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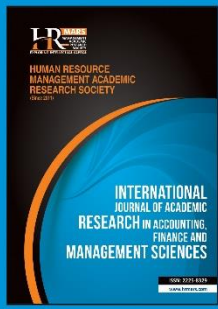
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## Seamless Learning from the Perspective of CFL Education: A Systematic Review

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### Abstract

The main objective of this paper is to review and update our understanding of seamless learning from the perspective of Chinese as a Foreign Language (CFL) education and identify possible future research directions. The novelty of this study is that it is the first systematic review of seamless learning from the perspective of CFL education. Furthermore, this paper would be valuable to comprehend pedagogical best practices as well as future research challenges in CFL education. The findings of past research exclusively emphasized seamless learning in CFL education during the non-epidemic period. Moreover, the findings of this paper reveal that most of the reviewed studies used qualitative methods, which are the most popular research method to investigate the outcome of seamless CFL learning on formal learning in primary school settings; that many research interests were focused on the use of seamless learning in Chinese vocabulary study, motivation and learning strategies, Chinese language skills advancement, and the challenges of seamless learning in CFL education. Eventually, further research to support sustainable seamless learning in CFL education is recommended.

**Keywords:** Seamless Learning, Chinese As a Foreign Language (CFL), Foreign Language Education, Perspective, Systematic Review

### Introduction

In recent years, a new concept has emerged, identified as seamless learning. This concept is predicated on the premise that learning should be maintained continuously, across various environments (Durak & Cankaya, 2018). It is a concept which has been catalysed by the development of digital technology which can be applied in educational contexts, facilitating opportunities for learners to learn anywhere and anytime (Abdullah & Hashim, 2021; Wong et al., 2016). Furthermore, educational technology applications have dramatically influenced the ecology of learning and teaching in educational settings, as evidenced by the global pandemic (Yin, 2022). For instance, the Covid-19 pandemic brought extraordinary disruption to education institutions, locally and globally (Godber, 2021; Yin, 2022). As a consequence of such a providential occurrence, seamless learning which celebrates the idea of allowing learners to learn whenever they are triggered to learn, without having any boundary, has

emerged and continues to develop (Abdullah & Hashim, 2021; Mykytiuk et al., 2022). To conceptualise this novel approach, seamless learning is defined as an intricate learning framework contingent on mobile devices which narrows the discrepancies between formal and informal learning, while simultaneously facilitating a sustained and uniform learning process irrespective of time and place (e.g., Wong & Looi, 2011; Abdullah & Hashim, 2021; Zhou et al., 2022).

In terms of the continuity between formal and informal learning settings, as a salient characteristic 'inherited' from the general form of seamless learning, the concept enables learners to connect their in-class (formal) learning to out-of-class (informal) learning without encountering any boundary (Abdullah & Hashim, 2021). Nonetheless, some scholars contend that the importance of classroom learning (i.e., formal learning settings) should not be downplayed (Hiew et al., 2018; Mouri et al., 2018). Indeed, through teacher-led facilitation, classroom language learning is likely to have an integral function of setting the learning goals and preparing learners for the relatively self-directed, authentic and social learning, among others (e.g., Wong & Looi, 2010a; Wong & Looi, 2010b; Wong et al., 2017). However, Wang (2018) notes that seamless learning ensures that learning time has the potential to be prolonged, from formal to informal learning, whereby although classes may have ended due to time constraints, learners can still easily continue their learning by accessing additional resources via the seamless learning approach.

Given these advantages to seamless learning, a substantial increase in research interest in seamless learning has manifested over the last decade, especially in foreign language education. Thus, concurrent with the boom in the development of Chinese as a foreign language (CFL) throughout the world, language learning theorists are actively endorsing the integration of formal and informal approaches which enable students to combine 'fragmented' knowledge and eliminate the 'seams', so as to refine (and ultimately redefine) the learning process (Wong et al., 2016; Xiao et al., 2021). Resultantly, the rapid development of Chinese smartphone applications and seamless CFL learning has garnered increased attention (Abdullah & Hashim, 2021; Su & Peng, 2022).

