



# Critical research trends of mobile technology-supported English language learning: A review of the top 100 highly cited articles

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## Abstract

Around the world, the number of English speakers and the significance of the English language are constantly increasing. Among various technology-supported instructional styles, Mobile Learning (M-Learning) has been recognized as a promising approach to enhance students' competencies and skills in the English language. By examining previous literature, a number of reviews have been performed to investigate the role of M-learning in the English language. However, none of these studies has highlighted the trends, opportunities, and challenges identified in the most cited articles that focused solely on the English language. Therefore, to address these limitations, this study performed a review of the top 100 most cited articles, published between 2007 and 2020, indexed by the Web of Science, and addressing the English language only. The results revealed that most research in Mobile English Language Learning (M-ELL) followed an experimental design and employed a single mobile learning implementation. Additionally, the current study identified a number of research areas that require additional research attention. For example, further research is needed among students learning from home, more qualitative research is needed, and additional research is required to improve students' higher-order thinking skills. The outcomes of this study provide a reference to researchers and educators who intend to use mobile technologies in the area of language education, especially in the context of the English language.

**Keywords** Mobile learning · Applications in subject areas · Teaching/learning strategies · Pedagogical issues · M-ELL

## 1 Introduction

English has been recognized as one of the most important languages around the globe and the cornerstone of human existence (Abidin et al., 2012; Stoios et al., 2019). In some countries, English is even used more frequently than the native languages (Rao, 2019). As such, there is a critical need for effective and high-quality education in order to produce competent English language users (Barnawi & Al-Hawsawi, 2017). To address this continuing interest in the English language, many countries have taken into account English in training programs at all educational levels (Hariharasudan & Kot, 2018; Zoghbor, 2018). In addition, several developing countries are considering teaching English as well as other foreign languages in school settings (Rahman & Pandian, 2018; Sah & Li, 2018).

A number of technology-enhanced learning techniques have been applied in English education. However, researchers have given increasing attention to mobile learning (m-learning) since the beginning of the 21st-century (Pedro et al., 2018). Given their prevalence and affordability, mobile devices are often described as the tools that have democratized access to technology, as there are more mobile devices in the hands of learners than any other type of technology, and these devices can be utilized for educational purposes, especially in the teaching and learning of the English language (Hockly & Dudeney, 2018).

Researchers have given increasing attention to mobile learning (m-learning), especially from 2004 onwards (Elaish, Shuib, Ghani, Mujtaba, et al., 2019a). Therefore, m-learning is recognized as a beneficial approach to facilitating formal and informal learning and access to knowledge (Traxler, 2007; Viberg et al., 2021). Due to the popularity of m-learning in second language acquisition, an independent domain of research has emerged, known as mobile-assisted language learning (MALL) (Kukul-ska-Hulme, 2009). Out of MALL, a sub-domain of research has emerged, called m-learning in English language learning (M-ELL), which focuses entirely on using mobile technology to provide an effective environment to teach and learn English (Elaish et al., 2019b). Several scholars have further emphasized the importance of using mobile technologies for language learning from the perspectives of situated learning (Özudogru & Özudogru, 2017) and mastery learning (Zhang, 2010). That is, enabling learners to practice and apply knowledge in authentic and meaningful contexts and without being limited by location and time is the key to the success of language learning.

Therefore, there is a need to examine how mobile applications have been adopted to facilitate English learning. According to Burke et al., (2022), many researchers have attempted to investigate m-learning. However, in the context of M-ELL, only a few reviews were conducted (e.g., Elaish et al., 2019b; Lin & Lin, 2019). In addition, by examining these reviews a pattern emerges, which shows that they can be divided into two main categories. The first category consists of reviews that approached M-ELL from a general and broad perspective (e.g., the main research domains, purposes, and evaluation methods used, and who the sample participants are). For instance, Elaish et al., (2019b) and Elaish et al., (2021) systematically reviewed the findings of 69 and 151 articles published between 2010 and 2015, and 2010 and 2017, respectively.

The second category consists of studies that addressed M-ELL from a specific angle. For example, Lin and Lin (2019) synthesized the outcomes of 33 research studies published between 2005 and 2018, to examine the effectiveness of m-learning technologies in advancing students' vocabulary skills. Further, Zhang & Crompton (2021) reported the outcomes of 438 studies published between 2008 and 2019, to demonstrate how m-learning is being utilized in Chinese higher education in the context of M-ELL.

Lin and Lin (2019) studied the previous research syntheses on mobile learning and reported their gaps and limitations. These studies offer significant synthetic and annotated bibliographies related to MALL, and have examined this field from different perspectives (Burstion, 2014, 2015; Duman et al., 2015; Godwin-Jones, 2011; Kukulska-Hulme & Shield, 2007, 2008; Sung et al., 2015; Viberg & Grönlund, 2012). However, these studies adopted a narrative review approach, which failed to report the actual effectiveness of the treatment, not to mention how the treatment effects vary due to the exertion of a single factor or from the combination of other factors.

Zhang & Crompton (2021) reviewed m-learning research in the recent decade (e.g., Crompton & Burke 2018; Duman et al., 2015; Kaliisa & Picard, 2017; Krull & Duarte, 2017). These studies revealed current research on mobile learning from different perspectives. However, little systematic research has touched on the status of mobile learning and its research trends in a specific context (China).

Both types of reviews provided detailed and insightful information regarding M-ELL research. However, studies in the first category attempted to evaluate the overall effectiveness of m-learning in advancing students' English language competencies. As a result, researchers and educators could find it challenging to form a clear consensus pertaining to the effectiveness of M-ELL, especially if they are interested in a specific language skill, geographical location, or research perspective. In terms of studies in the second category, a closer analysis suggests that these reviews followed a more focused approach, in which they looked at a specific English skill or research conducted within a particular nation, in an attempt to highlight the trends and challenges in M-ELL from a specific scholarly view.

