A Survey of Mobile Apps for Learning Chinese Vocabulary
(中文词汇的移动应用程序之调查)

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Abstract: Mobile technology is continually developing. Research suggests that mobile apps are beneficial for language learning. Yet, because apps developed by researchers are not accessible to the public, the benefits of mobile apps on the market remain unclear. This study reviewed the 22 most popular Chinese-vocabulary learning apps on the market for native speakers. The results of content analysis show that only two types of these apps have been designed: dictionaries and games, neither of which provide their users with opportunities to practice new words. Although these apps facilitated the use of one or more learning strategies, they generally lack clear learning goals, explanations, opportunities to practice, and feedback.

摘要：移动技术在不断地进步发展，有研究发现，移动应用程序能为语言学习带来益处。然而因为这些由研究人员开发的应用程序无法公开，所以移动应用程序在市场上的益处仍然不清楚。本研究回顾了 22 个目前市场上最流行的汉语词汇学习移动应用程序，这些程序为汉语母语者所使用本研究的分析结果表明，这些应用程序的设计只有两种类型：词典和游戏，而且它们都没有给用户提供练习新词汇的机会。虽然这些应用程序促进了一个或多个学习策略的使用，但它通常缺乏明确的学习目标，解释说明，练习机会和反馈功能。

Keywords: Mobile learning, learning strategies, vocabulary learning, educational apps

关键词：移动学习，学习策略，词汇学习，教育应用

1. Introduction

Vocabulary is a central component of language learning (Grabe, 2004). A good vocabulary can make a person's communication smooth and precise, and can enhance all four language skills, i.e., listening, speaking, reading and writing (Schmitt, 2000). Vocabulary knowledge, which is comprised of breadth (i.e., the number of words one

knows) and depth (i.e., the extent to which one comprehends each word), correlates positively with both reading comprehension (Qian, 1999) and cognitive functions (Marchman & Fernald, 2008).

Learning Chinese vocabulary is an essential component of the curricula of Chinese primary schools, which include grades one through six. In Hong Kong, students need to learn 4,914 words by grade three, and another 4,792 words by grade six, or a total of 9,706 words by the end of the primary stage. Most of these words are commonly used in Mainland China and Taiwan (Bureau, 2008). However, most studies of vocabulary learning have focused on students of English as a second language (e.g., Gu, 2002; Lip, 2009; Yip & Kwan, 2006); little scholarly attention, however, has hitherto been paid to Chinese vocabulary learning by native Chinese speakers. The new Chinese-language curriculum in Hong Kong requires students to improve all four language skills at the primary school level, with the first three grades focusing on the development of listening and speaking, and primary four through six focusing on reading and writing. Chinese vocabulary involves phonological, orthographic, morphological and grammatical features (Yang, 2017), and is the basis for the cultivation of all four language skills. Therefore, the exploration of effective ways to teach it is especially important.

With the advancement of mobile technology, a growing body of research has examined the use of mobile apps for vocabulary learning, and has consistently reported that the impact of such use was positive (e.g., Chiu, 2013; Redd, 2011; 2015) with regard to both breadth and depth (Wu, 2015). For example, Wu found that students using the smartphone app Word Learning-CET6 significantly outperformed those who did not use apps to acquire new English words. Other studies indicated that mobile gaming apps could expand their users' vocabulary (Redd, 2011), and that using mobile apps for vocabulary learning increased students' motivation (Wang, 2017; Wang, Teng, & Chen, 2015).

However, while certain mobile apps have demonstrated some potential to facilitate individuals' development of vocabulary knowledge, most studies have focused on just one app developed especially for learning English vocabulary. Although the literature suggests that the use of vocabulary-learning strategies is positively related to the breadth and depth of vocabulary knowledge (X. Zhang & Lu, 2015; Y. Zhang, Lin, Zhang, & Choi, 2017), questions about which vocabulary-learning strategies are promoted in and by mobile apps remain largely unanswered. Without a clearer understanding of how these vocabulary-learning apps were designed, then, it would be difficult for Chinese-language teachers to recommend appropriate ones to their students. Accordingly, the present study examines the most popular Chinese-vocabulary learning apps to determine how they facilitate the acquisition of vocabulary knowledge, specifically, whether and how the design of these apps promotes the development of vocabulary-learning strategies.

