



Learning Strategies in Self-directed Language Learning Using Mobile Technology in Higher Education: A Systematic Scoping Review

Yuzhi Lai¹ · Nadira Saab¹ · Wilfried Admiraal²

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Abstract

Language learners in higher education increasingly use out-of-class self-directed learning facilitated by mobile technology. In order to make informed educational decisions, this study sets out to provide an overview of empirical research into learning strategies that self-directed learners use with the support of mobile technology in language learning. Twenty studies were selected and systematically analysed, revealing the cognitive, metacognitive, social and affective strategies that self-directed learners used in their language learning processes. Low-cognitive strategies appeared to be more commonly reported than high-cognitive strategies. The use of metacognitive strategies was more closely associated with the forethought phase and performance phase than with the self-reflection phase, yet only a few articles reported all three metacognitive phases. Three kinds of social strategies were examined, and only one affective strategy was reported. Finally, implications of these findings and directions for future research are provided for self-directed learners, practitioners and researchers to facilitate self-directed learning and future work.

Keywords Self-directed language learning · Mobile-assisted learning · Learning strategies · Higher education · Review

✉ Yuzhi Lai
y.lai@iclon.leidenuniv.nl

Nadira Saab
n.saab@iclon.leidenuniv.nl

Wilfried Admiraal
w.f.admiraal@iclon.leidenuniv.nl

¹ ICLON, Leiden University Graduate School of Teaching, Leiden University, Kolffpad 1, 2333 AL Leiden, The Netherlands

² Centre for the Study of Professions, Oslo Metropolitan University, PO Box 4 St. Olavs plass, N-0130 Oslo, Norway

1 Introduction

The globalisation of economies and societies has consequences regarding the need to learn foreign languages for international communication, especially for academic and business purposes (Kramsch, 2014). These foreign language competencies are specifically relevant for students who attend courses abroad, either on campus or online, and academics who choose to work in an international context. In higher education, however, there is not much space to learn foreign languages as part of the subject curriculum in a discipline, and in some countries students do not receive enough in-class language exposure to ensure their learning success (Richards, 2015; Trinder, 2017; Tsou et al., 2006). Many students therefore try to improve their foreign language competencies outside the curriculum, in a self-directed way. Students use, for example, mobile apps such as HelloTalk, Twitter, YouTube, et cetera, to create their own learning environment (Lai et al., 2022). They may receive support from teachers, but the process is student-initiated and self-directed (Lai et al., 2022). Self-directed learning broadly refers to the process in which individuals take responsibility and initiative over their own learning process, including diagnosing the learning needs, designing the learning plan, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating their learning results, with or without others' help (Knowles, 1975; Merriam & Bierema, 2013). Many researchers use self-directed learning interchangeably with self-regulated learning (Loyens et al., 2008). Although their definitions are similar and both involve active engagement and goal-directed behaviour, the difference lies in the degree of control the learners have, specifically at the beginning of the learning process (Loyens et al., 2008). In self-directed learning, learners are the initiators of the learning tasks, whereas in self-regulated learning, they are not. In order to support this kind of self-directed learning, students can use mobile technology to learn foreign languages (e.g., Lai & Gu, 2011; Zhang & Pérez-Paredes, 2019). Mobile technology, which is defined as mobile phones, tablets, laptops and possible applications on them, has become popular due to its easy access to abundant resources and convenient connection with others, so students utilise it to develop their language competence in the authentic environment and maintain their interests in learning. However, adopting any learning approach or mobile technology does not guarantee successful learning (Vogel et al., 2009). How students conduct the learning process also matters, which may benefit from further research on improving the effectiveness of such learning experiences.

To date, most reviews on self-directed learning are not about student-initiated learning, but on self-regulated learning instead (e.g., Dent & Koenka, 2016; Jansen et al., 2019). Given the significance of this kind of learning approach, research on student-initiated self-directed learning outside class deserves more attention. For this reason, we conducted a review of self-directed language learning using mobile technology beyond the classroom, which could inform self-directed learners, educators and software developers on how to effectively enhance self-directed learning with mobile technology.

2 Self-directed use of mobile technology in language learning

In order to increase the opportunities to expose to foreign languages, learners use mobile technology as an instrument to learn foreign languages in an out-of-class and self-directed way (Lai et al., 2022). The characteristics of mobile technology, such as portability, individuality, social connectivity, and context sensitivity, have been broadly incorporated in language learning (Chinnery, 2006). Concerning portability, learners can use mobile technology to convenient and continual access to language resources and practice opportunities anytime and anywhere via applications such as Google or YouTube because mobile technologies are easily carried (Sung et al., 2015). Supported by its feature of individuality, mobile technology enables learners to personalize and customize the learning process based on their own needs and interest. About social connectivity, learners use mobile apps such as Skype and HelloTalk to collaborate or share with other language learners and native speakers in the target language, either synchronously or asynchronously (Lan et al., 2007). Regarding its context sensitivity, mobile technology allows learners to integrate language knowledge with real life and cultural context (Chen & Li, 2010). However, using mobile technology in learning does not guarantee successful learning (Vogel et al., 2009). Learners still need to employ appropriate strategies to support their language learning process.

A number of review studies regarding learning strategies in self-directed use of technology have been performed. Yet as mentioned above, most of these review studies are about self-regulated learning instead of self-directed learning missing the self-initiated element. In online learning setting, for example, Broadbent and Poon (2015) examined self-regulated strategies as correlates of academic outcomes in higher education through a review of 12 studies. They concluded that critical thinking, effort regulation, time management, metacognition, and peer learning were all positively related to learning outcomes, whereas the relationships with organisation, elaboration, and rehearsal were the least empirically supported. In addition, Stevenson et al. (2017) performed a meta-analysis of 17 studies to assess how concept mapping-based technologies (including computer software, mobile devices, web-based learning environment and electronic system) impacted self-regulated learning through various strategies. The findings showed that computer software was useful for developing cognitive strategies, teachers could stimulate metacognitive strategies, and both mobile technologies and teachers could help to enhance motivation. In the field of e-learning, Garcia et al. (2018) reviewed 19 articles to investigate whether learning self-regulated strategies could be supported by modern technologies in high school. The findings reported that self-evaluation and seeking information were the most researched categories, while seeking social assistance and environmental structuring were not examined in any study. Also, another review was conducted by Lee et al. (2019) to analyse 21 empirical articles published from 2008 to 2016 regarding self-regulated learning in MOOCs. The results showed that self-regulated learning positively correlated with learning in MOOCs, and contextual, behavioural, metacognitive, and motivational regulation strategies were identified. And in 2020, Anthonysamy

et al. (2020) reviewed 14 articles on how self-regulated learning strategies in a blended learning environment were related to positive non-academic outcomes. The results showed that these strategies were positively related to non-academic outcomes. Motivational belief strategies, resource management, and metacognitive knowledge were investigated most, whereas cognitive engagement strategies were examined in only a few studies.

