The Effectiveness of Smartphones on English Vocabulary Learning in Non-English-Speaking Countries: A Meta-Analysis and Meta-Regression

Abstract

This meta-analysis and meta-regression study examined the impact of smartphones on English vocabulary learning (EVL) in non-English-speaking countries (NESC). Analysis of 36 primary studies with 2,423 participants showed a significant impact of smartphones on EVL in NESC. Factors such as application type, assessment type, country, and publication type influenced this impact. A multivariable meta-regression analysis explained outcomes in primary studies, considering factors like application type, assessment type, country, intervention duration, language proficiency, and learning context. The study provides evidence supporting smartphones' effectiveness in English vocabulary learning in NESC. Attendees will understand this impact, recognize influential factors, gain insights from the meta-regression model, and receive practical recommendations for educational app developers, practitioners, researchers, and teachers to optimize English vocabulary learning.

Keywords: *English; Meta-Analysis; Meta-Regression; mobile-assisted language learning; smartphone; vocabulary*

English has become the dominant language in non-English speaking countries (NESC) due to its extensive use in business, tourism, and education (Bakay, 2017; Chen et al., 2021). However, NESC students face difficulties in acquiring English skills, especially in listening and speaking, primarily due to their limited vocabulary (Derakhshan & Kaivanpanah, 2011; Fithriani, 2021; Katemba, 2021). Vocabulary is undeniably crucial in the English language as it forms the fundamental building blocks of sentences, making a lack of vocabulary a significant obstacle for English learners. Limited vocabulary hampers students' ability to initiate conversations or write effectively, hindering their overall English language development. Conversely, having a robust vocabulary empowers language learners to construct sentences and express themselves meaningfully (Li & Hafner, 2022; Suwantarathi & Orawiwatnakul, 2015).

In NESC, learning vocabulary is challenging due to time constraints. Traditional classrooms often serve as the sole option for English learning in countries where English is not the native language. However, class time limits the opportunities for students to learn and practice vocabulary adequately. Moreover, outside the classroom, most English language learners lack avenues to practice their vocabulary. Hence, vocabulary acquisition in NESC is impeded by the limitations of location and time (Castro et al., 2016; Liu, 2018; Pingping et al., 2021).

Researchers seeking solutions to these constraints have suggested using smartphones as a supplementary tool to support English language learners in their vocabulary development anytime and anywhere (Chen & Chung, 2008; Kacetl & Klimová, 2019). With the widespread availability of smartphones among students, these portable devices offer advantages over textbooks and computers. They come equipped with various applications, such as voice recorders and Google Translate, that can enhance learners' vocabulary experiences. Smartphones overcome the limitations of time and space, enabling students to study vocabulary whenever and wherever possible (Luef et al., 2019; Metruk, 2022).

Several empirical studies conducted in China, Iran, and Turkey have examined the effectiveness of learning English vocabulary through smartphones and have demonstrated their positive impact on English vocabulary learning (Chen et al., 2021; Li & Hafner, 2022; Li, 2019; Wu, 2014; Alemi et al., 2012; Azabdaftari & Mozaheb, 2012; Derakhshan & Kaivanpanah, 2011; Hayati et al., 2013; Çelik, 2018; Dağdeler et al., 2020). However, existing meta-analyses in the field of mobile-assisted language learning (MALL) have not specifically focused on smartphones' effect on English vocabulary learning in NESC separately from English-speaking countries (ESC) (Chen et al., 2020; Lin & Lin, 2019; Metruk, 2022). Furthermore, these studies have not investigated the moderators that influence the effectiveness of smartphones in NESC. Therefore, the purpose of this meta-analysis and meta-regression study is twofold. Firstly, it aims to examine the effect of smartphones on English vocabulary learning in NESC. Secondly, it seeks to identify the moderators that impact the effectiveness of smartphones on English vocabulary learning in NESC. By conducting this study, we can bridge the existing gap in literature and provide valuable insights for educators, practitioners, and developers of educational apps.

Research Questions

1. What is the impact of smartphones on student EVL in NESC?
2. What are the moderators of smartphones' impact on EVL in NESC?