Past research on seamless CFL learning investigated the integration of seamless learning styles and their impacts on the acquisition of language skills, learning strategies, learner attitudes, and motivation, among other things (Jiang & Li, 2018; Jin, 2018). Nonetheless, a systematic review of seamless learning from the perspectives of CFL education is lacking. Moreover, it remains unclear as to what has been accomplished and what needs to be investigated further in the future. We are thus unable to fully comprehend pedagogical best practice as well as future research challenges due to the absence of information.

To address the above gaps, this paper offers a comprehensive review of pertinent research material in relation to the seamless learning in CFL education, with a time horizon of January 2010 to December 2021 (inclusive). The present paper not only updates our understanding regarding the integration of seamless learning in CFL research, but it shall also help identify research gaps in the current literature and highlight potential directions for future research. Accordingly, this paper is driven by the following two research questions in relation to the reviewed studies. Within the scope of seamless education in CFL contexts:

RQ1: What were the methodological trends regarding publications, research subjects, and methods during 2010-2021?

RQ2: What were the fundamental research interests of seamless learning in CFL research publications during 2010-2021?

## Materials and Methods

In this section, two main considerations are made, namely concerned with the data collection and data analysis of this research.

### Data Collection

In order to thoroughly explore preceding studies for the purposes of this review, key databases including the China National Knowledge Infrastructure (CNKI), Web of Science (WOS), and SCOPUS were searched, owing to their large citation data banks and superior peer-reviewed journals which adhere to high standard disciplines. Additionally, these databases provide invaluable resources for referring leading publications and constantly update their data archives in order to swiftly obtain information through the use of keywords and backward reference searches (e.g., Timmins & McCabe, 2005; Kaiblinger & Woschank, 2022; Liu et al., 2022). The databases are conducive for accurately detecting essential research material among a plethora of emerging trends. Moreover, the aforementioned databases enable the researcher to quickly skim through an abundance of resources and provide a pool of scholarly publications on a specified topic, thereby facilitating a swift and accurate detection of relevant publications.

In accordance with the goals and scope of this study, the determination of crucial research disparities was able to help the researcher in narrowing down the range of scientific interests. During the sequential stages of review, five rounds of selection were meticulously conducted. First round: A keyword search was adopted in the three aforementioned databases. Specifically, the chosen keywords include 'seamless learning', 'Chinese as a foreign language', and 'seamless Chinese learning'. These keywords were initially searched for in SCOPUS, yielding 32 results. Subsequently, the data search was repeated in WOS and CNKI, where 22 and 3 articles were obtained, respectively. Thus, the first round of searching identified a total of 57 studies.

Second round: To ensure a high degree of reliability, both the title and abstract pertaining to the extracted articles were assessed by comparing keywords. Ultimately, this process yielded 27 journal articles and conference contributions from SCOPUS, 10 from WOS, and 2 from CNKI (after excluding 18 duplicates and redundant entries). Following this cycle of selection, a total of 39 studies were available.

Third round: With a view to encompass pertinent journal articles which potentially may be disregarded by the keyword search, a backward reference search was conducted. Specifically, references to the prior identified 39 articles were evaluated to identify key studies in the field. This approach was demonstrably fruitful, generating 43 related articles.

Fourth round: Subsequently, the reliability of the sampled articles was appraised by verifying the titles and abstracts of the preceding 43 selected studies against the keywords. Consequently, 19 irrelevant articles were removed, and 24 associated articles were retained.

Fifth round: Previously, the fourth round (above) had successfully identified 63 suitable articles in line with the research topic. With the aim of guaranteeing a reliable systematic review, the remaining sampled articles were thoroughly investigated and screened against both the inclusion and exclusion criteria.

Specifically, the inclusion criteria comprised: (1) Publications between January 2010 (inclusive) and December 2021 (inclusive); (2) peer-reviewed complete text studies in English and/or Chinese, upholding high standards and substantial impact on the field of study based on objective and independent reviews of a qualified panel; and (3) a diverse categories of studies (especially empirical studies). Evidently, explicit research queries pertaining to the

empirical studies, population statistics, data samples, report findings, and applicable verdicts are yet to be resolved.