These reviews mentioned above were mainly about online courses, specific technologies, electronic tools or a blended learning environment, which were broader than mobile technology. Given the features of mobile technology in language learning claimed above, this study focused on just mobile technology. Additionally, although these reviews added understanding to the self-directed learning strategies using technology, they did not differentiate between teacher-initiated or student-initiated, nor in class or out of class learning. Considering the popularity of students-initiated exposure to foreign languages outside class and the significance of self-directed learning approach, it is essential to understand how students conduct their learning in a self-initiated and out-of-class way. Moreover, these above-mentioned strategies examined in previous review studies are not about foreign language learning. Specific strategies in foreign language learning need to be investigated, which could be conducive to foreign language learners and provide practical guidance for future investigations. To fill in these gaps, this study gained an insight into the learning strategies that university students used in their out-of-class self-directed language learning process.

Previous research has indicated that strategies played a vital role in language learning process and success. In the current study, learning strategies refer to behaviours which could “help learners to comprehend” (O’Malley & Chamot, 1990), “make learning easier, faster, more enjoyable, more self-directed, more effective, and more transferable” (Oxford, 1990), “mediate their own learning” (Hall, 2001), and finally enhance their language proficiency and boost confidence when using the language (Rusnadi, 2017). Qingquan et al. (2008) stated that research into learning strategies indicated that overall language performance was related to the level of strategy use. Effectively using learning strategies can improve learners’ language competencies and make them better learners (Hismanoglu, 2000). In the domain of language learning, O’Malley et al. (1985a) divided learning strategies into three categories based on the type or level of processing involved, namely cognitive, metacognitive and affective/social strategies, which is acknowledged to be the “full range of strategies” (O’Malley & Chamot, 1990, p. 44). Hsiao and Oxford (2002) proposed that the latter category should be further differentiated into social and affective strategies in order to increase the explanatory power of the original model. The final typology thus comprises the following four main components (O’Malley & Chamot, 1990):

1. Cognitive strategies mean mentally processing learning materials, such as *auditory representation, imagery, repetition, grouping, inferencing, translation, resourcing, deduction, summarising, recombination and note taking*;

2. Metacognitive strategies are associated with analysing planning, monitoring, and evaluating the learning process, such as *selective attention*, *advance organisers*, *directed attention*, *self-management* and *self-evaluation*;
3. Affective strategies involve managing the emotions, such as *self-encouragement*, *self-reinforcement* and *self-talk*, and
4. Social strategies concern interacting with people for the purpose of increasing the opportunities to practice foreign languages and get feedbacks, such as *cooperation* and *questioning for clarification*.

This scoping review gained an insight into students' learning strategies in self-directed language learning using mobile technology. We thus investigated four research questions:

1. What cognitive strategies did students use during their self-directed language learning using mobile technology?
2. What metacognitive strategies did students use during their self-directed language learning using mobile technology?
3. What affective strategies did students use during their self-directed language learning using mobile technology?
4. What social strategies did students use during their self-directed language learning using mobile technology?

3 Method

The guidelines employed in this scoping review study were the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) extension for Scoping Reviews (Tricco et al., 2018).

3.1 Data search

Utilising PRISMA (Moher et al., 2009) principles, this study began with an extensive search of the literature conducted using electronic searches and the snowballing method to retrieve relevant literature. The federated search service provided by the library of a research university in the Netherlands was used for the electronic search. It is a comprehensive database, whose sources include, amongst others, Web of Science, Taylor and Francis, Elsevier/ScienceDirect and EBSCOhost. Three sets of keywords were used: (1) self-directed-learning related keywords, including self-directed, SDL, self-regulated, SRL, “out of class”, autonomous, informal, and ubiquitous; (2) technology-related keywords, including mobile and technology; and (3) foreign-language related keywords, including “language learning”, “English learning”, and “foreign language learning”. When searching the electronic database, the three sets of keywords were combined. The search was conducted in February 2020, which served as the cut-off date for published articles. The articles had to be written in English and peer-reviewed. After collating all the relevant studies, the

snowballing method was used to find more relevant work based on reference lists in the studies from the electronic search.

3.2 Data selection

On 10th February 2020 the initial search yielded 342 articles that were related to self-directed learning and mobile technology. The title and abstract of each identified study were firstly screened for eligibility. The studies without full text and the studies unrelated to student learning were excluded, and 170 studies remained for future analysis.

Studies were included if they met these criteria:

- Students should use mobile technology, including mobile devices (laptop, smartphone, tablet) and applications on these devices, to support their learning.
- The learning tasks should be initiated and managed by the participants themselves, with or without teacher support, in the learning process.
- The learning content should be foreign languages.
- Involving students in higher education.
- Including the information on learning activities.

Ten percent of 170 articles were also read by a co-author based on the above-mentioned inclusion criteria. There was a discrepancy about one article. The two researchers held a discussion, and finally consensus was reached. Applying these inclusion criteria reduced our database to 20 studies, 13 from electronic searches and 7 from the snowballing method. This literature search and review procedure is illustrated in Fig. 1. Regarding the method of data collection and analysis, among the 20 studies, 3 studies used quantitative method, 1 used qualitative method, 1 used action research, and 15 used mixed methods (quantitative and qualitative method).

3.3 Data extraction and analysis

Author name, publication year, participants' proficiency levels and learning activities were extracted from each study. Each article was checked to extract the learning activities from the results and conclusion sections. These texts were coded as learning strategies based on O'Malley's classification, namely, metacognitive, cognitive, affective and social strategies, and specific strategies are explained in the results section and Appendix A. For example, it was coded as *Contextualisation*, categorized in [cognitive strategies](#), when participants learned new words and vocabulary in Facebook, as reported by Hamat and Abu Hassan (2019). These coded texts were sorted and summarised (See Appendix B). To ensure all relevant information extracted, 20 articles were double-checked by two researchers. When there were disagreements on the coding, these were discussed among researchers until the consensus was reached.

