Using Primary Language Support in a Computer-Based Intervention to Scaffold Second Language Learners

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The focus of this study is to determine whether the use of students’ primary language as a scaffolding strategy delivered via a computer-based intervention can improve the language outcomes of English Language Learners (ELLs). The results revealed a strong positive relationship between linguistic scaffolding and vocabulary scores while no significant relationship could be found between linguistic scaffolding and comprehension scores. The findings suggest that there is a positive relationship between linguistic scaffolding and students’ vocabulary scores. As students encountered linguistic scaffolding in their primary language while working on vocabulary skills within the intervention, their vocabulary scores tended to also increase accordingly. This finding also implies that providing linguistic scaffolding while working on comprehension skills suggests a negative relationship between linguistic scaffolding and comprehension scores.
INTRODUCTION

English Language Learners (ELLs) are students who are actively learning the English language and may benefit from English language support programs. The term ELL is used in the United States to describe students in K-12 who are in the process of learning English as a second language. The ELL population continues to increase in the United States’ school system. According to a 2017 report by the National Center for Education Statistics (NCES, 2017), the ELL population in schools constituted 9.4% of public school students. With respect to U.S. demographics, the most commonly reported home languages for ELLs is Spanish (77.1%). Arabic, Chinese, and Vietnamese are the next most commonly reported home languages (spoken by approximately 2.3%, 2.2%, and 1.8%, respectively). In addition, the NCES (2017) report revealed that ELLs have the tendency to lag behind their mainstream peers in reading fluency given the challenge they have of learning a new language.

Helping ELLs become successful in reading and language is a complex process because ELLs vary in proficiency levels and language instruction needs. Additionally, some ELLs are illiterate in their native language making the transition to English especially challenging (NCLEA, 2007). Moreover, traditional literacy instruction is usually not sufficient to ensure students are meeting grade level reading expectations (Li, 2012). Most ELLs need comprehensive oral language instruction to provide them with classroom survival skills as well as academic language skills. They need instruction that includes comprehensive input, verbal interactions, contextualized language, and a reduction of anxiety (Li, 2012). These challenges are similar to the results of a survey of teachers of ELLs in the state of California which outlined the top challenges for teachers when working with ELLs as (a) the wide range of abilities of students in their classroom, (b) insufficient instructional time, and (c) a lack of instructional tools (Gandara, Maxwell-Holly, & Driscoll, 2005). With the increasing population of ELLs and the notable achievement gap in reading comprehension, it is clear that effective instructional interventions for second language learning are needed to address the challenges faced by teachers and facilitate the integration of ELLs in the United States public school system. Providing ELLs with computer-based instruction and primary language support has the potential to close the achievement gap. In addition, computer-based instruction could help teachers differentiate instruction based on needs of the learner (Lucero, 2014; Walqui, 2006).
THEORETICAL FRAMEWORK

The Vygotskian Sociocultural Theory

There is a relationship between the concept of language acquisition and the Vygotskian Sociocultural Theory (SCT). The sociocultural paradigm states that social interactions create a rich environment to acquire a language, learn the pragmatics of the language, and acquire new knowledge through language (Warschauer, 1997). SCT claims that student-student and student-teacher interactions are key for each language learner to advance through their Zone of Proximal Development (ZPD). The ZPD is best illustrated by the gap between what the learner can accomplish without aid and what the learner could accomplish through collaboration with others, more knowledgeable peers (Warschauer, 1997). Likewise, according to SCT, human development is mediated by psychological tools and social interactions, the most important of which is language.

Focusing on language acquisition and its relationship with cognition and thought is another element of SCT. Vygotsky sought to divide the mental activity into a lower mental motor (memory, attention, and will) and a higher mental motor (logical memory, voluntary attention, problem solving, and planning). Lower functions or motors have the potential to evolve into higher-order motors through the implementation of mediation tools. In other words, the psychological tools can function as mediators between the learners and their intended learning goals (Vygotsky, 1978). According to Vygotsky, psychological tools can actually change the entire process and structure of the mental activity so long as the learner is involved in the process of changing behavior. This approach implies that mediation shapes the human activity by achieving higher mental functions and transforming learning processes (Warschauer, 1997). Therefore, initially, language learning acquisition may need adjustment and modification through the use of mediation tools to give the learner the possibility of improved language development and acquisition skills (Donato & McCormich, 1994). Examples of potential mediators in second language may include textbooks, visual aids, opportunities for second language interaction, and as Warschauer (1997) recommends, computers.

