Can CAI Improve Reading Achievement in Young ELL Students?

Haya Shamir, Kathryn Feehan, Erik Yoder and David Pocklington
Waterford Research Institute
hayashamir@waterford.org, kathrynfeehan@waterford.org, erikyoder@waterford.org, davidpocklington@waterford.org

Abstract

This study explored the effectiveness of a comprehensive computer-adaptive reading program of teaching kindergarten and second grade students' early reading concepts; specifically, the impact on early literacy skills of English Language Learners (ELL). Students attended two different districts in Texas and Florida during the 2015-2016 school year. The experimental groups used the CAI program, and the control groups either had low usage of the CAI program or did not use the CAI program depending on the district. Analyses revealed the ELL students in the experimental group outperformed students in the control group on standardized literacy assessments. These results indicate that the use of a CAI program in addition to the traditional classroom setting could have a great impact on early literacy skills, especially for students that are learning English as a second language.

Keywords: CAI, Literacy, ELL, Early Childhood Education
Main Conference Topic: Research on Technology in Education

Introduction

English Language Learners (ELL), students learning English as their second language in school, account for a significant and increasing percentage of the American student body (National Center for Education Statistics [NCES], 2015). In the 2013-2014 school year, over 4 million students, 9.3 percent of students attending public schools, participated in programs for ELL education and were assimilating into a new language and a new culture. In recent history, the percentage of the student body accounted for by ELL students has risen by as much as 10 percent, and there has been a corresponding increase in funding directed towards ELL programs in this same period (Horsford & Sampson, 2013). ELL students are, contrary to what may be the popular conception, not a homogenous group. Linguistic backgrounds for ELL students in the United States are drawn from all around the globe, and, while the majority are Spanish speaking, Korean, Vietnamese, Russian, Chinese, and many others are also represented (Office of English language Acquisition [OELA], 2015).

Young ELL students are likely to suffer from a number of disadvantages throughout their academic career in comparison to their peers. ELL status is correlated with low academic achievement as well as low socioeconomic status (Kanno & Cromley, 2013). In elementary school a typical student learns how to learn, acquiring the foundational building blocks for academic success. A young ELL student has to do the same thing while, at the same time, acquiring a new and unfamiliar language. For many students this process can start from the ground up with an entire new alphabet (Levitan, Mathison, & Billings, 2010). First generation ELL students may find it difficult to both practice this new language at home and receive help from their parents or guardians (Castañeda, Rodriguez-Gonzalez, Schultz, 2011). By middle school a disproportionate percentage of ELL students fail to meet a basic level of reading proficiency (NCES], 2015). Compared to English proficient students, ELL students are more

likely to drop out of high school and half as likely to achieve a bachelor's degree (Kanno & Cromley, 2013).

ELL status can isolate students. ELL students can miss out on contextual information and nuance that would be evident to a native speaker (Munro & Derwing, 1995). An ELL student's education might be impeded by unfamiliarity with a teacher's accent or another student's diction. Difficulty communicating with the class can make it harder to engage with a lesson, and difficulty communicating with a teacher can make it harder to get meaningful feedback. Outside of the classroom, ELL students are less likely to participate in academic or artistic extracurricular activities (Lariviere, 2016). By the end of high school an ELL student will be half as likely to participate in a musical ensemble as non-ELL students (Elpus & Abril, 2011).

