect Size Estimates based on Adjusted Mean Standard Scores by Measure



Note: Results for SSIS-RS were not presented in this figure because of non-significant effect sizes. Effect sizes are reported in absolute values.

Based on What Works Clearinghouse standards (version 4.1; 2020), the UPSTART Reading program produced meaningful impacts on enhancing pre-kindergarten children's reading competencies, including reading comprehension (Hedges' g = 0.44), phonological processing (Hedges' g = 0.26) and letter and word recognition (Hedges' g = 0.42). The UPSTART Math program also led to meaningful impacts for math concepts and applications among the control group of children (Hedges' g = 0.44).

There were no significant differences between children assigned to the UPSTART Reading condition with those assigned to UPSTART Math on measures of social skill development.[11]

Nevada UPSTART Return on Investment Analysis: *Exploratory Analysis*

A return-on-investment (ROI) analysis was conducted to systematically explore the impact of the UPSTART program on reducing early special education (SPED) risk factors in Pre-K. The ROI analysis below explores the utility and feasibility of the UPSTART program to serve as a targeted early intervention for Pre-K children with potential proximal cost savings to the Nevada school districts. The UPSTART program would help to close an important gap between early screening and intervention for the district.

The percentage of students needing special education services in the United States has steadily increased over the past decade. Data from the National Center for Education Statistics reveals that the number of SPED students aged 3-21 served in the United States has increased from 6.4 million (13% of all students) in 2011 to 7.1 million (14% of all students) in 2018 (Hussar, 2020). A similar trend has been happening in the State of Nevada. In Clark County, the largest school district in the state, the number of SPED students aged 3-21 increased from 31,852 (10.33% of all students) in 2011 to 39,292 (12.09% of all students) in 2018.[12] As the number of SPED designated students continues to increase, districts have had to respond to the cost increases associated with serving this population. In 2018, the cost to educate a SPED student in Clark County was $7,222 more than the cost to educate a general education student.[13] The

[11] See Appendix D for an exploratory look at program usage and subscale outcomes scores.
[12] (n.d.). Retrieved November 30, 2020, from http://nevadareportcard.nv.gov/di/

[13] The per pupil cost for a special education student in Clark County in the 2018-2019 academic year was $16,444. The per pupil cost for a general education student was $9,222. The cost of educating a special education student

purpose of this analysis is to explore the efficacy of the UPSTART Reading program in reducing the number of at-risk-for-SPED designations at kindergarten entry and hence lowering the potential cost to the district. A Return on Investment (ROI) analysis was conducted with guidance from the Cost Analysis Standards established by Institute of Education Sciences'(IES). The details of this exploratory research are outlined below.

Operational Definition for At-Risk for SPED

In Pre-K, "at-risk for SPED," was operationally defined and measured using the Letter and Word Recognition (LWR) subscale of the Kaufman Test of Educational Achievement, Third Edition (KTEA-3) (Kaufman et al., 2014). The LWR subscale was chosen because it is a strong early predictor of later reading achievement (Hammill, 2004; McIlraith, 2018; National Early Literacy Panel [NELP], 2008). In fact, a study of 642 children with language and/or nonverbal impairments found letter recognition in kindergarten to be the strongest predictor of reading difficulty in second grade (Catts et al., 2001). LWR additionally demonstrated strong reliability as a subscale in the KTEA-3 (Split-half reliability coefficient .98) (Kaufman & Kaufman, 2014).

A pre-determined cut-off point was used to define "at-risk for SPED" based on qualitative descriptors from the KTEA's technical and interpretive manual. These descriptors are associated with specific score ranges that describe the approximate distance of a standard score from the mean. Students who scored in the "Low" category (at or below the 8^{th} percentile) or "Very Low" (at or below the 2^{nd} percentile) were identified as students who were at-risk for

was subtracted from the cost of educating a general education student. It was determined that an additional $7,222 was spent to education a SPED student in the district for the 2018-2019 academic year. Data was retrieved through Clark County Public Records data request NRS 239.0107 on November 10, 2020.

needing resources beyond general education based on their reading skills. Children were assessed and classified before the Pre-K year and at the end of the Pre-K year.