Considering the importance of human interaction in the SCT, one cannot ignore the role of the teacher encompassed in language development and acquisition. It assumes that the teacher is an active participant in the learning process, scaffolding students’ learning until they can operate independently (Vygotsky, 1987). The concept of ZPD assumes that learners develop the most when they are presented with learning tasks that are just beyond their
individual learning abilities. As they struggle to accomplish the task independently, the presence of a more knowledgeable individual scaffolds the task for the learners, bridging the gap between what they cannot accomplish without aid, and what they can manage with support from others.

**Scaffolding**

Scaffolding is an instructional strategy that supports ELLs as they acquire the English language (Diaz-Rico & Weed, 2010). According to Li (2012), scaffolding creates a context for linguistic and academic development in a student's ZPD through social interactions. With scaffolding, the learner is dependent on others' support to achieve a task until he or she would be able to work independently (Dabbagh, 2003). This process is called fading; transferring the responsibility of completing the task from an agent with advanced knowledge in the agent can be in the form of a computer or a human to the learner (Pea, 2004). It is a contingent behavior when the learners’ actions depend on others to achieve a task and collaborative in nature when the learner and the tutor converse to jointly solve a problem (Kayi-Aydar, 2013; Li, 2012; Proctor et al., 2007; Walqui, 2006). Scaffolding is a bridging strategy used by teachers of ELLs which is based on the assumption that students are capable of acquiring new language concepts and skills if these concepts are established in their previous knowledge, i.e., in their native language (Walqui, 2006). Scaffolding is observed from the perspective of a more knowledgeable person (an expert of the subject matter; a teacher) working with a less knowledgeable person (a novice learner; a student) (Dabbagh, Marra, & Howland, 2019). In classroom settings, teachers are often spread too thin by having to provide scaffolding instruction for ELLs in public schools. Although ELLs could benefit from the same pedagogical approaches all learners do, there is an assumption that they need even more scaffolding as they are lacking English language skills in the content area (Lucero, 2014; Walqui, 2006).

**Scaffolding Using Primary Language Support**

Aside from the use of computer-based interventions that employ instructional scaffolding to support students, ELLs need further scaffolding in the classroom to successfully compete with their native English-speaking classmates. Particularly, they benefit from linguistic scaffolding using their primary language (Lucero, 2014; Walqui, 2006). Linguistic scaffolding is defined as an instructional strategy in which the teacher provides responsive language support using students’ primary language to improve language output (Lucero, 2014; Walqui, 2006).
The underlying assumption of the benefits of using primary language to scaffold ELLs lies in the commonalities found between the native language and the target language (Helman, 2004). Because languages have common sounds, teachers can use sounds from a student’s primary language to build phonological awareness and oral language skills in English. For example, as Helman noted, “teachers who have background knowledge about Spanish, as well as the factors that influence students’ language and literacy development in English, have more tools to effectively scaffold instruction for Spanish-speaking students” (p. 452).

Cook (2001) argued that the uniqueness of native language use in the classroom plays an integral role in learning a target language. His argument is supported by the underlying assumptions that the uniqueness of native language use is seen in code-switching where both languages are used simultaneously. One language is switched to another according to speed function, rules of discourse, and syntactic properties of the sentence. Similarly, Verhoeven (1994) demonstrated that some literacy skills, such as phonological awareness, letter recognition, and decoding skills, transfer from the learner’s native language to his second language.

To implement linguistic scaffolding for multiple language learners in a classroom using several native languages, the use of strategic language support delivered via technology can prove especially impactful on improving language reading skills of ELLs (Proctor et al., 2007; Ray-Subramanian & Coffee, 2010). However, empirical research to support these claims is scarce. Additionally, while research suggests that linguistic scaffolding delivered by the teacher in the classroom is effective for ELLs, it is not possible for one teacher to do this when ELLs come from multiple languages. Employing the use of technology to support multiple languages may be an optimal solution to provide linguistic scaffolding for ELLs.

