Technology in CFL Education

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Abstract This chapter reviews the emergence, development, and trends in applying technology to the teaching and learning of Chinese as a foreign language (CFL). By presenting the advantages that technology has brought into the area and examining the associated challenges from multiple angles, the chapter explores a number of practical yet critical issues in order to help readers better understand the increasingly entwined relationship between the two. It concludes with a reflection on the permeation of technology in everyday life, especially how the process of normalization may shape the outlook of CFL education in the years to come.

Keywords Computer assisted language learning (CALL) • CALL technology • Phases of CALL development • Behavioristic CALL • Communicative CALL • Integrative CALL • Intelligent CALL • Computer mediated communication (CMC) • Interactive and integrated language learning • CALL and learning CFL online

1 Introduction

Computer assisted language learning (CALL) has played an increasingly important role in CFL education, and as such, numerous technological applications to support and aid CFL teaching and learning have emerged. These range from highly specific solutions, such as the delivery of the sounds of individual characters and words, the display of character formation graphically stroke by stroke, and the comparison of speech waves made by students with a benchmark, to more integrated and high level approaches, including the evaluation of the degree of formality in a given body of text, the analysis of the usage and context of target words in corpus, and the ability to provide flexible participation and open access to an entire course. With the availability of this technology as a foundation for CFL teaching, a substantial portion of CALL technology is now being used to facilitate communication between students

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and teachers in cyberspace where mobile apps, Web 2.0 sites, and digital media empower learning online or "learning on-the-go" (Xie 2013; Zheng 2014).

Following the same line of inquiry found in other critical essays in the field (cf. Bourgerie 2003; Chen 2005; Yao 1996, 2009; Zhang 1998), this chapter examines the emergence, development, and trends in technology for CALL. While the term "technology" mainly refers to CALL programs and software, it extends to cover contemporary inventions that involve the use of mobile devices, multimedia players, and more. Due to the sheer magnitude of technology found in and beyond today's classrooms, it is virtually impossible to discuss in this chapter all aspects and applications of CALL's influence on CFL education over the last four decades. To further complicate the situation, many CALL technologies have quickly become out of date and out of use (e.g., Flash-based courseware, audio books, and a large number of short-lived websites). Keeping in mind these limitations, this chapter aims to focus on the historical development of CALL and critical transformations at every stage.

2 The Emergence of CALL in CFL Education

Among the early efforts and publications in the field, Cheng (1973), who taught at the University of Illinois, is widely recognized as the originator of CALL in CFL, though the actual use of computers in CFL goes back a few years further. When interviewed by the *New York Times*, Wang at Seton Hall University in New Jersey proudly claimed his system "the first in the world to teach Chinese" (Browne 1967, p. 67). Still, Cheng's article, the first of its kind in full length, describes the design, process, and insight of using the PLATO (Programmed Logic for Automated Teaching Operation) system mainly to teach characters, reading, and pronunciation. Without the PLATO project initiated at the University of Illinois in 1960 and its long lasting impact on CALL, it is unlikely Cheng's experiment that he described in his article could have taken place. For the first time on record, the computer, or more precisely, a central computer and several hundred terminals, helped CFL teachers create and utilize digital flashcards, drilled students on the pronunciation of words, integrated a digital dictionary with reading exercises that enabled readers to look up words on the screen, and reported learning progress so teachers could identify problems and weaknesses.

Interestingly enough, none of these efforts ever became fundamentally outdated despite the fact that the affiliated technology has transformed beyond recognition or become primitive by modern standards. However, there are similarities between Cheng's technology and the technology that is popular today. There was a touch panel attached to the screen so students no longer needed to type. The programs, not unlike today's cloud technology, were centralized and delivered content to numerous terminals via a network. Most surprisingly, PLATO's capability to convert voice input into a graphic display on the screen to let students compare and imitate was extraordinary in an era when the technology to digitally store and retrieve Chinese characters had just been developed. Digital flashcards, introduced by Cheng, remain

a staple due to their traditional role in language learning and the low associated technology, beseeching generations of CFL researchers to revisit the work by utilizing the latest technology loaded on the newest generation of devices.

Cheng (Chen and Cheng 1976; Cheng 1986, 1999) has revisited this issue many times over the past two decades, while Yao and Mark (1986), Kunst (1987), and Chun (1989), among others, have moved on to their own original explorations. Japanese educators were also drawn into the same technology explorations since they teach Kanji, i.e., Chinese characters (Nakajima 1988). As new forms or types of technology have emerged, CFL educators have worked to develop novel ways to use these technologies, such as to create sets of digital flashcards, and they have carried out a number of studies to show the effectiveness of the technology. Other studies focused on the use of various technical advancements that allowed computers to easily produce sound (Kunst 1987), to easily display graphics and images (Cheng 1991), to seamlessly incorporate other multimedia items (Fu 1996; Zheng 1997), to display animations and videos on demand (Chen 2006; Jin 2006; Lu et al. 2013; Zhu and Hong 2005), and finally, to give way to devices that are no longer around (Lin and Lien 2012; Xu and Jen 2005). The overarching pedagogical approaches span from teaching vocabulary in isolation (Chung 2002) and teaching in context (Kao et al. 2012) to teaching in a textual network where an individual character is linked by technology to many of its homophones and relevant phrases (Shei and Hsieh 2012). Central designs have drawn inspiration from a variety of cognitive theories, including dual coding theory (Chuang and Ku 2011; Kuo and Hooper 2004), multimodal theory (Chung 2008), competition theory, and level-of-processing theory (Shen 2011).

The true significance of Cheng's work goes far beyond the specific projects it discusses. The article unequivocally states the potential of CALL technology and constraints that define the field. One is overcome by an overwhelming sense of déjà vu when realizing how later scholars unconsciously reiterate what Cheng had anticipated in the field (c.f. Chun 1989; Liu 2007; Xie and Yao 2009; Zhang 1998; Zheng 2006). CALL offers the ability to induce immersion through its interactive nature and personalized attention, which the computer can provide to meet a student's individual learning needs. CALL is limited to a supplementary role, and each solution has a limited lifespan until the next technology emerges. There is also anxiety about technology encroaching on the traditional classroom. As materials expand from paper to digital content, the language learning process focuses less on mastering the material in question and more on mastering the navigation and understanding of the CALL programs themselves.

