# Preparing Students for Kindergarten: Waterford Upstart Summer Learning Path Program Effects

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# Preparing Students for Kindergarten: Waterford Upstart Summer Learning Path Program Effects

## Introduction

Summer learning programs have always been critical for helping students prepare for rising grades, offering learning opportunities beyond the school year, or, with the youngest learners, preparing for kindergarten. These additional learning opportunities are more critical now that school districts are struggling to bridge gaps in learning that occurred because of the COVID-19 pandemic. Families with preschool-aged children living in rural areas have less access to early childhood educational resources due to geographic and economic constraints, and the pandemic amplified this trend. School closures and other measures taken during the pandemic resulted in a steep decline in reading and math scores from 2020 to 2021, with only a slight rebound in 2022, and the drop was more pronounced among students with less access to educational resources, such as students in rural areas (U.S. Department of Education, 2022; Chapman & Belkin, 2022). Many districts and local education agencies are now proposing expanded learning opportunities beyond traditional school-year offerings, including early education interventions utilizing technology-based instruction.

Educational technology has become increasingly popular in rural areas that lack formal and informal educational resources. Rural living has many benefits but access to things like preschools, child development centers, museums, science centers, etc., can be limited when compared to urban areas. The emphasis on developing educational technology programs designed to target the needs of rural students, and especially those with gaps in school readiness skills due to an interruption in “normal” early childhood education, underscores the need for research on program effectiveness.

We studied the impact of the Waterford Upstart Summer Learning Path (SLP) program on the acquisition of early literacy and math skills that contribute to students' kindergarten readiness. The program was designed to be implemented during the summer months and to offer targeted curriculum and instruction adapted for the child's unique learning needs. The remainder of this report documents relevant background information, our research methods, results, and a discussion of the program's impact on school readiness skills.

## Getting Ready for Kindergarten: School Readiness in Rural Communities

Definitions of school readiness have evolved over time and continue to change based on growing evidence of the factors that contribute to strong kindergarten outcomes. School readiness is generally defined by the domains of cognition and knowledge (i.e., numeracy and literacy knowledge), communication skills, social-emotional learning, and self-regulation (Józsa et al., 2022). Recent longitudinal studies have found that the development of early math and reading skills at pre-k contribute to a smoother academic transition and can greatly contribute to the longer-term development of more complex skills (Fyfe et al., 2019; Józsa et al., 2022). Communication and social-emotional skills are essential for school readiness, but they were not the focus of the current study. It makes sense, however, that children who are prepared to interact with peers and teachers and who are able to manage themselves and their emotions will have an easier time adjusting to their new social setting compared to children without these skills.

***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 age three 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, Coltheart, Wilson, Valpied, & Wedgwood, 2009). Developing the knowledge of letter names and sounds requires deliberate and direct guidance (Castles, Rastle, & Nation, 2018) and has been linked to later reading comprehension success (Peng et al., 2019).

***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; Mejias, Muller, & Schiltz, 2019). Some research suggests that these early numeracy skills are the biggest predictors of later mathematics knowledge (Fyfe et al., 2019). Other studies found that early math skills were the most powerful predictors of later learning. Recent work continues to show the importance of early math, suggesting that there is a strong connection between primary math skill acquisition and later mathematical understanding (Terry, 2021). We also know that disparities that exist among math skills at pre-k, tend to widen as students progress through school (Burchinal et al., 2011; Nguyen et al., 2016).

***A Rural Context for Early Education.*** Despite the clear prescription for essential components of early school readiness, many young children still do not have equal access to the necessary supports. According to nationwide census data, preschool enrollment was just over

50% in 2021, meaning only half students ages 3 to 4, or 4.3 million students, were enrolled in preschool (U.S. Census Bureau, 2022). This access gap is especially devastating for rural children who are among the most difficult to serve and underserved population. Preschool capacity in rural areas, often lags when compared to preschool capacity in larger metropolitan areas (Allard, 2019).

Barriers to preschool access vary by geographic region, but in rural areas these obstacles often include transportation, qualified teacher workforce, and facilities which are particularly expensive in distant and remote locations. As a result, high-quality center-based preschools in rural states can be prohibitively expensive for statewide implementation and often have an admission waitlist (Charlson, 2017). Both lack of open preschool spots and preschool location are often cited as a barrier by rural parents (National Center for Education Statistics, 2023). Furthermore, existing programs are both geographically and financially impractical for many rural families, especially when participating at their own expense. It is no surprise that children in rural areas arrive at kindergarten with lower levels of school readiness than their more urban peers. In fact, on measures of reading and math, "rural children lag about 2–3 points (or .20 of a standard deviation) behind children living in small urban and suburban areas" (Miller & Votruba-Drzal, 2013).