In continuation with the focused approach established by Zhang & Crompton (2021) and Lin and Lin (2019), the present study aimed to review the trends of M-ELL from the perspective of highly cited articles published in the Web of Science database. The present study makes the following contributions: first, it offers an in-depth analysis through an evidence-based discussion regarding the effectiveness of M-ELL. Second, it provides comprehensive insights into M-ELL trends and challenges from the perspective of highly cited research studies. Therefore, it is hoped that this study will present useful information to aid researchers, educators, and application developers who are interested in M-ELL from three angles: (1) research designs and objectives; (2) learning devices, activities, and learning places; and (3) adopted subjects, sample sizes, analysis methods, and measurement issues by referring to the technology-based learning model (Lin & Hwang, 2019). Further, the analysis provided by this study might assist researchers and instructors from other language disciplines in acquiring further evidence concerning the effectiveness of m-learning as an instructional approach. To fulfill the above-mentioned objectives, the present review aimed to address the following research questions:

RQ1: What are the research designs and objectives of the top 100 highly cited M-ELL studies?

RQ2: What are the learning devices, activities, and learning places adopted by the top 100 highly cited M-ELL studies?

RQ3: What are the subjects, sample sizes, analysis methods, and measurement issues of the top 100 highly cited M-ELL studies?

## 2 Mobile Learning background and history

Crompton (2013, p. 4) defined m-learning as “Learning across multiple contexts, through social and content interactions, using personal electronic devices.” M-learning has become a generic term for mobile integration computing devices in teaching and learning (Grant, 2019).

Bransford et al., (2005) stated that m-learning goes beyond research and pilot projects toward large-scale services. They gave an example of an English in Action (EIA) project which has helped millions of people in Bangladesh improve their communicative English language skills. Two main motivations drive the growing interest in mobile learning. The first is the desire to equip each student with a powerful individual device, as this could provide a personalized and customized learning experience, and it is known that students learn more effectively when they draw on their own current understanding and make their own learning choices. The second is a growing recognition that in the 21st century, people must continue to learn throughout their lives, as knowledge and technologies advance rapidly (Sharples & Pea, 2014).

Thanks to the dedicated work of the mobile learning community, the past few years have seen an explosion in the growth of mobile learning across all sectors of education. Current perspectives on mobile learning generally fall into four broad categories: technocentric, relationship to e-learning, augmenting formal education, and learner-centered (Winters, 2007).

The educational process relies heavily on mobile learning, and many areas are increasingly developing mobile learning. Mobile apps are now the new breakthrough development of the era in learning skills in all fields, and social media platforms are strengthening the process. Mobile apps are not only text and videos but also tutorials, which show the actual processes (Qureshi et al., 2020).

In recent years, the educational model has benefited from the incorporation technologies that enrich the teaching-learning process. The benefits of using mobile devices in learning include constructivist learning, student behavior, learning spaces, collaborative learning, informal and self-directed learning, resources for teachers, technology and support, affordability and portability, availability and flexibility, and motivational learning (Criollo-C et al., 2021).

### 3 Research Method

#### 3.1 Article search

To retrieve the most relevant research articles, a keyword list was determined to figure out the features of the target articles by taking all possible combinations of keywords into account. The keyword list was adopted from Elaish, Shuib, Ghani, Mujtaba, et al. (2019a), Elaish et al. (2017), and Elaish et al. (2021). However, the mobile assisted language learning and MALL terms were added to the search strategy due to their importance in collecting the related articles. The adopted keyword list was “((mobile learning) OR (m-learning) OR (mlearning) OR (personalized learning) OR (ubiquitous learning) OR (u-learning) OR (anytime and anywhere learning) OR (mobil \* learn \*) OR (mobile assisted language learning) OR (MALL)) AND (English language).”

Some of these terms were selected because Mehdipour and Zerehkafi (2013) stated that personalized learning, ubiquitous learning, anytime and anywhere learning as well as handheld learning are among the many m-learning names depending on the field.

#### 3.2 Data source

The Web of Science is the main source for many quantitative studies to obtain bibliographic indicators (Ràfols et al., 2016). The selection method of WoS journals is based on their fulfilment of editorial standards and high scientific impact (Braun et al., 2000). Based on its perceived objectivity, the WoS has achieved an authoritative status in terms of identifying high-quality journals globally (Lillis & Curry, 2010).

The WoS was chosen because the quality of the research articles published in this database have been well recognized (Hussein et al., 2021). The strategy was used to search for the topics of Social Sciences Citation Index™ (SSCI) publications, as suggested by Chang et al. (2018). The search was conducted on December 23, 2021 and 1,717 articles were found. By limiting the search to journal articles in the field of education and educational research, a total of 992 articles were kept.

#### 3.3 Selection process

Each of the 992 articles was read separately to check whether mobile learning was used to learn the English language. The top 100 M-ELL cited articles were identified from the 17th to the 574th article. The possible reasons why so many irrelevant articles were selected using this strategy are as follows:

- The strategy selected articles which stated that the authors had used the English language to translate from another language for which mobile learning was used.
- The strategy selected articles that incorporated some of the previous work related to English language learning.
- The strategy selected articles because the authors included the word “English” in their contribution notes.

### 3.4 Coding Scheme

To provide detailed analysis of the content of articles included in this study, a number of coding schemes were implemented. These coding schemes covered a number of dimensions, namely, basic information, mobile devices (adopted Chang et al., 2018), research design (adopted from Johnson & Christensen 2000), research methods, roles of mobile learning (adopted Hwang 2014), learning place (adopted Hwang et al., 2008), statistical methods (adopted from Mertler & Reinhart 2016; Wert et al., 1954), measurement issues (adopted from Chang et al., 2018; Lai, 2019), participants (adopted Elaish et al., 2017, 2019b), and additional detailed information regarding each scheme which is listed in Table 1.

## 4 Results

### 4.1 Publication Situation, Nationalities, and journals

Fig. 1 shows the distribution of the top 100 cited articles in M-ELL, during the period 2007 to 2020. According to the results, the earliest article was written by Fallahkhair et al., (2007); it focused on the development processes of a cross-platform ubiquitous language learning service via interactive television (iTV) and mobile phones to learn the English language. During the period 2010 to 2018, more than six articles were published each year, with the sole exception of 2015. In addition, although this study was conducted at the end of 2021, two articles from the year 2020 were included.