For data analysis, Bloom's revised taxonomy is employed as the framework to measure cognitive strategies in order to determine the level of students' thinking

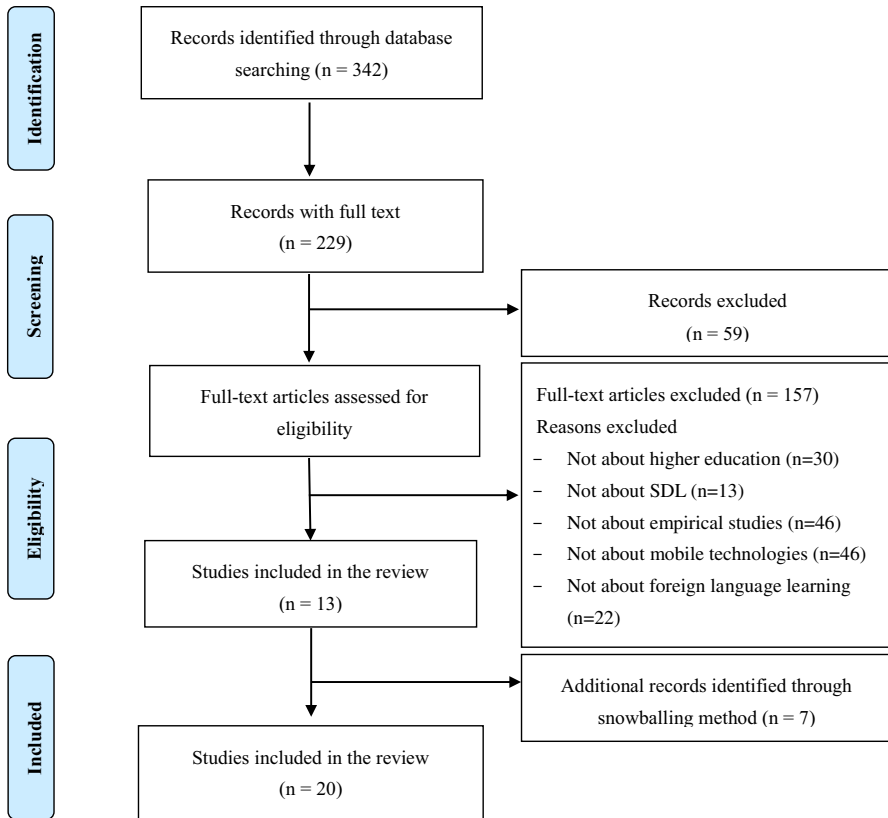


Fig. 1 Flow chart depicting the search and selection process. SDL denotes self-directed learning

(Anderson et al., 2001; Crompton et al., 2019). Anderson et al. (2001) categorized cognitive learning as six levels: 1) *remembering*, which refers to recalling and remembering basic facts and rules; 2) *understanding*, which means comprehending the meaning of information; 3) *applying*, which refers to executing knowledge, skills, or techniques in new situations; 4) *analysing*, which means breaking the information into its main parts; 5) *evaluating*, which means making judgments based on in-depth reflection; and 6) *creating*, which refers to creating new information. The six levels range from low-order, which requires less cognitive processing, to high-order, which requires deep learning and a greater degree of cognitive processing (Anderson et al., 2001). And, widely-accepted cyclical self-regulatory phases proposed by Zimmerman (2000, 2008) are selected as the framework to categorize metacognitive strategies so as to show how students regulate their learning process. The cyclical self-regulatory phases consist of *forethought*, *performance* and *self-reflection*. In the *forethought phase*, language learners can set learning goals, assess linguistic resources for language tasks, and plan how to reach these goals. In the *performance phase*, learners actually execute the task, monitor and regulate how

they are progressing. Finally, in the *self-reflection phase*, learners assess how they have performed the task (Zimmerman, 2000).

4 Results

4.1 Cognitive strategies

Cognitive strategies refer to processing the learning resources mentally or physically, or employing specific techniques in learning tasks, such as *deduction, imagery, auditory representation, resourcing, inferencing, translation, repetition, grouping, summarising, recombination, and note-taking* (O'Malley & Chamot, 1990). As mentioned above, cognitive learning is classified into six levels, including *remembering, understanding, applying, analysing, evaluating, and creating*, from low-order to high-order (Anderson et al., 2001). Based on the data extracted, we classified the specific strategies examined in the reviewed studies into one or two of the cognitive levels. The results are summarised in Table 1.

At the *remembering* level, the lowest cognitive level, eight kinds of learning strategies were identified. *Imagery, auditory representation* and *contextualisation* were the most frequently identified in the reviewed articles, followed by *repetition, recombination, note-taking, resourcing* and *grouping*. *Imagery* means learners utilize visual images to recite and understand new language contents or mentally represent problems (O'Malley & Chamot, 1990). It was identified in six articles. Learners used it through vocabulary apps such as Duolingo and Baicizhan (García Botero et al., 2019; Steel, 2012; Zhang & Pérez-Paredes, 2019) and digital flashcards (Lai, 2019; Lai et al., 2018) for vocabulary and grammar learning. *Auditory representation* refers to playing the sound of words, phrases, or sentences in the back of one's mind so as to assist in comprehending and recalling (O'Malley & Chamot, 1990). This was also identified in six articles, and it was used to learn vocabulary with language learning apps (García et al., 2018; Lai et al., 2017; Steel, 2012; Zhang & Pérez-Paredes, 2019), and practice pronunciation and speaking through musical videos and songs (Ma, 2017; Sockett & Toffoli, 2012). *Contextualisation* refers to "assisting comprehension or recall by placing a word or phrase in a meaningful language sequence or situational context" (O'Malley & Chamot, 1990, p.126). Five articles showed that learners used this strategy to learn new words, technical terms and specific expressions on Facebook (Hamat & Abu Hassan, 2019), natural learning environments created on YouTube and Podcast (Lai, 2019; Ma, 2017), and virtual online communities (Sockett & Toffoli, 2012). *Repetition* means learners intentionally practice and rehearse the words or phrases repeatedly (O'Malley & Chamot, 1990). Four articles involved this strategy. For example, learners watched movies or series, listened to songs over and over again for improving speaking skills (Lai et al., 2018; Ma, 2017; Sockett & Toffoli, 2012), and reviewed previously learned words through dictionary apps (Steel, 2012; Zou & Yan, 2014). *Note-taking*

Table 1 Cognitive strategies in six cognitive process levels

	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Alm (2015)	-	-	-	-	Resourcing	-
Celik et al. (2012)	-	Resourcing	-	-	-	-
Garcia et al. (2018)	Imagery; Auditory Representation; Recombination	-	Recombination	-	-	-
Hamat and Abu Hassan (2019)	Contextualisation	-	-	-	-	-
Lai (2019)	Imagery; Contextualisation; Note-Taking	Resourcing; Inferring	Deduction	-	-	-
Lai and Gu (2011)	-	Resourcing	-	-	-	-
Lai et al. (2017)	Imagery; Auditory Representation; Recombination; Grouping; Note-taking; Repetition	Resourcing; Auditory Representation	-	-	-	Resourcing
Lai and Zheng (2018)	Imagery; Recombination	Resourcing	-	-	Resourcing	-
Ma (2017)	Auditory Representation; Resourcing; Contextualisation; Repetition	Resourcing; Auditory Representation; Repetition; Translation	-	-	Resourcing	Resourcing
Sockett and Toffoli (2012)	Repetition; Auditory Representation; Contextualisation	Summarising; Auditory representation	-	-	-	-
Steel (2012)	Imagery; Contextualisation; Repetition; Auditory representation	-	-	-	-	-