In rural states with smaller populations, like South Dakota and Wyoming, state funded preschool is not offered, and early education investments are not typically prioritized over K-12 education (Miller & Votruba-Drzal, 2013; Showalter et al., 2017). While keeping available state revenue and cost issues in mind, families residing in rural communities demand an approach tailored to increasing options and building capacity to support young learners.

There are multiple avenues for addressing early academic skills for rising kindergarteners but in the wake of the pandemic, technology became a critical resource helping to relieve challenges around educational content availability and accessibility.

## Educational Technology & School Readiness

Over the last decade educational technology has become a regular part of everyday life for many young learners (Laidlaw & Wong, 2016) and in recent years has offered an essential means for children to receive instruction regardless of existing challenges. Computer-based instruction serves as a beneficial resource particularly in pre-k and early elementary curriculum because it often incorporates immediate feedback, visual graphics, and adaptative lesson plans (Macaruso, Hook, & McCabe, 2006; Barron et al., 2011). Teachers can strike a healthy balance between playful learning and structured lessons like early math and early literacy providing individualized programming to meet each child's needs (Rogowsky et al., 2017). Research studies have also supported a positive relationship between exposure to educational technology curriculum during pre-kindergarten and school readiness with benefits further enhanced by children's additional computer experience at home (Li et al., 2006). While educational technology may have been seen as a beneficial supplement to education in years prior to 2020, the pandemic made it an undeniable necessity and has since become an integral part of many educational interventions.

## Summer Learning Path Program

The Waterford Summer Learning Path (SLP) program is based on Waterford's Upstart program, a nine-month program, designed to prepare pre-k students to enter school ready to learn. The SLP program provided an opportunity for children in South Dakota and Wyoming to improve their school readiness during the summer months prior to their kindergarten year. The in-home computer-based software provided children with literacy and math instruction delivered online through adaptive lessons, digital books, and activities. The program was designed to promote learning through an individualized curriculum that adjusted to children's skill level.

Each math or literacy lesson has a main objective made up of a combination of activities like preassessment, introduction of terms, explicit teaching, practice, and post assessment. The preassessment determines if further explicit instruction is needed for a topic. If the main objective is vocabulary, for example, students in the reading program will engage in activities which include rhyming songs, read-with-me books, sequencing pictures with phrases in the correct order, and using story clues to predict an outcome. It was recommended that children participating in the SLP program use of the program software 20 minutes a day, five days a week from June through August; a 13-week duration. An overview of the curriculum is outlined in **Table 1**, but more detailed information on the summer reading and math curriculum can be found in **Appendix A**.

**Table 1. SLP Upstart Reading and Math Curriculum Main Objectives**

| Reading Curriculum | Math and Science Curriculum |
|---|---|
| Phonological Awareness | Numbers and Operations |
| Phonics | Measurement and Data |
| Comprehension and Vocabulary | Geometry |
| Language Concepts | Science Concepts |

The SLP Upstart program had several resources available to assist children in meeting the prescribed usage requirements. Before beginning the program, participating parents attended a comprehensive orientation where they reviewed the Upstart summer content, discussed strategies for motivating children to use the program consistently, and learned about software features and resources. A password-protected Parent Manager portal in the Upstart software program allowed parents to monitor children's usage on a daily basis, as well as review children's unit lesson scores, placement results, and specific activity recommendations for enrichment. Parents were also paired with a program staff member that provided technical and motivational support during the summer. Computer hardware and/or high-speed internet access were provided to all families for the duration of the SLP program to ensure equitable access and allow families to connect to the software online.

# Methods

## Research Design

We investigated the impact of the Upstart Summer Learning Path on improving pre-k reading and math outcomes prior to beginning kindergarten. An intent-to-treat randomized control trial (RCT) design was used (diagrammed in **Figure 1**) where children were randomly

assigned to either the SLP reading or SLP math program. Prior to random assignment and prior to the start of the program, early literacy and math pre-test measures were administered to all children. Children in both research conditions completed their respective SLP programs over a 13-week period and post-program assessments were conducted after the completion of the program in late summer 2022. We collected baseline, outcome, and student characteristic data through three different methods- parent surveys, child testing data, and Waterford usage data.

