Can Children Achieve Literacy Gains During the Summer?

Haya Shamir
Carolyn Ortiz-Wood
David Pocklington
Erik Yoder
Waterford Institute
United States
hayashamir@waterford.org
carolynwood@waterford.org
davidpocklington@waterford.org
erikyoder@waterford.org

Abstract: This study examined the efficacy of computer-assisted instruction (CAI) to teach literacy skills to early learners. Students who participated in an at-home learning program during the summer before their kindergarten year were provided with CAI software to use daily for several weeks. A pretest and a posttest were administered, at the beginning and end of the program, respectively, to assess the growth of student literacy skills throughout the program. Analysis of growth revealed that students achieved significantly higher literacy scores at the end of the program compared to the beginning. Significant growth was also found for students across a variety of demographic backgrounds. These results indicate that CAI can be an effective tool to offset summer learning loss.
Keywords: summer learning, literacy, CAI, Early Childhood

Introduction

Research into summer learning loss, also referred to as summer slide, has implicated it as one of the main, if not the singular, contributors to differences in reading ability between low and high socioeconomic status (SES) students (Allington & McGill-Franzen, 2017). In an early study, Alexander, Entwisle, and Olson (2001) noted a troubling trend in test scores in Baltimore public schools. Scores for low SES students would remain more or less the same from the end of one grade, through summer, and into the start of another, while scores for high SES students would rise during the same time. This seasonal disparity in learning resulted in low SES students falling farther behind their peers with each grade. These deficits can begin to accrue early in a student's education. When differences in beginning and end of kindergarten and beginning and end of first grade scores across demographic groups (SES, ethnicity, and sex) were assessed in a review of historic data from close to 20,000 students, most achievement gaps were exacerbated during the summer months (Downey, Von Hippel, & Broh, 2004). When these deficits are not effectively addressed, they can have a persistent and detrimental effect on student learning. A later analysis of differences in performance for students in the ninth grade found that roughly two-thirds of the disparity between rich and poor students could be attributed to differences in summer learning made in elementary years (Alexander, Entwisle, & Olson, 2007).

It is not a new observation that effective early intervention is important in education. The first years of a child's education are critical for mastering early literacy skills. Discrepancies in reading competency have been observed as early as prekindergarten (Weisleder & Ferland, 2013) and notable differences in how children approach reading are observable by the start of first grade (Herbers et al., 2012). A student failing to master these foundational skills is likely to suffer from more pronounced issues further into their career as they confront lessons that build on knowledge that the student does not have. These deficits can ultimately result in an educational "Matthew effect," where students who are already succeeding are the only ones primed for further success (Ricketts, Sperring, & Nation, 2014).

Some of the earlier research that identified seasonal learning differences as a potential issue also noted the importance of addressing achievement gaps as students begin their formal education (Alexander, Entwisle, & Olson, 2001). Well designed and implemented interventions in the summer months before kindergarten can have a positive

impact on literacy skills. A recent study, which assessed children in foster care during the two months prior to entering kindergarten, randomly assigned students to either receive traditional child welfare support or an intervention specifically targeting literacy and prosocial skills (Pears et al., 2013). When both groups of students began kindergarten, students who received the intervention significantly outperformed their counterparts on measures of early literacy skills. A review of the efficacy of 123 preschool interventions found that these programs were associated with improvements in cognitive skills, including reading, though the specific degree of efficacy varied from study to study (Camilli, Vargas, Ryan, & Barnett, 2010). Unfortunately, despite the efficacy of preschool interventions access to publicly funded prekindergarten in the United States school system is uneven (Barnett & Gomez, 2016). While the majority of states do provide some form of funding for early education, only three states guarantee truly universal pre-kindergarten education.