Method

The investigator utilized meta-analysis as the method to answer the research questions. Meta-analysis combines findings from multiple studies into a comprehensive review. Four main steps were followed: literature search, codebook development, data analysis, and results presentation.

Literature Search

For the literature search, various educational databases were searched between February 2021 and May 2022. The objective was to find relevant publications on smartphones and vocabulary learning. Grey literature was included to ensure a comprehensive search. Keywords such as "mobile-assisted language learning" and "mobile-assisted vocabulary learning" were used, resulting in 1985 titles. After eliminating duplicates, 623 references remained.

Selection Criteria

Selection criteria were applied to the references, including vocabulary as the dependent variable, smartphones as the independent variable, treatment and control conditions, between-subjects experimental design, and availability of statistical data. Based on these criteria (see Figure 1), 103 studies were retained. Additional studies were identified from prior meta-analyses' references, totaling 107 studies for full review. After review, 36 studies were selected for analysis.

Codebook

A codebook was developed using activity theory (AT) to code moderators that influence smartphone effectiveness on vocabulary learning. Moderators (see Figure 2) included subjects' characteristics, learning objectives, context, tools, and intervention duration. Inter-coder reliability was assessed, resulting in a coding scheme.

Data analysis was conducted using R statistical software. Effect sizes were calculated using Hedge's g. Outliers were identified and adjusted. The random-effects model was chosen due to study heterogeneity. Meta-regression was used to analyze moderation effects. Heterogeneity tests and publication bias assessment were conducted.

Publication Bias

The investigator checked for publication bias using a funnel plot. Figure 3 shows an asymmetric plot with effect sizes outside the funnel, indicating potential bias. Using Rosenthal's fail-safe N test, it would take 4846 missing studies to render the effect size insignificant. Thus, publication bias does not significantly affect the study's results.

Results and Discussion

The results and discussion are presented in a consistent fashion with the research questions.

What is the impact of smartphones on student EVL in NESC?

The overall weighted mean effect size was statistically significant (*RE:* $g = 0.81$), as shown in Table 1, indicating that smartphones had a significant impact on EVL in NESC. Regarding the heterogeneity of the included studies, the results (Q (35) = 109.19, $p < .05$, $I^2 = 68.51$) revealed a significant heterogeneity across the effect sizes of the studies, indicating that 68.51 % of the heterogeneity may be attributable to differences between studies (Lin & Lin, 2019; Wu et al., 2020).

What are the moderators of smartphones' impact on EVL in NESC?

As shown in Table 1, the random-effects model result was significantly heterogeneous (Q (35) = 109.19, $p < .05$, $I^2 = 68.51$). To investigate potential sources of heterogeneity at the subcategory and moderator levels, the investigator employed univariable and multivariable meta-regression and subgroup analyses. The moderator's results and discussion are structured as follows:

Significant Moderators

Application type. The *between-group heterogeneity (Q_B)* (see Table 2) revealed that the application type moderates significantly *(Q* (16) = 50, *p* <.05) the effect of smartphones on EVL in NESC. The significance of this moderator also implies that the difference between the application type subcategories was significant.

Assessment type. As shown in Table 2, the subgroup heterogeneity for the assessment type (*Q* (16) = 19, *p* <.05) is statistically significant. Despite the fact that Tsai and Tasi's (2018) study did not specify whether their findings are for ESC, NESC, or both, their assessment type findings are consistent with this study, indicating that assessment type is a significant factor. The univariable meta-regression revealed that assessment type could account for 19% variability in the study outcomes, but it did not reach a significant level.

Country. Table 2 reveals that country (*Q* (9) = 47.95, *p*<.05) significantly moderates the effectiveness of smartphones on EVL in NESC. This indicates that smartphone effectiveness differs depending on the country.

Insignificant Moderators

Educational Level. The analysis showed middle educational level (*g*= 0.99, *N*= 1) produced larger effect size than elementary (*g*= -0.37, *N*= 3), postsecondary (*g*= 0.3, *N*= 27), and secondary (g= 0.39, N= 4). However, since there is only one study on middle education, it is difficult to make a definitive claim about its superiority over other educational levels.