3 Three Phases of CALL Development

In the late 1990s, Mark Warschauer (1996, 1998 with Healey) identified three phases in the historical development of CALL, which he categorized in terms of the predominant theories of language learning over the previous 30 years: *Behavioristic CALL* (BC), *Communicative CALL* (CC), and *Integrative CALL* (IC). Warschauer

(1996) noted that "the introduction of a new phase does not necessarily entail rejecting the programs and methods of a previous phrase; rather, the old is subsumed within the new" (p. 3). Each phase was defined by instructional options made available by the computer and advances in computer technology, as well as rationales behind the different approaches.

The behaviorist teaching model, popular in the 1960s and 1970s, led to Behavioristic CALL, which featured repetitive drills and stimulus-response exercises interlaced with notes and messages in a digital format. The drill and practice exercises of BC often were used as auxiliary or remedial exercises for individualized instruction and freed up classroom time for other instructional activities. BC succeeded in taking advantage of the computer's mechanical qualities, including accuracy, tirelessness, meticulousness, and the ability to sort and process information rapidly. The PLATO system Cheng relied on in the 1970s epitomizes the advantages and drawbacks of BC.

The next phase, Communicative CALL, was popular in the 1970s and 1980s. CC attempted to provide skills practice through cross-cultural dialogues in real life situations where learners were permitted and often required to search and apply their language knowledge to identify situations, solve problems, and present synopses in response to stimulation from the programs. The focus was on learning elements of the language, such as grammar and vocabulary, in context and using the target language in activities that fostered motivation and interactivity. Text reconstruction, language games, and real-world simulations were common. Technology provided a context or scenario where users applied varying levels of originality and were at liberty to improvise as individuals or collaborate as groups to generate meaningful, practical language output. Computers were also seen as a tool for learning, with such capabilities as word processing, spell check, and desktop publishing available on personal computers.

The third, and perhaps current phase, Integrative CALL, involves the synthesis of language skills (listening, speaking, reading, and writing) in the context of a specific task or project-based activity so users are able to maximize benefits provided by the integration of multimedia technology. While CC often involved teaching compartmentalized skills, advances in computer technology in the late 1980s and 1990s made it possible to integrate different aspects of language learning in more authentic learning environments. Multimedia, or more precisely, the multimodal presentation of information on multiple possible platforms and media (on disk, online, on mobile devices), possesses the enchanting ability to not only combine text, audio, images, and video in unity, but also to draw together a number of sources that in the past were only available separately (TV, individual cassettes or recordings, or text). As a result, multimedia, combined with the Internet and disks, has become the bedrock of IC by helping put learners into linguistic situations and then forcing them to work their way out of those situations, calling on knowledge from multiple areas and extending learning beyond the boundaries of those in a classroom or textbook.

To be truly interactive, however, computer language learning programs would need to be able to respond to students' input, for example diagnosing problems with

pronunciation, grammar, vocabulary, or usage, and providing appropriate learning options, such as repetition or slowing down the presentation. This would involve *Intelligent CALL*, which Warschauer predicts will be the next stage of CALL development. Although Warschauer does not specifically address the teaching of CFL or the unique problems Chinese encounters as a less commonly taught, non-Latin script based language, he creates a point of reference for CFL educators to reflect on and review CALL's path from exotic, expensive supplementation to indispensable, essential practices. Warschauer's research does not prescribe a linear path for CALL, but focuses on making discussion possible and productive in the context of pedagogical and technical innovations.

3.1 Behavioristic CALL and Applications for CFL Instruction

Early CALL programs in CFL were predominantly behavioristic. These studies closely resembled Cheng's (1973) designs or attempted to recreate a similar effect with the model of *computer as tutor* (Taylor 1980). They were part of the teaching model in which information is disseminated from a central figure to numerous recipients, who receive, memorize, and produce answers. Yao (1996), Zhang (1998), Hsu and Gao (2002), and Bourgerie (2003), with some overlap, independently reviewed more than 50 CFL CALL programs. Those that teach vocabulary (characters + words) in the form of digital flashcards occupy the bulk of their reports. As a mechanized human teacher, the programs use linear logic to present and repeat information, allowing the user to see information on the computer screen, such as stroke order, stroke number, the meaning in Chinese and/or in English, pinyin script, relevant words, and example sentences. Users can also hear the pronunciation as recorded by a native speaker. In essence, these programs are a replication or logical extension of Cheng's early work. Still, there are a few particulars worth noting, such as the ability to search the glossary (e.g., *Chinese Word and Character Tutor*, *Wenlin*, *Follow Me Chinese*, *Hanzi Conversational*), to group words according to user-defined criteria (e.g., *Chinese Character Tutor for Microsoft Windows*, *Chinese Character Tutor*), and to compare the user's pronunciation with that of a native speaker (e.g., *Electric Dragon*, *Professional Interactive Chinese*, *Write Chinese*). Furthermore, most have one or more built-in modules for exercises and exams, such as recognition practice (e.g., *Chinese Character Tutor*), a self-testing section that assists the learner in remembering the beginning of each stroke (e.g., *Hyper Xizi*), and quizzes on a character's sound, meaning, and written form (e.g., *Chinese Word and Character Tutor*, *Step into China*, *Chinese Characters Primer*).

Technology continues to break new ground in other aspects of CFL education, including listening comprehension. Many programs have been developed aided by the computer's "patience," the ability to quickly rewind and fast forward, the ability to easily store a large quantity of audio files, and the convenience of integrating sound into images or videos. These programs attempt to enhance users' sensitivity to individual sounds for better word recognition and to develop strategies for quickly

digesting large chunks of texts, such as predicting words, identifying key phrases, recognizing word-order patterns and syntactic structures, and so on. Advances in multimedia technology have made it possible to include a variety of media and hyperlinks in programs that can act as tutors. For example, an instructional program based on the animation "*Nezha Conquers the Dragon King*" allows users to watch the film in a sentence by sentence manner to better study the script. Students may focus their attention on a particular segment and watch it multiple times. They may also pause, look into the glossary in English and/or Pinyin, and make connections between the image on the screen and in the text. Compared to the traditional method of giving pure auditory signals, playing sound in tandem with an image or images is a giant step forward because "the use of context to illustrate verbs and idioms is particularly effective," as one reviewer commented (Ross 1991, p. 301). Another example is *Hyper Chinese*, which drills students to listen and repeat. Covering a wide range of issues in pronunciation and speaking, the program is good at reinforcing correct responses with the feature to record and log errors.

