



# Exploring the impact of a CALL tool for emergent bilinguals

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## Abstract

This study evaluates the impact of a computer-assisted language learning (CALL) tool for the acquisition of academic English and oral language skills in children learning English as a second language. Using a quasi-experimental design, we compare English proficiency scores for K-5 students who did or did not use the program during the 2020–21 school year. Analyses showed that learners who used the program scored higher on the overall test, including on the oral and written domains, compared to students who did not use the program. When controlling for prior year achievement, we found small, positive but non-significant effects for program users. Proficiency analyses did not reveal any significant differences between student groups. The results show promising evidence that CALL tools, and particularly those focused on oral language development, can be used to provide structured support to students for learning academic English and developing greater overall English language proficiency.

**Keywords** Academic English · English as a second language · English language proficiency · Young English learners · Oral language proficiency · Computer-assisted language learning

## Introduction

### English learners in the United States

An increasing number of children in the United States are learning English as a second language (ESL). From 2010 to 2018, English Learners (ELs) increased from 4.5 to roughly 5 million students, or 10% of all public-school students in the US (NCES, 2021). These students face numerous challenges related to academic language development and tend to underperform on measures of language and literacy achievement compared to their English-proficient peers (Abedi, 2004; NCES, 2019). Students who are classified as “EL” and receive specialized English language services must show annual progress toward English language proficiency, most often via high-stakes, standardized assessments (Wolf, 2022) before they can be reclassified out of EL services. English

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proficiency expectations for ELs include developing social/interpersonal language, general academic language, and technical discipline-specific language which aligns with the broader language demands of content-area academic standards across the US (Wolf, 2022). Despite this, many ELs do not acquire the language proficiency needed to succeed in content-area classes such as Language Arts and Math, even after several years in the public school system (Menken et al., 2012; Olsen, 2014). Additionally, many ELs do not receive specialized English services or receive services that are not appropriate for their English proficiency levels (Menken & Kleyn, 2010). Consequently, they face declining long-term academic outcomes while they remain in EL programs with inadequate English-language support and receive unequal access to appropriately challenging curriculum (Callahan, 2005).

The majority of ELs in the US are born in the US (NASEM, 2017), and often become proficient in the foundational and social oral language used in informal contexts, such as with friends (e.g. Menken & Kleyn, 2010). Nevertheless, the language demands of schooling differ in several ways from more informal language (Snow, 2010) and pose a notable challenge for students from linguistically diverse backgrounds. This “Academic English” has varying definitions (Valdés, 2004), but generally is characterized as a formal register of standard English which encompasses linguistic features from the sound to the discourse level (Scarcella, 2003). For young elementary learners, academic language is language needed to interact in the classroom and to successfully obtain and make use of subject matter information (Valdés, 2004).

Research shows there is a close relationship between language-based skills, such as comprehension and production of syntactic structures, and reading comprehension development (Tong et al., 2024), as well as how explicit, oral language instruction can benefit the language and literacy outcomes of ELs (NASEM, 2017; Vaughn et al., 2006). Despite this, ELs are often not met with ample opportunities to practice and be explicitly taught this language (Scarcella, 2003; Genesee et al., 2006). A weak foundation in academic language impedes ELs from being able to fully access and benefit from academic content instruction in English (Abedi, 2004; Menken & Kleyn, 2010).

Computer-assisted language learning (CALL) tools may serve as a promising avenue to address the academic language needs of ELs (Grgurović et al., 2013; Ware & Hellmich, 2014). Research shows that CALL tools can improve academic achievement outcomes for ELs in grades 6–8 (Harper et al., 2021). In general, however, there is limited evidence of how CALL tools may benefit the linguistic development of younger children (Macaro et al., 2012). Additionally, there are relatively few studies that examine the use of CALL tools for oral proficiency development (Alvarez-Marinelli et al., 2016; Bang et al., 2020), and even less so on academic language proficiency. Furthermore, while various literacy technology programs are available to children learning English (Lee et al., 2020), these tools focus primarily on the development of written (not oral) language skills (Ysquierdo, 2018), foundational word-level literacy skills (e.g. phonemic awareness; Guo et al., 2023; Kazakoff et al., 2018), or they are designed for children acquiring social language skills in contexts where English is not the majority language of society and education (Bang et al., 2020). Given these gaps in previous CALL research literature and the problem statement of English language education in the US, in this study, we present a novel CALL tool designed to support oral academic language skills of ELs and explore the effectiveness of this tool for helping students attain greater language proficiency. This evaluation focuses on young ELs in the context of the US, where English is the predominant language of education.