**Figure 1. Evaluation Design**

| | **May 2022** | | | **August-September 2022** | |
|---|---|---|---|---|---|
| Registered SLP Upstart Students | Pre-Test | **Random Assignment** | **SLP Upstart Summer Reading**<br>**SLP Upstart Summer Math** | Post-Test | Kindergarten |

The RCT design allowed us to examine both reading and math program impacts using the students participating in the other program as the comparison group. That is, when examining the program's impacts on reading skills (Letter and Word Recognition, Reading Comprehension, Reading Core), students who used the summer reading program were considered the treatment group and students who used the math program were considered the control. When analyzing math program impacts, the SLP math program students served as our treatment group and the reading students served as our control group. Regardless of participation in the summer reading or the summer math program, all children completed both literacy and math assessments.

## Research Questions

The following questions guided our research:

*Research Question 1.* Do pre-k students who were randomly assigned to the SLP math program score higher at the end of the summer on measures of early math skills compared to pre-k students randomly assigned to the SLP Reading program?

*Research Question 2.* Do pre-k students who were randomly assigned to the SLP Reading program score higher at the end of the summer on measures of early reading skills compared to pre-k students randomly assigned to the SLP math program?

## Procedure

After program enrollment, student and family contact information was provided to ETI to recruit participants for the research study. All enrolled families were contacted by phone and email throughout May. For those agreeing to participate, parent surveys were sent via email and child assessments were individually administered by trained test administrators. Due to logistical restrictions in place as a result of the pandemic, all test administration was conducted using a virtual/online platform. The assessments were conducted using remote testing procedures developed to address the health and safety regulations (see **Appendix B** for more details). The entire assessment procedure was completed in 30-40 minutes on average and was collected during the same calendar window with identical procedures for those assigned to the math and the reading groups. All families were invited to participate in an identical post-test assessment after the intervention end date, roughly thirteen weeks later. Families were offered an incentive to participate in the research study, receiving one incentive at pre-test and another for

participating in the post-test. The research staff systematically conducted quality assurance checks of the data and the test administration procedures to ensure quality and consistency.

## Sample

In the spring of 2022, 580 families in South Dakota and Wyoming were recruited by Waterford to participate in the Summer Learning Path program. All students enrolled in the summer learning program were invited to participate in the research study[1], resulting in 329 pre-kindergarteners, half of which were randomized into the reading program (n=166, 50%) or the math program (n=163, 50%). Random assignment was done after families completed the pre-test assessment. The overall research sample was 57% (329/580=57%) of the total program group size at the start of testing. Demographic information for those included in the study can be found in **Table 2.**

[1] Program families were excluded from the evaluation if their child was not proficient in English or had a diagnosed learning disability.

**Table 2. Demographic Characteristics of SLP Research Study Sample**

| Demographic Categories | | SLP Math (n=153) | SLP Reading (n=150) |
|---|---|---|---|
| Child's Gender | Male | 76<br>50% | 77<br>51% |
| | Female | 77<br>50% | 73<br>49% |
| Child's Ethnicity | White | 129<br>84% | 118<br>79% |
| | Hispanic | 1<br>1% | 4<br>3% |
| | Asian/Pacific Islander | 3<br>2% | 3<br>2% |
| | Native American | 2<br>1% | 5<br>3% |
| | African American | 0<br>0% | 0<br>0% |
| | Other | 18<br>12% | 20<br>13% |
| Child's Language | English | 150<br>98% | 146<br>97% |
| | Other | 3<br>2% | 4<br>3% |
| Parent Educational Attainment | High school graduate | 21<br>14% | 27<br>18% |
| | Some College | 43<br>28% | 40<br>27% |
| | College Graduate | 54<br>35% | 48<br>32% |
| | Advanced Degree | 32<br>21% | 33<br>22% |
| Parent Marital Status | Married | 128<br>84% | 120<br>80% |
| | Otherwise | 25<br>16% | 30<br>20% |

*Percentages in the table are based on those providing a response in Waterford's participant records and may not add to 100% due to rounding.*
*Sample sizes based on available demographic data.*

## Measures of Early School Readiness

We assessed early school readiness skills in math and literacy as measured by the Kaufman Test of Educational Achievement, Third Edition (KTEA-3), across the following domains:

| Literacy | Math |
|---|---|
| **Letter and Word Recognition** (LWR)- lower and uppercase letter identification, naming letters and corresponding phonetic sounds, and reading basic pre-primer words. | **Math Concepts and Applications** (MCA)- basic concepts such as number identification, shape identification, and varying quantities. |
| **Reading Comprehension** (RC)- basic concepts such as matching pictures with words, reading and following commands, and reading sentences and answering questions | **Math Computation** (MC)- math calculation problems, simple counting, number identification, addition, and subtraction. |
| **Reading Core Composite**- combines both literacy subscales and is one of three Core Composites that make up the KTEA-3's academic skills battery composite. | **Math Core Composite**- combines both math subscales and is one of three Core Composites that make up the KTEA-3's academic skills battery composite |