Sheltered Instruction Observation Protocol (SIOP) is an example of a validated approach to educating ELL students by directly addressing the isolating effect of not speaking the lingua franca (Echevarria, Vogt, & Short, 2013). SIOP seeks to engage the student in the lesson plan. The approach calls for tailoring material to the individual student's level of competency, as well as providing them with regular opportunities for interaction and meaningful feedback. SIOP has a demonstrated track record of increasing academic success (Echevarria, Vogt, & Short, 2013). There are interesting parallels that can be drawn between the strengths of SIOP and the structural benefits of computer-assisted instruction (CAI). Like SIOP, CAI facilitates engagement with the curriculum and can provide individualized performance-appropriate lesson plans for each student. Also like SIOP, CAI has been demonstrated to increase academic achievement for ELL students. Research has shown ELL students instructed with CAI to be more engaged with the material than control students instructed with a traditional curriculum (Billings & Mathison, 2012). Randomized trials have shown that students receiving CAI augmented education have better post-test performances on literacy measures compared to students using strictly conventional approaches (Al-Mansour & Al-Shorman, 2009). Students receiving computer-assisted language learning tend to outperform their peers receiving traditional instruction on reading comprehension measures (Marzban, 2011).

Emerging technologies are also taking the education of ELL students out of the classroom. The use of mobile devices, such as cell phones and tablets, in English language education is becoming more widespread as those technologies become increasingly accessible (Kukulska-Hulme, Norris, & Donohue, 2015). These mobile approaches have been shown to rapidly improve linguistic skills such as spelling, grammar, and vocabulary (Chinnery, 2006). Recent research into a web-based multi-media platform designed to teach grammatical skills showed that the technology produced a conducive environment by entertaining, engaging, and educating its users (Baturay, Daloglu, & Yildrim, 2010). The use of CAI remains a relatively new approach to educating ELL students, and further research is necessary in order to ensure that these emerging technologies are leading to better learning outcomes.

Methods

Participants

District 1. The first district consisted of 3,326 students enrolled in a public school district in Texas during the 2015-2016 school year. Approximately 40% of the students in the district are Hispanic, 30% are Caucasian, and 15% are African American.

District 2. The second district consisted of 3,589 kindergarten and second grade students enrolled in a public school district in Florida during the 2015-2016 school year. The majority of students in the district are Hispanic or Caucasian, and approximately one-half of the students qualify for free lunch.

Materials

***Computer-adaptive Software*.** The program offers a comprehensive, computer-adaptive pre-reading and 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 Texas Primary Reading Inventory (TPRI). The TPRI is an early reading assessment designed to identify the reading development of students in kindergarten through third grade and is administered to students individually. The test identifies students that are at risk for reading difficulties and sets learning objectives for these students.

VLT. The VLT is a county reading and writing test used to determine a student's instructional level in reading and writing according to Florida State Standards in kindergarten, first grade, and second grade.

Procedure

Kindergarten experimental students were expected to use the adaptive curriculum for fifteen minutes per day, five days per week throughout the 2015-2016 school year, and second grade experimental students were expected to use the adaptive curriculum for thirty minutes per day, five days per week throughout the 2015-2016 school year.

In the first district, the TPRI was administered at the beginning and end of the year. In the second district, the VLT was administered at the end of the 2015-2016 school year.

Findings

District 1

Kindergarten

The analysis includes students that participated in the TPRI test at the beginning and at the end of the year. The experimental group for kindergarten (n = 212) consisted of students who used the adaptive curriculum throughout the 2015-2016 school year. The control group (n = 1,484) consisted of students who did not use the adaptive curriculum during the 2015-2016 school year, but instead received traditional in-class literacy instruction instead for the same amount of time that the experimental group received CAI instruction. Thus, overall exposure to literacy instruction was the same for both groups.

Group Differences Using Independent Samples t-tests. Independent samples t-tests examining gains from beginning of year scores to end of year scores were conducted (Table 1).

Letter Name Identification. Analysis of gains revealed a significant difference between groups $t(1, 438) = -5.74$, $p < .01$ due to higher gains made by students in the experimental group (M = 12.03) than by control students (M = 5.63). Effect size (d = 0.74).

Letter to Sound Linking. Analysis of gains revealed a significant difference between groups $t(1, 301) = -2.51$, $p < .05$ due to higher gains made by students in the experimental group (M = 4.63) than by control students (M = 2.80). Effect size (d = 0.51).