2. Literature review

2.1 Vocabulary-learning strategies

Vocabulary-learning strategies are specific actions or techniques that learners use to develop their vocabulary knowledge. Several studies have examined the use of domain-general learning strategies in vocabulary acquisition, including cognitive and metacognitive strategies (Gu & Johnson, 1996; Y. Zhang et al., 2017). The former refers to the use of skills or techniques to process vocabulary information (e.g., association), and the latter, to individuals' ability to regulate their cognition (e.g., by setting vocabulary-learning goals). Similarly, though they did not focus on vocabulary learning, Oxford and Ehrman (1995) identified six language-learning strategies: cognitive, metacognitive, mnemonic, compensatory, affective, and social. Mnemonic strategies help learners to link one item or concept with another, or to learn and retrieve information in orderly strings (e.g., by creating acronyms). Compensatory strategies help them overcome their lack of knowledge (e.g., by guessing based on context). Affective strategies rely on learners' emotions (e.g., rewarding themselves for good performance). Finally, social strategies help them work with others, and to understand the target culture as well as the language (e.g., by verifying their knowledge through asking questions).

Using Schmitt's (1997) Vocabulary Learning Strategies Survey, Zhang and Lu (2015) conducted an exploratory factor analysis that yielded five vocabulary-learning strategies: learning the forms of words, "PIC/IMG," association, repetition, and word listing. The first strategy, learning the forms of words, refers to learning phonological and/or orthographic forms. Studying how to write a Chinese word is a typical example of this strategy. The second strategy, PIC/IMG, refers to linking words to images or situations. A typical example of using this strategy is to make an image of the words' meaning. The third learning strategy, association, refers to linking words to morphologically or semantically related ones. An example of using association would be studying words with the same radicals. The fourth learning strategy, repetition, is to repeat words or to continuously study the word frequently over a period of time. The fifth example, word listing, refers to the use of word lists to study and recite new words.

Zhang and Lu found that each of these strategies affected vocabulary knowledge in a different way, with forms and association being positively correlated with both vocabulary breadth and depth, and word lists negatively correlated to both of the same variables, while PIC/IMG was negatively correlated to vocabulary depth only.

2.2 Educational mobile apps

A recent meta-analysis of mobile-assisted language learning by Sung, Chang, and Yang (2015) found a moderate effect size of 0.55. However, most of the studies it covered focused on apps developed by researchers, many of which were unavailable to the public. Despite an increasing number of educational apps available from the iTunes App Store, Google Play, and similar platforms in Asia and elsewhere, little is known about how they have been designed for language learning, as systematic scholarly reviews of such apps are still in their infancy. The handful of reviews that have been

conducted suggest that the majority focus on drill-and-practice activities. Highfield and Goodwin (2013), for example, reviewed the iTunes App Store's math apps and lamented the limitations of their pedagogical designs. More recently, Papadakis, Kalogiannakis, and Zaranis (2018) examined Google Play's selection of educational apps for Greek preschoolers, which were again dominated by the drill-and-practice approach, and came to similar conclusions. Worse, Blair (2013) as well as Vaala and Levine (2015) highlighted how little feedback was provided in math and literacy apps respectively. Callaghan and Reich (2018) pointed out that such feedback (as was provided by mobile apps) encouraged learning through a trial-and-error approach, rather than helping users to understand the material better.

The present researchers were unable to identify any review studies that particularly focused on vocabulary apps available to the general public. This study therefore helps to fill in that gap by reviewing popular vocabulary apps for Chinese children.

3. Methods

Qualitative content analysis was used to examine the learning strategies supported by popular mobile apps for learning Chinese vocabulary. Qualitative content analysis is a qualitative approach to reveal information that is not available by studying the surface of the content. Rather, this approach involves systematic procedures to make valid inferences from text (Anderson, Rourke, Garrison, & Archer, 2001), including retrieving, evaluating, and coding a specific type or types of content. In this case, the content, or unit of analysis, consisted of mobile apps available on the iTunes App Store (China), the iTunes App Store (Taiwan), Google Play, and Xiaomi App Store as of October 2018. Content retrieval and evaluation will be described in section 3.1, and coding will be described in section 3.2.

3.1 Mobile-app selection

The research team reviewed the top ten free vocabulary-learning mobile apps for native Chinese speakers from each of the four app stores mentioned above. Two search terms, 词汇 [words] and 词语 [vocabulary], were used in both their traditional and simplified forms on all four platforms.

3.2 Coding framework

To capture the design aspects of mobile apps, both top-down and bottom-up coding approaches were employed. The top-down coding adopted Zhang and Lu's five vocabulary-learning strategy categories discussed above (learning the forms of words, PIC/IMG, association, repetition, and word listing). While this approach was capable of capturing such strategies in a general sense, it could not capture any special affordances of mobile devices. Thus, bottom-up coding was used to explore whether mobile apps used strategies other than those identified by Zhang and Lu.