Table 1 (continued)

	Remembering	Understanding	Applying	Analysing	Evaluating	Creating
Trinder (2017)	Note-Taking	-	-	-	-	-
Wrigglesworth and Harvor (2018)	-	Resourcing;	-	-	-	-
Yao (2016)	-	Resourcing;	-	-	-	-
Zhang and Pérez-Paredes (2019)	Imagery; Auditory Representation	Auditory Representation	-	-	-	-
Zou and Yan (2014)	Repetition	Resourcing; Imagery	-	-	-	-

“-” denotes no cognitive strategy identified here

means “writing down key words and concepts in abbreviated verbal, graphic, or numerical form” (O’Malley & Chamot, 1990, p.126). Three articles mentioned this strategy when interacting with vocabulary instruction on Facebook (Lai, 2019), listening to English songs (Lai et al., 2018) and watching films (Trinder, 2017), so as to better memorise new words and expressions. *Recombination* means combining known knowledge in a new way to formulate meaningful sentences or language expressions (O’Malley & Chamot, 1990). Three articles included using *recombination* for grammar learning through quizzes to combine known elements with the newly learned (García Botero et al., 2019; Lai & Zheng, 2018; Lai et al., 2018). *Grouping* means making classifications of words, phrases, or sentences based on their attributes or meaning, and *resourcing* means understanding or reciting language elements by utilizing reference books, encyclopedias, websites, dictionaries, etc. (O’Malley & Chamot, 1990). These two strategies were each only mentioned in one article. Lai et al. (Lai et al., 2018) showed that learners *grouped* the new words into customised lists saved in online dictionaries for vocabulary learning. Ma (2017) reported that learners knew and kept updated information regarding cultural practices and lifestyles by reading news from Yahoo US or UK (*Resourcing*).

Seven kinds of strategies were identified at the *understanding* level. *Resourcing* was the most commonly identified strategy, with nine articles mentioning it. Dictionaries, translating tools, search engines, and news were examined as the resourcing tools for learners to check word meaning, understand word usage and appreciate target culture (e.g., Celik et al., 2012; Wrigglesworth & Harvor, 2018; Yao, 2016). *Auditory representation* is used by learners to practice and improve listening skills via listening to BBC Radio (Zhang & Pérez-Paredes, 2019), television series (Sockett & Toffoli, 2012), English songs and articles (Ma, 2017) and podcasts (Lai et al., 2018). *Imagery*, *translation*, and *repetition* were identified in one article. Some learners used Youdao Dictionary app to learn foreign languages, which provides imaginative descriptions that include pictures to help understand terms and abstract words (*Imagery*) (Zou & Yan, 2014). *Translation* refers to the use of the native language as a basis to understand and/or produce the foreign language (O’Malley & Chamot, 1990). Ma (2017) reported that learners first read English-version news on the BBC and then read Chinese-version news on Yahoo Hong Kong (*Translation*). They also read news repetitively and habitually to enhance their reading skills (*Repetition*) to improve reading skills. *Inferencing* and *summarising* were identified in one article. *Inferencing* is using the known information to infer the meaning of new elements, predict results, or complete the tasks (O’Malley & Chamot, 1990). Lai (2019) showed that learners used this strategy to guess word meanings and infer a film’s meaning from character actions and facial expressions when listening to songs and watching movies. *Summarising* refers to summing up the gained information in a written or mental way (O’Malley & Chamot, 1990). Sockett and Toffoli (2012) reported that learners summarised the meanings, or at least the songs’ subject, when listening.

Two kinds of strategies were identified at the *applying* level. One is *deduction*, which means applying rules to comprehend or create language output (O’Malley & Chamot, 1990). This was reported by Lai (2019), who showed that learners applied correct grammar in order to interact with friends on WhatsApp. Another

is *recombination*, which learners employed to apply what they learned in writing and listening exercises to construct new sentences in Duolingo (García Botero et al., 2019).

No strategies were identified at the *analysing* level, and *resourcing* was the only strategy examined at the *evaluating* and *creating* levels. Three articles identified *resourcing* strategy at the *evaluating* level. Two (Lai & Zheng, 2018; Ma, 2017) mentioned that learners used dictionary apps to ensure the correct collocations in essays, and another (Alm, 2015) described using the google search engine to test—through counting the number of hits—whether the words, phrases and sentences were accurate. In the *creating* level, Lai et al. (2018) and Ma (2017) indicated that some learners used dictionary apps to help write sentences or essays (*Resourcing*).

In summary, Table 1 shows that 16 out of 20 articles reported learners employing cognitive strategies, with more strategies at the *remembering* and *understanding* levels than at *applying*, *analysing*, *evaluating* and *creating* levels. This indicates that language learners mainly conduct more low-order learning strategies than high-order learning strategies. Table 2 indicates 12 strategies identified in the cognitive learning processes. The strategies which are identified most are *resourcing* and *auditory representation*, which are low-level strategies.

4.2 Metacognitive strategies

Metacognitive strategies concern the learning process and include planning for learning goals, monitoring learning tasks, and evaluating learning outcomes, such as *self-monitoring*, *self-management*, *selective attention*, *advance organisers*, *directed attention*, and *self-evaluation* (O'Malley & Chamot, 1990). These metacognitive strategies are proved beneficial in learning success (Nückles et al., 2020). Their monitoring and controlling role in cognition means that metacognitive strategies

Table 2 Number of reviewed articles involving in learning strategies in six cognitive categories

Strategies	Remembering	Under- standing	Applying	Analysing	Evaluating	Creating
Resourcing	1	9	-	-	3	2
Auditory representation	6	4	-	-	-	-
Imagery	6	1	-	-	-	-
Repetition	4	1	-	-	-	-
Contextualisation	5	-	-	-	-	-
Note taking	3	-	-	-	-	-
Recombination	3	-	1	-	-	-
Grouping	1	-	-	-	-	-
Inferring	-	1	-	-	-	-
Deduction	-	-	1	-	-	-
Summarising	-	1	-	-	-	-
Translation	-	1	-	-	-	-

“-” denotes no article involving in the learning strategies here

are viewed as deep-processing and higher-order strategies (Martínez-Fernández & Vermunt, 2015). The cyclical self-regulatory phases contain the *forethought*, *performance* and *self-reflection phase* (Zimmerman, 2000), which is employed to categorize metacognitive strategies.