In addition, the articles included in this review were divided into two periods. This follows the classification approach adopted by Lai (2019), who divided the results of their review into three periods, with each period spanning 7 years; they then compared the three groups. Thus, in the current study, the first period was 2007 to 2013 (45 articles), and the second period was 2014 to 2020 (55 articles). The distribution of articles revealed that more research was published between 2014 and 2020, which implies an increasing interest among researchers and educators in using m-learning in the area of the English language.

In this study, the nationalities of the first author only were taken into consideration. From the results, only 20 nationalities appeared in the highly cited M-ELL articles. According to Fig. 2, which lists countries and areas with more than two contributions, Taiwan has produced the majority of research (45 articles), followed by China (13 articles), Turkey (7 articles), the United States (5 articles), Australia and Japan (4 articles), and North Cyprus and the United Kingdom (3 articles each).

**Table 1** Analysis of coding schemes

Coding scheme	Dimensions
Basic information	This scheme addressed the following information: <ul style="list-style-type: none"> <li>• Distribution of articles, according to the year of publication, countries, and journals.</li> </ul>
Mobile devices	In this review, mobile devices were categorized as the following: <ul style="list-style-type: none"> <li>• Wearable devices</li> <li>• Smart phones</li> <li>• Tablet PCs</li> <li>• Traditional mobile devices (e.g., Personal Digital Assistants (PDAs) or notebooks)</li> <li>• Mixed/varied or not-specified</li> <li>• No use of devices</li> </ul>
Research Design	The research design of the articles included in this review was also taken into consideration and included: <ul style="list-style-type: none"> <li>• Experimental design (Randomized controlled trials (RCTs))</li> <li>• Quasi-experimental</li> <li>• No experimental design</li> <li>• Qualitative design</li> <li>• Mixed methods</li> <li>• Analytical research</li> </ul>
Research methods	<ul style="list-style-type: none"> <li>• Single mobile learning implementation</li> <li>• Comparing mobile learning with other learning methods</li> <li>• Comparing different designs of mobile learning</li> <li>• Observation and interviews</li> <li>• Literature and theoretical-based analysis</li> </ul>
Roles of mobile learning	In M-Learning, mobile devices assume one of these roles: <ul style="list-style-type: none"> <li>• Accessing learning materials only</li> <li>• Accessing learning materials and performing assessments</li> <li>• Learning with full online support</li> <li>• Learning across contexts</li> <li>• Not-specified</li> <li>• No activities</li> </ul>
Learning place	<ul style="list-style-type: none"> <li>• Classroom or laboratory</li> <li>• School campus</li> <li>• Home</li> <li>• Real-world contexts related to learning content</li> <li>• Across contexts (e.g., two or more places)</li> <li>• Not-specified</li> <li>• None</li> </ul>
Statistical methods	The statistical methods are categorized into the following: <ul style="list-style-type: none"> <li>• Descriptive</li> <li>• Chi-square</li> <li>• <i>t</i> tests</li> <li>• One-way ANOVA/ANCOVA</li> <li>• Two-way ANOVA/ANCOVA</li> <li>• Principle components analysis</li> <li>• Regression analysis</li> <li>• Structural equation modeling (SEM)</li> <li>• Cluster analysis</li> <li>• Time series</li> <li>• Sequential pattern analysis</li> <li>• Interviews</li> </ul>

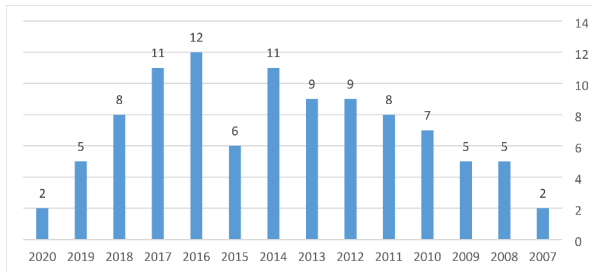
**Table 1** (continued)

Coding scheme	Dimensions
Measurement issues	<p>This scheme focuses on assessing the outcomes of the intervention included in this study; these outcomes were classified into the following categories:</p> <ul style="list-style-type: none"> <li>• Affect</li> <li>• Technical</li> <li>• Behavior</li> <li>• Correlation</li> </ul>
Participants	<p>Information regarding participants was analyzed according to the following dimensions:</p> <ul style="list-style-type: none"> <li>• English skills <ul style="list-style-type: none"> <li>o Vocabulary</li> <li>o Writing</li> <li>o Reading</li> <li>o Listening</li> <li>o Speaking</li> <li>o Grammar</li> <li>o all (all the English skills)</li> <li>o Not specified</li> <li>o more than one and less than all</li> </ul> </li> <li>• Group size <ul style="list-style-type: none"> <li>o non-grouped</li> <li>o grouped</li> </ul> </li> <li>• Assessment <ul style="list-style-type: none"> <li>o Interview</li> <li>o Questionnaire</li> <li>o Test</li> <li>o mixed except for “Not specified” and others</li> </ul> </li> <li>• English acquisition problems <ul style="list-style-type: none"> <li>o Lack of identifying needs, reports, or studies, or testing the effect of technologies</li> <li>o Motivation</li> <li>o Language difficulties or limitation of vocabulary, reading materials are not available</li> <li>o Lack of equipment or poor current equipment, technique, or software</li> <li>o Culture</li> <li>o Unstandardized curriculum, unqualified English teachers or improving their quality</li> <li>o Other.</li> </ul> </li> <li>• Students <ul style="list-style-type: none"> <li>o University students</li> <li>o School/ pre-school students</li> <li>o Learners/ users/ students (not specified)</li> <li>o Mixed: students and teachers (school/ university)</li> <li>o Teachers</li> <li>o Mixed: school and university students</li> <li>o Others</li> </ul> </li> </ul>
Some additional items have been extracted from the reviewed articles	<p>English language focused, which refers to studies that studied English language only or combined with other language or fields of science (such as math, science, etc.). The second item depends on the taxonomy (adopted from Elaish et al., 2017) of a mobile learning application (pure: only mobile technology or blended: mobile technology mixed with other technology such as computers) and whether the application is a game or non-game application.</p>

