Imagination Library of Colorado: Effects on Kindergarten Readiness and Skills

REPORT HIGHLIGHTS:

- ILCO participation led to a 0.13 standard deviation higher score on the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) assessment at kindergarten entry compared to similar children in the same school who did not participate. This increase is substantial, particularly given the low cost of ILCO implementation.
- ILCO reduced the likelihood of children scoring "well below benchmark" on the DIBELS assessment, an indicator of a potential significant reading deficiency, by between 16% and 24%.
- There was no effect of ILCO participation on children's scores on the Teaching Strategies GOLD assessment's Language or Literacy domains.

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Abstract

The Imagination Library of Colorado (ILCO) program mails books monthly to the homes of children birth to age 5 at no cost to families. In 2021, Senate Bill (SB) 20-185 went into effect in Colorado, which subsidized half the cost of books for the program. A subsequent bill, SB21-268, mandated a program evaluation. This study finds that ILCO participation increased kindergarteners' scores by 0.13 standard deviations on a standardized measure of literacy skills, the Dynamic Indicators of Basic Early Literacy Skills (DIBELS) assessment. ILCO also decreased the likelihood that a child would score "well below benchmark" on the DIBELS, an indicator of a potential significant reading deficiency, by between 16% and 24%. Both outcomes were statistically significant. There were no significant effects of ILCO participation on children's scores on the Teaching Strategies GOLD Language or Literacy domains, a more foundational measure of children's knowledge and skills at kindergarten entry. Through continued and future investment in ILCO, Colorado may be able to improve students' reading skills in kindergarten and beyond and decrease the need for later reading intervention.

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Acknowledgements

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This work would not be possible without anonymized data provided by the Linked Information Network of Colorado (LINC). The findings do not necessarily reflect the opinions of the Colorado Governor's Office of Information Technology or the organizations contributing data.

Data Sources

This study used data from two types of sources:

1. The Dollywood Foundation provided child-level participation data for the Imagination Library program from 2012-2023. These data were used to determine treatment status for the evaluation.
2. Four school districts provided student-level demographic and outcomes data for the cohorts of students entering kindergarten in 2018-2023, excluding fall 2020 due to disruptions associated with the COVID-19 pandemic.

LINC matched ILCO participation data to student demographics and outcomes data from the four school districts. LINC then provided de-identified data sets to the Colorado Evaluation and Action Lab for analysis.

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Introduction

The Imagination Library of Colorado (ILCO) book program mails books monthly to children birth to age 5 at no cost to families. These books include tips to support reading and early literacy interactions between families and children. The program is part of the international Dolly Parton's Imagination Library (DPIL) network.

Some Colorado communities have been involved with Imagination Library since 2002. Participation expanded considerably in 2021 when Senate Bill (SB) 20-185, subsidizing half the cost of books for the program, went into effect. ILCO began its partnership with the Colorado Evaluation and Action Lab in 2022 to evaluate the program as mandated in SB21-268.

This evaluation estimates the causal impact of Imagination Library participation on kindergarten readiness and early literacy skills using a matched comparison design. The evaluation leverages data from four school districts: Denver Public Schools (DPS), Harrison School District 2 (Harrison), Salida School District R-32 J (Salida), and Westminster Public Schools (WPS). These districts were intentionally selected to be from regions of the state that participated in ILCO since well before the COVID-19 pandemic (including kindergarteners entering school in fall 2018 or 2019), and since the pandemic (kindergarteners entering school in fall 2021, 2022, or 2023). Consequently, the results reported here are reflective of the combined impacts of historical and expansion funding.

Effects of Book Distribution Programs in Other Contexts

Research on book distribution programs finds positive associations between participation and the home literacy environment (HLE).[1, 2, 3] In turn, the HLE is predictive of stronger language and literacy skills for young children.[4, 5, 6] Even the informal HLE—less structured activities such as having access to books and engaging in shared reading, which are both areas targeted by ILCO—can positively relate to children's school performance in preschool and early elementary school.[7]

National research literature also indicates some association between book distribution programs and child outcomes. Although there has not been any outcomes research in Colorado, previous studies in other locations have found positive differences at kindergarten entry for participating children in language and literacy outcomes broadly,[8] and in specific skills including letter identification,[9, 10, 11, 12, 13] rhyming,[14, 15] beginning sound awareness,[16] letter sounds,[17, 18] spelling,[19] concepts about print,[20] and expressive and receptive vocabulary.[21] However, some studies have found null effects of book distribution programs.[22, 23, 24]

Importantly, few studies have used the types of methods necessary to isolate the causal effect of ILCO on kindergarten readiness, such as those applied here. The associations observed between DPIL participation and kindergarten readiness in these other studies are likely due, at least in part, to the types of families that select into program participation. For example, when DPIL recruitment happens primarily in libraries, only families who already value books—as indicated

by visiting the local library—are included. These children's literacy outcomes would likely be higher than average even in the absence of participation in a book distribution program.

Colorado's Context

The Imagination Library book program is administered by local affiliates who are responsible for recruiting families and promoting the program. Prior to SB20-185, affiliates were also responsible for raising the funding necessary to cover 100% of the wholesale cost of the books as well as mailing costs. With SB20-185, the state covered 50% of the total costs of disseminating books, while affiliates covered the remaining 50% starting in 2021.

ILCO operates widely:

- Currently, all 64 counties across Colorado enroll children. ILCO provides both English-only and Spanish/English bilingual books.
- As of March 2025, 27% of children birth to age 5 in Colorado receive Imagination Library books each month. Since the statewide expansion of the program in 2021, over 2 million books have been distributed.