Ke (2012) revealed in his recent review of the entire CFL field that CFL speaking has been explored less in research and teaching than other areas of Chinese language learning. However, technology has made some progress in enhancing the learning of spoken Chinese, drilling users on authentic pronunciation and intonation, lending a helping hand to a task that demands a great amount of patience, accuracy and consistency to perform. For example, Voice Thread allows students to interact online with speech instead of text alone, and Rich Internet Applications from clear.msu.edu provide a dynamic means to embed audio and video in homework. Still, the Record and Compare (R&C) option found in many CALL programs is one of the best known achievements to this regard. When Chen and Cheng (1976) and F. Wang (1986) first mentioned the R&C feature in the early years of the personal computer, the attempt to record and display one's aural input in a graphical form and compare it with a benchmark made by a native speaker was too revolutionary to be feasible. Bulky, expensive, and esoteric devices required to do so at that time were discouraging enough on their own. Decades later, Bourgerie's (2003) review has found that there are more than ten programs, including *Chinese Express*, *EZ Language Vocabulary/Pronunciation Tutor*, *Instant Immersion Mandarin Chinese*, *Language Learning Beginner and Everyday Series*: *Chinese*, *Learn Mandarin Chinese*, *Talk Now*!, *Standard Chinese Course*, among others, claiming to have this feature. A study by Chan (2003) further proves the advantages and practicality of integrating R&C in lower level classes to improve students' awareness of tones, intonation, stress, and more. The visual aids provide much-needed help in recognizing target language and demystifying the speech process so students can quickly play back their utterance, identify their mistakes or imperfections, and then make improvements by comparing waveforms and pitch contours made available by technology. Benefits do not lie so much in the specific details to be learned as much as the positive, active experience of learning when students and their teachers "dare to try out… play around, have some fun, and enjoy" (p. 82).

Looking back, some BC programs to teach Chinese attempted to introduce interactivity, but interactivity was limited due to the limitations of technology. Interactive

features were occasionally found as secondary or even decorative attributes of CFL software. There are programs that allow students to search for a character and teachers to add and edit entries (e.g., *Chinese Word and Character Tutor*, *Wenlin*), to mark certain cards for later review (e.g., *Electric Dragon*, *Professional Interactive Chinese*), or to compile personal vocabulary lists (e.g., *Dr Do Chinese Multimedia Language Trainer*). CFL CALL programs gradually began imitating and incorporating existing features from other programs to serve their own purposes, taking advantage of what had already been created. On the one hand, newer programs face the danger of becoming an assortment of unrelated features as they duplicate each other's efforts and include similar features without giving enough consideration to other important aspects of learning, such as purpose or ergonomics. This can be observed in software and other programs that focus on teaching characters, where later programs are surprisingly homogenized. On the other hand, such an appropriation may suggest the need for programmers to communicate with each other to reduce redundancy, but also to work towards a common goal of improving the effectiveness of CFL learning activities through further study and refinements.

3.2 Communicative and Integrative CALL and Applications in CFL

As CFL programs evolved to the Communicative Stage, educators soon realized that using CALL programs to drill an individual skill would lead to virtually no true engagement, regardless of the level of technological sophistication. This is probably the main reason why at the communicative and integrative stages the examination section commonly found in BC programs gradually gave way to communicative tasks that involved applying more than one skill to reach a certain goal. By definition, Communicative CALL refers to programs that focus their efforts on helping to create and maintain a learning community where usage and patterns of language can be learned implicitly via "discussion and discovery among students working in pairs or groups" (Warschauer and Healey 1998, p. 57). In CFL instruction, CC more often than not needs to stay connected with other programs as information is collected from external resources and incorporates different sensory modalities (aural, oral, and visual) to ensure communication.

Despite Warshauer's (1996) classification of CC and IC as two separate stages, CC and IC have long been in a state of mixed existence in the field of CFL. The development and growth of both has not followed a chronological path. CALL for CFL instruction has been able to move very quickly from CC to IC because of the new technologies that have made it possible to integrate multimedia into learning programs and to communicate through the Internet. Communicative CALL as it played out in the 1970s and 1980s was a notch above the drill and practice courseware of BC, but personal computers had just been introduced to the public and the models of *computer as tool* and *computer as stimulus* were being explored for lan-

guage teaching, in addition to *computer as tutor* (Warshauer 1996). New types of educational communication and ways to integrate the teaching of various aspects of language learning are now possible thanks to the prevalence of the Internet and Internet connected devices, such as computers, tablets, and smart phones. CALL programs have thus been able to largely free themselves from the BC paradigm which emerged at the turn of the century when schools were rushing to purchase large computer systems and working to secure Internet access (Clark and Mayer 2003; Gillespie and McKee 1999). Meanwhile, Internet or network-based CALL programs appeared and were expanded after catching up with the latest technological advancements. According to the modes and platforms they use, three major categories now dominate the scene, and they are either directly or loosely associated with Web 2.0 technology that allows users to interact and collaborate. Web 2.0 has been a big, and loud, buzzword in recent years because of its capability "to establish mutual awareness, develop social interactions, to form social relationships, and build learning communities" (Tu et al. 2008, p. 336).