**Using Computers to Provide Linguistic Scaffolding**

In practical considerations for selecting and implementing literacy instruction interventions for use with ELLs, Ray-Subramanian and Coffee (2010) explained that the use of computer-based interventions has the potential to provide individualized instruction to ELLs in the components of language and literacy instruction. More importantly, they argued that linguistic scaffolding using computer-based instructional programs “may be a particularly promising method for offering native language support to ELLs who do not have access to teachers and peers in their general classrooms who share the same primary language” (p. 11). In a study that exemplifies the use of information technology in a digital learning environment specifically designed for second language learning, Rodriguez, Filler, and Higgins
Amro and Dabbagh (2012) studied the effects of Spanish primary language support embedded in a reading intervention called Lexia on 28 ELLs and observed a significant increase in language acquisition measured by the program amongst students who participated in the digital intervention. Although this exploratory study indicated that students who received Spanish oral language instruction had a greater gain in their reading comprehension skills, there was no control group and therefore it is difficult to determine if the computer program was the cause of this increase in language skills. Moreover, the study was not conducted using the ZPD framework.

Dalton and Grisham (2007) attempted to scaffold ELLs and struggling readers using a universal digital literacy environment with an embedded strategy for using primary language support to scaffold vocabulary acquisition. This study is especially relevant to this research as it sought to investigate the frequency of times second language learners accessed native language support rather than how effective primary language support was for the users. The findings of the study revealed that ELLs accessed the scaffolding support on glossary words frequently. Not only that, considering the focus of the study, ELLs who were reading below the baseline were more likely to access native language support as opposed to other ELLs who were working closer to the baseline. The fact that ELLs have accessed the native language support and chose to take advantage of the embedded vocabulary strategy support sheds light on the importance of integrating primary language scaffolding. This finding demonstrates the need for making linguistic scaffolding accessible to ELLs to allow them to access the same content their non-ELL peers are working on.

Research has also demonstrated the benefits of native language support for literacy and language instruction. For students lacking foundational skills in English, using their native language can be a key element of literacy instruction. Educators are most likely to agree that ELLs in schools are best supported through native language scaffolding by bilingual teachers and classmates, however, ELLs often do not have access to bilingual teachers and peers in mainstream classrooms (Proctor et al., 2007). Thus, in such environments, scaffolding with primary language support is best provided in other forms such as embedding primary language through computer-based programs. If designed and implemented within the terms of the ZPD, where scaffolding principles are evident, these types of programs may be a promising method for offering primary language support to ELLs in situations where they do not have direct access to bilingual teachers or peers who share the same native language in their classrooms.

Scaffolding using primary language support makes it less challenging to help elementary and secondary ELLs access academically challenging instruction and curriculum. Technology can provide a number of practical
scaffolding tools using the primary language of the learner to provide rigorous content to those who need to develop their reading fluency and academic vocabulary in English. Using technology with embedded native language support allows teachers to invite students to engage in highly challenging academic tasks and provide equity of learning so their ELLs can compete with their mainstream classmates (Kamil, 2003; Leu, 2000).

Although computers will not replace teachers in schools, there is certainly a belief they can lighten teachers’ instructional load. Clifford (2016), Provost of the Defense Language Institute, argued that although computers will not replace teachers in schools, teachers who do not use computers will most likely be replaced with those who do. Computer-delivered instruction that follows the guidelines and recommendations of providing linguistic scaffolding to ELLs can help students acquire literacy and language skills. As technology evolves, promising research on employing linguistic scaffolding via computer-based interventions has yet to be conducted. It is imperative to build on the existing analyses and conduct research in different settings and perhaps prototype an effective computer-based linguistic scaffolding that fits within the ZPD framework. Although the history of using technology to improve language acquisition is long, recent research on technology-supported language learning is scarce. The focus of the current study is to determine whether the use of students’ primary language as a computer-based scaffolding strategy is correlated with the language outcomes of ELLs.