> *"Los libros bilingües apoyan mucho el aprendizaje, y vocabulario."*
>
> *("Bilingual books greatly support learning and vocabulary.")*
>
> **- Participating Parent**

- As of August 2024, 41% of books distributed by ILCO were in ZIP codes identified as providing "low" or "very low" opportunity for young children.

In Colorado, affiliates vary in their recruitment approaches in terms of location, intensity, and degree to which outreach is targeted. Recruitment strategies are particularly important for the validity of the matching design employed here. We have greater confidence that our findings reflect the true impact of the ILCO book program, rather than the types of families who happen to be recruited, if families are recruited in places that people from diverse backgrounds frequent. This might include birthing hospitals, community events, and public schools, rather than in libraries or high-end grocery stores.

Some specific recruitment activities deployed by the affiliates impacting this study include:

- **Chaffee County** (Salida): Coordination with local Early Childhood Council; partnership with local hospital to include enrollment information in "new birth packets;" registration days held at preschools; launch party and ongoing display of registration forms at regional library and child care facilities; tabling at community events.
- **Denver** (DPS): Partnership with Denver Housing Authority to provide books and display recruitment materials; partnership with child- and family-serving agencies in Denver; intentional outreach to Spanish-speaking communities in Denver.

- **El Paso** (Harrison): Partnership with Community Partnership for Child Development to enroll all Head Start children in their catchment area; enrollment efforts with other nonprofit partners of Pike's Peak United Way. This affiliate briefly paused enrollment in their highest-income ZIP codes in 2016-2017, when children in the sample could have been enrolling.
- **Westminster** (WPS): Intentional recruitment in low-income elementary schools within their catchment area; outreach to all child care centers in Adams County; tabling at libraries and other community events.

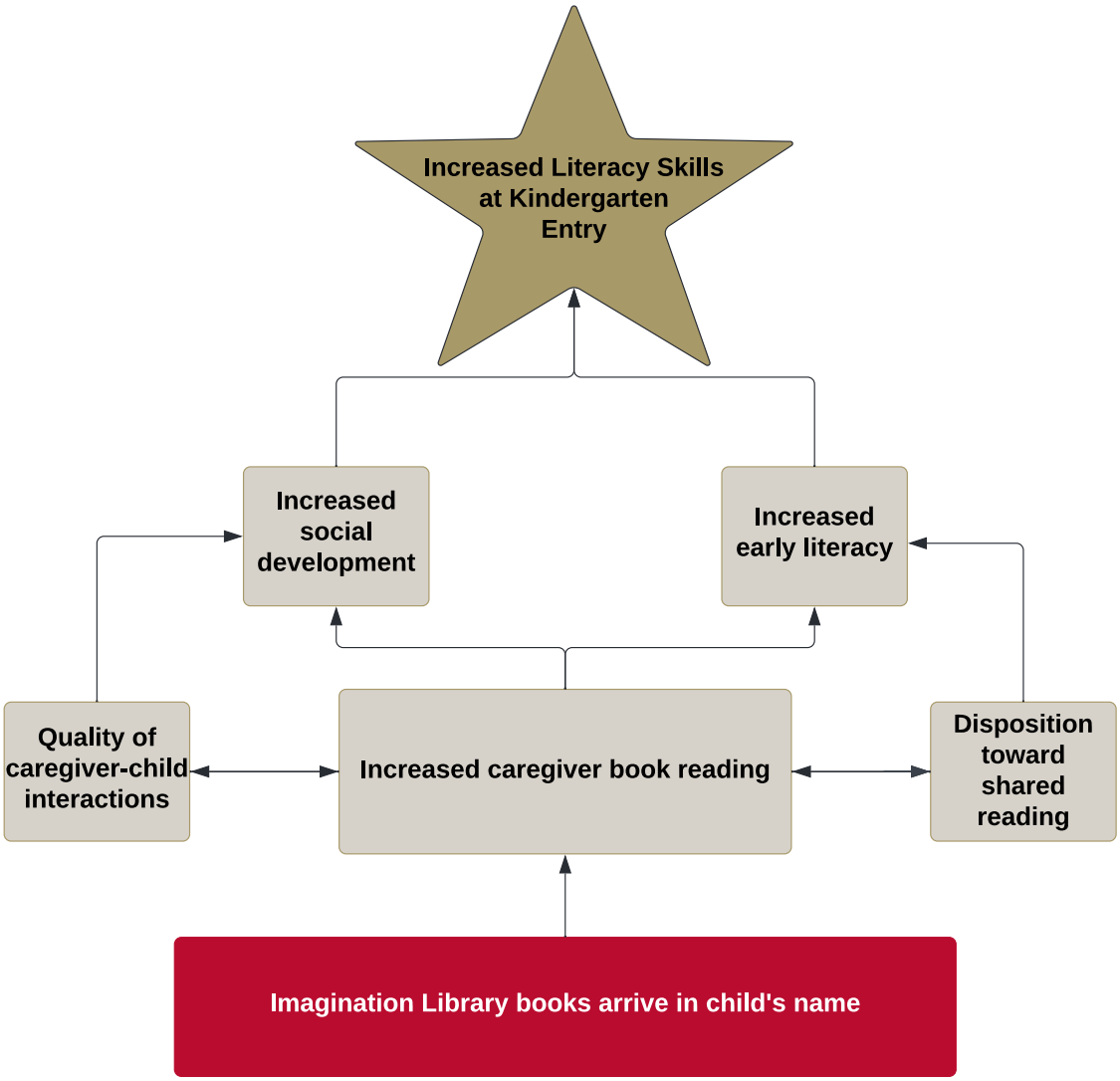
While there is some activity at libraries, ILCO recruitment by these four affiliates disproportionately takes place at locations frequented by families facing economic challenges (e.g. Head Start centers). This is *not* a threat to the validity of the study's matching design. Any positive effect we find of the ILCO program occurs in spite of the fact that ILCO-participating children are *less* likely to score well on kindergarten literacy assessments than other children.

