Technology and Language – What Works and What Does Not: A Meta-analysis of Blended Learning Research

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This meta-analysis examines the effectiveness of technology employed in language-related blended-learning research by summarizing the outcomes of the measured dependent variables of 59 samples. The effect sizes yielded from the samples were acquired by applying Cohen’s (1988; 1992) \( d \) formula. The estimation was done using the standardized mean difference score, divided by the standard deviation pooled across the treatment and control groups. The findings denote that there is an overall effectiveness to blended-learning; however, the disparity of the effect sizes found implies that the effectiveness is contingent and reliant to the context and how technology is applied. There were also instances of negative effect sizes, suggesting hidden factors that adversely altered the outcomes of the technological intervention. The review also discovered that there is a pattern for performance to be used predominantly as the dependent variable in assessing the effectiveness of the technology. Nevertheless, this should not limit the use of performance as the only measure. Other dependent variables, such as motivation and attitudes, warrant consideration as indicators for measuring the efficacy of a blended-learning intervention.

Keywords: language, blended learning, meta-analysis, learner’s performance, secondary dependent variables

Introduction

In an effort to optimize the transmission of knowledge to learners, educators are perpetually working towards inventing more and more effective pedagogical methods to enhance teaching and learning (Leitner, Khalil, & Ebner, 2017; Pollard, Hadjivassiliou, Swift, & Green, 2017). Disquisitions about innovative pedagogical approaches are a hallmark of educators, and this study will focus on one aspect the discussion: technology, and more specifically, blended learning.

Technology offers a novel means for languages, cultures, and the world to be conveyed and understood (Chun, Kern, & Smith, 2016). In fact, in the context of learning among the millennials, technology constitutes a significant contribution (Benson, 2006; Greenhow, Robelia, & Hughes, 2009). Research has established that language learners do incorporate technology into their out-of-class learning repertoire (Inozu, Sahinkarakas, & Yumru, 2010; Murray, 2008). In the context of language teaching and learning, a large and growing body of literature has investigated how language pedagogy has progressed from teacher-focused to student-focused. The shift has created a change towards learning where students, specifically second language (L2) learners, are empowered with a sense of autonomy and heightened motivation (Banditvilai, 2016; Salaberry, 2001). For instance, computer assisted language learning (CALL) researchers have emphasized how technology can enhance language learning and language...
proficiency compared to the traditional, face-to-face approach (Blake, Wilson, Cetto, & Pardo-Ballester, 2008). Other researchers have looked at how L2 learners regulate and maintain identity in an online setting (Spiliotopoulos & Carey, 2005; White, 2007), the relationship between intercultural competence and pragmatic development (Zeiss & Isabelli-Garcia, 2005), and how multimedia tools aid language learning (Grgurović, Chapelle, & Shelley, 2013). However, it has also been noted that the nature and sorts of technology used in language learning research is rather restricted and somewhat standard and conventional compared to other disciplines (Howard, & Scott, 2017; Winke & Goetler, 2008; Zhang, 2010). In this field, numerous CALL classes are typically supplemented with language tools or software designed to augment a specific skill. Often, these tools necessitate the use of hardware to warrant the learning process, for instance headphones, microphones, and webcams. This hardware unfortunately may lag behind the latest available software or technology, and this in turn may lead to less access and usage of the technology amongst students.

In addition, the concept and definition of blended learning is often vaguely defined. Existing research in the field of blended learning has acknowledged a variety of definitions involving different tenets of blended learning. For instance, web-based technology and pedagogic approaches may be integrated with face-to-face instruction (Driscoll, 2002), whereas elsewhere blended learning refers to only the use of technology for language pedagogy occurring outside the classroom. The equivocal and inconsistent definitions—as well as the diverse types of technologies employed and anchored on different factors, variables, and contexts—may lead to overgeneralizing the effectiveness of technology in education. The hype over the concept of blended learning has caused many researchers to design and implement technological interventions in the classroom. This observation has fueled the researcher’s interest and led to the question of whether these variations of technological use and interventions in the context of language teaching and learning are indeed effective and have a significant impact on learners. In its attempt to address the issues postulated above, this study aims (1) to examine the effectiveness of blended-learning research, as ascertained by measuring effect sizes, and (2) to summarize the outcomes of the measured dependent variables employed in the language-related blended-learning studies through the application of meta-analysis.

