

Appendix 1: MALL Overviews and Meta-Analyses: 2006-2020

Author(s)	Year	Title
AbuSa'aleek, A.	2014	A review of emerging technologies: Mobile Assisted Language Learning (MALL)
Afzali, P., Shabani, S., Basir, Z., & Ramazani, M.	2017	Mobile-assisted vocabulary learning: A review study
Al-Qudaimi, K.	2013	Mobile-Assisted Language Learning: A literature review
Arvanitis, P., & Krystalli, P.	2020	Mobile Assisted Language Learning (MALL): trends from 2010 to 2020 using text analysis techniques
Bozdoğan, D.	2015	MALL revisited: Current trends and pedagogical implications
Burston, J.	2015	20 years of MALL project implementation: A meta-analysis of learning outcomes
Burston, J., & Athanasiou, A.	2020	Twenty-five years of MALL experimental implementation studies - What do we really know about it?
Calderón-Márquez, A., Duarte, M., & Berns, A.	2017	Tendencias y tipos de aprendizaje en MALL: Una revisión sistemática de la literatura (2012-2016)
Çelik, Ö. & Yavuz, F.	2018	An extensive review of literature on teaching vocabulary through mobile applications
Chen, Z., Chen, W., Jia, J., & An, H.	2020	The effects of using mobile devices on language learning: A meta-analysis
Chinnery, G.	2006	Going to the MALL: Mobile Assisted Language Learning
Cho, K., Lee, S., Joo, M-H., & Becker, B	2018	The effects of using mobile devices on student achievement in language learning: A meta-analysis
Chwo, G., Marek, M., & Wu, V.	2018	Meta-analysis of MALL research and design
Cong-Lem, N.	2018	A review of research in mobile-assisted collaborative language learning
Darmi, R., & Albion, P.	2014	A review of integrating mobile phones for language learning
Derakhshan, A., & Khodabakhshzadeh, H.	2011	Why CALL not MALL: An in-depth review of text-message vocabulary learning
Duman, D., Orhon, G., & Gedik, N.	2015	Research trends in mobile assisted language learning from 2000 to 2012
Elaish, M., & Shuib, L.	2019	Mobile learning for English language learning assessment and evaluation: A review
Elaish, M., Shuib, L., Ghani, N., & Yadegaridehkordi, E.	2019	Mobile English Language Learning (MELL): A literature review

Elgort, I.	2018	Technology-mediated second language vocabulary development: A review of trends in research methodology
Eutsler, L., Mitchell, C., Stamm, B., & Kogut, A.	2020	The influence of mobile technologies on preschool and elementary children's literacy achievement: A systematic review spanning 2007-2019
Fu, Q-K.	2018	Impacts of mobile technologies, systems and resources on language learning: A systematic review of selected journal publications from 2007-2016
Guanuche, A., Eiriz, O., & Espí, R.	2020	Corrective feedback through mobile apps for English learning: A review
Gutiérrez-Colón, M., Frumuselu, A., & Curell, H.	2020	Mobile-Assisted Language learning to enhance L2 reading comprehension: A selection of implementation studies between 2012–2017
Hassan Taj, I., Sulan, N., Sipra, M., & Ahmad, W.	2016	Impact of Mobile-Assisted Language Learning (MALL) on EFL: A meta-analysis
He, R., & Xu, X.	2019	Mobile experience in learning Chinese: Review and recommendations
Hwang, G-J., & Fu, Q-K.	2018	Trends in the research design and application of mobile language learning: A review of 2007–2016 publications in selected SSCI journals
Kacatl, J. & Klímová, B.	2019	Use of smartphone applications in English language learning - A challenge for foreign language education
Kamasak, R., Özbilgin, M., Atay, D., & Kar, A.	2020	The effectiveness of Mobile-Assisted Language Learning (MALL): A review of the extant literature
Kartal, G.	2019	WhatsApp? A critical analysis of mobile instant messaging research in language learning
Kukulkska-Hulme, A.	2016	Mobile assistance in language learning: A critical appraisal
Kukulkska-Hulme, A., & Shield, L.	2007	An overview of Mobile Assisted Language Learning: Can mobile devices support collaborative practice in speaking and listening?
Kukulkska-Hulme, A., & Shield, L.	2008	An overview of Mobile Assisted Language Learning: From content delivery to supported collaboration and interaction
Kukulkska-Hulme, A., & Viberg, O.	2018	Mobile collaborative language learning: State of the art
Lee, S.	2019	A systematic review of context-aware technology use in foreign language learning