Children's *Letter & Word Recognition* was assessed with a 100-item scale, ranging from 0-100. *Reading Comprehension* was measured using a 68-item scale ranging from 0-68. *Math Concepts and Applications* was measured with an 87-item scale ranging from 0-87. Math Computation was measured with a 32-item scale ranging from 0-32. Once raw scores were calculated for each domain, they were converted to standard scores. The KTEA-3 has shown good psychometric properties with the overall reliability ranging from 0.87 to 0.95.

## Statistical Analysis

Our statistical approach included three phases: a group baseline equivalence analysis, an attrition analysis to determine if we were within the acceptable attrition boundaries for an RCT set by What Works Clearinghouse (WWC, 2022), and ordinary least squares regression (OLS) to

test our hypotheses.

***Baseline Equivalence.*** Baseline equivalency testing was conducted before formal hypothesis testing. Using independent samples *t*-tests, we established equivalence between the summer reading and summer math groups for all pre-test achievement scores.

***Attrition Analysis.*** Ideally, all children who were pre-tested would have been post-tested. However, as in most studies that rely on repeated measures, that ideal is rarely attained. Overall and differential attrition was observed for each group and compared to the acceptable levels of bias set by What Works Clearinghouse standards (5.1; 2022)

***OLS Regression.*** Ordinary least squares (OLS) multiple regression models were conducted to examine the relationship between participation in the SLP program and the relevant outcome variables, namely literacy achievement or math achievement. Regression covariates in the OLS models, included treatment status, baseline achievement scores at pre-test, and a state blocking variable.

We defined the following variables for each pre-kindergarten child in multiple linear regressions to estimate the impact of SLP reading or math on our outcome variables of interest: $Y_{ij}$ is the child's score on post-test measures of letter and word recognition, reading comprehension, math concepts and applications, math computation, reading core, and math core; Treatment ($T_{ij}$) is an indicator for whether the child received the intervention; $Y^{Pre}{}_{ij}$ is the child's score on pre-test measures (pre-test covariate); $Y^{state}{}_{ij}$ is an indicator of the state in which the child resides (South Dakota= 1, Wyoming= 2). One possible linear regression model that uses these variables is the following:

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

The βs in Eq. 1 are regression coefficients that describe the relationship between each variable

and the pre-kindergartner's post-test score:

- $\beta_0$ is the intercept;
- $\beta_1$ is the expected increase in the post-test score for pre-kindergarteners who participated in the SLP Upstart Reading intervention relative to students who participated in the math intervention;
- $\beta_2$ is the effect of pre-test data; and,
- $\beta_3$ is the state in which the child resides.

***Effect Sizes.*** Effect sizes were calculated based on the adjusted mean difference between the treatment and control groups divided by the unadjusted pooled standard deviation, an estimate known as Hedges' g. The adjusted mean difference between the two groups was derived from the linear regression analysis and controlled for pre-test scores and state. This study used an effect size benchmark of 0.26 based on averaging the effect sizes across other educational research with similar outcomes measures, intervention type and target.

# Results

***Key Takeaway.*** Students participating in the SLP math program scored significantly higher than their reading counterparts on measures of early math skills at the end of the program. We did not, however, find statistically significant impacts of the summer reading program on early literacy outcomes.

## Baseline Equivalence

Random assignment inherently controls for participant differences that may exist across

treatment and control groups. However, we conducted an analysis to confirm baseline equivalence on factors that may influence school readiness skills, such as pre-test assessment scores. Using independent samples *t*-tests, we established equivalence between the reading and math groups on pre-test measures of achievement finding no statistically significant differences.

**Table 3** presents additional detail of the pre-test mean scores on the early constructs of interest- reading comprehension, letter and word recognition, math concepts and math computation. Initial results from *t*-tests indicate that there were no significant pre-program differences between children assigned to reading and math conditions on any subscale, showing comparable levels of early literacy and math between the two experimental groups prior to beginning the SLP program.