Feedback. The studies that reported feedback contributed positively (*g*= 0.21, *N*= 5) to the overall effect of smartphones compared to those that did not report feedback (*g*= -0.20, *N*= 31).

Intervention duration. The effect sizes for interventions of less than four weeks, less than ten weeks, and less than twenty weeks were 0.22, 0.28, and 0.06 (see Table 2), respectively. However, the differences in effect sizes between these durations were not statistically significant.

Language proficiency. The interventions targeting participants at the beginner level of language proficiency had a significantly negative effect size (-0.27), whereas interventions with participants at the beyond-beginner level showed a slightly positive effect size (0.11). However, the differences in effect sizes between these proficiency levels were not statistically significant. Further research is needed to explore the impact of mixed proficiency and not reported (NR) categories on the outcome of interest.

Multivariable Meta-Regression Analysis

As previously indicated in the univariable meta-regression analysis, no single independent variable could independently account for the variability (*Q* (35) = 109.19, *p* <.05, I^2= 68.51) in the primary studies' vocabulary outcomes of this study. The researcher conducted a multivariable meta-regression analysis to determine which combination of moderators explains the variability in the effect of smartphones on EVL in NESC. Among various models tested (see Table 3), a model including application type, assessment type, country, intervention duration, language proficiency, and learning context explained 99% of the outcomes. Adding or removing certain moderators rendered the model insignificant, while others had no effect. The intervention duration was the only moderator that positively influenced the model's ability to explain heterogeneity.

Limitations

This study has limitations due to its selection criteria. Only English-language research meeting specific criteria was included, excluding studies in other languages. Future studies should consider research in languages other than English. Additionally, the analysis did not include studies relying solely on self-reported data, such as interviews or surveys. To obtain a

comprehensive understanding of smartphone effectiveness on EVL in NESC, future research should synthesize both quantitative and qualitative studies.

Conclusion

This meta-analysis addressed the gap in MALL literature by synthesizing 36 primary studies on the effectiveness of smartphones for English vocabulary learning (EVL) in NESC. The findings showed that smartphones have a statistically significant and positive impact on EVL in NESC ($g = 0.81$). The effectiveness varied based on application type, assessment type, country, and publication type, indicating potential moderators. Univariable meta-regression analysis didn't identify a single variable explaining the outcomes, but a multivariable model including application type, assessment type, country, intervention duration, language proficiency, and learning context explained 99% of the heterogeneous outcomes.

Implications and Future Directions

This meta-analysis has important implications for teachers, educators, researchers, and educational app developers regarding the effectiveness of smartphones for EVL in NESC. The study highlights the impact of assessment type on smartphone effectiveness, suggesting that different assessment types can yield different outcomes. Multiple-choice assessments were the most commonly used type. Educators can benefit from considering the assessment types outlined in this study to align with their teaching needs.

Moreover, the study emphasizes the significance of choosing the right applications for vocabulary instruction. The analysis revealed various application types, with SMS being the most prevalent. Each application type may lead to different results, underscoring the importance of careful application selection.

For researchers, the findings point out gaps in MALL research, particularly in the examination of assessment types and feedback. Only one previous meta-analysis studied assessment types, indicating the need for more research in this area. Additionally, feedback was addressed in a limited number of studies, highlighting the gap that needs to be filled by future primary studies.

Educational app developers can benefit from the study's insights by recognizing the importance of incorporating assessment types into their app features. Including assessment options can enhance learner feedback and provide valuable progress information to both learners and teachers.

References

An asterisk in the references signifies studies that were considered for the analysis.

*Alemi, M., Sarab, M. R. A., & Lari, Z. (2012). Successful learning of academic word list via MALL: Mobile Assisted Language Learning. *International Education Studies*, *5*(6), 99-109.

*Andújar-Vaca, A., & Cruz-Martínez, M. S. (2017). Mobile instant messaging: WhatsApp and its potential to develop oral skills. *Comunicar. Media Education Research Journal, 25*(1).

*Azabdaftari, B., & Mozaheb, M. A. (2012). Comparing vocabulary learning of EFL learners by using two different strategies: Mobile learning vs. flashcards. *The Eurocall Review, 20*(2), 47-59.