Inferring Word Meaning. Analysis of gains revealed a significant difference between groups $t(1, 1663) = -4.54$, $p < .01$ due to higher gains made by students in the experimental group (M = 0.23) than by control students (M = 0.05). Effect size (d = 0.34).

Linking Details. Analysis of gains revealed a significant difference between groups $t(1, 1672) = -6.68$, $p < .01$ due to higher gains made by students in the experimental group (M = 0.11) than by control students, who decreased in score on average (M = -0.35). Effect size (d = 0.49).

Recalling Details. Analysis of gains revealed a significant difference between groups $t(1, 1670) = -4.01$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.58$) than by control students ($M = 1.36$). Effect size ($d = 0.30$).

Listening Comprehension Total Score. Analysis of gains revealed a significant difference between groups $t(1, 1570) = -7.74$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.96$) than by control students ($M = 1.07$). Effect size ($d = 0.58$).

Table 1: District 1 Overall Kindergarten TPRI Gains by Substrand

	Experimental			Control			
	M	*SD*	*N*	*M*	*SD*	*N*	*p*
Letter Name Identification	12.03	8.51	71	5.63	8.61	369	.00**
Letter to Sound Linking	4.63	3.41	27	2.80	3.63	276	.01*
Inferring Word Meaning	0.23	0.65	207	0.05	0.51	1458	.00**
Linking Details	0.11	1.03	211	-0.35	0.92	1463	.00**
Recalling Details	1.58	0.82	210	1.36	0.74	1462	.00**
Listening Comprehension Total	1.96	1.56	201	1.07	1.51	1371	.00**

Group Differences by ELL Status Using Two-Way ANOVAs. Two-way ANOVAs were conducted to examine the effects of the adaptive curriculum on gains by ELL status for each substrand (Table 2).

Letter Name Identification. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Letter Name Identification gains, $F(1, 436) = 1.84$, $p = .176$. Simple effects analysis showed that ELL students' gains in the experimental group were slightly higher than in the control group, but the difference was not significant.

Inferring Word Meaning. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Inferring Word Meaning gains, $F(1, 1661) = 0.72$, $p = .397$. Simple effects analysis showed that ELL students in the experimental group significantly outperformed students in the control group.

Linking Details. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Linking Details gains, $F(1, 1670) = 0.31$, $p = .576$. Simple effects analysis showed that ELL students in the experimental group significantly outperformed students in the control group.

Recalling Details. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Recalling Details gains, $F(1, 1668) = 0.57$, $p = .451$. Simple effects analysis showed that ELL students in the experimental group significantly outperformed students in the control group.

Listening Comprehension Total. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Listening Comprehension Total gains, $F(1, 1568) = 0.05$, $p = .832$. Simple effects analysis showed that ELL students in the experimental group significantly outperformed students in the control group.

Table 2: District 1 Overall Kindergarten TPRI Gains by ELL Students

	Experimental			Control			
	M	*SD*	*N*	*M*	*SD*	*N*	*p*
Letter Name Identification	6.86	7.98	14	3.42	7.45	59	.18
Inferring Word Meaning	0.33	0.61	43	0.08	0.56	175	.01**
Linking Details	0.43	1.17	44	0.09	1.06	176	.03*
Recalling Details	1.82	0.92	44	1.53	0.81	177	.02*
Listening Comprehension Total	2.57	1.71	42	1.70	1.70	167	.00**

Second Grade

The analysis includes students who participated in the TPRI test at the beginning and at the end of the year. The experimental group for second grade (n = 138) consisted of students who used the adaptive curriculum throughout the 2015-2016 school year. The control group (n = 1,492) consisted of students who did not use the adaptive curriculum during the 2015-2016 school year, but instead received traditional in-class literacy instruction instead for the same amount of time that the experimental group received CAI instruction. Thus, overall exposure to literacy instruction was the same for both groups.

Group Differences Using Independent Samples t-tests. Independent samples *t*-tests examining gains from beginning of year scores to end of year scores were conducted (Table 3).