Lee, Y-S., Sung, Y-T., Chang, K-E., Liu, T-C., & Chen, W-C.	2014	A meta-analysis of the effects of learning languages with mobile devices
Lin, C-C., Lin, V., Liu, G-Z., Kou, X., Kulikova, A., & Lin, W.	2019	Mobile-assisted reading development: A review from the Activity Theory perspective
Lin, J-J., & Lin, H.	2019	Mobile-assisted ESL/EFL vocabulary learning: A systematic review and meta-analysis
Liu, T., Shadiev, R., & Hwang, W-Y.	2018	Review of research on MALL in familiar authentic environments
Mahdi, H.	2018	Effectiveness of mobile devices on vocabulary learning: A meta-analysis
Metruk, R.	2019	The CALL of the MALL: The use of smartphones in higher education. A literature review
Ok, M., & Ratliffe, K.	2017	Use of mobile devices for English language learner students in the United States: A research synthesis
Peng, H., Jager, S., & Lowie, W.	2020	Narrative review and meta-analysis of MALL research on L2 skills
Pérez-Rodríguez, M., & Delgado-Ponce, A.	2018	Medios móviles emergentes en la enseñanza de lenguas
Persson, V., & Nouri, J.	2018	A systematic review of second language learning with mobile technologies
Shadiev, R., Hwang, W-Y., & Huang, Y-M.	2017	Review of research on mobile language learning in authentic environments
Shadiev, R., Liu, T., & Hwang, W-Y.	2019	Review of research on mobile-assisted language learning in familiar, authentic environments
Solikhah, I., & Wirawati, D.	2020	Mobile-Assisted Language Learning and its insights in teaching academic writing: A literature review
Stockwell, G.	2019	Insights from Replication on the Factors Affecting Task Engagement in Mobile-based Learning Activities
Sung, Y-T., Chang, K-E., & Yang, J-M.	2015	How effective are mobile devices for language learning? A meta-analysis
Uzunboylu, H., & Genc, Z.	2017	Analysis of documents published in Scopus database on foreign language learning through mobile learning: A content analysis
Viberg, O., & Grönlund, Å.	2012	Mobile Assisted Language Learning: A literature review
Wang, H-Y., Liu, G-Z., & Hwang, G-J.	2017	Integrating socio-cultural contexts and location-based systems for ubiquitous language learning in museums: A state of the art review of 2009-2014

Yang, J.	2013	Mobile-Assisted Language Learning: Review of the recent applications of emerging mobile technologies
Yu, Z.	2019	A systematic review on mobile technology-assisted English learning
Yükselir, C.	2017	A Meta-synthesis of qualitative research about Mobile-Assisted Language Learning (MALL) in foreign language teaching
Zamborova, K., & Klímová, B.	2020	Use of mobile applications in developing reading comprehension in second language acquisition –A review study
Zhou, W.	2020	Mobile-assisted Chinese learning as a foreign language: An overview of publications between 2007 and 2019

Appendix 2: Experimental MALL Studies Meeting Inclusion Criteria

Author(s)	Year	Title
Abduh, M.	2019	The effect of implementing MALL applications on learning pronunciation of English by EFL learners at Najran University
Agbatogun, A.	2014	Developing learners' second language communicative competence through active learning: Clickers or communicative approach?
Aghajani, M., & Zoghipour, M.	2018	The comparative effect of online self-correction, peer-correction, and teacher correction in descriptive writing tasks on intermediate EFL learners' grammar knowledge: The prospect of Mobile-Assisted Language Learning (MALL)
Al Yafei, O., & Osman, M.	2016	Mobile phone apps: An emerging e-platform for vocabulary learning and retention
Alemi, M., Sarab, M., & Lari, Z.	2012	Successful learning of academic word list via MALL: Mobile Assisted Language Learning.
Alkhezzi, F., & Al-Dousari, W.	2016	The impact of mobile learning on ESP learners' performance
Arens, K., Gove, M., & Abate, R.	2018	Oral reading fluency with iPods

Ataee, E., Fatemi, M., & Ashraf, H.	2015	The effect of short message service on Iranian lower intermediate EFL learners' reading comprehension through skimming and guessing strategies awareness
Bataineh, R., Al-Hamad, R., & Al-Jamal, D.	2018	Gender and EFL writing: Does WhatsApp make a difference?
Bataineh, R., Baniabdelrahman, A., & Khalaf, K.	2018	The effect of e-mail and <i>WhatsApp</i> on Jordanian EFL learners' paraphrasing and summarizing skills
Billings, E., & Mathison, C.	2012	I get to use an iPod in school? Using technology-based advance organizers to support the academic success of English learners
Bitter, G., & Meylani, R.	2016	The effect of an m-learning English speaking software app on students' learning English in Chiang Rai municipality schools 6 and 7 in Thailand
Castañeda, D., & Cho, M-H.	2016	Use of a game-like application on a mobile device to improve accuracy in conjugating Spanish verbs
Chen Hsieh, J., Wu, W-C., & Marek, M.	2017	Using the flipped classroom to enhance EFL learning
D'Agostino, J., Rodgers, E., Harmey, S., & Brownfield, K.	2016	Introducing an iPad app into literacy instruction for struggling readers: Teacher perceptions and student outcomes
Dehghan, F., Rezvani, R., & Fazeli, S.	2017	Social networks and their effectiveness in learning foreign language vocabulary: A comparative study using <i>WhatsApp</i>
Demmans Epp, C.	2016	Supporting English Language Learners with an Adaptive Mobile Application
Elfeky, A., & Masadeh, T.	2016	The effect of mobile learning on students' achievement and conversational skills
Estartki, N., & Bazyar, M.	2016	The effect of MALL on pre-intermediate EFL learners' writing performance
Farangi, M., Kamyab, J., Izanlu, M., & Ghodrat, M.	2017	The effect of using SMS as a post-task activity on Iranian EFL learners' grammar knowledge
Fathi, J., Alipour, F., & Saeedian, A.	2018	Enhancing vocabulary learning and self-regulation via a mobile application: An investigation of the <i>Memrise</i> app