### Literature Review

The emergence of technology has offered great prospect for cultivating language learning, and in the context of L2 classrooms, blended learning has a distinct function (MacDonald, 2008). Blended learning allows the classroom instructor to coalesce traditional learning with elements of technology which could facilitate a myriad of learning behaviours, as well as different levels of proficiency. Learning is subject to a variety of factors, and educators agree that self-regulated learning strategies play an important role (Ramdass & Zimmerman, 2011). Herein, utilizing technology within the context of L2 learning could reinforce a sense of autonomy whereby learners could benefit tremendously. Undoubtedly, the use of technology for augmenting language teaching has found support among researchers, with numerous studies demonstrating that the insertion of technology into syllabi facilitates language teaching and learning (e.g., Brodskaya & Thiele, 2004; Eugene, 2006; Hixon, 2008; Miner, 2004; Timucin, 2006; Wong 2004).

Studies have shown how technology is effective in assisting the development of teaching approaches and methods, specifically in the aspect of the amplification of students’ knowledge (Al-Mekhlafi, 2006; Frigaard, 2002; Timucin, 2006). Although implementing technology in classroom instruction is efficacious and beneficial, some of the previous studies deliberated about the importance of creating learning software grounded in pedagogy and learning theories, whereas others claimed that constructing CALL tools should precede instructional design principles (Allen & Periyasamy, 1997; Armstrong & Yetter-Vassot, 1994; Masters-Wicks, Postlewate, & Lewenthal, 1996). Arguments have been established on the incorporation of technology in the language teaching and learning context which have shaped
pedagogical approaches employed by language instructors. One such argument concerns the meaningful pedagogic design of CALL activities. Many researchers argue that the design should be student-centered, and numerous studies indicate that positive repercussions from the incorporation of technology include increased motivation, immediacy, and interaction within the landscape of language teaching and learning (Brandl, 2002; Gilbert, 2001; Murday & Ushida, 2002; Ushida, 1996; Van Aacken, 1999; Warschauer, 1996), thus contributing to one of the important attributes to the success of SLA within computer-assisted environments. In addition to the positive motivation and attitudes among L2 learners, technology allows and encourages learners to be more independent. This aspect of autonomous learning produces an important sense of authority in which learners are responsible for their own learning; such a sense of independence was not permitted with the conventional approach in L2 classrooms (Chapelle & Heift, 2013). However, do all incorporated technologies possess quality and well-thought out designs?

Interaction is imperative for SLA, and circumstances for interaction are feasible in the technology-enhanced language-learning setting. L2 learners are able to discover meaningful environments to negotiate meaning and to integrate learning via interaction and collaboration with others (Okonkwo, 2011). For instance, the use of the social networking website, Facebook, enables more opportunities and possibilities for students to work together using the platform to engage in an environment of collaborative interaction. Thus, technology has facilitated active environments utilizing computer-mediated communication (CMC) in which language learners can participate and contribute, creating a dynamic interaction which in turn results in positive interactions (Blake, 2000; Godwin-Jones, 2011; Kitade, 2000; Lockley, 2011). To exemplify this, Miyazoe and Anderson (2010) stated that writing can be taught in a blended-learning context, and in their research, they also found that the participants improved their skill to distinguish varying English writing styles, and that they have positive perceptions towards blended-learning topics. Hence, it has been shown that language skills can be obtained and learnt in a blended learning environment. However, given the breadth of language and technology research, it is necessary to establish the efficaciousness of blended learning in language learning contexts, as is done in the current study.

Methodology

In order to attain a methodical and structured analysis, the meta-analysis in this study adapted Cooper's (2010, p. 12) seven-stage approach. These stages make up a persistent and iterative procedure. Since each stage is to some degree diverse, the subheadings for every stage mirror the actual approach of the study. As such, the study applies systematic procedures and principles for analyzing research in the area of blended learning in L2 education.

To attain eligible studies, Wiley Online Library, Taylor and Francis Online, Springer, ERIC, Elsevier, ScienceDirect, ResearchGate, ProQuest, JSTOR, IEEE, Sage Journals, APA PsycNET, CALICO Journal, Penn State University Library, Editlib, IGI Global, anitacrawley.net, ascilite.org.au, ajet.org.au, and Questia were searched systematically from the year 1988 to 2015, looking for studies addressing the application of technology in the context of language teaching and learning. Studies prior to 1988 were excluded since prior technology to that time was relatively unsophisticated compared to the current circumstances. The limit of the review was done up to year 2015, when the initial draft was completed. Keywords, such as “control vs. treatment groups”, “blended learning” and “dependent measures”, were utilized to examine published studies. Keywords for “control” and “treatment” indicated interventions, such as with computer-assisted programs and courseware. Keywords for “blended learning” indicated the use of technology in the aspect of delivery and approach of learning materials. Keywords for “dependent measures” indicated how the dependent variable was measured against the independent variable(s).

