科技与中文教学

Journal of Technology and Chinese Language Teaching

Volume 12 Number 1, June 2021
二〇二一年六月　第十二卷第一期

Editor-in-chief

De Bao Xu

Executive editor

Jun Da

Editors

Shijuan Liu

Song Jiang

Chin-Hsi Lin

Copy editor

Steven Day

ISSN: 1949-260X
http://www.tclt.us/journal

科技与中文教学

Journal of Technology and Chinese Language Teaching

A peer-reviewed online publication with in-print supplement
ISSN: 1949-260X http://www.tclt.us/journal

Volume 12 Number 1, June 2021

Articles

Approaching Chinese Radical Awareness through 3D Printing
(用 3D 打印培养汉字偏旁意识) 1
Yu, Qiaona (俞巧娜), *Wake Forest University (维克森林大学)*

多媒体教材对初级汉字学习者自主学习之影响
(The Effects of Multimedia Assisted Materials for Self-Learning Chinese Characters)...23
Cheng, Hsiujen (鄭琇仁), *National Kaohsiung Normal University (高雄師範大學)*
Hung, Hsin-han (洪新涵), *National Sun Yat-sen University (中山大學)*
Yeh, Tingchia (葉庭嘉), *National Kaohsiung Normal University (高雄師範大學)*

Using Online Applications to Enhance Phonetic Acquisition among Learners of Chinese
(网络应用对汉语学习者语音习得的有效性研究).....51
Xu, Hongying (徐红英), *University of Wisconsin-La Crosse (威斯康星大学拉克罗校区)*
Li, Yan (李艳), *University of Kansas (堪萨斯大学)*

Teacher Agency in Adapting to Online Teaching during COVID-19: A Case Study on Teachers of Chinese as an Additional Language in Macau
(教師發揮能動性以適應 2019 冠状病毒病期間的在綫教學：
基於澳門對外漢語教師的個案研究) 82
Gong, Yang (龔陽), *University of Macau (澳門大學)*
Fan, Chun Wai (范進偉), *University of Macau (澳門大學)*
Wang, Chuang (王闖), *University of Macau (澳門大學)*

职前汉语二语教师教育技术接受量表研制与开发
(Development and Validation of the Pre-Service L2 Chinese Teachers' Educational Technology Acceptance Scale).....102
孙培健 (Sun, Peijian), *浙江大学 (Zhejiang University)*
张军 (Zhang, Lawrence Jun), *奥克兰大学 (University of Auckland)*

Supporting Online Chinese Narrative Writing Pedagogy through Metacognitive Writing Process and Approach: A Design-Based Research
(应用元认知写作过程和方法支持在线华文记叙文写作课程的设计本位研究).....117
He, Fei (贺菲), *SingChin Academy (广州新侨学校)*
Lin, Chin-His (林金锡), *The University of Hong Kong (香港大学)*

Columns

Read-Along Videos for L2 Chinese Learners
(给汉语为二语学习者用的“跟着读”影片) 138
Diane Neubauer (杜雁子), *University of Iowa (爱荷华大学)*

科技与中文教学

Journal of Technology and Chinese Language Teaching

A peer-reviewed online publication with in-print supplement
ISSN: 1949-260X http://www.tclt.us/journal

Sponsor

Department of World Languages, Literatures, and Cultures, Middle Tennessee State University

Editorial board

Jianhua Bai, Kenyon College (2021)
Dongdong Chen, Seton Hall University (2022)
Chin-Chuan Cheng, National Taiwan Normal University (2021)
Jozef Colpaert, Universiteit Antwerpen (2021)
Jun Da, Middle Tennessee State University (2022)
Steven Paul Day, Benedictine University (2022)
Ik-sang Eom, Hanyang University (2021)
Jia-Fei Hong, National Taiwan Normal University (2021)
Shih-Chang Hsin, National Tsing Hua University (2021)
Song Jiang, University of Hawaii at Manoa (2022)
Hong Gang Jin, University of Macau (2022)
Nishi Kaori, the University of Kitakyushu (2021)
Richard Kern, University of California, Berkeley (2021)
Siu Lun Lee, the Chinese University of Hong Kong (2021)
Chin-Hsi Lin, the University of Hong Kong (2022)
Shijuan Liu, Indiana University of Pennsylvania (2022)
Scott McGinnis, Defense Language Institute-Washington Office, USA (2021)
Kazuko Sunaoka, Waseda University (2021)
Hongyin Tao, University of California, Los Angeles (2021)
Li Wei, Rollins College (2021)
Tianwei Xie, California State University, Long Beach (2021)
De Bao Xu, University of Macau (2022)
John Jing-hua Yin, University of Vermont (2021)
Hong Zhan, Embry-Riddle Aeronautical University (2021)
Weidong Zhan, Peking University (2021)
Phyllis Zhang, George Washington University (2022)
Zhengsheng Zhang, San Diego State University (2021)

Editorial staff

Editor-in-chief: De BaoXu, University of Macau
Executive editor: Jun Da, Middle Tennessee State University
Editors: Shijuan Liu, Indiana University of Pennsylvania
Song Jiang, University of Hawaii at Manoa

Chin-Hsi Lin, The University of Hong Kong
Copy editor: Steven Paul Day, Benedictine University

Contacts

URL: http://www.tclt.us/journal
Email: editor@tclt.us

Approaching Chinese Radical Awareness through 3D Printing (用 3D 打印培养汉字偏旁意识)

Yu, Qiaona
(俞巧娜)
Wake Forest University
(维克森林大学)
yuq@wfu.edu

Abstract: Radical awareness has proven beneficial for Chinese character learning. Although radical knowledge is typically introduced at the early stages of L2 Chinese learning, its application is often delayed. This exploratory case study explored an innovative technology-mediated task design to introduce 3D printing to character teaching. The 3D printed characters physically reshaped the learning unit from stroke to component and introduced haptic learning. Upon completion of the 3D character project, the learner exhibited improved recognition of form and meaning for radicals, characters, and the interactions thereof. The learner was better able to notice the size, meaning, form variation of radicals, and the in-depth configuration and compositional logic of components, as well as to restructure character network via radicals. Additionally, by viewing the task as an interactional blueprint to engage teacher-student collaboration, this study iteratively developed a 3D character task series comprised of 3D character composing, radical knowledge instruction, character network building, and handwriting practice.

摘要：培养汉字偏旁意识有助于学习汉字。汉语二语学习者往往在学习初期就接触到偏旁部首，却无法及时掌握并应用。本文通过探索性个案研究将 3D 打印引入汉字教学，发现 3D 汉字帮助学习者实现了汉字学习单位由笔画到偏旁部首的转变。学习者通过完成一系列 3D 汉字任务提高了应用偏旁部首知识的能力，加深了对偏旁的大小、意义、形状变化、汉字结构及构字法的认知，并能通过偏旁将汉字进行关联、重组。另外，本文通过开放性的任务设计由师生共同参与、摸索出了一套由 3D 汉字重组、偏旁教学、汉字网络建构、汉字手写构成的组合任务。

Keywords: Chinese character learning, radical awareness, 3D printing, task as an interactive blueprint

关键词: 汉字学习、偏旁部首意识、3D 打印、动态任务设计

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

1. Introduction

Chinese characters have been a major challenge for English-speaking Mandarin learners (Everson, 2011; Ke, Wen, & Kotenbeutel, 2001). With a nonalphabetic orthography, Chinese dictionaries sort characters by selective character components called radicals (部首, *bùshǒu*), meaning "section head". Radical awareness relates to understanding the role of radicals in the Chinese writing system (Li, Anderson, Nagy, & Zhang, 2002). Shen and Ke (2007) defined radical awareness as the functional understanding of the role of radicals in forming Chinese characters and the ability to use this knowledge consciously in learning characters.

Radical awareness is a crucial part of Chinese morphological knowledge, and it has proven beneficial for L2 Chinese character learning (Chen, Allport, & Marshall, 1996; Taft & Zhu, 1994; Taft, Zhu, & Peng, 1999). L2 Chinese teaching has undertaken varied approaches to facilitate radical awareness, including technology-assisted means of instruction. Three-dimensional (3D) printing provides new opportunities for character-learning task design via elevated visual and haptic sense of form and space that are infeasible in 2D representation. There have been attempts introducing 3D printing technology into a language classroom by reporting on the design of different spatial character models (Kanev, Oido, Yoshioka, & Mirenkov, 2012). The application of 3D printing in character learning, however, lacks a systematic pedagogical design. One challenge is that designing technology-mediated tasks requires navigating a more complex set of issues compared with designing face-to-face tasks (Lai & Li, 2011). Moreover, no study has monitored and evaluated the effects of 3D printing technology on character learning.

This case study explores an effective task design for incorporating 3D printing technology into L2 Chinese learning and investigates how it might affect radical awareness development. The exploratory process also provides an example for innovative technology-mediated task designs by navigating a teacher-student collaborative framework with applicable steps.

2. Review of literature

2.1 Instructions on Radical Awareness

Radical awareness, despite its early benefit for L2 Chinese character learning, plateaus from the end of first year through the end of second Chinese character learning (Shen & Ke, 2007). Attempting to address the plateau, a few recent studies explored radical awareness instruction in lower-level Chinese classrooms of English speakers, and reported positive results from facilitating learners' identification and establishment of an association between radical and character. Shen and Xu (2015) directed elementary-level learners to use orthographic knowledge to associate radicals with the sound, shape, and meaning of characters. Such association-making effort was reported to have promoted mental processing of characters and helped develop a character network. Xie (2019) designed

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

open-book radical assignments for elementary-level learners that provided character formulation information, showed English definitions and/or sounds of radicals/units, and required identification and writing of the appropriate radicals/units. Learners reported improved radical knowledge and application in character processing, but no change in overall character learning strategy. Xu and Padilla (2013) found incorporating meaningful interpretation and chunking (MIC) of character enhanced immediate learning and retention for high school students at elementary to intermediate level. They also found allowing students the agency of creating MIC themselves more effective than imposing teachers' interpretation and chunking.

In addition to identifying and establishing the radical-character association, this study argues that character learners need a pedagogical design where they can proactively apply radical-character association in reproducing characters. It is noted that productive character practice imposes challenging cognitive restructuring onto the learners as they go through four steps: *task identification*, *task representation*, *decision making*, and *decision execution* (Shen & Ke, 2007). In the case of a character composing task, learners must first *identify* that the task is for them to sort out the correct combinations of components and use them to compose characters. Learners' second step is resorting to long-term memory about radical meaning, form, and compositional relations, as well as character configuration and orientation. During this phase, learners must mentally *represent* the task and hypothesize different combinations that may emerge simultaneously. This is a highly complex cognitive process. Third, learners must *decide* which combinations are appropriate, after potentially resuming and evaluating many combinations in mental representations. Finally, learners *execute* the decision by writing or dragging together online the compound characters. The cognitive restructuring process in a character composing task reveals that the radical-character association is far more complex than a point-to-point connection. It exhibits an intricate network coordinating information of radical meaning, form, and compositional relations, as well as character configuration and orientation.

2.2 3D Printing Tasks for Chinese Character Learning

Affordance of 3D printing technology does not merely transfer a task into a 3D setting, rather, it shapes and adds possibilities to the task design and practice. To continue with the character composing task, it is not exactly executable to combine mixed components when handwriting characters stroke by stroke. A computer screen may allow learners to digitally drag character components together, but is still faced with technical challenges. One challenge is the unavailability of non-radical components in computer input system. Another challenge is that even for radicals that are accessible via typing, they are not necessarily stored in their original form being part of a compound character. For instance, the typable 女 takes its form as an independent character rather than its narrow or compressed form being a radical in characters like 妈, 娄. Similarly, the typable 贝 does not take its radical form in characters like 购, 贡, or 赢. Such challenges faced in a 2D mode can be addressed by 3D printing technology. Additionally, printing the characters and manually cutting the paper to separate character components can leave clues to the orientation. In contrast, 3D printed characters are individually complete yet remain dissectible into true-sized components.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

In addition to enabling full execution of the character composing task, 3D printing technology presents learners with additional haptic cues. Haptic information helps learners draw upon tacit embodied knowledge through bodily experiences (Reiner, 1999, 2008). Haptic technology provides users with somatosensory (touch) information by simulating an object's hardness, weight, or inertia, as well as its shape, smoothness, slippage, and temperature (Bivall, Ainsworth, & Tibell, 2011). Meaning-making is a dynamic process that involves visual, aural, and kinesthetic representations. Rather than simply add together information received from different sensory channels, multiple modalities coordinate to confirm, complement, and even challenge each other to provide comprehensive resources for further contemplation and analysis (Kress & van Leeuwen, 2001). The use of multimedia tools and animations have provided important support for character recognition, stroke orders and sequences learning, as well as associations building between phonetic, semantic, and orthographic components of Chinese characters (Chen et al., 2013; Chung, 2008; Jin, 2003; Zhan & Cheng, 2014). Moreover, multimedia instruction also demonstrated positive effects when applied in combination with writing and/or reading (Xu et al., 2013; Xu & Padilla, 2013). Character learning has attempted to integrate haptic information by typing with finger(s) following the pre-recorded letter/character trajectory on touchscreen (Eid et al., 2007). The application of finger touch and stroke-tracing, however, could be considered narrow haptic sensory because only the fingertips are engaged. 3D printing technology enables an integration of in-depth haptic sense via full hand touch of 3D objects. 3D printing technology not only enables full execution of a character composing task, but also adds more variations to the task design.

2.3 Task as an Interactional Blueprint

An effective task requires deliberate design and engaging implementation. Thorne (2005) defined tasks through two stages: task-as-workplan versus task-in-process. Before walking into the classroom, instructors have a task design in mind as the workplan. Once in process, learners superimpose their own various learning purposes on the given task-as-workplan and reinterpret it as they adjust their actual task-in-process between achievement and survival purposes (Breen, 1987). Because it is the actual conduct of the task that generates diverse learning outcomes, task quality and efficacy should be evaluated by how it actually unfolds. Rather than analyzing the structure of the task, research should focus on the task-in-process and examine the derived features from the interactional demands it placed on participants (Samuda & Rounds, 1993). To reconcile the dynamic interaction between task-as-workplan versus task-in-process, Jenks (2006) defined task as an interactional blueprint that establishes a framework for guiding task-takers to successful completion with flexibility of interpretation and negotiation. By this definition, the task-taker and task-designer have equally important perspectives. Researchers should be more cognizant of how learners perceive the goals, procedures, and significance of tasks (Duff, 1993).

This study fully recognizes the dynamic interaction between task-as-workplan and task-in-process. Viewing task as an interactional blueprint, this study took a teacher-student collaborative approach at designing a 3D character project. The instructor elicited learner's

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

input throughout the project to understand how the learner actually executed the task and revise the designs for future learning.

3. Research Questions

This study explores two primary research questions:

1. How does 3D printing technology affect early L2 radical awareness development?
2. What may be an effective task design applying 3D character learning in an elementary-level Chinese class?

4. Methods

4.1 Exploratory Case Study

When there are no earlier studies on a particular topic, exploratory research can set the foundation for future conclusive research (Bhattacherjee, 2012; Singh, 2007). An exploratory case study offers an in-depth analysis of the complex real-life changes and interrelations of different contextual factors (Gillham, 2000; Yin, 2014). This study employs an exploratory case study approach for three main reasons. First, given the scarcity of studies on applying 3D printing technology in Chinese character learning, there are many unknown dynamics that a controlled method may not be able to elicit. Second, a case study in a one-on-one teaching setting allows focused observation and elicitation of learner's behavior and perspective. Finally, the accessibility and affordability of 3D printing equipment, material, and training is still limited. An exploratory case study investigating the applicability and effectiveness of 3D character tasks can shed light on wider classroom adoption of 3D characters.

4.2 Participant and Research Context

Participant Chris (pseudonym) is a junior staff member (Age: 35) at a private research university in the U.S. Growing up as a third-culture kid, he has lived across the world and had studied Afrikaans, Spanish, and Italian (for 0.5-2 years each). Seeing an increased population of Chinese international students on campus, Chris aspired to better serve their wellbeing and received university support to study Mandarin. His goal was to be able to have simple conversations in Mandarin with Chinese students, and gain further understanding of their experiences, culture, and perspectives. After completing 22 hours of one-on-one study sessions with the instructor (who is also the researcher), Chris took a two-week work trip to Shanghai. During this trip, he received intensive exposure to Chinese characters on street and store signs, public transportation maps, as well as inside buildings. The intensive input motivated him to have a better grasp of Chinese characters. Therefore, the instructor designed a character project utilizing 3D printing technology for

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Chris. Prior to the 3D character project, Chris had been continuously taking individual sessions with the instructor for a total of 39 hours across three months.

The instructor and Chris completed a 3D printing workshop with safety training. The university offers a makerspace that provides students hands-on experiences beyond traditional classrooms, aiming to foster students' creativity, ingenuity, problem solving, and intellectual curiosity. The makerspace provides free access to Ultimaker (3 and S5) 3D printers, as well as printing materials including polylactic acid (PLA) and polyvinyl alcohol (PVA). Prior to the use of the 3D printers, the makerspace staff offer users safety training and workshops on Tinkercad design software and Ultimaker Cura slicing software. The staff are also available for technical support and troubleshooting consultation throughout the process of 3D printing.

4.3 Objectives and Procedures

One week prior to the 3D character project, the instructor interviewed Chris to establish the learning objectives and procedures. In the interview, Chris shared that his biggest challenge of character learning was the stark difference between two writing systems. He had been relying on rote memorization for character learning. However, he occasionally found it helpful to connect new characters with previously learned ones that share components. Once he identified shared parts, he could then decompose characters to focus on the unknown parts. By doing so, he leveraged his existing knowledge rather than re-learning the whole character. However, he self-critiqued for making up his own compositional reasoning and desired a systemic orthographic understanding.