Computer-assisted instruction (CAI) is an educational approach that may be useful in addressing summer learning loss. CAI leverages the structural advantages inherent in interactive media to improve student learning outcomes. CAI can be adaptive, engaging, and responsive in a way that can be difficult for traditional, teacher conducted large group instruction (Jethro, Grace, & Thomas, 2012). Research has already demonstrated the efficacy of CAI in a classroom setting (Saine et al., 2010; Stetter & Hughes, 2010). When used correctly, CAI can tailor a lesson to the needs and ability of a student in real time (Jethro, Grace, & Thomas, 2012). CAI, through interactive media and immediate feedback, can increase engagement for young readers and encourage their active participation (Flewitt, Messer, & Kucirkova, 2015). Additionally, CAI literacy interventions have been shown to be effective at closing demographic achievement gaps (Schechter et al., 2015). However, what is more relevant to addressing seasonal deficiencies is that CAI can require less physical infrastructure than traditional, on-site, in-person prekindergarten and, as result, can be utilized in environments where traditional preschool is not practical or feasible (Shamir et al., 2019). In general, time spent at home is an untapped educational resource; a comparatively small amount of a student's time until graduation is actually spent in school (Anders et al., 2012). CAI can help to ensure that this time is fully utilized by bringing targeted literacy content into students' homes in the otherwise quiet months before the start of kindergarten.

The current study evaluates the efficacy of a targeted CAI summer program for students in the months prior to entering kindergarten. It is predicted that the literacy skills of students using the program will improve over the course of the program.

Methods

Participants

This study consisted of four-year-old students (N = 3,082) across 11 states during the summer of 2021 before their kindergarten year. The sample was 34.01% Caucasian, 27.48% African-American, 22.06% Hispanic, 5.71% Asian, and other ethnicity accounting for 10.74% of the sample. 85.62% of the students in the sample spoke English as their primary language. The sample was 48.96% female. 59.25% of the sample lived below 185% of the poverty line, based off of the 2021 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 (Annual Update of the HHS Poverty Guidelines, 2021).

Materials

Waterford Upstart

A home-based, technologically enabled, kindergarten readiness program. Through Upstart, families are provided with equipment and coaching in order to facilitate parental involvement and student engagement. The program gives students access to an adaptive early literacy curriculum and prepares them for academic success in kindergarten.

Waterford Reading Academy (WRA)

WRA offers a comprehensive, computer-adaptive reading curriculum for pre-kindergarten through second grade students. The software presents a wide range of multimedia-based activities in an adaptive sequence tailored to each student's initial placement and his or her individual rate of growth throughout the complete reading curriculum.

The Waterford Assessment of Core Skills (WACS)

WACS is an adaptive assessment designed to assess 11 key pre-literacy and reading skills. Initial content validity for WACS was established against state and national standards for the 11 subtests. All items were then calibrated for Item Response Theory to determine item difficulty. To establish concurrent validity and predictive validity student performance on WACS was compared to performance on five commonly used standardized tests also measuring early reading skills; all correlations between tests are significant, ranging from r = .41 to r = .78 (median r = .63). Additional analyses indicate that WACS is internally consistent and has strong test-retest reliability (r = .90).

Procedure

Students that participated in the program were expected to use WRA for 20 minutes a day, five days per week. Usage was tracked within the program and monitored weekly, and total minutes of the adaptive curriculum usage for the duration of the program per group was calculated. WACS was administered at the beginning and end of the program to assess the literacy skills of the students before and after their participation in the program. Note that because it was not possible to administer the WACS assessment in person because of COVID-19, start of program results were adjusted based on previously proctored Upstart participants.

Findings

Time Point Differences Using Paired Samples t-test

A paired samples t-test was conducted to examine differences between beginning of program and end of program WACS scores (see table 1, figure 1). Analysis revealed a significant difference between beginning and end of program scores, $t(1298) = 45.21$, $p < .05$), with students achieving significantly higher WACS scores after participating in the Summer Learning Program (SLP) (M = 2641.96, SD = 578.88) compared to their WACS scores at the beginning of the program (M = 1989.85, SD = 375.17). Effect size (d = 1.25).