A total of 3,558 titles were found before a thorough scanning was done. The titles acquired from the searches were scrutinized prior to selection for this study to eliminate those that clearly did not meet the inclusion criteria. Eligible studies were found via local library and inter-library databases as well as via
Google and Google Scholar searches. In addition to the searches, the reference lists of the obtained studies were also scrutinized to look for additional studies to review.

**Inclusion Criteria**

The number of scholarly research articles chosen for the study was 59 samples, all selected between the years of 1988 to 2015. This included blended-learning samples relevant and pertinent to this study. All articles were validated as pertinent by matching relevant terms acknowledged in the literature on blended learning (Graham, 2006), which included (a) blended, (b) hybrid, and (c) technological intervention. Other terms included “technology”, “computer”, “web-based instruction”, “online”, “Internet”, “blended learning”, “hybrid course”, “simulation”, “electronic”, “multimedia”, “Second Language Acquisition (SLA)”, “second language learning”, “grammatical”, “lexical”, “oral”, “reading”, “writing”, “speaking”, and “vocabulary”. The samples encompassed in the meta-analysis were carefully chosen based on a set of detailed criteria adapted from pertinent meta-analysis studies (Bernard et al., 2009; Cook et al., 2008; Means et al., 2013; Means et al., 2010; Sitzmann et al., 2006; Tamim et al., 2011).

**Included Samples**

The 59 included samples were derived from databases indicated in Table 1 below. It was observed, from various meta-analysis studies, that there was no indication of the minimum or maximum number of studies required for pooled analysis. According to Valentine, Pigott, and Rothstein (2010), “researchers will need to postulate a typical within-study sample size and will also need to either (a) determine the smallest important effect size given the research context or (b) make an educated guess about the effect size that is likely to be found” (p. 233). Moreover, the size of the included sample does not affect multiple comparisons (Pigott, 2012). Table 1 below encapsulates the 59 samples included in this study.

| TABLE 1: |
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| Fifty-nine Samples according to Range of Year |