In line with the preceding assertions, the following exclusion criteria were imposed: (1) Articles published before 2010 were excluded; (2) Articles overlooking the Chinese language as an academic discipline were ruled out; (3) Articles neglecting the use of seamless learning in CFL were eliminated. From the sample size of 63 detected studies, 34 studies were omitted based on the above criteria. As a result, a total of 29 studies were sampled for the purposes of conclusive analysis of seamless learning in CFL education research. Figure 1 outlines the search process of the aforementioned review. Predominantly, this review of seamless learning in CFL contexts aims to identify the fundamental research interests and methodological trends from published studies; to achieve this aim, the thematic and frequency analysis methods were integrated to analyse suitable literature references, reinforcing the magnitude of work involved in the study.

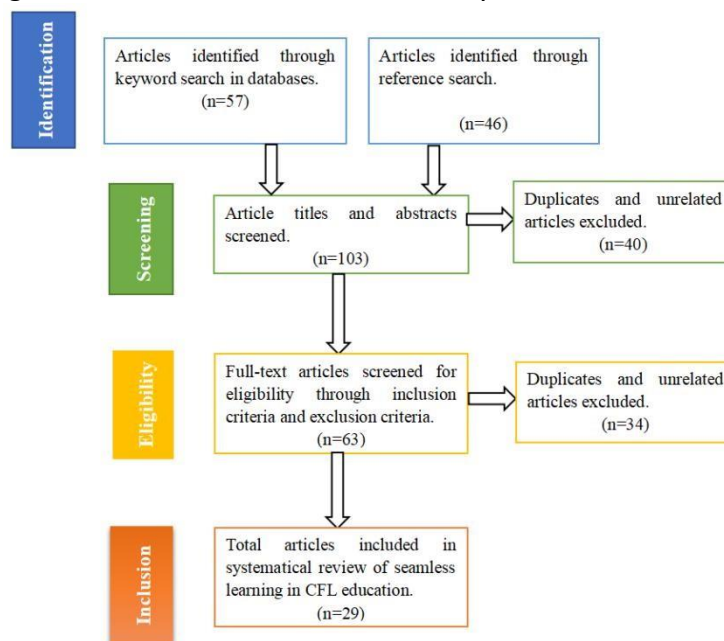


Figure 1: Flow diagram for the systematic review process (Adapted from Moher et al., 2009).

### Data Analysis

Thematic analysis is ideal for our purposes in that it permits flexible interpretation and provides unrestricted access to large datasets by differentiating them along the lines of overarching themes. In addition, it adheres to the protocols posited by (e.g., Braun & Clarke, 2006; Greenland & Moore, 2022; Kaiblinger & Woschank, 2022). Upon scrutinising the selected articles and comprehending the underlying ideas inherent to each one, a set of initial general codes were generated (Braun & Clarke, 2006; Greenland & Moore, 2022). Subsequently, the research questions were reviewed and a provisional list of possible themes for each question was developed based on the general codes generated during the initial step. Finally, the themes were reviewed for coherence and distinction. Upon conclusion of this coding process, the process of frequency analysis was employed in order to quantify and report the findings. Additionally, the number of occurrences of individual features were counted and presented.



## Results and Discussion

Driven by the two research questions, the review results are presented below. The discussion on methodological trends is also presented, which comprises the findings on publications, research subjects and research methods pertaining to studies on seamless learning in relation to RQ1