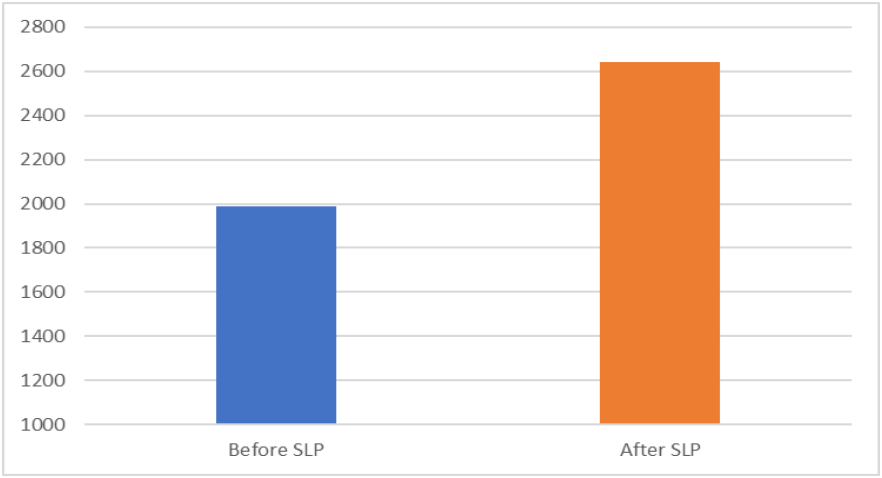

Figure 1: Average WACS from the beginning of the SLP program and the end of the program

			Before SLP		After SLP		
		N	*M*	SD	*M*	SD	*p*
Overall		1299	1989.85	375.17	2641.96	578.88	0*
Ethnicity	African American	318	2059.51	393.01	2645.14	611.03	0*
	Asian	99	2162.93	366.71	2894.93	537.37	0*
	Caucasian	369	1975.46	336.73	2703.05	530.60	0*
	Hispanic	341	1864.24	352.02	2455.03	549.60	0*
	Other	157	2045.11	396.87	2728.39	600.37	0*
Gender	Female	633	2010.59	387.40	2671.36	586.97	0*
	Male	666	1970.14	362.35	2614.01	570.13	0*
Socioeconomic Status	Over 185% Poverty	481	2026.11	348.41	2719.24	518.04	0*
	Under 185% Poverty	640	1956.08	386.65	2566.38	595.52	0*
Preschool Attendance	No Other Preschool	813	1985.80	364.43	2657.20	572.42	0*
	Other Preschool	486	1996.64	392.75	2616.45	589.25	0*
Primary Language	English	1006	2021.10	377.67	2686.65	571.42	0*
	Non-English	278	1876.11	345.62	2474.56	576.43	0*
State	CO	134	1937.38	349.05	2645.80	472.84	0*
	DC	6	1800.50	621.52	2705.33	882.18	0*
	IL	62	2079.34	414.14	2575.42	619.26	0*
	LA	87	1958.90	348.60	2501.92	569.19	0*
	MA	139	2018.88	356.65	2714.24	582.31	0*
	MD	184	1988.20	395.28	2612.59	638.78	0*
	MO	67	2001.51	333.84	2713.45	632.83	0*
	NH	22	1882.27	349.58	2616.05	498.44	0*
	NY	162	2080.29	394.28	2723.01	645.33	0*
	VA	107	2045.53	405.50	2648.14	562.89	0*
	WA	329	1936.84	353.51	2619.94	529.21	0*

*$p < .001$

Time Point Differences by Demographics using Mixed Design ANOVAs

Further analysis was conducted to examine the impact of demographics and SLP on average end of program scores. Six mixed design ANOVAs were performed, using WACS scores as the within-subjects variable, and the demographic variables as the between-subjects variable for each statistical test (see table 1, figures 2-3).

Ethnicity

Analysis indicated that there was a significant interaction between the effects of the SLP program and ethnicity, $F(4,1279) = 5.19$, $p < .05$. Post-hoc pairwise comparisons showed that on average, end of program WACS scores were significantly higher than the beginning of program WACS scores across all ethnicities

Gender

Analysis indicated that there was no significant interaction between the effects of the SLP program and gender, $F(1,1297) = 0.34$, $p = .558$. Post-hoc pairwise comparisons indicated that for both female and male students, WACS scores achieved at the end of the SLP program were significantly higher than WACS scores achieved at the beginning of program.