Fishburn, T.	2008	Mobile Device Reading Interventions in the Kindergarten Classroom.
Gromik, N.	2015	The effect of smartphone video camera as a tool to create digital stories for English learning purposes
Gürlüyer, M.	2019	Examining students' perceptions and achievements in terms of the utilization of <i>WhatsApp</i> in learning EFL vocabulary
Hazaea, A., & Alzubi, A.	2016	The effectiveness of using mobile on EFL learners' reading practices in Najran University
Head, T.	2016	Supporting Literacy with iPads: A Pilot Study in Second-Grade Classrooms
Hedjazi Moghari, M., & Marandi, S.	2017	Triumph through texting: Restoring learners' interest in grammar
Hobbs, D.	2017	Flashcards and the <i>Memrise App</i> for English Vocabulary Acquisition
Hung, H-T.	2017	The integration of a student response system in flipped classrooms
Jeong, K-O.	2017	University students' perception and motivation of using digital applications as effective English learning tools
Jeong, N-S.	2017	The effects of mobile-mediated learning on university students' English writing achievement. [in Korean]
Jia, C., & Hew, K.	2019	Supporting lower-level processes in EFL listening: The effect on learners' listening proficiency of a dictation program supported by a mobile instant messaging app
Jin, N.	2017	Mobile-assisted language learning: Using WeChat in an English reading class
Kamalian, A., & Sayadian, S.	2014	The role of short text messaging in Iranian EFL vocabulary learning and motivation
Khansarian-Dehkordi, F., & Ameri-Golestan, A.	2016	Effects of mobile learning on acquisition and retention of vocabulary among Persian-speaking EFL learners
Khodabandeh, F., Alian, J., Soleimani, H.	2017	The effect of MALL-based tasks on EFL learners' grammar learning

Khodashenas, M., & Amouzegar, E.	2013	The effect of using MALL on Iranian EFL learners vocabulary learning
Kim, H-S.	2019	The use of Socrative and Kahoot! in English grammar
Kim, N-Y.	2018	Effects of reading aloud tasks through a mobile phone on EFL vocabulary and reading comprehension skills
Kim, P., Higashi, T., Carillo, L., Gonzales, I., & Gàrate, A.	2011	Socioeconomic strata, mobile technology, and education: A comparative analysis
Kimura, M., Obari, H., & Goda, Y.	2011	Mobile technologies and language learning in Japan: Learn anywhere, anytime
Kongcharoen, C., Prasunpaengsri, S. & Wongmeekaew, T.	2017	Investigating applications of mobile translator for assisting English vocabulary learning
Laban, M.	2017	The Effectiveness of Using Mobile Learning in Developing Eleventh Graders' English Grammar Learning and Motivation for English
Li, J., & Cummins, J.	2019	The effect of using text messages for English language learners' vocabulary instruction
Li, Z., & Hegelheimer, V.	2013	Mobile-assisted grammar exercises: Effects on self-editing in L2 writing
Lin, C-C.	2014	Learning English reading in a mobile-assisted extensive reading program
Lin, J. M-C., & Wu, Y-J.	2010	Netbooks in sixth-grade English language classroom
Liu, G-Z., Chen, J-Y., & Hwang, G-J.	2018	Mobile-based collaborative learning in the fitness center: A case study on the development of English listening comprehension with a context-aware application
Long, D., & Szabo, S.	2016	E-readers and the effects on students' reading motivation, attitude and comprehension during guided reading

Ma, X., & Yodkamlue, B.	2019	The effects of using a self-developed mobile app on vocabulary learning and retention among EFL learners
Magagna-McBee, C.	2010	The Use of Handheld Devices for Improved Phonemic Awareness in a Traditional Kindergarten Classroom
Mashhadi, A., & Khazaie, S.	2018	Familiar or unfamiliar context? Application of m-games in the blended module of L2 learning
Milone, M.	2011	Student comprehension of books in Kindle and traditional formats
Minalla, A.	2018	The effect of WhatsApp chat group in enhancing EFL learners' verbal interaction outside classroom contexts
Mousavinia, S., Hayati, A., & Khazaie, S.	2014	An investigation into the impact of abbreviated didactic texting on language learning
Neumann, M.	2018	Using tablets and apps to enhance emergent literacy skills in young children
Obari, H., & Lambacher, S.	2014	Impact of a blended environment with m-learning on EFL skills
Obari, H., & Lambacher, S.	2015	Successful EFL teaching using mobile technologies in a flipped classroom
Pacheco, B.	2017	The Impact of iPad Multimodalities on the Literacy Skills of Adolescent Males Identified as Low-Achieving Reader
Pirasteh, P., & Mirzaeian, V.	2015	The effect of Short Message Service (SMS) on learning phrasal verbs by Iranian EFL learners
Rachels, J., & Rockinson-Szapkiw, A.	2018	The effects of a mobile gamification app on elementary students' Spanish achievement and self-efficacy
Rahimi, M., & Miri, S.	2014	The impact of mobile dictionary use on language learning
Rahimi, M., & Soleymani, E.	2015	The impact of mobile learning on listening anxiety and listening comprehension