### Methodological Trends

#### Publications

Having examined the review of the selected 29 studies, we can determine that the importance of seamless learning has been increasing until 2018 (Figure 2). Notably, from 2010 to 2018, a vast number of articles were published, a finding which is consistent with the trend identified in the area of mobile-assisted learning. This can be explained by the increased popularity of smartphones, the rapid growth of mobile-based educational tools, and their increased application to support seamless learning in CFL education (e.g., Hiew et al., 2018; Jiang & Li, 2018; Xiao et al., 2021). Surprisingly, from 2019-2021, only one review article about mobile-assisted CFL learning Zhou (2020) was published by a Chinese author. During this time, scholars have done a lot of research on seamless learning environment, mode and application, mainly through literature analysis and investigation, as demonstrated by (Xiao et al., 2021). However, this discussion on seamless learning in CFL education has not been extended to the situation of the COVID-19 pandemic. Additionally, most research focuses on non-language field, while the research on language education is not sufficient, especially on CFL education (e.g., Kayalar, 2022; Shadiev et al., 2022). Although seamless learning in CFL education has not gained sufficient attention from researchers, it is fairly promising and no doubt it is a prospective area of research in mainland China.

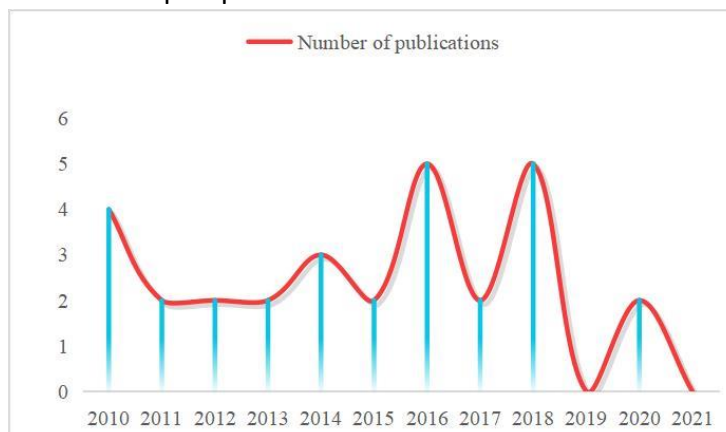


Figure 2: Seamless learning in CFL studies published on an annual basis from 2010 to 2021.

#### Research Subjects

A careful examination of the research subjects indicates that the majority of earlier studies have focused on Primary CFL students (a total of sixteen studies), with six studies involving Secondary CFL learners between 2010 and 2021. Another five studies involved Undergraduates CFL learners. Furthermore, adults in seamless learning contexts were the focus of two studies. Figure 3 depicts research subjects from the selected articles that address the utilisation of seamless learning in CFL education research, all within formal, informal, and mixed learning contexts at different educational levels. This finding indicates that within the field of CFL education research, seamless learning was predominantly concerned with primary school students (sixteen studies), followed by secondary school

students (six studies). However, when looking at the research contexts, the ‘Formal learning context’ is witnessing an exponential growth within the time period of 2010-2021.

This trend can be explained by the fact that the twenty-first century has been characterised by intense trajectory of technological development as well as concomitant a transformation in the field of education (Xiao et al., 2021). It also demonstrates that there appears to be an increasing tendency to incorporate seamless learning into the classroom, influencing the current school/ university school curriculum, considering the possibilities and opportunities that seamless learning has in being an essential element of supplementing and boosting students’ learning experiences.

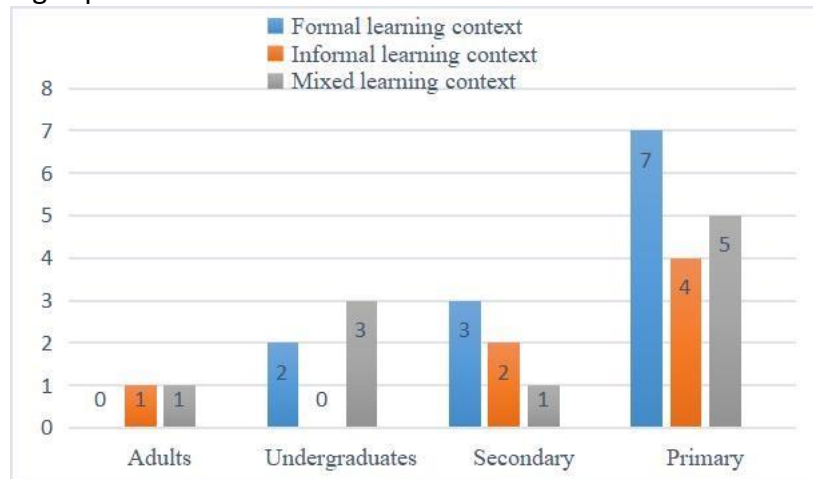


Figure 3: Research contexts at different educational levels.