| Range of Year | No. | Sample | Database |
| --- | --- | --- | --- |
| 1980 - 1989 (n=2) | 1 | Casteel (1989) | Editlib |
| | 2 | Reitsma (1988) | JSTOR |
| | 3 | Adair-Hauck, Willingham-McLain, & Youngs (1999) | CALICO Journal |
| | 4 | Allen (1995) | Sage Journals |
| | 5 | Bejarano, Levine, Olshtain, & Steiner (1997) | Elsevier / Science Direct |
| | 6 | Cahill & Catanzaro (1997) | Research Gate |
| | 7 | Cheng, Lehman, & Armstrong (1991) | Taylor & Francis Online |
| | 8 | Liou, Wang, & Hung-Yeh (1992) | CALICO Journal |
| | 9 | Owston, Murphy, & Wideman (1991) | Taylor & Francis Online |
| | 10 | Shany & Biemiller (1995) | JSTOR |
| 1990 - 1999 (n=10) | 11 | Toro (1995) | Elsevier / Science Direct |
| | 12 | Vollands, Topping, & Evans (1999) | Taylor & Francis Online |
| 2000 - 2009 (n=31) | 13 | Abrams (2003) | Wiley Online Library |
| | 14 | Al-Jarf (2004) | Research Gate |
| | 15 | Al-Jarf (2005) | Research Gate |
| | 16 | Al-Jarf (2007) | Miscellaneous Databases |
| | 17 | Bailey (2002) | Penn State University Library |
| No. | Author(s) & Year | Source |
|-----|-----------------|--------|
| 18 | BAŞ & Kuzucu (2009) | CALICO Journal |
| 19 | Blake (2009) | Wiley Online Library |
| 20 | Blake, Wilson, Cetto, & Pardo-Ballester (2008) | Editlib |
| 21 | Chamberlain, Daniels, Madden, & Slavin (2007) | ERIC |
| 22 | Demetriadis & Pombortsis (2007) | Editlib |
| 23 | Fuente (2003) | Taylor & Francis Online |
| 24 | Fujishiro & Miyaji (2009) | Miscellaneous Databases |
| 25 | Gulek & Demirtas (2005) | ERIC |
| 26 | Heiman (2008) | ERIC |
| 27 | Hlas, Schuh, & Alessi (2007) | Sage Journals |
| 28 | Hu, Hui, Clark, & Tam (2007) | IEEE |
| 29 | Kost (2004) | Miscellaneous Databases |
| 30 | Leu, Castek, Hartman, Coiro, & Henry (2005) | Miscellaneous Databases |
| 31 | Maki & Maki (2002) | APA PsycNET |
| 32 | Mioduser, Tur-Kaspa, & Leitner (2000) | Wiley Online Library |
| 33 | Nicolson, Fawcett, & Nicolson (2000) | Wiley Online Library |
| 34 | Pavonetti, Brimmer, & Cipielewski (2002) | JSTOR |
| 35 | Payne & Whitney (2002) | CALICO Journal |
| 36 | Reber (2005) | Research Gate |
| 37 | Rovai & Jordan (2004) | ERIC |
| 38 | Satar & Özdener (2008) | Wiley Online Library |
| 39 | Sequeira (2009) | Miscellaneous Databases |
| 40 | Van Daal & Reitsma (2000) | Wiley Online Library |
| 41 | Woltering, Herrler, Spitzer, & Spreckelsen (2009) | Springer |
| 42 | Young (2008) | CALICO Journal |
| 43 | Zheng, Young, Brewer, & Wagner (2009) | CALICO Journal |
| 44 | Adas & Bakir (2013) | Miscellaneous Databases |
| 45 | Al-Qahtani & Higgins (2013) | Wiley Online Library |
| 46 | Al-Sorail-Alqahnti (2010) | Miscellaneous Databases |
| 47 | Behjat, Yamini, & Bagheri (2012) | Questia |
| 48 | Dracopoulos (2012) | Miscellaneous Databases |
| 49 | Farrah & Tushyeh (2010) | Research Gate |
| 50 | Kocoglu, Ozek, & Kesli (2011) | ascilite.org.au / ajet.org.au |
| 51 | Masters, Kramer, O’Dwyer, Dash, & Russell (2010) | Sage Journals |
| 52 | Mekheimer (2012) | CALICO Journal |
| 53 | Moore & Jones (2014) | Sage Journals |
| 54 | Oh, Lee, Park, & Cho (2014) | Miscellaneous Databases |
| 55 | Szymańska & Kaczmarek (2011) | JSTOR |
| 56 | Uzun & Senthurk (2010) | Miscellaneous Databases |
| 57 | Vernadakis, Giannouls, Tsitskari, Antoniou, & Kioumourtzoglou (2012) | Miscellaneous Databases |
| 58 | Wichadde (2014) | IGI Global |
| 59 | Zhang, Song, & Burston (2011) | ProQuest |

2010 - 2015 (n=16)
Calculation of Effect Size

To calculate treatment versus control effect size (ES), the indicator used for the purpose of this study was the standardized mean difference score, defined as the difference between the posttest mean of the treatment group and the posttest mean of the control group divided by the standard deviation pooled across the treatment and control groups (Cohen, 1988; Mark, Lipsey, & Wilson, 2001). The mean difference ESs were computed independently for each treatment versus control group, in relevance to samples that comprised of one treatment and one control group, as well as samples that comprised of a number of treatment and control groups. Hence, some samples provided a number of ESs due to the several treatment groups and several outcome measures. According to Rosenthal (1991), the ES is calculated when the mean difference between experimental and control groups are the numerator and the Pooled Standard Deviation (PSD) is the denominator. Samples with data in the form of t values, F values, p levels and frequency are calculated using formulas provided by Mark, Lipsey, and Wilson (2001). For this study, the calculation of the ES employed Cohen’s (1988; 1992, p. 157) $d$ formula, where the value was derived from the subtraction between the mean value of the experimental group and the mean value of the control group, and subsequently divided with the standard deviation of the experimental group. However, if the value was not provided, a pooled value from both groups were utilized. Formula 1 and 2 were employed as follows.

**Formula 1: The ES is the standardized mean difference between two groups**

$$d = \frac{\text{Mean}(\text{experimental}) - \text{Mean}(\text{control})}{\text{pooled Std. dev.}}$$

Alternatively, if the mean values were not given, a t-test was used instead. Cohen’s $d$ in relation to t-test could be employed as the following formula.