Reichenberg, J.	2014	The Use of iPads to Facilitate Growth in Reading Comprehension Skills of Second Grade Students
Rogowsky, B., Terwilliger, C., Young, C., & Kribbs, E.	2018	Playful learning with technology: The effect of computer-assisted instruction on literacy and numeracy skills of preschoolers
Roussel, S., & Galan, J.	2018	Can clicker use support learning in a dual-focused second language German course?
Seyyedrezaei, S., Kazemi, Y., & Shahhoseini, F.	2016	Mobile-Assisted Language Learning (MALL): An accelerator to Iranian language learners' vocabulary learning improvement
Small, N.	2017	The Effect of a Student Response System on Sixth-Grade Reading, English, and Language Arts Achievement
Tabatabaei, O., & Goojani, A.	2012	The impact of text messaging on vocabulary learning of Iranian EFL learners
Ünal, Ö.	2015	Investigating the use of mobile-based vocabulary notebooks on students' vocabulary achievement in English language learning
Union, C., Union, L., & Green, T.	2015	The use of eReaders in the classroom and at home to help third-grade students improve their reading and English/language arts standardized test scores
Wang, B-T., Teng, C-W., & Chen, H-T.	2015	Using iPad to facilitate English vocabulary learning
Wang, F., & Suwanthep, J.	2017	Constructivism-based mobile application for EFL vocabulary learning
Wang, Y-H.	2017	Integrating self-paced mobile learning into language instruction: Impact on reading comprehension and learner satisfaction.
Wierson, D.	2013	Effects of an iPad Application on Vocabulary and Comprehension in a Sixth-Grade Classroom

Willoughby, D., Evans, M., & Nowak, S.	2015	Do ABC eBooks boost engagement and learning in preschoolers? An experimental study comparing eBooks with paper ABC and storybook controls
Wu, Q.	2015	Designing a smartphone app to teach English (L2) vocabulary
Wu, T., Sung, T., Huang, Y., Yang, C., & Yang, J-C.	2011	Ubiquitous English learning system with dynamic personalized guidance of learning portfolio
Wu, T-T.	2018	Improving the effectiveness of English vocabulary review by integrating ARCS with mobile game-based learning
Wulandari, M.	2019	Improving EFL learners' speaking proficiency through Instagram Vlog
Xiao, J., & Luo, Y.	2014	The speech evaluation method of English phoneme m-learning system
Yang, J-Y., & Che, P-C.	2015	Improving college students English learning with Dr. Eye Android Mid
Zarei, G., Jalilifar, A., & Khazaie, S.	2013	Does it make a difference? L2 vocabulary learning via mobile and conventional mode
Zhang, H., Song, W., & Burston, J.	2011	Reexamining the effectiveness of vocabulary learning via mobile phones

Appendix 3: Effect Sizes of the Included MALL Studies (Between-Group)

#	Study name	Hedges' g	CI Lower limit	CI Upper limit
1	Abduh, M 2019	0.82	0.24	1.43
2	Alavinia, P & Qoitassi K, 2013	5.81	4.47	7.39
3	Alemi M, Sarab M & Lari Z, 2012	0.45	-0.16	1.07
4	Alkhezzi F & Al-Dousari W, 2016 (Vocabulary)	0.87	0.23	1.54
5	Alkhezzi F & Al-Dousari W, 2016 (Grammar)	0.41	-0.22	1.05
6	Alkhezzi F & Al-Dousari W, 2016 (Writing)	0.09	-0.54	0.72
7	Al Yafei O & Osman M, 2016	-0.27	-0.86	0.31
8	Ataee E, Fatemi M & Ashraf H, 2015 (skimming)	1.15	0.59	1.75
9	Ataee E, Fatemi M & Ashraf H, 2015 (guessing)	0.61	0.07	1.17
10	Ataee E, Fatemi M & Ashraf H, 2015 (reading)	0.17	-0.37	0.71
11	Billings E & Mathison C, 2012 (HMD/experimental)	0.84	0.43	1.26
12	Billings E & Mathison C, 2012 (DVD experimental)	0.29	-0.08	0.67
13	Chen Hsieh J et al. 2017	0.74	0.33	1.16