*Bakay, Ş. (2017). *Investigating the effectiveness of a mobile device supported learning environment on English preparatory school students' vocabulary acquisition* (Doctoral dissertation, Middle East Technical University, Ankara).

*Basal, A., Yilmaz, S., Tanriverdi, A., & Lutfiye, S. (2016). Effectiveness of mobile applications in vocabulary teaching. *Contemporary educational technology*, *7*(1), 47-59.

*Basoglu, E. B., & Akdemir, O. (2010). A comparison of undergraduate students' English vocabulary learning: Using mobile phones and flash cards. *Turkish Online Journal of Educational Technology-TOJET, 9*(3), 1-7.

*Bieńkowska, I., Klimczok, A. Polok, K., & Modrzejewska, J. (2021). Use of mobile assisted language learning (MALL) in teaching vocabulary to ESP students. *The International Journal of Research in Teacher Education, 12*(3), 81-95

Castro, G. G., Dominguez, E. L., Velazquez, Y. H., Matla, M. R., Toledo, C. E., & Hernandez, S. P. (2016). MobiLearn: context-aware mobile learning system. *IEEE Latin America Transactions, 14*(2), 958-964.

*Çelik, Ö. (2018) *The effect of using mobile applications on literal and contextual vocabulary Instruction* (Yayınlanmamış yüksek lisans tezi. Balıkesir Üniversitesi Sosyal Bilimler Enstitüsü).

*Chakir, M. (2018). *The integration of mobile phones in EFL contexts: Using Messenger applications to learn English vocabulary* (Master's thesis, Southern Illinois University at Edwardsville).

*Chen, C. M., Chen, L. C., & Yang, S. M. (2019). An English vocabulary learning app with self-regulated learning mechanism to improve learning performance and motivation. *Computer Assisted Language Learning*, *32*(3), 237-260.

Chen, C. M., & Chung, C. J. (2008). Personalized mobile English vocabulary learning system based on item response theory and learning memory cycle. *Computers & Education, 51*(2), 624-645.

*Chen, Z., Jia, J., & Li, W. (2021). Learning curriculum vocabulary through mobile learning: impact on vocabulary gains and automaticity. *International Journal of Mobile Learning and Organisation*, *15*(2), 149-163.

Chen, Z., Chen, W., Jia, J., & An, H. (2020). The effects of using mobile devices on language learning: A meta-analysis. *Educational Technology Research and Development*, *68*(4), 1769-1789.

*Dağdeler, K. O., Konca, M. Y., & Demiröz, H. (2020). The effect of mobile-assisted language learning (MALL) on EFL learners' collocation learning. *Journal of Language and Linguistic Studies*, *16*(1), 489-509.

*Derakhshan, A. & Kaivanpanah, S. (2011). The impact of text-messaging on EFL freshmen's

