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# Preventing Summer Learning Loss: A Randomized Control Trial

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**Abstract** Identifying effective methods that can counteract seasonal trends in learning loss is essential to ensure continuous literacy growth of young learners. Computer-assisted instruction (CAI) is a solution for providing an effective summer literacy program that could help offset summer learning loss. In this study, four-year-old students from South Dakota and Wyoming were randomly assigned to use either an early literacy or early math and science summer learning CAI program. Students were expected to use the CAI for 20 min a day, five days a week, during the summer before entering kindergarten. Literacy performance was assessed at the beginning and end of the program, and scores of students who were assigned to the literacy program were compared to the scores of students who were assigned to use the math and science program. Students who used the literacy program scored significantly higher in overall literacy and for the subskills of blending and letter recognition than their control group counterparts. Demographic effects were assessed for students experiencing poverty and students of color. For these demographics, students in the experimental group outperformed their control group counterparts in overall literacy scores and blending and letter recognition subskills.

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## 1 Introduction and Literature Review

Seasonal patterns of learning loss associated with the summer months have historically been a concern for educators and researchers. Early explorations of this phenomenon estimated that students lost as much as one month of instruction during the summer [1]. Later research would illustrate that the impact is likely far more pronounced when considering a compounding effect over multiple years [2]. In a seminal study, Borman and Dowling (2006) demonstrated the remarkable efficacy of early exposure to summer learning programs on literacy outcomes [3]. Over a three-year period, students who attended at least two summer sessions outperformed comparison students by the equivalent of half a grade. The association between learning loss and the summer months is so ingrained that it has been used as a measuring stick to predict learning loss during periods when children are deprived of access to traditional instruction, as in the global COVID-19 pandemic [4].

Summer learning loss does not impact all students equally. In the months between the end of kindergarten and the start of first grade, children from higher socioeconomic backgrounds make greater learning gains than their peers [2]. Research has attributed most of the impact of differing socioeconomic backgrounds on learning outcomes in the ninth grade to differences in the availability of summer learning activities during the elementary school year [5]. Students who are already struggling are at greater risk of falling further behind their peers over the summer [6]. Once students fall behind their peers, an extensive and resource-intensive support network is often needed to bring them back to the expected baseline [5]. Attempting to address achievement gaps after the fact can be counterproductively expensive. As a result, timely prevention is often the best policy.

Access to quality school instruction is an essential equalizer [7]. Discrepancies in performance between students experiencing and not experiencing poverty and between other demographic groups tend to grow faster during the summer months while they shrink towards equilibrium during the school year. Meta-analyses have shown that summer learning interventions are commonly implemented and tend to have a positive effect on preparing participating students for success as they enter the next school year [8]. Summer learning programs can be structured to recruit disadvantaged students without stigmatizing them [9]. These interventions can also be employed early on in a child's educational career; a small sample ($N = 14$) study of prekindergarten students found that participation in a summer learning program led to significantly higher scores on measures of emergent literacy skills [10].

Historic suggestions for addressing seasonal learning discrepancies have also included adopting proactive measures to reform the entrenched agrarian school calendar [5]. However, such suggestions tend to be viewed as impractical. Modern communication infrastructure provides another avenue for addressing summer learning loss by bringing the classroom into the home and allowing for continuing instruction during the fallow months. A recent trial of a short-duration remote preschool intervention found that participation was associated with increased engagement during lessons and significant gains across multiple social-emotional and literacy domains [11]. While in-person instruction is beneficial, it may not be essential. A randomized controlled study examined the possibility of using a texting-based program to improve literacy skills for students as they progress through early grades [12]. Not only did texting increase reading comprehension for third and fourth-grade students, it also increased parent engagement, driving up attendance at parent-teacher conferences. Further research is needed to explore the use of CAI as a universally beneficial tool for summer learning loss.