Graphophonemic Knowledge - Set 1. Analysis of gains revealed a significant difference between groups $t(1, 1604) = -3.51$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.26$) than by control students ($M = 0.88$). Effect size ($d = 0.31$).

Word Reading - Set 1. Analysis of gains revealed a significant difference between groups $t(1, 1437) = -6.84$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.23$) than by control students ($M = 0.55$). Effect size ($d = 0.64$).

Word Reading - Set 2. Analysis of gains revealed a significant difference between groups $t(1, 1448) = -5.62$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.67$) than by control students ($M = 0.98$). Effect size ($d = 0.51$).

Word Reading - Set 3. Analysis of gains revealed a significant difference between groups $t(1, 1453) = -3.68$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.55$) than by control students ($M = 1.09$). Effect size ($d = 0.34$).

Word Reading - Set 4. Analysis of gains revealed a significant difference between groups $t(1, 1453) = -2.79$, $p < .01$ due to higher gains made by students in the experimental group ($M = 1.65$) than by control students ($M = 1.27$). Effect size ($d = 0.26$).

Table 3: District 1 Overall Second Grade TPRI Gains by Substrand

	Experimental			Control			
	M	*SD*	*N*	*M*	*SD*	*N*	*p*
Graphophonemic Knowledge -Set 1	1.26	1.32	136	0.88	1.21	1470	.00**
Word Reading - Set 1	1.23	1.26	126	0.55	1.04	1313	.00**
Word Reading - Set 2	1.67	1.50	131	0.98	1.32	1319	.00**
Word Reading - Set 3	1.55	1.35	131	1.09	1.36	1324	.00**
Word Reading - Set 4	1.65	1.46	131	1.27	1.50	1324	.01**

Group Differences by ELL Status Using Two-Way ANOVAs. Two-way ANOVAs were conducted to examine the effects of the adaptive curriculum on gains by ELL status for each substrand (Table 4).

Graphophonemic Knowledge - Set 1. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Graphophonemic Knowledge - Set 1 gains, $F(1, 1602) = 1.97$, $p = .161$. Simple effects analysis showed that ELL students in the experimental group significantly outperformed students in the control group.

Word Reading - Set 1. There was a significant interaction between the effects of ELL status and the adaptive curriculum on Word Reading - Set 1 gains, $F(1, 1435) = 4.78$, $p < .05$. Simple effects analysis showed that ELL students' gains in the experimental group were slightly higher than in the control group, but the difference was not significant.

Word Reading - Set 2. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Word Reading - Set 2 gains, $F(1, 1446) = 0.08$, $p =$

.781. Simple effects analysis showed that ELL students in the experimental group significantly outperformed students in the control group.

Word Reading - Set 3. There was no significant interaction between the effects of ELL status and the adaptive curriculum on Word Reading - Set 3 gains, $F(1, 1451) = 2.55$, $p = .111$. Simple effects analysis showed that ELL students' gains in the experimental group were slightly higher than in the control group, but the difference was not significant.

Table 4: District 1 Overall Second Grade TPRI Gains by ELL Students

	Experimental			Control			
	M	*SD*	*N*	*M*	*SD*	*N*	*p*
Graphophonemic Knowledge - Set 1	1.41	1.23	34	0.73	1.15	175	.00**
Word Reading - Set 1	0.93	1.41	27	0.69	1.30	160	.28
Word Reading - Set 2	1.55	1.43	31	0.91	1.38	160	.02*
Word Reading - Set 3	1.13	1.45	31	1.03	1.29	160	.71

District 2

Kindergarten

The experimental group for kindergarten (n = 1,287) included students who used the adaptive curriculum for more than 1,000 minutes throughout the 2015-2016 school year. The control group (n = 43) included students who used the adaptive curriculum for less than 500 minutes throughout the 2015-2016 school year. Students in the control group received traditional literacy instruction in the remaining time.