vocabulary learning. *The EUROCALL Review*, *19*, 47-55.
*Fageeh, A. A. I. (2013). Effects of MALL applications on vocabulary acquisition and motivation. *Arab World English Journal*, *4*(4)..
*Fithriani, R. (2021). The Utilization of mobile-assisted gamification for vocabulary learning: Its efficacy and perceived benefits. *Computer Assisted Language Learning Electronic Journal (CALL-EJ)*, *22*(3), 146-163.
*Hayati, A., Jalilifar, A., & Mashhadi, A. (2013). Using Short Message Service (SMS) to teach English idioms to EFL students. *British journal of educational technology*, *44*(1), 66-81.
*Huang, C. S., Yang, S. J., Chiang, T. H., & Su, A. Y. (2016). Effects of situated mobile learning approach on learning motivation and performance of EFL students. *Journal of Educational Technology & Society*, *19*(1), 263-276.
Kacetl, J., & Klímová, B. (2019). Use of smartphone applications in English language learning-A challenge for foreign language education. *Education Sciences*, *9*(3), 179.
*Katemba, C. (2021). Enhancing vocabulary performance through mobile assisted language learning at a rural school in Indonesia. Enhancing vocabulary performance through mobile assisted language learning at a rural school in Indonesia. *Acuity: English Language Pedagogy, Literature, and Culture*, *6*(1).
*Khabsarian-Dehkordi, F., & Ameri-Golestan, A. (2016). Effects of mobile learning on acquisition and retention of vocabulary among Persian-Speaking EFL learners. *CALL_EJ*, *17*, 43-56.
*Lee, P. (2014, September). Are mobile devices more useful than conventional means as tools for learning vocabulary? *In 2014 IEEE 8th International Symposium on Embedded Multicore/Manycore SoCs* (pp. 109-115). IEEE.
*Li, Z. (2019). *Promoting L2 idiomatic competence among Chinese college students via WeChat* (Doctoral dissertation, University of South Florida).
*Li, Y., & Hafner, C. A. (2022). Mobile-assisted vocabulary learning: Investigating receptive and productive vocabulary knowledge of Chinese EFL learners. *ReCALL*, *34*(1), 66-80.
Lin, J. J., & Lin, H. (2019). Mobile-assisted ESL/EFL vocabulary learning: A systematic review and meta-analysis. *Computer Assisted Language Learning*, *32*(8), 878-919.
Liu, J., & Zhang, J. (2018). The Effects of Extensive Reading on English Vocabulary Learning: A Meta-Analysis. *English language teaching*, *11*(6), 1-15.
*Lu, M. (2008). Effectiveness of vocabulary learning via mobile phone. *Journal of computer assisted learning*, *24*(6), 515-525.
Metruk, R. (2022). Smartphone English Language Learning Challenges: A Systematic Literature Review. *SAGE Open*, *12*(1), 21582440221079627.
*Motallebzadeh, K., & Ganjali, R. (2011). SMS: Tool for l2 vocabulary retention and reading comprehension ability. *Journal of Language Teaching & Research*, *2*(5).
*Motallebzadeh, K., Beh-Afarin, R., & Daliry Rad, S. (2011). The Effect of short message service on the retention of collocations among Iranian lower intermediate EFL Learners. *Theory & Practice in Language Studies*, *1*(11).
Pingping, G., Qiuyao, W., & Linyan, B. (2021). Enhancing students' mobile-assisted language learning through self-assessment in a Chinese college EFL context. *Journal of Education and e-Learning Research*, *8(2)*, *238-248.*
*Rahimi, M., & Miri, S. S. (2014). The impact of mobile dictionary use on language learning. *Procedia-Social and Behavioral Sciences*, *98*, 1469-1474.

*Saran, M., Seferoglu, G., & Cagiltay, K. (2012). Mobile language learning: Contribution of multimedia messages via mobile phones in consolidating vocabulary. *The Asia-Pacific Education Researcher, 21*(1), 181-190.

Sung, Y. T., Yang, J. M., & Lee, H. Y. (2017). The effects of mobile-computer-supported collaborative learning: Meta-analysis and critical synthesis. *Review of educational research, 87*(4), 768-805.

*Suwantarathip, O., & Orawiwatnakul, W. (2015). Using Mobile-Assisted Exercises to Support Students' Vocabulary Skill Development. *Turkish Online Journal of Educational Technology-TOJET, 14*(1), 163-171.

*Tabatabaei, O., & Goojani, A. H. (2012). The impact of text-messaging on vocabulary learning of Iranian EFL learners. *Cross-Cultural Communication, 8*(2), 47-55.

Tsai, Y. L., & Tsai, C. C. (2018). Digital game-based second-language vocabulary learning and conditions of research designs: A meta-analysis study. *Computers & Education, 125*, 345-357.

*Tosun, S. (2015). The effects of blended learning on EFL students' vocabulary enhancement. *Procedia-Social and Behavioral Sciences, 199,* 641-647.

*Wu, Q. (2014). Learning ESL vocabulary with smartphones. *Procedia-Social and Behavioral Sciences, 143*, 302-307.

*Wu, Q. (2015). Designing a smartphone app to teach English (L2) vocabulary. *Computers & Education, 85*, 170–179.

*Wu, Q. (2015). Pulling mobile assisted language learning (MALL) into the mainstream: MALL in broad practice. *PloS one, 10*(5), e0128762.

*Wu, T.-T., & Huang, Y.-M. (2017). A mobile game-based English vocabulary practice system based on portfolio analysis. *Educational Technology & Society, 20* (2), 265–277.