### **Research Methods and Designs**

Although the study of seamless learning in CFL education is a relatively new field of academic research, a variety of research methods have been utilised across the reviewed studies. Table 1 illustrates that the most popular research method is found to be qualitative methods (fourteen studies). Following this, case study (two studies), descriptive analysis (four studies), content analysis (four studies), design-based research (DBR) (two studies) and observation/ interviews (two studies) were the leading research designs within qualitative methods. A quantitative research is established as the second most preferred research method (nine studies), characterised by using quasi-experimental measurements (such as pre- and post-tests or a t-test, and others) (four studies) as well as surveys (two studies) and experimental designs (three studies). Mixed method design is ranked third (six studies), featuring triangulation (four studies) and embedded (two studies).

Table 1

*Types of research methods and designs.*

Methods	Frequency	Design	Frequency
Quantitative	9	Survey	2
		Experimental	3
		Quasi-experimental	4
Qualitative	14	Case study	2
		Observation/ Interview	2
		Descriptive analysis	4
		Content analysis	4
		Design-based research (DBR)	2
Mixed	6	Triangulation	4
		Exploratory	2
Total		29	

Based on the findings above, previous research into seamless learning in CFL education has thus far been more concerned with understanding respondents' perceptions or attitudes than articulating clear descriptions of learners' engagement. Impressively, this finding is consistent with the examination made by (Aguayo & Eames, 2017; Song & Hwang, 2020), into the status of using mobile technology in foreign language education, which also found that the majority of the literature reviewed had employed a qualitative method in generating their findings.

### Research Interests

Despite the review of 29 articles investigating seamless CFL learning failing to gain attention from prominent researchers over the span of 11 years, the aspect of seamless learning is highlighted as a reasonably promising avenue and deemed a fruitful field of research in Mainland China (Mouri et al., 2018; Xiao et al., 2021). Furthermore, the concept of seamless learning is gradually attaining prominence in the contemporary era. In tandem with web-based devices and mobile technologies, students can actively embark on the path of knowledge irrespective of time and place, especially in the field of foreign language education (Xiao et al., 2021). Specifically, this paper is aimed at delving deeper into the utilisation of seamless learning in CFL education. Therefore, to facilitate a straightforward answer to RQ2, the thematic analysis method is adopted to deduce the following research interests addressed by the selected studies (Figure 4).



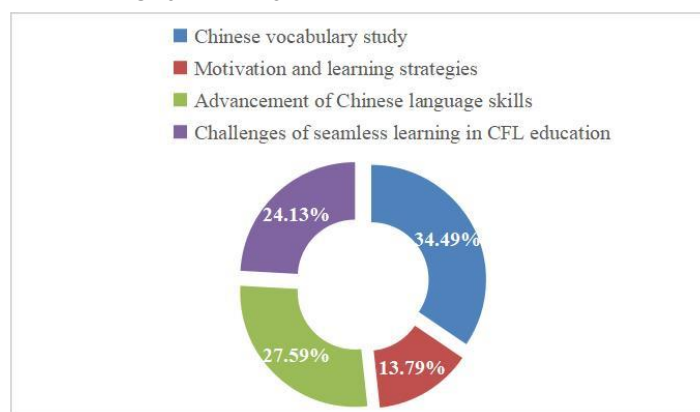


Figure 4 Research interests.

We can observe that ten papers focus on Chinese vocabulary study (34.49%), four papers on motivation and learning strategies (13.79%), eight investigations research the advancement of Chinese language skills, such as reading, communicative, writing skills and others (27.59%), whereas seven papers focus on the challenges of seamless CFL learning (24.13%), making a total of 29 studies (100%).