The primary research questions of this study are:

1. Is there a relationship between the use of primary language scaffolding delivered via computer-based intervention and ELLs’ reading comprehension score?

2. Is there a relationship between the use of primary language scaffolding delivered via computer-based intervention and ELLs’ vocabulary score?

**Research Null Hypotheses**

Given the research questions, the following null hypotheses are considered:

**H01**: There is no statistically significant relationship between embedding primary language scaffolding in computer-based interventions and reading comprehension scores of ELLs.

**H02**: There is no statistically significant relationship between embedding primary language scaffolding in computer-based interventions and vocabulary scores of ELLs.
METHOD

Research Design

This study used quantitative research methods. The statistical technique appropriate for a continuous dependent variable such as reading comprehension and vocabulary scores and a continuous independent variable (linguistic scaffolding) is linear regression analysis (Dimitrov, 2013).

Intervention

The intervention used in this study was a computer-based program designed to teach English to students in elementary schools. The program followed an adaptive logic that calibrated placement and sequencing decisions to provide students with vocabulary and reading instruction to meet their individual needs. An initial benchmark was given to predict students’ skill levels and determine a developmentally appropriate entry point in the curriculum for each student. Students then spent most of their program time learning and developing new skills. The computer-based intervention offered multilingual students the primary-language support they needed to master the English language. Teachers were able to customize support for each student by choosing either English-only instruction or primary-language supported instruction. As the student’s ability to understand English increased, primary language support strategically faded away, keeping the student challenged, but not overwhelmed at their ZPD. One form of scaffolding is primary-language fading support, which translated key instruction and vocabulary in the early stages in the program but gradually removed the linguistic support as students improved in reading and moved to advanced levels in the intervention. Other scaffolding was provided through illustrations, front-loaded vocabulary, audio support, interactive glossary words, instructional feedback, strategic questions, and adaptive content that provided extra practice as needed.

For the experimental group, the instructor enabled the language support for the students. Once enabled, native language support was directly embedded in the student learning path and given during the following curriculum areas:

**First-time instructions:** Activity instructions were initially given in the student’s primary language.

**Vocabulary Instruction:** New vocabulary words were initially translated into the primary language.

**Phonological Awareness:** Phonemic awareness activities teach students to recognize sounds from their primary language that are also used in English, as well as sounds that are found in English but not in their primary language.
Abstract Concepts: Difficult concepts like rhyming or answering inferential questions were explained in the primary language. Constructive Feedback: If students answer a comprehension question incorrectly, feedback was given to them in the native language.

Participants and Setting
The researcher followed a purposeful sampling approach to identify the participants and the setting. The participants for this study were ELLs in grades 1-5 at a school district in a northeastern state. The school with the treatment group received the computer-based intervention with the primary language support while the school with the control group received the computer-based intervention with no primary language scaffolding. The decision whether the school received native language support or not was done at the school level.

The sample size consisted of 251 ELL students. According to Dimitrov (2013), the sample size allows the researcher to test the null hypothesis with an alpha level of .05 and a statistical power of .7, while maintaining a medium effect size. It is important to note that no computation of statistical power was done and the research only relied on the general recommendation for the adequate sampling size. Both schools used the program during an after school block. The program was used twice a week throughout the school year. Each session was set for 45 minutes for each student.

Instrumentation
Internal assessment on reading comprehension and vocabulary were used to gather data on students’ performance as they progress through the curriculum. Every lesson taught in the program was followed by a formative assessment and scored before students move to the next level. The computer-based intervention gathered students’ performance data specific to point-in-time skill level, developmentally-appropriate placement in the program, and the sequence of content and instruction. Below are descriptions of the internal formative assessment activities in the program used in this study.

First, the reading comprehension measure assessed students’ understanding of text through a component of simplified books and advanced books lessons. Students had the opportunity to read both fiction and nonfiction passages. Students answered multiple choice, literal, and inferential comprehension questions related to the passages they read.

Second, the vocabulary measure assessed students’ oral vocabulary knowledge using sentence context. Oral academic language was assessed
following the conclusion of each lesson. The assessment was conducted with video prompts containing both audio and visual stimuli. For example, to determine whether a student knows the meaning of a specific vocabulary, a student might watch three short videos then he/she would be prompted to select the video that correspond with given word.