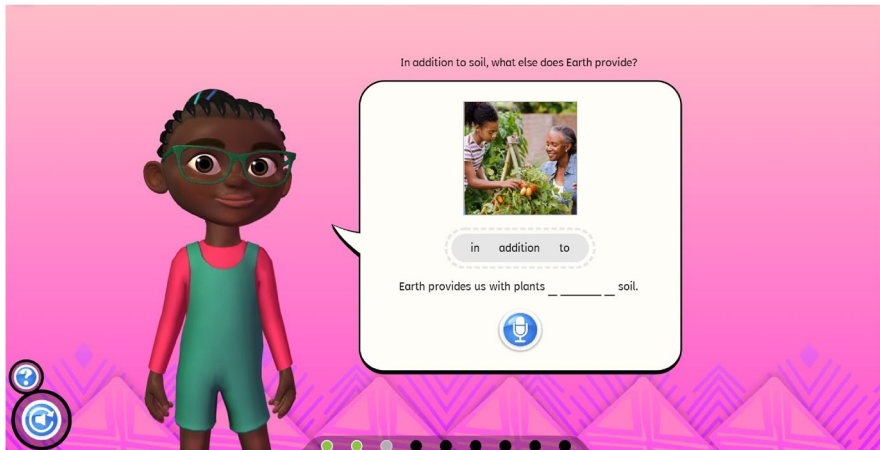


Fig. 1 Example conversation activity

## Designing a digital learning experience for emergent bilinguals

In response to the language learning needs of ELs in the US, a team of applied linguists and English language curriculum designers developed Lexia® English Language Development™ (Lexia English). This CALL tool is designed to improve the English language skills needed for Emergent Bilinguals<sup>1</sup> in grades K-6 to succeed in academic contexts and was released in July 2020, during the midst of the COVID-19 pandemic. The program is intended to supplement, rather than replace, English language development instruction for ELs, and students are expected to use the online program between 30 and 60 min per week. The program emphasizes the development of oral language skills via speaking and listening activities that scaffold content from science, social studies, math, and biographies of program characters. Consistent with other CALL programs, Lexia English explicitly teaches English grammar and vocabulary, which are embedded in listening and speaking activities. Learners are guided through the program by 17 Emergent Bilingual characters from different cultural and linguistic backgrounds. To support use in schools, the program content was designed based on the English Language Development standards of multiple states in the US (49 out of 50 states; California standards: Lexia Resources for Literacy Learning, n.d.-a). Students are expected to develop low-level linguistic skills such as multiword expressions and vocabulary, as well as higher-level skills related to discourse functions and language used for discussing academic content. For example, Fig. 1 shows a speaking activity that is part of the lesson “Evaluating with Esther using prepositions.” The activity specifically focuses on the multi-word preposition “in addition to” under the broader speaking purpose of “Evaluate” and the theme of “Protecting Earth’s Resources.”

The linguistic components of the program were intentionally developed based on theories within the interaction approach to second language acquisition (SLA) research (Gass

<sup>1</sup> The term Emergent Bilingual is often used to capture an additive, asset-oriented perspective of English-language learning (García et al., 2008). To be consistent with CALL literature, we use “EL” throughout this paper.

& Mackey, 2015; Lexia Resources for Literacy Learning, n.d.-b). Program activities focus on the role of linguistic output (“Output Hypothesis”; Swain, 1995), and speaking activities are framed as scaffolded conversational interactions with program characters. By incorporating language instruction and input as academic conversations, this helps prepare learners for academic discourse and interactions they are likely to encounter in their classrooms. Learners are presented with language frames as a form of comprehensible input (“Input Hypothesis”; Krashen, 1982) to help them produce complete sentences. These sentences contain target vocabulary and grammar according to the specific program unit. An example Conversation activity is shown in Fig. 1. Program characters first model the sentence, followed by repetition by the character and student together, then just the student independently. This allows students to engage in purposeful repetition and practice needed to achieve fluency and automaticity (DeKeyser, 2007) for which they may otherwise have limited opportunities in the classroom. A built-in Speech Recognition Engine measures correct usage of grammatical structures, and instant corrective feedback is provided to learners (Philp et al., 2008) by visually highlighting incorrect sentence segments. This helps trigger learners’ metalinguistic awareness as they hypothesize utterance formulation, test out sentences, and receive feedback as to whether they were understood by their interlocutors (Swain, 1995). The program also contains different non-speaking exercises to support language comprehension development. These include exercises such as listening to a short narrative and completing multiple-choice questions and event sequencing tasks, as well as drag-and-drop and fill-in-the-blank tasks focused on specific grammar skills.

Various design features are incorporated into the program to help motivate learners and keep them engaged. The program contains features like a progress bar, content badges, and achievement certificates so students see evidence of their progress and learning. To support student learning with appropriately challenging materials, an auto-placement tool suggests where in the program’s 19 levels a student should start. Furthermore, the program is adaptive and incorporates a scaffolded learning design: if a learner fails to provide the correct answer to an activity after two attempts, they are guided toward a supported round of the activity in which the target sentence is broken down into smaller chunks with explicit repetition and, at higher levels, also includes metalinguistic feedback (Ai, 2017).

In addition to the student program, scripted teacher-led lesson plans are recommended to educators to use with students by either pre-teaching content and language skills, or re-teaching skills that students may need additional practice with. These lessons are available through the program’s progress monitoring platform where educators have access to student program activity in an online platform, including student achievement (e.g. accuracy on activities), progress (e.g. number of units completed), and usage (e.g. total minutes spent in the program). These are additional features which support educators in providing targeted oral language practice to learners in the classroom setting.