**Formula 2: Cohen’s $d$ in relation to t-test is used as formula**

$$d = \frac{t}{\sqrt{df}}$$

- Where $t$ is the value of t-test and $df$ is the degree of freedom.
- Degree of freedom is computed by the following formula:

$$df = n_1 + n_2 - 2$$

- Where $n_1$ is the sample size of the 1st group, and $n_2$ is the sample size of the 2nd.

As mentioned above, the number of ESs yielded by a sample correlates with the number of dependent variables identified. Due to the multiple ESs associated with this method, multi-variable samples, such as with Dracopoulos (2012) and Mekheimer (2012), would need to undergo an additional step in calculation, as opposed to single-variable samples like Abrams (2003), which only required the application of either Formula 1 or 2. In this case, for every multi-variable sample, the average ES was calculated by taking the sum of each ES yielded by the respective dependent variable, and dividing the values by the number of corresponding dependent variables as shown in calculation 1 below.

**Calculation 1: Average ES of multi-variable samples**

$\frac{\text{Sum of Effect Size}}{\text{Number of Dependent Variables}}$

- Where Effect Size(ES) are the individual ES associated with the different dependent variables of a multi-variable sample
Interpretation of Effect Size

ES is a benchmark supplemented by Cohen (1988), used to gauge and to interpret the differences found between two subject groups. Cohen cautiously defined ES across three ranges—(a) “small, $d = .2$”, (b) “medium, $d = .5$”, and (c) “large, $d = .8$”—stating that “there is a certain risk inherent in offering conventional operational definitions for those terms for use in power analysis in as diverse a field of inquiry as behavioural science” (p. 25).

Results and Discussion

The results are organized into four tables (Tables 2–5). Table 2 displays samples with large and medium ES. Table 3 displays the samples with small ES, meanwhile, Table 4 juxtaposes samples with multiple dependent variables, and Table 5 presents the samples with negative ES. Of the 59 samples, 45 were from single variable samples and 14 were from multi-variable samples. Overall, the results of the synthesized samples indicated the superiority of blended learning approaches. The outcomes of the measured dependent variables are stated in the respective tables.

Table 2 shows the results of the calculation of the mean ES for 18 samples with a single dependent variable reported with large or medium ESs. Twelve samples yielded a large ES whilst six samples yielded a medium ES. It is noted that the preponderance of the dependent variables from this cohort is performance, which is likely linked to how an intervention is measured as a significant predictor for effectiveness and persistence in the learning process. It is noteworthy to highlight that from the findings, 16 samples reported performance as the dependent variable, potentially suggesting a high significant impact of the treatment incorporated in the context of teaching and learning. Scrutinizing the findings, the large and medium effect sizes are allied to the outcome obtained through the administered tests (posttest scores, achievement test, etc.), which is the most common measure of academic achievement. The findings are consistent with those of Rossett, Douglis, and Frazee (2003), who noted the “speedier performance on real world tasks by people who learned through a blended strategy” (p. 1). Besides that, Dziuban, Moskal and Hartman (2005) also posited that the performance of students engaged in blended learning is “as good as, or in some cases better, than face-to-face” (p. 6). Many of the blended learning practitioners and instructors leverage blended environments to improve students’ outcomes and performance, for instance, the aspects of language acquisition, such as speaking, reading, and vocabulary attainment, in ways that may not be materialized through the face-to-face contexts. This finding corroborates with samples done by Garrison and Kanuka (2004) and Gray and Tobin (2010), who argued that blended learning enables the attainment of competency. While it may not be or should not be the only indicator to measure effectiveness, there is a positive relation between performance and technology in achieving language learning outcomes.
Table 2: Samples with Large or Medium ES