Wu, Q., Zhang, J., & Wang, C. (2020). The effect of English vocabulary learning with digital games and its influencing factors based on the meta-analysis of 2,160 test samples. *International Journal of Emerging Technologies in Learning (iJET), 15*(17), 85-100.

*Yousefzadeh, M. (2012). Mobile-based learning vs. paper-based learning and collocation words learning. *Journal of Educational and Instructional Studies, 2*(3), 216-220.

*Zhang, H., Song, W., & Burston, J. (2011). Reexamining the effectiveness of vocabulary learning via mobile phones. *Turkish Online Journal of Educational Technology-TOJET, 10*(3), 203-214.

Table 1

The Effect Size of Smartphone on EVL in NESC

	Effect size				Test of heterogeneity			
Model	*K*	*g+*	*SE*	95% CI	*Q*	*df*	*p*	$I^2\%$
Random	36	0.81*	0.04	0.73 - 0.89	109.19	35	0.01	68.51

Note. *= $p < .05$, *K*=number of studies, *SE*=standard Error, *CI*= confidence interval, *df*= degree of freedom, *g+* = Hedges' *g*

Table 2

The moderators of The Effect Size of Smartphone on EVL in NESC

Moderator	*K*	Hg	*CI* (95%)	Test of Heterogeneity		*Adj* R^2
				Q_B	*df*	
Application Type				55*	16	-0.1
CollocatApp	1	0.35	-0.45 - 1.15			
CSIEC	1	-1.32*	-2 - 0.65			
Electronic Dictionary	2	-0.22	-0.99 - 0.55			
EVLAPP-SRLM	1	-1.09*	-1.93 - 0.26			
Flash Card	1	-1.28*	-2.07 - 0.5			
Google Map	1	-0.91*	-1.65 - 0.18			
Kahoot, Flash Card, WhatsApp	1	-1.31*	-2.05 - 0.58			
Line	1	-0.33	-1.09 - 0.43			
MeWe	1	-0.62	-1.5 - 0.26			
MGBEVPS	1	-0.85*	-1.59 - 0.12			
MMS	1	-0.45	-1.37 - 0.47			
Quizlet	2	-0.38	-1.1 - 0.35			
SMS	12	-0.52*	-1.13 - 0.1			
WeChat	1	-0.9*	-1.64 - 0.17			
WhatsApp	4	-0.38	-1.02 - 0.26			
Word learning	4	-0.62*	-1.25 - 0.01			
Zhimi	1	-0.35	-1.16 - 0.46			
Assessment type				19.04*	10	-0.19
Building a sentence with a new word	1	-0.06	-0.54 - 0.41			
Fill in the blank	3	-0.17	-0.67 - 0.34			
Fill in the blank and translate	1	0.29	-0.39 - 0.97			
Multiple choice	19	-0.04	-0.45 - 0.38			
Multiple choice and writing	1	0.12	-0.67 - 0.91			
NR	4	0.07	-0.42 - 0.55			
Speaking	1	0.73	0.12 - 1.35			
Write a sentence	1	-0.4*	-0.99 - 0.19			