The instructor and learner then established learning objectives. Upon completion of the 3D character project, Chris would be able to: i) gain knowledge on basic radicals; and ii) apply radical knowledge in character processing. To reach the objectives, five 1.5-hour weekly sessions were designed, each consisting of three steps. Step One was a 3D character composing task designed in accordance with learners' four cognitive restructuring phases. The characters (see Appendix A) were selected according to two principles: 1) the characters included varied structures: integral, left- (middle-) right, top- (middle-) bottom, or (Half-) enclosure; and 2) the characters are composed of targeted radicals studied in the textbook of use: *Integrated Chinese Vol. 1* (4th ed.) (Liu, 2016). Before the session started, the instructor mixed up and laid out the 3D components of eight characters. To begin with, Chris *identified* his task to sort out the correct combinations in order to compose eight characters. He then referred to radical and character knowledge as he tested out different *representations* of 3D component combinations. Based on evaluation of such externalized representations, Chris finalized the *decision* on his pick of combinations and *executed* his decision by reproducing eight characters, either correct or mistaken. Step Two was a radical knowledge instruction session. The instructor asked scaffolding questions to heuristically guide Chris to identify the sound, shape, and meaning of radicals as well as their role in compound characters. Step Three aimed to create a character network via shared radicals. Chris was asked to brainstorm other characters sharing the same radicals and compare their meanings, and then explore online dictionaries for characters listed under the designated radical. As the task design evolved with learner's

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

continuous feedback, Step Three later eliminated the brainstorming, but proceeded with online dictionary exploration and additional review of previously learned characters sharing the same radicals.

4.4 Data Collection and Analysis

A mixture of qualitative and quantitative data was collected to measure progressive radical awareness development. At the end of each study session the instructor interviewed Chris for 15 minutes to elicit his self-perceived performance, strategy, and feedback. The interview results were used to track his performance and co-construct the task design for future sessions. In addition, Chris received pre-test (See Appendix B) and post-test (See Appendix C) to assess his radical awareness change. Table 1 summarizes the timeline of data collection.

Table 1 Timeline of Data Collection

Prior Week	Week 1	Week 2	Week 3	Week 4	Week 5
Pre-test	Study Session 1	Study Session 2	Study Session 3	Study Session 4	Study Session 5; *Post-test*
Interview A	Interview 1	Interview 2	Interview 3	Interview 4	Interview 5

4.4.1 Semi-Structured Interviews

In addition to Interview A (see Table 1) that established the learning objectives, weekly semi-structured interviews were conducted to elicit the learner's perceived task-in-process and facilitate teacher-student collaboration on task design. Each interview started with Chris self-assessing and reflecting on his in-session learning experience and comparing his character learning process in 3D versus 2D. Chris was then probed on his thinking process during specific in-session performance. Next, Chris was asked to provide suggestions on the instructional design of upcoming study sessions and potential applications of 3D character learning in a classroom setting. Finally, each interview concluded with an open-ended question for Chris to share additional feedback. All interviews were audio-recorded. The recordings were transcribed by Amazon Transcribe and then proofed by the researcher.

4.4.2 Radical Awareness Test

In addition to the weekly interviews, pre- and post-tests were conducted to examine Chris's radical awareness development. The format of pre- and post-tests was adapted from He and Ke's (2007) but replaced the vocabulary test with a character writing test. Both tests consisted of four sections. The first section *radical perception test* asked to identify the character structure with provided options (i.e., left- (middle-) right, top- (middle-) bottom, (half-) enclosure, integral) and then decompose the character components. The second section *radical knowledge test* asked to provide the English meaning of the given radicals. The third section *radical knowledge application test* consisted of two parts. Part A provided groups of three novel characters sharing an identical component but different

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

radicals. It asked to judge the meaning of radicals and select the character that best fits the English translation provided. Part B provided partial characters and asked to write out the missing radicals based on the English meaning of characters. This part was considered challenging because it required both writing the correct radical and adding it in correct position (e.g., left, right, top, bottom, enclosure) based on knowledge of character configuration, orientation, and composition. To avoid giving out configurational information, every given part of characters took a full character block (e.g., 半, 龙) rather than a partial character block (e.g., 半, 龙). The last section *character writing test* required writing characters with pinyin and English meaning provided. To assure consistent item distribution and difficulty, the pre- and post-tests were evenly split from a master test, except that both second sections shared identical items. When completing the third and fourth section, the learner was not allowed to refer to the first and second sections.

5. Results

The results showed that application of 3D printing technology facilitated the early radical awareness development of the L2 Chinese learner. The collaborative and iterative effort between teacher and student led to a successfully designed 3D character learning task series. The subsequent sections provide an in-depth look at the results.

5.1 Radical Awareness Development

The end-of-session interviews revealed progressive development of the learner's radical awareness along the five weeks. Throughout the project, Chris repeatedly expressed his excitement and affirmed his belief in its faciliatory effect on character learning. Upon completion of the 3D character project, Chris commended (in Interview 5) the project was "a huge success" and believed that he mostly achieved the goal by "having a better understanding of what radicals are, how they impact meanings of characters, and how they combine to make characters". Chris's performance and feedback fell into several different categories: character processing units, character configuration, compositional relations of character components, and character network building via radicals.

5.1.1 Radical as a Processing Unit

By holding 3D radicals in hand, a learner may conveniently perceive them as units of form-meaning connections. For instance, holding a 3D radical 女 (female) as a whole, Chris claimed (in Interview 1 and 4) it helped him perceive it as an individual meaningful unit rather than three inextricable strokes, which naturally directed his attention to the assembling logic of these 3D pieces.

Such processing unit shift from stroke to radical was confirmed in another example. When trying to put together 大 (big) and 耳 (ear) for character 耷 (big ear), Chris rotated the 3D piece of 耳 clockwise to figure out its orientation. As he reflected (in Interview 3), it was due to his unfamiliarity with component 耳 and its spatial relationship with 大. By contrast, he would not need to rotate 大, he claimed, because 大 is so common that he

quickly identified and established its form-meaning connection. With the strokes not dissectible in 3D pieces, Chris was forced to process at radical level. It is also worth noting that component rotating is not possible in a handwriting mode but is enabled by the 3D presentation. This extra possibility helped Chris notice an additional dimension of character component layout: orientation.

With radicals established as individual meaningful units, Chris's attention was further directed to its variations. Chris noticed one radical may take variations in shape and position. Continuing the example of radical 女, Chris commented (in Interview 4) that 女 may be tall and thin, taking the left side of a character such as 𡿨 in 姐 or 娜; Alternatively, 女 may be short and wide, taking the bottom position such as 𡿧 in 要 or 姜 (See Figure 1). Processing at radical level amplified the shape variation of the same radical, which was more noticeable by the learner. In addition, being able to hold tangible 3D radicals enabled the additional haptic sensory for noticing the difference.

Figure 1 Pictures of 3D Printed Characters: 女、姐、娜、要

5.1.2 Character Configuration

The 3D pieces allowed the learner to gauge the size of character components using both visual and haptic senses. Since Chinese characters all fit into a standard square, a learner must identify, measure, and copy the character size and structure, which is challenging in handwriting. Therefore, character handwriting practice sheets typically print blocks for learners to write within the lines. According to Chris (in Interview 3), the additional height of a 3D character delineates an invisible outline square that is tactile compared with a 2D block. Learners may judge whether two pieces belong together by measuring how well they spatially (i.e., horizontally, vertically, enclosed) fit together to form a standard square. For instance, a component of a left-right configured character (e.g., 扌) would not spatially match a component of a top-bottom configured character (e.g., 癶). Chris's sense of a standard square was even fine-tuned to differentiate characters of the same configuration. For instance, after trying out different combinations of 𧾷, 亡, 忄, and 包, he finally decided and executed the correct combinations of 忙 and 跑. One of the reasons Chris (in Interview 4) rejected the combinations of 𧾷亡 and 忄包, was that 𧾷亡 looked wider than a normal character.

In addition to the square size of a whole character, the learner's attention was further directed to nuanced balance between compositional parts. In his aforementioned rejection of the 跀 and 怉 combinations, he (in Interview 4) also observed that the stroke 一 of 亡 is high up next to the 口 of 跀, whereas the end of stroke 丿 in 包 fits into the open space below the 口 of 跀. He therefore concluded that 跀 and 包 fit better, taking into account both the character square size and the within-character balance. Moreover, Chris also raised awareness of the balance between space and stroke numbers. He concluded (in Interview 4), though to be orthographically validated, that the left-side components usually have a small number of strokes if taking a small portion of the character space. Being able to test out different 3D radical combinations pivoted learner's discovery of the inner-character interactions in terms of component size, stroke shape, and stroke number.

5.1.3 Compositional Relations

The 3D character project facilitated Chris's coordination of both radical form and meaning cues, through the process of deducing the component compositional relations. Chris demonstrated coordination of form and meaning in positioning the individual components within a character. At earlier stages (in Study Session 2), Chris made mistakes by reversing the components, but despite that he was able to quickly identify the character configuration. For instance, Chris quickly identified 阝 and 刂 in a left-right configuration based on their shape, but horizontally reversed the two pieces and created a noncharacter (刂阝). As he learned more semantic radicals, he was more able to tap into radical form and meaning when figuring out their configurational position. For instance, Chris surmised (in Interview 2 and 3) that 宀 (roof) often goes on top based on its meaning, thin-shaped radicals such as 阝 in 哪, 日 in 明 go on the left in accordance with their form, and 灬 (fire) always takes the bottom place based on its form and meaning. The mistakes Chris made also reflected the mental rulesets that he had created. After identifying 夕 and 冖 in a top-and-bottom configuration, Chris created a noncharacter (冖夕) by vertically reversing the two components. The reason, as Chris reflected, was that he had mistaken 冖 for the roof radical 宀 on top. Chris asserted that he would have not made such mistakes, had he handwritten on a stroke basis instead of processing at a component level.

In addition to positioning individual radicals, Chris worked to rationalize the layout of components through meaningful interpretation of their compositional relation. After placing 木 and 子 in a top-and-bottom configuration, Chris created a noncharacter (子木) by vertically reversing the two components. His reflection (in Interview 3) revealed that he navigated the composition through both form and meaning cues. He thought having 木 at the bottom built a balanced foundation whereas having 子 at the bottom seemed stilting. Furthermore, trees are rooted in the ground. After the instructor explained that fruits hanging down the tree makes a character 李 (plum), he was excited by the meaningful composition of 木 and 子. This composition relation was uptaken as Chris was able to write the character 李 in its correct form in the post-test. Chris continuously looked for meaningful compositional relation to help memorize the characters, but was aware that many characters lack transparent and applicable orthographic reasoning due the changes over time. Following Xu and Padilla's (2013) suggestion to let students create their own interpretation rather than imposing teachers' interpretation and chunking, this 3D project

encouraged Chris to create his own rationalizations even if not orthographically valid. For instance, Chris (in Interview 3) decomposed 都 (all) into 土 (earth), the 日 (sun), and 阝 (ear, mountain). He then interpreted 都 as everything between heaven and earth, and used this interpretation to rationalize the combination of these three components and solidify his memory of the character. Learning and applying radical knowledge in character compositional relation engaged Chris in higher-level cognitive effort, which enhanced the learner's character memorization. Chris (in Interview 5) believed such memories "would stick harder and come alive easier when needed", compared with the character memory gained through mechanically copying characters.

5.1.4 Character Network via Radicals

By exploring and reviewing characters sharing the same radicals, Chris was presented opportunities to proactively build a character network for efficient character learning. Chris expressed (in Interview 3) his appreciation for being able to explore online dictionary pages where unknown characters are listed by radical. Typically, students learn new characters along the introduction of new vocabulary. By participating in the 3D character project, Chris started restructuring his character repertoire by building a character network via radicals. Rather than incidentally accumulating characters alongside the introduction of new vocabulary, Chris systemically made connections among unrelated and even unknown characters. For instance, when exploring characters sharing radical 阝, Chris was surprised to realize that there are left-sided 阝 (mountain slope) shared by topographic features (e.g., 陵, 陡, 险), and right-sided 阝 (city, county) shared by many place names (e.g., 郦, 邛, 邗). He expressed appreciation (in Interview 3) for systemically making such connections and categorizations, helping in his effort to organize learned characters. Chris (in Interview 5) had primed himself to "always be on the lookout for specific radicals to grab on to when learning new characters", which indicated a development of radical awareness and readiness for its application. Chris reflected that such radical awareness prepared him with a great foundation and confidence for learning new characters in the classroom and beyond.

5.1.5 Overall Radical Awareness Development

Results of the pre-and post-tests confirmed the findings from weekly interviews on Chris's radical awareness progress, as shown in Table 2. In the first section, *Radical Perception*, Chris demonstrated a good sense of character configurations by achieving almost perfect scores. He lost points in both pre- and post-tests due to over-decomposing compound characters. For instance, rather than decomposing 图 (enclosure structure) into two meaningful components of 囗 and 冬, Chris over-decomposed 图 (enclosure structure) into 囗, 夂, and 丶. Another example of over-decomposing was dissecting the phonetic component of 馆 (left-right structure) into 宀 and 目. All over-decomposing occurred with non-radicals, for which Chris had not yet established the form-meaning connections and perceived only visibly separate form. Since the 3D character project focused on radical components, improvement in non-radical components would not be expected.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

In the second section, *Radical Knowledge*, Chris was able to identify and write down the specific meaning of 22/30 radicals in pre-test and 24/30 radicals in post-test. However, the reasons Chris lost points each time were different. In the pre-test Chris lost points mostly due to giving no answers or wrong answers, but in the post-test Chris lost points mostly due to giving only generic meaning of same semantic category radicals such as 走 (walk, run), 足 (foot), and 辶 (tread). It seemed that the 3D character project helped him identify the semantic categories of radicals.

The third section, *Radical Knowledge Application*, was considered the most challenging. However, Chris's scores improved by 8 points in this section from the pre-test to the post-test. This is the biggest improvement out of the four sections, with the most improvement found in the Part B of this section. Chris showed increased capability of identifying the missing semantic radicals and writing them out at the correct position (i.e., top, bottom, left, right, enclosed, inside).

In the final section, *Character Writing*, Chris was able to correctly write 22/30 characters in the pre-test and only improved by one in the post-test. One potential cause was that the 3D project focused on reproducing characters with provided components and did not require writing the characters. Even though there was not much improvement in Chris's score, he again lost points for different reasons in the pre- and post-tests. In the pre-test, Chris mainly lost points due to leaving blanks. In the post-test, Chris lost points due to confusing radicals (忙 written as 忄亡) or writing only the radical (病 with only 疒), which still showed his progressed character knowledge.

Table 2 Pre- and Post-tests Scores

	Radical Perception (20)	Radical Knowledge (30)	Radical Knowledge Application (30)	Character Writing (30)
Pre-test	18	22	19	22
Post-test	19	24	27	23

5.2 An Evolving Instructional Design

In addition to reflecting on his performance and strategy, Chris was also invited to share input on the instructional design in the weekly interviews. The instructor then interpreted the student's feedback in the framework of radical awareness operationalization, and further incorporated it within the established project objectives and procedures. By viewing the task as a teacher-student joint effort it became an interactional blueprint that shaped an evolving instructional design.

5.2.1 Task Series on Demand

Each study session began with a 3D character composing task which Chris found (in Interview 5) "a really different way of studying Chinese" and significantly sparked his curiosity, compared with relying on rote memorization. After Chris was spotted (in Study

Session 3) rotating radical clockwise for its correct orientation, the instructor deliberately displayed the radicals in random orientations. The purpose was to present an opportunity for the learner to raise awareness of radical orientation.

Once Chris sorted out eight characters with an identification of radical-character associations, the instructor (in Study Session 1) asked Chris to brainstorm other characters that share the same radicals to compare and contrast. Chris found this very challenging, which indicated that learner needed scaffolding to navigate a complex process of building character networks via radicals. The instructor therefore moved to the next task where Chris browsed an online dictionary for lists of characters that share the designated radicals. The instructor also eliminated the brainstorming task in the following sessions but focused on online exploration with scaffolding. In addition to scaffolding, the online dictionary exploration provided a positive affective filter for learner. When going through the dictionary sites, there occurred rare characters that even the instructor did not recognize. Chris commented (in Interview 3) that made him realize "even native speakers do not necessarily know all the characters". This realization allowed him to feel less anxious and more encouraged to be exposed to and learn unknown characters. The online exploration also served as a springboard for sustained conversations on radicals and radical-character associations that typically hold no place in a structured classroom. For instance, when going over the characters sharing 女 (female) radical, the instructor shared how such characters, derogatory or commendatory, revealed Chinese traditional value and perception of women. Chris was exhilarated by such conversations and commented (in Interview 5), "I just feel like I have been on a track learning structured grammar and vocabulary following the textbook, whereas this project is so open and I got to ask these random questions and learn these pieces that I wouldn't have been able to... I wouldn't have thought to ask those questions just from reading the textbook."

While Chris enjoyed the online dictionary exploration, its task design could become unfocused. For frequently used radicals there can be too many characters listed to fully review. The instructor's response was more selectively exploring characters under each radical. The instructor then counterbalanced the scope of character network in online exploration by tasking Chris to scan the textbook vocabulary list for learned characters sharing the designated radicals. Such quick reviews presented Chris opportunities to revisit and uncover connections among previously learned characters. As Chris commented (in Interview 3), it allowed him to renew his interpretation of characters, further understand the meaning of semantic radicals and their role in the characters, and thus solidify his character memorization. The scheduled overlap and repetition of radicals across study sessions also made Chris feel impressed by how much he remembered and motivated him to continue the effort.

Despite his progress shown in the character writing section of the post-test (partially providing the characters rather than leaving blanks as he did in the pre-test), Chris expressed the desire for more progress. It could be that more study sessions are required beyond five weeks to see more significant progress. Chris also expressed the desire for supplemented handwriting practice in addition to 3D character tasks. He commented (in Interview 5), "I think that I needed to be more intentional in translating back from 3D to

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

2D. Like if the test had been putting the pieces together, I think I've done a better job than having to write it myself." This may have identified two missing links. One link was missed between component and stroke. In the 3D character project, the learner comprehended, memorized, and reproduced characters using the processing unit of component. In writing practice, learners would be required to additionally process at the stroke level. The other link was missed between the different reproducing levels of character composing and writing. While composing 3D components requires a learner to reproduce characters with building blocks provided, character writing requires further productive skills in order to introduce, stretch, and conclude individual strokes and form them in equidistant, connecting, and intersecting interconnections. The increased radical application skills gained from 3D character composing and networking tasks may be further utilized to increase the efficiency of writing practices, if such tasks are used in combination in varied format.

5.2.2 Presentation of 3D Characters

Throughout the study, the instructor and learner experimented for a best 3D character presentation in terms of dissection, size, weight, smoothness, and color. For most compound characters, their components are decomposition-ready once 3D printed out. For instance, once character 叫 is printed, its semantic component 口 and phonetic component 丩 are automatically separated since no strokes were adjacent or overlapped. Character 哪 automatically prints out three decomposed pieces, 口, 刀, and 阝. 3D printed integral characters remain as individual pieces. However, some compound characters, like 奋, consist of two or more adjacent radicals. The adjacent parts could be manually separated using a knife, but cutting leaves traces that gives out hint in character composing task. Digital pre-cut on Tinkercad would ensure better quality. Some other characters like 高, 馆, 照 are printed out with more than desired number of pieces. One may adjust the thickness of layer or use transparent material to connect the separated pieces as needed.