From this phase of the analysis, four major aspects of discussion can be identified. These include Chinese vocabulary study related to the utilisation of seamless learning motivation; learning strategies utilised under seamless learning environment; advancement of Chinese language skills developed under seamless learning environment, as well as the challenges of seamless CFL learning.

### ***Chinese Vocabulary Study***

Ten studies investigating seamless Chinese vocabulary learning have been found. For instance, Wong & Looi (2010b) presented a case study of seamless learning in the context of Chinese idioms. This study demonstrates how students were enthusiastically using their handheld devices to make lots of sentences in their daily lives during the periods of study. Likewise, Wong et al (2010) discovered that the seamless learning model is an efficient means of improving learners' Chinese idiom learning. Notwithstanding these novel insights, small sample sizes have been a serious limitation characterising these studies. Subsequently, Wong (2012) examined the learner content creation process in a proportionate seamless Chinese vocabulary learning environment, whereby the notion of induction-based peer learning presumably offered hope of translating Chinese learning into an authentic learning experience. Furthermore, Wong (2013a), as well as Wong (2013b), contend that seamless learning aided their research samples' understanding of Chinese vocabulary. Correspondingly, Wong et al. (2015a) observed that CFL learners could engage in vocabulary learning even when they held negative attitudes toward the perceived usefulness of the seamless learning approach. However, it is found that these studies did not address errors in vocabulary usage across a wide range of contexts.

As elaborated by Wong et al (2016), MyCLOUD can help students to improve the fluency of Chinese vocabulary use among intermediate- and advanced-level students. The study discovered that optimistic vocabulary growth stemming from the number of artefacts (including sentences formulated by students using target vocabulary) and the number of comments generated during peer learning was evident. Significant improvements in vocabulary growth and usage were found (Wong et al., 2016, p. 18). Moreover, to demonstrate how seamless learning promotes Chinese vocabulary acquisition and learning

efficacy, Wong et al (2017) selected the mean artefact score, mean length of utterances, number of social-authentic artefacts and online peer comments and replies as indicators of the learning impact. Their findings reveal significant improvements in all the tabulated aspects.

These findings are consistent with the importance of situating vocabulary acquisition and learning in appropriate contexts, a pedagogical approach advocated by linguists and language-learning theorists (Nation, 2001; Zhang et al., 2021). According to expositions and research in the field of pragmatics, seamless learning effectively connects the gap between learning linguistic forms and nurturing skills in real-life language applications. Still, some scholars contend that prior studies are limited to merely exploring the extent of vocabulary growth in relation to the number of artefacts, online peer comments, replies, and other such markers (e.g., Wong et al., 2016; Song & Hwang, 2020). In addition, a vast portion of the research on seamless learning in CFL education predominantly emphasises the dominance and intervention of Chinese instructors, which fails to unequivocally personify the innate concept of seamless learning so as to encourage learners to inculcate self-directed learning. Moreover, the aforementioned results indicate that seamless learning is intrinsically linked to vocabulary growth (Wong et al., 2016). Notably, the primary reason for this may be due to the process of students' artefact generation, which tends to encourage the usage of target vocabulary in conjunction with integrating both retained and newly learned words to achieve optimum vocabulary growth (Aw et al., 2016; Song & Hwang, 2020).

### ***Motivation and Learning Strategies***

Four papers investigating motivation and learning strategies were reviewed in this section. For instance, Wong et al. (2011) discovered that through the actual stages of artefact creation and online interactions, the reinforcement of admirable motivation and progressive development in student

Chinese vocabulary learning emerged as a prevailing theme. In addition, clarified learner motivation and the varied strategies students applied in a seamless learning environment, finding that their motivation predicted the learning strategies they used in this environment. Similarly, Sriyanalug (2017) revealed that students had favourable attitudes toward the use of mobile devices in improving Chinese proficiency in a seamless learning environment. Likewise, Chee et al (2017)'s research on students' perceptions demonstrated that incorporating seamless learning into CFL education could significantly enhance students' motivation and interest.