Parents are highly satisfied with the Imagination Library program and see value in their child participating. Based on survey data collected by ILCO, 64% of parents say they are reading to their child(ren) more often, and 98% say that their child has an increased interest in looking at books on their own. Additionally, 93% of parents say that Imagination Library books are helping prepare their child for kindergarten.

> *"This is an amazing and incredibly generous program. Not only have these books helped my child's speech and literacy development, they have brought us all closer together as a family."*
>
> **- Participating Parent**

Taken together, these are promising indicators that ILCO may be supporting young children's language and literacy skills. As shown in the program's theory of change (Figure 1), when children receive books from ILCO, it is hypothesized that caregiver book reading with their children increases. More caregiver book reading leads to improved quality in caregiver-child interactions and children's improved disposition toward shared reading. This creates a positive feedback loop in which more reading occurs. Through these pathways, we expect to see increased social development and early literacy skills in young children, which together increase literacy skills at kindergarten entry.

Figure 1. Imagination Library of Colorado Theory of Change



This study examines the effects of ILCO on the program's long-term outcome of increased literacy skills at kindergarten entry. Because language and literacy are closely intertwined, especially in early childhood, we also examine children's language skills at the same timepoint.

Measuring Early Language and Literacy Skills

Kindergarten students in Colorado engage in standardized assessments of early skills, including language and literacy. Two of these assessments include:

- An interim assessment required by Colorado's **Reading to Ensure Academic Development Act** (**READ Act) assessment**. At the beginning of the school year, teachers are required to assess K-3 students' literacy development in phonemic awareness, phonics, vocabulary development, and reading fluency with an approved "interim assessment."[25] This allows

for early intervention for students who are determined to have a significant reading deficiency (SRD). The skills measured by READ Act assessments are correlated with grade-level reading performance.[26]

One approved and widely used READ Act interim assessment is the **Dynamic Indicators of Basic Early Literacy Skills (DIBELS)**. Scoring in the "well below benchmark" range on the DIBELS is indicative of a potential SRD, and students in this range undergo further diagnostic assessment.[27, 28]

- A **kindergarten school readiness assessment (KSRA).** KSRAs do not determine whether children will be allowed to enroll in school. Instead, they are used to provide "a clear understanding of the knowledge, skills, and behaviors with which students enter kindergarten" to inform learning and instruction.[29] One approved and widely used KSRA in Colorado is the **Teaching Strategies GOLD** (TS GOLD)**.** The TS GOLD is an observational assessment on which kindergarten teachers rate students' skills across domains, including Language and Literacy. KSRAs are completed within the first 60 days of the school year.[30]

Both TS GOLD and DIBELS assessments provide information that is intended to inform instruction but in slightly different ways. The TS GOLD is completed based on teacher observation and provides a broad snapshot of children's skills, including those that are foundational (e.g., listening to and understanding complex language, interacting during reading experiences). Therefore, the research team hypothesized that ILCO participation would be more closely related to outcomes on the TS GOLD assessment. The DIBELS focuses on specific early literacy skills (e.g., letter naming, phonemic segmentation) and is administered through direct assessment. Because these skills are not explicitly taught through ILCO participation, the research team hypothesized that these skills were less likely to be affected by ILCO participation.

Description of the Study

This study addressed one confirmatory and three exploratory research questions:

- **Research Question 1:** What is the impact of participating in the ILCO book program on children's literacy skills at kindergarten entry, compared to demographically similar children attending the same school who did not participate? (Confirmatory)
- **Research Question 2:** What is the impact of participating in the ILCO book program on the likelihood of scoring "well below benchmark" on a standardized literacy assessment at kindergarten entry, compared to demographically similar students in the same school who did not participate? (Exploratory)
- **Research Question 3:** What is the impact of participating in the ILCO book program on the *Language domain* of kindergarten readiness scores of participating children, compared to

demographically similar students in the same school who did not participate? (Exploratory)

- **Research Question 4:** What is the impact of participating in the ILCO book program on the *Literacy domain* of kindergarten readiness scores of participating children, compared to demographically similar students in the same school who did not participate? (Exploratory)

To estimate the causal impact of participation, this study used a matching design. This process allowed us to identify two children who were demographically similar—"statistical twins"—where one child participated in ILCO and the other did not. Because children were not randomly assigned to participate in ILCO, the gold standard for establishing causality, we cannot definitively say that our results are causal. However, to ensure that children receiving ILCO were compared to otherwise similar non-participating children, we matched children within schools and academic years. This avoids the many challenges of residential (racial and socioeconomic) segregation that occur even within school districts. The within-schools matching approach, coupled with high-quality matching (see Table A2 in Appendix A), supports our ability to confidently describe our results as the causal effects from ILCO participation.

Data on program participation were provided by the Dollywood Foundation, the organization that manages the international Imagination Library program. Student data were provided by four school districts for the cohorts of students entering kindergarten in 2018-2023, excluding 2020 due to COVID-19. Districts were chosen to intentionally represent diverse regions of the state with respect to geography, population, and demographics.