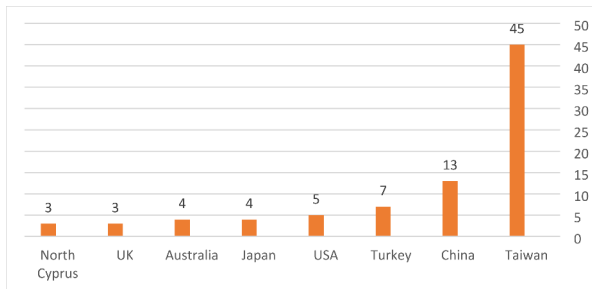
Furthermore, the authors of the top 100 highly cited articles came from 68 different institutions. The institute with the highest number of articles (9) is National Taiwan Normal University, while National Cheng Kung University published five articles, National Chengchi University published four articles, and Lunghwa Univer-



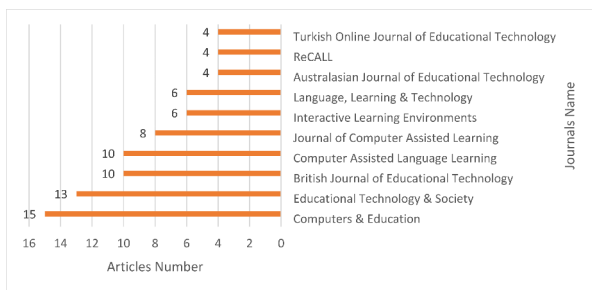
**Fig. 1** Distribution status of highly cited M-ELL studies



**Fig. 2** Nationalities which appeared more than twice in M-ELL articles



**Fig. 3** Top 10 journals publishing M-ELL articles



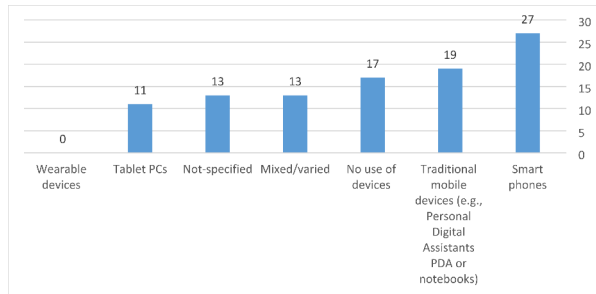
sity of Science and Technology published three. Two articles each were published by 15 institutions, while 59 institutions published one each.

It was also found that 80 of the top 100 highly cited M-ELL articles were published by 10 journals, as shown in Fig. 3. On the other hand, those 10 journals received 91.2% of the citations (4,636 out of 5,080), with Computers & Education alone receiving 26.3% of all citations (1,338 out of 5,080). The British Journal of Educational Technology ranked second in terms of citations, with 687 (just under half of Computers & Education’s citations).

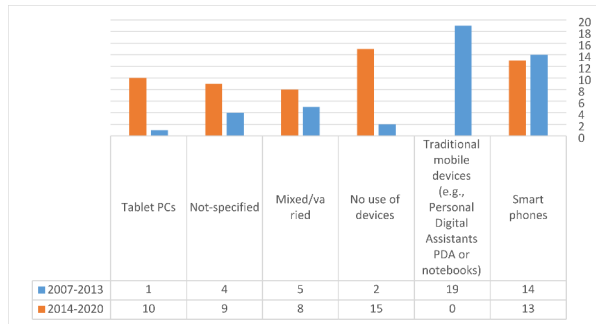
### 4.2 Types of Mobile Devices

In terms of device usage, Fig. 4 shows that 27 articles adopted smart phones, 19 used traditional mobile devices, and 13 utilized mixed mobile devices. In addition, 13 articles did not specify which type of mobile technology they used in their research.

**Fig. 4** Mobile devices adopted in M-ELL studies



**Fig. 5** Mobile devices adopted in M-ELL studies in each period



Finally, 17 articles did not employ any mobile devices. There was no use of wearable devices among these 100 articles.

From 2007 to 2013, 45 articles were published. As shown in Fig. 5, the majority of the research (19 articles) was mainly conducted using Personal Digital Assistants (PDAs) (e.g. Cheng et al., 2010), followed by smart phones (14 articles) (e.g. Shen et al., 2008), while only one study employed tablet PCs in English language learning (e.g. Lan et al., 2007).

From 2014 to 2020, the use of smart phones remained relatively stable with 13 articles. The popularity of tablet PCs increased dramatically in this time period (10 articles), along with mixed mobile devices (8 articles). In addition, there was a notable upsurge in the number of studies that did not specify the adopted mobile technology (9 articles) and studies that included no use of mobile technology at all (15). Further, PDA technology attracted no research interest in this period. For instance, Lai (2016) adopted smart phones to create a mobile immersion environment with the mobile instant messaging application, WhatsApp. In Shadiey et al.'s (2015) study, students took pictures of didactic objects in an authentic, familiar environment and used English to describe their pictures in written and oral annotations using tablet PCs. Yao (2015) used a variety of devices to improve students' ability to apply English efficiently.

The adoption of Global Positioning Systems (e.g. Khemaja & Taamallah 2016), Augmented Reality (e.g. Liu & Tsai 2013), or Bluetooth (e.g. Shao & Crook 2015) in English language learning was found in the literature. However, some emerging technologies, such as infrared rays and the Internet of Things, were not adopted by these studies.