## Using CALL tools for ELs during the pandemic

In the US, ELs have been one of the most heavily affected groups by the COVID-19 pandemic (OCR, 2021, pp. 18–21). The pandemic exacerbated challenges that ELs already faced, including reduced access to high-quality instructional resources and grade-level content (Murphy & Torff, 2019) and limited opportunities to practice speaking English (GAO, 2020). This has presented numerous challenges for educators in states with high numbers of ELs. California has the highest percent of K-12 ELs in US public schools at 19.4% (NCES, 2021); 23% for elementary-age (K-5) students (CDE, 2021b). In March

2020, California closed in-person instruction for nearly all K-12 public school students (Cano & Wiener, 2020). By the start of the new school year in August 2020, however, California rapidly oscillated between in-person, remote, and hybrid instruction. In this study, we examine the effects of using the Lexia English CALL program in a large-scale implementation context during the 2020–21 school year from one California school district. We evaluate whether use of this tool as part of instruction for ELs leads to improved student learning, as measured by scores from an English language proficiency assessment. Although standardized tests do not capture all that students learn, high English language proficiency test scores can help ELs to be reclassified as Fluent English Proficient (CDE, 2021a), which has long-term implications for student academic success in the US (Johnson, 2019). English language proficiency tests measure a wide range of linguistic structures and vocabulary, in contrast to most researcher-developed measures. They also incorporate all four domains of language (speaking, listening, reading, and writing), and thus are an appropriate outcome measure for examining a learner’s overall language proficiency. We pose the following research question: Can a CALL tool focused on academic English and oral language skills improve the English language proficiency outcomes of young ELs? We hypothesize that use of a CALL program focused on the development of academic English and oral language skills will positively impact students’ English language proficiency test scores, as evidenced by significantly<sup>2</sup> higher scores for students that use the program compared to students that do not.

## Methods

We used a quasi-experimental design, in which students who used Lexia English in a school district were compared to students in the same district who did not use the program and adopted an observational approach by analyzing extant secondary data available in district records. We used a purposive sampling method by recruiting a partner district with relatively strong implementation of Lexia English in the first year that it was available to students. This is an important factor as it allows us to investigate effects of program use on student outcomes given that districts may have access to a program but not actually utilize it with their students. Specifically, 46.8% of students were using the program for at least 30 min weekly during the school year. Once we identified the partner district, we signed a data exchange agreement with the district to share anonymized student demographic and assessment data from the English Language Proficiency Assessment for California (ELPAC).

## Participants

The district shared data for all elementary students receiving EL services in the 2020–21 school year. These students were labeled as “EL” according to state guidelines (CDE, 2021a). The analytic sample included 2034 ELs in grades K-5 across 21 schools. All district educators and ELs had access to the CALL program in the 2020–21 school year, including the online program and teacher-led lessons. However, based on changes in school and home learning environments due to the pandemic, students differed greatly in terms

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<sup>2</sup> We consider statistical significance to be at the  $\alpha=0.05$  level.

of how often they used the program or whether they used it at all. Thus, we constructed the treatment group based on whether students had completed at least one program unit ( $n=1478$ ). Students in the comparison group ( $n=556$ ) did not use the program. Educators had autonomy over how they instructed some students but not others to use the CALL program, although we do not have data on how these decisions were made for each student. However, we present results from an educator survey around implementation and return to this in the Limitations section. Given that sample sizes were not equal between treatment and comparison groups,<sup>3</sup> we included various student and school-level fixed effect predictors in our statistical analyses to account for any unintended group differences (Shadish et al., 2002).

Students in the sample were diverse. Most identified as Hispanic (44%) or Asian (41%), and female students represented 45% of the analytic sample. In total, students spoke 50 different home languages, with the most common being Spanish (44%). Additionally, 46% of students qualified for free-or-reduced priced lunch (FRL), which is a proxy for low socioeconomic status. Students were distributed across grade levels: 20.5% in kindergarten, 21.9% in 1st grade, 17.2% in 2nd grade, 15.8% in 3rd grade, 12.7% in 4th grade, and 11.8% in 5th grade. Table 1 shows that demographic characteristics were similar between the treatment and comparison groups.

Due to cancellations of standardized testing in March 2020 as a result of COVID-19, prior year achievement data was missing for most students. However, a subset of students did have this data ( $n=307$ ) since they tested prior to closures due to the pandemic. The demographic makeup of this group (Table 1) differed from the full analytic sample in that there was a lower percentage of Asian students and higher percentages of Hispanic students, students with Spanish as their home language, and FRL-eligible students. Additionally, the subsample of students was mostly concentrated at higher grades. Specifically, 45.3% were in 4th grade, and 42.3% in 5th grade. Kindergarten students were not included in the subsample due to lack of prior achievement scores (ELPAC testing begins in kindergarten).

## Instructional materials

Students in the comparison group did not use the CALL program and received “business-as-usual” instruction instead. Based on documentation from the school district, all new ELs in the district were enrolled in Structured English Immersion environments, where English is the primary language of instruction. The district-adopted core curriculum for English language arts, which all ELs received, was *Units of Study* (<https://www.heinemann.com/collection/uos-k5r>) and all students in the district had other supplemental digital literacy tools available to them which were focused on building reading comprehension strategies and foundational literacy skills. Thus, students in the comparison group likely used other educational technology tools which reinforced reading and writing-related skills. This contrasts with the speaking and listening-focused instruction provided by the CALL program. In addition to core English literacy instruction, the state of California requires ELs to receive daily specific English language development instruction, and the district

<sup>3</sup> Chen and Liu (2019) provide approximate sample sizes for educational technology research, according to which the sample size in the current study is in line with proposed sizes for detecting an effect size of 0.20 at  $\alpha=0.05$  and a power of 0.80.