| No. | Sample                                                                 | Dependent Variable          | Outcomes                                      | Effect Size | Strength |
|-----|------------------------------------------------------------------------|------------------------------|-----------------------------------------------|-------------|----------|
| 1   | Behjat, Yamini, & Bagheri (2012)                                       | Performance                  | Gain in Posttest Reading Performances         | 3.000       | Large    |
| 2   | Hlas, Schuh, & Alessi (2007)                                          | Performance                  | Average Number of Words Spoken                | 2.920       | Large    |
| 3   | Satar & Özdener (2008)                                                | Performance                  | Speaking Proficiency                          | 1.630       | Large    |
| 4   | Al-Qahtani & Higgins (2013)                                           | Performance                  | Achievement Test                              | 1.350       | Large    |
| 5   | Al-Sorailey-Alqahtani (2010)                                          | Performance                  | Overall Grade                                 | 1.350       | Large    |
| 6   | Mioduser, Tur-Kaspa, & Letiner (2000)                                  | Performance                  | Letter Naming                                 | 1.200       | Large    |
| 7   | Al-Jarf (2007)                                                         | Performance                  | Posttest Scores                               | 1.180       | Large    |
| 8   | Cahill & Cantazaro (1997)                                             | Performance                  | Essay Score                                   | 1.060       | Large    |
| 9   | Adas & Bakir (2013)                                                   | Performance                  | Student Achievement Scores Posttest           | 1.000       | Large    |
| 10  | Nicolson, Fawcett, & Nicolson (2000)                                   | Performance                  | Posttest Reading Standard Score               | 1.000       | Large    |
| 11  | Sequeira (2009)                                                       | Performance                  | Oral Proficiency Scores                       | .860        | Large    |
| 12  | Vollands, Topping, & Evans (1999)                                      | Performance                  | Shortened Edinburgh Group Reading Test        | .820        | Large    |
| 13  | Masters, Kramer, O’Dwyer, Dash, & Russell (2010)                       | Knowledge                    | Vocabulary Scale Scores                       | .760        | Medium   |
| 14  | Shany & Biemiller (1995)                                               | Performance                  | Posttest Reading Comprehension                | .760        | Medium   |
| 15  | Fujishiro & Miyaji (2009)                                              | Performance                  | Pronunciation                                 | .750        | Medium   |
| 16  | Payne & Whitney (2002)                                                | Performance                  | Gain in Mean Oral Proficiency Score           | .690        | Medium   |
| 17  | Zhang, Song, & Burston (2011)                                          | Learning Efficiency          | Vocabulary Test Performance                   | .620        | Medium   |
| 18  | Liou, Wang, & Hung-Yeh (1992)                                          | Performance                  | Posttest Performance                           | .550        | Medium   |

Table 3 depicts samples with small and negative ES. It should be noted that the majority of the dependent variables from this cohort is performance. Of the 27 samples, 19 samples reported performance as their dependent variable, four samples reported satisfaction, and the other four samples reported attitude, learning efficiency, knowledge, and motivation as their dependent variables. Four samples generated negative value ES from their samples. A negative ES is obtained when the control group performs better than the treatment group. Specifically, the experimental mean is lower than the control mean, indicating that the technological interventions employed were not effective. At first glance, this large pool of small-effect samples may seem to suggest that the blended learning approaches

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implemented were ineffective. An approach that does little to improve the learners’ performance does not necessarily equate to a failed approach; for instance, it still might be effective in improving a student’s attitude towards a subject. There are other confounding variables which influence performance; for instance, language learners differ in motivation, language proficiency, background, learning styles, and ability to use technology, as well as the instructional context. Even though a given blended-learning approach may have failed to see drastic improvements in performance in the short-term experiment, the learners’ improved attitude towards learning, something the researches might have overlooked, could eventually translate to greater performance in the long run when fully implemented. This notion is supported by researchers who suggest that motivated students show greater achievement (Gulek, 2003; Haydel & Roeser, 2002; Roderick & Engel, 2001; Roth & Paris, 1991; White, 1989). However, there is an extent to which small ES is conjectured as a concern. According to Abelson (1985) and Rosenthal (1991), when the effects are prolonged and perpetual, or when a significant number of people are involved, or when the repercussions are tremendous, a small ES is still considered as an important finding which may contribute to interpreting the overall effectiveness of a treatment.