**Table 3. Baseline Equivalence of Reading and Math Groups by Construct**

| | | Pre-test | | | | |
|---|---|---|---|---|---|---|
| **Subscale** | ***N*** | **Mean** | ***SD*** | ***t*-value** | **Difference** | **St. Difference[2]** |
| **Reading Comprehension** | | | | | | |
| Reading | 163 | 87.42 | 13.35 | 0.7321 | 1.11 | 0.081 |
| Math | 166 | 86.31 | 14.13 | | | |
| **Letter and Word Recognition** | | | | | | |
| Reading | 163 | 89.64 | 15.33 | 0.9768 | 1.75 | -0.107 |
| Math | 166 | 91.39 | 17.10 | | | |
| **Math Concepts and Applications** | | | | | | |
| Reading | 163 | 93.37 | 12.62 | 1.1117 | 1.63 | -0.122 |
| Math | 166 | 95.00 | 13.93 | | | |
| **Math Computation** | | | | | | |
| Reading | 163 | 85.28 | 17.08 | 0.5270 | 0.98 | -0.058 |
| Math | 166 | 86.26 | 16.65 | | | |

[2] Hedges' *g* Effect Size: Treatment minus control divided by pooled standard deviation.

## Attrition Analysis

Pre-test assessments were administered to 329 children (163 assigned to the summer reading group and 166 assigned to the summer math group), and 270 students completed a post-test assessment about thirteen weeks later (130 assigned to summer reading, 140 assigned to summer math). Based on these numbers, the study had an overall attrition rate of 17.9% and a differential attrition rate of 4.6% (see **Table 3**). According to standards set by What Works Clearinghouse, an overall attrition rate of 17.9% must have a differential attrition rate of less than 5.7% to have a tolerable threat of bias under both optimistic (i.e., attrition is exogenous or unrelated to the intervention) and cautious (i.e., attrition is endogenous or related to the intervention) assumptions regarding the relationship between attrition and outcomes. Attrition rates in **Table 3** show that overall and differential attrition between math and reading students were within acceptable levels of bias set by What Works Clearinghouse standards (5.1; 2022) and that our RCT design was intact after reviewing the attrition analysis.

**Table 4. Number of Participants in Research Sample**

| Group | Reading | Math | Total Sample |
|---|---|---|---|
| Children Pre-Tested | 163 | 166 | 329 |
| Children Post-Tested | 130 | 140 | 270 |
| % Attrition | 20.2% | 15.6% | 17.9% |
| % Differential Attrition | | 4.6% | |

## Program Impacts on Outcome Variables

***Math Achievement***. We hypothesized that students who used the SLP math program would score higher on measures of math than students in the reading comparison condition. Our

findings indicate that the SLP math program had a significant impact on children's early math skills, as measured by Math Concepts and Applications, Math Computation and Math Core scales (see **Tables 5-7**).

**Table 5. Math Concepts and Applications Scale (N=140)**

| Variable | *B* | *SE B* | *β* |
|---|---|---|---|
| (Constant) | 22.77 | 3.71 | |
| Math Treatment | 1.99 | 0.97 | 0.08** |
| Pre-Test | 0.76 | 0.04 | 0.77** |
| State | 0.42 | 1.14 | 0.14 |
| $R^2$ | | 0.61 | |
| *F* | | 138.23 | |
| *Note.* *p<0.05; ** p<0.01 | | | |

**Table 6. Math Computation Scale (N=140)**

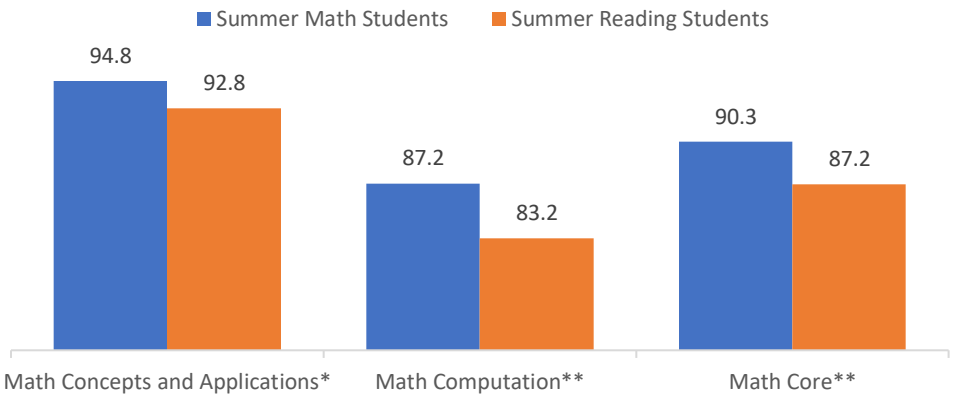
| Variable | *B* | *SE B* | *β* |
|---|---|---|---|
| (Constant) | 30.33 | 3.89 | |
| Math Treatment | 4.00 | 1.42 | 0.13** |
| Pre-Test | 0.63 | 0.42 | 0.67 |
| State | 2.42 | 1.67 | 0.65 |
| $R^2$ | | 0.48 | |
| *F* | | 82.07 | |
| *Note.* *p<0.05; ** p<0.01 | | | |