## 2 Research Goal

The current randomized controlled trial assessed the efficacy of Waterford Reading Academy (WRA), a CAI program, as a summer learning intervention. Students were randomly assigned to either a reading condition or a math and science condition. It is hypothesized that students assigned to the reading condition will outperform comparison students assigned to the math and science condition on literacy skills.

## 3 Research Methodology

### *3.1 Participants*

Participants of this study were recruited for the summer of 2022 from South Dakota and Wyoming and included four-year-old students ($N = 265$). The sample was primarily Caucasian/White (90.83%), and almost half of the sample (49.34%) lived in a household below 185% of the poverty line as determined by the 2022 US Department of Health and Human Services criterion, which compares the income of a household to the estimated expenses of a household of that size [13].

### *3.2 Materials*

**Summer Learning Path (SLP)**. A home-based kindergarten readiness program that provides students with adaptive educational software to teach early literacy, math, and science skills. The program provides a software-based curriculum to families who may not otherwise have access to computers or reliable internet equipment. Regular contact with coaches is used to encourage student engagement with the program.

**Waterford Reading Academy (WRA)**. A computer-adaptive software program designed for students in pre-kindergarten through second grade to teach reading, math, and science skills. The curriculum includes a wide range of multimedia-based activities, such as animated songs and digital books, presented to each student in an adaptive sequence tailored to their initial placement and individual learning path.

**The Waterford Assessment of Core Skills (WACS)**. WACS is a computer-adaptive assessment of pre-literacy and reading skills, including the subskills: blending, initial sound, letter recognition, letter sound, segmenting, sight words, real words, nonwords, vocabulary, listening comprehension, and reading comprehension. State and national standards were used to establish initial content validity for these 11 subskills. Item response theory was then used to determine item difficulty. Concurrent and predictive validity were determined by comparing students' performance on WACS to performance on five commonly used standardized tests of early reading skills; correlations between WACS and each of the tests are significant, ranging from $r = 0.41$ to $r = 0.78$ (median $r = 0.63$). WACS has also been demonstrated to have strong internal consistency and test–retest reliability ($r = 0.90$).

**Procedure**. Students were randomly assigned to use either the reading software (reading group) or the math and science software (math and science group), and all students were encouraged to use their respective software regularly, for 20 min per day, five days per week. Students' literacy skills were assessed using WACS both at the beginning and the end of the program. The final analytic sample included students in the reading group ($n = 114$) and the math and science group ($n = 151$) who completed both the beginning- and end-of-program assessments. End-of-program scores were analyzed using beginning-of-program scores as a covariate to control for initial differences.

## 4 Research Outcomes

### *4.1 Group Differences Using ANCOVA*

Group differences in performance on end-of-program overall WACS scores, while controlling for beginning-of-program performance, were assessed using an ANCOVA (see Fig. 1). A significant effect for the intervention on end-of-program scores was identified, $F(1, 262) = 5.31$, $p < 0.05$, where students assigned to the reading condition ($M = 2{,}684.04$) outperformed students assigned to the math and science condition ($M = 2{,}565.72$). Effect size ($d = 0.26$). Students assigned to the reading condition scored in the kindergarten advanced range, while those assigned to the math and science condition scored in the kindergarten intermediate range.

Group differences for each basic subskill of the WACS assessment while controlling for beginning-of-program scores were assessed using six additional ANCOVAs. No significant effects were indicated for letter sound, listening comprehension, or vocabulary, though students assigned to the reading condition outperformed those assigned to the math and science condition.