**Table 1** Descriptive statistics

	Full sample			Prior achievement subsample		
	Comparison	Treatment	All	Comparison	Treatment	All
N (%) Female	235 (42)	687 (46)	922 (45)	37 (42)	95 (43)	132 (43)
N (%) White	72 (13)	155 (10)	227 (11)	12 (14)	25 (11)	37 (12)
N (%) Hispanic	198 (36)	706 (48)	904 (44)	41 (47)	108 (49)	149 (49)
N (%) Black	8 (1)	21 (1)	29 (1)	0 (0)	7 (3)	7 (2)
N (%) Asian	266 (48)	570 (39)	836 (41)	33 (38)	71 (32)	104 (34)
N (%) Other	12 (2)	26 (2)	38 (2)	2 (2)	8 (4)	10 (3)
N (%) Spanish home language	199 (36)	697 (47)	896 (44)	40 (45)	109 (50)	149 (49)
N (%) Free-reduced lunch	229 (41)	708 (48)	937 (46)	52 (59)	108 (49)	160 (52)
Mean (SD) ELPAC 20–21 overall scale score	1472 (109)	1487 (70)	1483 (83)	1518 (54)	1513 (51)	1514 (52)
Mean (SD) ELPAC 20–21 oral scale score	1470 (107)	1488 (69)	1483 (81)	1512 (61)	1512 (60)	1512 (60)
Mean (SD) ELPAC 20–21 written scale score	1473 (126)	1487 (93)	1483 (104)	1523 (61)	1514 (53)	1517 (56)
Total students	556	1478	2034	88	219	307

emphasized development of students' productive language skills in relation to academic content and themes. During remote instruction, all EL students continued to receive designated English-language instruction and were provided with a district laptop where they could access Lexia English and other digital learning tools at home. Due to rapidly changing public health guidelines, we were unable to collect observational data on how the district's English-language programs were implemented for treatment and comparison students.

The district had access to the CALL program since the start of the school year in August 2020. For our analyses, we restricted program usage data between August 2020 and the start of the district's ELPAC testing date in February 2021. As seen in Table 2, program usage for the treatment group was similar between the full sample and the prior achievement subsample. On average, students used the program for 11 weeks. There was greater variability in average weekly minutes for the subsample compared to the full analytic sample, and a slightly lower number of program units completed. A program unit consists of multiple activities around a single topic, and on average, takes about five minutes to complete.

### Assessment of English language proficiency

The ELPAC is a standardized language proficiency test which all ELs in California are required to take once a year until they are reclassified as Fluent English Proficient. It assesses academic English language proficiency in reading, writing, listening, and speaking, and it is aligned to California English language development standards (2021a; CDE, 2014). The ELPAC provides scores on a vertical scale (1150–1700 grades K-2, 1150–1800 grades 3–5) for the overall test as well as for the oral domain (speaking and listening) and written domain (reading and writing; CDE, 2021a). For each grade, the overall and domain scale scores are also grouped into four performance levels (minimally developed, somewhat developed, moderately developed, and well developed).

We analyze scores and proficiency levels from the spring 2021 ELPAC, which students took between February and May 2021 (the standard ELPAC testing window). We transformed raw scale scores into standardized z-scores by subtracting the grade-specific mean from each students' test score and dividing that difference by the grade-specific standard deviation. This transformation expresses all students' test scores as deviations from their grade-specific mean, and it helps to disentangle the relationship between students' enrolled grade and their test scores (i.e., students in higher grades tend to score higher). Since this study did not use a randomized-controlled design, we interpret differences in standard deviation units as comparable to effect sizes (ESs), as opposed to other statistics which directly compare true treatment and comparison groups

**Table 2** Program usage data (treatment group)

	Full sample (n = 1478)	Prior achievement subsample (n = 219)
Mean (SD) minutes program use per week	42 (48)	41 (76)
Mean (SD) total weeks used	11 (8)	11 (9)
Mean (SD) total program units completed	85 (119)	79 (111)



(e.g. Hedge's *g*). This also allows the “effect” of CALL program use to be expressed in standard deviation units. For proficiency levels, we created a binary proficiency variable (1 = proficient, 0 = non-proficient) based on performance levels. Students with a performance level of 4 (“well developed”) were considered proficient, otherwise they were labeled as non-proficient. ELPAC level 4 is one criterion used for reclassifying ELs as Fluent English Proficient (<https://www.cde.ca.gov/sp/el/rd/reclass1920.asp>).