Data Collection

The data for this study came from students’ formative assessment scores on reading comprehension and vocabulary for the 2016-2017 school year. Reading comprehension and vocabulary scores are measured automatically by the program through formative assessments. There was no risk associated with the study as the datasets and the evaluation process did not include progress data that could be traced back to individual students. The datasets included grade level classification, primary language support, time spent on the intervention, progress scores on comprehension, and progress scores on vocabulary. The data did not include participant socio-economic status, their ethnicity, or how long they had been classified as ELLs.

Data Collection and Analysis

All information and data were organized and maintained through SPSS. The data export consisted of 251 records. Linear regression was used as the primary method of analysis in this study. Therefore, regression analysis was the basic statistical method for testing both null hypotheses.

The most important test of the hypotheses dealing with the parameters of the model in this study was to determine whether the slope of the regression line differs significantly from zero. In other words, the appropriate null hypothesis for this test is \( H_0: \beta_1 = 0 \) (Dimitrov, 2013). If the \( H_0: \beta_1 = 0 \) is not rejected, one of the following is true:

a. For a true underlying straight line model, linguistic scaffolding provides little or no difference in predicting reading comprehension scores or vocabulary scores.

b. The true underlying relationship between linguistic scaffolding and reading comprehension scores or vocabulary scores is not linear.

If the \( H_0: \beta_1 = 0 \) is rejected, the following is true: linguistic scaffolding provides significant information for predicting reading comprehension and vocabulary scores.

A Pearson product-moment correlation was conducted to evaluate both null hypotheses in that there is no statistically significant relationship between linguistic scaffolding and students’ achievement scores in reading comprehension and vocabulary of ELLs (\( N=251 \)). The Pearson product moment correlation was used to examine the null hypothesis at an alpha level
of .05 and a statistical power of .7 in order to maintain a medium effect size (Dimitrov, 2013). A Pearson product moment correlation was the most appropriate form of analysis because of the nature of the variables and the research questions (Dimitrov, 2013). The sample size used for the Pearson r was 251, which was above the correlational design requirement of 121 (Dimitrov, 2013).

To generate inferences from the sample in the linear regression model, Dimitrov (2013) pointed out that researchers must test four assumptions. First, regression analysis assumes that variables are normally distributed. As Dimitrov (2013) stated, “Outliers can be identified either through visual inspection of histograms or frequency distributions, or by converting data to z-scores” (p. 152). Second, regression analysis assumes a linear relationship between the independent and dependent variable. This was tested through the use of scatterplots of residuals to examine linear and curvilinear relationships. A third assumption is that the variables are measured without error, and thus are reliable. The fourth and final test is the assumption of homoscedasticity. Homoscedasticity means that the variance of errors is the same across all levels of the IV (independent variable). When the variance of errors differs at different values of the IV, heteroscedasticity is assumed (Dimitrov, 2013). In order to check this assumption, the researcher made a visual examination of the standardized residuals (the errors) by the regression.

The independent variable was linguistic scaffolding. The dependent variables were reading comprehension and vocabulary scores. The data was screened for outliers using a Box and Whisker plot for each variable. The assumption tests (outlined above) were completed prior to analyzing the data. Since the sample size was greater than 50, a Kolmogorov-Smirnov test was used to determine normality. Based on the Central Limit Theorem, since the same size was greater than 30, normality was assumed (Dimitrov, 2013). A scatter plot was used to analyze the assumption of bivariate outliers and a linearity.

The assumption of bivariate normal distribution was also examined using a scatter plot. Descriptive statistics, including mean and standard deviation, were calculated on reading comprehension and vocabulary scores. Pearson’s r was analyzed to determine the strength of the relationship between the two variables. A significance level of .05 (p<.05) was set for the analysis.

**FINDINGS**

A Pearson product-moment correlation was employed to determine the relationship between linguistic scaffolding and achievement scores in reading comprehension and vocabulary. The research questions were analyzed individually to determine the relationship among the continuous variables.
Both reading comprehension scores and vocabulary scores were normally distributed among the 251 participants.