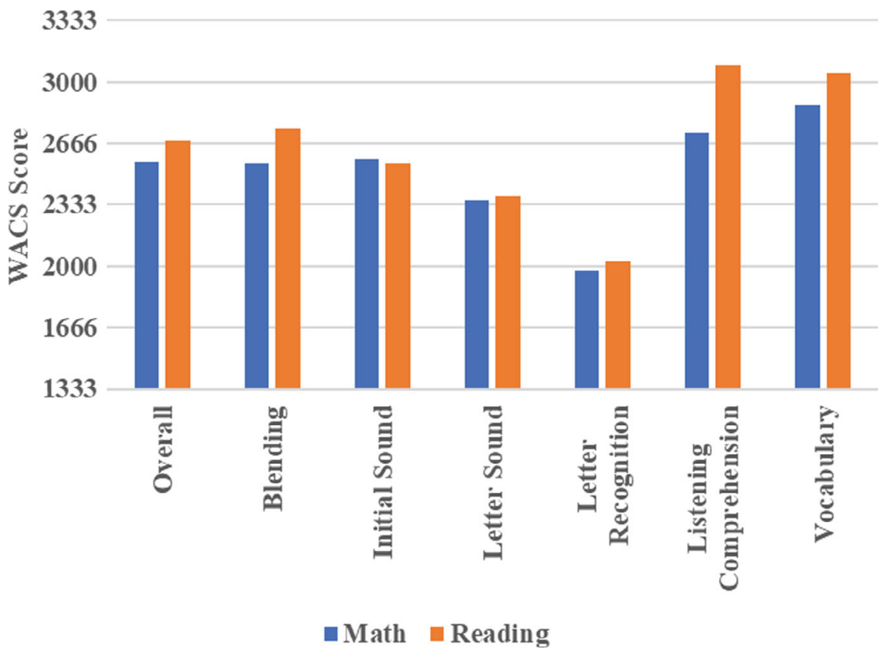


**Fig. 1** WACS end-of-program scores covarying for beginning-of-program scores by Subskill

A significant effect was indicated for the intervention on end-of-program blending scores while controlling for beginning-of-program scores, $F(1, 262) = 4.19, p < 0.05$, where students assigned to use the reading program ($M$ = 2,742.98) outperformed students assigned to use the math and science program ($M$ = 2,558.79). Effect size ($d = 0.25$).

A significant effect was indicated for the intervention on end-of-program letter recognition scores while controlling for beginning-of-program scores, $F(1, 262) = 4.04$, $p < 0.05$, where students assigned to use the reading program ($M$ = 2,026.58) outperformed students assigned to use the math and science program ($M$ = 1,973.72). Effect size ($d = 0.23$).

## *4.2 Group Differences Using ANCOVA—Demographics*

Multiple independent ANCOVAs were conducted to evaluate potential interactions between demographics and end-of-program performance while accounting for the variance contributed by beginning-of-program performance on subskills identified as significant in the earlier analysis (overall, blending, and letter recognition; see Table 1).

**Table 1** Adjusted WACS end-of-program scores by demographics

| Experience of Poverty | No | | | | Yes | | | |
|---|---|---|---|---|---|---|---|---|
| | Math and Science, $n = 43$ | | Reading, $n = 30$ | | Math and Science, $n = 63$ | | Reading, $n = 50$ | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Overall | 2,542.67 | 403.99 | 2,704.69 | 404.08 | 2,633.04 | 404.20 | 2,708.00 | 403.96 |
| Blending | 2,634.99 | 712.03 | 2,738.67 | 713.51 | 2,525.03 | 713.77 | 2,720.05 | 712.63 |
| Letter Recognition | 1,918.32 | 207.14 | 2,019.78 | 207.61 | 2,009.49 | 207.64 | 2,045.14 | 207.13 |
| Race/ Ethnicity | Caucasian/White | | | | Students of Color | | | |
| | Math and Science, $n = 122$ | | Reading, $n = 86$ | | Math and Science, $n = 29$ | | Reading, $n = 28$ | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Overall | 2,597.61 | 412.41 | 2,694.19 | 412.87 | 2,431.68 | 412.43 | 2,652.78 | 413.20 |
| Blending | 2,588.89 | 725.77 | 2,758.13 | 727.44 | 2,431.97 | 725.03 | 2,696.70 | 725.55 |
| Letter Recognition | 1,978.08 | 211.95 | 2,024.43 | 211.95 | 1,955.11 | 212.19 | 2,033.44 | 215.32 |