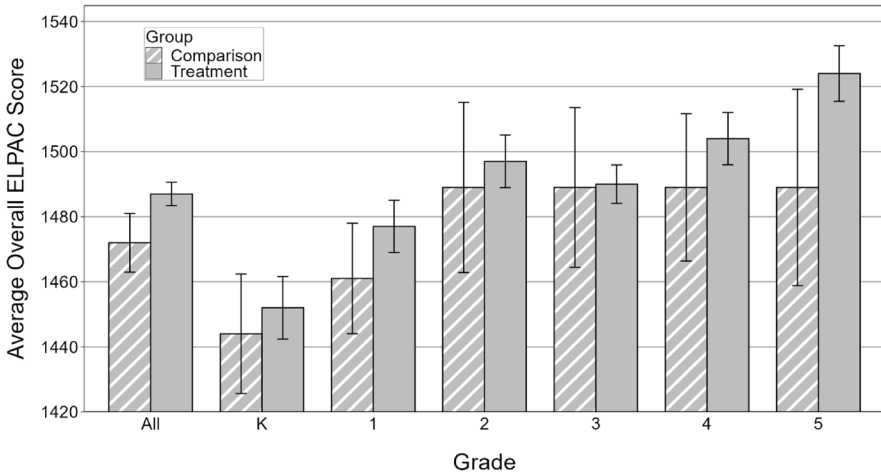
## Implementation survey

To better understand how the CALL program was being implemented, we developed and administered two online surveys to instructors in California. The first survey (respondent  $n=42$ ) was administered in October 2020 and the second in March 2021 (respondent  $n=95$ ). The surveys contained rating scale questions related to how the program was being used.

## Analytic approach

We fit a series of multiple regression models, using linear regression for the standardized ELPAC scale scores and logistic regression for the proficiency analysis (1 = proficient, 0 = not proficient). For both analyses, our models included a main effect for whether a student used Lexia English (1 = treatment, 0 = comparison), and statistical controls for students' demographic characteristics and enrolled school. We controlled for demographic differences between treatment and comparison groups by creating dummy variables for gender (1 = female, 0 = male), free-reduced price lunch eligibility (1 = yes, 0 = no), ethnicity, and home-language. Ethnicity was included as several dummy-coded variables (1 = Group membership, 0 = non-membership) based on whether a student was Hispanic, Black, Asian (including “Asian,” “Filipino,” “Pacific Islander”), White, or Other (including “American Indian or Alaskan Native”, “Two or More Races”). We represented home-language differences based on whether a student spoke Spanish at home or not (1 = yes, 0 = no) since Spanish was the dominant home language among students in our sample. We also added a student's enrolled school as a predictor to further control for variability in CALL program implementation across schools. Finally, prior year achievement data was available for a small subset of students. Prior year achievement is often a strong predictor of educational outcomes (i.e., students who are generally high-achieving may influence outcomes), and may confound estimates of the effect of a program. Thus, we ran separate, secondary analyses for the prior achievement subsample using the same regression models described above to test the sensitivity of our results.

For the regression model results, we present coefficients for Lexia English use, which is our primary variable of interest to estimate the effect of the program, as well as for various demographic predictor variables. Greater predicted English language outcomes for the treatment group relative to the comparison groups are represented by positive coefficients for standardized score analyses and coefficients greater than 1 for proficiency analyses. We present coefficients for control variables, but do not interpret them as we had no a-priori hypotheses of effects.



**Fig. 2** Average, unadjusted overall ELPAC scores by grade with 95% confidence interval bars

## Analysis and results

### ELPAC standardized score results

As shown earlier in Table 1, on average, the treatment group scored 15 points higher than the comparison group on the overall ELPAC. Figure 2 shows that this pattern holds across grades.

The regression analyses, shown in Table 3, confirmed these descriptive trends. Students in the treatment group scored significantly higher on the ELPAC than students in the comparison group. For the overall ELPAC, students who used the CALL program were predicted to score, on average, 0.197 SDs above their grade-specific mean after controlling for student demographics and school-related differences, compared to students who did not use the program. This means that ELs who used the CALL program have higher language proficiency outcomes than ELs who receive traditional instruction.

For the ELPAC oral and written subdomain scores, after controlling for student demographics and school-related differences, students who used the CALL program were predicted to score, on average, 0.224 SDs above their grade-specific means on the ELPAC oral subdomain and 0.153 SDs on the ELPAC written subdomain compared to students who did not use the CALL program. Both these effects were statistically significant, and the larger effect for the oral subdomain aligns with the program's emphasis on development of oral language skills.<sup>4</sup>

We conducted separate regression analyses with the same demographic and school-related fixed effects, as well as a fixed effect for grade (contrast-coded) and an interaction term for CALL program use by grade. We then analyzed pairwise contrasts to compare students in treatment and comparison groups by grade; coefficients are shown in Table 4.

<sup>4</sup> Although we do not have the proper experimental design to support using Hedge's  $g$  and Cohen's  $d$ , we report calculations here for comparison: overall ELPAC ( $d=0.187$ ,  $g=0.187$ ), ELPAC oral ( $d=0.211$ ,  $g=0.211$ ), ELPAC written ( $d=0.130$ ,  $g=0.130$ ).