Key Findings

> **Key Finding 1: ILCO participation led to a 0.13 standard deviation (SD) higher score on the DIBELS assessment at kindergarten entry compared to similar children in the same school who did not participate. This increase is substantial, particularly given the low cost of ILCO implementation.**

ILCO improved students' early literacy skills by 0.13 SD. This is substantial. While education researchers traditionally look for a change above 0.5 SD to have a "medium" effect, this is in the context of intentionally delivered, often resource-heavy interventions. In contrast, ILCO does not explicitly target the skills measured by the DIBELS. ILCO's most immediate goals are to increase children and families reading together. While these practices are anticipated to lead to the longer-term literacy skills captured on the DIBELS, an effect of this size on the DIBELS is quite large.

We also examined whether there are differences in treatment effects for students who were Multilingual Learners (MLL) or for students who were free and reduced-price lunch (FRL) eligible.

Neither exhibited statistically significant differences by group, indicating that differences in DIBELS scores were not driven by any one of these subgroups. ILCO participation appears to be broadly effective.

> **Key Finding 2: Compared to similar children in the same school who did not participate in ILCO, children who participated in ILCO had 37% lower odds of scoring "well below benchmark" on the DIBELS assessment. In other words, ILCO reduced the likelihood of this indicator of a potential SRD by between 16% and 24%.**

"Well below benchmark" is a DIBELS threshold for identifying a potential SRD. ILCO-participating children's lower odds of scoring below this threshold means fewer participating children need remedial support in reading when they enter kindergarten. This can set students on a positive reading trajectory and reduce the system, district, and school resources needed to make up early gaps.

> **Key Finding 3: There was no effect of ILCO participation on children's scores on the TS GOLD assessment's Language or Literacy domains.**

Contrary to expectations, we did not see any relationship between ILCO participation and children's scores on the TS GOLD assessment. This was surprising, especially given the significant positive findings on the DIBELS, because the skills measured on the TS GOLD are generally considered to be foundational to the literacy-specific skills on the DIBELS. The non-findings on the TS GOLD indicate that literacy-focused measures like the DIBELS may be more effective at picking up on meaningful differences in kindergarteners' skills.

Implications

This study shows that Imagination Library participation increased students' literacy skills at kindergarten entry (as measured by the DIBELS) and decreased the likelihood that students score "well below benchmark." No effects were found for language or literacy skills measured on the kindergarten readiness assessment, TS GOLD.

Together, these results suggest:

> **Imagination Library has the potential to inexpensively boost children's early literacy skills. These skills are important in that they predict children's later reading skills throughout elementary school.**

ILCO-participating children scored 0.13 SD higher than non-participants on the DIBELS in the fall of their kindergarten year. While this could be considered a small effect, it is large in the context of the scope of the program. Imagination Library is low cost (currently costing the state $1.30 per child per month, plus limited overhead) and does not require specific training to implement—parents simply use the time they already have with their children to read the books delivered monthly.

Additionally, other research also suggests that when elementary students are in classes with strong readers, their own reading skills benefit.[31, 32] An upward trend in children's literacy skills could compound across the early elementary years, even for students who did not participate in ILCO.

By maintaining or increasing statewide investment in ILCO, Colorado could potentially decrease the rate of students with SRDs.

Colorado's READ Act is intended to get children reading on grade level by the end of third grade. Based on the above finding, greater ILCO participation is likely to lead to fewer students with SRDs in kindergarten. At scale, this could amount to fewer resources needed to remediate children's skills in K-3 to achieve the goal of third grade reading proficiency, making the higher up-front cost pay off in terms of longer-term resources.

Results from TS GOLD reinforce concerns raised elsewhere about how the assessment is implemented, and data are used in elementary schools.

It was unexpected to find significant differences for ILCO participants on the DIBELS, which tests discrete literacy skills, but not on the TS GOLD, which measures broad skills that are foundational to the DIBELS. As mentioned above, domain-specific measures like the DIBELS may be more finely tuned and able to pick up on skill differences across students. This concern is also noted in a technical report reviewing the merits and limitations of Colorado-approved KSRAs. In general, the TS GOLD only "Partially Meets" technical merit.[33] While authentic assessment is considered good practice in the early childhood years,[34] the technical report also notes that there are not specific guidelines for administering the tools, and there are concerns about inter-rater reliability.[35]

KSRA data are intended to be used to inform instruction. If results are not specific or consistent enough to be meaningful, however, it is unlikely teachers will be successful in using them. Districts should consider how and whether TS GOLD data are being used, determine whether the assessment adds value to instruction, and be clear with teachers how to collect and act upon the resulting data.

A future study should examine whether early literacy gains from ILCO participation are sustained through third grade.

READ Act assessments are administered in kindergarten because the skills children have early in elementary school lay the groundwork for later learning. Early intervention—whether heavy touch intervention from a literacy coach or simply a teacher's intentional instruction—is important for meeting the state's goal of children reading at grade level by the end of third grade.

Statistically significant and substantially large DIBELS findings indicate that ILCO is a promising intervention to start children's reading journey in kindergarten. A future study should examine the impact of Imagination Library participation on longer-term reading skills to see if these early gains remain, are built upon, or fade over time as students' elementary school experience seeks to even the playing field.

Methods

This study used a matching design to estimate causal impacts of ILCO participation. Within schools and academic years, ILCO-participating children were matched with non-participating children on characteristics shown in the education research literature to be related to the kinds of language and literacy outcomes measured in this study. This allowed us to address the limitations of previous research on Imagination Library by better isolating the effects of treatment.

Study Sample

Students included in this study were drawn from four participating school districts: DPS, Harrison, Salida, and WPS. Districts were selected for geographic and demographic diversity, and for their region's longer history of Imagination Library programming. This supported a balance of participating and non-participating children in the sample and enhanced representativeness of the state as a whole. Other considerations were school district capacity to participate in data sharing and which assessments were used to meet state KSRA and READ Act requirements.