Four kinds of strategies were examined in the *forethought phase*: *resource management*, *organisational planning*, *environment management* and *advance organisation*. *Resource management* refers to seeking, arranging, or adjusting resources for learning. In the reviewed studies, this strategy was identified when learners were creating authentic learning opportunities (e.g., Celik et al., 2012; Lai, 2019; Lai & Gu, 2011; Zhang & Pérez-Paredes, 2019), preparing learning resources such as making personalised vocabulary lists in order to learn new words and facilitate essay writing in later phases (Lai et al., 2018; Ma, 2017), acquiring more useful materials after subscribing to bloggers who teach foreign languages (Zou & Yan, 2014), and selecting the appropriate learning materials based on the better-known Q&A online forums, such as the Zhihu and Douban apps in China (Zhang & Pérez-Paredes, 2019). Learners also downloaded mobile apps in advance for language learning (Steel, 2012). *Organisational planning* means generating plans for language learning tasks (O'Malley & Chamot, 1990). For example, learners set up learning plans by themselves (Celik et al., 2012) or with the help of mobile apps (Ma, 2017; Steel, 2012; Zhang & Pérez-Paredes, 2019). *Environment management* is used to set up and arrange a learning environment to make learning easier. Some learners set up environments by changing the language settings of mobile devices or applications into the target language (Alm, 2015; Chen, 2013). O'Malley and Chamot (1990) define *advance organisation* as “previewing the main ideas and concepts of the material to be learned, often by skimming the text for the organising principle” (p.119). In the current review, however, *advance organisation* refers to previewing what will be learned. It was only mentioned in one article, which reported that participants used technology to taste the language to be learned, and generate a specific plan (Lai & Gu, 2011).

Eight kinds of strategies were found in the *performance phase*, the second phase of the cyclical self-regulatory phases, including *comprehension monitoring*, *production monitoring*, *time management*, *selective attention*, *directed attention*, *resource management*, *effort management*, and *problem identification*. *Monitoring* encompassed *comprehension monitoring* (checking whether learners understand) (Lai, 2019) and *production monitoring* (checking whether learners' language output is correct) (Lai & Zheng, 2018; Lai et al., 2018). *Time management* refers to adjusting the time spent on specific tasks in order to get better results, such as extending the study hours based on study pace (Celik et al., 2012; Lai & Gu, 2011). *Selective attention* means knowing how to focus on specific aspects of language learning before executing tasks (O'Malley & Chamot, 1990). Lai (2019) reported that learners paid particular attention to using correct grammar when they applied the grammar knowledge learnt to daily interaction with friends. Sockett and Toffoli (2012) also showed that learners paid much more attention to dialogue for the purpose of learning sentence structure when watching films. *Directed attention* means doing or setting something beforehand to remind learning tasks (O'Malley & Chamot, 1990). Learners sometimes reminded themselves to learn by keeping memory bars

of vocabulary apps high (García Botero et al., 2019) and displaying study reminder popups in the English Liulishuo app (Zhang & Pérez-Paredes, 2019). *Resource management* or *effort management* means adjusting learning resources or efforts needed in learning process. In the study by Celik et al. (2012), learners increased learning resources when they needed more, while Zhang and Pérez-Paredes (2019) showed learners made more efforts when they saw posts about the achievements of friends or classmates on vocabulary learning apps. *Problem identification* is identifying the problems which should be solved in tasks, or the parts that hinder understanding and completing tasks (O'Malley & Chamot, 1990), and was adopted to identify comprehension problems after repeatedly listening to English songs (Sockett & Toffoli, 2012).

The only learning strategy in the *self-reflection phase* is *self-evaluation*, which refers to “checking the outcomes of one’s own language learning against a standard after it has been completed” (O'Malley & Chamot, 1990, p.119). Lai and Gu (2011) and Zhang and Pérez-Paredes (2019) showed that learners assessed their language proficiency through Facebook, email and language learning apps like Liulishuo to see if they understood things well. Lai and Zheng (2018), Ma (2017) and Steel (2012) reported that learners assessed how much they knew about vocabulary and grammar through testing apps or websites.

In summary, 13 out of 20 reviewed articles are associated with metacognitive strategies in self-directed language learning. Table 3 shows that the number of reviewed articles involving the *forethought phase* is the most, followed by that in the *performance phase* and the *self-reflection phase*, and only two articles involve using metacognitive strategies in all three phases.

From these reviewed studies, we found that self-directed learners managed different aspects of their own learning process, such as environment, resources, time and effort. O'Malley and Chamot (1990), however, only reported a general *self-management* strategy. In order to show how learners manage their learning process in more detail, we divided the *self-management* strategy into four subcategories, including *environment management*, *resource management*, *time management* and *effort management*.

4.3 Affective strategies

Similar to cognitive and metacognitive strategies, affective strategies have an essential role in language learning, especially in independent settings (Hurd, 2008). These are understood as managing the emotions that affect the learning involvement (O'Malley & Chamot, 1990). The use of these strategies assists learners in managing their feelings and attitude towards learning (Chou, 2004) to generate self-motivation and maintain interest and attention during a task, and finally to increase engagement and persistence and cultivate independent learning abilities (Fatemeh & Fereidoon, 2016). *Self-motivation*, *self-reinforcement*, *self-encouragement* and *self-talk* belong to this type of strategy (O'Malley & Chamot, 1990). Among the reviewed articles, only *self-motivation* strategy was identified, which refers to driving learners to keep going by reminding themselves of the benefits of self-directed learning or mastering

Table 3 Metacognitive strategies in the three phases

Authors (year)	Forethought phase	Performance phase	Self-reflection phase
Alm (2015)	Environment management	-	-
Celik et al. (2012)	Resource management; Organisational planning;	Time management; Resource management	-
Chen (2013)	Environment management	-	-
Garcia et al. (2018)	-	Directed attention	-
Lai (2019)	Resource management	Selective attention; Comprehension monitoring	-
Lai and Gu (2011)	Resource management; Advance organisation	Time management	Self-evaluation
Lai et al. (2017)	Resource management;	Production monitoring	-
Lai and Zheng (2018)	-	Production monitoring	Self-evaluation
Ma (2017)	Resource management; Organisational planning	-	Self-evaluation
Socket and Toffoli (2012)	-	Selective attention; Problem identification	-
Steel (2012)	Resource management; organisational planning	-	Self-evaluation
Zhang and Pérez-Paredes (2019)	Resource management; organisational planning	Directed attention; Effort management	Self-evaluation
Zou and Yan (2014)	Resource management	-	-

“-” denotes no metacognitive strategy identified here

new languages (O'Malley & Chamot, 1990). Two studies (Celik et al., 2012; Lai & Gu, 2011) mentioned that learners used technology to decrease boredom and increase the enjoyment of learning tasks, which effectively maintained their interest and enthusiasm in learning and motivated them to persevere and commit to their learning goals.