**Table 3** Regression results for ELPAC scores analysis (standardized z-scores)

	Full sample			Subsample with prior achievement		
	Overall	Oral	Written	Overall	Oral	Written
	Intercept	- 0.268* (0.116)	- 0.164 (0.119)	- 0.335** (0.117)	0.014 (0.146)	- 0.018 (0.188)
Lexia English use	0.197*** (0.051)	0.224*** (0.052)	0.153*** (0.051)	0.037 (0.075)	0.020 (0.097)	0.060 (0.083)
Prior year score	-	-	-	0.534*** (0.033)	0.501*** (0.044)	0.494*** (0.036)
Free-reduced lunch	- 0.214*** (0.048)	- 0.148** (0.049)	- 0.255*** (0.048)	- 0.048 (0.066)	- 0.046 (0.085)	- 0.052 (0.073)
Gender (female)	0.117** (0.040)	0.084* (0.041)	0.117** (0.041)	0.003 (0.056)	0.045 (0.073)	- 0.021 (0.062)
White	0.069 (0.143)	0.119 (0.147)	0.034 (0.144)	0.132 (0.178)	0.327 (0.230)	- 0.045 (0.196)
Black	- 0.183 (0.218)	- 0.171 (0.222)	- 0.138 (0.218)	- 0.184 (0.246)	- 0.028 (0.318)	- 0.330 (0.270)
Asian	0.152 (0.139)	0.217 (0.142)	0.099 (0.139)	0.131 (0.174)	0.393● (0.224)	- 0.142 (0.192)
Other	0.301● (0.183)	0.335● (0.187)	0.248 (0.183)	- 0.037 (0.193)	0.060 (0.249)	- 0.078 (0.211)
Non-Spanish home language	0.209 (0.137)	0.054 (0.140)	0.306* (0.137)	0.058 (0.164)	- 0.227 (0.212)	0.346● (0.180)
School fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
R <sup>2</sup>	0.195	0.159	0.193	0.552	0.399	0.501

Standardized coefficients presented first, standard errors in parentheses. Prior year scores were included as standardized z-scores for overall, oral, and written domains depending on the analysis

\*  $p < .05$

\*\*  $p < .01$

\*\*\*  $p < .001$

●  $p < .10$

**Table 4** Coefficients for CALL program use by grade

	Full sample			Subsample with prior achievement		
	Overall	Oral	Written	Overall	Oral	Written
Kindergarten	0.054 (0.099)	0.113 (0.102)	0.025 (0.099)	–	–	–
Grade 1	0.135 (0.095)	0.113 (0.097)	0.134 (0.095)	–	–	–
Grade 2	0.386** (0.126)	0.435** (0.129)	0.288* (0.127)	–	–	–
Grade 3	0.188 (0.120)	0.210● (0.123)	0.136 (0.120)	–	–	–
Grade 4	0.172 (0.128)	0.320* (0.131)	0.099 (0.128)	0.024 (0.103)	0.033 (0.137)	0.002 (0.115)
Grade 5	0.468** (0.139)	0.382** (0.142)	0.505** (0.139)	0.143 (0.113)	0.061 (0.150)	0.217● (0.126)

Standardized coefficients presented first, standard errors in parentheses

\* $p < .05$

\*\* $p < .01$

\*\*\* $p < .001$

● $p < .10$

Similar results were seen for the overall ELPAC and ELPAC written subdomain. Specifically, students who used the CALL program were predicted to score significantly higher than students who did not in grades 2 and 5, although positive effect sizes were seen for all other grades. The largest effect sizes were seen for 5th grade students. For the ELPAC oral subdomain, significant positive effects of using the CALL program were seen for grades 2, 4, and 5, with the largest effect for grade 2, and a positive effect approaching significance for grade 3 ( $p = 0.087$ ).

### ELPAC proficiency results

The proficiency analysis results are presented in Table 5. Coefficients represent odds ratios, where an odds ratio of 1 means that there are even odds of attaining proficiency (i.e., the variable does not affect the outcome); values greater than 1 are associated with higher odds of an outcome and less than 1 are associated with lower odds. Students who used the CALL program and students who did not were found not to be significantly different in terms of English proficiency, both for the overall ELPAC and subdomains. As seen in Table 5, coefficients for Lexia English use are greater than 1 for the overall ELPAC and oral subdomain, which is the expected direction if using the program increases a student's English language proficiency odds. However, these effects are not statistically significant, which may be due to the intensity of the intervention.

### Sensitivity analyses

We conducted sensitivity analyses for the subset of students with prior year ELPAC scores (see Table 3). This revealed that there were no significant differences in standardized scores for the overall ELPAC, ELPAC written subdomain, and ELPAC oral subdomain between