3.3 Data analysis

Each author coded one of the four stores using the search terms mentioned above. After coding was completed, each app was demonstrated in a group meeting, at which time it was decided whether the codes accurately reflected its design features and underlying approach.

4. Results

4.1 Types of mobile apps

The research team identified 22 representative apps, comprising 10 dictionaries and 12 educational games (Table 1). All were listed on the first pages of their respective app stores' search results, and all had a large number of downloads and comments. It is worth noting that among many of the dictionary apps, "vocabulary" referred to Chinese idioms or fixed expressions, commonly in four-character forms (e.g., 亡羊补牢, [it's not too late to correct a problem]).

4.2 Vocabulary-learning strategies

In addition to the five strategies identified by Zhang and Lu (2015), a metacognitive strategy emerged from the coding process, which typically is promoted through educational games. Not all apps promoted the use of only one learning strategy. The strategy that was most prominent was forms (19 apps), followed by learning through games (12 apps), word listing (11 apps), learning through association (10 apps), PIC/IMG (seven apps), and repetition (three apps).

Table 1: A list of Chinese vocabulary-learning apps

Type	Apps	Forms	PIC/IMG	Association	Repetition	Word listing	Metacognitive strategy
Dictionary	成语辞典（Hisand Liu）	v		v			
	成语大詞典（商務印書館）	v		v	v	v	
	國語辭典-教育部重編國語辭典修訂本	v					
	漢語字詞典—最新版成語詞典&現代漢語詞典	v		v		v	
	現代漢語詞典（商務印書館）	v		v	v	v	
	中文字典—漢字拼音部首筆畫釋義查詢翻譯	v		v		v	
	漢語字典和漢語成語詞典—主持人配音	v				v	

	百度漢語—讓學習漢語更簡單	v				v	
	給兒童的注音及拼音詞彙工具書 (幼稚園)		v				
	成語詞典故事漢語造句大全					v	
Game	快樂中文 (Fun Chinese) 兒童漢語	v	v				v
	錯別字	v		v			v
	成語接龍-填填看	v					v
	中文連詞—漢語詞彙找茬			v	v	v	v
	我愛普通話—益智好玩的休閒娛樂文字遊戲單機	v	v				v
	成語玩命猜：1300 道看圖猜成語	v	v	v			v
	成語連連消：中文詞語消除謎題遊戲	v		v		v	v
	成語消消消—全民瘋狂玩消成語小遊戲	v					v
	看圖猜成語	v	v				v
	开心划词	v		v		v	v
	成語大挑戰（繁體版）	v	v				v
	搜詞之王（mobrix）	v	v			v	v
Total		19	7	10	3	11	12

The following sections provide examples of how each strategy was promoted by different mobile apps.

4.2.1 Learning Phonological or orthographic forms

Learning the forms of words consists of two parts: the orthographic (written form) and the phonological (spoken form). Most vocabulary-learning apps display the correct form, but in a variety of ways. For example, in the case of orthographic forms, the app 现代汉语词典 [Modern Chinese Word Dictionary] developed by The Commercial Press [商务印书馆] presents animations of stroke orders when the user clicks on a word (Fig. 1).

Figure 1. Stroke-writing animation in the app 现代汉语词典 [Modern Chinese Word Dictionary]

Some apps, such as 成語辭典 [Idiom Dictionary], developed by Hisand Liu, display words in a large size in an eight-segment grid to aid the user's clear understanding of their orthographic forms (Fig. 2).
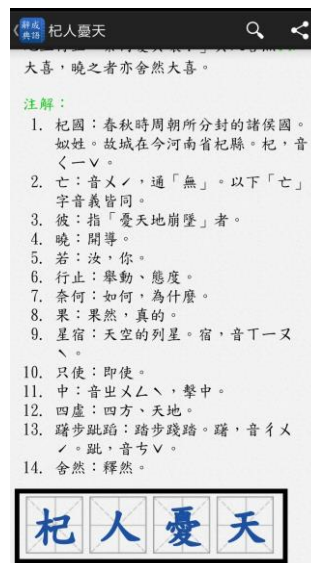

Figure 2. Words displayed at a large size in grids in the app 成語辭典 [Idiom Dictionary]

To aid the learning of phonological forms, the apps provide several types of romanization. In the app 现代汉语词典 [Moden Chinese Word Dictionary], for example, when learners click the speaker button below a character, they will hear the sound of the word and also see it in the Roman alphabet. The vocabulary-learning apps targeted at Mainland China mostly provided Pinyin only.