TABLE 3:
Samples with Small ES

| No. | Sample                                      | Dependent Variable | Outcomes                              | Effect Size | Strength |
|-----|---------------------------------------------|--------------------|---------------------------------------|-------------|----------|
| 1   | Fuente (2003)                               | Knowledge          | Oral Receptive Task Scores            | .470        | Small    |
| 2   | Van Daal & Reitsma (2000)                   | Performance        | Posttest Word Reading                 | .460        | Small    |
| 3   | Blake (2009)                                | Performance        | Speaking Rate                         | .458        | Small    |
| 4   | Allen (1995)                                | Performance        | Holistic Score                        | .430        | Small    |
| 5   | Vernadakis, Giannousi, Tsitskari, Antoniou, & Kioumourtzoglou (2012) | Satisfaction | Composite Student Evaluation Score on Satisfaction | .430 | Small |
| 6   | Casteel (1989)                              | Performance        | Posttest Results                      | .400        | Small    |
| 7   | Bejarano, Levine, Olshtain, & Steiner (1997) | Attitude           | Overall Participation                 | .380        | Small    |
| 8   | Reitsma (1988)                              | Performance        | Posttest Reading Time                 | .370        | Small    |
| 9   | Al-Jarf (2005)                              | Performance        | Posttest Scores                       | .340        | Small    |
| 10  | Gulek & Demirtas (2005)                     | Performance        | Cohort 1 (Grade 8 students) Achievement | .320 | Small |
| 11  | Al-Jarf (2004)                              | Performance        | Posttest Results                      | .300        | Small    |
| 12  | Adair-Hauck, Willingham-McLain, & Youngs (1999) | Performance | Cultural Knowledge                   | .270        | Small    |
| 13  | Leu, Castek, Hartman, Coiro, & Henry (2005) | Performance        | Online Reading Comprehension (ORCA-IM) (Final) | .260 | Small |
| 14  | Szymańska & Kaczmarek (2011)                | Performance        | Recall Test (After the Placement Test) | .240        | Small    |
| 15  | Bailey (2002)                               | Satisfaction       | Students' Satisfaction                | .230        | Small    |
| 16  | Demetriadis & Pombortsis (2007)             | Learning Efficiency | Posttest Questionnaire Results         | .180        | Small    |
| 17  | Chamberlain, Daniels, Madden, & Slavin (2007) | Performance        | Gates Reading Test Total            | .140        | Small    |
| 18  | Abrams (2003)                              | Performance        | Gain in communicative units           | .130        | Small    |
Table 4 depicts samples with multiple dependent variables documented in this study. Therefore, they produced and fashioned multiple ESs. The table also shows a calculated average ES. In this table, 2 large ESs, 4 medium ESs, and 8 small ESs were reported, making the total samples for the multiple dependent variables 14. One sample was found with negative ESs: Cheng, Lehman, & Armstrong (1991). The juxtaposition demonstrated above by examining the differences of ES among multiple dependent variables may be helpful for researchers who wish to investigate these variables further.

**TABLE 4: Samples with Multiple Dependent Variables**

| No. | Sample | Dependent Variables and Effect Sizes | Average Effect Size | Strength |
|-----|--------|--------------------------------------|---------------------|----------|
| 1   | Toro (1995) | Performance: 2.510; Attitude: -.090 | 1.210 | Large |
| 2   | Owston, Murphy, & Wideman (1991) | Performance: .260; Attitude: 2.010 | 1.135 | Large |
| 3   | Uzun & Senturk (2010) | Performance: 1.030; Attitude: .450 | .740 | Medium |
| 4   | Reber (2005) | Motivation: .940; Satisfaction: .424 | .682 | Medium |
| 5   | BAŞ & Kuzucu (2009) | Performance: .530; Attitude: .580 | .555 | Medium |
| 6   | Farrah & Tushyeh (2010) | Performance: .090; Attitude: .960 | .525 | Medium |
| 7   | Woltering, Herrler, Spiter, & Speckelsen (2009) | Motivation: .410; Satisfaction: .580 | .495 | Small |
| 8   | Dracopoulos (2012) | Performance: .690; Motivation: .270 | .480 | Small |
| 9   | Zheng, Young, Brewer, & Wagner (2009) | Performance: -.160; Attitude: .560; Motivation: .705 | .368 | Small |
| 10  | Mekheimer (2012) | Performance: .310; Attitude: .280 | .295 | Small |
| 11  | Heiman (2008) | Performance: .060; Satisfaction: .470 | .265 | Small |
| 12  | Maki & Maki (2002) | Performance: .430; Satisfaction: -.270 | .080 | Small |
| 13  | Oh, Lee, Park, & Cho (2014) | Performance: .020; Attitude: .170; Motivation: -.120 | .023 | Small |
| 14  | Cheng, Lehman, & Armstrong (1991) | Performance: -.370; Attitude: -.590 | - .480 | Small |