4.4 Social strategies

Social interaction is essential for language learning since it provides authentic social contexts for language use and practice (Derakhshan & Hasanabbasi, 2015). Not all social interactions have a positive effect on foreign language acquisition, however (Mushtaq & Benraghda, 2018; Raut & Patil, 2016). Social strategies are needed in order to benefit from the possibilities that social interaction offers. These strategies include *cooperation* and *questioning for clarification* (O'Malley & Chamot, 1990), and *help-receiving*. *Cooperation* was the most frequently reported strategy, with 12 articles, which means learning with others to update information, check learning outcomes, or get feedback on learning performance (O'Malley & Chamot, 1990). Learners used social media like WhatsApp, MSN, Facebook, MySpace, Skype, Twitter and WeChat to practice foreign languages with friends, anonymous native speakers and classmates (Chen, 2013; Kuznetsova & Soomro, 2019; Lai, 2019; Wigglesworth & Harvor, 2018; Yao, 2016), and to sometimes remind each other about the mistakes they were making (Lai, 2019). *Questioning for clarification* is also reported, which refers to “eliciting additional explanation, rephrasing, examples, or verification from a teacher or peer” (O'Malley & Chamot, 1990, p.120). Zou and Yan (2014) and Ma (2017) showed that participants adopted this strategy through discussion forums or social networking tools. *Help-receiving* is a strategy which involves other agents, such as teachers and friends, actively offering support to learners. Teachers, brothers, and friends were reported as providing help, including resource recommendation and strategy sharing in the self-directed language process (e.g., Lai et al., 2016; Yao, 2016).

Fourteen out of 20 of the reviewed articles reported social strategies used in the self-directed language learning process. Self-directed learners are also usually recommended useful learning materials and effective learning tips by teachers, peers or friends to enhance their learning. O'Malley and Chamot (1990), however, did not report a strategy about this. In order to explain this support from others, we add a new strategy, called *help-receiving*, to show this kind of activity.

5 Discussion

This review examined the learning strategies employed by university students in the self-directed language learning process using mobile technology. Only 20 articles were included in this review, as many other studies focused on teacher-initiated self-regulated learning. In order to make informed educational decisions about different aspects of language learning, this review has investigated the cognitive,

metacognitive, affective and social strategies that learners use in their self-directed learning process. These strategies range from low-level cognitive processes, such as *remembering* and *understanding*, to processes at a high level of cognitive complexity, such as *planning*, *monitoring*, *reflecting*, *evaluating* and *creating*. It was clear from the literature review that the use of cognitive strategies was more commonly reported in relation to low-level cognitive processes, *remembering* and *understanding*, than in high-level cognitive processes, *applying*, *analysing*, *evaluating* and *creating*. The two most frequently used strategies, *resourcing* and *auditory representation*, are low-level cognitive strategies. Although these low-level strategies are appropriate and work well when learning for a short-term purpose or when learning facts and details (Setiyadi, 2001), in order to improve overall language performance, they should be complemented with the use of high-order strategies throughout the learning process (Aharony, 2006; Setiyadi, 2001; Yot-Domínguez & Marcelo, 2017). Therefore, more research is necessary to examine the higher-order strategies. More of the reviewed articles examined the metacognitive strategies associated with the *forethought phase* and *performance phase* than those related to the *self-reflection phase*, and only a few articles reported on all three metacognitive phases. Only one affective strategy, *self-motivation*, was reported in two articles, and three kinds of social strategies were examined in the reviewed articles. Future studies are encouraged to focus on social and affective strategies as they are related to effective learning in language learning (Chamot, 2005; Zeynali, 2016).

5.1 Self-directed language learning and self-regulatory phases

Only two articles reported on all three self-regulatory phases. Zimmerman (2000) stated that self-regulation is cyclical, from the *forethought phase* to the *performance phase* to the *self-reflection phase*, and that the three phases are all essential for self-directed learners. The *forethought phase* helps learners strategically prepare for upcoming tasks, the *performance phase* is important as learners make adjustments to their learning promptly according to the feedback from monitoring and evaluating, and *self-reflection* influences the *forethought* processes of a learner's subsequent learning actions in fulfilling the self-regulatory cycle (Zimmerman, 2000, 2008). To our best knowledge, however, few empirical studies examined whether participating in all three phases would lead to better language performance. We thus encourage more empirical research on the impact of using a complete cycle of self-regulatory processes.

5.2 Affective strategies

This review study showed that affective strategies received little attention in research regarding self-directed language learning using mobile technology since only two reviewed articles reported one similar strategy, *self-motivation*. One possible reason is that researchers may not pay much attention to affective strategies in the mobile environment because using mobile technology itself has played a highly motivating role in the process due to its appealing characteristics (Jones et al., 2006). However,

although using mobile technology can motivate self-directed learners to learn, it is temporary, and learners are easily distracted, interrupted (Crescente & Lee, 2011; Kacetl & Klímová, 2019; Wolters & Rosenthal, 2000). There is thus still a need to investigate affective strategies as they can boost a learner's continuance motivation in the mobile learning environment and have a great effect on the success of language learning (Anderson, 1991). Addressing other emotional feelings is also crucial. Nasri et al. (2015) revealed that some language learners were susceptible to negative emotions like diffidence, anxiety and trauma. Affective strategies, such as *self-encouragement* and *self-reinforcement*, may assist them in managing these negative emotions, further achieving successful learning (Nasri et al., 2015). Researchers and self-directed learners are therefore recommended to focus more on affective strategies in the future as well (Vermunt & Donche, 2017).

5.3 Limited knowledge about strategies for language learning

Several reviewed articles showed that learners had limited knowledge about strategy use (Lai et al., 2016; Zhang & Pérez-Paredes, 2019) and technology use (Chen, 2013; Lai & Gu, 2011; Lai & Zheng, 2018) in the self-directed learning process using mobile technology. Lai et al. (2016) and Zhang and Pérez-Paredes (2019) stated that learners had difficulties in locating and selecting useful, appropriate and trustworthy resources and effectively using them for language learning. Chen (2013) and Lai and Zheng (2018) showed that learners lacked the necessary knowledge and experience to utilise mobile devices for establishing social connections and authenticity. In order to address these issues, teachers are encouraged to facilitate and support learners in technology-enhanced language learning environments, which is in line with the review study by Zhou and Wei (2018). Lai (2015) reported that teachers could provide “affection support, capacity support and behaviour support”, which strengthens a learner's awareness of the usefulness of technological resources, improves their abilities to locate and utilize these resources for learning, and scaffolds them experimenting with resources in out-of-class learning. However, teachers saw themselves a minimal role as they overestimated students' abilities and worried about their limited knowledge to offer assistance (Lai et al., 2016). This finding therefore highlighted the significance of increasing teacher awareness that they can play various roles in enhancing student knowledge of, and skills in, using mobile technology in the out-of-class self-directed learning. There is also a call for more research on how to enable teachers to exert their influence on fostering students' self-directed learning using technology.