Assessment of At-Risk for SPED

Children in both Cohort 1 and Cohort 2 were assessed prior to the Pre-K year. Those performing at or below the 8th percentile (as described above) were identified as "at-risk for SPED." Out of the 550 children who completed the pre and posttest (treatment *n* = 272 control *n* = 278), a total of 103 (treatment *n* = 51 control *n* = 52) scored within the "Low" or "Very low" range and were categorized as "at-risk for SPED" at pretest (**Table 10**).

Table 10. Assessment of "At-Risk for SPED"

	Pretest (N = 550) tr (n = 272) ctrl (n = 278)	
	Observations	Percentage
Low or Very Low		
Treatment	51	19%
Control	52	19%
Total	**103**	-
Note. Sample includes only children who completed pre and posttests.		

Percent Change After Posttest

A second assessment was conducted at the end of the Pre-K year after completing the UPSTART program. We examined the number of children in the treatment (Reading) and control (Math) conditions whose literacy skills improved enough to move them out of the "at-risk for SPED" category during the Pre-K year. At the end of Pre-K, a total of 55% of the treatment group moved out of the risk category compared to 38% of the control group. There was a 12% difference in the percentage of students who moved out of the "at-risk for SPED" classification between the treatment and control (**Table 11**).

Table 11. PRE to POST % Change for Letter Word Recognition for "at-risk" children

	Treatment (n = 51)		Control (n = 52)		T-C Difference
	Observations	Percentage	Observations	Percentage	
Increased	28	55%	20	38%	12%
Stayed the Same	23	45%	32	62%	

Cost Analysis

To determine the cost to educate a special education student in Nevada, cost data was retrieved through a public records data request from the largest school district in the state, Clark County. [14] Cost data collection was generated utilizing a combination of retrospective (previous district expenditures) and prospective (future cost of UPSTART per pupil) costs.[15] Clark County spent an average of $16,444 per-pupil for a student designated as needing special education services during the 2018-2019 school year[16]. The total per-pupil expenditure for general education students was $9,222, resulting in an additional cost per-pupil for a special education student of $7,222.

Net program benefits were defined as the dollar amount (using the most updated per-pupil costs provided by the district) associated with the percent reduction of SPED designations for Clark County students. Program costs reflect the cost to the district to implement the UPSTART program.

[14] Clark County Public Records data request NRS 239.0107, November 10, 2020
[15] The current cost analysis does not include an inflation calculation.
[16] The most recent audited data available is from the 2018-2019 school year.

We present a hypothetical calculation here as an example of return-on-investment results, using the 103 students from Cohort 1 and Cohort 2 who were considered low/very low literacy performers at pretest. The ROI calculations below reflect the costs that would be recovered if all 103 children participated in the treatment (Reading) program. Net program benefits refer to the cost savings from a 12% reduction in at-risk for SPED designated students (Table 13). The district recovered an average of $7,222 per-pupil for each student who was *not* designated as SPED[17]. In this example, the UPSTART program would have increased the literacy scores of 12 low performing children, pulling them out of the risk category, and resulting in a potential program benefit of $86,664 ($7,222 x 12 children). The UPSTART program cost was estimated at $2,000 per pupil[18] or $206,000 total for all 103 children.

ROI Calculation (103 students):

ROI = (Net program benefits/Program costs) x 100%

ROI = ($86,664/$206,000) x 100%

ROI = 42%

The ROI in the calculation above shows 42% of the costs were returned as benefits.

As a secondary example, if we were to increase the hypothetical sample to 1000 students identified as low/very low in literacy at pretest, the cost savings to the district (or net program benefits) would be $866,640.

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[17] In 2018, the cost to educate a SPED student in Clark County was $7,222 more than the cost to educate a general education student

[18] This is a cost estimate and will be adjusted to reflect actual costs in coordination with Waterford.

Discussion, Limitations and Recommendations

The current study measured the extent to which the Nevada UPSTART program improved children's school readiness primarily in early literacy and social emotional development, and secondarily in early math concepts and applications. In addition, we conducted an exploratory return on investment analysis to weigh program costs against potential benefits to students. We found that children who participated in UPSTART'S reading program during their preschool year outperformed their comparison counterparts on measures of early literacy skills such as Reading Comprehension (ES .44), Phonological Processing (ES .26) and Letter and Word Recognition (ES .42). Similarly, we found that children who participated in the UPSTART math program during the same period outperformed their comparison counterparts on measures of math concepts and applications (ES .44). All effects were found to meet or exceed our threshold for having a substantive impact on children's learning and development (set at ES .26). Accompanying these notable findings was an ROI calculation of 42%.