We examined the cohorts of students entering kindergarten between fall 2018 and fall 2023, excluding 2020 due to limited data collection during the COVID-19 pandemic. The number of matched children included from each school district and in total are shown in Table 1. WPS was unable to provide TS GOLD data.

Table 1. ILCO Study Sample Size

School District	DIBELS Score Analysis	DIBELS Benchmark Analysis	TS GOLD Language Analysis	TS GOLD Literacy Analysis
DPS	138	154	854	384
Harrison	1,158	1,158	1,434	1,434
Salida	375	375	381	381
WPS	150	150	-	-
Total	**1,821**	**1,837**	**2,669**	**2,199**

Matching and Baseline Equivalence

Based on available data and what the literature says are important predictors of young children's language and literacy development, we matched on students' age at start of kindergarten, their status as an MLL, their sex (male/female), and whether they were eligible for FRL, including an indicator for if this data point was missing. We also restricted the matching pools to students within the same school and academic year to account for changes in academic practices over time, effects of the COVID-19 pandemic, school-level policies, and racial and socioeconomic segregation within districts. Matches obtained through this process were high quality, as described in Appendix A, Tables A2 through A4.

Analysis Approach

Effects of ILCO were analyzed separately for each research question on slightly different samples based on data availability. When predicting assessment scores, we used a linear regression model; when predicting the odds of scoring "well below benchmark," we used a logistic regression model. In all models, we included fixed effects for school year and district, and interactions between school year and district for post-COVID school years. This allowed us to account for systematic differences over time and for each district, particularly as schools recovered from the COVID-19 pandemic. Additional covariates were included based on baseline equivalence findings, as documented in Table A5.

Conclusion

Since its statewide expansion in 2021, ILCO has extended its reach to over 84,000 children per month, comprising 27% of children birth to age 5 statewide. Families appreciate the program and feel as though it is preparing their children for kindergarten—a feeling that is backed by our findings. When young children participated in Imagination Library, they had significantly lower odds of being at risk for a potential SRD and had significantly higher scores on the DIBELS at kindergarten entry. The specific tasks on the DIBELS are predictive of later reading skills. Particularly in light of the minimal cost and effort of administering ILCO, the size of ILCO participants' advantage was substantial. No effects were observed for the Language or Literacy domains of the kindergarten readiness assessment, the TS GOLD, which may indicate a need to revisit assessment procedures and data use for this tool.

Local affiliates and statewide funding together have the potential to improve early literacy, reduce the intensity of literacy intervention students need once they reach school, and move closer to the goal of students reading on grade level in third grade. The 2021 statewide expansion of ILCO was a meaningful investment in Colorado's young children and families that may continue to pay dividends through elementary school and beyond.

Appendix A: Technical Appendix

This technical appendix provides additional detail about the study design, matching approach, baseline equivalence, and outcomes of the Imagination Library of Colorado (ILCO) study from four participating school districts: Denver Public Schools (DPS), Harrison School District 2 (Harrison), Salida School District R-32 J (Salida), and Westminster Public Schools (WPS).

Study Design

This study used a matching design to estimate the causal effect of ILCO on literacy skills at kindergarten entry. Because we were unable to randomize children into participation, we relied on matching within school years and, importantly, within schools. Because of residential segregation, elementary schools within a single district can vary widely while being demographically homogenous within each school. Given the type of recruitment efforts followed by ILCO affiliates, matching within school and academic year largely accounts for systematic differences in the unobservable characteristics of families that cannot be fully controlled outside of a randomized controlled trial.

Matches were made between ILCO participants and non-participants. Children were labeled "ILCO participants" if they were enrolled in Imagination Library for at least 3 years at any time before their fifth birthday, *or* if they were enrolled for the 18 months immediately preceding their fifth birthday. "Non-participants" were those who *never* enrolled in Imagination Library and were eligible to be matched with an ILCO participant. "Comparison" children are "non-participants" who were successfully matched with an "ILCO participant." Children who were enrolled in ILCO for an insufficient amount of time to be considered "participants" were dropped from the study.

A methodological concern with previous studies of Imagination Library is potential upward bias of results because of unaccounted for differences between participating and non-participating children. For example, if enrollment typically happens in libraries or other literacy-rich settings, it is possible that Imagination Library more often reaches families that already engage in literacy activities and would score higher on literacy measures at kindergarten entry with or without the program. For our matching strategy to be valid, children who are recruited for ILCO participation must be no more likely to score well on kindergarten literacy assessments than other children in the absence of ILCO.

Therefore, to understand the potential threats to the validity of our methods, we requested information from local affiliates administering Imagination Library on how they have historically conducted enrollment activities. Contrary to our concerns, affiliates used targeted recruitment to reach children and families who have been historically marginalized and disadvantaged in relation to literacy (e.g., Head Start families, Spanish-speaking families). This means that recruitment efforts may in fact be oversampling from these families, potentially biasing our results *downward*.

Matching Approach

To maximize the number of students who could be retained for analysis, we conducted matching separately for the Dynamic Indicators of Basic Early Literacy Skills (DIBELS), Teaching Strategies GOLD (TS GOLD) Language, and TS GOLD Literacy samples. We treated the students with each assessment as a unique pool from which to select a match who would also have results for that assessment.

Matching procedures differed slightly for each of the school districts, as described in Table A1. These differences were the result of school district size, relative sizes of treatment and control groups, types of assessments administered, variation in which data were provided, and ability to achieve effective matches parsimoniously. Overall, matching decisions were made to prioritize the inclusion of as many students as possible for each analysis, with some exact matching on student characteristics used to help achieve balance on relevant matching characteristics.