The first technological advancement is computer mediated communication (CMC), including its spin-offs and minor variants, such as email (listserv, group email, etc.), instant messengers (such as ICQ, MSN, QQ, or mobile apps such as WeChat, WhatsApp, Line), newsgroups, chat rooms, and so on. The second is social media, including collaborative projects (Wikis), blogs and microblogs (Twitter, Weibo), content communities (YouTube, Fluentu, podcasts), social networking sites (Facebook), and virtual social worlds (Second Life), based on Kaplan and Haenlein's well-known classification (Kaplan and Haenlein 2010). The third is hybrid learning and distance learning, which create a comfort zone by merging reality with the realm of a virtual world and deliver course content via technology to students who are located physically away from the campus. Massive Open Online Course (MOOC) is a major innovation in this regard. They make use of the internet to build a learning community among people who, by no traditional means, can meet and interact. Often taught by professors at top universities, these free, non-credit, open enrollment courses are great examples of the integration of technologies, such as the Internet, video/file sharing, instant messaging and social networks. Consisting of video lectures, PowerPoints, reading material, handouts, discussion forums, and homework, a MOOC course sometimes can become so popular that tens of thousands of people sign up for it at the same time (Cathy 2013). Educators with much enthusiasm are now beginning to explore MOOC's potential to enlarge the population base of CFL learners (Zheng 2014).

Interactive and integrated language learning needs to foster, sustain, and evaluate collaboration and group interactions no matter what platform or by what means the knowledge is disseminated. The model of *computer as tool for social interaction* has led to advancements in the field of CFL education. Every form and type of mass-market digital product has been appropriated and used by CFL educators, in one way or another, to serve communicative needs. Exemplary cases include blogs (Hou 2009; Xie 2006), online chats (Wang and Feng 2012; Yao 2009), wikis (Liao 2012; Wang 2010; Li 2012), Weibo (Lu 2012), Facebook (Jin 2009; Magriney 2010), YouTube (Wang 2012a; Tan 2012), and Twitter (Wang 2012b).

The simple task of doing one's homework on a computer and emailing the assignment to a teacher in 1999 involved three highly specialized programs, namely, Njstar word-processor, Wenlin Chinese learning tool, and Njstar communicator, not to mention the plight of sending the homework as an attachment, rather than writing everything in the email itself in case the Chinese characters and other content were corrupted in the encoding-decoding process (Xie 1999). Obviously, these issues are nonexistent in today's world. Take the popular social network WeChat as an example. Designed for mobile devices but able to run smoothly in a web browser on PC or Mac, it provides a complete solution to transfer text, audio recordings, pictures, and videos to multiple recipients at one time while making video or voice calls trivial. It is by no means merely an instant messaging client. Rather, the user can stay in touch with friends under the "Moments" page, take a few photos then share with others, add or respond to comments on others' posts, and conveniently embed content from external resources, such as web pages, Google Maps, YouTube, and much more. Unlike some popular social networks, such as Facebook or Twitter, where users' attempts to control what groups of friends, family, and accomplices can see often fall short, WeChat discreetly maintains a moving wall between what one is allowed or not allowed to see. Chinese teachers have done a number of projects with WeChat to foster not only specific language skills, such as speed reading and casual writing, but more importantly, the sense of being a team member in order to foster interaction with others via text, pictures, voice recordings, and even videos. WeChat presents a truly integrative communicative experience that students in 1999 could barely dream of (Hu 2014).

4 Issues Specific to Technologies for CFL Instruction

4.1 CALL and Chinese Character Writing

It may be time to admit that the skill of writing every character onto paper from memory may be a waste of time (Allen 2008). Setting aside the radical nature of such a proposition, many serious scholars are unable to resist the tremendous impact of letting students input characters with a regular keyboard rather than writing by hand, which serves to save time and effort that can be spent on more valuable skills, such as listening and speaking. In research on teaching other foreign languages (e.g., ESL, Spanish, German), how to develop writing with Web 2.0 tools is the most studied topic (Wang and Vásquez 2012). The overall paradigm shift from cognitive processing to social interaction in second language education reaffirms the current importance placed on communication in authentic situations. Xie (1999) welcomes the convenience of typing characters on a modern PC despite his uncertainty about whether or how much typing can undermine character recognition and word memorization. Xie (2003, 2011) along with other scholars (Xu and Jen 2005) kept the discussion ongoing over the last decade and have come close to reaching a consensus that in comparison to handwriting, typing is more beneficial because it

can motivate students, free up effort, and stimulate recognition.[1] Plus, it is inevitable because the opportunity to write characters on paper is becoming rarer in real life as communication becomes more and more digitalized.

The change from painstakingly learning how to write characters stroke by stroke by hand to effortlessly letting the computer handle the work helps keep students much more motivated in actual communication. This is a giant leap for CFL CALL, and the decision to take it must be made collectively by teachers, students, and the market as a whole, and must take into consideration technological advances that were not available when pre-Internet CALL first was applied to teaching characters. Ironically, early efforts of CALL for character writing served to drive students and teachers *away* from the activity it was originally meant to supplement. The activity of rote memorization and tedious drills has given way to the desire and demands of communication, and vocabulary has become merely a secondary matter in the overall picture (Xie 2002; Zhang 2009). Take using Google Docs to develop writing as an example. CFL teachers have found that a major innovation in the "cloud" era is students can edit others' writing and thus learn from correcting or being corrected by their peers. "Cloud" technology invites collaboration and interaction so multiple authors can "share the same online database, work on the same document simultaneously and track the changes and comments" (Chen 2014b, p. 8).

4.2 CALL and Vocabulary Learning

In addition to using the Internet for collaboration, CFL programs need to simplify users' efforts by giving them a centralized solution. Electronic dictionaries offer the best option for this as they access information online and organize it. Xie (2010) provided a preliminary review of electronic dictionaries for CFL learning. J. Wang's study (2008) and others (Lee 2003; Porter 2003; Wang and Upton 2012) have shown the benefits of using an electronic dictionary to help with vocabulary learning. Linkit (Shei and Hsieh 2012) makes an illustrative case. Similar to Clavis Sinica, it is a program designed specifically to combine the strengths of the textbook and the Internet. When students look up a word after typing it in, the program presents relevant data from both the textbook and Internet or a bilingual dictionary. The ultimate goal is to use a hierarchical network model to sift and sort the language material from the Internet so learners can quickly cross-reference key morphemes by choosing to read examples that best suit their language level.