In addition to Pinyin, vocabulary-learning apps targeting the Taiwanese market (e.g., 成語辭典 [Idiom Dictionary] developed by Hisand Liu) provide Zhuyin Fuhao (Bopomofo).

4.2.2 PIC/IMG

Most of the apps using PIC/IMG organized words semantically, and provided specific situations in which the learners would use them. For example, when learning words related to colors in the app 學中文 [Fun Chinese], users see a black-and-white room, then hear a word for a color, and have to click on the corresponding color of an object. When an answer is correct, the object will change to this color (Fig. 3).

Figure 3. Learning words through PIC/IMG in the app 學中文 [Fun Chinese]

While 學中文 [Fun Chinese] aims to help learners develop sound-to-meaning connections through PIC/IMG, mobile apps can also support meaning-to-form connections using the same learning strategy. The app 成語大挑戰 [The Idiom Challenge], for example, displays an image related to the meaning of a word; users need to guess that meaning based on the image, and then form the word by selecting four Chinese characters from among an unorganized group of characters given below (Fig. 4).

Figure 4. An image in the app 成語大挑戰 [The Idiom Challenge] that hints at the meaning of the Chinese idiom 食言而肥 [Break one's word]

Similarly, the app 給兒童的注音及拼音詞彙工具書 (幼稚園) [The Tool Book of Words with Pinyin and Bopomofo for Kindergarteners] presents images related to the meaning of a word above the position within that word that produce the same Chinese consonant or vowel as the initial sound of the depicted item (Fig. 5).

Figure 5. An image in the app 給兒童的注音及拼音詞彙工具書 (幼稚園) [The Tool Book of Words with Pinyin and Bopomofo for Kindergarteners] showing pictures of words that start with the same consonant

4.2.3 Association

The results of content analysis showed that three types of associations were used in Chinese vocabulary-learning apps: synonyms and antonyms, common morphemes, and topics. Several of these apps were intended primarily to help children learn the meanings of synonyms and antonyms. For example, 小学生同义词近义词反义词词典—辞海版新课标 [Thesaurus for Elementary-school Students Based on the New Curriculum] displays synonyms and antonyms for words that the user searches for (Fig. 6).

Figure 6. Synonyms and antonyms in the app 小学生同义词近义词反义词词典—辞海版新课标 [Thesaurus for Elementary-school Students Based on the New Curriculum]

Similarly, the app 詞語消消連—語文近義詞反義詞比拼 [Word Crush: The Thesaurus Challenge] helps users connect words with their synonyms and antonyms

using games. Correct pairings of synonyms and antonyms increase the user's score (Fig. 7).

Figure 7. Synonym-antonym pairing game in the app 詞語消消連—語文近義詞反義詞比拼 [Word Crush: The Thesaurus Challenge]

The second subtype of association strategy that the sampled Chinese vocabulary-learning apps used was based on morphemes, with the aim of creating lexical links between words. This was done in two ways: idiom solitaire and displaying words with similar morphemes. Idiom solitaire was used in the app 成語接龍闖關：玩成語謎題，看成語故事 [Chinese Idiom Solitaire], which asks users to select characters from a brief list (e.g., 莫, 斗, 禍) to complete a Chinese idiom (Fig. 8). At the time of writing, there are 500 levels in this app, with the difficulty gradually increasing as one moves up levels.

Figure 8. Idiom solitaire in the app 成語接龍闖關：玩成語謎題，看成語故事 [Chinese Idiom Solitaire]

The promotion of morpheme use for vocabulary learning was commonly used in the sampled dictionary apps. For example, 现代汉语词典 [Modern Chinese Word Dictionary] automatically presents several words (e.g., 醒脾, 脾氣) containing the same target morpheme (in this case, 脾; Fig. 9).

Figure 9. Words containing the same morpheme in the app 现代汉语词典 [Modern Chinese Word Dictionary]

Lastly, some of the vocabulary-learning apps organized words by topic to facilitate users' learning of similar words. Taking the app 成語詞典故事漢語造句大全 [Stories of Chinese Idioms: Sentence Bank] as an example, idioms were categorized by themes, such as seasons, mood, climate, and people (Fig. 10). Users can learn various idioms related to a theme by clicking the corresponding link.