Table A1. Matching Approaches by School District

Matching Criteria	DPS	Harrison	Salida	WPS
Matching Approach	1:1 nearest neighbor	1:1 nearest neighbor	Many to one generalized full matching	1:1 nearest neighbor
School Year	Exact match	Exact match	Exact match	Exact match
School	Exact match	Exact match	Exact match (only one school in sample)	Exact match
Age (months) as of August 1	Within 5 months	Within 5 months	Within 5 months	Within 5 months
Multilingual Learner (MLL)	Matching covariate	Matching covariate	Matching covariate	Exact match
Student Sex	Matching covariate	Matching covariate	Exact match	Matching covariate
Free and reduced-price Lunch (FRL) Status	Matching covariate	Matching covariate	Matching covariate	n/a- Not provided
Assessed in Spanish with the Indicadores Dinámicos del Éxito en la Lectura (IDEL; Spanish-language DIBELS)	For DIBELS matching only	n/a - no IDEL data provided	n/a - no IDEL data provided	n/a - no IDEL data provided

Baseline Equivalence

Baseline equivalence is an important quality check for matching studies like this one. To buttress the claim that the results of this study represent the causal impact of ILCO on children's literacy skills, we confirm that students are, on average, effectively matched with their "statistical twins" on the characteristics that would likely influence their language and literacy performance. Consistent with the What Works Clearinghouse,[36] if differences in the mean value of a characteristic are very small between treatment and comparison groups (effect size < 0.05), we consider the groups exactly matched. If differences are small (0.05 ≤ effect size < 0.25), we statistically correct for the differences by including the variables as covariates in the relevant analytic model. If differences are large (effect size ≥ 0.25), the groups are not well-matched for that characteristic and the causal interpretation of the treatment may be compromised.

Across all matching pools, predictors were exactly matched or statistically corrected, meaning that students were well-matched overall (see Tables A2 through A4).

DIBELS Sample

The DIBELS sample initially consisted of all students who had valid scores on the DIBELS assessment during the fall of their kindergarten year. The final DIBELS sample consisted of all treatment students with complete data matched to one comparison student each (or in the case of Salida, slightly less than one unique person each).

Overall, treatment and control groups were very well matched on demographic characteristics within school and academic year (Table A2). Sample-wide, mean differences between treatment and comparison groups were small for sex (effect size = -0.07) and FRL eligibility (effect size = -0.07). However, all demographic variables were within range for a statistical adjustment to meet baseline equivalence. Mean differences in White/non-White are also small (effect size = -0.11). Although this variable is not used as a matching variable, it is still included as a covariate in the regression models.

Unbalanced group sizes (n=949 treatment and n=888 control) are the result of many-to-one matching in Salida where treatment students outnumbered potential comparison students. Weighted means and standard deviations (SD) were used for effect size calculations and are reflected in Table A2 (mean control weight = 1.15; mean treatment weight = 1.0).

Table A2. Baseline Equivalence, DIBELS

Variable	Control Mean (SD) (n=888)	Treatment Mean (SD) (n=949)	Effect Size
School Year: 2018	0.20 (0.40)	0.20 (0.40)	-0.01
School Year: 2019	0.22 (0.41)	0.22 (0.42)	0.01
School Year: 2021	0.21 (0.41)	0.22 (0.41)	0.01
School Year: 2022	0.18 (0.39)	0.19 (0.39)	0.02
School Year: 2023	0.19 (0.39)	0.18 (0.38)	-0.04
Age (Months)	64.99 (3.28)	65.05 (3.52)	0.02
MLL	0.07 (0.26)	0.07 (0.26)	0.00
Female	0.50 (0.50)	0.47 (0.50)	-0.07
FRL Status: Missing	0.08 (0.28)	0.08 (0.27)	-0.04
FRL Status: Eligible	0.61 (0.49)	0.58 (0.49)	-0.07
Assessed in Spanish with IDEL (used for Research Question 2 only)	0.01 (0.09)	0.01 (0.09)	-0.04
Non-White*	0.68 (0.46)	0.64 (0.48)	-0.11

*Reported here for informational purposes but not included as a formal matching variable.

Teaching Strategies GOLD Samples

TS GOLD matching was conducted separately for the Language and Literacy domains because not all children had valid scores in both domains. The TS GOLD Language sample initially consisted of all students who had valid scores on the TS GOLD Language assessment during the fall of their kindergarten year while the Literacy sample consisted of all students with valid scores on the TS GOLD Literacy assessment. The final samples for each domain consisted of all treatment students with complete data matched to one comparison student each (or in the case of Salida, slightly less than one unique person each). Westminster was unable to provide TS GOLD data.

Overall, treatment and control groups were very well matched on demographic characteristics within school and academic year in both domains (Tables A3 and A4). Only the mean difference between treatment and comparison groups was small for sex in the TS GOLD Language domain (effect size = -0.06), so sex was included as a control variable in all Language-domain regressions.

Mean differences in White/non-White were also small in the Language domain (effect size = -0.06). Although this variable was not used as a matching variable, it was still included as a covariate in the regression models.

Weighted means and SD were used for effect size calculations for the Language domain and are reflected in Table A3 (mean control weight = 1.12; mean treatment weight = 1.0). Similarly, for the Literacy domain presented in Table A4, weighted means and SD were used (mean control weight = 1.15; mean treatment weight = 1.0).