Programs mentioned in Xie's (2010) review showcase learning through the Internet beyond a controlled environment, so users can search, digest, and then go

[1] Xu and Jen's paper has triggered a considerable wave of reactions from the Chinese teachers' community. A heated debate took place in the following issues of the journal regarding the idea of letting students learn how to type and partially or completely let go of the skill of writing characters. To learn more, please refer to the "Letters from Readers" section of *Journal of Chinese Language Teachers Association*, volume 40, issue 3 and volume 41, issue 1.

on to create content they find meaningful and significant. Meanwhile, scholars have started to pay more attention to this change in technology as they distinguish between the micro level of CALL, i.e., "its ability to highlight stroke composition, pronunciation, meaning, and character components" (Everson 2003, p. 143) and the macro-level, namely, the ability to provide connections between characters/vocabulary, to search and prepare online text into level-appropriate material, to grant users the power to select and save the parts they regard as important, and to keep track of their learning progress. This difference in focus sets newer programs apart from their predecessors by bringing more attention to how users create their own content with the help of technology, letting users quickly and conveniently look deep into pieces of information whenever the need arises.

Electronic dictionaries remind CFL educators of the lack of a coordinated effort in the field to bridge the pedagogical and technological gap between the task of working on instructional texts and dealing with authentic materials. Internet connectivity allows programs to pull in rich data from the online world, leveraging the power of associative memory so users can acquire new knowledge through connections to what they have learned previously. As a result, lower level skills, such as vocabulary and pronunciation, lose the spotlight and sometimes are not even associated with any specific CALL program when the focus of technology shifts from knowledge acquisition to communicative roles. Examples can be found in multiple reports (Liu and An 2011; Liu and Zhang 2013; Xu and Ma 2014; Zheng 2004). A close look at CFL teaching methods reveals that on one hand vocabulary learning, in terms of knowing the meaning, pronunciation, and written form of a word, loses its focal status and becomes a prerequisite for students to master before class. On the other hand, students still use BC programs with repeated drills and individual pacing to help them to remember, recall, and look up words. The teacher's main task then is to stimulate output, coordinate group activities, correct mistakes, and assess student progress.

5 CALL and Learning CFL Online

The sophistication of the Internet in recent years has opened up a vast and wild land where learning online, including websites, virtual communities, long distance education, and hybrid courses, all claim a share, leaving CFL educators to decide how and to what degree knowledge that requires predominantly rote memorization, such as vocabulary and sentence patterns, should be taught. Yao (2003) reviewed over 50 websites relevant to Chinese teaching and classified them into five categories, namely, those that provide Chinese teaching and learning materials; those that facilitate face-to-face courses; those that work in conjunction with printed textbooks; those that offer courses completely online; and those that are somewhere in between. The review did not discover any websites that offered innovative methods for teaching characters. Other reviews (Xie 2008a; Xie and Yao 2009; Xu 2007) conducted in the following years obtained similar results, except for finding a handful of

innovations, including a program called *iChinese*, which takes a visual approach by supplying images and pictures so heritage learners with some language background can quickly develop their literacy, and also a website that allows everyone to create, share, and search flashcards according to their interest (c.f. Yao 2009).

5.1 Virtual Learning Communities

Regarding virtual learning communities, Second Life, a large online community where users can assume a role and interact with others in different locations and scenarios, has attracted considerable attention. One of the most revolutionary aspects of Second Life is its capability to simulate the "real world" (Chen 2010), i.e., providing a number of realistic scenarios to simulate total immersion in which learners are motivated to communicate and interact. Learners try to identify characters and words written in the visual landscape, click and find the meaning of objects they see in a virtual kitchen, and apply their knowledge by asking and answering questions from peers and the teacher through instant messaging. In one scenario, students are asked to step into a virtual infirmary. They review vocabulary when they see objects in the room and even have the opportunity to acquire additional words if interested. They can also invite themselves to take a simulated check-up, integrating what they have learned by communicating with the doctor about their physical condition and medical history (Liu 2010). The virtual reality experience delivered by technology accelerates vocabulary learning, especially in conjunction with other activities, to a higher level when students take the initiative to seek out information, consolidate different skills, interact with others, and solve problems in collaboration with others (Grant and Huang 2010).

5.2 Distance Education

Long distance education and its counterpart, i.e., hybrid coursework, in which part of the course content is migrated to cyberspace, also has become more interactive in the cloud age. Its flexibility and inclusiveness to accommodate different learning modes (learners who prefer visual, aural or somatic stimuli), learning habits (learners who often procrastinate or those who prefer to preview and be prepared, learners who take scarce or voluminous notes), and personality types (shy, introverted learners versus outgoing and extraverted learners) have made it an ideal means to enlarge the population base of CFL education (Liu and Zhang 2013; Stickler and Shi 2011). Even when globalization was still in its early stages, educators already started to outsource part of the teaching load to individuals in other regions who can accept lower payment and work alternate hours due to the time difference (Sunaoka and Haruki 2003). Globalization continues to grow and the prospects for distance education become even more tantalizing. Xie (2008a, 2013) shares his experience using

voice/video chat software to connect teachers and students who are separated by the Pacific Ocean. He and others (Liu and An 2011; Meng 2010; Zheng 2004) find that one of the key elements for a long distance program to succeed is a sense of sharing, namely, an awareness of the interconnectivity among the student, the teacher, and the student's peers, in addition to their obligation to reach out and communicate. Learning can happen first at the moment when students respond to a task and then again when they receive productive feedback from others.

In recent years, distance and hybrid education have expanded in the depth and breadth of digital operations, and have worked to transform CALL programs from pure instructional apparatuses to an assemblage of course management systems, tools, and peer sources (Demski 2013; Wilson 2013). Students on a platform called "iKnow," for example, can seamlessly synchronize and share their digital notes via audio or video, track the editing process, upload learning materials, and launch discussions with peers and the teacher (Chen 2014a). Distant/hybrid education in that event not only demands learners to engage in communication during multiple occasions in various forms (the discussion in and out of class, homework, group projects, etc.) in the same way a traditional class does but also it invites students to select, manage, and synthesize their digital assets, including different types of CALL programs mentioned above to achieve communication and shared learning strategies (Kan and McCormick 2012).

5.3 Mobile Devices

Going forward, mobile devices and their apps can be considered the newest phase of the Internet. This new, radical form of integrative communication relies on mobile devices, which integrate almost all types of communicative modes possessed by the PC along with a staggering level of mobility to accompany users from dawn to dusk so they can share, interact, and learn in and out of the classroom. In a nutshell, mobile devices provide more than what a PC can offer, including the potential of a multi-touch screen, a three-axis gyro, embedded cameras, a microphone, a persistent Internet connection, and a virtual personal assistant with artificial intelligence, who can answer questions and interact with the user to a certain extent (e.g., SIRI).