Literacy Development. Nevada is a state prioritizing kindergarten readiness for its youngest learners. Research has continued to show that early literacy skills are strong predictors of how well children will learn to read during early instruction (McIlraith, 2018; National Early Literacy Panel [NELP], 2008), and something as fundamental as basic letter knowledge has been identified as one of the best predictors of how well children will learn to read during the first two years of school (National Reading Panel, 2000). The UPSTART Reading program (treatment) can support such teaching and learning efforts and appears to improve dual language learners (DLL) and monolingual English students' performance equally. DLL students scored lower on measures of reading comprehension (β = -0.08, p = 0.001) and phonological processing (β = -0.13, p = 0.001), than monolingual English students across both treatment and control groups, a trend that should be followed to see if DLL students can make up the literacy achievement gap as they enter kindergarten. For example, some research has shown that while early on DLL students' literacy development can lag behind their monolingual peers', they catch up in early grades and show no long-term deficits in reading development (Hammer et al., 2014).

Math Development. Early math skills have gained traction as a critical component of school readiness and important predictor of later academic achievement (Hardy & Hemmeter, 2019; Jordan et al., 2010). Our research design supported an exploratory study of math effects which greatly favored the control group students (ES .44) who were given UPSTART Math as an alternative comparison condition. DLL status was not a factor in math achievement scores, a positive finding showing that household language had less of an effect on math learning. The math findings need to be tempered with the understanding that this was an exploratory analysis and not all randomly assigned students received the math assessment. Given this caveat, we think future studies of UPSTART should explore this trend more and focus on early math skill development. One possibility would be to design an RCT that used UPSTART Reading as the experimental comparison condition and UPSTART Math as the treatment.

Socio-Emotional Development. In addition to the academic building blocks to school readiness, multiple studies have demonstrated how social-emotional development (SED) is also a key component. Children more skilled at engaging with teachers and peers experience a smoother transition from preschool to kindergarten (Raver & Knitzer, 2002; Darling-Churchill & Lippman, 2016). The UPSTART program did not have a measurable impact on children's development of key social and emotional skills, and children in both the treatment and control conditions had similar scores at post-test. There are several possible reasons for this, and follow-up studies could build on them. First, most children in both groups scored at or above average for their age across all social-emotional development measures, indicating they all had strong SED. The SED measure used may not have been sensitive enough to pick up between group differences since both groups were scoring at its upper bounds. Second, the SED measure was parent report, and there could have been response bias favoring higher scores across both groups.

Return on Investment. In our exploratory ROI analysis, the UPSTART reading program was shown to be effective in developing early literacy skills in children most at-risk for SPED classification, potentially mitigating the need for district provided costly resources. These savings were conceptualized to be a return on money invested in running the program. Although exploratory in nature, the ROI analysis provided evidence that the UPSTART program may offer monetary benefit to the school system by addressing specific skill deficits among Pre-K children, helping them arrive at kindergarten better equipped to transition forward and avoid SPED classification. These findings are, however, based on a risk-reduction model narrowly defined by letter word recognition skills (i.e., risk of SPED classification is reduced by improving LWR achievement scores for students who have on average the lowest test scores in our sample), but the analysis is not backed by school SPED classification data. Future research could examine actual kindergarten SPED classification rates for the experimental groups.

Limitations

Pandemic Year Influences. The 2020-2021 program year suffered major disruptions due to COVID-19, and marks a time when families were adjusting and adapting to unprecedented modifications made to their lives, schools, and workplaces across the state. It is possible that certain populations of children were more negatively impacted by the pandemic. For example, certain families may have had multiple school-age children enrolled in at-home remote classes for the year, parents may have been out of work, and other major disruptions that could have impacted their ability to facilitate their preschool child's use of UPSTART. We were unable to control for all possible scenarios in our analysis, which may have influenced the results.

Recommendations for Future Research

Social and Emotional Skill Development. More research is needed to more fully understand how programs such as UPSTART are impacting the social skill development of Pre-K children, and how the intervention can be optimized. A couple possible future research directions would include adding a multi-method approach to data collection, such as conducting student observations and other more detailed forms of SED assessment and studying the parents alongside the children. For example, the UPSTART program targets SED through parent education and engagement on topics relevant to social and emotional learning, so a study could define and measure short-term outcomes on the parents as mediators to the ultimate goals of improving students' SED.