**Descriptive Statistics**

There were 251 participants for both schools, with a relatively equal split between students who used the computer-based intervention with primary language scaffolding enabled \(N=102\) and those who received the intervention with no linguistic scaffolding \(N=149\). Descriptive statistics are reported in Table 1.

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Treatment ((n=))</th>
<th>Control ((n=))</th>
<th>Total ((n=))</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>15</td>
<td>22</td>
<td>37</td>
</tr>
<tr>
<td>Second</td>
<td>38</td>
<td>42</td>
<td>80</td>
</tr>
<tr>
<td>Third</td>
<td>27</td>
<td>28</td>
<td>55</td>
</tr>
<tr>
<td>Fourth</td>
<td>11</td>
<td>29</td>
<td>40</td>
</tr>
<tr>
<td>Fifth</td>
<td>11</td>
<td>28</td>
<td>39</td>
</tr>
</tbody>
</table>

The treatment group had a mean vocabulary score of 86.38 \((SD=7.30)\) and a mean reading comprehension score of 80.90 \((SD=11.67)\). The vocabulary scores had a negative skewness \((-0.495)\) and a positive kurtosis \((0.244)\), indicating that increasingly fewer participants have low scores and tails are heavier and the peak is sharper than a normal distribution. Similarly, the reading comprehension scores had a negative skewness \((-1.065)\) and a positive kurtosis \((0.514)\), indicating that increasingly fewer participants have low scores and tails are heavier and the peak is sharper than the normal distribution.

In contrast, the control group had a mean vocabulary score of 84.82 \((SD=8.59)\) and a mean reading comprehension score of 84.64 \((SD=7.80)\). The vocabulary scores had a negative skewness \((-1.340)\) and a positive kurtosis \((4.385)\), indicating that increasingly fewer participants have low scores and tails are heavier and the peak is sharper than the normal distribution. Similarly, the reading comprehension scores had a negative skewness \((-1.065)\) and a positive kurtosis \((0.514)\), indicating that increasingly fewer participants have low scores and tails are heavier and the peak is sharper than the normal distribution. The reading comprehension scores and vocabulary scores descriptive statistics per group are presented in Table 2.
Table 2
Means and Standard Deviation for Students’ Achievement Scores in Reading and Vocabulary by Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Comprehension Scores</th>
<th>Vocabulary Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td>Treatment</td>
<td>102</td>
<td>80.90</td>
</tr>
<tr>
<td>Control</td>
<td>149</td>
<td>84.67</td>
</tr>
</tbody>
</table>

Null Hypothesis One

**H01**

The first null hypothesis was tested as follows:

**H01**: There is no statistically significant relationship between embedding linguistic scaffolding in computer-based interventions and reading comprehension scores of ELLs.

The Pearson product moment correlation was employed to examine the first null hypothesis. Prior to applying the correlation model, a scatter plot was used to analyze the assumption of bivariate linearity as well as to identify any outliers. The shape of the scattered plot confirmed the assumption of linearity, as presented in Figure 1.

A simple linear regression was calculated to determine the relationship between reading comprehension scores and primary language linguistic scaffolding. The null hypothesis could not be rejected, indicating there was a negative relationship between linguistic scaffolding and reading comprehension scores, $F(1,24) = 9.24$, ($p < .13$), with $R^2$ of 0.03. Table 3 shows the computations of Pearson product-moment correlation coefficient to assess the relationship between linguistic scaffolding and reading comprehension scores. Participants’ predicted reading comprehension score is equal to $77.16 - 3.73$ when linguistic scaffolding is given, indicating that participants’ reading comprehension score on each assessment decreased by 3.73% whenever they encountered linguistic scaffolding.
Figure 1. Scatter plot illustrating the association between linguistic scaffolding and reading comprehension scores.

Table 3
Simple Linear Regression Analysis for Linguistic Scaffolding and Predicting Student's Reading Comprehension Score (N = 251)

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>Std. Error</th>
<th>B</th>
<th>R</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Language Support</td>
<td>-3.73</td>
<td>1.22</td>
<td>-0.18</td>
<td>0.18</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Note. *p < .05. **p < .13.

a. Dependent Variable: Reading Comprehension

b. Predictors: (Constant), Linguist Scaffolding

Null Hypothesis Two

H02

The second null hypothesis was tested as follows:

H02: There is no statistically significant relationship between embedding linguistic scaffolding in a computer-based intervention and vocabulary scores of ELLs.