Throughout the 3D character project, Chris had continuously expressed his excitement about being able to touch, hold, and feel the written abstract symbols as 3D pieces, as it gave him a tactile, substantial, and satisfying feeling. The tactile pieces transformed a character composing task into a fun game putting together puzzle pieces. After testing out different printing dimensions, a character of 5 x 5 x 1 cm was found to balance size and weight with printing efficiency. Above a certain size separated strokes may become adjacent. For instance, two separate level strokes in 找 may merge to one line as in 找. It is better to 3D print complete characters and dissect them rather than printing out individual radicals, as the former retains accurate spatial configuration information of characters and components.

After testing all the colors provided (gold, black, and red) in the makerspace, red was picked to capture the learner's attention and because it is considered an auspicious color in Chinese culture. When 3D printing batches of characters, sticking to the same material, color, and size setting allows consistency of characters across study sessions. It allows task designs to select and mix characters previous used. When adopting the 3D character project in a classroom with more students, Chris suggested (in Interview 2) to

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

further gamify the character composing task by presenting the 3D pieces in a bag. Chris also proposed an idea of 3D magnets to allow composition on other surfaces.

6. Discussion

This study explored an innovative utilization of 3D printing and demonstrated it as an effective means for Chinese character instruction. The results of the pre- and post-tests and end-of-session interviews aligned to suggest a prominent increase of learner's radical knowledge application upon completion of the 3D character project. Furthermore, by employing teacher-learner collaborative efforts in an iterative task design, this study demonstrated a methodology for innovative technology adoption.

6.1 3D Printing for Radical Awareness Development

The introduction of 3D printing triggered a series of changes in character presentation and processing, which facilitated character learning. The 3D presentation of characters shifted the processing unit of characters from handwritten strokes to tactile components. Chinese compound characters, once 3D printed, are naturally dissected into component pieces due to the visible diminutive space in between. However, such 3D pieces are not further decomposable since they are printed as whole. The 3D components form a tangible pathway between meaningless strokes and networks of characters. They transformed character learning from weaving strokes in handwriting, to placing individual components in the right orientation, relative position, and correct combination with others to form characters.

When processing at component level, additional haptic cues provided learners spatial information that facilitated their discovery of more in-depth configuration information at levels of individual component, component-component interaction, radical-character association, and character-character interaction. For individual components, the learner was more able to notice individual radical size, orientation, form variation, and typical position taken within a character. For component-component interaction, the learner was able to infer and retain in-depth information of their spatial relation. The tactile pieces provided the learner a hands-on Lego-like experience instead of mentally representing combinations of components. It presented the learner opportunities to not only recognize the configuration category (e.g., left- (middle-) right, top- (middle-) bottom, (half-) enclosed), but also make connections within the same configuration category. The learner was able to notice that even within the same configuration category, there is great variation in relative space shared by two components and interaction of stroke shape and number between two components in a compound character. For radical-character association, the learner's awareness of compositional logic was fostered. The role of radicals in a character was included in the interpretation of character compositions. When no transparent orthography was detected, the learner created his own meaningful interpretation to rationalize the compositional relations. For character-character interaction, 3D character radicals were used to engage the learner in character exploration and

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

restructure character repertoire based on shared radicals. The character network via shared radicals offered an organized way for effective information processing.

6.2 Collaborative and Iterative Task Design

The adoption of 3D printing technology reshaped the character learning and opened up exciting possibilities for innovative task designs by incorporating haptic cues. Based on the results of this exploratory case study, a task series consisting of four parts is recommended: i) a *3D character composing task* where a learner recomposes the mixed 3D components into characters; ii) a *radical knowledge and component relation session* where a learner is guided to discover the sound, shape, and meaning of common semantic radicals as well as their role in compound characters; iii) a *character network building* session that restructures character repertoire by exploring unknown characters and reviewing learned ones that share the same radicals; and iv) *character handwriting practice* which facilitates a learner to apply radical awareness in producing complete or partial characters. Additionally, considering the positive effect of applying a combination of character learning practice (Xu & Padilla, 2013; Xu et al., 2013; Chen et al., 2013), an instructional design may be tailored to students' needs and by adding reading practice, writing practice, and multimedia instruction utilizing text, image, animation of stroke-sequenced-animation, and pronunciations.

This task design was the result of a student-teacher collaborative effort, which may be applicable to other task designs incorporating innovative technology. As an exploratory endeavor to apply 3D printing technology in Chinese character teaching, this study encountered many unknowns in the task design and its instructional effects. This study started with reviewing the definition and operationalization of radical awareness as well as previous instructional endeavors to facilitate its development. Based on the literature, the researcher/instructor designed a 3D character project to focus on bridging the gap between radical knowledge and its application. The learner superimposing and reinterpreting tasks was fully acknowledged as the dynamic interaction between task-as-workplan and task-in-process to engage both instructor and learner in an iterative process of task co-construction. By allowing the learner to reflect on his performance and strategy at the end of each study session, the instructor was able to elicit how the 3D printing affected Chinese character learning. The learner was also invited to share suggestions to instructional design. The instructor was thus able to take learner's suggestions and interpret them in the framework of radical awareness operationalization. The updated task design was then promptly tested in class and iterated via further reflection. By engaging the learner in the iterative design of task-in-progress, the learner showed more agency in learning. Chris maintained his curiosity and excitement throughout the 3D character project and was always looking forward to the next session. Finally, after iterative revision, a 3D character task series was suggested for future character learning and teaching.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

7. Conclusions

This case study explored the task design and instructional effects of adopting 3D technology in Chinese character learning and teaching. The character tasks mediated with 3D printing technology positively affected learner's radical knowledge and application skills through radical-character association. The introduction of 3D printing reshaped the learning unit of character from stroke to component, which enabled task design to direct learners to further notice the size, meaning, variation, in-depth configuration, and compositional logic of components, and to restructure character network via radicals. This study demonstrated a method of incorporating innovative technology via the collaborative and iterative efforts of both instructor and student.

Results of this study should be interpreted within its limitation of a case study. As an exploratory case study, this project took the first step to provide a foundation for future research. By recruiting more participants, future instructional design will be able to recognize and address the needs of a more diversified student body with varied language aptitude, experience, learning styles, and cognitive skills. By expanding the scope of 3D character tasks, functional non-radical components can also be included in pedagogical design. A controlled design would provide a closer look at the specific effects of 3D character learning and its applicability in different contexts. With more study to incorporate the character learning component at the course and curriculum level, a longitudinal study beginning the end of first year through the end of second year would provide a look into the effects of 3D character learning across the radical knowledge application developmental plateau.

References

Bhattacherjee, A. (2012). *Social science research: Principles, methods, and practices*. University of South Florida Open Access Textbooks Collection.

Bivall, P., Ainsworth, S., & Tibell, L. A. (2011). Do haptic representations help complex molecular learning? *Science Education*, *95*(4), 700–719.

Breen, M. (1987). Learner contributions to task design. *Language learning tasks*, *7*, 23–46.

Chen, H. C., Hsu, C. C., Chang, L. Y., Lin, Y. C., Chang, K. E., & Sung, Y. T. (2013). Using a radical-derived character e-learning platform to increase learner knowledge of Chinese characters. *Language Learning & Technology*, *17*(1), 89–106.

Chen, Y. P., Allport, D. A., & Marshall, J. C. (1996). What are the functional orthographic units in Chinese word recognition: The stroke or the stroke pattern? *The Quarterly Journal of Experimental Psychology 49A*: 1024–1043.

Chung, K. K. (2008). What effect do mixed sensory mode instructional formats have on both novice and experienced learners of Chinese characters? *Learning and Instruction*, *18*(1), 96–108.

Duff, P. A. (1993). Tasks and interlanguage performance: an SLA research perspective. In G. Crookes & S. Gass (Eds.), *Tasks and language learning: integrating theory and practice* (pp. 57–95). Multilingual Matters.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Eid, M. A., Mansour, M., El Saddik, A. H., & Iglesias, R. (2007, September). A haptic multimedia handwriting learning system. In G. Friedland, W. Hürst, & L. Knipping (Eds.), *Proceedings of the ACM workshop on educational multimedia and multimedia education* (pp. 103–108). Association for Computing Machinery.

Everson, M. E. (2011). Best practices in teaching logographic and non-Roman writing systems to L2 learners. *Annual Review of Applied Linguistics*, *31*, 249–274.

Gillham, B. (2000). *Case study research methods*. London and New York: Continuum.

Jenks, C. J. (2006). *Task-based interaction: the interactional and sequential organization of task-as-workplan and task-in-process* [Unpublished manuscript]. School of Education, Communication and Language Sciences, Newcastle University.

Jin, H. (2003). Empirical evidence on character recognition in multimedia Chinese tasks. *Concentric: Studies in English Literature and Linguistics*, *29*(2), 36–58.

Kanev, K., Oido, I., Yoshioka, R., & Mirenkov, N. (2012, March). Employment of 3D printing for enhanced kanji learning. In V. Klyuev & A. Vazhenin (Eds.), *Proceedings of the 2012 Joint International Conference on Human-Centered Computer Environments* (pp. 165–170). Association for Computing Machinery.

Ke, C., Wen, X., & Kotenbeutel, C. (2001). Report on the 2000 CLTA articulation project. *Journal of the Chinese Language Teachers Association*, *36*(3), 25–60.

Kress, G. R., & van Leeuwen, T. (2001). *Multimodal discourse: The modes and media of contemporary communication*. Edward Arnold.

Lai, C., & Li, G. (2011). Technology and task-based language teaching: A critical review. *CALICO Journal*, *28*(2), 498-521.

Li, W., Anderson, R. C., Nagy, W., & Zhang, H. (2002). Facets of metalinguistic awareness that contribute to Chinese literacy. In W. Li, J. Gaffney, & J. Packard (Eds.), *Chinese children's reading acquisition* (pp. 87–106). Springer.

Liu, Y., Yao, T., Bi, N., Ge, L. & Shi, Y. (2016). *Integrated Chinese (volume 1)* (4th ed.). Boston: Cheng & Tsui Company, Inc.

Singh, K. (2007). *Quantitative social research methods*. Sage.

Shen, H. H., & Ke, C. (2007). Radical awareness and word acquisition among nonnative learners of Chinese. *The Modern Language Journal*, *91*(1), 97–111.

Reiner, M. (1999). Conceptual construction of fields through tactile interface. *Interactive Learning Environments*, *7*(1), 31–55.

Reiner, M. (2008). Seeing through touch: the role of haptic information in visualization. In J. K. Gilbert, M. Reiner, & M. Nakhleh (Eds.), *Visualization: Theory and practice in science education* (pp. 73–84). Springer Netherlands.

Samuda, V., & Rounds, P. (1993). Critical episodes: Reference points for analyzing a task in action. In G. Crookes & S. Gass (Eds.), *Tasks from a pedagogical perspective: Integrating theory and practice* (pp. 125–138). Multilingual matters.

Shen, H., & Xu, W. (2015). Active learning: Qualitative inquiries into vocabulary instruction in Chinese L2 classroom. *Foreign Language Annals*, *48*(1), 82–99.

Taft, M., & Zhu, X. (1994). The presentation of bound morphemes in the lexicon: a Chinese study. In L. Feldman (Ed.), *Morphological aspects of language processing* (pp. 293-316). Erlbaum.

Taft, M., Zhu, X., & Peng, D. (1999). Positional specificity of radicals in Chinese character recognition. *Journal of Memory and Language*, *40*(4), 498–519.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Thorne, S. L. (2005). Epistemology, politics, and ethics in sociocultural theory. *The Modern Language Journal*, *89*(3), 393–409.

Xie, Y. (2019). Instructional interventions and character learning strategies: A study on orthographic study assignments. In K. Y. Sung (Ed), *Teaching and learning Chinese as a second or foreign language: Emerging trends*. Lexington Books.

Xu, X., & Padilla, A. M. (2013). Using meaningful interpretation and chunking to enhance memory: The case of Chinese character learning. *Foreign Language Annals*, *46*(3), 402–422.

Xu, Y., Chang, L. Y., Zhang, J., & Perfetti, C. A. (2013). Reading, writing, and animation in character learning in Chinese as a foreign language. *Foreign Language Annals*, *46*(3), 423–444.

Yin, R. K. (2014). *Case study research design and methods* (5th ed.). Sage.

Zhan, H., & Cheng, H. J. (2014). The role of technology in teaching and learning Chinese characters. *International Journal of Technology in Teaching and Learning*, *10*(2), 147–162.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Appendix A Characters and Targeted Radicals of Each Study Session

Session	Characters	Targeted radicals
1	请、贵、呢、朱、茶、红、菜、图	讠、贝、口、纟、艹、囗
2	叫、名、国、找、友、话、高、姐	口、夕、囗、讠、扌、女
3	哪、耷、他、明、点、李、馆、课	阝、耳、亻、日、灬、子、饣、讠
4	病、打、晚、她、忙、看、男、跑	疒、扌、日、女、忄、目、田、跹
5	歌、问、去、想、字、聊、洗、起	欠、门、心、宀、耳、氵、走

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Appendix B Pre-test

Part 1/4. Choose the structure of the characters (from ABCD) and write out their radicals/components. (20 points)

A. Left- (middle-) right **B.** Top- (middle-) bottom **C.** (Half-) enclosure **D.** Integral

姐( ) _____	男( ) _____	做( ) _____
过( ) _____	聊( ) _____	哪( ) _____
字( ) _____	国( ) _____	两( ) _____
不( ) _____	学( ) _____	照( ) _____
图( ) _____	律( ) _____	意( ) _____
可( ) _____	王( ) _____	问( ) _____
医( ) _____	女( ) _____	

Part 2/4. Write down the meaning of the given radical. (30 points)

人(亻) _____	刀(刂) _____	力_____	女_____
口_____	囗_____	大_____	小_____
子_____	心_____	手(扌) _____	日_____
月_____	木_____	水(氵) _____	火(灬) _____
疒_____	辶_____	田_____	目_____
糸(纟) _____	耳_____	言(讠) _____	贝_____
走_____	足(⻊)_____	金(钅) _____	门_____
雨_____	食(饣) _____		

Part 3/4. a. Circle the character best fits the meaning provided in English based on their radicals. (10 points)

1. Attendant: 恃 峙 侍
2. Silver: 银 恨 痕
3. To water: 烧 饶 浇
4. To peak: 嫖 瞟 膘
5. To stroll: 逛 诳 侄
6. To step: 跨 垮 刳
7. To drive: 驾 架 痂
8. Raw silk: 绡 捎 削
9. Imperial concubine: 妃 纪 忌
10. To bribe: 贿 囿 痏

b. Provide the missing radical of each character based on the English meaning given. (20 points)

1. Hot: 执 2. Poem: 寺 3. To cure: 了 4. Companion: 半 5. Orchid: 惠
6. To enclose: 韦 7. To shout: 咸 8. Child: 亥 9. To ponder: 田 10. To lift: 是
11. Shining: 翟 12. Lake: 胡 13. Tree: 对 14. To sleep: 垂 15. To go to: 卜
16. Stagger: 册 17. Dumpling: 交 18. Fortune: 才 19. Deaf: 龙 20. To embroider: 秀

Part 4/4. Write the character with the pinyin and English provided. (30 points)

qǐng (please) ____	guì (expensive) ____	ne (end-of-the-sentence particle) _____
chá(tea) _____	hóng (red) _____	cài (dish) _____
tú (picture, as in túshū guǎn) _____	jiào (call) _____	míng (name) _____
zhǎo (look for) _____	huà (words) _____	gāo (tall) _____
jiě (elder sister) _____	nǎ (where) _____	tā (he) _____

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Appendix C Post-test

Part 1/4. Choose the structure of the characters (from ABCD) and write out their radicals/components. (20 points)

A. Left-(middle-) right **B.** Top-(middle-) bottom **C.** (Half-) enclosure **D.** Integral

呀( ) _____ 大( ) _____ 书( ) _____
绍( ) _____ 谢( ) _____ 家( ) _____
才( ) _____ 常( ) _____ 因( ) _____
高( ) _____ 同( ) _____ 起( ) _____
开( ) _____ 这( ) _____ 星( ) _____
下( ) _____ 馆( ) _____ 觉( ) _____
上( ) _____ 咖( ) _____

Part 2/4. Write down the meaning of the given radical. (30 points)

人(亻) _____ 刀(刂) _____ 力_____ 女_____
口_____ 囗_____ 大_____ 小_____
子_____ 心_____ 手(扌) _____ 日_____
月_____ 木_____ 水(氵) _____ 火(灬) _____
疒_____ 辶_____ 田_____ 目_____
糸(纟) _____ 耳_____ 言(讠) _____ 贝_____
走_____ 足(⻊)_____ 金(钅) _____ 门_____
雨_____ 食(饣) _____

Part 3/4. a. Circle the character best fits the meaning provided in English based on their radicals. (10 points)

1. nail 钉 顶 叮 2. soup 肠 汤 疡 3. leap 趵 钓 讨
4. muscle 肌 讥 饥 5. beautiful 嬛 寰 擐 6. greedy 贪 含 衾
7. remote 迢 沼 岩 8. scar 疤 笆 杷
9. footman 仆 补 扑 10. weft 围 尾 纬

b. Provide the missing radical of each character based on the English meaning given. (20 points)

1. To cook, to boil: 享 2. To talk: 井 3. To be ill: 丙
4. To serve (as a servant): 司 5. luxuriant growth of fragrant grass: 妻
6. To be prisoned: 人 7. To roar: 孔 8. orphan: 瓜 9. angry: 奴 10. To pick up: 佥
11. Dry in the sun: 西 12. River: 可 13. Pine tree: 公 14. To blink: 乏
15. To walk with spirit: 礻 16. To halt feet: 主 17. Round flat cake: 并
18. To compensate: 音 19. To listen tentatively: 令 20. Thin strong silk: 肙

Part 4/4. Write the character with the pinyin and English provided. (30 points)

diǎn (dot, to point, to order) _____ lǐ (plum, last name) _____
guǎn (a venue/location for restaurant, library) _____ guó (country) _____
kè (class, course) _____ bìng (to be ill) _____ wǎn (late) _____
tā (she) _____ máng (busy) _____ pǎo (to run) _____ gē (song) _____
wèn (to ask) _____ xiǎng (to think) _____ zì (character) _____ liáo (to chat) _____