Dual Language Learners. This study represents an important step in understanding the differential effects of a school readiness intervention among both dual language learners and monolinguistic learners. The intervention was equally successful with both DLL and Non-DLL children: we found that regardless of DLL status, children participating in the reading program did better on reading outcomes, and those participating in the math program did better on exploratory math outcomes. We also found that DLL children tended to underperform on specific measures of early literacy compared to their monolinguistic counterparts, but our study did not attempt to understand the variations and complexities of the home learning environment of DLL students. Future studies could investigate ways in which the home learning environment interacts with UPSTART and develop a better understanding about ways to help close the literacy achievement gap.

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APPENDIX A. Virtual Assessment Procedures

The format of the school readiness assessments changed as a result of safety measures instituted to prevent the spread of the novel coronavirus (SARS-CoV-2). In this Appendix we describe the testing procedures implemented for in-person assessments at pre-test for Cohort 1 and the virtual testing assessments implemented for all data collection periods after Summer 2019. Our approach focused on maintaining the integrity of the assessments and keep the procedures similar despite the change in testing format.

In-Person Testing. At the beginning of in-person testing, parents were provided a paper consent form to complete by the test administrator. Once the consent form was signed, parents were asked to complete the parent survey and SSIS Rating Scales online using a tablet provided by ETI staff. While parents were working on the survey, the test administrator conducted the assessment with the child using a set of KTEA-III instruments and Stimulus Books' 1 and 2. Parents received an Amazon gift card and children received stickers as a thank you for their participation at the end of the testing session.

Virtual Testing. ETI modified data collection procedures during the summer of 2020 to complete all testing online. All measures used to collect parent and student data were moved to online systems that were remotely managed by ETI staff. A link to complete the informed consent form, parent survey and the SSIS Rating Scales survey were emailed to parents for completion prior to their child's online assessment. For students, a combination of video conferencing, desktop sharing and computer co-browsing software was used to create an online interactive testing platform that mimicked in-person testing using the KTEA-III. Test administrators had visual contact and audio capabilities with the student through video conferencing and the student could interact with the test stimuli through a custom co-browsing software application. These features allowed for an interactive “virtual KTEA-III” test, and the student could point to test stimuli using her/his computer mouse.

Test administrators assisted parents with the technical setup prior to the child assessment to ensure the appropriate technology was present and functioning properly (called a “tech check”). Once the tech check was completed, the test administrator could then conduct the assessment with the child. Gift cards for completing the testing and the online forms were emailed to parents following completion of all parent forms and the virtual child assessment.

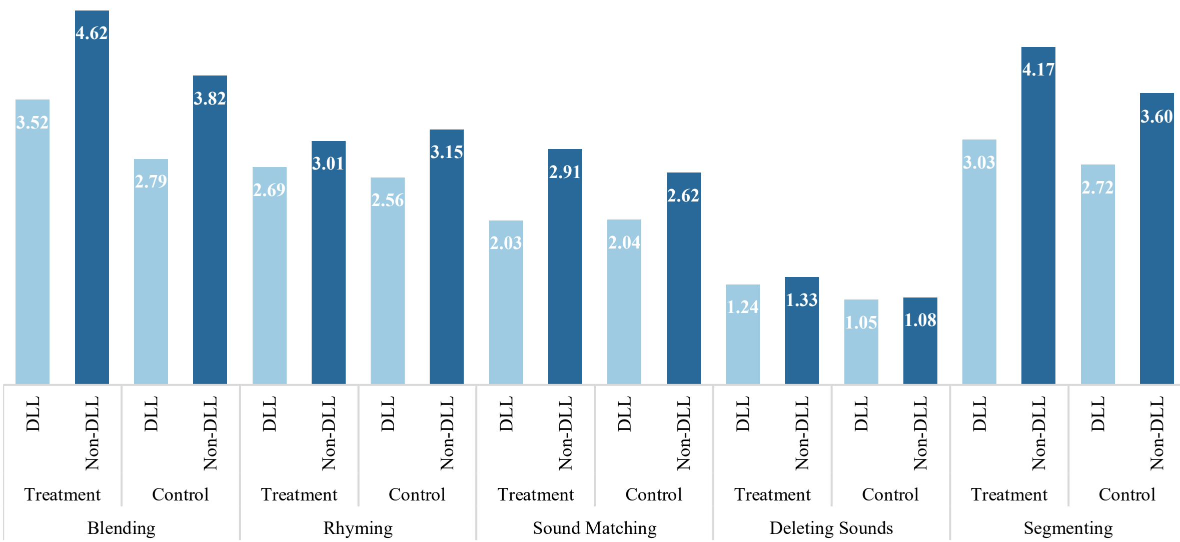
APPENDIX B: Phonological Processing Subscales Post-Test Means