Notably, Wong et al (2015b) argued that the assessment of motivational factors and learning strategies in seamless language learning (SLL) by specific scholars was lack despite the emergence of various research studies on SLL. It is conducive that such strategies are instrumental in making up the shortfalls that hinder aspiring individuals, wherein the intricate stages of any learning activity can be widely attributed to the extent of student's motivation and the learning strategies they employ (Wong & Looi, 2011). Consequently, informed by (Wong et al., 2015b), the degree of student reflexive perceptions of adopted strategies pertaining to SLL offers valuable insights and an empirical basis that empowers researchers to gauge the efficacy of their formulated activities; this concordantly offers great potential when devising future learning designs.

However, the challenges of peer reviews and students' levels of motivation haven't been sufficiently well monitored, which led to some learners providing many negative replies. Furthermore, these negative replies (from their peers) were found to annoy some students,

diminishing their motivation. Hence, there is a need for future research to access CFL learner motivation and its relationship with the process of peer reviews.

### ***Advancement of Chinese Language Skills***

Eight papers examined the advancement of Chinese language skills through seamless learning, including reading, communicative and writing skills. Particularly, three studies addressed mobile CFL reading. According to Chang et al (2010), a wireless handheld system (WHS) was provided, designed to assist students in improving their reading skills by implementing reading strategies and cooperative learning in small reading groups. In concordance with their findings, Chee et al (2017) discovered that learners primarily utilized mobile apps to decode reading materials and memorize the meaning and pronunciation of new words in their study of mobile app-based reading strategies. Furthermore, informed by He & Yang (2016), after four weeks of documented intervention, the experimental groups (implementation of smartphone application) were found to have outperformed the control group (conventional method) on reading tests.

Turning to seamless CFL speaking, two papers focused exclusively on the use of seamless learning platform. Lan & Lin (2016) developed the MobileMan (Mobile Mandarin learning platform) aiming at assessing overseas Chinese students' Chinese communicative skills on the seamless platform (whereby it was used in both formal and informal educational contexts). In the study, students benefited from seamless learning in connecting the gaps between inside and outside the classroom learning. In a similar study, Jiang & Li (2018) investigated CFL learners' perceptions of seamless WeChat learning activities after being paired with native speakers, whereby CFL learners were tasked to complete weekly assigned activities. It was discovered that seamless WeChat learning activities were a great supplement to classroom learning insofar that CFL learners could seamlessly use native speaker resources to improve their Chinese speaking skills.

For Chinese language writing, three studies reported positive results after adopting a seamless learning platform. As stated by Tan et al. (2014), the 'Nanyang Wenba' blog was adopted as a seamless Chinese learning platform to conduct a pilot study on creative composition writing. Their findings reveal improvements in students' writing levels and motivation (Tan et al., 2014). A similar study was conducted by Tan & Liu (2016) on CFL writing via the seamless iWrite.sg platform. It was found that the iWrite.sg platform was an effective supplement to seamless learning, in that it encouraged students to utilise learning resources and mobile assisted technology to improve their Chinese writing skills. However, Tan et al (2018) posit that Chinese language creative writing instructions in Singapore have proven to be ineffective in rejecting traditional teaching methods, owing to the fear among students of inadvertently deviating from the central topic in examinations. Nonetheless, the proposed seamless learning approach was found to be moderately beneficial in enhancing the scope of learner's Chinese writing and novel thinking capabilities. However, small sample sizes (n=14) remain a limitation for this and many earlier studies.

To summary, the above results indicate that most previous studies have been concerned with the effectiveness of seamless learning in improving CFL students' ability to use Chinese to read, write and speak, which was often measured by instruments and/or individuals' stated perceptions of the integration of mobile devices or of the specific seamless learning platforms employed. Given that seamless learning bridges the gap between traditional classroom learning and informal learning and thus facilitates a continuous and smooth learning process

not limited by time or place, it is understandable that such measures were found to have improved CFL language comprehension, communication, and application. Furthermore, the reviewed studies are found to have improved students' abilities to construct meaningful sentences and speak with greater accuracy and confidence. However, even qualified instructors face arduous hurdles in monitoring and evaluating the seamless CFL learning process of learners despite the integration of educational technology (Wong & Hsu, 2016). The aforementioned postulate aligns with the ideas of Xiao et al. (2021), who argues that novel advancements could potentially jeopardise traditional classroom learning. Therefore, a rational approach of bridging the gap between the three Socio- techno- pedagogical practices (Wong et al., 2016) will constitute the future research trajectory based on the educational context of CFL.