**Table 2** Percentage of research design in each period

Research design	2007–2013 ( <i>n</i> =45)	2014–2020 ( <i>n</i> =55)	2007–2020 ( <i>n</i> =100)
Experimental	53%	42%	47%
Non-experimental	22%	16%	19%
Qualitative	5%	20%	13%
Mixed methods	18%	13%	15%
Analytical	2%	9%	6%

**Table 3** Percentage of research methods adopted in each period

Research methods	2007– 2013 ( <i>n</i> =45)	2014– 2020 ( <i>n</i> =55)	2007– 2020 ( <i>n</i> =100)
Single mobile learning implementation	33%	23%	28%
Comparing mobile learning with other learning methods	22%	22%	22%
Comparing different designs of mobile learning	27%	22%	24%
Observation and interviews	13%	22%	18%
Literature and theoretical-based analysis	5%	11%	8%

### 4.3 Research Design

Table 2 shows the distribution of the top 100 cited articles in M-ELL, according to their research design. It was found that 47% were experimental design studies (e.g. Chen & Hsu 2008), 19% employed non-experimental designs (e.g. Hsu 2013), while 15% of studies conducted mixed methods (e.g. Chen et al., 2019), and 13% of studies employed a qualitative design (e.g. Hsieh & Tsai 2017). Only 6% employed analytical research. In general, the experimental, non-experimental, and mixed methods decreased in the second period. On the other hand, qualitative design and analytical research increased in the same period.

### 4.4 Research Methods

According to the results in Table 3, the research method with the highest percentage is single mobile learning implementation (28%) (e.g. Cavus & Ibrahim 2009), followed by comparing different mobile learning designs (24%) (e.g. Sandberg et al., 2014), comparing mobile learning with other learning methods (22%) (e.g. Liu 2009), and observation of learners' behaviors and collection of their perceptions of learning through interviews (18%) (e.g. Kearney & Maher 2019). The percentages of these three research methods are very similar. On the other hand, literature and theoretical-based analysis was only used in 8% of the studies (e.g. Baran 2014).

There is an interesting finding that the use of single mobile learning implementation and comparing different mobile learning designs reduced in the second period. However, the use of observation and interviews and literature and theoretical-based analysis increased in the second period. Comparing mobile learning with other learning methods did not see any changes from the first to the second period.

**Table 4** Ratio of roles of m-learning in individual periods

Roles of mobile learning	2007– 2013 ( <i>n</i> =45)	2014– 2020 ( <i>n</i> =55)	2007– 2020 ( <i>n</i> =100)
Accessing learning materials only	15%	14%	29%
Accessing learning materials and performing assessments	3%	7%	10%
Learning with full online support	9%	8%	17%
Learning across contexts	14%	10%	24%
Not-specified/ No activities	4%	16%	20%

**Table 5** Percentage of learning places in each period

Learning places	2007–2013 ( <i>n</i> =45)	2014–2020 ( <i>n</i> =55)	2007– 2020 ( <i>n</i> =100)
Classroom or laboratory	33%	20%	26%
School campus	16%	6%	10%
Home	0%	2%	1%
Real-world contexts related to learning content	11%	6%	8%
Across contexts	29%	32%	31%
Not-specified	7%	11%	9%
None	4%	23%	15%

#### 4.5 Roles of Mobile Learning

Table 4 presents the roles of mobile learning in the M-ELL studies. Approximately one in three studies (29%) employed mobile devices for learners to access learning materials only (e.g. Zheng et al., 2018). Although the role of employing mobile devices in learning across contexts (e.g. Y.-M. Huang et al., 2012a, b) declined during 2014 to 2020, this role was the second most popular choice among researchers in M-ELL, with a utilization rate of 24%. Interestingly, studies that did not use any activities or which did not clearly state the role of the mobile devices during the learning activity increased noticeably during the second period, constituting 20% of studies (e.g. Hoi 2020; Serin, 2012). Learning with full online support received relatively the same research interest during both periods. Finally, despite the fact that using mobile devices as a tool to evaluate learning materials and learning performance (e.g. Kondo et al., 2012) increased during the second period, this role was the least frequently assigned to mobile devices, comprising 10% of the studies only.

#### 4.6 Learning places

Table 5 shows that 31% (e.g. Zhonggen et al., 2019) of learning interventions were conducted across learning contexts. In addition, almost 26% of studies (e.g. Dashtestani 2016) were conducted in a classroom or laboratory. Studies performed on school campuses and in real-world contexts received similar research interest, with 10% and 8%, respectively. This diversity in learning places indicates that M-ELL allows learners to learn anywhere, especially across contexts and in classrooms or laboratories, as 57% of studies were conducted in these places. However, other locations such as

**Table 6** Percentage of statistical methods in each period

Statistical methods	2007– 2013 ( <i>n</i> =45)	2014– 2020 ( <i>n</i> =55)	2007– 2020 ( <i>n</i> =100)
Descriptive	31%	35%	33%
<i>t</i> tests	40%	25%	32%
One-way ANOVA/ANCOVA/ MANOVA/ MANCOVA	25%	38%	32%
Interviews	35%	18%	26%
Two-way ANOVA/ANCOVA/ MANOVA/ MANCOVA	6%	5%	6%
Chi-square/ Partial least squares	4%	6%	5%
Principle components analysis	2%	0%	1%
Regression analysis	4%	7%	6%
SEM	6%	22%	15%
Cluster analysis	0%	0%	0%
Time series	0%	2%	1%
Sequential pattern analysis	0%	2%	1%
None	22%	9%	15%

homes attracted very limited research, at 1% only. However, 15% of the studies did not use mobile devices at all (e.g. García-Sánchez & Luján-García 2016).

#### 4.7 Statistical methods

Table 6 illustrates that one third of the studies included in this review focused on using descriptive statistical analysis (33%) (e.g. Ma 2017), while the two methods of one-way ANOVA / ANCOVA / MANCOVA (e.g. Zou & Xie 2018) and *t* tests (e.g. Oberg & Daniels 2013) were employed by 32% of studies. In addition, other analysis methods such interviews attracted notable research attention, as almost one in every four studies conducted interviews with participants. Other statistical methods observed in as few as 6% of studies were two-way ANOVA/ANCOVA/MANOVA/MANCOVA (e.g. Chang, Lei, et al., 2011) and regression analysis (e.g. Huang et al., 2012a, b). Additionally, 15% of the studies did not use any statistical method or did not specify which method was used (e.g. Kim & Smith 2017).