The Pearson product moment correlation was employed to examine the second null hypothesis. Prior to applying the correlation model, a scatter plot was used to analyze the assumption of bivariate linearity as well as to
identify any outliers. The shape of the scattered plot confirmed the assumption of linearity, as presented in Figure 2.

![Scatter plot](image)

**Figure 2.** Scatter plot illustrating the association between linguistic scaffolding and vocabulary scores.

A simple linear regression was calculated to predict the vocabulary scores from primary language linguistic scaffolding. The null hypothesis was rejected, indicating there is a statistically significant, strong positive correlation between linguistic scaffolding and vocabulary scores, $F(1,24) = 2.23$, ($p < .003$), with $R^2$ of 0.005. Table 4 shows the computations of Pearson product-moment correlation coefficient to assess the relationship between linguistic scaffolding and vocabulary scores. Participants’ predicted vocabulary score is equal to $87.92 + 1.55$ when linguistic scaffolding is given, indicating that participants’ vocabulary score on each assessment increased whenever they encountered linguistic scaffolding.

### Table 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>$B$</th>
<th>Std. Error</th>
<th>$B$</th>
<th>$R$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Language Support</td>
<td>1.55</td>
<td>1.04</td>
<td>0.094**</td>
<td>0.09</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Note. *$p < .05$. **$p < .003$.  
 a. Dependent Variable: Vocabulary Scores  
b. Predictors: (Constant), Linguistic Scaffolding
The current study addressed a gap in the literature by determining the strength of the relationship between linguistic scaffolding delivered via computer-based intervention and achievement scores in reading comprehension and vocabulary among ELLs in the U.S. public-school system. The predicted variables were students’ achievement scores in reading comprehension and vocabulary of ELLs reported in the computer-based intervention. This study included a survey of the current literature on the use of students’ primary language support to scaffold ELL language learning. If a strong, positive relationship can be established between scaffolding using students’ primary language delivered via computer-based intervention and achievement scores in reading comprehension and vocabulary, then schools can justify spending valuable instructional time and resources to use interventions that provide linguistic scaffolding.

The research questions asked if a relationship exists between linguistic scaffolding and comprehension and vocabulary scores of ELLs, as measured by the computer-based intervention. The results from this research aligned with prior research on the use of primary language to scaffold language learning for ELLs (Proctor, Carlo, August, & Snow, 2005; Ray-Subramanian & Coffee, 2010). Specifically, the results revealed a strong positive relationship between linguistic scaffolding and vocabulary scores, while no significant relationship could be found between linguistic scaffolding and comprehension scores. Additionally, the findings support existing research by arguing that ELLs need more scaffolding in the classroom to successfully compete with native English speaking classmates. According to Lucero (2014), ELLs benefit from linguistic scaffolding using the native language of the student to accelerate English language acquisition. Cook (2001) found that learning the syntactic properties of a language and the sentence structure in both languages helps students in code-switching where students can connect both languages simultaneously online to accelerate language acquisition. Students can switch from one language to another when learning a new language. As students encounter linguistic scaffolding while working on vocabulary skills within the intervention, their vocabulary scores increase accordingly.

On the other hand, the results for the regression analysis between linguistic scaffolding and comprehension scores were surprising. Based on the regression analysis, the results indicate that providing linguistic scaffolding while working on comprehension skills implies a negative relationship. The lack of relationship between linguistic scaffolding and comprehension outcomes contradicts the findings of Rodriguez et al. (2012). While exploring the effects of providing students’ native language support using Lexia,
a computer-based intervention, Rodríguez et al. (2012) reported that students who received Spanish oral language instruction had greater gains in the reading comprehension skills. Regardless, it is difficult to determine whether the instructional design of Lexia to provide linguistic scaffolding is instructionally similar to that of the intervention used in this study.