**Table 5** Logistic regression results for proficiency analysis

	Full sample			Subsample with prior achievement		
	Overall	Oral	Written	Overall	Oral	Written
	Intercept	0.204*** (0.071)	0.933 (0.255)	0.083*** (0.039)	0.102* (0.095)	1.497 (1.023)
Prior year proficient	-	-	-	8.191*** (4.745)	4.567*** (1.636)	14.925*** (10.903)
Lexia English use	1.042 (0.143)	1.065 (0.133)	0.939 (0.136)	1.250 (0.511)	1.063 (0.380)	0.812 (0.404)
Free-reduced lunch	0.416*** (0.057)	0.514*** (0.061)	0.363*** (0.058)	0.646 (0.254)	0.485* (0.154)	0.426 (0.225)
Gender (female)	1.034 (0.116)	0.990 (0.098)	1.098 (0.134)	1.004 (0.331)	0.933 (0.251)	0.741 (0.326)
White	0.960 (0.391)	0.989 (0.346)	0.682 (0.304)	0.464 (0.595)	1.466 (1.252)	0.097 (0.151)
Black	0.350 (0.257)	0.286 (0.183)	0.391 (0.294)	0.000 (0.000)	0.207 (0.289)	0.000 (0.000)
Asian	1.063 (0.420)	1.022 (0.346)	0.742 (0.318)	0.230 (0.290)	0.837 (0.701)	0.168 (0.247)
Other	1.289 (0.667)	1.823 (0.816)	0.677 (0.392)	0.078 (0.134)	0.593 (0.585)	0.146 (0.269)
Non-Spanish home language	2.526* (0.995)	1.948* (0.651)	3.390** (1.469)	6.158 (7.661)	1.230 (0.983)	9.704 (13.910)
School fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Tjur's R <sup>2</sup>	0.186	0.126	0.152	0.174	0.180	0.209

Odds ratios presented first, standard errors in parentheses

- p* < .05
- \*\**p* < .01
- \*\*\**p* < .001
- p* < .10

students who used Lexia English and students who did not. The positive regression coefficients for Lexia English use suggest that students who used the program were predicted to score, on average, 0.037 SDs above their grade-specific mean on the overall ELPAC, 0.020 SDs on the ELPAC oral subdomain, and 0.060 SDs on the ELPAC written subdomain, compared to students who did not use the program. These effect sizes are all smaller than those in the full sample analysis but are nonetheless still positive.

We conducted a separate sensitivity analysis with just students in grades 4 and 5 (given the small numbers of students with prior achievement scores in 1st, 2nd, and 3rd grades) to examine the interaction of CALL program use by grade (see Table 4). This revealed positive, but non-significant effects of Lexia English use on all three ELPAC score outcomes. For grade 5, students who used the CALL program were predicted to score, on average, 0.217 SDs above their grade-specific mean on the written ELPAC, compared to students who did not, and this approached significance ( $p=0.087$ ).

Additionally, we conducted proficiency analyses following the same methods as the full sample analyses and including a prior year achievement variable. This revealed no differences between the treatment and comparison groups, seen in Table 5. Odds ratios for Lexia English use for overall ELPAC and ELPAC oral subdomain are greater than 1, which is the expected direction if use of the CALL program increases a student's odds of attaining a high level of English proficiency. The lack of significant effects across all models for the prior achievement subsample may be due in part to extraneous variables, such as cognitive-linguistic development, or potential grade-specific confounds due to only including students in grades 4 and 5. We return to this in the discussion.

## Survey results

We analyzed survey results to better understand how Lexia English was being implemented across California in fall 2020 and spring 2021. Educators reported using the CALL program with learners primarily during ESL instructional blocks (fall: 89%; spring: 77%), and students were using the program both at school and at home (47% fall 2020; 31% spring 2021). Only 40% of respondents in fall 2020 and 19% in spring 2021 reported using the teacher-led lessons. Of those educators who reported not using these lessons, the majority cited reasons due to time limitations (fall: 67%; spring: 65%). Those who responded “yes” reported using these lessons at least twice per week (fall: 80%; spring: 46%). Overall, these responses reflect California's shift to hybrid and/or remote instruction for the majority of the 2020–21 school year and the challenges that this may have introduced for educators in fully utilizing components of Lexia English apart from the online program.

## Discussion

The results showed that a CALL program focused on academic English and oral language skills may lead to improved student English language learning. Specifically, students who used the CALL program scored higher than students who did not on a standardized English language proficiency assessment, including 0.197 SDs higher on the overall assessment, 0.224 SDs higher on the oral domain (listening, speaking), and 0.153 SDs higher on the written domain (reading, writing). Importantly, these effects hold when student demographics and school-related differences are also accounted for. Grade-specific interactions revealed significant effects for grades 2 and 5 for overall and written subdomain scores.

For oral subdomain scores, significant effects of CALL program use emerged for grades 2, 4, and 5, and a marginal effect for grade 3, consistent with the program's emphasis on the development of oral language skills. It is unclear why the effect of CALL program use was not more consistent across grades and is a question that warrants further investigation. Proficiency analyses did not yield any significant results, although use of the CALL program was still associated with greater odds of being English proficient for the overall ELPAC and oral subdomain. We speculate that the lack of significant results may be due to a couple different reasons. One possibility relates to intervention intensity. Due to COVID-19 circumstances, students had considerable agency over how much they used the program and educators may have varied in the extent to which they provided students with additional targeted instruction via the offline, teacher-led lessons. Another possibility is that students may have differed in other cognitive-linguistic skills that are relevant for additional language acquisition in children. For example, metalinguistic control and phonemic awareness have been shown to predict grammar comprehension in instructional contexts where English is taught as a foreign language (Kieseier et al., 2022). This remains speculative, however, as we did not administer any cognitive assessments to students. Overall, we remain cautious in our interpretations given that there was a limited amount of prior achievement data. That is, we cannot rule out the possibility that these positive outcomes are based to some degree on higher-achieving students using the CALL program. The lack of significant program effects for the prior achievement sample may have also been confounded with grade-specific effects, as only students in grades 4 and 5 were included in these sensitivity analyses. Although the results are promising, clearly this is an area for further investigation as we aim to better understand the contexts and for who such a CALL program is effective.