**Experience of Poverty**. Analysis indicated no significant main interactions for the experience of poverty across the three subskills examined, with $p$ values ranging from $p = 0.297$ (letter recognition) to $p = 0.674$ (blending). Simple effects, with Bonferroni corrections, were then analyzed to further parse within-group differences. This analysis indicated that for students both experiencing and not experiencing poverty, scores for students assigned to the reading condition tended to be higher than scores for comparison students, though differences were not significant. When examining the letter recognition subskill, students not experiencing poverty assigned to the reading condition significantly outperformed their comparison peers. Simple effects analysis with Bonferroni correction also indicated that students not experiencing poverty assigned to the reading condition significantly outperformed comparison students assigned to the math and science condition, $t(181) = 4.23$, $p = 0.041$.

**Race/Ethnicity**. Analysis indicated no significant main effects for race and ethnicity across the three subskills examined, with $p$ values ranging from $p = 0.317$ (overall) to $p = 0.856$ (letter recognition). Bonferroni corrected simple effects analysis indicated that for most cases observed, when the performance of students who used the reading program was compared to the performance of students who used the math and science program, students in the reading condition outperformed their peers, though differences were not significant. Notably, for overall scores, students of color assigned to the reading condition significantly outperformed comparison students assigned to the math and science condition, $t(260) = 4.08$, $p = 0.044$.

## 5 Discussion

According to previous research, summer learning programs have been found to counteract seasonal trends in learning loss and improve literacy outcomes for students [3, 8, 10]. Overall literacy performance was significantly higher for students who were randomly assigned to the reading condition than those assigned to the math and science condition, resulting in an effect size of 0.26, indicating a meaningful effect. Across all literacy strands assessed, the scores from the experimental group were higher than their control group counterparts. For the literacy strands of blending and letter recognition, students assigned to the reading condition scored significantly higher than those in the math and science condition. This indicates the benefit of the WRA reading program in improving summer literacy scores and supports previous findings that summer learning programs can improve literacy outcomes [3, 10].

## 6 Conclusions

An important consideration regarding literacy programs is that they benefit all students [5]. Across all races/ethnicities and socioeconomic statuses assessed, students randomly assigned to the reading group outperformed students in the math and science group in overall literacy skills, as well as the literacy strands of blending and letter recognition. This indicates that overall and in various literacy strands, the WRA reading program effectively improves literacy skills for all students. As with prior research that indicated opportunity gaps narrowing during the year, regular access to quality instruction was a remarkable equalizer in the current study.

Since this program was conducted over the summer rather than over a full academic school year, it can be expected that the majority of students spent most of their time in the early portion of the learning curriculum. Developing letter recognition and letter sound skills are emphasized at the beginning of the reading program. Results reflect this, as seen through the reading group's higher letter recognition and letter sound scores. This demonstrates the reading program's effectiveness in teaching essential skills in a short amount of time, setting a foundation for more advanced reading skills.

Previous research has found that the lack of accessibility to summer learning activities can be attributed to most of the impact of differing socioeconomic backgrounds in school [5]. Given the design of WRA to provide early education to those who may not otherwise have access to it and the program's effectiveness for all students, WRA is well-positioned to help bridge the gap early on and prime all students for future academic success.

## 7 Future Steps

It is appropriate here to briefly acknowledge some limitations of the current study. While the sample was varied enough to allow a valid examination of demographics, most students were White/Caucasian. A more racially and ethnically diverse sample would allow these results to be more generalizable. While the current study demonstrated the efficacy of this educational program in the short term, there is no longitudinal data, and its impact in the long term remains a question for further research. Future studies can improve this by studying summer learning interventions in other regions, focusing on recruiting a diverse sample and making use of longitudinal data.

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