Write down translation	3	0.06	-0.4 - 0.51			
Write meaning	1	0.7*	-0.14 - 1.54			
Write sentences	1	-0.2	-0.91 - 0.51			
Country				47.95*	9	0.22
China	7	-0.34*	-0.58 - -0.10			
Indonesia	2	0.99*	0.54 - 1.43			
Iran	10	0.35*	0.11 - 0.59			
Morroco	1	0.04	-0.51 - 0.58			
Poland	1	0.12	-0.31 - 0.54			
Saudia Arabia	1	0.87*	0.14 - 1.59			
Spain	1	0.85*	0.34 - 1.35			
Taiwan	5	-0.19	-0.46 - 0.09			
Thailand	1	-0.07	-0.54 - 0.4			
Turkey	7	-0.05	-0.32 - 0.22			
Educational level				3.15	4	-0.03
Elementary	3	-0.37	-1.12 - 0.37			
Middle	1	0.99*	-0.15 - 2.1			
NR	1	0.37	-0.8 - 1.52			
Postsecondary	27	0.3	-0.28 - 0.87			
Secondary	4	0.39	-0.34 - 3390			
Feedback				2.77	1	-0.03
Given	5	0.21	0.04 - 0.45			
NR	31	-0.20*	-0.44 - 0.03			
Intervention duration				4.03	3	-0.02
Less than twenty weeks	10	0.06	-0.47- 0.60			
Less than four weeks	4	0.22	0.13 - 0.55			
Less than ten weeks	21	0.28	0.08 - 0.63			
One week	1	-0.07	-0.61 - 0.47			
Language Proficiency				7.01	3	-0.01
Beginner	10	-0.27	-0.52 - -0.02			
Beyond-beginner	16	0.11	0.16 - 0.28			
Mixed	1	0.25	0.67 - 0.29			
NR	9	0.13*	0.03 - 268			
Learning context				3.49	2	-0.05
Formal	16	-0.39*	-0.80 - 0.01			
Informal	18	0.04	0.14 - 0.22			
Mixed	2	0.4*	-0.02 - 0.81			
Publication type				12.25*	3	0.03
Article	31	0.23	-0.13 - 0.61			
Conference paper	1	-0.47*	-0.92 - 0.02			
Dissertation	2	-0.24	0.62 - 0.14			
Master's thesis	2	-0.5*	0.84 - 1438			
Teaching methods				8.69	6	-0.08
Blended learning	1	-0.55*	-1.20 - 0.09			

Collaborative learning	2	0.62*	-0.09 - 1.31
Flipped classroom	3	0.76*	0.07 - 1.43
Game-based learning	1	0.41	-0.35 - 0.17
Self-directed learning	20	0.69*	0.06 - 0.32
Situated learning	1	0.35	-0.41 - 0.11
Teacher-led	8	0.56*	-0.1 - 0.21

Note. *= $p < .05$, *K*=number of studies, *CI*= confidence interval, *RSE*= residual standard error, *df*= degree of freedom, *Adj* R^2 = adjusted r squared, *NR*= not reported

Table 3

*The Summary Model of Application Type, Assessment Type, Country, **Intervention Duration** Language Proficiency, and Learning Context*