**Table 7. Math Core Scale (N=140)**

| Variable | *B* | *SE B* | *β* |
|---|---|---|---|
| (Constant) | 22.102 | 3.34 | |
| Math Treatment | 3.11 | 1.03 | 0.11** |
| Pre-Test | 0.75 | 0.36 | 0.78** |
| State | 0.85 | 1.22 | 0.26 |
| $R^2$ | | 0.64 | |
| *F* | | 155.85 | |
| *Note.* *p<0.05; ** p<0.01 | | | |

As illustrated in **Figure 2**, SLP math students scored significantly higher than SLP Reading students on all three of the math subtests (2 pts. higher on Math Concepts and Applications; 4 pts. higher on Math Computation; 3 pts. higher on the Math Composite), suggesting that the SLP math program was successful in helping children develop key early math skills in the months leading up to kindergarten.

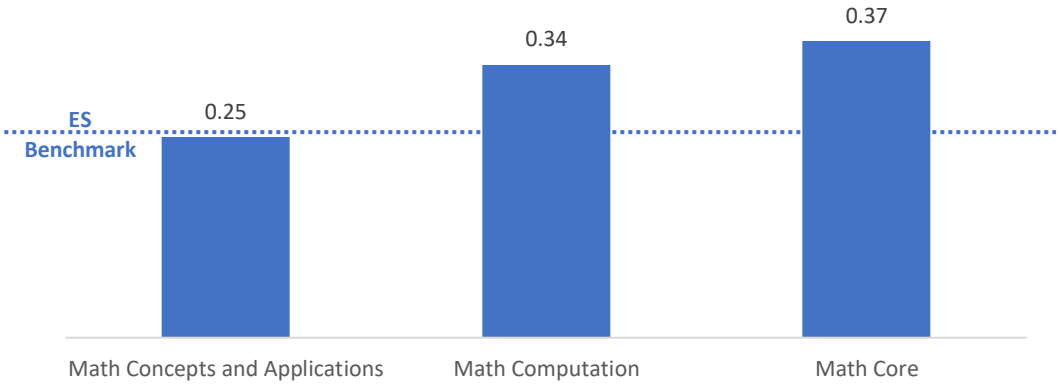
**Figure 2. Adjusted Mean Score Comparison at Entrance to Kindergarten**




***= p≤.01; *p≤.05.*

We then calculated Hedges' g effect sizes to illustrate the magnitude of the difference between the two conditions. **Figure 3** illustrates the strength of the effect on children's emerging math skills relative to the set benchmark for similar educational interventions. The SLP math program had a substantive impact on skills related to Math Computation (g = 0.34), and the Math Composite (g = 0.37) and was just under the effect size threshold for Math Concepts and Applications (g = 0.25).

**Figure 3. SLP Upstart Math Program Effect Sizes**




This study provides evidence that a condensed timeframe focused on early mathematical skills was effective for increasing math abilities in rising kindergarteners.

***Summer Reading***. We hypothesized that treatment students who used the SLP reading program would score higher on measures of early literacy than students participating in the math program. We did not, however, observe significant differences for any of the reading subscales between SLP reading students vs. SLP math students. We discuss the implications of this finding in the discussion section below.

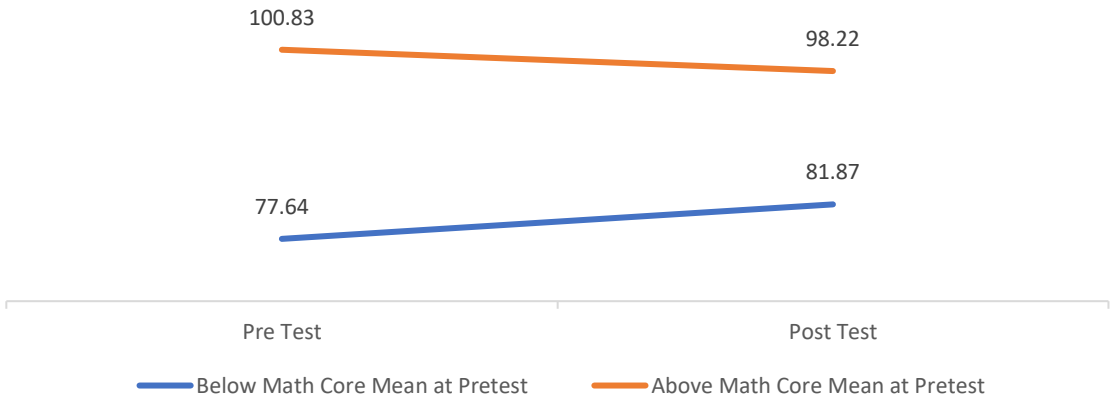
## Exploring Differential Treatment Effects