When the two periods are compared, the results suggest that One-way ANOVA / ANCOVA/MANOVA/MANCOVA, Chi-square/partial least squares, regression analysis, and SEM experienced growth in research interest. However, on the other hand, during the second period, the implementation rate of *t* tests, interviews, and Two-way ANOVA/ANCOVA/MANOVA/MANCOVA declined.

#### 4.8 Measurement issues

According to the results in Table 7, the most investigated research outcomes are affect and cognition, with 76% and 74%, respectively. A closer look at these outcomes, especially the cognition category, reveals that improving students' academic achievement (e.g. Chang, Tseng, et al., 2011) was the most researched outcome, as it was investigated by more than half of the studies included in this review. Other learning outcomes in the cognition category such as collaboration/communication (e.g. Liu et

**Table 7** Percentage of measurement issues in each period

Dimension	Sub-dimension	2007– 2013 (n=45)	2014– 2020 (n=55)	2007– 2020 (n=100)
Cognition	Achievement	36%	29%	51%
	Higher-order thinking performance	7%	5%	10%
	Collaboration/communication	7%	18%	13%
Affect	Technology acceptance	20%	7%	13%
	Attitude/effort	20%	11%	15%
	Self-efficacy/belief	7%	11%	9%
	Satisfaction /interest	31%	20%	25%
	Cognitive Load	9%	9%	9%
	Interview/ open-ended questions	4%	5%	5%
	Technical	Learning performance (skillful)	15%	33%
Behavioral	Behavioral analysis	11%	11%	11%
Correlation	Correlation or cause-and-effect analysis	11%	16%	14%
Review	Review	0%	5%	3%

al., 2017) and higher-order thinking were not thoroughly examined, comprising only 13% and 10%, respectively, although the studies that focused on communication/collaboration more than doubled during 2014 to 2020. Despite being less observed during the second period, in the affect category, the most studied outcome was satisfaction/interest (e.g. Wang et al., 2009), as it was assessed in 25% of the studies included in this review. Concerning other learning outcomes in this category, such as attitude/effort and technology acceptance (e.g. Chang et al., 2013), both domains were studied in equal measures, with 15% and 13%, respectively. Further, in the technical category (e.g. Huang et al., 2016), 25% of studies addressed improving students' learning performance from a technical point of view.

#### 4.9 Participants, English Skills, Group size, Assessment, and English Acquisition problems

Most articles in this field (54%) studied the effect of M-ELL on university students (e.g. Chang et al., 2012), as shown in Table 8. Most of the studies recruited participants of the same type, except for 4% of studies adopting mixed groups of participants, such as teachers and students together (e.g. Ng & Nicholas 2013) or school and university students (e.g. Jung 2014). In addition, 4% of studies did not refer to any research participant. In conclusion, most studies (79%) focused individually on university or school students only. The other types of participants, whether together or separately, received very little attention, especially mixed (students and teachers or school and university students).

English skills could be “vocabulary,” “reading,” “listening,” “speaking,” “writing,” or “grammar.” In the present study, the “targeted English language skills” could

**Table 8** Percentage of participants in each period

Participants	2007– 2013 ( <i>n</i> =45)	2014– 2020 ( <i>n</i> =55)	2007– 2020 ( <i>n</i> =100)
University students	29%	25%	54%
School/pre-school students	12%	13%	25%
Learners/users/students (not specific)	1%	5%	6%
Mixed: students and teachers (school/university)	1%	2%	3%
Teachers	1%	4%	5%
Mixed: school and university students	0%	1%	1%
Others	0%	2%	2%
None	1%	3%	4%

**Table 9** Percentage of English skills in each period

English skills	2007–2013 ( <i>n</i> =45)	2014–2020 ( <i>n</i> =55)	2007–2020 ( <i>n</i> =100)
All	16%	27%	43%
Vocabulary	9%	11%	20%
Writing	1%	1%	2%
Reading	5%	5%	10%
Listening	3%	1%	4%
Speaking	1%	2%	3%
Grammar	0%	0%	0%
More than 1 and less than all	10%	8%	18%

be one of the categories: single skill, more than one skill, and all skills. As shown in Table 9, and 43% of the studies stated that their intervention addressed all English language skills (e.g. Al-Fahad 2009) but some of them did not provide any such information, while 18% of the studies aimed to enhance more than one English skill of the participants (e.g. Gu et al., 2011). Finally, 20% of the studies focused on the vocabulary skill (e.g. Liu 2016).

Regarding studies that investigated one language skill, vocabulary was the most targeted. Overall, 91% of the studies only focused on studying or improving all English language skills together, more than one but not all, vocabulary or reading. The other skills received little focus in terms of being studied either individually or in combination with other skills.

In the M-ELL research, four main types of assessment were carried out, namely questionnaires (e.g. Lim et al., 2011), tests (e.g. Sandberg et al., 2011), interviews (e.g. Wong & Looi 2010), and observations (e.g. Khemaja & Taamallah 2016). According to the results in Table 10, and 39% of the studies used one of these types as the only assessment method for the study; with a utilization rate of 23%, questionnaires were the most employed form of assessment among these four types. It should be noted that some studies did not provide clear information regarding the assessment methods they used (e.g. Mahdi 2018), while other studies used a questionnaire and observation, or only conducted a review to study usage trends (e.g. Hsu 2016). In addition,

**Table 10** Percentage of assessment methods in each period

Assessment methods	2007–2013 ( <i>n</i> =45)	2014–2020 ( <i>n</i> =55)	2007–2020 ( <i>n</i> =100)
Interview (I)	1%	3%	4%
Questionnaire (Q)	13%	10%	23%
Test (T)	3%	5%	8%
Q+I	5%	3%	8%
T+I	2%	3%	5%
T+Q	6%	8%	14%
T+Q+I	7%	10%	17%
Observation (O)	1%	3%	4%
Q+I+O	1%	1%	2%
I+O	0%	2%	2%
T+Q+I+O	1%	0%	1%
T+Q+O	3%	0%	3%
Not specified	1%	2%	3%
Other	1%	5%	6%