Five subscales were combined to create the phonological processing standard score, including blending, rhyming, sound matching, deleting sounds and segmenting. These subscales did not have age-standardized scores, but we thought it was valuable to observe the relationship between average scores and language groups, so the raw mean scores are presented in **Figure 8** for visual analysis. The subscales contained different numbers of items, were not equally difficult, had unique growth curves, and produced varying distributions of scores, all of which indicated the subscales should not be compared to each other; however, we can compare treatment to control and language status within each subscale raw score comparison.

We found that monolinguistic children directionally outperformed DLL children across the subscales of phonological processing, regardless of treatment condition (**Figure 8**), however the differences were only a point or less. Children participating in the reading program (regardless of DLL status) directionally scored higher than those participating in the math program on both Blending and Segmenting. We observed only trivial treatment differences for Rhyming, Sound Matching and Deleting Sounds.

The mean score differences in **Figure 8** were based on children's post-test mean scores. Again, the analysis of the phonological subscales was directional only using the raw scores without age-standard score equivalents.

Figure 8. Treatment and Control Phonological Processing Mean Scores by Subscale and DLL Status



APPENDIX C: Social Skills Subscales

A descriptive analysis of the SSIS subscales and SSIS composite reveals that most children, regardless of treatment condition, scored average or above based on a norm group of similarly aged peers (**Figure 9**). This suggests that children using the UPSTART program shared similar social skill development to their peers.

Figure 9. Social Skill Levels at Post-Test by Condition (Treatment: N=272 and Control: N=278)