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Journal of Technology and Chinese Language Teaching Volume 12 Number 1, June 2021
http://www.tclt.us/journal/2021v12n1/chenghungyeh.pdf pp. 23-50

多媒体教材对初级汉字学习者自主学习之影响
(The Effects of Multimedia Assisted Materials for Self-Learning Chinese Characters)

Cheng, Hsiujen
(鄭琇仁)
National Kaohsiung Normal University
(高雄師範大學)
t3645@mail.nknu.edu.tw

Hung, Hsin-han
(洪新涵)
National Sun Yat-sen University
(中山大學)
aa00140@g-mail.nsysu.edu.tw

Yeh, Tingchia
(葉庭嘉)
National Kaohsiung Normal University
(高雄師範大學)
610518009@mail.nknu.edu.tw

摘要：本研究從自主學習探討兩種多媒體教材對漢字自學模式之「學習成效」、「學習觀感」、「學習型態」、「學習策略」四方面的結果。研究團隊設計部件概念的字本位字卡，以擴增實境和紙本小書兩類為延伸教材形式，針對 6 位在台灣初學漢字的國際交換生進行研究。執行為期 6 週的系統性以及階段性的自學模式並搭配其實體課程進行學習評量，以小份量的學習內容漸進式學習，並採用混合研究法分析質性與量化資料，收集 6 次的測驗，1 次的訪談調查，8 筆觀察記錄。研究結果顯示(1) 擴增實境和紙本小書兩種類型的素材對漢字初學者的辨識漢字具成效; 傳統紙本小書的形式有助於記憶拼音，AR 卡則有助於部件認讀， (2)學習者對兩種自學漢字認讀教材都表示高度的肯定，(3)多數學習者屬視覺與動覺合併的學習型態；(4)兩種素材的特性皆啟動不同學習者偏愛的學習策略。此研究之結果可作為數位教與學的參考，研究建議與限制於本文討論。

Abstract: Based on the concept of self-learning, this study aims to investigate the impact of the two types of multimedia assisted Chinese characters' materials on learning efficiency, perceptions, styles, and strategies. Researchers designed radical-based cards and the Chinese characters learning contents presented in augmented reality forms and in printed booklets. Six subjects, international exchange students from a national university located in southern Taiwan, participated in a 6-week classroom experiment where they received weekly Chinese characters learning content and learned it in self-learning mode. Data were collected through pretests and posttests, interviews, and in-class observations. A mixed method was conducted to analyze data qualitatively and quantitatively. The findings showed that (1) the multimedia assisted Chinese characters' learning materials promoted learning efficiency in two forms; learning with booklets helps remembering pinyin and augmented reality materials help radical recognition. (2) students perceived self-learning materials for learning Chinese characters positively. (3) most students were mixed learners of visual and kinesthetic learning styles. (4)

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

booklets and AR materials triggered Chinese learners' learning strategies accordingly. Findings can be the references for Chinese characters teaching and learning or teacher training. Research discussions and suggestions for further studies were included.

關鍵詞: 擴增實境、漢字學習、自主學習、學習型態、多媒體學習認知

Keywords: Augmented reality, Chinese character learning, Learner's autonomy, Learning style, Cognitive learning theory of multimedia learning

1. 研究動機

研究者於過往的漢字學習研究初步發現：當控制學習內容時，非漢字文化圈學習者，如美籍學習者，初學漢字時偏愛低階多媒體互動性(low interaction)的學習環境，過多的多媒體互動設計，如動畫、點選、選單等，造成其學習認知負荷，沒有漢文化背景的學習者因無先備知識，低階動態圖文設計讓其較能集中注意記憶學習內容(Cheng, 2017)。因此，多媒體學習認知負荷與學習者先備知識相互影響著教學素材的設計。論教學現場，多數海內外的華語教師在漢字教學上採隨文認讀之教學模式，課堂時數不足不但無法集中識字，教師也無法顧及學習者漢字程度以及學習型態(learning style)的差異；甚至為了提高註冊率，有些學校在初學階段採不教策略(Shen, 2014)。除了教學困難外，研究也顯示學習漢字是學習者感到很痛苦的項目，與教師間缺乏共知性(舒兆民、林金錫，2007; Poole, 2015)，因此，漢字學習淪為學生自學或是視情況處理的常態。

事實上學習者有著多元學習型態，如聽覺、動覺、視覺等，研究顯示接觸與自己學習型態類似的教學模式，更能牢記學習資訊、獲得較高的學習成就、也能提高學習興趣 (黃馨誼、陳又菁，2013) 。因此，數位素材融入漢字初學之課程相對能滿足不同學習型態以及大腦學習認知的負荷，亦是現代華語教學者協助外籍學習者自學漢字時得有的專業知識。

從傳統上來說，藉由書本的素材作為漢字學習的媒介為常見的做法，二十一世紀，數位資源充分，自主學習成為取得知識的管道之一，亦可是教師訓練學生學習的方法，而學習應滿足多元學習型態以及數位行動學習習慣，以支持自主學習以及滿足自主學習的成效。近年來發展的擴增實境 (Augmented Reality) 科技，讓學習者可同時運用實體素材和虛擬多媒體素材，提高學習的趣味性(Barreira, et al., 2012)，研究也證實擴增實境可成功吸引學習者的學習素材 (Tsai & Yen, 2014)。語言學習是一種互動的過程，而學習興趣與學習成效息息相關， 擴增實境的有趣性、多元性融入於漢字自學的環境裡，提供視覺與聽覺的學習刺激，可滿足現代學習者的多種學習型態，此為本研究的研究動機。

如前所提，漢字初級學習者接觸的內容是需要系統性的提供小單位的學習份量，目的是為了把握學習者的學習認知負荷量。不少相關研究指出學習部件是華語為外語的初學者較有效漢字學習的開始(Shen, 2014；謝錫金，2000)，此與多媒體學習負荷的概念不謀而合，從學習認知的角度分析，將漢字整體資訊以小單位的部件呈現，可幫助學習者漸進式吸收字的結構，若以高頻部件延伸字推疊，有助於建構漢字認讀的初步概念，同時也能降低漢字認讀的難度，提高學習自信心(Cheng, 2017)。

綜合以上，本研究欲藉多元學習型態以及多媒體學習認知理論幫助初到台灣學習的國際交換生快速的建構中文字認讀的能力，並以學習者前一級的中文教材為內容，建立以漢字部件為介面的字卡再結合擴增實境與傳統小書兩類多媒體形式，搭建一套能讓初級漢字學習者可漸進且自主學習的入門漢字學習內容，在小單位的學習內容和學習份量的系統性安排下，驥期能進一步觀察與比較學生在不同漢字媒材下對漢字學習的影響，做為未來華語教師鼓勵初級外籍生以自主學習輔以課堂學習之漢字學習模式。故研究問題為：

1. 初級二語漢字學習者於系統性輔助學習模式下使用多元漢字傳統素材(小書冊)與數位素材(擴增實境)的「漢字認讀的成效」為何?
2. 初級二語漢字學習者於系統性輔助學習模式下使用多元漢字傳統素材(小書冊)與數位素材(擴增實境)「學習觀感」為何?
3. 初級二語漢字學習者於系統性輔助學習模式下的「學習策略」為何?
4. 初級二語漢字學習者於系統性輔助學習模式下的「學習型態」為何？

2. 文獻探討

依據本研究目的，所涉略的文獻領域包含漢字學習與多媒體學習認知、擴增實境與教育應用、學習型態相關的研究、科技接受模式，本段梳理文獻研究的結果，以為研究參考。

2.1 漢字學習與多媒體學習認知

人類的大腦在處理多媒體訊息時，都先藉由短期記憶處理訊息。Mayer 的多媒體學習認知理論(Cognitive theory of multimedia learning; CTML)指出大腦以雙軌道的模式處理多媒體訊息，資訊由感官的視覺、聽覺雙軌接受訊息後，又分別以語文(語音或文字)與圖像雙軌道處理資訊，此過程大腦會自動選擇處理的訊息，該訊息於工作記憶(短期記憶)中處理，而工作記憶的承載量有限，因此，每次的新資訊都是少量處理， 此過程是經大腦的選擇、組織、融合等資訊處理過程而達學習之效(Mayer, 2005)。此也意味著提供給大腦的多媒體圖文設計關乎大腦是否有效處理訊息，因為大腦選擇的資訊若是雜亂，在組織資訊時，會顯得吃力。另外，學習者能否掌控多媒體學習素材也與其學習效率有關，Mayer (2003)認為學習者在數位媒體的學習環境裡，若學習者能掌控「學習步調 (pace)」與「順序(order)」，能學得更好。研究者利用此理論於 2017 年美籍大學生初學漢字的研究(Zhan & Cheng, 2017)

結果顯示 14 位大學生分別學習 2 次互動性以及直線性的漢字多媒體教材後，立即性測驗以及延遲測驗顯示學習者使用線性的多媒體教材的學習成效高於使用互動性的教材，起因於初學漢字者，對許多的訊息皆是陌生的，因此，學習的訊息量越少，如字形、拼音、翻譯即可、使用介面越是簡易越能觸使他們專心記憶部件。

Chuang 與 Ku (2011) 針對 66 位零起點的美籍大學生藉由多媒體學習象形字漢字的記憶結果與觀感，分為「圖-語音」類以及「圖-文字」類的教材，資料顯示學習者在此 2 組的學習成效沒有很大的差別，2 組學習者對此兩類教材的喜愛也沒有差別，分別表示「圖與漢字的連結性」(語音組) 和「圖與漢字的敘述的關聯性」(文字組)是他們喜愛教材的原因，漢字的象形字保有圖像化的特質，因此，圖像與象形字的關係是無庸置疑的。Lin (2020) 將 120 位幼兒分為四組，分別用不同的多媒體呈現相同的漢字學習內容，藉以探討多媒體融入漢字的教學呈現並找出最佳設計，其研究結果表示若要瞭解字義，加上圖片輔助才能達到最佳成效。

綜合論之，從多媒體學習認知的角度探討，初學漢字時，特別是非漢字文化圈者，因對漢字結構的陌生，多媒體教材的內容訊息不宜過多，若遇象形字，則善用與部件高度相關的圖像，低互動性多媒體素材較能讓初學者集中注意於學習內容而大腦不易受到干擾，最後，善用圖、文、語音的輔助，亦能促使漢字學習效果提升。

2.2 擴增實境與教育應用

擴增實境是擴充(supplement)真實生活環境 (Azuma, 1997)，亦是在真實世界裡與虛擬的多媒體元素包含 3-D 圖像、圖片、影像、動畫、文字等互動，近年來已開發國家行動載具(mobile device)發展日趨成熟，擴增實境與行動載具的結合更加的密切在生活中，因此也有「行動擴增實境(Mobile Augmented Reality)」的說法(Ramya, 2017)。

擴增實境早於 1900 年代實已存在，因科技技術的成熟，才於近期又被關注，哈佛商業評論 (2017) 的 2017 年 11 月號還大膽地描述擴增實境至 2020 年會被廣泛的應用於生活。教育的應用也算普及包含幼兒(Hsu, 2017)、兒童(Barreira, et. al, 2012)、大學生(Liu & Tsai, 2013)、成年人(Ho, Hsieh, Sun & Chen, 2017)等，以及語言學習，如詞彙、寫作等。

討論擴增實境於外語教與學的研究時，多數以英語學習者之大學生或小學生居多，可惜的是鮮少中文為第二(外)語的研究。Barreira, et. al (2012) 研究 26 位母語為葡萄牙文的小學學童學習英文詞彙，課程將學習者分為傳統以及虛擬(AR)遊戲兩組，讓其個別於不同組別中學習，結果顯示 AR 組別的學童英文的學習成效高於傳統組別。土耳其的大學生學習英文詞彙(Solak & Cakir, 2015)融入擴增實境教材能提升大學生學習英文詞彙的動機以及學習成效。Liu 和 Tsai (2013) 的英文為外語的台灣大學生寫作狀況研究結果也顯示利用 AR 模式下的行動學習可促進學生於寫作主題、內容和語言投入。用於台灣國小英文學習的研究(李來春，郝光中，2013)，問卷結果顯示擴增實境素材有效地誘發 33 位國小三年級學童的學習動機，前後測測

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

驗結果顯著，說明該素材提高了英文學習效率。同樣的結果也在 Hsu (2017)的國小三年級兒童初學英文單字的成效顯著，且即使學童學習策略的差異(自由型以及線性任務型)都如此。綜合來看，不論研究對象的人數多寡，似乎在提升學習成效(Barreira, et. al, 2012; Liu & Tsai, 2013; Solak & Cakir, 2015; Hsu, 2017;李來春，郝光中，2013)和提升學習動機(Solak & Cakir, 2015; 李來春，郝光中，2013)上有共識。

論及擴增實境素材與其他素材之比較，前人研究並沒有一致性的結論，許于仁和黃一倚(2017) 針對博物館學習教材研究指出相較於傳統的紙本教材，AR 擴增實境支援的數位學習教材因其互動性高，可提高學習者的學習興趣，提高學習的專注力與效率 ，且學習者願意花費學習的時間也較長，然 Yan 與 He (2020) 的研究指出，傳統的圖文形式和 AR 支持的漢字學習素材對漢字學習都有成效，但沒有顯著差異。對比較教材形式來說，仍存在著文獻缺口，需更多文獻檢驗素材形式對學習的影響。

2.3 學習型態 (Learning Styles)與數位學習相關研究

許多研究證明，若教學風格與學習型態能相互契合，學生所習得的資訊，記憶較為鮮明、學習態度會更加正面、也能培養更多成功的學習者。Werner (2003) 指出學生有意識地選擇自己偏好的學習型態與策略可對學習成效產生正面的影響。Bandler 與 Grinder (1979) 以感官區分學習者偏好使用的學習型態為 VAK (Visual, Auditory, Kinesthetic)，分為視覺型、聽覺型、動覺型。視覺型學習者對於視覺的學習刺激感受較明顯，透過圖片、影片、圖表、圖形、流程圖、排版過後的學習介面，亦或是學習材料上符號、顏色之劃記都能輔助該類型學習者提升學習興趣、加速理解過程。聽覺型學習者對於環境聲音較敏銳，此類學習者在乎自己能否專注，像是需要絕對安靜或是不同類型環境聲音等學習空間，其學習的特性偏向以聽講、錄音、講故事、音樂、談話、提問、念讀等方式進行學習。動覺型學習者偏好透過雙手、身體親自體驗操作，而書寫、觸摸等動作指令有助於他們集中注意力，故戲劇、活動、舞蹈、實驗等須改變狀態的動態課程能提升他們的學習效率。其他學者像是 Kolb (1981)發現學習型態會因為學習者的個人專業與職業而有所差異或以腦部構造分類學習型態(Herrmann, 1991)。因此，Murat (2013) 提出課程提供的教材與設計應具備彈性，讓不同的學生都能從中發展出適合自己的學習型態與策略。

然而，對二語學習者來說，不僅教學與學習型態應具備共通點，仍須仰賴多元、彈性的學習過程方能達到契合（Liu, & He, 2014）。Liu 和 He (2014) 建議可提升二語學習之成效的三個步驟：(1) 以學習者為中心量身定制課程 (2) 探索並發展適合學生的教學型態 (3) 適時調整課程與擴展學習方式。結合二語教學的數位教材型態越來越多元化，除了以影像、語音、圖示、文字等方式呈現教材，也可自製數位教材、動畫融入教學。黃馨誼與陳又菁(2013)將學生分為視覺型、語言型風格，依據不同學習型態搭配紙本與數位閱讀教材，發現若能視學習者偏好的學習型態給予適合的教材，學習成效便能有所提升，此外，若學生能依照個人學習負荷量分段學習，有效的增加認知負荷量，成效比未分段學習的學生更為集中與提升。

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

2.4 科技接受模式

隨著結合數位科技的學習越發普遍，討論科技接受度的議題從未削減，而當中以 Davis (1989) 的科技接受模式(Technology Acceptance Model, TAM)最廣為應用。然而，科技接受模式將重點聚焦於影響科技使用因素的討論，主要用以預測、了解並提升科技接受度，細部探討變數對科技使用者的信念 (beliefs)、態度(attitudes)和意向(intentions)的影響關係，影響變數包括 (見圖 1)：外部變數(external variables)、知覺有用性(perceived usefulness)、知覺易用性(perceived ease of use)、使用態度(attitude toward using)、行為意向、實際使用行為(actual behavior use)，其中，「知覺有用性」(perceived usefulness)和「知覺易用性」(perceived ease of use)會間接影響使用態度，使用態度進而影響行為意象，最後直接牽動使用行為 (吳智鴻、蔡依錞，2014)。本文欲藉由 Davis (1989)提出之科技接受模式中重要的兩個變數「知覺有用性」(perceived usefulness)和「知覺易用性」(perceived ease of use)的角度，檢視學習者於本教學研究的模式下的觀感，進一步探討或預測實際學習者的使用行為，多數的文獻採科技接受模式時用於量化資料分析，本研究以這樣的概念檢測學習者的質性訪談資料。

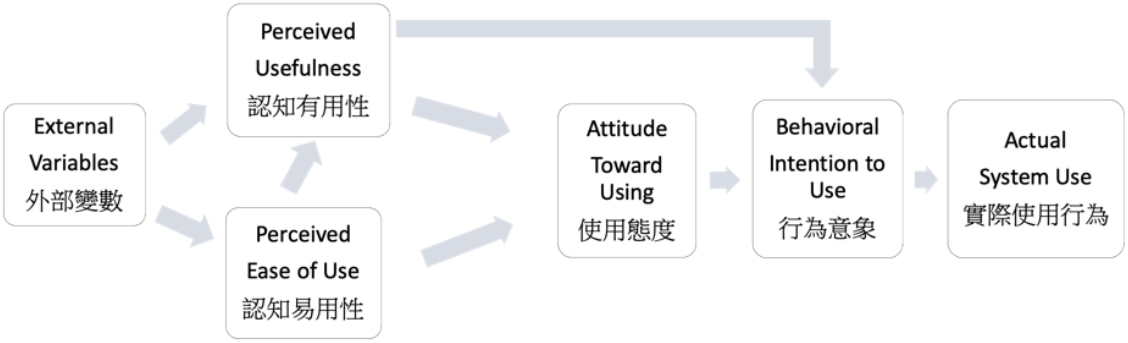


圖 1 科技接受模式 Technology Acceptance Model, TAM
註：取自"User acceptance of computer technology a comparison of two theoretical models Management Science", by Fred D. Davis, Richard P. Bagozzi and Paul R. Warshaw, 1989, MANAGEMENT SCIENCE, Vol. 35, No.8, P. 98