Group Differences Using an Independent Samples t-test. An independent samples *t*-test examining group differences in VLT end of year scores between the experimental group and the control group was conducted (Table 5). Analysis of end of year scores revealed a significant difference between groups, $t(1, 1328) = -1.97$, $p < .05$, due to higher end of year scores made by the experimental students (M = 79.35) than the control students (M = 72.56). Effect size (d = 0.31).

Group Differences by ELL Status Using a Two-Way ANOVA. A two-way ANOVA was conducted to examine the effects of the adaptive curriculum on VLT end of year scores by ELL status (Table 6). There was no significant interaction between the effects of ELL status and the adaptive curriculum on VLT end of year scores, $F(1, 1326) = 3.57$, $p = .059$. Simple effects analysis showed that for ELL students, students in the experimental group significantly outperformed students in the control group.

Second Grade

The experimental group for second grade (n = 2,150) included students who used the adaptive curriculum for more than 1,200 minutes throughout the 2015-2016 school year. The control group (n = 109) included students who used the adaptive curriculum for less than 500 minutes throughout the 2015-2016 school year. Students in the control group received traditional literacy instruction in the remaining time.

Group Differences Using an Independent Samples t-test. An independent samples *t*-test examining group differences in VLT end of year scores between the experimental group and the control group was conducted (Table 5). Analysis of end of year scores revealed a significant difference between groups, $t(1, 2257) = -2.57$, $p < .05$, due to higher end of year scores made by the experimental students (M = 71.24) than the control students (M = 66.19). Effect size (d = 0.25).

Group Differences by ELL Status Using a Two-Way ANOVA. A two-way ANOVA was conducted to examine the effects of the adaptive curriculum on VLT end of year scores by ELL status (Table 6). There was no significant interaction between the effects of ELL

status and the adaptive curriculum on VLT end of year scores, $F(1, 2255) = 0.01$, $p = .913$. Simple effects analysis showed that ELL students' end of year scores in the experimental group were slightly higher than in the control group, but the difference was not significant.

Table 5: District 2 Overall VLT End of Year Scores

	Experimental			Control			
	M	*SD*	*N*	*M*	*SD*	*N*	*p*
Kindergarten	79.35	22.06	1287	72.56	26.91	43	.05*
Second Grade	71.24	20.02	2150	66.19	20.48	109	.01*

Table 6: District 2 VLT End of Year Scores by ELL Students

	Experimental			Control			
	M	*SD*	*N*	*M*	*SD*	*N*	*p*
Kindergarten	69.65	24.42	172	50.00	32.07	8	.01*
Second Grade	63.78	21.08	365	58.59	20.81	22	.23

Conclusions

The purpose of the current study was to evaluate the efficacy of CAI on developing early literacy skills for English Language Learner students. These students typically come to school having to learn a second language, making learning how to read and write a longer and more challenging process than their native English-speaking peers experience. ELL students demonstrated dramatic improvements in learning skills following use of CAI-enhanced curriculum: Use of CAI consistently increased performance on reading metrics. The current study demonstrated this exhaustively by assessing results in terms of gain scores and end of year scores while controlling for beginning of year scores. In all cases, students receiving CAI curriculum had better learning outcomes than students receiving traditional, teacher-directed lessons. These findings are consistent with, and extend the findings of, previous research which pointed to better learning outcomes coinciding with the use of CAI (Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010).

ELL students using CAI outperformed students in control groups on reading-related measures. Students in the experimental condition demonstrated greater gain scores for Inferring Word Meaning, Linking Details, Recalling Details, and Graphophonemic Knowledge. Students in the experimental group also outperformed the control group on multiple word reading sets. ELL students did not significantly improve on all metrics, but there was improvement on the majority of the reading skill metrics assessed. The current findings support the hypothesis that implementing adaptive CAI software into curricula can help ELL students improve their English skills in the classroom setting, with the hopes of preventing them from being isolated or being disadvantaged in any way in the classroom.