14	D'Agostino J et al. 2016	0.76	0.19	1.36
15	D'Agostino J et al. 2016	0.75	0.18	1.34
16	D'Agostino J et al. 2016	0.76	0.19	1.35
17	Demmans Epp C, 2016 (End-test)	1.71	1.04	2.43
18	Elfeky & Masadeh 2016	1.54	0.93	2.20
19	Farangi, M et al. 2017	0.73	0.27	1.21
20	Fathi, J et al. 2018	0.60	0.08	1.14
21	Fishburn T, 2008 (Initial Sound Fluency)	0.10	-0.13	0.33
22	Fishburn T, 2008 (Letter Naming Fluency)	0.10	-0.12	0.33
23	Fishburn T, 2008 (Nonsense Word Fluency)	0.29	0.06	0.52
24	Fishburn T, 2008 (Phoneme Segmentation Fluency)	0.33	0.10	0.56
25	Fishburn T, 2008 (Word Use Fluency)	0.25	0.02	0.48
26	Head, T. 2016	0.18	-0.27	0.63
27	Hedjazi Moghari M, Marandi, S. 2017	0.75	0.23	1.29
28	Jeong NS, 2017	-0.13	-0.71	0.45
29	Kamalian A & Sayadian S, 2014	0.95	0.43	1.50
30	Khansarian D & Ameri G 2016 (post-test)	1.12	0.66	1.61
31	Khodabandeh, F et al. 2017	8.53	7.00	10.28
32	Khodashenas M & Amouzegar E, 2013	1.53	0.97	2.14
33	Kim NY, 2018 (vocabulary)	0.22	-0.25	0.69
34	Kim NY, 2018 (Reading Comprehension)	-0.21	-0.68	0.26
35	Kongcharoen C et al. 2017	0.98	0.34	1.67
36	Li J & Cummins J, 2019 (Targeted)	0.37	-0.04	0.79
37	Li J & Cummins J, 2019 (Untargeted)	0.30	-0.13	0.74
38	Lin CC 2014 (AVERAGE)	1.43	0.96	1.93