When scholars examined the degree to which technological features on a tablet or a smart phone could be harnessed and the ways to do so, they found tremendous potential (Yuen 2011). A short review (Lin and Lien 2012) of a number of CALL programs (apps) on iPad resulted in some noticeable discoveries. First, some apps (*Pleco*, *CamDictionary*, *TextGrabber*, *Siri*, *Dragon Dictation*, *iFlyDictation*) now have OCR (Optical Character Recognition) or ASR (Automatic Speech Recognition) functions, which can recognize, annotate, or translate language input in the format of pictures or sound. This new technology expands vocabulary learning from just studying materials handed out by the teacher to discovering and making sense of words in the environment. Second, apps can now ask users to use their fingers rather than the mouse to write on the screen for writing practice (*eZi Test Chinese*, *Chinese*

Writer, *trainchinese Chinese Writer*, etc.). The programs have become more responsive to the correct strokes and more sensitive to catching wrong ones. Third, both the notion and the function of gaming are often touted, especially since mobile devices and apps are light, portable, yet powerful. They are intrinsically more entertaining and enjoyable than those on the computer.

The fusion of gaming and learning then seems logical. For example, *Play & Learn Chinese*, as its name suggests, allows the user to hear a word and touch the corresponding object on the screen. *E Shen Bao Dong Gua* (E神煲冬瓜) is another game in which the user receives a shopping list and needs to find the appropriate items before time runs out. Perhaps the most prominent example is the app called *Skritter*, which is arguably the most successful one in the mobile world of character teaching. Its creation was quite dramatic, yet natural. The founder, who first came to Beijing in his early twenties, was sleepless, exhausted, and loaded with anxiety. He aimlessly sat on the couch and watched his roommate playing a Nintendo DS until he suddenly came across an idea. Seeing his roommate using a stylus to draw on the Nintendo's screen, he realized that the same action could be used in the activity of learning how to write Chinese characters. Before long this "crazy endeavor" took off (Anonymous 2014).

5.4 Immersion-Like Online Learning Environments

The other approach goes further, changing the ecology of education in daily life by creating an immersion-like learning environment and mentality. It is possible to have a long lasting impact on the way students respond to the task of learning and bridge the gap between education and life. Some educators use the term "seamless learning" to highlight its innovations, namely, the ability to engage students in learning in different settings, on different occasions, and in different roles as individuals or with others (Wong and Looi 2011). Similar to what the language immersion experience promises, "seamless learning" via self-discovery, peer activities, and teacher-student interaction is collaborative, synchronized, and of course, ubiquitous (Looi et al. 2010). Liu's project provides a good example (Liu et al. 2012). They use the Levels of Processing Theory (Craik and Lockhart 1972) as a pedagogical guideline and implement a personalized electronic dictionary called *My Mictionary* based on cloud technology. Unlike most dictionaries, it does not give out information about specific characters or words. Instead, it starts as a wordless book and asks students to identify and add words into it during the learning process. Once a new word is added, the system then searches and loads its explanation and illustrative sentences from the Internet and other sources. From then on, students can add more information (hyperlinks, images, audios/videos, or texts) into the entry to enrich its value under a teacher's guidance. Over time, *My Mictionary* becomes a hybrid book that records both the content of learning and the learning progress itself. Sharing it with peers and with a teacher further enhances the sense of communication, especially when students start to enjoy learning in a manner

similar to what they do when they update their social media pages, i.e., taking a photo, making a comment on a sentence or two, then actively checking and responding to each other's comments.

The program's developers rely on the integrative nature of the program to allow users to create and share their own content as they discover and have fun engaging with others. This may greatly impact classroom teaching especially at higher levels of CFL learning because teachers can now pay more attention to developing complex language skills in class by "outsourcing" the mechanistic aspects of language learning to after-school hours. More importantly, CALL motivates students to seek out new information and provides them with much needed support so they can better comprehend class content as well.

6 Reflections on Normalization and the Future of CALL in CFL Education

A few years after Warschauer categorized the stages of CALL development as BC, CC, and IC, Bax (2003) also identified three stages: Restricted, Open, and Integrated CALL. He also predicted that in the future, CALL would not consciously be associated with the technology that powered it, what he referred to as "normalization." Following his thinking, a few CFL educators have started to consider the issue by summing up the changes CALL has brought to Chinese classes. Xie (2008b), in particular, listed a few conspicuous characteristics he observed as technology is becoming an integral part of teaching and learning, including the digitalization of communications between teachers and students, online resource centers that gather and disseminate learning/teaching materials, and the role of social media in organizing, motivating, and guiding conversations so students can be exposed to more types of language input.

The new technologies mentioned in Xie's review (2008b) are less bounded by commercial factors and pedagogical issues. Taking a quick look into a teacher's or student's computer, one can discover a conglomerate of various technologies that function in many different directions and on many levels of instruction at once. From cloud storage solutions, such as Dropbox and Google Drive, which share documents, to online dictionaries containing many thousands of words, from search engines that index and identify useful information, to digital translators that occasionally jeopardize learning, from programs that can edit pictures and sounds, to software teachers can use to create 3D animations with ease, from taking notes digitally to taking quizzes online, from making internet calls to jointly editing documents online, such software and services help teachers and students discover, manage, and operate their digital lives in an ever intrinsically connected way.

While Bax's (2003) vision of the future of CALL is appropriate for the most part, his forecast of normalization raises a number of critical issues that are unique to the field. In his revisit of the issue, Bax (2011) advocated that CALL should be

understood in terms of economic, social, and scientific factors in order to avoid the so-called single agent fallacy, which focuses on the inventor or technology itself. Based on this view, the fusion of CFL and CALL, or more specifically, the long history of applying technology to CFL education in the U.S. is anything but a coincidence. The connection between CFL and CALL originated in and has been maintained by the importance of technology in American culture. The U.S. is home to a gigantic social lab where technological innovations and scientific breakthroughs are made in abundance so it is natural for technology to be applied to CFL teaching and learning. Using technology for CFL instruction speaks on a deeper level to an implicit, yet undeniable inclination people possess to offset the laborious, tedious part of any endeavor to a machine or other technology. Learning how to write characters and memorizing hundreds of non-alphabetic words is unquestionably one of the most daunting tasks in the CFL learning process.