3. 研究方法

本研究採用混和型研究法(Mixed Method)，觀察華語為二語的漢字初學者於課程期間系統性的輔以分段自主學習漢字並配合評量的狀況，以習字字卡為媒介呈現兩類素材(小書以及擴增實境)來滿足學習者多元學習型態，最終期望建構學習者對漢字結構的概念。於此模式下探究學習者之學習觀感、學習策略、漢字認讀的學習成效。於 2018 年春季於台灣的大學語言中心進行為期約莫六週的課堂研究。

3.1 研究對象

本研究採方便取樣，邀請六位於某大學之國際交換生參與本計劃。研究對象背景，如表 1，依據文化背景劃分，漢字文化圈者 3 位(S1, S5, S6)，非漢字文化圈者 3 位(S2, S3, S4)。依據程度，3 位(S3, S4, S5)為中文為零起點程度，兩位為 A1 等級(S2, S6)，1 位為 A2 等級(S1)，其分級制度則參考台灣華語能力測驗（Test Of Chinese as Foreign Language, TOCFL）之詞彙量與對應的歐洲共同語文參考架構（Common European Framework of Reference for Languages, CEFR[1]）程度而定。研究對象來台學習之專業皆非中文，專業課程全英文授課，唯一能學習華語之管道為學校所開設的國際交換生之中文選修課程，正是本研究之場域。為了解決研究對象背景的差異可能造成研究結果的不確定性，研究者分析與比較 6 位學生在漢字形音義的基礎，亦是前測結果。顯示六位的前測成績近似，不受程度以及漢字文化圈背景與否的影響，故納入 6 位學生的資料共同分析，詳細分析請見 4. 研究資料分析之學習成效。

表 1 研究對象背景

代碼	國籍	漢字文化圈	中文程度	主修課程語言	已學習中文時數
S1	韓國	V	A2	中文	三個月，96 個小時
S2	印尼		A1	英文	三個月，48 個小時
S3	法國		零起點	英文	三個月，48 個小時
S4	法國		零起點	英文	三個月，48 個小時
S5	越南	V	零起點	英文	無
S6	日本	V	A1	英文	三個月，48 小時

3.2 研究設計

本研究提出課堂輔助自學模式目的是彌補課堂中因課時限制，而教師未能系統性訓練部件、建構漢字結構概念等困境，此模式學習者可自主控制學習時間，由教師系統性提供的學習教材，輔助學生建構漢字認讀概念，以貼近華語教師教學現場的課室需求。2018 年春季於國際交換學生的中文選修課程，該課程每周兩堂各兩個小時。研究團隊進行為期六週六個單元的課室研究，單元一、三、五為「卡-AR」模式，單元二、四、六為「卡-小書」的研究設計。是單一受試研究法的 A-B-A-B 設計，受試者可重複且多次接受 A 與 B 兩種實驗刺激，這類的設計比起只有 AB 的研究設計來說更加的有效度，因為受試者多次的進行刺激，並立即收集每次學習的前後測結果，研究者可更加確認收集資料的穩定度，藉此比較兩種實驗的結果。

本研究教師依據筆畫數多寡設定易至難的單元內容。每周提供一單元的學習內容給該班的學生，進行自主學習五日。學習者由字卡認讀部件，第一周接觸 AR(A1)的素材，第二周接觸小書冊(B1)，兩種不同類型的素材學習延伸字詞，讓

[1] TOCFL 華語能力測驗與對應的 CEFR 歐洲共同語文參考架構 https://www.sc-top.org.tw/chinese/LS/test5.php.

學習資訊以每周定量且多元媒體型態內容的漸進式進行，約莫每周 7 至 9 個部件，如表 2 所示，共接觸 AR 素材 3 次，小書冊 3 次，兩類教材穿插學習的目的是也為了解決研究對象人數過少的缺口，而每一型態的資料都能收集三次學習成效，以斷定研究成果。

每週研究流程包含五步驟: (1)進行前測測驗、(2)發單元部件認讀卡與 AR 或小書素材、(3)學生自主學習五日、(4)收回字卡與素材與(5)進行後測。依此五步驟，進行六次循環實驗，實驗執行前，解釋並協助說明部件卡以示範啟動 AR app 的操作，以確保每位學生沒有技術問題干擾。實驗過程中，由班級教師進行觀察紀錄，並在實驗後進行線上個別訪談，如表 2 所示。

最後，藉著收集前後測、訪談、教師觀察紀錄等資料檢驗學習者之漢字部件認讀之記憶狀況，進而分析學習觀感、策略、型態。

表 2 研究設計與流程細節

步驟	實驗設計與操作	部件數	部件
執行前	操作說明		
(A1)單元一 (AR)	(前後測)	7	一人亻八（刂）十又
(B2)單元二 (小書)	(前後測)	8	弓土大女子寸小工
(A2)單元三 (AR)	(前後測)	8	巾口心（忄）（扌）氵戈戶
(B2)單元四 (小書)	(前後測)	9	斤日月木欠止田白目
(A3)單元五 (AR)	(前後測)	9	示礻禾立竹米耳行言
(B3)單元六 (小書)	(前後測)	9	走足金門隹雨食頁馬
	訪談	50	

3.3 教材設計

漢字自學素材的設計步驟含(1)建立部件資料庫、(2)字卡設計與製作、(3)傳統小書與數位 AR 學習內容設計與製作。本教材設計之目的為藉由字卡建構部件概念，再經由小書或數位 AR 學習內容認識延伸漢字及相關已學字詞，進而提升學習者漢字辨讀能力，並應用於日常生活的認讀上，以達到舉一反三之效。

(1) 部件資料庫建構

步驟如下：(1)挑選部件 (2)部件難度排序。第一步挑選部件時，研究者梳理文獻資料後，參考黃沛榮(2012)三原則所建議的 67 個整字與 11 個非整字部首。為了協助學習者部件連結與歸納的能力，研究者媒合學習者中文課程的初級教材 < 零起點入門華語教材> 中之漢字部件，最後選出 50 個能與學習者當期課程教材生詞漢字相呼應且重複率高的部件，目的是藉由低一階的口語詞彙堆疊學習者的漢字認讀詞彙。第二步則按筆畫數分為初中高三程度，由易至難安排六個單元的學習內容，透過已學習過的部件，以舊帶新，協助學生認讀漢字、連結、猜測字與詞義。筆畫

數少的延伸字較為高頻，字數較多，依據延伸字數平均安排，每單元的部件數約 7 至 9 個 (見表 2 之部件欄位)。

(2) 字卡設計與製作

依據研究者 2017 年漢字學習研究結果，教材內容不能超出學習認知的負荷量，對非漢字文化圈學習者來說，初學時部首、筆順、英文翻譯三項訊息已達初學者之大腦負荷，遇象形字時，則加上似字形之圖像(如耳字)，以協助記憶部件的形體，非象形字時，則採字義之圖像。圖 2 左圖為部件字卡範例，字卡正上方為部件，右下為對應的圖片，部件下方為標音(漢拼與注音符號)以及英文翻譯，卡片正下方為筆順，以協助學習者在視覺上能立即辨識該字之書寫順序，為了兼顧拼音與注音符號學習者之需求，於下方並列兩種拼音系統。當學習者學習字卡搭配小書冊周次時，他們會拿到中間這一套素材包含字卡以及小書冊，小書冊封面為抱著書冊的學習者。若是 AR 科技學習周次時，他們會拿到字卡而已(如右圖)，字卡封面是拿著手機的學習者，以辨別字卡搭配的功能。

圖 2 部件字卡

(3) 小書與 AR 學習內容設計與製作

以內容論之，小書與 AR 教材的內容都是部件字卡的延伸字詞，延伸字詞的選材來源為初級教材，從教材中尋找具備同部件之漢字與詞彙。延伸字意旨相同部件下的字以及詞，設計上部件以紅色顯著標記，正下方標音與意義，畫面正下方藍色部分為延伸詞，詞則是初級課本會出現的生詞，如圖 3，如「耳」的延伸字為「聽」、延伸詞為「音樂廳」，音樂廳為學習者前冊華語課本之認讀生詞。小書與 AR 教材的內容排版與顏色是一樣的。

圖 3 小書以及 AR 影片內容

以素材形式論之，小書形式則以紙本翻閱式形式一頁一頁呈現延伸字、詞、拼音與翻譯，如圖 4，故本文視小書為紙本或傳統書本形式，延伸字之部件標紅色，延伸詞於書冊下方藍色處。AR 教材，學習者需要以智慧型手機或載具掃描字卡，手機螢幕可看見動態的延伸字詞的出現，故 AR 視為數位形式。如圖 5，其動態影像依序呈現，先以紅色呈現部件再出現延伸字的其他部件、拼音與翻譯，再出現延伸詞，如耳→聊→聊天，並搭配背景音樂，刻意不錄製發音等人聲，目的是讓學生能專注於字的結構，讓大腦的視覺與聽覺負荷能更集中於漢字、詞、意義三項元素記憶與認讀。

圖 4 小書形式

圖 5 AR 形式

3.4 研究工具

為回應研究問題，本研究收集學生之前後測結果、訪談與課室觀察紀錄，以下分項說明。

(1)前後測驗

前測目的是檢視學習者對漢字的起點程度，進一步判定研究對象可納入資料分析的基準；前後測則是做為學習成效的分析之用。本研究之前後測共 6 份，依據研究者的部件、字詞的單元資料庫出題，題目包含(1)部件發音、(2) 標示漢字中的部件，共兩大題。第五週才開始加入 (3)部件的英文意義。因此，測驗五與六資料最完整，題目包含形音義。

因實驗操作之失誤，第一次單元的前測資料未能及時收集，因此，前測測驗結果收集了第二、三、四、五、六單元，後測則有六個單元的資料。其中 S2、S5、S6 都曾經缺考，故缺了 9 筆資料，因此，此次研究共收集了 51 筆資料。研究者以該次的平均分數取代。為了避免學生自主學習前與後受其他課堂因素干擾，前測測驗於學習字卡核發前進行，後測則是學習者自學後五日的課堂一開始進行，因此，課堂時間僅進行測驗，不教授任何學生自學的內容。同時，也告知研究對象，測驗的結果不影響其課堂的成績，全是自願性質的參與，保護受試者權益。

(2)訪談

如表 3 所示，訪談題目包含基本資料、學習策略、學習觀感三方面，採結構式訪談，使用的語言以中、英雙語進行，學生能以慣用的語言與最舒服的狀態回覆，並由研究助理訪談，以避免學生對於實驗過程的表述影響其上課成績的顧忌。該研究計畫於 6 次循環後，以線上視訊的方式進行訪談。考量期末後，許多外籍生有旅行計畫，故使用視訊訪談模式以提高訪談之完成率，6 位學習者皆如期完成訪談。本研究共收集 6 位學生的訪談資料。

表 3 訪談內容

基本資料	1. 學生基本資料：姓名、國籍、母語
學習策略	2. 每次你都花多少時間學習？ 3. 你常用 AR card 的哪個(些)功能？為什麼? 4. 你常用 AR 卡和小書的哪個(些)功能？為什麼?
學習觀感	5. 哪一個幫助你記住中文字？為什麼? 6. 要是你想學漢字，你還會用哪一個？為什麼？ 7. 你喜歡哪一種卡？為什麼？ 8. 你覺得還要有什麼，對你學中文字更有幫助？為什麼？

(3) 教師課堂觀察筆記與資料

參與教師於每次發下素材後，開始觀察學生的使用狀況。實驗期間共計 8 筆課堂觀察筆記，觀察記錄項目分別為施測日期、學生反應與行為。

4. 研究資料分析

本研究採用質性與量化的綜合分析，分別探討漢字自主學習之學習成效、學習使用的策略、對此種模式的學習觀感三方面的結果。

4.1 學習成效

學習成效為研究者針對來台就學之國際學生，探討在課程輔以系統性自學模式下，漢字部件認讀以及拼音的情形，接著分析前後測與比對兩類素材之測驗結果。然而，為免 6 位學習者因語言程度、有無漢字背景之差異影響結果，因此，本研究於實驗前先從前測觀察兩者的語言起點程度，後決定納入 6 位研究對象資料比較，再分析整體現象，分析如下：

(1) 先備知識討論（漢字與非漢字背景學生起點程度檢測）

語言程度來說，研究者將 6 位學生的前測漢字認讀成績分為零起點 (S3, S4, S5) 以及非零起點 (S1, S2，S6)兩組觀察。結果於表 4，6 位同學 (S1, S2, S3, S4) 並沒有因為中文程度的起點不同而在漢字認讀先備知識上有很大的差異，成績多數落在 11 至 13 間，只有 S5 的成績較明顯的低(M5=3.5)，然 S5 其中文程度是零起點，在漢字認讀也是零起點，是位剛入門的學習者。

表 4 學生語言程度與前測

程度	學生代碼	平均數
A2	S1	12.35
A1	S2	12.35
A1	S6	11.64
零起點*	S3	13.2
零起點*	S4	11.8
零起點	S5	3.5

*三個月中文學習時數

以漢字和非漢字文化圈的背景來看，表 5 所示除了 S5 的完全零起點外，其他學生(S1, S2, S3, S4，S5) 的漢字認讀先備知識似乎也沒有太大的落差，因此，本研究的研究對象，似乎不因其語言文化背景，漢字認讀的先備程度有所差異。以上前測分析，6 位學生對漢字的先備知識不受程度以及漢字文化圈背景與否的影響，因此，仍納入 6 位學生的資料共同分析。

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

表 5 研究對象漢字文化圈與否與其前測成績

組別	國籍	學生代碼	平均數
漢字文化圈	韓國	S1	12.35
	越南	S5	3.5
	日本	S6	11.64
非漢字文化圈	印尼	S2	12.35
	法國	S3	13.2
	法國	S4	11.8

(2) 前後測結果

為瞭解學習者是否認識當週部件，本研究從讀音、從漢字辨讀部件，以及部件形音義三方面進行前後測。研究團隊設定測驗的評量標準，如下：

第一部分-部件發音，標準為一部件一分，無標註聲調者不扣分，聲調有誤則扣一半。 第二部分-標示漢字中部件，只要圈選出當週所學部件即可得分，一個部件一分，若圈選整個漢字則不算分。第三部分-標註部件英文意義則根據學生填寫的英文義給分，正確者得一分。此外，因每週的部件數量不同，故前後測的總分也不同，為分析學習者之學習狀況，以百分比進行成績計算單位，便於後續進行前後資料比對。

首先，研究結果顯示不論素材類型，整體後測成績(M 後=69) 是高於前測(M 前=62) 成績，顯然課程輔以系統性自主學習的模式能讓漢字學習有些成效，但可惜未達顯著(p =.625)。接著，表 6 顯示 AR-卡(M=72)和小書-卡(M=66)的後測平均成績分別都高於前測， AR-卡的後測成績也高於小書-卡的成績，可惜的是也未能在統計上達顯著的效果(p_{AR}=0.89, $p_{小書}$=0.51)。以上前後測結果意味著教師若能系統性的提供漢字部件自主學習教材，提供這兩類的素材於初級華語學生自主學習漢字是有幫助的，且數位形式略勝於小書形式，雖未能有統計上的明顯的成效，但令人振奮的是後測的結果都顯示進步，漢字自主學習的成果傾向於佳。

表 6 兩類型素材之前後測平均成績

項目	前後測驗	人數	平均得分數	p
AR- cards	pre	6	68	.809
	post	6	72	
Book- card（小書）	pre	6	56	.51
	post	6	66	

進一步分別分析測驗題內的漢字讀音以及認讀部件兩項的前後測成績，表 7 顯示學習者以小書自學條件下，學習後的拼音後測成績 (85.1) 高於前測 (38)，且是顯著差異(p<.05)，意味著學習者在小書模式學習拼音，可達顯著的學習成果，此為有趣的發現，研究者合併學習策略與型態、教師觀課以及訪談等資料，進一步分析其原因，並於「學習策略與型態」段落詳談。而 AR 卡的學習模式下學習拼音，後測

成績(70.6)也高於前測(59.5)，可惜的是未達統計上的顯著標準。綜合來看，AR 卡和小書兩者在拼音上的表現都是不錯的，小書在前後測的學習成果更甚一籌。

以部件學習成果來看，表 7 顯示小書和 AR 的學習條件下後測成績($M_{小書}$=67, M_{AR}=84.8)分別都高於其前測($M_{小書}$=63, M_{AR} =72.6)，可惜未達統計上的顯著性。綜合來看，此兩類的學習素材能夠幫助初學者建立部件概念。

表 7 小書和 AR 素材的拼音、部件的前後測平均成績

項目	前後測驗	人數	平均得分數	p
小書拼音	前	6	38	.00 *
	後	6	85.1	
AR 拼音	前	6	59.5	.559
	後	6	70.6	
小書部件	前	6	63.65	.85
	後	6	67	
AR 部件	前	6	72.6	.44
	後	6	84.8	

接著比較 AR 卡以及小書學習素材，表 8 顯示學習者的後測於學習拼音與部件認讀成效的差異，以拼音來說，小書(M=85.16)的成效稍優於 AR 卡(M=79.66)，以部件認讀來說，AR 卡(M=72.67)認讀成效優於小書(M=67.00)，但兩者都未達顯著差異(p>.05)。意味著素材的特性可能影響著不同學習項目的成效，小書的紙本模式稍能協助初學者記住其拼音，而 AR 的數位模式可協助學習者記住其部件結構，可能是設計中利用顏色標記字的部件 (如圖 3)，在 AR 模式時可動態的依序讓部件更明顯的引起學習者的注意力，以利於學習者專注部件的認讀。而研究者在「4. 2. 學習策略分析」時，也在教師觀察記錄部分發現學生在拿到小書時，會拿起紙寫下筆記，其中也記下拼音，因此，推論傳統小書的紙本引導學習者的筆記動態學習行為，藉著書寫手腦並用協助記憶拼音；AR 數位形式以動態依序顯示且標記顏色部件於字的結構，藉此讓學習者專注於部件資訊，透過不斷接收重複影像的刺激而記住部件於漢字的結構。

表 8 AR 與小書的 pinyin 和部件的後測

項目	分項	平均數	P
pinyin	AR	79.66	.475
	小書	85.16	
部件	AR	72.67	.762
	小書	67.00	

綜合以上資料，(1)兩類素材對初級漢字學習者自主學習時，都有益於漢字學習，從兩種形式來看，AR 素材的後測學習成效似乎略優於傳統紙本的小書冊形式，然而，(2)傳統紙本小書的形式更顯著地協助初級學習者記憶拼音。(3)以素材形式來說，紙本小書屬於紙本操作的模式，AR 屬於數位媒體結合紙本字卡模式，前者