Figure 10. Thematic classification of idioms in the app 成語詞典故事漢語造句大全 [Stories of Chinese Idioms: Sentence Bank]

4.2.4 Repetition

Repetition-based learning strategies are typically used in second-language learning. In traditional settings, learners generally make lists of target words they want to review, and do so often. Among the sampled vocabulary-learning apps, several featured word-list making (as discussed further in the next section), but only a few facilitated the use of repetition for vocabulary learning. For example, the app Quizlet [詞卡] allowed users to create a list for studying unfamiliar words; the app 中文 [Chinese] prompted users daily with new words, and; 汉语词汇学习机—汉语词汇轻松学 [10,000 Chinese Words and Phrases] tested users on a given word until they remembered it. However, these were rare exceptions to the rule that Chinese vocabulary-learning apps for native speakers do not promote repetition strategies.

Among the majority of the sampled apps that did not directly promote repetition, 现代汉语词典 [Modern Chinese Word Dictionary] allowed users to create a review plan for the words they added to their word lists based on their subjective levels of familiarity with each one (Figs. 11-12).

Figure 11. Desired words ranked by their familiarity in the app 现代汉语词典 [Modern Chinese Word Dictionary]

Figure 12. A word-review plan in the app 现代汉语词典 [Modern Chinese Word Dictionary]

4.2.5 Word listing

In traditional settings, learners can use the vocabulary sections of their textbooks or make their own word lists to review words they have learned. Chinese vocabulary-learning apps, despite being not directly comparable to textbooks, also facilitate word listing in various ways.

First, as mentioned in the section on association above, several apps' organize content semantically (e.g., 成語詞典故事漢語造句大全 [Stories of Chinese Idioms: Sentence Bank], Fig. 12). This allows learners to navigate words they want to learn, review, or practice. Another example is the app 开心划词 [Word Search], a game that asks learners to find a list of words based on scattered characters (see the words next to the lightbulb icon at the bottom of Fig. 13), using animals as prompts. The same app also allows users to create their own word lists with which to challenge their friends.
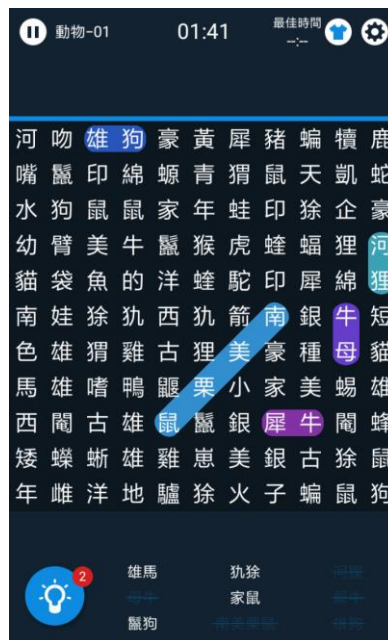

Figure 13. Word-search game in the app 开心划词 [Word Search]

In the dictionary app 中文字典-汉字拼音部首笔画释义查询翻译 [Chinese Dictionary: Search by Characters, Pinyin, Radicals with Meanings and Translations], after finding the meanings of a word, users can click a star icon in the top right corner to add it to their personal word list (Fig. 14) and later review that list in their dashboard (Fig. 15).

5:08

〈   词语详情   ADS ★

泾 渭 同 流

拼音：[jīng wèi tóng liú]

反义词：泾渭分明

◆词语解释

泾渭：泾水、渭水。比喻是非、好坏不分。

Figure 14. Adding to a word list in the app 中文字典-汉字拼音部首笔画释义查询翻译 [Chinese Dictionary: Search by Characters, Pinyin, Radicals with Meanings and Translations]

5:13

〈   收藏夹   🗑

擎天玉柱   成语 >

旁若无人   成语 >

泾渭同流   成语 >

Figure 15. Word list in the app 中文字典-汉字拼音部首笔画释义查询翻译 [Chinese Dictionary: Search by Characters, Pinyin, Radicals with Meanings and Translations]

4.2.6 Metacognitive strategies

Metacognitive strategies emerged during our coding process, which were promoted through educational games in the apps. As Gee (2008) noted, games create a situated learning environment in which players can try different ways of solving a particular problem. During that process, players use multiple metacognitive strategies, such as setting goals and monitoring progress.

现代汉语词典 [Modern Chinese Word Dictionary] is a good example of an app that promotes both setting goals and monitoring progress. Setting goals was facilitated through selecting words that users wanted to study. Monitoring progress was promoted by asking users to rate their familiarity with words (see Fig. 11).