Table A3. Baseline Equivalence, TS GOLD Language

Variable	Control Mean (SD) (n= 1,307)	Treatment Mean (SD) (n= 1,362)	Effect Size
School Year: 2018	0.17 (0.38)	0.17 (0.38)	0.00
School Year: 2019	0.18 (0.39)	0.18 (0.39)	0.01
School Year: 2021	0.24 (0.43)	0.24 (0.43)	0.00
School Year: 2022	0.20 (0.40)	0.20 (0.40)	0.00
School Year: 2023	0.21 (0.41)	0.21 (0.41)	-0.01
Age (Months)	65.26 (3.46)	65.27 (3.68)	0.00
MLL	1.08 (0.27)	1.09 (0.28)	0.02
Female	0.50 (0.50)	0.48 (0.50)	-0.06
FRL Status: Eligible	0.55 (0.50)	0.53 (0.50)	-0.04
Non-White*	0.60 (0.49)	0.57 (0.49)	-0.06

*Reported here for informational purposes but not included as a formal matching variable.

Table A4. Baseline Equivalence, TS GOLD Literacy

Variable	Control Mean (SD) (n= 1,072)	Treatment Mean (SD) (n= 1,127)	Effect Size
School Year: 2018	0.20 (0.40)	0.20 (0.40)	-0.01
School Year: 2019	0.20 (0.40)	0.20 (0.40)	0.00
School Year: 2021	0.24 (0.43)	0.24 (0.43)	0.00
School Year: 2022	0.18 (0.38)	0.18 (0.38)	0.01
School Year: 2023	0.19 (0.39)	0.18 (0.39)	0.00
Age (Months)	65.31 (3.45)	65.29 (3.68)	0.00
MLL	1.08 (0.28)	1.09 (0.29)	0.02
Female	0.49 (0.50)	0.48 (0.50)	-0.03
FRL Status: Eligible	0.60 (0.49)	0.58 (0.49)	-0.04
Non-White*	0.64 (0.48)	0.62 (0.49)	-0.04

*Reported here for informational purposes but not included as a formal matching variable.

Analysis and Outcomes

Analyses were conducted separately for each research question, with slightly different groups and group sizes (described in Table 1). The approach for each and the demographic covariates included are shown in Table A5.

Table A5. Analytic Approach and Covariates Included

Research Question	Analysis Approach	Demographic Covariates Included
1. DIBELS score	Linear regression	Female, FRL eligibility, White/non-White
2. DIBELS well below benchmark	Logistic regression	Female, FRL eligibility, White/non-White
3. TS GOLD Language score	Linear regression	Female, White/non-White
4. TS GOLD Literacy score	Linear regression	White/non-White

In all analyses, we also included predictors for school year and school district, and interactions between school district and year for “post-COVID” years. These are intended to account for the variability experienced by school districts across time and place in pandemic recovery.

Descriptive statistics for the control and treatment groups are shown in Table A6.

Table A6. Descriptive Statistics for Outcomes

Outcome	Control Mean (SD)	Control n	Treatment Mean (SD)	Treatment n	Effect Size
DIBELS Scale Score (Z-Score)	-0.04 (0.99)	888	0.11 (1.06)	949	0.15
DIBELS – Well Below Benchmark	0.49 (0.50)	888	0.41 (0.49)	949	-0.20
TS GOLD Language Score (Z-Score)	0.00 (.59)	1,307	-0.01 (0.56)	1,362	-0.01
TS GOLD Literacy Score (Z-Score)	0.02 (0.99)	1,072	0.02 (1.04)	1,127	0.01

DIBELS

To answer the first research question, we examined whether ILCO participation predicted scores on the DIBELS. Because school districts changed which version of the DIBELS was used over the study period, we standardized scores for each version of the assessment. Descriptive statistics and results for the outcome itself are thus reported using standardized scores.

ILCO participation was associated with a 0.13 SD increase in scores on the DIBELS at kindergarten entry when accounting for school year, school district, interactions between school district and year post-COVID, and demographic characteristics as presented in Table A7.

Table A7. Results of Confirmatory DIBELS Score Analysis (n=1,821)

Predictors	Estimates (Standard Error)	*p*-value
ILCO participation	0.13** (0.05)	**0.012**
School Year: 2019 (relative to 2018)	0.05 (0.07)	0.453
School Year: 2021 (relative to 2018)	-0.86** (0.33)	**0.010**
School Year: 2022 (relative to 2018)	-0.08 (0.30)	0.797
School Year: 2023 (relative to 2018)	-0.30 (0.28)	0.288
Student is in Harrison (relative to DPS)	-0.80*** (0.25)	**0.001**
Student is in Salida (relative to DPS)	-0.51** (0.26)	**0.047**
Student is in WPS (relative to DPS)	-0.78** (0.31)	**0.011**
Female (relative to male)	0.00 (0.05)	0.985
FRL Status: Eligible (relative to not eligible)	-0.33*** (0.06)	**<0.001**
Non-White (relative to White)	-0.27*** (0.06)	**<0.001**

**p<0.10*, ***p<0.05*, ****p<0.01*

Note: Results presented are from a model that also included interaction terms of district x school year.

Next, we examined whether ILCO participation reduced the odds of scoring "well below benchmark" on the DIBELS. This is an indicator of a potential significant reading deficiency (SRD). Lower odds indicate that ILCO is positively affecting student performance. ILCO participation led to 0.73 times the odds of scoring "well below benchmark," when accounting for school year, school district, interactions between school district and year post-COVID, and the demographic characteristics described in Table A8.