39	Lin JMC & Wu YJ, 2010 (writing)	0.51	0.09	0.94
40	Lin JMC & Wu YJ, 2010 (listening)	0.37	-0.05	0.80
41	Lin JMC & Wu YJ, 2010 (speaking)	0.32	-0.10	0.74
42	Magagna-McBee C, 2010	0.28	-0.17	0.74
43	Milone M, 2011	-0.03	-0.53	0.47
44	Mousavinia S, et al. 2014	23.97	21.04	27.21
45	Pirasteh P & Mirzaeian V, 2015	0.69	0.22	1.16
46	Rachels J & Rockinson-Szapkiw A. 2018	-0.05	-0.36	0.25
47	Rahimi, M & Soleymani, E 2015	0.99	0.41	1.60
48	Reichenberg J, 2014	-0.35	-0.80	0.10
49	Roussel S & Galan J, 2018	60.59	51.17	71.33
50	Seyyedrezaei S et al. 2016	0.82	0.30	1.36
51	Small N, 2017 (reading)	0.04	-0.27	0.35
52	Tabatabaei O & Goojani A, 2012	0.90	0.38	1.45
53	Ünal, Ö, 2015	1.28	0.61	2.00
54	Walters J ,2012	0.10	-0.11	0.31
55	Wang BT et al. 2015	0.85	0.38	1.34
56	Wang, F & Suwanthep J, 2017 (overall)	1.67	1.20	2.16
57	Wang YH, 2017 (Business Administration)	0.34	-0.14	0.83
58	Wang YH, 2017 (Information Management)	1.64	1.08	2.23
59	Wang YH, 2017 (Tourism Management)	0.58	0.09	1.08

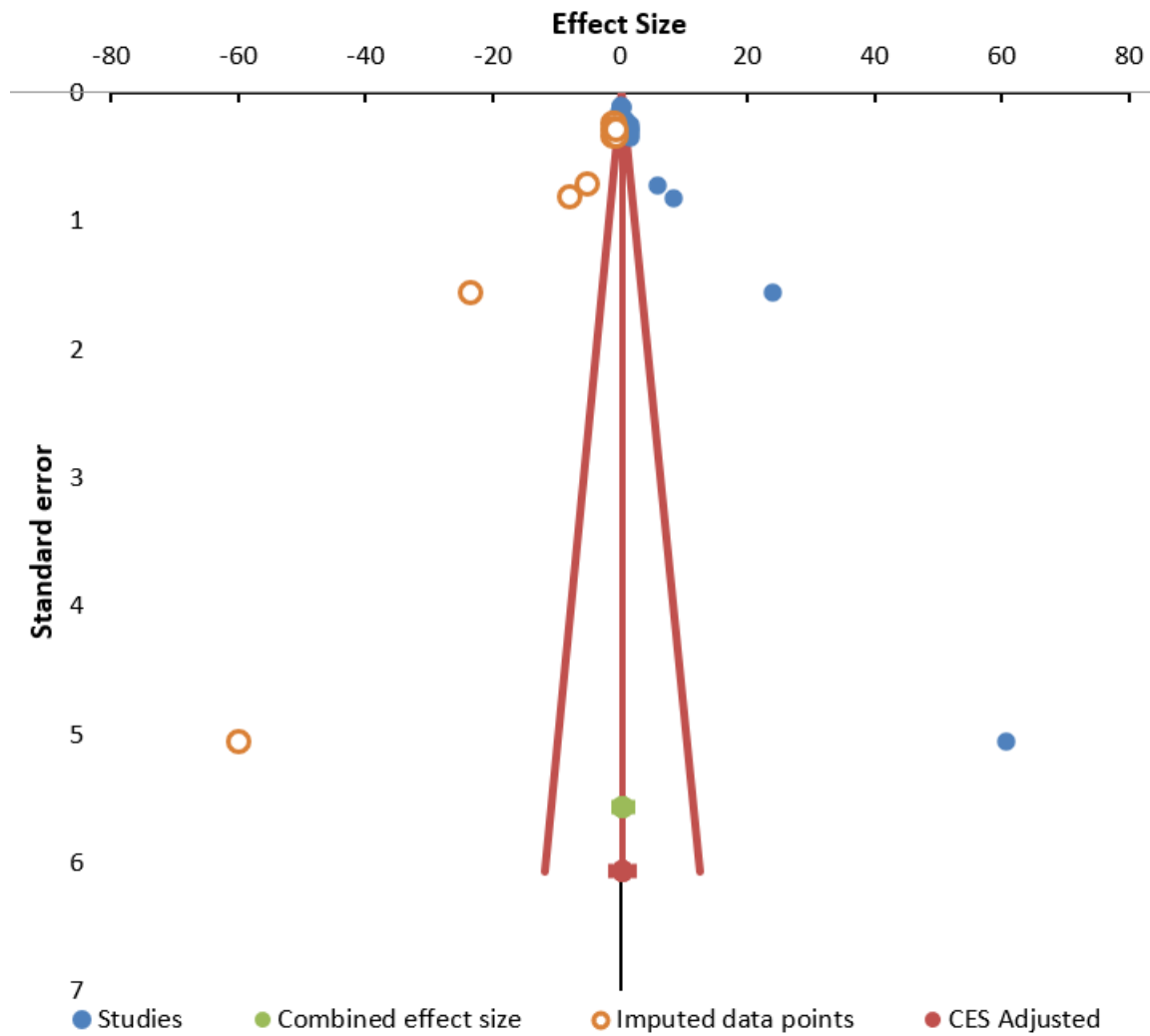
60	Wierson, D 2013	-0.16	-0.76	0.43
61	Wu, Q, 2015	0.63	0.15	1.12
62	Wu, TT 2018	0.78	0.26	1.31
63	Zarei G et al. 2013	1.31	0.76	1.89
64	Zhang H et al. 2011	0.62	0.16	1.08