We explored how student and family characteristics affected predicted math achievement program outcomes[3]. We added variables to our regression models to determine if demographic and socio-economic factors (students' gender and ethnicity; parents' marital status, family income or student performance), influenced the predicted group mean scores. We did not find any statistically significant differential treatment effects when analyzing the influence of the demographic and socio-economic factors; however, we did find that math treatment students

[3] Differential treatment effects were not explored for reading because no main treatment effects were found.

who began the program with lower math scores (low performance) had a larger average gain in math learning by the end of the program.

**Figure 4. Math Core Outcomes for Low and High Performers**




Low vs. high baseline performance was studied by creating two groups of math program participants based on their pre-test scores on the Math Core subscale, (1) students who fell below the mean score (n=78 or 47%) or (2) students who fell above the mean score (n=88 or 53%); **Figure 4** shows the beginning of summer means and the end of summer means for the two groups of summer math program students. We found that students who began the summer with below average mean scores in math (blue line), demonstrated slightly more growth in their early math achievement compared to those who began much higher (orange line). That is, the lower performing group at pre-test gained about 4 points by the end of the summer program, compared to the higher performing group who appeared to decline slightly.

## Summary and Discussion

Children participating in the SLP math program demonstrated higher scores on early math outcome measures, compared to the control group (those participating in the reading program). We additionally observed that those defined as either low or high math performers at pre-test, demonstrated a different rate of learning by the end of the summer. We found that a short-term intervention targeting early math skills provided a higher boost to young learners struggling in that domain, relative to those already showing pre-k competencies in math. The implications of the program's impact on early math are important. The benefits of an early math skillset are far reaching, with longitudinal studies documenting improved readiness for school entry (Watts et al., 2014; Nelson & McMaster, 2019) and higher levels of academic and math achievement (Shanley et al., 2017; Terry, 2021; Watts et al., 2014). Basic numeracy skills learned prior to kindergarten, are found to be the most consistent and important predictors of test scores in both reading and math across elementary school (Nelson & McMaster, 2019; Litkowski et al., 2020; Terry, 2021).

We did not, however, find significant differences in literacy outcomes for students who participated in the SLP reading program compared to their control group peers (the math group). It is possible that a shorter program did not allow sufficient time for students to display growth or advance their literacy skills between pre-test and post-test. Researchers have demonstrated that the growth and benefits derived from short interventions on math skills, were not necessarily shown on reading skills (Ran et al., 2021; McCombs et al., 2014). We found no differential impacts of either program based on demographic variables. These findings are addressed given our focus on learning and resource gaps and the use of educational technology in rural preschool and school readiness instruction.

***SLP to Close Resource & Learning Gaps.*** This study occurred amid growing concerns that the pandemic negatively affected kindergarten readiness due to lack of preschool access and staffing shortages reducing the number of children served. Nationwide preschool data have shown that enrollment trends have not fully rebounded to pre-pandemic enrollment numbers (Friedman-Krauss et al., 2022). The SLP program was positioned to meet this need but its utility for underserved pre-k student extends beyond addressing a period of crisis. Families with young children growing up in rural communities have long been aware of the gap in early educational resources. In fact, the limitations that exist for rural families such as the mere distance to the nearest pre-k program, have likely been the reality for years. Therefore, the lack of resources is not easily remedied through adding more programs or more staff to existing programs. An entirely different way to bridge the gap is needed. Irrespective of local, state or national educational priorities, the SLP program has the innovative infrastructure and increasing evidence to provide an efficient and timely boost for young children.

***SLP Educational Technology and Rural School Readiness*.** Educational technology as a resource to combat inaccessibility and increase early competencies is a powerful offering, regardless of a program's ability to satisfy all prerequisite skills. The SLP program tackles geographic barriers by bringing the solution directly to rural families. The children reap the benefits from home without negotiating transportation, parental work schedules or time needed to travel long distances. It provides seamless access to curriculum for those who may otherwise not have the ability to participate in school readiness programs. The condensed nature of the program may also ease challenges for some families unable to commit to or afford a full year program. For rural children, educational technology becomes the access bridge to pre-kindergarten content and instruction that adapts to the needs of the specific child. This alternative

is particularly crucial in communities where early education may not be a state priority, pre-k programs are cost prohibitive, and geographic challenges make participation nearly impossible.