### ***Challenges of Seamless Learning in CFL Education***

In relation to the challenges of seamless learning in CFL contexts, seven studies were reviewed. Wang (2018) discovered potential drawbacks in the realm of literature. These drawbacks include reading complications due to small screens; limited storage; excessive multitasking; and, imperfect software – all of which were found to impede the learning process. Predominantly, as demonstrated by both Xiao et al (2021); Xin et al (2018), learners are inclined to possess a favourable disposition towards the usability of smartphones and pertinent applications in foreign language learning.

From the sampled articles, it is clear that the initial aspect of challenges concerns instructors' commitment, whereby instructors were required to diligently adapt to the emerging educational concepts, leverage innovative teaching methods in class, and establish an appropriate teaching environment for students' seamless learning (Lan et al., 2014). Additionally, they are often expected to be qualified in computer technology and to contemplate the incorporation of technology in facilitating seamless learning among students from the perspective of designers (e.g., Yang & Yin, 2018; Wong et al., 2017; Zhou, 2020)

Incidentally, the latter aspect prioritizes students' commitment. In view of the emphasis of the seamless learning platform on the relation between formal and informal learning, a major workload is inevitably imposed on student learning responsibilities outside the classroom. Consequently, the students believed that complications stemming from seamless learning activities to be cumbersome (Hwang & Hu, 2014), impeding their informal education performance. Moreover, prevalent technological errors such as the time constraints for voice messages, a lack of user-friendly devices, interruption in the form of advertisements on social platforms and other such distractions actually hindered the ability of students to devote themselves to seamless CFL learning (Wong et al., 2011).

Nonetheless, seamless learning in CFL education is emerging, and it is found to generate better outcome in Chinese learning, such as fostering greater student interest in their daily experiences with the target Chinese vocabulary, from which learning Chinese becomes more motivated and varied, improving Chinese language creative writing. Although Abdullah & Hashim (2021), with support from Xiao et al (2021), argues the new advancements pose a threat to traditional classroom learning due to continuous and numerous seamless learning activities, through proper planning of learning designs with an emphasis on learners' interactions with the physical world, seamless learning is able to enhance seamless learning in CFL education.

## Conclusion

This research presented a systematic review of the use of seamless learning in CFL education research from January 2010 to December 2021. A sample of 29 publications were identified and reviewed. Methodological trends and fundamental research interests of seamless learning in CFL education research publications were reviewed. The findings herein reveal that there has been a rapid uptick in publications focusing on seamless learning in CFL education over the last five years, with the majority carried out in formal learning contexts. To investigate the integration of seamless learning in CFL education, qualitative research methods were most frequently employed, particularly in the development of CFL language skills and vocabulary studies. Despite technical challenges and workload issues being reported, seamless learning was found to be successful in stimulating student Chinese vocabulary learning and advancement. Furthermore, seamless CFL learning is found to have enhanced students' language performance, which catalyzed learner motivation, interest, and engagement. These findings have provided some valuable insights into how seamless CFL learning empowers students' Chinese language learning, which has benefited our understanding of their incorporation and activity design. However, the findings of past research exclusively emphasized seamless learning in CFL education during the non-epidemic period. Future research is recommended to consider how to implement seamless learning in CFL education during the global pandemic (e.g., COVID-19; SARS-CoV ). Besides, it remains unclear how seamless learning can be used to improve students' proper use of vocabulary and cultural understanding. A fruitful future research direction could be to address the issue through seamless learning inside and outside of the CFL (formal) classroom.

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