Table A8. Results of Exploratory DIBELS "Well Below Benchmark" Analysis (n=1,837)

Predictors	Odds Ratios (Standard Error)	*p*-value
ILCO participation	0.73*** (0.07)	**0.002**
School Year: 2019 (relative to 2018)	0.90 (0.14)	0.497
School Year: 2021 (relative to 2018)	2.77 (2.18)	0.206
School Year: 2022 (relative to 2018)	1.15 (0.87)	0.853
School Year: 2023 (relative to 2018)	3.46* (2.50)	0.086
Student is in Harrison (relative to DPS)	3.50* (2.33)	0.060
Student is in Salida (relative to DPS)	2.31 (1.60)	0.226
Student is in WPS (relative to DPS)	3.08 (2.40)	0.148
Female (relative to male)	0.89 (0.09)	0.250
FRL Status: Eligible (relative to not eligible)	2.11*** (0.27)	**<0.001**
Non-White (relative to White)	1.88*** (0.24)	**<0.001**

**p<0.10, **p<0.05, ***p<0.01*

Note: Results presented are from a model that also included interaction terms of district x school year.

To support interpretability, we converted the adjusted odds ratio (OR) to relative risk. This approach provides reasonable upper and lower bound estimates for ILCO's treatment effect depending on the prevalence of scoring well below benchmark in the target population.

$$Risk\ Ratio = \frac{aOR}{(1 - baseline\ risk) + (baseline\ risk * OR)}$$

The risk ratio depends on how prevalent the outcome is in a baseline group. We calculated a range based on two potential baseline levels. A conservative level of risk is estimated using the percentage of comparison students in our sample who scored well below benchmark (49%). Assuming the baseline risk of scoring well below benchmark is 49%, we estimate that students participating in ILCO are roughly 16% less likely than non-participating peers to score well below benchmark.

A higher-end estimate used a baseline group of kindergarten students identified as having an SRD across Colorado in the 2023-24 school year (15.4%), according to publicly available data from the Colorado Department of Education. Assuming the baseline risk of scoring well below benchmark is 15.4%, we estimate that students participating in ILCO are roughly 24% less likely than non-participating peers to score well below benchmark.

Using this approach, we obtained a reasonable range for the ILCO treatment effect of a 16% to 24% reduction in the likelihood of scoring well below benchmark.

Teaching Strategies GOLD

Exploratory analyses were then conducted for the Language and Literacy domains of the TS GOLD. To support interpretation, TS GOLD scores were standardized for each domain. Results are reported using these standardized scores.

First, we examined whether ILCO participation led to improved performance on the Language domain of the TS GOLD. There was no effect of ILCO participation on scores on the TS GOLD Language domain when accounting for school year and school district, interactions between school district and year post-COVID, and demographic characteristics as described in Table A9.

Table A9. Results of Exploratory TS GOLD Language Analysis (n=2,669)

Predictors	Estimates (Standard Error)	*p*-value
ILCO participation	-0.01 (0.02)	0.586
School Year: 2019 (relative to 2018)	0.03 (0.04)	0.412
School Year: 2021 (relative to 2018)	0.77*** (0.08)	**<0.001**
School Year: 2022 (relative to 2018)	0.93*** (0.08)	**<0.001**
School Year: 2023 (relative to 2018)	1.06*** (0.08)	**<0.001**
Student is in Harrison (relative to DPS)	0.86*** (0.07)	**<0.001**
Student is in Salida (relative to DPS)	0.88*** (0.08)	**<0.001**
Female (relative to male)	0.01 (0.02)	0.545
Non-White (relative to White)	-0.15 *** (0.02)	**<0.001**

**p<0.10, **p<0.05, ***p<0.01*

Note: Results presented are from a model that also included interaction terms of district x school year.

Finally, we examined whether ILCO participation led to improved performance on the Literacy domain of the TS GOLD. There was no effect of ILCO participation on scores on the TS GOLD Literacy domain, when accounting for school year and school district, interactions between school district and year post-COVID, and demographic characteristics described in Table A10.

Table A10. Results of Exploratory TS GOLD Language Analysis (n=2,199)

Predictors	Estimates (Standard Error)	*p*-value
ILCO participation	-0.02 (0.04)	0.742
School Year: 2019 (relative to 2018)	-0.05 (0.07)	0.465
School Year: 2021 (relative to 2018)	-1.55 *** (0.29)	**<0.001**
School Year: 2022 (relative to 2018)	-1.12 *** (0.28)	**<0.001**
School Year: 2023 (relative to 2018)	-1.31*** (0.28)	**<0.001**
Student is in Harrison (relative to DPS)	-1.36 *** (0.27)	**<0.001**
Student is in Salida (relative to DPS)	-0.85*** (0.28)	**0.002**
Non-White (relative to White)	-0.09 * (0.05)	0.068

*$p<0.10$, **$p<0.05$, ***$p<0.01$

Note: Results presented are from a model that also included interaction terms of district x school year.

Additional Analyses

Exploratory subgroup analyses were conducted to see if ILCO participation affected DIBELS or TS GOLD scores differently for Multilingual Learner students or children who are FRL eligible. There was no evidence of differential effects of treatment for either group on any outcomes.

We also examined whether differences were observed for racial/ethnic subgroups beyond the White/non-White designation included in the model. Differences among non-White groups were insubstantial.

Additionally, we engaged in a robustness check for the TS GOLD results. We hypothesized that one reason for significant DIBELS findings and no significant TS GOLD findings was because Westminster was not present in the latter. Therefore, we re-ran the DIBELS analysis without Westminster students. When the 150 Westminster students were excluded, we did not observe any meaningful change to the point estimates, and both the score and benchmark outcomes remained significant ($p < 0.001$ and $p < 0.01$, respectively). This suggests that the null results for TS GOLD are not simply due to the differences in the school districts included in the analyses.

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