保有紙本教材可動態書寫的優點，後者保有紙本字卡閱讀、數位多媒體以及行動學習的特點。觀察成績平均數，傳統紙本小書的形式有助於記憶拼音，AR 卡則有助於部件認讀。以上結果意味著素材多媒體模式的特點與學習項目特性相輔助時，學習成果可能受正面影響，然也可能受學習型態所致，因此，進一步觀察學習行為與型態，分析可能的結果，詳細分析見下段落。

4.2 學習策略

每個人都會有不同的學習策略，其策略可能與其所花費時間、課堂以及課後操作方式以及與個人學習型態相關。為觀察學生的學習策略，研究者由訪談資料以及教師課堂觀察紀錄歸納學習者在此自學模式下其使用的學習策略，並進一步以三類學習型態：視覺型、聽覺型、動覺型分析學生的學習策略。

(1) 花費時間

自主學習五日所花費於提供素材的時間，表 9 顯示 6 位學生中有 4 位學生花了一個小時或一個小時以上的時間，1 位學生(S3)約 40 分鐘，1 位學生(S6)僅花 15 分鐘，整體來看，大約每位學生平均花費 40 分鐘 (0.8 小時) 時間於自主學習教師所提供的漢字部件教材。本研究所提供的教材稱得上吸引多數的學生，在自學的模式下，多數且來自不同國際背景的學生能自主學習 1 或 1 小時以上的時間，僅 S6 花較少的時間。

表 9 學習者使用素材花費時間

學生代碼	每次你都花多少時間學習？(小時)
S1	1
S2	1
S3	0.6
S4	1
S5	1 ~1.5
S6	0.25
平均	0.8

(2) 學習者課堂行為的改變

此系統性自主學習模式搭配課堂時間評量漢字學習結果，因此，教師的課室觀察也很重要，紀錄裡也發現，雖然課堂的後測測驗不影響學生的該班成績，然到了實驗第二次時，提早到的學生開始會主動在後測評量前，拿起研究團隊提供的小書或字卡複習。

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

> 施測者習慣於剛上課時先做後測測驗，因為學生習慣這樣的模式，如果提早到了教室都有拿起小書或 AR 字卡複習的習慣，但是都是視覺型的閱讀複習(教師觀察記錄 20180515)。

而實驗進行至第四次時，此時小書和 AR 卡都進行兩輪了，教師觀察記錄發現有兩位學生(S1, S5)將小書的內容整理至自己的筆記，後測時，學生則複習筆記，筆記內容包含研究教材的內容如部件、延伸字、拼音、生詞，因此，似乎學生的漢字自主學習行為也因實驗的系統性和階段性設計有了些正面的影響。

> 今天發現，S1、S5 有另外將小書內容統整在自己筆記上的習慣，所以進行小書後測前，他們看的不是小書，他們是看自己的筆記。筆記上的內容是「漢字部件-擁有那些部件的漢字和拼音-生詞範例」，但是使用 AR 字卡的週別，學生並不會另外統整筆記 (教師觀察記錄 20180517)

然而，在 AR 字卡週時，卻沒有做筆記的習慣，推測是數位形式設計問題使然，此情況在第一次實驗時，曾有學生反應過影片的速度較快，瀏覽時無法同時寫字，推論此可能是沒有做筆記的原因，可做為未來研究修正參考。

> S3 一邊聽 AR 小卡的背景音樂，一邊試圖寫下漢字，但因為速度對於她來說有點太快，她無法即時看筆順再低頭寫下漢字(教師觀察記錄 20180503)

整體來說，本研究的規律性、系統性和階段性自主學習輔以課堂時間評量的模式漸漸改變了學生對漢字學習的課堂行為包含測驗前主動複習字卡或小書，複習自行整理的筆記。可推論此類的實驗模式適合與教師課程相互搭配，一來不占用過多課堂時間，二來也能提升學生在自主漢字學習上的積極度與成效。

(3) 操作兩類漢字素材的情形

藉訪談學習者使用兩類素材的情形，發現對於不同形式的素材其操作方式也不同。以 AR 自學的結果顯示(見表 10)，5 位學生(S1, S3, S4, S5, S6)都一致表示會(1)檢視部件意義，以及(2)檢視部件，全部的學生都利用手機掃描字卡瀏覽 AR 漢字影片。由此可見，初級的學習者面對自學漢字時，他們會嘗試接觸互動式動態的多媒體資訊，字義和部件是他們的重點學習項目，可推論 AR 輔助的動態內容讓學生產生好奇心，而更趨使其瀏覽字卡以及延伸字的互動 AR 影片。

表 10 學習者操作 AR 字卡的行為

AR	學生代碼	人數
1.check the meaning 2.check the characters	S1, S3, S4, S5, S6	5
3.use the mobile device to check the videos	S1, S2, S3, S4, S5, S6	6

小書素材的結果顯示，因所有的素材(含字卡與小書)都是紙本為主，學習者操作狀況就顯得多樣，而整體來說，平均約莫四種重點策略(如表 11)。表 11 顯示，3 位學生(S1, S4, S6)學習過程中檢視字義，3 位學生(S1,S2, S3) 利用小書找部件延伸字，2 位學生(S3, S5)檢視筆順與部件(S3, S4)，S6 利用小書檢視拼音。

表 11 操作小書的行為

小書	學生代碼	人數
check the meaning	S1, S4, S6	3
use the book to check the words	S1, S2, S3	3
check the characters	S3, S4	2
check stroke order	S3, S5	2
check the pinyin	S6	1

綜合來看，於 AR 自主學習漢字週時，半數學習者將重心放於字義以及延伸字詞學習，即是 AR 動態學習內容，1、2 位學生投入多一點時間在字卡的筆順與部件上。同樣的在小書學習週時，有半數以上的學生在小書的延伸字詞上下功夫，字卡所花費的工夫也不少，處理的學習項目較多樣，除部件形音義外，還有筆順、延伸字、詞、拼音。

4.3 學習型態

本研究進一步藉由訪談紀錄以及教師觀察紀錄歸納學生學習型態。綜合小書和 AR 素材來看，6 位學習者的學習型態都並非單一類型，且分別受兩類素材的影響。首先，以視覺型、讀寫型、聽覺型三類分類。

論視覺型，表 12 顯示 6 位在 AR 學習和小書學習時都利用視覺學習，一致性表示會藉瀏覽 AR 漢字影片學習部件的延伸漢字；而小書學習時，視覺型的學習目的性種類較多。表 13 顯示小書學習時，4 位學習者(S1, S4, S5, S6)利用小書記憶漢字，有 4 位學習者(S1, S2, S3, S4)認為小書的模式學習時易於掌控和鎖定學習範圍， 3 位學習者(S3、S4、S6)在課程中會主動翻閱小書，並觀察小書的漢字，1 位學習者(S4)認為小書認讀字較快。綜論之，不論是 AR 或小書所有學習者的策略都專注於一個目的——認讀漢字，數位素材可能礙於載具操作的自由度限制了視覺型學習策略使用。

表 12 訪談紀錄分析視覺型學習者

素材	人數	學生代號	反饋
AR	6	S1、S2、S3、S4、S5、S6	看漢字影片
小書	6	S1、S2、S3、S4、S5、S6	(見下表)

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

表 13 小書的視覺型策略與反饋

人數	學生代號	反饋
4	S1、S4、S5、S6	協助記憶漢字
4	S1、S2、S4、S3	易於鎖定範圍
3	S3、S4、S6	學習小書的漢字
1	S4	認讀文字快

動覺型學習意指學習者身體親自體驗操作，以書寫、觸摸等動作指令為主要學習手段。兩種素材提供了學習者不同的動態學習模式，6 位學生其中有 5 位是屬動覺型的學習者。表 14 顯示在使用 AR 素材時，4 位學習者(S1, S4, S5, S6)表示會使用智慧型載具掃描字卡啟動 AR 的互動影片記憶延伸字，2 位(S3 和 S5)比起靜態的小書，他們更常藉著載具操作、瀏覽 AR 影片動態依序呈現學習漢字的結構。表 15 也顯示小書的 4 位學生採取翻閱紙本的方式查閱漢字內容，2 位學生(S3, S6)會在小書上書寫或是做筆記。這些互動性動作是啟動學習者動覺型策略的佐證。

表 14 兩素材之動覺型學習反饋

素材	人數	學生 ID	反饋
AR	4	S1、S4、S5、S6	手機掃描互動性 AR 學習漢字意思
	2	S3、S5	手機掃描互動性 AR 檢視漢字結構
小書	4	S1、S2、S3、S4	翻看查閱
	2	S3、S6	書寫

論聽覺型，聽覺型學習者對於環境聲音較敏銳，需要絕對安靜或是不同類型環境聲音等學習空間，其學習的特性偏向以聽講、錄音、講故事、音樂、談話、提問、念讀等方式進行學習，環境聲音也影響著其學習行為。表 15 顯示學習者在 AR 學習週時，所驅動的 AR 動態影像下的背景音樂會啟動 2 位學生(S3, S6)之學習策略。如 S3 在 AR 影片的音樂聲中，寫下漢字；S6 聽到小卡背景音樂後會很興奮，學生在看影片的過程中也能讓其學習較集中，不因影片速度與個人學習速度不同而失去耐性 。本研究之 AR 影片採用背景音樂而非錄製人聲，因此，聽覺型學習者可能因音樂而降低學習焦慮增加學習樂趣，故音樂對聽覺型學習者來說，是啟動學習的關鍵。

表 15 訪談紀錄分析聽覺型學習者

素材類型	人數	學生代號	反饋
AR	2	S3、S6	喜歡聽小卡背景音樂

進一步綜合分析歸納 6 位學生的學習型態，表 16 顯示以視覺和動覺學習的人數較多，尤其是此研究中全數的學習者皆為視覺型學習者。以聽覺學習的人數少了一半以上，僅有 2 人，故在漢字學習上，仍以視覺和動覺學習為主。不論素材類型，可歸納兩類學習者:(1)視覺、動覺與聽覺三項合併學習者共 2 位(S3、S6)，約 1/3 的學習者， (2)依據學習素材的型態，視覺與動覺合併學習者人數約為 5-6 位，(3)單一型態傾向者，似乎於本研究中沒有對應的學習者。綜合論之，漢字學習時，多數

以上的學生會採用視覺、動覺兩種合併的學習型態，以協助其達成學習成效，且仍有 1/3 學習者受到聽覺的影響，因此，音樂或語音的資訊也是教材設計可考量因素。

表 16 依據訪談資料歸納每位學生的學習型態

學生代碼	視覺		動覺		聽覺	
	AR	小書	AR	小書	AR	小書
S1	V	V	V	V		
S2	V	V		V		
S3	V	V	V	V	V	
S4	V	V	V	V		
S5	V	V	V			
S6	V	V	V	V	V	
人數	6	6	5	5	2	
百分比	100%	100%	83%	83%	33%	0%

4.4 學習教材的觀感

本研究欲理解學習者對此自主學習模式下對教材的學習觀感，並分析學習者的訪談資料、統整學習者的看法，再分別從有用性以及易用性角度分析與歸納。

(1) 整體的觀感

整體來說，表 17 顯示結果很平均，各有 3 位學生在自學時候對兩類型的漢字學習教材表示能幫助其記住漢字，AR 數位以及小書的漢字素材各有 50%的支持者，AR 素材支持者為 S1、S3、S5，而小書支持者為 S2、S4、S6，此結果顯示學習者並沒有對某種素材喜好的趨向性，觀察學習者之語言背景的漢字文化圈與否也沒有特定的傾向，然以學習型態來看，兩種學習型態合併者也都各占一半。

表 17 學習者對漢字素材喜好

哪一個幫助你記住中文字?	學生代碼	人數
AR video	S1, S3, S5	3
Books（小書）	S2, S4, S6	3

(2) 科技接受模式分析: 認知有用性與認知易用性

進一步以科技接受模式中的「認知有用性」及「認知易用性」觀察學生喜好的原因，也了解其學習態度及使用意向。以有用性以及易用性兩項指標來分析，表 18 顯示 3 位支持小書者(S2、S4、S6)表示小書具易用性，意味著學習者使用小書因其易掌控自己的學習內容，如翻閱至自己想學習的內容(S2、S4)，以及易隨著自己的學習速度而學習漢字(S6)。

而 AR 素材亦有 3 位支持者(S1、S3、S5)表示其內容的有用性，如 S1 指出啟動 AR 後，可學習更多漢字，S3 認為 AR 影片的漢字依序地呈現字的結構正如有人標

記出漢字部件引導漢字結構，此設計助益大，S5 認為 AR 影片一步步速度撥放字的結構也幫助他學習。因此，看得出來小書紙本教材更趨近於易用性和 AR 教材的動態呈現趨近於漢字學習的有用性。

表 18 科技接受模式「認知有用性」及「認知易用性」之訪談內容

項目	反應素材以及內容	反應人數	學生代碼	訪談內容
易用性	小書容易翻讀，也可掌控自己學習的內容以及速度。	3	S2	如果我用書，我可以一直看那個字，我不知道，我知道的我不需要看。
			S4	I prefer the books because you can like watch whatever you want and the video are a bit too slow.
			S6	因為 對我 小書比較方便 比較 I can 快比較 like easy to study?
有用性	AR 影片有趣、容易學習	3	S1	我覺得 AR video 的漢字比較多 還有…這個有意思…所以我看的時候…我常常使用 AR video
			S3	I think the videos.
				Because we can see like characters. I don't know... like someone is writing it, so we can see like how supposed to be written.
			S5	So I prefer to use the app because it’s would be like appear step by step slowly and I quite find interesting

然數位教材面臨技術性的議題，3 位學習者(S2、S4、S6)對 AR 素材的不易用性表示意見。表 19 顯示 3 位學習者都認為 AR 影片播放速度對他們來說稍慢，且 3 位學習時都喜歡翻閱小書，因此認為 AR 影片素材無法掌控前後資訊的播放是可惜的。

表 19 AR 素材之不易用性

項目	人數	學生代碼	反饋
AR 素材無法筆記	1	S6	手機 app 上面我不能 like 寫漢字，可是 paper 的上面我可以寫，所以 你可能幫忙我們學中文
AR 影片內容撥放慢	3	S2	它的 transition 太慢了，所以要等，所以要看久一點。
		S4	I prefer the books because the video was like a bit slow
		S6	因為那個 action from one 漢字 to the other 漢字 it's 我覺得很慢
AR 操作線性	2	S2	我感覺用 AR，如果我已經知道第二個字，還有我忘了第五個字，我要看第五個字，我要等那個四個字過才能看到第五個字。因為我不能 choose next, next, next…所以要等，要等，所以我的時間要過了。
		S6	我覺得這個 app 很 cool. It's like 3D 我覺得很 cool. 可是一點忙

綜合論述，論小書和 AR 兩類漢字學習的教材時，分析結果指出傳統紙本翻閱以及輔以智慧型手機學習的數位模式，都有各半數的喜好者。各自學習者支持的原因源自於教材形式原有特質，以傳統小書來說，具備可翻閱以及做筆記的特質，學習者易掌控學習內容，因此傾向於對小書形式的易用性讚許。數位 AR 素材則是其依據學習步驟設計動態呈現學習內容，且搭配顏色標記等的特點，學習者傾向於對 AR 教材內容理解的有用性，然數位形式的學習內容，撥放教材也不受喜愛主控性高的小書學習者青睞，因此，也同步呼應學習者之學習型態影響其對教材形式的看法。

5. 研究結果與結論

漢字學習對華語初學者來說是極具挑戰性的，對教師來說，也是相對耗時的項目，中文為二語和外語的初學中文時該不該介紹漢字的議題也有不少的討論(Poole, 2015)。在科技發展的推波助瀾下，教師可利用的教材形式更加多元，不但有數位形式更可結合非數位形式的素材尋求對學習者最有用以及最容易使用的漢字學習內容。同時，教師的教學型態以及資源亦可漸漸將主導權轉換至學習者，鼓勵學生自主學習，並同時搭配課程進度，不失是一個完美的解套的方法。Ya 與 He(2020)指出 AR 教材能促使學習者更加專注於學習內容與細節，Liu 和 He (2014)建議以學習者為中心的課程、配合學生的教學型態、有調整課程與擴展學習方式的自由度三條件可提高語言學習的效能。因此本研究搭配傳統紙本以及數位 AR 多元的自主學習的漢字教材，以部件、字、詞系統性、階段性的漸進式讓學習者小單位自己藉由漢字學習教材的操作，輔以規律的評量以建構漢字認讀的概念，提高漢字學習成效。

本研究經過六次的反覆學習循環以及評量，研究結論如下。首先，規律的提供小份量自主學習的內容搭配定律的評量，即使課堂中沒有教授的內容亦能讓初級學習者慢慢建構漢字認讀的基本能力。從研究測驗結果得知，學習者在小書和 AR 教材的引導下，是進步的，雖然未達顯著。基於 Mayer (2005)的多媒體學習認知理論，大腦的認知負荷量有限，每次資訊約是 5 至 7 的小單位，可有效處理。正呼應本研究之研究設計，每週學習 7 至 9 個部件以及其延伸字，學生不易感到壓力，大腦認知學習上也不易超出負荷。因此，教師於自主學習分配上能採用分段式的學習，或許困難的學習項目在難度拆解下，能讓學生慢慢的習得知識，此結論也與黃馨誼與陳又菁(2013)的研究結果相似。

其次，教學素材的類型啟動學習者的學習策略。於研究訪談以及教師觀察紀錄顯示以傳統紙本書冊（小書）的類型來看，其有助於學習者書寫也促使初學者動筆記下學習資訊，比如寫下拼音或是記下各自整理的重點。AR 教材則以手機瀏覽，然教材設計需具備引導學習者注意力並依序學習特點，即能藉由數位形式讓大腦注意資訊並有效處理資訊，如本研究的部件結構以動態和顏色呈現，於瀏覽時，學習者觀看字的結構，以集中注意力建構認讀漢字結構。因此，漢字自主學習的教材可善用數位以及非數位形式的特質以誘發不同學習者的學習策略。