**Table 11** Percentage of English acquisition problems in each period

English acquisition problems	2007– 2013 ( <i>n</i> =45)	2014– 2020 ( <i>n</i> =55)	2007– 2020 ( <i>n</i> =100)
Lack of identifying needs, reports, or studies or testing the effect of technologies	21%	36%	57%
Motivation	17%	10%	27%
Language difficulties or limitation of vocabulary, and unavailability of reading materials	7%	5%	12%
Lack of equipment or poor current equipment, technique, or software	0%	2%	2%
Culture	0%	1%	1%
Unstandardized curriculum	0%	0%	0%
Unqualified English teachers or improving their quality	0%	0%	0%
Other	0%	1%	1%

during the second period, the assessment method that combined tests, questionnaires, and interviews received more attention than any other method of assessment.

In relation to problems associated with English language acquisition, Table 11 reveals that 96% of studies focused primarily on addressing the lack of studies that test the effect of m-learning technologies (e.g. Hwang et al., 2016), promoting students' motivation (e.g. T. T. Wu, 2018), and highlighting language difficulties or limitations of vocabulary, and unavailability of reading materials (e.g. Liu 2016).

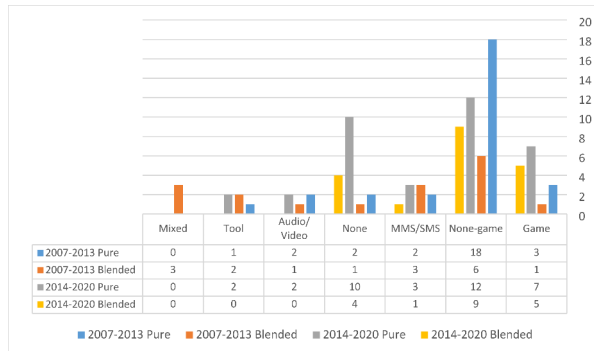
More than half of the studies were investigation studies. There were no studies of the curriculum or of teacher quality problems. Only a few studies (1%) were related to cultural problems.



**Table 12** Number of English language only studies in each period

English language only	2007–2013 (n=45)	2014–2020 (n=55)	2007–2020 (n=100)
Yes	39%	41%	80%
No	6%	14%	20%

**Fig. 6** Mobile learning taxonomy with M-ELL application type in each period



#### 4.10 Some additional items were extracted from the reviewed articles

In the second period, there was an increase in the number of studies focusing on the English language only (41%) (e.g. Chang et al., 2016); however, the number of studies that investigated English along with other aspects (e.g. Looi & Wong 2014) increased and received more attention, as illustrated in Table 12. Additionally, all review studies studied English language with other languages (e.g. Duman et al., 2015) except for one (Elaish et al., 2019b).

Finally, Fig.6 shows that m-learning applications can either be used on their own, purely without any support from other technology, or blended, which means the application in question is used within other technologies; in addition, concerning the type of application used by the studies included in this review, the results in Fig. 6 reveal that around one third of studies employed a non-game application, which refers to the use of a mobile application without showing evidence of gaming, SMS/MMS, or media (e.g. Zhonggen et al., 2019). Further, the non-game applications, during both periods, in pure and blended forms, were the most used at a rate of 45%.

In pure settings, gaming applications (e.g. Kondo et al., 2012) were the second most employed form of technology. Regarding other forms of technology, during the second period, MMS/SMS such as WhatsApp was the third most implemented form of technology at 9% (e.g. Avci & Adiguzel 2017).

## 5 Discussion

Highly cited articles are regarded as valuable and quality indicators for the continuity of research (Garousi & Fernandes, 2016). Via analyzing the most cited articles, the potential research foci or designs that could attract a great deal of attention could be

identified, and thus helpful recommendation for future studies can be offered (Lai, 2019).

In this study, research studies published between 2007 and 2020 and indexed by the Web of Science online repository were selected to analyze and review the 100 most cited articles in the area of M-ELL research. The Web of Science database was selected for the best coverage of scientific journal citations (Farooq & Feizollah, 2021; Laato et al., 2022). Analysis of research output according to the year of publication shows that M-ELL attracted considerable research attention throughout the years. It was also found that many studies reported that m-learning had positive impacts on participants' performance or perceptions (Elaish et al., 2017; García Botero et al., 2019; Kim et al., 2013; Liu, 2009).

Recently, qualitative and analytical research have received more attention as the preferred research designs in M-ELL studies. This increase in the use of qualitative research in different fields of science and industry has been discussed by Frost (2021) and Mohajan (2018). On the other hand, experimental (pre, quasi, true) research designs were still commonly used in this field (47%). Ross & Morrison (2013) mentioned the importance of the experimental research design in the relevant field, because "The behavioral roots of educational technology and its parent disciplines have fostered usage of experimentation as the predominant mode of research" (p. 1031).

Comparison of two different methods (mobile vs. mobile or mobile vs. traditional) or just single implementation have been used extensively in M-ELL studies (82% in the first period), but this decreased to 67% in the second period, indicating that since the second period, researchers began to study the use of mobile learning in education from different directions, as Wu et al., (2012) reported after a review of previous studies. This transfer was reinforced after the study of Hwang et al., (2014) who observed unsatisfactory achievement among students even if they were motivated. Thus, the study in a related field moved from comparison with other methods or measuring single implementation to different directions studied by means of observation and interviews.

Regarding the role of mobile learning, accessing learning material had the highest number of studies (29%). This was also stated by Lai (2019) who reviewed the top 100 highest cited mobile learning articles. In the second place, with a slight difference, was learning across contexts. This growing interest in this role is justified due to the importance of this role, which provides learning guidance and supplementary materials or feedback to learners via mobile devices. Additionally, Hwang (2014) observed that this role is essential as it also helps students deal with problems as well as gain real-world knowledge.