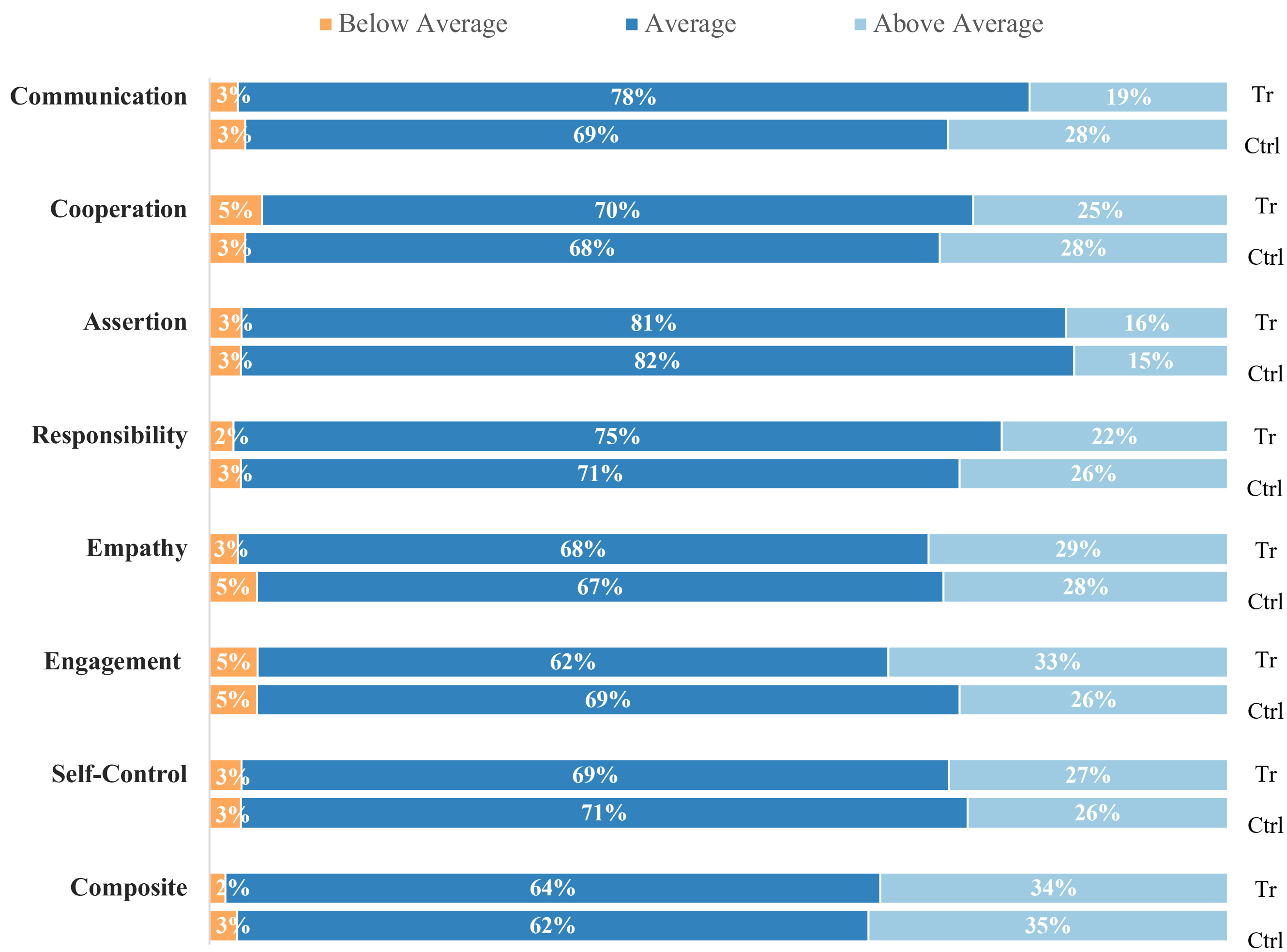
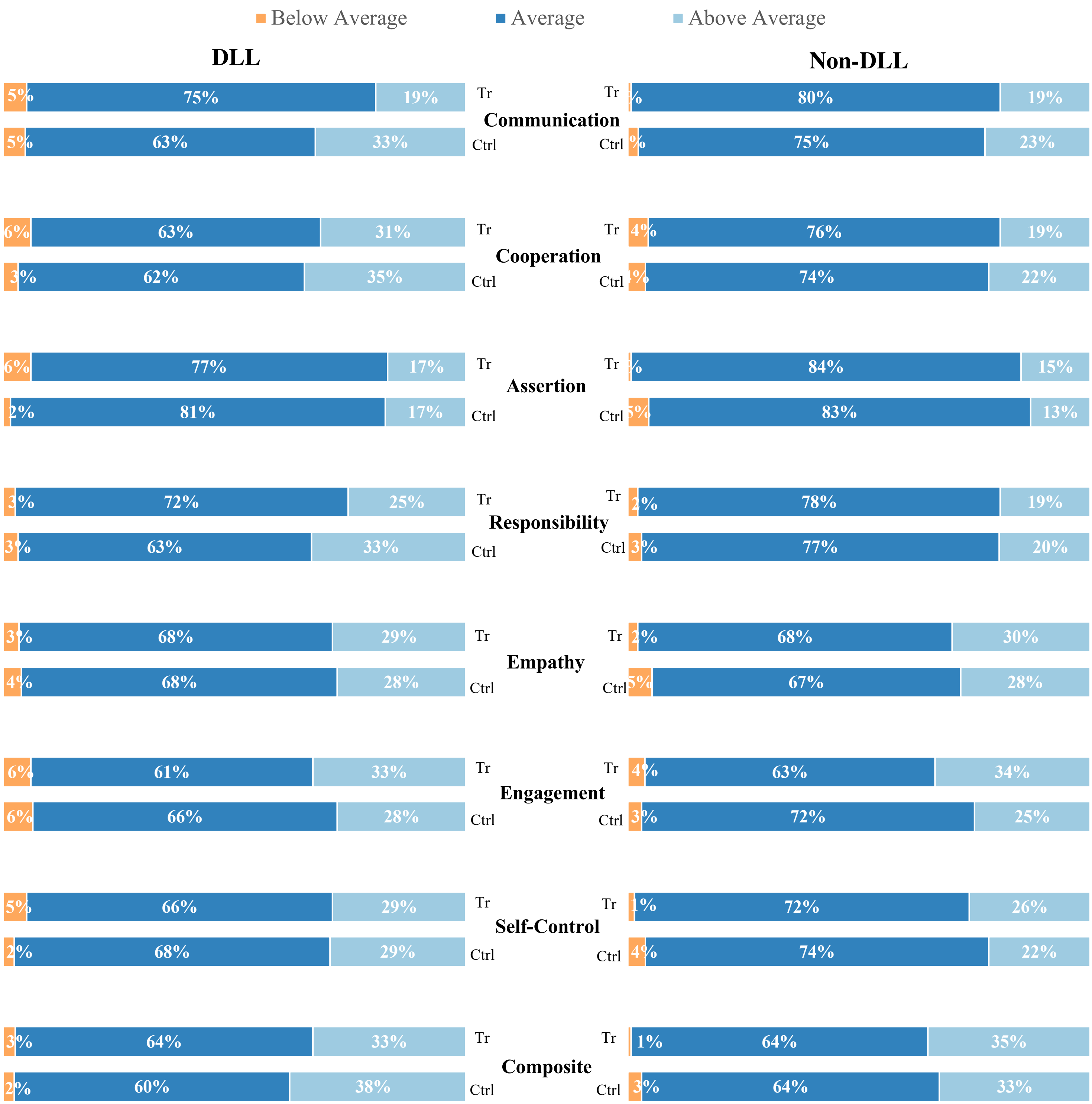