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

第三，當比較紙本和 AR 兩種自主學習教材形式時，對學習成效影響沒有差異，與 Ye 和 He(2020)的研究結果相似，其結果指出圖像式和 AR 輔助的漢字學習教材對於學習者漢字認讀的能力皆可提升但兩者卻沒有顯著的差異，而本研究的小書和 AR 教材都能提升學習者漢字認讀能力，但兩者比較時沒顯著差異。依據本研究之學習型態分析，也推論學習者都屬於多重學習型態者，且多數是視覺以及動覺合併型的學習者，因此，紙本小書和 AR 都能啟動學習者視覺刺激、親自翻閱、操作行動載具掃描資訊等動能學習行為。故推測是無差異的主因之一。

第四，傳統紙本教材可翻閱的主控性使的學習者同意教材的易用性，而 AR 教材內容於漢字結構的動態顯示以及標示提示的數位形式，使的學習者同意數位教材對於漢字認讀概念建構的有用性。本研究資料顯示初級學習者於教材形式的認同呈現各半數的支持者，此結果呼應了 Mayer (2003)的觀點，認為學習者在多媒體的學習環境裡，若學習者能掌控「學習步調」與「順序」，能學得更好。不論傳統的紙本小書或是數位的 AR 形式皆提供了學習者學習步調與順序的特質與彈性。

最後，本研究的結果發現多數的學習者都偏向混和型的學習型態，且多數是視覺與動覺行混和型態的學習者，此亦提醒教師們教學時要擴展自己教學素材的多元性才亦滿足學習者，同步也能促進學習者有效學習，正如 Murat (2013)提出課程的教材與設計應具備彈性，讓學生能從中發展出適合自己的學習型態與策略。

以上結果意味此類系統性輔助自主學習融合多元漢字傳統素材與數位素材模式可提升初級漢字認讀能力，且其具備不占用課堂時間、解決教師教學時數不足的顧忌、滿足學習者學習策略與型態的需求，具備多方面的優勢，華語教師可鼓勵初級外籍生以自主學習輔以課堂學習之漢字學習模式習得。另一方面，為排除課室可能的干擾因素，實驗的課程，其教學內容不干擾學習者漢字學習的內容，若將其運用於非實驗性的教學現場時，可進一步發展對應的課室教學策略，以為教學與師資培訓單位參考，具有教學應用的可能性很高。

6. 研究限制與建議

本研究屬課室研究，因此，部分設計貼近於教學現場的狀況，以下匡列本研究限制並提出未來研究建議。首先，本研究因單一課室研究受限於該班選修課程人數以及缺曠課影響，因此樣本數少亦有缺資料的風險，未來的研究可納入更多班級的學習者，進一步判別本研究之自主學習模式的可行性以及學習成效，亦可於量較多的資料下驗證學習者之學習型態的差異。第二、研究對象為成人學習者，且都在台灣的大學學習的國際交換生，其學習需求是滿足其學術成就，此狀況可能與短期學習者和其他年齡之學習需求有異，因此，未來研究可針對不同年齡學習者如青少年或是兒童的課堂進行課堂研究，輔以自主學習的模式，進一步統整與比對年齡和不同背景者對此模式的學習狀況與觀感。第三、不同語言程度的學習者所需不同的自學項目，未來研究可針對中級或高級學習者自主學習的語言項目研討。

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

參考文獻

Azuma, R. T. (1997). A survey of augmented reality. *Presence: Teleoperators & Virtual Environments*, *6*(4), 355-385.

Bandler, R., & Grinder, J. (1979). *Frogs into princes: Neuro-linguistic programming*. Real People Press.

Barreira, J., Bessa, M., Pereira, L.C., Adão, T., Peres, E., & Magalhaes, L. (2012). MOW: Augmented Reality game to learn words in different languages: Case study: Learning English names of animals in elementary school. *7th Iberian Conference on Information Systems and Technologies (CISTI 2012)*, 1-6. https://ieeexplore.ieee.org/document/6263236

Cheng, H. J. (2017). Examining pre-service Chinese teachers' multimedia design: A CTML-based quantitative study, *Journal of Technology and Chinese Language Teaching*, *8*(1), 16-35.

Chuang, H. Y., & Ku, H. Y. (2011). The effect of computer-based multimedia instruction with Chinese character recognition. *Educational Media International*, *48*(1), 27-41.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340. doi: 10.2307/249008

Herrmann, N. J. (1991). Creative. *Behavior*, 4, 275-295.

Ho, S. C., Hsieh, S. W., Sun, P. C., & Chen, C, C. M. (2017). To activate English learning: Listen and speak in real life context with an AR featured U-learning system. *Educational Technology & Society*, *20*(2), 176-187.

Hsu, T. C. (2017). Learning English with Augmented Reality: Do learning styles matter? *Computers & Education*, *106*, 137-149.

Hsu, Y. J., & Huang, Y. Y. (2017). Exploring the Impact of Augmented Reality M-Learning on Learning Style and Learning Efficiency in the Museum Guide. *Taiwan Educational Review Monthly*, *6*(1), 202-222. [許于仁, 黃一倚. (2017). 探討擴增實境式行動學習在博物館導覽中對學習風格與學習成效之影響. *臺灣教育評論月刊*, *6*(1), 202-222.]

Huang, H. Y., & Chen, Y. J. (2013). Research on the effects of learning style and presentation on learning outcomes and cognitive load [paper presentation]. *The 9th International Conference on Knowledge Community*, Taipei, Taiwan. [黃馨誼、陳又菁. (2013). 現對學習成效與認知負荷影響之研究. *第九屆知識社群國際研討會*, 台北, 台灣]

Huang, P. R. (2006). *Theory and practice of Chinese character teaching*. Lexue shuju. [黃沛榮. (2006). *漢字教學的理論與實踐*. 樂學書局有限公司.]

Huang, P. R. (2012). The radicals of Chinese characters and their pedagogical issues. *Journal of Chinese studies Chinese Culture University*, 24, 19-44. [黃沛榮. (2012). 漢字部首及其教學問題. *中國文化大學中文學報*, 24, 19-44.]

Kolb, D.A. (1981). Learning styles and disciplinary differences. In A.W. Chickering (Ed.), *The modern American college* (pp. 232–255). Jossey-Bass.

Lee, L. C., & Hao, K. C. (2005). A research of Augmented Reality on interactive English digital learning materials —A case study of 3 games for the 5th graders of elementary school. *International Journal of Digital Media Design*, *5*(1), 51-64.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

[李來春, 郝光中. (2013). 擴增實境應用於互動式英語教材教學之研究——以國小五年級英語三個單元為例. *國際數位媒體設計學刊*, *5*(1), 51-64.]

Liu, J., & He, Q. (2014). The match of teaching and learning styles in SLA. *Creative Education*, *5*(10), 728.

Liu, P. E., & Tsai, M. (2013). Using augmented-reality-based mobile learning material in EFL English composition: An exploratory case study. *British Journal of Educational Technology*, *44*(1), 1–4.

Lin, C. H. (2020) An exploration of proper multimedia arrangement for Chinese character learning based on cognitive load theory: An example with preschool students. *International Journal on Digital Learning Technology*, *12*(1), 1-22.

Mayer, R. E. (2003). The promise of multimedia learning: using the same instructional design methods across different media. *Learning and Instruction*, *13*, 125-139.

Mayer, R. E. (2005). Cognitive theory of multimedia learning. *The Cambridge handbook of multimedia learning*, *41*, 31-48.

Murat, G. (2013). The effect of students' learning styles to their academic success. *Academic Journal*, *8*(17), 1634-1641.

Poole, F., & Koyin, S. U. N. G. (2015). Three approaches to beginning Chinese instruction and their effects on oral development and character recognition. *Eurasian Journal of Applied Linguistics*, *1*(1), 59-75.

Ramya, G., & Madhumathi, P. (2017). Adopting Augmented Reality for English language teaching and learning. *Language in India*, *17*(7), 352-360.

Shen, H. (2014). Level of cognitive processing: Effects on character learning among non-native learners of Chinese as a foreign language. *Language and Education*, *18*(2), 167-182.

Shu, Z. M., & Lin, C. H. (2007). Teaching experiment of multi-media orthographic Chinese characters strategy. In *International conference on internet Chinese education.* Overseas Compatriot Affairs Council, Republic of China (Taiwan) (pp. 221-232). [舒兆民, 林金錫. (2007). 多媒體正體漢字之策略教學實驗. *第五屆全球華文網路教育研討會網站論文集*. 中華民國僑務委員會, 221-232.]

Solak, E., & Cakir, R. (2015). Investigating the role of Augmented Reality technology in the language classroom. *Croatian Journal of Education*, *18*(4), 1067-1085.

Tse, S. K. (2000). *Comprehensive and effective teaching and learning of Chinese characters.* Greenfield Educational Center. [謝錫金 . (2000). *高效識字法*. 青田教育中心.]

Werner, K. (2003). *Learning style awareness and the appropriate prescription of study strategies to improve student understanding of work/study habits* [Unpublished doctoral dissertation]. University of Alaska Anchorage.

Wu, C. H., & Tsai, Y. C. (2014). Using technology acceptance model for investigating the social network website *Facebook* usage intention. *Journal of Liberal Arts and Social Sciences*, *10*(1), 29-44. [吳智鴻, 蔡依錞. (2014). 以科技接受模式來探討社群網站 Facebook 的使用意圖. *國立臺灣科技大學人文社會學報*, *10*(1), 29-44.]

Yan, H., & He, X. (2020, July) The Impact of Interactive AR on Learning Ability of Children's Chinese Characters Self-learning. In T. Ahram & C. Falcão (Eds.), *Advances in usability, user experience, wearable and assistive technology. AHFE*

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

2020. Advances in Intelligent Systems and Computing, 1217, 684-689. Springer, Cham. https://doi.org/10.1007/978-3-030-51828-8_90

Zhan, H., & Cheng, H. J. (2017). Multimedia-assisted Chinese character second language acquisition: Is more interaction actually better? In M. Chang, M. Jong, T-W. Chan, S. Yu, F. Wu, B. Li, W. Chen, C-K. T-C. Hsu, T-Y. C-Y. Chuang, C-Y. Hsu, Y. Zhou, M. Liu, G. Chen, C-C. Chang, & S. Tu (Eds.), *Conference Proceedings of the 21st Global Chinese Conference on Computers in Education 2017* (pp. 355-364). Global Chinese Society for Computers in Education.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

附件一 前後測範例

第三週前測

Pretest week 3

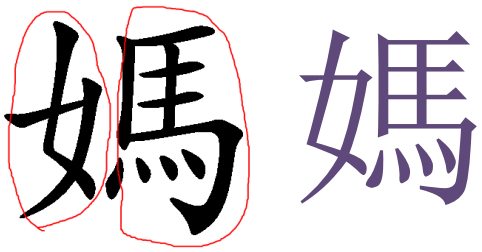
Name:_____ Nationality:_____

一、Please write down the pinyin of the radicals.

Example	馬
Pinyin	**mǎ**

radicals	巾	口	扌	氵	心	忄	戈	戶
Pinyin								
meaning								

二、Please find the radicals of each characters that you could recognize by **coloring** the radical(s).



Example

1	吃	錢	情	法	問	怎
2	可	名	忙	沒	懂	市
3	幫	所	思	我	您	唸
4	師	打	常	叫		

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

第三週後測-第一頁/共兩頁

Posttest week 3

Name:_____ Nationality:_____

1. How much time do you spend in the radical cards?
_____
請問你花多少時間?

2. What do you do when you are using the radical cards?
_____
在用字卡的時候，你會做甚麼?

☐ Only read the cards 讀卡	☐ check the stroke order 看筆順
☐ check the meaning 看翻譯	☐ use the mobile device to check the videos 看影片
☐ Others 其他	

3. Do you think these radical cards are helpful for you to finish the exercises from class? Yes / No__
你覺得字卡可以幫你完成老師的作業嗎?
If yes, which parts?
如果是，哪一部分?

☐ radical 部件	☐ stroke order 筆順
☐ meaning 翻譯	☐ videos 影片
☐ Others 其他	

4. How do you like the AR videos?
你覺得影片怎麼樣?

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

第三週後測-第二頁/共兩頁

一、 Please write down the pinyin of the radicals.

Example	馬
Pinyin	**mǎ/ㄇㄚˇ**

radicals	巾	口	扌	氵	心	忄	戈	戶
Pinyin								
meaning								

二、Please find the radicals of each characters that you could recognize by **coloring** the radical(s).

Example 媽 媽

1	吃	錢	情	法	問	怎
2	可	名	忙	沒	懂	市
3	幫	所	思	我	您	唸
4	師	打	常	叫		

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Using Online Applications to Enhance Phonetic Acquisition among Learners of Chinese
(网络应用对汉语学习者语音习得的有效性研究)

Xu, Hongying
(徐红英)
University of Wisconsin-La Crosse
(威斯康星大学拉克罗校区)
hxu@uwlax.edu

Li, Yan
(李艳)
University of Kansas
(堪萨斯大学)
yanli@ku.edu

Abstract: Previous literature shows gaps in effective ways to enhance phonetic acquisition among beginning-level learners of Chinese, including tones, initials, and finals, especially in settings outside of laboratories. The present study explored the effectiveness of integrating self-paced use of online applications in non-lab settings in helping students improve their perception and production of Chinese syllables. Three groups of participants were recruited and they underwent training in different settings: one group received four 15-minute sessions using online applications in class; one group completed the same sessions outside of class; the third group received traditional teacher-led instruction and pen-and-paper Pinyin practice in place of the practices using online applications. The two experiment groups performed similarly: both groups showed better retention of their gains after the training ended than the traditional instruction group. Learners also embraced the use of these online applications as effective learning aids.

摘要：文献显示目前对如何帮助中文初级阶段学生有效习得中文语音的研究，特别是在日常课堂环境下进行的习得研究比较缺乏。本研究探讨了网络应用在日常教学中帮助中文入门级学生习得中文语音系统方面所起的作用，包括帮助学生提高辨识、认读中文音节的准确性。一共有三组学生参加了本次研究：一个实验组在课上进行了四次 15 分钟的使用网络应用的拼音练习；另一个实验组在课下进行了四次 15 分钟的使用网络应用的拼音练习；第三组则在实验组使用网络应用进行拼音练习的时间内，在课堂内采用传统教师带领下的语音训练、在课外进行传统的纸笔拼音听力练习。结果发现实验组的学生相较对照组的学生在训练结束后较好地保持了辨识、认读中文音节的准确性。这些学生也把网络应用视为一种有效的学习辅助工具。

Keywords: Online applications, Chinese syllables, perception, production, learning experiences

关键词：网络应用、中文音节、音节辨识、音节认读、学习体验

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

1. Introduction

Intelligible speech is essential for effective communication, and good pronunciation is an integral part of that, especially for second-language (L2) learners (Arteaga, 2000; Morin, 2007; Thomson & Derwing, 2015). Good pronunciation also helps the construction of a learner's identity in the target language (Levis, 2007). Instruction and training in pronunciation in second language acquisition is indispensable if learners wish to achieve targeted proficiency. However, in the traditional language classroom setting, instruction on pronunciation is often neglected in favor of the development of other skills such as linguistic competence, writing, and so on. (Isaacs, 2009; Thomson, 2011). Studies have shown that students rarely receive sufficient instruction and feedback on pronunciation from their teachers due to a lack of time and/or appropriate resources (Collins & Munoz, 2016; Neri et al., 2010). As a tonal language, Chinese pronunciation system employs different pitch heights and contours to distinguish meaning and has some consonants and vowels that are challenging to English-speaking learners of Chinese (Chun et al., 2015; Jongman et al., 2006). For beginning adult learners, the first few weeks of exposure to the Chinese language constitutes a critical window in the development of their ability to perceive and produce Chinese sounds because adult production and perception systems demonstrate only a certain degree of plasticity (Wang et al., 1999; Wang et al., 2003).

Pronunciation training for Mandarin Chinese is closely related to Pinyin, a transliteration system using Roman letters to represent the sounds of Mandarin Chinese. Pinyin is currently the most popular tool Chinese language learners use in learning Chinese. Chinese learners not only need Pinyin to learn the Chinese sounds, but can also use it as an aid for reading Chinese texts and to key in Chinese characters on their computers (Shei, 2014). Pinyin enables adult non-native speakers to better grasp the Chinese sound system and learn new vocabulary more quickly while developing spoken language proficiency without being intimidated by Chinese characters (Everson, 2011).

The Pinyin system consists of initials, finals, and tones. The initial represents the consonantal beginning of a syllable. Finals are mainly vowels or vowels with nasal endings that follow the initial in a syllable. There are four tones in Mandarin Chinese, namely the high-level tone (T1), the high rising tone (T2), the dipping tone (T3), and the high falling tone (T4). These four tones are represented by diacritic marks that are placed over the main vowel in each syllable. The Pinyin system seems to be simpler than Chinese characters as a way for English-speaking L2 Chinese learners to learn pronunciation as it employs the same Roman letters used in English. However, learning Pinyin is not as simple as many people believe. In Pinyin, one letter may represent many different phonemes which sound very different to non-Chinese speakers. For example, the letter *e* can either be transcribed as [ê] or as [e]. The same Roman letter may represent similar yet different sounds in Mandarin Chinese and English. For example, the letter c is pronounced [ts^h] in Chinese, whereas it is pronounced [k^h] in English most of the time. Learning Pinyin means essentially learning a new orthographic system: learners need to establish the correct sound-symbol mapping while acquiring the Chinese pronunciation system. Li and Xu (2018) did a survey among instructors of Chinese and found that the majority of them

agreed upon the importance of learning Chinese Pinyin while lamenting the limited instruction time that can be devoted to teaching Pinyin in class. It would seem, then, that Chinese teachers all face this question: How to assist Chinese learners most efficiently in mastering Pinyin given the limited instruction time? Computer-assisted pronunciation training (CAPT) might be an answer. Levis (2007) reviewed major empirical studies on CAPT to discuss how technological tools that have long been used in phonological training can also be applied to teaching. These studies show that CAPT is effective in improving pronunciation accuracy and that CAPT learning transfers to novel contexts and lasts over time. There is also evidence showing that improvements in perception can lead to improvements in production (Bradlow et al., 1997). Levis (2007) pointed out that CAPT can provide individualized instruction outside of class and can also help those instructors who feel unprepared to teach pronunciation due to lack of proper training.

There have been studies on how CAPT can help L2 Chinese learners acquire the Chinese pronunciation system (e.g., Beutner, 2001; Chun et al., 2015; Godfroid et al., 2017; Wang et al., 2003). However, most of the studies focus on tone acquisition and few studies focus on the acquisition of consonants and vowels. This study, aiming to provide a possible solution to the current dilemma in Pinyin instruction and phonetic training, investigated whether CAPT can help L2 Chinese learners establish the mapping between the Chinese pronunciation system and Pinyin, including consonants, vowels, and tones.