Due to the notable difficulty of learning Chinese and the unfaltering reliance on technological solutions, a so-called "Fear and Awe" mindset has emerged. CALL programs oftentimes flaunt and establish their strength in areas where learners cannot otherwise find a quicker, easier solution before giving up on the challenge. To learn and then memorize how to write a character stroke by stroke by hand is a typical example. Many CALL programs, including ones on mobile devices, act in concert to show characters with a stroke by stroke animation. This is arguably one of the most persistent features of technology to teach the Chinese language, the history of which goes back to the very beginning of CALL in CFL, as reported in Cheng's 1973 article.

However, the issue of how effective it really is to present characters with an associated stroke animation in comparison to introducing the character's etymological formations, highlighting components, and/or vocalizing the pronunciation, has largely been overlooked by software designers and educators alike. The ineffectiveness, or even the actual disadvantages, of using stroke by stroke animation has been proven by multiple studies (Jin 2006; Zhu and Hong 2005). In reviewing a textbook dedicated to the sole purpose of teaching Chinese characters, Shen (2011) raised concerns when she observed that character knowledge, such as "methods of character formation and etymology to genealogy and orthography," is "extremely helpful to beginning learners but seldom found in textbooks" (p. 118). She then goes on to stress the imperative to present students with the origin, formation/transformations, and interconnectivity of characters in hopes that educators can actively search for appropriate methods to foster meaningful learning. Her remarks reveal the counterproductive methods employed in many CALL programs that are pleasing to the eye but may not connect to CFL theory or research.

Another example can be found in the common practice of displaying Pinyin, the vocabulary, and its English meaning simultaneously on a flashcard, digitally or otherwise. Scholars have studied the effect of learning from this strategy and have come to the preliminary conclusion that the order of presentation does affect cognition and retention (Chung 2007, 2008). This being the case, CALL programs should pay more attention to recommendations and findings from empirical studies, rather than letting intuitive thinking and the wow factor cloud their vision (Murray and Barnes 1998).

While technology lures prospective users with promises of convenience, interactivity, consistency, and effectiveness, it can also work to complicate and compromise learning. The effectiveness of CALL is contingent upon numerous factors, for instance, budget, administrative and technical support capacity, the level of integration between technology and pedagogy, students' readiness and financial means, and so on (Killion 2013; Rienties et al. 2013). Its reliance on financial capital and the market as a whole, in addition to its power to transform learners from speakers of the language to merely operators of a machine, restricts the potential of CALL as it was first envisioned. Since technology first was used to teach Chinese, scholars have compared the volume and scope of CALL projects during the 1980s in the U.S. with those of China. According to Sun's (2009) encyclopedic reference book, no more than five articles were published in China before 1990 on the CALL technologies, and they focused almost entirely on teaching characters and pronunciation, the only practical target the technology in China could achieve at the time. In contrast, the *Journal of the Chinese Language Teachers Association*, along with other U.S. based periodicals, has published studies since the early 1970s on how to apply technology to diverse topics on advanced devices. This disparity persisted until the late 1990s (Alber 1996) when China's economy started to bloom. Yet in other parts of the world, the level of technology people in developed countries take for granted may still be out of reach to many. The predicament that a multimedia classroom could be deprived of an Internet connection or some kind of projector to show a PowerPoint, or is untimely forced out of service due to the lack of replacement parts, is a cold reminder of how constraints can define and deplete potential (Shen 2013; Xu and Zheng 2011).

Another important point to consider is the life cycle of a program can predict its longevity and vitality. It is common knowledge that the first generation of a technology is usually less than perfect and, therefore, needs to keep updating and reinventing itself in order to improve and reach the general populace. Technology as applied to CFL is usually short lived and unsustainable, to say the least. This may result from the erratic relationship between CFL and CALL. At first, individual educators designed and pioneered programs for their own classes (c.f. Yao 1996), which sometimes accidentally turned into something of commercial value. As commercial products began to dominate the scene, the ability to stage joint ventures between educators and investors became more difficult. In both cases, the products were rarely updated or revised because educators prefer to stay away from the market, whereas for-profit companies may not survive long enough in the market to have a chance to even make updates. Most companies listed in Bourgerie's (2003) review are now gone, and most of the websites mentioned are no longer accessible. HipiHi, an online 3D virtual world game introduced and highly recommended by S. Liu (2010) is now discontinued.

Perhaps the rise and fall of an individual CALL program is mandated by the laws of nature. Normalization suggests a healthy life cycle of birth and demise. In theory, whenever one program or website sinks into oblivion, the code, language materials, and experience should stay as long as they are recyclable to nourish other programs that come later. However, business rivalry, platform incompatibility, disputes over

intellectual property, among many other factors, oftentimes will prevent this transition or transformation from happening. Reinventing the wheel is the norm. For example, take the recorded pronunciation of basic vocabulary. What should have been available all along is now impossible to ignore: there needs to be a voice library that not only contains recording of common words and essential sentences but that also is easy to search and quote, for teachers, students and program designers to draw from. Yet many years have passed since the first group of digital flashcards was created, and a voice library is still not openly available. Speech synthesis may provide a solution, but its quality and level of sophistication need further improvement (Yeh 2012; Yeh et al. 2013).

In recent years, a new relationship between teachers and technology has emerged, namely, teachers have ceased to assume a dominant role in creating and designing CALL programs and materials. On one hand, there are super-sized, multinational corporations that launch products, including mobile devices and apps, cloud technology, social media, and more that are commercially successful and popular. On the other hand, CFL educators are limited to appropriating a product's functionality to meet their own teaching objectives. For example, a teacher may use TubeChop.com to "chop" and play sections of a YouTube video, then display a piece of interactive instructional material made by "Articulate Storyline," and finally go to superteachertools.net to randomly assign student groups for class activities. Seeing the distance between these two operations, namely, the functionality of commercial products and teachers' efforts at adaptation and appropriation, scholars need to spend more effort studying the behaviors and choices of users, i.e., how they actually make use of CALL programs, how they interact with each other, and when best to introduce interventions to aid in the learning process. Normalization needs this pivotal knowledge to be complete (Schmid 2008).