Across contexts (learning in more than one place as Hwang et al., (2008) stated) was found in the highest number of M-ELL studies (31%). This finding is contrary to the observation of Sung et al., (2017) who stated that the classroom is a good place to conduct mobile learning studies. However, in terms of study period, Sung et al., (2017) reviewed articles from 2000 to 2015, and therefore their findings were confirmed by this study which found that classrooms or laboratories were the most common places to conduct studies in the first period (2007–2013), comprising 33%

of the studies. Homes received less attention (1%), suggesting that more focus on using M-ELL at home may be needed, especially during the COVID-19 pandemic.

The three most widely used statistical methods are descriptive statistics, one-way ANOVA, and *t* tests, either performed individually or in combination in one study. This can be justified as 46% of studies included in this review performed comparisons of instructional styles (mobile vs. mobile or mobile vs. traditional), in which these statistical approaches were implemented to find out whether group means are significantly different from each other or not (Dąbrowska et al., 2009). In addition, these three statistical methods are tools of quantitative research studies, which is the most widely used type of research compared to qualitative research (Dimitrov, 2008). Moreover, descriptive statistics are summary statistics that summarize features of the collected information and are used in most types of research methods (Mann, 2007).

In M-ELL studies, with the exception of review studies, it was found that research interventions which focused on behavioral analysis received very limited research attention. A reasonable explanation for this could be the limited number of studies that followed a qualitative research approach, as Wolcott (2008) maintained that qualitative research is an appropriate way to study human behavior on many topics, even in a different cultural context. This finding is in line with Lai's (2019) study which reviewed the top 100 highly cited articles in m-learning as well as Chang et al.'s (2018) meta-review to find the research foci of m-learning in nursing training.

Most studies examined all English skills together (or did not specify which skills they focused on), followed by studies that examined vocabulary skills. Few studies looked at other skills such as writing, while no research was conducted on grammar. This finding is in line with Elaish, Shuib, Ghani, and Yadegaridehkordi's finding (2019b).

Most studies used questionnaires, tests, observations, and interviews as assessment methods to evaluate participants' achievements or perceptions from the cognition, affect, or technical dimensions. Some studies aimed to analyze the relationships between these dimensions. This implies that further research is needed to investigate students' behavioral patterns or interactive patterns based on the logs in the m-learning systems.

"Lack of identifying needs, reports, or studies or testing the effect of technologies" was the most studied problem investigated by these English language learning articles (57%). This indicates that this field is still in its infancy and that more studies are needed to cover all of its aspects, trends, and challenges. Receiving far less research attention, motivation was the second most studied problem, as it was covered by 27% of studies. This is contrary to Elaish et al.'s (2021) findings. Thus, from the top 100 highly cited articles, we are able to perceive the research trend from a different angle.

Most of the studies (80%) focused only on learning English. However, all review articles (except for one) included studies on English with other languages or fields of science. Different languages (e.g. English, Japanese, and Chinese) generally have different structures and ways of describing terms and meanings. McCloskey (1998) identified that languages are complex and could be significantly different in terms of their vocabulary, grammar, syntax, and numerous other characteristics. Crystal (1987) mentioned that the similarity of language structures could be an important factor affecting students' language learning performance. If a language has a similar

structure to that of the students' native language, the students' learning load could be much lower than that of learning a completely different language. Boroditsky (2001) recognized that one's language affects how one thinks about the world.

## 6 Conclusion

This study reviewed the top 100 highly cited M-ELL articles in the Web of Science database. The major findings can be summarized as follows: (1) most of the M-ELL studies adopted an experimental research design to examine mobile learning usage for English language learning; (2) single mobile learning implementation was the most frequently adopted research method by the M-ELL studies; (3) in the M-ELL research, most mobile devices were used to access learning materials; (4) in the M-ELL research, most studies were conducted across contexts; (5) the descriptive statistics, *t* test, and one-way ANOVA/ANCOVA statistical methods were the most widely used in the M-ELL studies; (6) in the M-ELL research, most studies focused on students' cognition; (7) university students were the most targeted audience in the existing M-ELL literature; (8) most of the M-ELL studies attempted to improve all English skills; (9) questionnaires were the most used assessment methods among the M-ELL studies; (10) the issue "lack of identifying needs, reports, or studies or testing the effect of technologies" has been frequently investigated; (11) in pure and blended learning settings, most of the studies used non-game applications; and (12) smart phones were the most common platform for mobile application to support language learning.

From the discussion of the M-ELL review results, suggestions and recommendations for future work are listed as follows:

- There is a need to investigate how M-ELL research was impacted by the COVID-19 pandemic, especially among students learning from home.
- Students' behavioral and interactive patterns in M-ELL can be applied to identify the relationships between the patterns and their educational outcomes.
- There is a need for more qualitative research studies to study the behavior of learners in the context of the English language.
- There is a need for further studies to apply mobile learning to grammar, writing, reading, and listening learning.
- There is a need for further review of studies focusing only on learning English using mobile learning because the difference between languages affects the results of the study.
- In M-ELL studies, there has been very limited interest in higher order thinking skills; therefore, upcoming studies are strongly advised to conduct more research to improve students' higher order thinking skills in the area of English language.
- The term "M-ELL" should be used in relevant studies to help researchers select the exact articles without mixing them with unwanted articles.

## 7 Limitations

Although this study has presented a detailed analysis of the most cited research articles in M-ELL, the results are limited by three factors, namely keywords, timeline, and database. A more detailed set of keywords, an expanded timeline, and the inclusion of another online repository would have produced a larger number of articles, which in turn could make the findings of this study more inclusive and generalizable.

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**Data Availability** The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

## Compliance with Ethical Standards

**Conflicts of interest/Competing interests** The authors have no conflicts of interest to declare that are relevant to the content of this article.

Research involving human participants and/or animals.

This research did not include human or animal participants, hence, for this type of study formal consent is not required.

**Informed consent** As a corresponding author, I confirm that this paper has been read and approved for submission by the all the name authors.

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