Figure 10 presents the social skill benchmarks (Below Average, Average, Above Average) based on treatment condition and Dual Language Learners (DLL) status.

Figure 10. SSIS Levels at Post-test by Condition and DLL Status

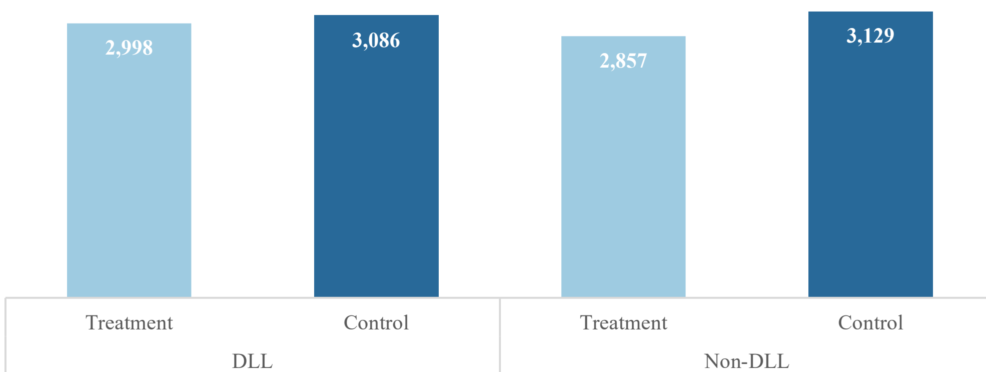


APPENDIX D: Relationship between Usage and Outcomes

We explored the trends in usage descriptively and conducted a correlational analysis of total program use with each of the outcome variables.

Figure 11 depicts the total usage based on the four conditions: DLL Treatment, DLL Control, Non-DLL Treatment and Non-DLL Control. Total usage was similar across the conditions, with the control groups for both DLL and Non-DLL showing slightly higher total time; 1 hour more among DLL and 4 hours more among Non-DLL.

Figure 11. Average Total Use in Minutes by Condition and DLL Status



Results of the correlation analysis show that program use was positively correlated with some early literacy outcomes, but the strength and significance of the association varied among DLL and non-DLL treatment children (**Table 12**). Program use was positively associated with Letter and Word Recognition for both Non-DLL and DLL children with a slightly stronger relationship for DLL participants (LWR: Non-DLL $r = 0.189$; DLL r = 0.258). Reading Comprehension and program usage was significantly correlated for Non-DLL children only (r = 0.254). That is, as time with the program increased, so did scores on these literacy subscales. We did not find a relationship between program use and Phonological Processing, Math Concepts or Social Emotional learning.

Table 12. Relationship between Program Use and Outcome Measures by DLL Treatment Status

	Letter and Word Recognition (LWR)	Reading Comprehension (RC)	Phonological Processing (PP)	Math Concepts & Applications (MCA)	SSIS
Non-DLL Treatment	0.189*	0.254**	0.145	0.092	0.080
DLL Treatment	0.258**	0.036	0.059	-0.000	-0.117

Note. *p<0.05; ** p<0.01

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