Table 5 shows a summary of samples with negative ES. Although it may be uncommon to have treatments backfiring, there are actually plausible reasons as to why this occurred. Cheng, Lehman, and...
Armstrong (1991), one of the samples listed, concluded that the control group’s unexpectedly high performance “may have resulted from over-compensatory behaviour or other factors” (p. 62); in other words, unaccounted or uncontrollable factors may have played a role. In concurrence with that notion, Konetes (2009) goes as far as to posit that there are far greater, external “cultural, industrial and global forces that act to influence the field of distance learning and how programs develop” (p. 59). Simply put, an experiment is always at risk of producing unexpected results when certain factors, important yet elusive, are carelessly overlooked. One such hidden factor comes in the form of the Hawthorne Effect, or more commonly referred to as the observer effect. The term was first coined when discovered in the Hawthorne Western Electric Company Plant, Illinois, from 1924-1932; an experiment was run to determine whether the productivity of workers would increase when working conditions were altered (Mayo, 1949). It turned out that irrespective of what changes were made to the conditions, the workers’ productivity always improved. In other words, the Hawthorne Effect can overshadow differences between an experimental group versus a control group in experimental research. However, some researchers argue that the inevitability of behavioural change in the context of blended learning research is expected, therefore affecting the outcome of transmuting learning (Brown, 1992; Jones, 1992). Furthermore, another acceptable explanation is the role of confounding variables in the samples included, for instance, existing knowledge and experience, which may have contributed to the results (Bidarra & Rusman, 2017). A fair experiment is done on the assumption that both experimental and control groups are at par in knowledge or skills, but the reality may be that the control group happened to possess the pre-requisite knowledge to outperform the experimental group. Thus, researchers are advised to be cautious when incorporating similar interventions.

**TABLE 5:**
**Samples with Negative ESs**

| No. | Sample                                          | Effect Size |
|-----|-------------------------------------------------|-------------|
| 1   | Blake, Wilson, Cetto, & Pardo-Ballester (2008)  | -.020       |
| 2   | Hu, Hui, Clark, & Tam (2007)                    | -.040       |
| 3   | Moore & Jones (2014)                            | -.110       |
| 4   | Rovai & Jordan (2004)                           | -.440       |
| 5   | Cheng, Lehman, & Armstrong (1991)               | -.480       |

**Conclusion**

This study was conducted with the aim (1) to examine the effectiveness of technological interventions in L2 learning by measuring effect sizes and (2) to summarize the outcomes of the measured dependent variables employed in the language-related blended-learning studies through the application of meta-analysis. The findings from the study suggest an overall effectiveness of blended learning. However, the variation of effect sizes yielded from the analysis suggests that at its core, the effectiveness is contingent and reliant to the context and how technology is applied. At this juncture, the implications of the findings generated from this study can influence the application of specific technology use in language learning, which can be inferred from the respective effect sizes reported. The fact that a number of the included samples reported both large and medium effect sizes, blended-learning practitioners can adapt the findings by replicating similar use of technology. In a similar vein, this study also discerned that several of the included samples fashioned a negative effect size; therefore, it is advisable that these uses of technological interventions be avoided. From the findings, it is also revealed that blended learning has the potential to improve learners’ performance. It is important to note that the majority of samples reported performance as the dependent variable. Nevertheless, researchers cannot be too fixated on viewing performance as the sole indicator of the effectiveness of blended learning, nor should they neglect hidden factors, such as the Hawthorne Effect (Mayo, 1949), which can adversely affect an experiment. Having
deliberated on the findings, the researcher recommends that besides focusing on the performance as the sole or primary dependent variable, it is deemed apt for blended learning practitioners to incorporate secondary dependent variables in future investigations. Undoubtedly, performance is the predominant ruler in measuring the efficacy of an intervention implemented; however, secondary dependent variables, such as motivation, are also of importance. Introducing secondary dependent variables such as motivation and satisfaction allow blended learning phenomenon to be investigated with more nuance. The enhancement of the four skills in language learning—reading, writing, listening, and speaking—can be augmented with the aid of technological intervention as part of classroom instruction to create autonomous learners (Banditvilai, 2016; Strotmann, Bamond, Lago, Bailen, Bonilla, & Montesinos, 2014). In summary, as indicated in this meta-analysis, the research demonstrates a far-reaching empirical endorsement for adapting blended-learning techniques in language classrooms, and in many cases, a blended-learning environment has been shown to surpass that of an ordinary classroom without it.

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