5.4 Importance of social interaction

Although this study did not focus on technology use, several reviewed studies (Lai & Gu, 2011; Lai & Zheng, 2018; Lai et al., 2018) showed that students seldom used technology for social interaction and were sceptical about it because they were not confident about their proficiency levels during online interactions, were afraid of getting incorrect feedback, and lacked an overlap between online friends and

possible language partners (Lai & Gu, 2011; Lai & Zheng, 2018; Lai et al., 2018). Nevertheless, social interaction is essential since self-directed language learning is seen as a social activity (Alvi & Gillies, 2015; Heil et al., 2016). Mobile technology can also facilitate social interaction in the language learning process, as mobile technology offers language learners the possibility of sharing files, data or simple messages, and authentic opportunities to use what they have learned practically through cooperating and communicating with their peers, native speakers or teachers (Trousas et al., 2014). These affordances are beneficial for long-term language practices, further motivating learning and enhancing language performance (Kukulska-Hulme & Viberg, 2018). In order to maximise the potential of mobile technology for social interaction in language learning, future studies are advised to systematically examine the factors that affect the use and effects of mobile technology for social interaction in learning, and explore effective educational interventions to promote the use of technology by self-directed learners for social interaction in self-directed language learning.

5.5 Limitations and future directions

Many reviewed studies lack information about the participants' proficiency levels. Only 11 out of 20 studies reported the proficiency levels of the participants. Most focused on beginners or intermediates, and only one focused on advanced students. From earlier research, we knew that students at different proficiency levels used strategies differently (Green & Oxford, 1995; Hong-Nam & Leavell, 2006; Park, 1997; Wharton, 2000). We thus recommend that future studies provide more information about participants' proficiency levels in their studies, as this information may enable researchers to do further research in related fields and offer more evidence to educators in order to plan efficient scaffolding for self-directed learners. More attention should also be paid to the less-explored learner populations to see whether there are more varieties in their strategy patterns and skills, and their targeted language areas (Steel, 2012).

5.6 Practical implications

The research findings reveal cognitive, metacognitive, social and affective strategies that self-directed learners use in their learning process. These findings have a number of implications for empowering self-directed learners, educators/teachers, and software agents.

It is recommended that self-directed learners prepare themselves before starting self-directed learning. Self-directed learning seems to be more appropriate for intermediate and advanced language learners than for beginners (Sakai & Takagi, 2009; Ünal et al., 2017). Language learners can conduct self-directed learning only when they reach a basic proficiency level. Good language learners usually use a larger number and wider range of strategies in combination (Chamot et al., 1996; Nasri et al., 2015; Oxford, 1999). Some language learners, however, used just one or two types of strategies in their self-directed learning process (e.g., Trinder, 2017; Wigglesworth & Harvor, 2018). In

order to become better self-directed language learners, it is necessary for learners to reach a basic proficiency level and integrate more appropriate strategies into their learning processes, especially deep-level cognitive strategies and affective strategies.

From the perspective of language educators/teachers, guidance should be provided for learners in order to facilitate their autonomous learning effectively. Given the limited knowledge that self-directed learners have of strategy use and technology use, teachers could recommend a wide range of technological resources, share metacognitive and cognitive strategies for effective use of the resources, and encourage students to actively use technology to support their language learning (Zhang & Pérez-Paredes, 2019). In order to better advise and support self-directed learners, teachers should also be supported in raising their awareness of the multiple roles they could have, such as providing affective support, capacity support and behaviour support, and equipping themselves with the necessary knowledge and skills to foster the self-directed learning of students.

For software developers, more adaptive learning features should be incorporated into software applications to help formulate users' personalised learning experiences based on their learning styles, background and technological access, which could offer better learning experiences for self-directed learners. Our findings show that independent learners seldom participate in high-level cognitive processes and often could not get useful feedback when interacting with others. These issues may be addressed by software developers by incorporating adaptive features into software applications. Software applications with adaptive features could make "intelligent" decisions based on users' performance (Heil et al., 2016), such as designing high cognitive activities if learners master the low-level skills, and providing correct and personalised feedback based on the mistakes that users make during social interactions. More work is needed to track the effectiveness of these adaptive features. Based on the empirical results, it may be appropriate to make suggestions about the software design outcome.

6 Concluding remarks

Along with the increasing necessity of self-directed learning using mobile technology, there is a need to understand the self-directed learning process. This systematic scoping review examined 20 empirical studies to determine the learning strategies that self-directed learners used in their learning process. The main conclusion of this review was that self-directed learners used cognitive, metacognitive, social and affective strategies in their learning process, ranging from the simplest to a high level of intentionality and cognitive complexity. More precisely, low-cognitive strategies appeared to be more commonly reported than high-cognitive strategies. The use of metacognitive strategies was more closely associated with the forethought phase and *performance phase* than with the *self-reflection phase*, yet only a few articles reported all three metacognitive phases. And, three kinds of social strategies were examined, and only one affective strategy was reported. We call for more studies to gain insight into affective strategies and high-order cognitive process in self-directed language learning. In order to further exploit self-directed language learning using mobile technology, future research is advised to focus on the support of other agents for self-directed learners and the relationships between the proficiency levels of self-directed language learners and their strategy use.

Appendix 1

Table 4

Taxonomy of language learning strategies from O'Malley and Chamot (1990)

Dimensions	Categories	Explanations
Cognitive strategy	Repetition	Intentionally practicing and rehearsing the words or phrases repeatedly
	Resourcing	Understanding or reciting language elements by utilizing reference books, encyclopaedias, websites, dictionaries, etc
	Grouping	Making classifications of words, phrases, or sentences based on their attributes or meaning
	Note taking	Writing down key words and concepts in abbreviated verbal, graphic, or numerical form
	Summarising	Summing up the gained information in a written or mental way
	Deduction	Applying rules to comprehend or create language output
	Imagery	Utilizing visual images to recite and understand new language contents or mentally represent problems
	Auditory representation	Playing the sound of words, phrases, or sentences in the back of one's mind so as to assist in comprehending and recalling
	Recombination	Combining known knowledge in a new way to formulate meaningful sentences or language expressions
	Inferencing	Using the known information to infer the meaning of new elements, predict results, or complete the tasks
	Translation	Using the native language as a basis to understand and/or produce the foreign language
	Contextualisation	Assisting comprehension or recall by placing a word or phrase in a meaningful language sequence or situational context
	Metacognitive strategy	Advance organisation
Selective attention		Knowing how to focus on specific aspects of language learning before executing tasks
Directed attention		Doing or setting something beforehand to remind learning tasks
Organisational planning		Generating plans for language learning tasks