Socioeconomic Status

Analysis indicated that there was a significant interaction between the effects of the SLP program and socioeconomic status, $F(1,1119) = 7.28$, $p < .05$. Post-hoc pairwise comparisons showed that for students above and below 185% of the federal poverty guideline, WACS scores achieved at the end of the SLP program were significantly higher than WACS scores achieved at the beginning of program.

Preschool Attendance

Analysis indicated that there was no significant interaction between the effects of the SLP program and prior attendance of another preschool program $F(1,1297) = 3.00$, $p = .083$. Post-hoc pairwise comparisons showed that for both students who attended preschool and for those who did not, WACS scores achieved at the end of the SLP program were significantly higher than WACS scores achieved at the beginning of program.

Primary Language

Analysis indicated that there was no significant interaction between the effects of the SLP program and language, $F(1,1282) = 3.62$, $p = .057$. Post-hoc pairwise comparisons showed that for students whose primary language was English and for students whose primary language was not English, WACS scores achieved at the end of the SLP program were significantly higher than WACS scores achieved at the beginning of program.

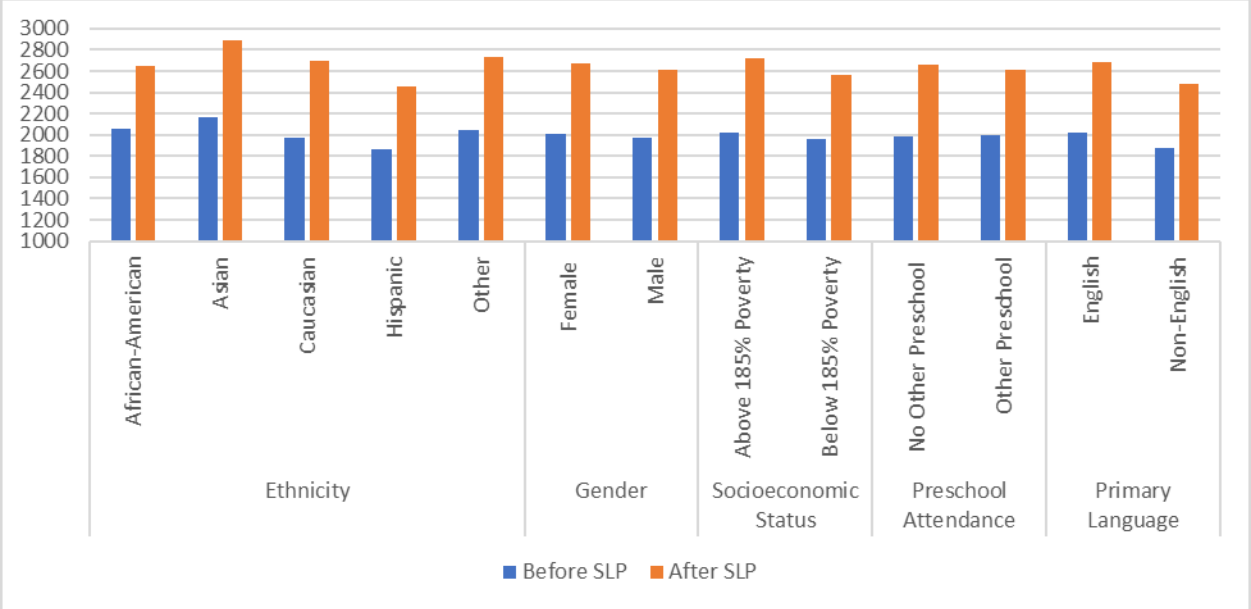

Figure 2. Before and After SLP WACS Scores by Demographics

State

Analysis indicated that there was no significant interaction between the effects of the SLP program and the state in which each SLP program implementation took place, $F(10,1288) = 1.76$, $p = .063$. Post-hoc pairwise comparisons were conducted to examine the effect of SLP on WACS scores, depending on state. Post-hoc pairwise comparisons showed that, across all states, the end of program WACS scores were significantly higher than the beginning of program WACS scores.