Model	Adjusted R Square	Std. Error of the Estimate
1	0.99*	0.02

Figure 1
Flow chart of the literature search

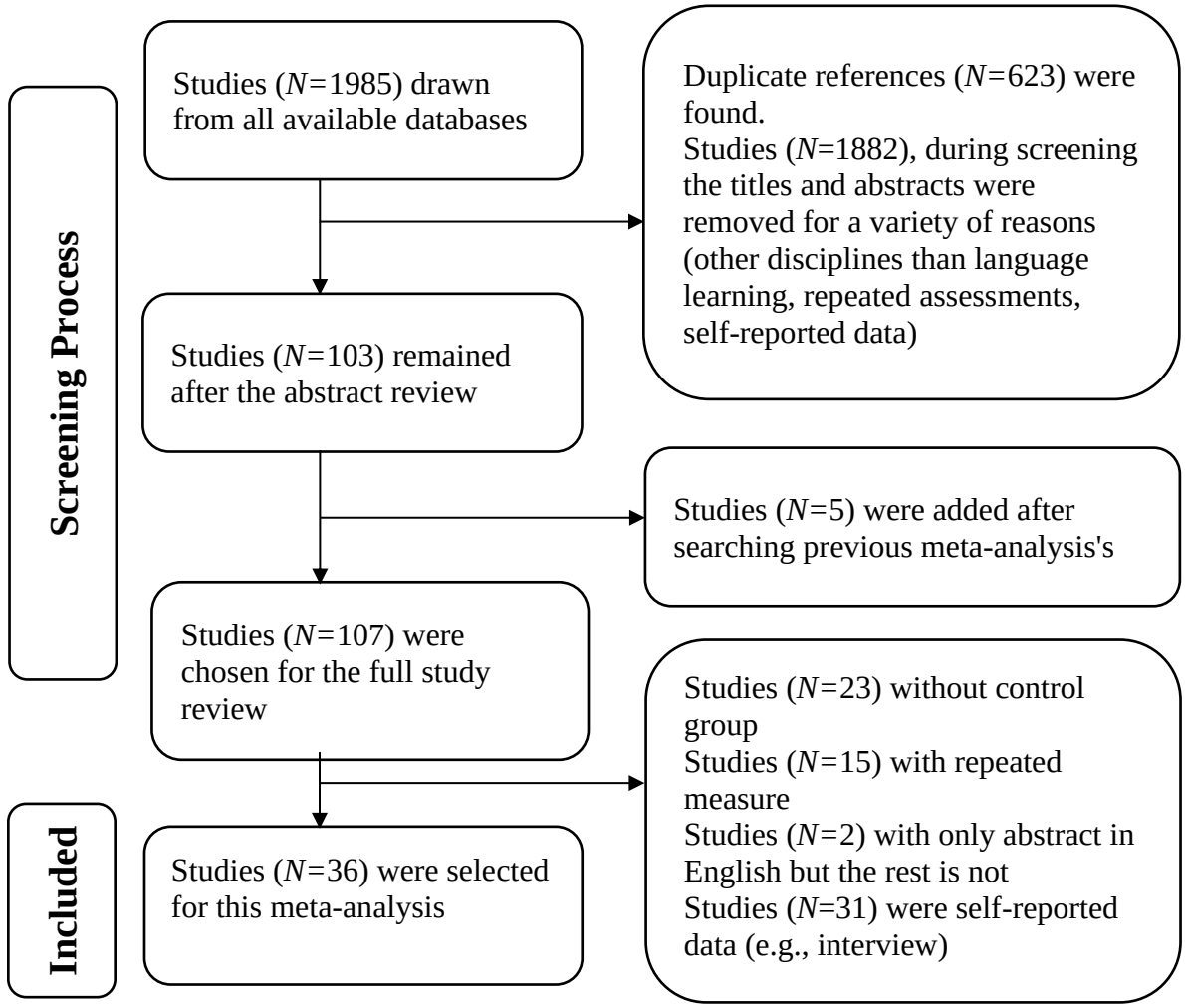
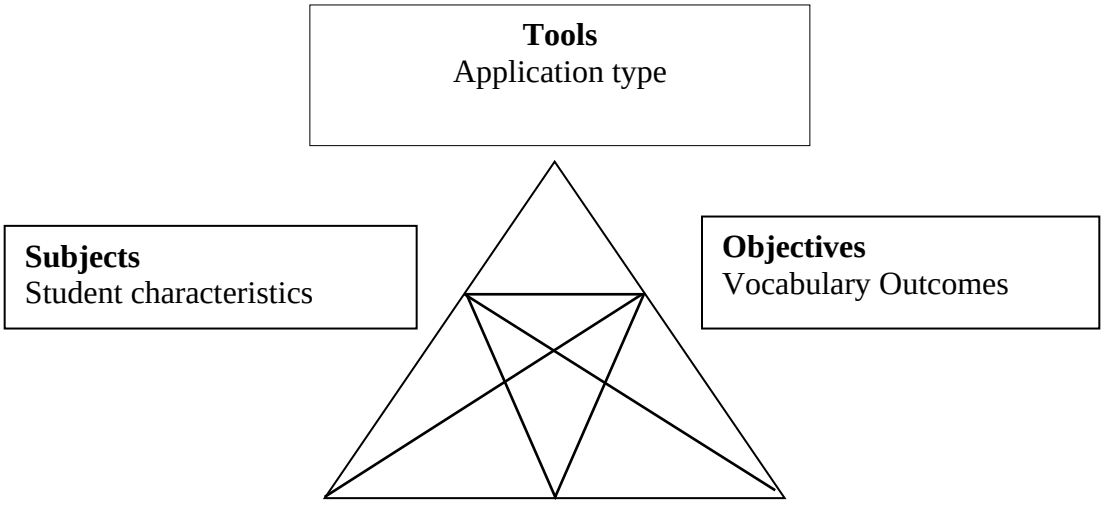


Figure 2
The activity theory adopted from Sung, Yang, and Lee (2017)



Rule/Control
Assessment Type
Feedback
Intervention duration
Publication Type
Teaching methods

Context
Learning context

Figure 3
Posttest funnel plot