The last point to make regarding normalization is that fast, incessant progress and changes that occur in technology may delay or even sabotage attempts to apply technology to CFL learning. Yao (2003) discovered that over 49,200 websites contained the keyword "learn Chinese" and 7,380 were related to "teach Chinese," while a study published in the same year revealed the cold reality that the users surveyed "as a whole did not think that access to the computer ha[d] improved their language learning process, at least they did not see obvious benefits" (Ihde and Jian 2003, p. 38), partially because about one-fourth of the respondents could not even make their computers display Chinese characters on the Internet. This means that efforts to use technology for CFL learning may be for naught or become completely obsolete if not made available to potential users in a timely fashion. The short life of hundreds of websites, the numerous third-party programs that enable a computer to properly display Chinese characters, to send messages, and to teach Chinese remotely have attempted, and failed, to help users learn Chinese and have showcased just how ephemeral technological innovations can be.

A comprehensive survey by the Chinese Language Teachers Association (CLTA) in 2012 provided a timely snapshot of the degree to which technology has become normalized in CFL instruction and disclosed specific names and types of programs that were most and least commonly used by Chinese teachers. The survey first

recognized the normalization of Email, Microsoft Word, and methods of inputting Chinese, which are "no longer…high-tech devices…just regular tools like pens" (Li et al. 2014, p. 41), and then named PowerPoint, Google, and YouTube as the most used applications in Chinese classrooms. Quiz maker, IPads, and IPhone apps were found to be the least popular. Wikis, self-created web pages, and blogs were avoided by most teachers as well. The under-representation of the later inventions reflects the pattern that new technology has to live through a "wait-and-see" period before being normalized some years later if their functions prove to be general enough to meet the versatile needs of diverse textbooks and curricula.

However, the survey suggested another possible form of normalization in the prevalence of course management systems, such as Blackboard, Moodle, WebCT, and D2L, which help teachers manage their courses. With these tools, teachers not only can promptly deliver more course content, but also can better communicate and assess their students in a timely manner. Students in turn become more accustomed to digital or digitalized course activities. Though Blackboard and other course management systems are not strictly CALL per se, they do carry many common functions of regular CALL programs to present information, host forums, exchange files, give assessments, collect responses, hold group discussions, track activities, and much more (Unal and Unal 2014). Therefore, their ever increasing presence in education suggests one more path that normalization is taking. Above all, CALL technology is subject to pedagogy, which also changes from time to time. CFL educators need to find and maintain a balance between what can and cannot be outsourced to technology in order to avoid wasting time and effort on technology that is much less useful than it first appears to be. For example, the use of online virtue communities, such as Second Life, to teach CFL at first glance was attractive and offered an opportunity for interactive learning. Yet in reality, most users walked away from virtual communities after the newness wore off, leaving behind the charming bodies of their avatars, along with clothes, cosmetic add-ons, personal belongings, and of course, awkward-looking virtual spaces which took much time and labor to build but failed to foster any personal attachments. Xie (2014) has unequivocally admitted that teachers' efforts invested in Second Life, including holding virtual conferences and creating different communicative scenarios, apparently were not on the right track. With much regret, Xie also noted the downfall of a few other technological products, including listserv, blogs, and podcasts.

7 Conclusion

Technology emerges and disappears. Even CFL educators and teachers who have long been following technological advances can hardly pin down or map the ideal, quintessential technologies for CFL learning. When reviewing the status-quo and potential of technology for CFL education in the early 1990s, Alber (1996) found the "electronic frontier" was being pushed ahead by the CD-ROM. With the capability of delivering bulky multimedia materials and large, complex software, the

CD-ROM seemed to him the ultimate technological development of the future. A little more than a decade later, Yao (2009) explicitly stated in his survey of the field that "what we can do with CDs and DVDs on the computer, we can also do on the Internet and more" (p. 2). The Internet at that time mainly consisted of websites and web pages, but this is no longer the case after only a few years. Apps have grown exponentially in number and function on mobile devices and are infringing on the traditional borders of websites (Brumberger 2011). According to Flurry Blog, an enterprise that specializes in gathering and analyzing mobile marketing statistics, over 80 % of the time spent on smart phones and tablets is spent using apps (Khalaf 2013). The web, the report claims, is "already facing a serious challenge."

This chapter brings to light the complicated relationship between technology and CFL education. Adopting Warschauer's (1996) chronology to conceptualize and enunciate the transformations CALL has gone through in CFL since its inauguration four decades ago, the discussion above suggests the difficulty of technology to be totally integrated into CFL learning. By enumerating and evaluating the end products that CALL technologies have made available, the chapter reflects on the critical relationship between the production and reception of technology, factoring in both pedagogical shifts and scientific innovations. Subjected to these two dominant forces, users and producers are now more independent than ever. This ubiquitous, yet humble, operation revolves around the ways a user "uses" or "plays" with a program, applying practical tactics conditioned by the individual's motivation and learning style. As long as users keep on making and remaking, appropriating and re-appropriating the functions found in a CALL program to serve their own interests, innumerable transformations will occur in the development of CALL programs. Given the difficult task of learning Chinese and the growing enthusiasm in applying technology to teaching, it is only reasonable to believe that many CALL programs will change their focus from the production-end to the reception-end of CALL development by prioritizing user experiences, for teachers and students alike. Next generation programs with enhanced portability, transferability, and manageability will take into account infinite transformations by means of bulk information sharing in order to pave a way to normalization. Course management systems are taking the lead in this.

Following the same line of development, wearable devices and new equipment becoming available on the mass market will carry on the task of bringing technological power into the arena of language education. These new devices create a "hybrid reality" or "mixed reality" where the physical and digital merge to harness the advantages of both. One of the challenges of CFL technology is to find ways to catch up with this hybrid reality. Still, technology in CFL needs to carry out the most burdensome and mechanistic aspects of the learning process while gradually making such activities more communicative and integrated.

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