Moreover, the underlying assumptions of the benefits of using native language to scaffold ELLs lies in the commonalities found between the native language and the target language (Helman, 2004). Helman (2004) argued that by learning common sounds between students’ native language and English, it helps students learn English phonics rapidly. It is therefore assumed that students who had Spanish language support would have outperformed students who had Arabic native support since Spanish and English languages share more sound commonalities. Further research is needed to study the relationship between sound commonalities between specific languages and whether it leads to developing phonological skills.

Finally, the lack of relationship between linguistic scaffolding and students’ comprehension scores contradicts arguments made by Verhoeven (1994). Specifically, Verhoeven (1994) suggested that bilingual students should be able to transfer their native language phonological awareness, letter sounds, and decoding skills to learning English as a second language. Future research is needed to examine whether transferability of letter sounds, phonics, and decoding skills works for certain languages than others.

Considering the nature of the program and the implementation at both schools, this negative relationship could be explained in the fact that usage was uneven across the grade levels in both schools. Further investigation to examine the relationship between time spent on the intervention and the outcomes on comprehension scores is needed to determine if “time spent” directly affects the overall achievement on comprehension.

Another explanation for the negative effect of linguistic scaffolding on comprehension scores can be found in the adaptive nature of the program. This is a critical issue in evaluating the relationship between the variables. Students will move through the program at different rates depending on use and skill level. This study did not examine whether all students had the same starting point or ending point in the program. Data used for the study came from the average mastery percentages of the formative assessments on vocabulary and reading. In other words, a sample size of students who started on the same lesson set in the program would have yielded different results.

A third explanation of the lack of relationship between linguistic scaffolding and comprehension scores could be explained in the adaptive logic behind assessment suite. The assessment is driven by student performance.
Performance data inform adaptive nature that decides placement and program sequencing decisions to meet individual learner needs. An initial assessment determines students’ skill levels and determines developmentally appropriate starting points in the program. This helps ensure that learners only encounter content and instruction that is appropriately challenging without compromising the rigor in the program. However, some students may have not taken the test seriously or guessed the correct answers and, as a result, did not start the program at a developmentally appropriate content, monitoring students’ progress directly impacts their progress. It can be inferred if teachers monitor students’ progress consistently, they would have identified some students could have benefited from further intervention. Future research on the role of the teacher within computer-based intervention could provide more insights on whether coupling linguistic scaffolding with teacher-led intervention yields to better reading comprehension outcomes for ELLs.

The results of this study are promising and necessitate further research in the area of computer-based and adaptive instructional programs. It is essential for future research to incorporate a broader sample of participants from different socio-economic backgrounds. Given the mixed results on reading comprehension and vocabulary scores, further research should examine the relationship of linguistic scaffolding and reading comprehension scores in different placement points and across different languages in the instructional program. Determining the starting points in the program is critical in allowing the researcher to find the potential key environment and instructional strategies where linguistic scaffolding is found to create the optimum opportunity in increasing comprehension scores. Further, looking at native languages individually is needed to determine which languages will most likely yield significant outcomes from linguistic scaffolding. Finally, it is critical for future studies to measure students’ fluency level in their native language to determine the relationship between linguistic scaffolding while learning English as a second language.

CONCLUSIONS

The purpose of this study was to examine the relationship between linguistic scaffolding embedded in a computer-based intervention and students’ achievement scores in vocabulary and reading comprehension. The findings of this study add to the framework based on a body of literature and empirically confirmed the linguistic scaffolding framework. Statistical results suggest that embedding native language support to ELLs in computer-based interventions in schools enhances students’ English vocabulary acquisition. This points to the positive impact that computer-based scaffolding
and language support may have on students’ individual academic achievement in vocabulary. However, no positive relationship was found between embedding linguistic scaffolding and students’ individual academic achievement scores in comprehension. ELLs at schools face many challenges in reading and may need further support to succeed. From this perspective, this study provides a holistic view of how incorporating linguistic scaffolding in computer-based interventions can accelerate language acquisition. Identifying which aspects on linguistic scaffolding as predictors of students’ academic achievements will help instructional designers and curriculum specialists determine how to effectively provide linguistic scaffolding in computer-based interventions to further support ELLs in schools.

References