Limitations of the current study should be acknowledged. While a cross section of grades from multiple school districts was employed, no longitudinal data was gathered. The current study argues that CAI offers benefits to ELL students, but these findings cannot be extended longitudinally. Further research could benefit from exploring whether the benefits of early CAI education are sustained into middle school and beyond. Additionally, longitudinal data could explore the relative of efficacy of multiple years of CAI curriculum taken together.

References

[1] Al-Mansour, N. S., & Al-Shorman, R. E. A. (2012). The effect of computer-assisted instruction on Saudi University students' learning of English. *Journal of King Saud University-Languages and Translation, 24*(1), 51-56.

[2] Baturay, M. H., Daloglu, A., & Yildirim, S. (2010). Language practice with multimedia supported web-based grammar revision material. *ReCALL*, *22*(3), 313-331.
[3] Billings, E., & Mathison, C. (2012). I get to use an iPod in school? Using technology-based advance organizers to support the academic success of English learners. *Journal of Science Education & Technology*, *21*(4), 494-503.
[4] Castañeda, M., Rodríguez-González, E., & Schultz, M. (2011). Enhancing Reading Proficiency in English Language Learners (ELLs): The Importance of Knowing Your ELL in Mainstream Classrooms. *The Tapestry Journal: An International Multidisciplinary Journal on English Language Learner Education*, *3*(1), 38-64.
[5] Chinnery, G. M. (2006). Emerging Technologies, Going to the MALL: Mobile Assisted Language Learning. *Language learning & technology*, *10*(1), 9-16.
[6] Echevarria, J. J., Vogt, M. J., & Short, D. J. (2013). *Making content comprehensible for elementary English learners: The SIOP model*. Pearson Higher Ed.
[7] Elpus, K., & Abril, C. R. (2011). High school music ensemble students in the united states a demographic profile. *Journal of Research in Music Education*, *59*(2), 128-145.
[8] Horsford, S. D., & Sampson, C. (2013). High-ELL-Growth States: Expanding Funding Equity and Opportunity for English Language Learners. *Voices in Urban Education*, *37*, 47-54.
[9] Kanno, Y., & Cromley, J. G. (2013). English language learners' access to and attainment in postsecondary education. *Tesol Quarterly*, *47*(1), 89-121.
[10] Kukulska-Hulme, A., Norris, L., & Donohue, J. (2015). Mobile pedagogy for English language teaching: a guide for teachers.
[11] Lariviere, M. L. (2016). Extracurricular activity participation and English Language Learners: Second language acquisition and academic performance (Doctoral dissertation, Sam Houston State University).
[12] Levitan, M., Mathison, C., & Billings, E. S. (2010). The effect of primary language podcasts on third grade English language learners' performance in English-only science education contexts. *Electronic Journal of Literacy Through Science9*.
[13] Marzban, A. (2011). Improvement of reading comprehension through computer-assisted language learning in Iranian intermediate EFL students. *Procedia Computer Science*, *3*, 3-10.
[14] Munro, M. J., & Derwing, T. M. (1995). Foreign accent, comprehensibility, and intelligibility in the speech of second language learners. *Language learning*, *45*(1), 73-97.
[15] National Center for Education Statistics (2015). NAEP overview. Retrieved December 12, 2016 from http://www.nces.ed.gov/nationsreportcard/about/
[16] Office of English Language Acquisition (2016). Languages Spoken by English Learners. Retrieved February 23rd 2017 from http://www.ncela.us/files/fast_facts/OELA_FastFactsAllLanguages.pdf
[17] Saine, N. L., Lerkkanen, M. K., Ahonen, T., Tolvanen, A., & Lyytinen, H. (2010). Predicting word-level reading fluency outcomes in three contrastive groups: Remedial and computer-assisted remedial reading intervention, and mainstream instruction. *Learning and Individual differences*, *20*(5), 402-414.