The results align with positive effect sizes (ESs) reported for other CALL tools and English-language education. The ESs seen in this study are consistent with those reported for bilingual education in the US (Rolstad et al., 2005; ES=0.23). While the CALL tool presented in this study is not meant to replace bilingual education, this study provides promising evidence that such CALL tools can be incorporated into English language education programs to facilitate student learning and proficiency development. The positive ESs are also similar to those found in studies of CALL programs used by older students in the US (Harper et al., 2021) and younger children in English as a Foreign Language contexts (Bang et al., 2020), although not as large in magnitude possibly due to differences in study settings and outcome measures (Grgurović et al., 2013; Lee et al., 2020). The results presented here may represent an underestimate of the true effect of the program if it is implemented as designed and intended, in classroom settings as opposed to remote and hybrid learning environments.

The results highlight the importance of research into how CALL tools can be used to provide structured support for students' oral language development, which may help improve students' language proficiency. Education research has shown evidence of improved English language outcomes broadly for ELs who receive targeted oral language instruction and practice (Vaughn et al., 2006; Wang, 2021). However, there is limited research on CALL tools specifically for oral proficiency development (Bang et al., 2020; Harper et al., 2021), and less so on academic language in contexts where English is the medium of instruction (c.f. Alvarez-Marinelli et al., 2016). Research with technology for young ELs has primarily focused on written language or foundational literacy skills (Guo et al., 2023; Kazakoff et al., 2018; Lee et al., 2020), which may not necessarily lead to improvements in broader, standardized measures of speaking and listening for comprehension (Ysquierdo, 2018). Relatedly, few studies have looked at high-stakes standardized

assessments for language learning outcomes (Harper et al., 2021; Wang, 2021; Ysquierdo, 2018). The positive results here also provide evidence for the effectiveness of adaptive learning designs in CALL programs specifically for oral language development (Slavuj et al., 2017), an area which has been underexplored. In particular, the CALL program examined in this study combines elements of an intelligent language tutor by incorporating an adaptive learning design with automatic corrective feedback (Slavuj et al., 2017) which becomes more explicit in nature based on student accuracy in the activity and their level in the program (Ai, 2017). These features help personalize learning to address specific areas where a student may need additional support and practice. Finally, the results may have implications for the benefits of dialogue-based CALL tools (Bibauw et al., 2022). Note that the program activities are framed as scripted, academic conversational interactions with program characters, and not free, open-ended dialogue. Nevertheless, the CALL program examined here is not intended to replace real-life conversational interactions, and its affordances lie in complementing classroom instruction.

As a last point, we examined the effectiveness of a CALL tool in an authentic, large-scale implementation context using a student sample that is diverse in demographic characteristics (e.g. home language, age). This is in contrast to highly controlled studies which focus on students from similar backgrounds and age (e.g. Bang et al., 2020; Vaughn et al., 2006). In this way, we may be able to generalize program effect sizes better than some experimental studies, and also may expect similar outcomes for use of such CALL tools in other contexts where English is the dominant language of schooling.

## Limitations and future directions

This study has a few limitations. First, we did not randomly assign students to use the CALL program or not, which limits our ability to make causal claims between program use and language outcomes. Survey data revealed that educators were primarily using the CALL program during ESL instruction, although we cannot say how they chose to allocate program use amongst ELs. It is possible, for example, that educators strategically assigned students with relatively weak oral language skills to use the CALL program rather than other reading- and writing-focused tools. This is speculative and remains open for further investigation. Nevertheless, we statistically controlled for student and school characteristics to account for any systematic differences between treatment and comparison groups. Given that the sample was relatively large and diverse in terms of grades, genders, socioeconomic status, and linguistic backgrounds, the findings may still generalize to young ELs from different backgrounds. Additionally, we collected only a limited amount of prior year achievement data from a non-representative group of students to tease apart the extent to which learning outcomes are driven by the program itself compared to being driven by higher-achieving students using the program. When prior achievement scores were incorporated in the sensitivity analyses, use of the CALL program was still positively associated with positive learning outcomes, although these effects were non-significant. Finally, we were not able to conduct classroom or home observations to directly examine how the program was being implemented, due to pandemic-related social-distancing restrictions. However, the survey data does provide some information about how educators were using the program with students. Incorporating observational data of students and educators would help shed light on the mechanisms behind the effectiveness of the program.



## Conclusion

The promising outcomes of this study point to the value of incorporating CALL tools focused on oral language development, such as Lexia English, into English language education for ELs. Programs focused on explicit instruction for learning academic English and developing oral language skills may help young ELs attain greater overall English language proficiency by providing targeted instruction which classroom learners and educators may otherwise have limited time for. Overall, this study contributes to theory-informed research and development of effective classroom educational technology tools for language learning and literacy development in young learners.

## Declarations

**Employment** This submission evaluates the effectiveness of a commercial product. All three authors were salaried employees of Lexia at the time of the study, and they do not receive commission on sales of products. Teachers and schools carried out the implementation of the program independently.

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