Appendix 4: Effect Sizes of the Included Studies (Within-Group)

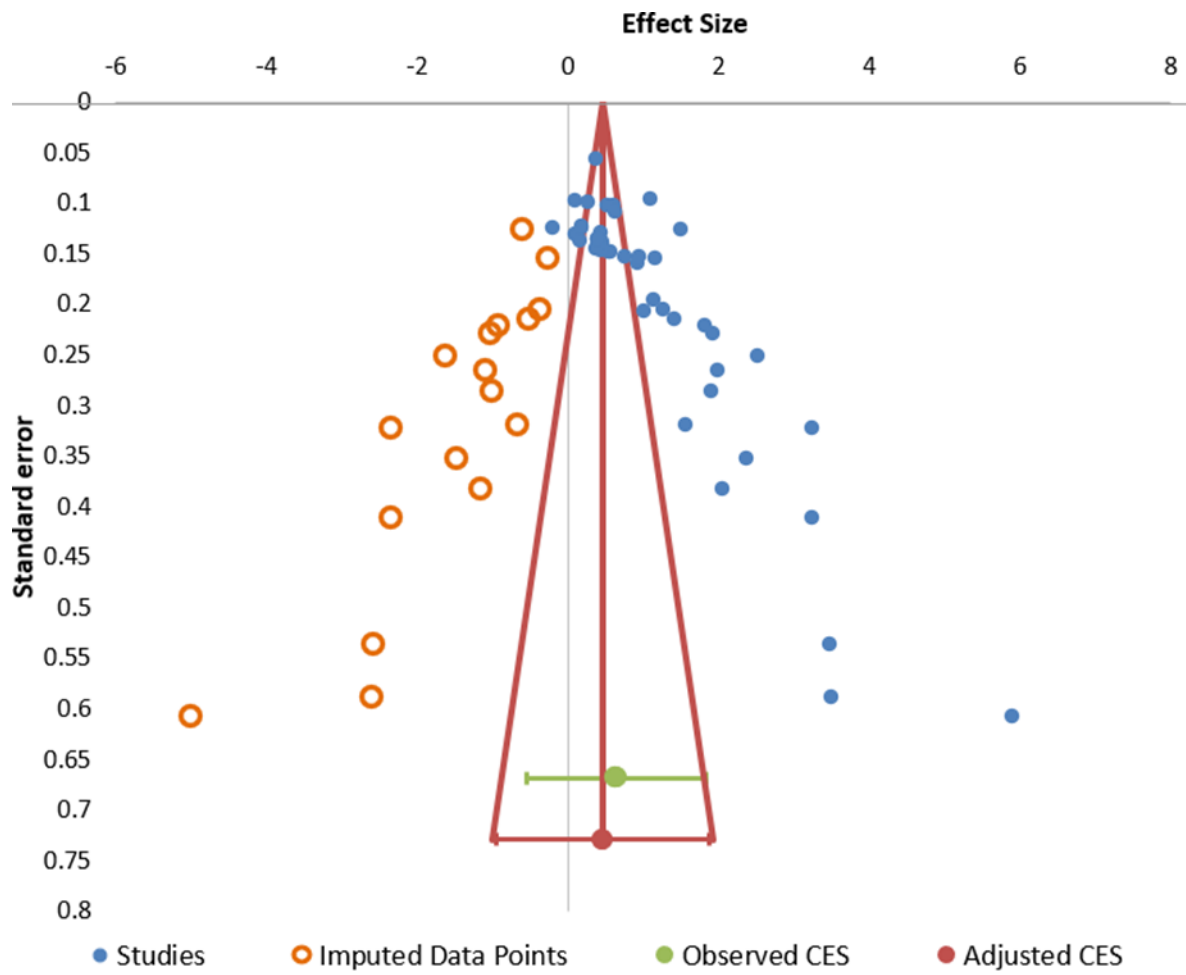
#	Study name	Hedges' g	CI Lower limit	CI Upper limit
1	Agbatogun A. 2014 (Clicker's)	1.18	0.86	1.49
2	Agbatogun A. 2014 (Comm. Approach)	0.93	0.60	1.26
3	Aghajani, M & Zoghipour, M 2018 (self-correction)	3.51	2.28	4.74
4	Aghajani, M & Zoghipour, M 2018 (peer-correction)	3.50	2.38	4.63
5	Aghajani, M & Zoghipour, M 2018 (teacher-correction)	2.07	1.27	2.87
6	Bataineh, R., Al-Hamad, R., & Al-Jamal, D (Female)	0.20	-0.06	0.45
7	Bataineh, R., Al-Hamad, R., & Al-Jamal, D (Male)	-0.18	-0.43	0.08
8	Bitter & Meylani, 2016	0.38	0.27	0.50
9	Castañeda, D & Cho, M-H. 2016 (Beginner)	0.77	0.46	1.08
10	Castañeda, D & Cho, M-H. 2016 (Intermediate)	1.58	0.91	2.25
11	Gromik, N 2015	0.63	0.42	0.83
12	Gürlüyer M, 2019	1.52	1.27	1.77
13	Hazaea A & Alzubi A, 2016 (total - 4 reading practices)	5.92	4.68	7.16
14	Hung HT, 2017 (Kahoot! Individual)	1.02	0.58	1.45
15	Hung HT, 2017 (Kahoot! Peer)	1.91	1.31	2.51
16	Jeong KO 2017 (reading)	0.12	-0.08	0.32
17	Jeong KO 2017 (listening)	0.29	0.08	0.49
18	Kim HS, 2019 (Kahoot!)	1.29	0.87	1.72
19	Kim HS, 2019 (Socrative)	1.16	0.75	1.56
20	Kim HS, 2019 (Paper)	2.01	1.46	2.56
21	Kimura M et al. 2011	0.53	0.33	0.74
22	Liu, G-Z et al. 2018 (post-test)	0.96	0.65	1.27
23	Obari, H & Lambacher, S, 2014	1.10	0.91	1.30
24	Obari H & Lambacher S, 2015 (speaking)	1.43	0.98	1.87
25	Pacheco B, 2017 (vocabulary)	0.45	0.18	0.72
26	Pacheco B, 2017 (reading)	0.64	0.42	0.86
27	Wang HY et al. 2018 (High Ability)	2.38	1.64	3.13
28	Wang HY et al. 2018 (Low Ability)	3.26	2.40	4.12
29	Willoughby D et al. 2015 (Letter name/Ebook)	0.48	0.20	0.76
30	Willoughby D et al. 2015 (Letter name/Paper book)	0.58	0.27	0.88
31	Willoughby D et al. 2015 (Letter name/Storybook)	0.42	0.12	0.72
32	Willoughby D et al. 2015 (Letter sound/Ebook)	0.41	0.13	0.69
33	Willoughby D et al. 2015 (Letter sound/Paper book)	0.57	0.26	0.87
34	Willoughby D et al. 2015 (Letter sound/Storybook)	0.45	0.15	0.76
35	Willoughby D et al. 2015 (Sound-same/Ebook)	0.10	-0.17	0.37
36	Willoughby D et al. 2015 (Sound-same/Paper book)	0.18	-0.11	0.46
37	Willoughby D et al. 2015 (Sound-same/Storybook)	0.39	0.09	0.69