Metacognitive strategies were not promoted in isolation. Rather, in these games, they were promoted in conjunction with cognitive strategies identified by Zhang and Lu (2015). Learning a new word involves acquiring knowledge of its forms, sounds, and

meanings. The games that the sampled mobile apps feature typically provide one or more such components of a word and ask users to provide at least one additional component. Several examples have been mentioned earlier in this paper, including 學中文 [Fun Chinese], which asks users to click an object with the color corresponding to a color-word's sound (Fig. 3). Similarly, 成語大挑戰 [The Idiom Challenge] illustrates the meanings of Chinese idioms and asks users to pick up characters to form its words in an orderly manner (Fig. 4). Chinese Idiom Solitaire provides some orthographic parts of words and asks users to complete them (Fig. 8). One additional example, the app 开心划词 [Word Search], uses only one type of word information, i.e., it requires users to find words in a grid full of otherwise random characters (Fig. 13). Some of the vocabulary-learning apps also used lexical associations in their game designs: e.g., the pairing of synonyms and antonyms in the app 詞語消消連—語文近義詞反義詞比拼 [Word Crush: The Thesaurus Challenge] (Fig. 7).

5. Discussion

This paper's review of the 22 most popular Chinese-vocabulary learning apps on the market as of October 2018 yielded several interesting findings. These findings can be subdivided into two main categories: the apps' design aspects and their facilitation of vocabulary-learning strategy use.

5.1 Design

Only two types of apps were reviewed: dictionaries and games. While this finding is not especially surprising, it suggests that the affordances of mobile devices for vocabulary learning are not being fully exploited. While dictionary apps allow users to find information about words quickly, only a few allowed users to add their search results to their word list for later review. In other words, despite looking up the meaning(s) of a word as the start of learning it, not the end goal, none of the sampled apps provided their users with opportunities to proceed further.

The Chinese-vocabulary games examined exhibit a similar limitation, and in effect did not seem to have been designed for learning. While they created engaging environments in which users could use their word knowledge to complete various tasks, these games' designs all assumed that their users already knew the words embedded in them. For example, if users of the app 成語大挑戰 [The Idiom Challenge] (Fig. 6) did not know a given Chinese idiom, the game did not provide sufficient information for them to learn it. Conversely, players of idiom solitaire will be able to win the game if they have a certain baseline knowledge of the Chinese idioms in the app 成語接龍闖關：玩成語謎題，看成語故事 [Chinese Idiom Solitaire] (Fig. 10), even if this knowledge does not extend to the idiom they are using at any given moment. Word-search games are no different in this respect. Players can find the target word without knowing what it means (Fig. 15). In short, the sampled games have all been designed primarily to facilitate practice of users' existing knowledge, rather than their learning of new words.

5.2 Learning strategies

All five strategies identified by Zhang and Liu (2015) were used in these apps, though several incorporated only one or two. As mentioned earlier, given that all 22 apps were categorizable as either dictionaries or games, the amount of learning that occurs when using them is likely to be limited. Notably, none appear to take into account any learning goals, a key aspect of any learning strategy (Zeidner, Boekaerts, & Pintrich, 2000). Worse, none include any mechanisms whereby users can test their understanding of words. Other than game scores, wins, and losses, none of the apps provide feedback at any point. The games appeared to even have been designed based on an assumption that their users will already have sufficient knowledge to complete them, which may explain why hints and feedback are rare to nonexistent.

Several limitations of this study need to be noted. First, the researchers used only two search terms to identify Chinese vocabulary-learning apps for native speakers, and thus could have overlooked well-designed learning apps that did not happen to have "vocabulary" in their descriptions. Second, the coding framework was based on learning in traditional settings, and thus may not have been comprehensive enough to cover all the sampled apps' features. While bottom-up coding was used to allow new themes to emerge, a new theme, metacognitive strategy, was duly identified.

6. Conclusion

Families' access to mobile devices and the Internet has steadily increased (Plowman, McPake, & Stephen, 2010), and research has consistently demonstrated mobile devices' potential for language learning. However, while several prior studies have shown that vocabulary-learning apps may be beneficial, the present study's findings suggest that the most popular such apps may not have optimal designs for vocabulary learning, at least in the Chinese case. Lacking clear learning goals, explanations, opportunities to practice, and feedback, these apps are unlikely to provide sufficient scaffolding for users' learning of new words. App developers should give due consideration to how mobile apps can better support such features, rather than using drill-and-practice tasks or simply assuming users know words already.

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