## Limitations

***Sample***. It should be noted that the current study included a relatively small sample of children residing in rural communities in South Dakota and Wyoming. The families enrolled in the SLP program were predominantly white, limiting our ability to generalize our findings more broadly to all types of pre-k children.

***Post-pandemic factors***. Though data were collected after the height of the pandemic (2022), it is possible that families were still feeling the impacts of the historic event. Some families may have delayed their child's start in kindergarten, due to learning challenges brought on by covid restrictions. It is also possible that parents utilized additional resources (in addition to SLP reading or SLP math) over the summer months to boost student school readiness. While we acknowledge that these factors exist, we were unable to control for all possible scenarios in our analysis, which may have influenced the results.

## Future Research

There are several things we would recommend for future summer learning program research, based on the lessons learned during this study.

***Expand the sample***. To broaden our understanding of how summer learning programs work for students of all backgrounds, we recommend that future research include a larger sample of students from different racial/ethnic and socio-economic groups and from states in different geographic regions in the country. There are inevitably other groups of pre-k children besides those in rural communities that would benefit from the accessible nature and high-quality curriculum of the SLP program. This will help generalize the findings across diverse

populations of pre-k students and extend the evidence for the types of students who may benefit most.

***High-need groups***. The current study provided some evidence that the learning growth was greatest for those performing below average at the beginning of the program. Additional research focused on the summer programs' ability to target students in specific high-need subgroups, both academically (low performers) and demographically (low SES or other diverse populations of students), could offer more information about the way in which these types of programs may serve as a preventative resource. We recommend further study in order to unpack the specific benefits on at-risk students.

***Summer literacy***. As noted, we did not find significant literacy findings for SLP reading students. To understand how an abbreviated reading program may have impact on student literacy scores, more information is needed on the characteristics of successful computer-based short-term literacy interventions. Research should specifically focus on thresholds of use for students acquiring early literacy skills, in order to gauge if amount and intensity is a critical player for swift literacy improvement.

Summer learning programs have become more critical in recent years with state and local education agencies working hard to address widespread disruptions and the lingering impacts. Given challenges related to access, opportunity, and resources, an effective computer-based summer learning program provides a viable option to many different families but is particularly suited for underserved students who have historically struggled with limited early education resources. In the case of the SLP program, the in-home delivery method with provisioned technology, inherently removed barriers to access due to geographic or socio-economic

limitations. This is an important time to study the impacts of summer learning programs, with funding and attention focused on implementing expanded learning efforts across the country. We encourage early education researchers to continue to provide evidence for summer programs that support academic school readiness for rising kindergarteners. The opportunity for underserved children to get prepared in the months leading up to kinder and subsequently influencing their early academic trajectory could be a game changer.

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## Appendix A. Upstart Curriculum

### Table A 1. Upstart Math Program Domains and Skills

| Upstart Math Domains | Level 1 Math Skill |
|---|---|
| Numbers & Operations<br>Teaches number recognition, place value, counting, and arithmetic computation. | • Recognize, order, and write numbers 0 through 20.<br>• Order, count, and sequence numbers to 100 by ones and tens<br>• Use strategies to compare group size (more than, less than, or equal to) |
| Operations & Algebraic Thinking<br>Teaches arithmetic computation. | • Use objects, drawing, etc., to represent addition and subtraction.<br>• Add and subtract within 10, including solving word problems.<br>• Fluently add and subtract within 5<br>• Introduce place value of 2-digit numbers |
| Measurement & Data<br>Develops a foundational understanding of measurement, time, and money. Prepares students to analyze data. | • Compare, classify, and describe measurable attributes of objects.<br>• Use digital and analog clocks to tell time to the hour.<br>• Identify coins and their value |
| Geometry<br>Teaches properties of shapes, positioning, and the identification of parts of regions or groups. | • Identify basic shapes regardless of their orientation and environment.<br>• Create composite shapes.<br>• Learn about shape positioning.<br>• Understand similarities and differences in 2- and 3-dimensional shapes |

**Table A 2.Upstart Reading Program Domains and Skills**

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

## Appendix B. 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). Our approach focused on maintaining the integrity of the assessments and keep the procedures similar despite the virtual testing format.

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 and parent 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.

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