38	Wu T et al. 2011 (Guidance-experimental group)	3.26	2.60	3.92
39	Wu T et al. 2011 (Reading-experimental group)	2.53	2.02	3.04
40	Wu T et al. 2011 (Paper/control group)	0.19	-0.06	0.44
41	Xiao J & Luo Y, 2014 (teacher)	1.94	1.47	2.41
42	Xiao J & Luo Y, 2014 (system)	1.84	1.38	2.29
43	Yang JY & Che PC, 2015	0.40	0.12	0.68

Appendix 5: Funnel Plot Assessment of Asymmetry in Data (Between-Group)



Appendix 6: Funnel Plot Assessment of Asymmetry in Data (Within-Group)



Appendix 7: Subgroup Analysis Related Moderator Variables (Between-Group)

Category	N	g	95% CI	Q	P _Q	I ²	Z-value	P ¹	Q _B
Language learner competence level									1.48*
L1 studies									
Pre-literate	18	0.30	0.20 to 0.41	19.59	0.296	13%	6.21	0.000	
Weakly literate	4	0.61	0.18 to 1.05	2.74	0.434	0%	4.50	0.000	
L2 studies									
Beginner	6	1.24	-1.25 to 3.72	65.66	<0.001	95%	1.28	0.201	
Intermediate	20	1.34	-0.38 to 3.06	368	<0.001	95%	1.63	0.103	
Advanced	3	0.59	-0.68 to 1.85	6.38	0.041	69%	2.00	0.046	
Mixed	2	30.5	-350 to 411	139.9	<0.001	99%	1.02	0.309	
Not specified	31	0.64	0.41 to 0.87	165	<0.001	82%	5.78	0.000	
Language area focus									0.74*
Grammar	8	3.49	-2.52 to 9.50	388	<0.001	98%	1.37	0.170	
Letter/word recognition	20	0.37	0.26 to 0.49	26.55	0.116	28%	6.73	0.000	
Listening	5	0.57	0.20 to 0.93	6.72	0.152	41%	4.33	0.000	
Reading	14	0.41	0.06 to 0.75	72.27	<0.001	82%	2.56	0.010	
Speaking	3	2.96	-7.30 to 13.2	54.88	<0.001	96%	1.24	0.215	
Vocabulary	27	0.80	0.06 to 1.55	224	<0.001	88%	2.22	0.027	
Writing	4	0.28	-0.27 to 0.82	4.44	0.218	32%	1.61	0.107	
Other	3	0.52	-0.86 to 1.89	11.26	0.004	82%	1.62	0.105	
Institutional environment									15.8**
Pre-school	17	0.31	0.20 to 0.43	19.35	0.251	17%	6.06	0.000	
Primary	17	0.30	0.11 to 0.50	40.30	<0.001	60%	3.32	0.001	
Secondary	12	1.39	0.19 to 2.59	130.7	<0.001	92%	2.54	0.011	
Tertiary	30	0.77	-0.04 to 1.58	273.9	<0.001	90%	1.94	0.052	
Language institute	4	0.53	-0.21 to 1.26	6.65	0.084	55%	2.28	0.023	
Adult education	2	1.20	0.02 to 2.38	0.26	0.609	0%	12.9	0.000	
Not specified	2	12.4	-134 to 159	211.9	<0.001	99%	1.08	0.281	
Intervention duration									0.50*
8-9 weeks	29	0.50	0.20 to 0.80	118.9	<0.001	76%	3.41	0.001	
10-12 weeks	22	1.15	-0.25 to 2.55	319.4	<0.001	93%	1.72	0.086	
13-16 weeks	21	0.57	0.34 to 0.80	88.2	<0.001	77%	5.15	0.000	
> 2 semesters	12	1.15	-1.55 to 3.84	241	<0.001	95%	0.93	0.350	
Abbreviations: N: number of studies included; g: Hedges' g; Q: Q test; P _Q : P-value of Q-test, Q _B : Sum of squares									
¹ Two-tailed P-value for overall ES									
*p > 0.05 (not statistically significant); **p < 0.001									

Appendix 8: Subgroup Analysis Related Moderator Variables (Within-Group)

Category	N	g	95% CI	Q	P _Q	I ²	Z-value	P ¹	Q _B
Language learner competence level									40**
L1 studies									
Pre-literate	9	0.39	0.26 to 0.52	10.81	0.213	26%	7.11	0.000	
Weakly literate	2	0.56	-0.64 to 1.75	1.23	0.267	19%	5.93	0.000	
L2 studies									
Beginner	5	1.82	0.78 to 2.87	87.9	<0.001	95%	4.83	0.000	
Intermediate	11	1.82	1.12 to 2.52	130.5	<0.001	92%	5.79	0.000	
Advanced	2	1.44	-4.24 to 7.12	6.40	0.011	84%	3.22	0.001	
Mixed	4	0.61	-0.19 to 1.42	44.65	<0.001	93%	2.42	0.015	
Not specified	23	1.21	0.70 to 1.73	453	<0.001	95%	4.89	0.000	
Language area focus									10.8**
Grammar	9	1.66	0.83 to 2.49	117	<0.001	93%	4.61	0.000	
Letter/word recognition	12	0.73	0.14 to 1.33	159.5	<0.001	93%	2.71	0.007	
Listening	2	0.61	-3.66 to 4.89	13.44	<0.001	93%	1.82	0.069	
Reading	6	1.09	-0.89 to 3.07	109	<0.001	95%	1.42	0.156	
Speaking	8	1.11	0.68 to 1.55	93	<0.001	93%	6.04	0.000	
Vocabulary	6	1.98	0.92 to 3.05	126	<0.001	96%	4.79	0.000	
Writing	8	1.07	0.30 to 1.83	105	<0.001	93%	3.29	0.001	
Other	5	1.13	0.26 to 2.01	68	<0.001	94%	3.58	0.000	
Institutional environment									165**
Pre-school	9	0.39	0.26 to 0.52	10.81	0.213	26%	7.11	0.000	
Primary	4	0.69	-0.01 to 1.39	20.17	<0.001	85%	3.15	0.001	
Secondary	10	0.92	0.33 to 1.51	107.1	<0.001	92%	3.54	0.000	
Tertiary	27	1.38	0.95 to 1.81	512.6	<0.001	95%	6.60	0.000	
Language institute	2	2.58	-3.55 to 8.71	8.70	0.003	89%	5.35	0.000	
Not specified	3	2.92	0.92 to 4.93	6.26	0.008	79%	6.26	0.000	
Intervention duration									3*
8-9 weeks	23	0.84	0.46 to 1.22	329.9	<0.001	93%	4.55	0.000	
10-12 weeks	13	1.67	1.21 to 2.13	162.3	<0.001	93%	7.87	0.000	
13-16 weeks	13	1.45	0.52 to 2.38	287	<0.001	96%	3.40	0.001	
> 2 semesters	7	0.87	0.50 to 1.23	41	<0.001	85%	5.81	0.000	
Abbreviations: N: number of studies included; g: Hedges' g; Q: Q test; P _Q : P-value of Q-test, Q _B : Sum of squares ¹ Two-tailed P-value for overall ES *p > 0.05 (not statistically significant); **p < 0.001									