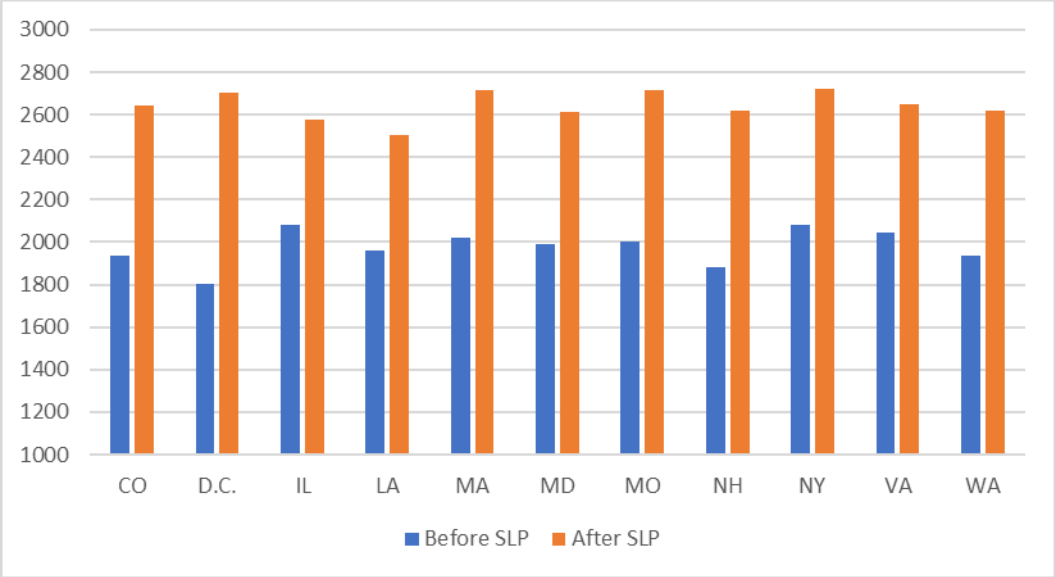

Figure 3. Before and After SLP WACS Scores by State

Discussion

To close achievement gaps between students and ensure equity in the success of young learners, there is a need for high quality education solutions that are accessible to all students. Summer learning loss can exacerbate existing achievement gaps between students, and this is especially impactful during early childhood education and for students in low socioeconomic households (Alexander et al., 2007). Reading interventions that take place over the course of a summer can help mitigate summer learning loss (Pears, et al., 2013), and CAI is a useful approach during summer months when in-person instruction may not be available.

While CAI can be an effective tool to foster learning gains, research has also shown that implementation fidelity of CAI has a strong, positive relationship with learning outcomes (Archer et al., 2014). This indicates that to receive the full benefit of CAI, students need to use the software as prescribed. In the current study, the program took steps to ensure students were able to meet the software usage requirements to the best of their ability by having coaches check in with families regularly and encourage student engagement.

Results of the current study support our hypothesis that CAI can provide a positive impact on pre-kindergarten students' literacy skills and prevent summer learning loss. Students who participated in the program achieved significantly higher literacy scores on the posttest compared to their literacy scores on the pretest. The large overall effect size signifies a strong, meaningful learning outcome for these students. The results indicate that the students not only avoided summer learning loss of literacy skills they had developed during their prekindergarten year, but the students had actively improved their literacy skills over the course of the summer program as well. Additionally, these positive results were seen across all demographics, regardless of ethnicity, socioeconomic status, gender, preschool attendance, primary language, or location. These findings support previous research that has shown positive effects of CAI on literacy skills across demographics (Schechter et al., 2015)

One limitation to this study is that there was no comparison group, since all students in the program used the software. The study does demonstrate that students made progress during the summer months, that this progress was substantial, and that every group of students who participated in the program benefited from the program, but

the lack of a comparison group of students who did not participate in the program limits the ability of this study to attribute that progress solely to the summer learning program. Future research could explore the efficacy of this intervention using a random assignment model.

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