Table 4 (continued)

Dimensions	Categories	Explanations	
Affective strategy	Problem identification	Identifying the problems which should be solved in tasks, or the parts that hinder understanding and completing tasks	
	Production monitoring	Checking whether learners' language output is correct	
	Comprehension monitoring	Checking whether learners understand	
	Time management	Seeking, arranging, or adjusting time for learning	
	Effort management	Seeking, arranging, or adjusting efforts for learning	
	Resourcing management	Seeking, arranging, or adjusting resources for learning	
	Self-evaluation	Checking the outcomes of one's own language learning against a standard after it has been completed	
	Self-motivation	Driving learners to keep going by reminding themselves of the benefits of self-directed learning or mastering new languages	
	Social strategy	Questioning for clarification	Eliciting additional explanation, rephrasing, examples, or verification from a teacher or peer
		Help-receiving	Other agents, such as teachers and friends, actively offering support to learners
Cooperation		Learning with others to update information, check learning outcomes, or get feedback on learning performance	

Appendix 2

Table 5

Studies coded by proficiency level, cognitive dimension, metacognitive dimension, affective dimension and social dimension

Authors (year)	Country	Proficiency level	Cognitive strategies			Metacognitive strategies			Affective strategies	Social strategies		
			Remembering	Understanding	Applying	Analyzing	Evaluating	Creating			Forethought phase	Performance phase
1 Alm (2015)	New Zealand	x					x				x	
2 Celik et al. (2012)	North Cyprus	x		x				x				x
3 Chen (2013)	China	x								x		
4 Garcia et al. (2018)	Colombia		x								x	
5 Hamat and Abu Hassan (2019)	Malaysia		x									
6 Kuznetsova and Soomro (2019)	The United States											

Table 5 (continued)

	Authors (year)	Country	Proficiency level	Cognitive strategies			Metacognitive strategies			Affective strategies	Social strategies	
				Remembering	Understanding	Applying	Analyzing	Evaluating	Creating			Forethought phase
7	Lai (2015)	China										
8	Lai (2019)	China	x	x	x				x			x
9	Lai and Gu (2011)	China	x	x					x			x
10	Lai, Hu & Lyu (2017)	China	x	x					x			x
11	Lai, Yeung & Hu (2015)	China										x
12	Lai & Zheng (2017)	China	x	x								x
13	Ma (2017)	China	x	x					x			x
14	Socket and Toffoli (2012)	France	x	x								x

Table 5 (continued)

	Authors (year)	Country	Proficiency level	Cognitive strategies			Metacognitive strategies			Affective strategies	Social strategies
				Remembering	Understanding	Applying	Analyzing	Evaluating	Creating		
15	Steel (2012)	Australia		x					x		
16	Trinder (2017)	Austria	x	x							
17	Wrigglesworth & Harvor (2017)	South Korea	x	x							x
18	Yao (2016)	China			x						x
19	Zhang and Pérez-Paredes (2019)	China		x	x			x	x		x
20	Zou and Yan (2014)	China	x	x	x			x			x

Appendix 3

Table 6

Mobile applications mentioned in this study

Mobile Apps	Description	Websites
Baiczhan	Bai Ci Zhan is an APP that helps users to recite words. The software sets up a series of dictionaries such as high school entrance examination vocabulary, college entrance examination vocabulary, and sixth-level vocabulary. Users can choose a dictionary and make a study plan to determine the amount of words to recite every day. Users can also play vocabulary games with others	https://www.baiczhan.com/
Douban	Douban.com is a Chinese social networking service website that allows users to record information and create content related to film, books, music, recent events, and activities in Chinese cities	https://www.douban.com/
Duolingo	Duolingo is an American platform that includes a language-learning website and mobile app, as well as a digital language-proficiency assessment exam	https://www.duolingo.com/
English Liulishuo	English Liulishuo App is an engaging and fun English learning mobile app. It empowers you to learn English efficiently and happily through the combination of advanced auto-scoring engine of spoken English developed in Silicon Valley, professional English training courses, comprehensive learning materials, and well-designed leveled games	https://www.liulishuo.com/en/liulishuo.html
Facebook	Facebook is an American online social media and social networking service	https://www.facebook.com/
MySpace	Myspace is a social networking website that allows users to make personal profiles to connect with friends, share messages, photos, blog posts, and video, as well as stream music	https://myspace.com/
Quizlet	Quizlet is an American online study application that allows students to study information via learning tools and games. It trains students via flashcards and various games and tests	https://quizlet.com/en-gb
Skype	Skype is a telecommunications application that specializes in providing video chat and voice calls between computers, tablets, mobile devices, and smartwatches over the Internet. Skype also provides instant messaging services. Users may transmit text, video, audio and images. Skype allows video conference calls	https://www.skype.com/zh-Hans/
Twitter	Twitter is an American microblogging and social networking service on which users post and interact with messages known as "tweets". Users can read, post, like, and retweet tweets. It can also be used for the purpose of foreign language learning	https://twitter.com/

Table 6 (continued)

Mobile Apps	Description	Websites
WeChat	WeChat is a Chinese multi-purpose messaging, social media and mobile payment app developed by Tencent. Some learners take advantages of its functions of social media and messaging to learn foreign languages with others	https://www.wechat.com/en/
WhatsApp	WhatsApp Messenger, or simply WhatsApp, is an American freeware, cross-platform messaging and Voice over IP (VoIP) service owned by Facebook, Inc. It allows users to send text messages and voice messages, make voice and video calls, and share images, documents, user locations, and other media	https://www.whatsapp.com/
Yahoo	Yahoo provides a Web portal, search engine Yahoo! Search, and related services, including Yahoo! Directory, Yahoo! Mail, Yahoo! News, Yahoo! Finance, Yahoo! Groups, Yahoo! Answers, advertising, online mapping, video sharing, fantasy sports, and its social media website	https://hk.yahoo.com/
Youdao Dictionary	Youdao Dictionary is an online and offline electronic dictionaries and it can support of 107 languages among Chinese in translation, such as English, Japanese, Korean, French, German, Russian, Spanish, Portuguese etc.	https://youdao.com/
YouTube	YouTube is an American online video-sharing platform. It allows users to upload, view, rate, share, add to playlists, report, comment on videos, and subscribe to other users. It offers a wide variety of user-generated and corporate media videos	https://www.youtube.com/
Zhihu	Zhihu is a Chinese question-and-answer website where questions are created, answered, edited and organized by the community of its users	https://www.zhihu.com/signin?next=%2F

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Declarations

Conflict of interest None.

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Note: Studies marked with an asterisk were included in the review analysis.

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