This article is organized as follows: Section 2 provides an overview of the research on pronunciation instruction (PI) and the integration of CAPT and Chinese phonological training. Sections 3, 4, 5, and 6 describe the current empirical study, including research questions, methods, results and discussion. Section 7 draws a conclusion based on the experiment and discusses the pedagogical implications of this study. Section 8 considers the limitations of the current study and suggests directions for future research.

2. Research on Pronunciation Instruction (PI) and the Integration of CAPT and Chinese Phonological Training

Most studies on pronunciation instruction (PI) and the integration of CAPT and PI have investigated its effectiveness on learning segmental and suprasegmental features of L2 English. Saito (2012) did a synthesis of 15 quasi-experimental studies that explored the effects of instruction on the development of L2 pronunciation. Ten of the studies focused on L2 English, three on Spanish, one on French and one on Portuguese. None was on L2 Chinese. Lee et al. (2015) did a meta-analysis of PI effects based on 86 studies. They pointed out that 83 out of the 86 studies involved either L1 or L2 English and thus a more diversified sampling in research along this line was called for. Mahdi and Khateeb (2019) did a meta-analysis on the effectiveness of CAPT based on 20 studies. Nineteen out of the 20 studies focused on L2 English. Because the relation between L1 and L2 has an impact on the acquisition of L2 pronunciation (Flege, 1995; Thomson, 2011), the skewed sampling (a majority of the studies in L2 English) in PI and CAPT research could be affecting the generalizability of the findings from these studies to the instruction of pronunciation in other target languages, including L2 Chinese.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Among the studies on the training of students in Chinese pronunciation, there are many that focus on helping students improve either their perception or their production of Chinese tones, and the majority of these studies concern themselves with auditory training (Zhang, 2018). Wang et al. (1999) found that intensive tone training in a lab setting could improve L2 Chinese learners' perception of tones. This kind of training can also facilitate production (Rochet, 1995; Wang et al., 2003). A similar trend appears in CAPT research on the training of L2 Chinese pronunciation. Most studies focus on the perception or production of tones after some CAPT intervention. Beutner (2001) found that using computer-assisted interactive feedback helped L2 Chinese learners improve their tone production. Chun et al. (2015) found that L2 Chinese learners' tone production improved after they compared the visualizations of the tones they produced with those created by native-speakers. Godfroid et al. (2017) explored whether the types of cues, used alone or together, had an impact on the training effects of learners' perception of Chinese tones and they found that dual-cues did not offer an advantage over single-cues and that pitch contours and numbers worked better as cues than colors. However, the studies were all conducted in a lab setting. Can similar but more flexible training be conducted out of the lab to assist learners' acquisition of the Chinese pronunciation system? As Thomson (2011) points out, there is a gap between the findings from experimental studies and actual classroom implementation. More studies in classroom settings with training procedures that can be mimicked more easily in similar situations are clearly needed.

However, some studies (Olsberg et al., 2007) discovered a dependence of tone perception on syllable perception. They found that once the spectral information was removed or filtered, subjects' ability to identify the tones decreased. Sharma et al. (2015) found that native speakers of Chinese had as much trouble identifying finals in non-word syllables as they did identifying tones. Lin and Lin (2010) found that vowel information was available earlier than tonal information in native Chinese speakers' perception of monosyllables. Hu (2009) found that both native speakers of Chinese and L2 Chinese learners performed better in perceiving a whole syllable than in perceiving tones, initials, and finals. There was no significant difference in their perception between tones and finals. Pytlyk (2011) established that orthographic information exerts influence on L2 learners' perception of phonemes and whole syllables. All of the studies indicate that initials and finals should be part of the training process though more research is needed on how to help learners improve their perception of initials and finals.

Research from previous studies in the areas of both PI and CAPT has shown that production is closely linked to perception (Baker & Trofimovich, 2006; Flege, 1995; Thomson, 2011). As Thomson (2011) puts it, "in most cases, pronunciation inaccuracies betray underlying perceptual inaccuracies" (p.744), therefore, "improvement in perception should allow learners to more effectively monitor their own productions" (p.749). Previous studies have shown that training in perception can result in an improvement in production (Bradlow et al., 1997; Lambacher et al., 2005; Thomson, 2011; Wang et al., 2003). Bradlow et al. (1997) found that, after receiving perception training in distinguishing between the two English consonants /l/ and /r/, L1 Japanese learners of L2 English improved their pronunciation of these two consonants. Wang et al. (2003) noted an 18% improvement in the pronunciation of Mandarin tones among L1 English L2 Chinese

learners after perceptual training. Thomson (2011) found that, after receiving computer-based high variability phonetic training (HVPT) in the pronunciation of 10 English vowels, L1 Chinese L2 English learners significantly improved their pronunciation of these vowels as measured by intelligibility. However, these studies either focused on L2 English consonants or vowels, or tone production among L2 Chinese learners. Few studies have looked into whether computer-assisted perception training might help L2 Chinese learners improve both their perception and their production of Chinese consonants, vowels and tones.

The present study fills the gaps by investigating whether CAPT used in a non-lab setting can help L2 Chinese learners establish the mapping between the Chinese pronunciation system, including tones, initials and finals, and Pinyin, and whether perception training for learners can help their production in these aspects.

3. Purpose of the Current Study

Our study addresses some of the gaps identified in the discussion above and explores the way that integrating computer-assisted training programs – online applications in this study – into the language instruction curriculum can help students improve their perception and production of Chinese syllables, including initials, finals) and tones. Specifically, this study addresses the following questions:

1) Can online applications help students improve their overall perception of Chinese initials, finals and tones?
2) Can online applications help students improve their production of Chinese initials, finals and tones?
3) Does the context of the training (i.e., in class or outside of class) have an impact on the training results?
4) How well are the online training applications accepted by learners of Chinese?

4. Methods

The study adopted a quasi-experimental design, including a pretest, the training, a post-test, and a delayed post-test. A delayed post-test was included to see if any training effects were retained after the training period.

4.1 Participants

Twenty-six English-speaking learners of Chinese from two universities in the American Midwest participated in the study. They were all beginning-level Chinese learners who had no experience learning Chinese or any tonal language before the training started. Three intact classes were used as convenient samples. The classes were put into three settings: Group 1 received the treatment (i.e., use of online applications) in class, Group 2 received the treatment outside of class, and Group 3 did not receive treatment either in class or outside of class; instead, they received traditional instructor-led training

in class (i.e., no online applications) and did traditional pen-and-paper Pinyin practice outside of class to make sure their Pinyin practice time was comparable to that of the two experimental groups. Group 1 and Group 3 were from one university and Group 2 was from another university. The groups were assigned in this manner so that the differences observed, if any, would more likely arise from training rather than possible differences in the student population, although these two universities are both located in Midwest and have a similar student composition. The pre-test showed that there was no significant differences among the groups. The study started with 33 qualified participants, however, seven participants either did not complete one of the tests or missed a training section and were thus excluded from our analysis. Table 1 summarizes the distribution of participants and their demographic information. None of the participants had any history of hearing, speech, or language difficulties.

Table 1 Demographic summary of participants

Group	*No.*	*Gender*	*Age*
Group 1: Training in class	12	M=6; F=6	20
Group 2: Training outside of class	5	M=3; F=2	19
Group 3: Traditional instruction	9	M=4; F=5	19

4.2 Materials

Two online applications were selected as training material: one is the Pinyin learning application (Pinyin Practice hereafter) embedded in the website http://www.pinyinpractice.com; the other is Pinyin Tutor (https://sla.talkbank.org/pinyin/), a website developed by a research group at Carnegie Mellon University. Pinyin Practice provides practice in different categories: tones, initials, and finals. There are also self-administered quizzes that ask students to type in the Pinyin of the sound they hear, including tones. For the practice part, learners listen to the syllables, with a choice of screen display – either characters or Pinyin, or both, or none – and then they either pick or enter the target part (tone, initial, or final). Instant feedback is given (correct or incorrect) after each attempt. Correct answers are displayed after a certain number of attempts that can be pre-set by the learner in the self-administered quiz mode, but not in the practice mode. A running tally of both successful and unsuccessful attempts is displayed throughout the process.

Pinyin Tutor provides students with a similar platform on which to practice their perception of Chinese pronunciation and to match it with Pinyin orthography. Learners listen to a target syllable or word and then type the Pinyin into a text box to indicate what they hear. If what is entered matches the sound that was produced, positive feedback (congratulations) will be given and the next target item will be presented. If what is entered is not correct, the Pinyin Tutor gives feedback on which component of the entered syllable is incorrect and lets the learner try again. Learners can also click on “Listen to Your Attempt” button to hear the sound that matches the Pinyin they have entered so that they can compare the two syllables and notice the difference. In addition, Pinyin Tutor automatically collects the incorrectly perceived syllables and keeps them through subsequent practice rounds until all the syllables are correctly entered in Pinyin. These two online applications were chosen because they are both free and can be used on any digital

device. More importantly, they both provide instant feedback, which is considered one of the most beneficial and important features for CAPT (Lee et al., 2015; Levis, 2007; Thomson, 2011.)

4.3 Measurement of Perception and Production

Participants completed one perception task and one production task on each pre-test, post-test and delayed post-test. The perception task (Task 1) had three sections, with 22 tokens in each section. In Section 1, participants listened to a syllable three times and then wrote down the initial and tone they heard as the final of the syllable was provided. Section 2 followed the same design but elicited responses only to finals and tones. Section 3 elicited responses to the whole syllable. The syllables were not selected from any textbooks. Eleven initials and 11 finals were used in the perception task. The initials consisted of two subsets: one that was easy to identify and one that was more challenging to identify as determined by findings from previous research (Hu, 2009; Pytlyk, 2011). There were two categories of finals: simple vowels, and compound vowels. The initials and the finals were then put together so that a) each initial and each final appeared four times, and b) each syllable was a meaningful syllable in Chinese (See Appendix A for a complete list of the syllables used in Task 1). The syllables used in Sections 1 and 2 were the same, though given in a different order. The tokens in Section 3 were different from those in Sections 1 and 2.

The production task (Task 2) consisted of the 44 syllables that were used in Task 1 (see Appendix B). Participants were asked to read the syllables aloud as accurately as they could. They recorded their readings and then submitted the files to a learning management system.

4.4 Procedure

Because this study was conducted at two universities instead of one, extra effort was made to keep the research context as consistent as possible. During the period in which this study was conducted, instructors of these three participating classes strictly followed the same class schedule and used the same set of instructional materials including the PowerPoint presentation on Pinyin, classroom practice materials, and assignments. These three groups differed only in the way they did Pinyin practice (using online apps vs. not using them; using online apps in class vs. using them outside of class), which is the focus of this study. In this way, except for the training methods, the input and feedback participants received was as similar as possible under the circumstances. Instructors briefly introduced Pinyin and the Chinese pronunciation system before the training started. All three groups of participants signed consent forms and then took the pre-test. In the pre-test, Task 1, the perception test, was completed in class and Task 2, the production test, was assigned as homework. The training period included four 15-minute sessions implemented over two weeks. During the training period, participants received either instructor-led in-class Pinyin training or training using online applications in class.

Group 1 participated in the training sessions using the online applications in class: they used Pinyin Practice for the first two sessions and Pinyin Tutor for the remaining two. After class, they completed worksheets on Pinyin. These worksheets provided practice on tones, initials and finals and they were designed to be completed in 15 minutes. Group 2 received traditional instructor-led Pinyin practice in class, during which the instructor listened to students' pronunciation and gave corrective feedback when needed. After watching tutorial videos that showed them how to use the online applications, participants in Group 2 completed the training sessions as after-class assignments. They were asked to practice Pinyin on Pinyin Practice or Pinyin Tutor for 15 minutes for 4 days and report the time they spent and any issues they encountered. Group 3 worked as the control group. They did not use either application, neither in class nor after class. Instead, they received traditional instructor-led practices in class, similar to what Group 2 received, and completed the same worksheets as Group 1 did after class. This design was created to ensure that the Pinyin practice each group received and completed was comparable.

Table 2 Training design and training materials

Groups	*In-class practices*	*Outside-class practices*
Group 1	On-line applications	Pinyin worksheets
Group 2	Instructor-led Pinyin practice	On-line applications
Group 3	Instructor-led Pinyin practice	Pinyin worksheets

All of the groups took a post-test right at the end of the training period and then took a delayed post-test four weeks later. Both the post-test and the delayed post-test consisted of a perception task and a production task. The tokens used in the post-test and the delayed post-test were the same as the ones used in the pre-test, but in a different order.

After the delayed post-test, a survey was given to the students in Groups 1 and 2 to collect feedback on the use of the online applications. The survey had multiple choice questions, Linkert-scaled questions, and open-ended questions. Please see Appendix C for the whole survey.

4.5 Data Coding

The authors graded Task 1, the perception task, manually. In this task, students heard a sound and then provided a missing initial, final and/or tone. The participants received 1 point for each correct initial, final and tone. Accuracy rates were calculated for a) each category: initials, finals, and tones; b) each participant, and c) each specific initial, final, and tone. The two authors graded all the answers separately and then compared the results: the two sets had been graded exactly the same way. Thus, the inter-rate reliability for this part was 1.

For Task 2, the production task, three raters in total were involved in the rating process. Two raters listened to the syllables and graded the initial, final, and tone of each syllable on a 5-Linket scale with 5 being native-like and 1 being totally unintelligible. Each rater independently rated all 26 participants on all 44 syllables recorded in the pre-test, post-test and delayed post-test. If there was only a one-point difference between the two raters, the average of the two scores was used. If the difference was more than one point,

the third rater was enlisted to listen to those syllables and rate them and the average of the three scores was used.

All of the data were first recorded in an Excel file and then exported to SPSS for statistical analysis. The student survey was distributed in hard copy and responses were entered in an Excel file and manually analyzed question by question. For the perception and production data, mixed measures ANOVAs were conducted to compare the means. The small number and uneven distribution of participants in each group reduced the power to detect significant differences, but the assumptions behind the decision to use ANOVAs were satisfied. A Quantile-quantile plot of residues was created and did not show any significant departure from normality. In other words, no group sample deviated significantly from normal distribution values. Adjustments were made when the Test of Equality of Covariance was significant.

5. Results

The results are reported based on the research questions listed in the previous section. The scores from the overall perception and from specific components, namely initials, finals, and tones, are reported first, followed by the overall production scores and specific scores from initials, finals and tones.

5.1 Results of the Perception Tests

The overall performance results of the three groups across the three perception tests are summarized in Figure 1 and Table 3. Group 1 and Group 2 show a similar trend: their perception accuracy increased over time: from pre-test, to post-test, and to delayed post-test. Meanwhile, the standard deviation declined along these tests, which means the performance within each group became more consistent. However, the same trend was not found among the students in Group 3, whose perception accuracy showed an increase on the post-test but a decrease on the delayed post-test. Likewise, the standard deviation fluctuated among the tests, which indicates that the variation within the group remained large.

Table 3 Perception accuracy rates among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Group 1 (Training in class) n=12	60.2	17.9	81.2	13.2	83.4	9.8
Group 2 (Training outside class) n=5	55.1	25.5	79.6	6.4	84.8	6.0
Group 3 (Traditional instruction) n=9	53.8	17.2	79.9	11.5	77.2	14.4

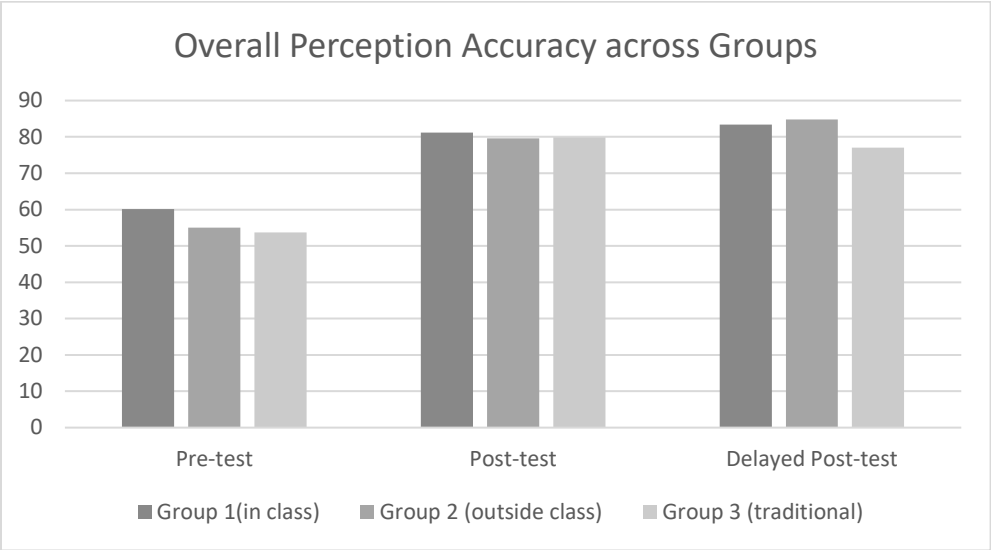


Figure 1 Perception accuracy among the groups across the tests

In order to see whether the differences among the groups within each test and across the tests were statistically significant, a mixed measures ANOVA was conducted with the within-group factor having three levels: pre-test, post-test and delayed post-test and with group as the between-subject factor. When the mixed measures ANOVA was first run, Box's Test of Equality of Covariance was significant ($p = .011$). After removing two outliers from Group 3 and one outlier from Group 1, the equality of covariance was not significant ($p = .097$). The assumption was thus satisfied. Since Mauchly's Test of Sphericity was also significant ($p = .002$), the adjusted values from Greenhouse-Geisser corrected analysis are reported here. There was a significant main effect of time: $F(1.35, 19) = 64.80$, $p < .001$. The results of pair-wise comparisons show that the accuracy rates on the post-test and the delayed post-test were significantly better than those on the pre-test. There was no significant difference between the delayed post-test and the post-test. However, there was no interaction effect between time and group: $F(2.70, 40) = .57$, $p = .69$. The results indicate that all of the groups did better after the training, and their gains were largely retained in the long term. However, the improvement across the tests did not differ significantly among the groups.

The perception accuracy rate for each category – initials, finals, and tones – was also calculated by sections in the perception test: Section 1 asked students to provide the missing initials and tones, Section 2 asked students to provide missing finals and tones, and Section 3 asked students to provide the whole syllable. The purpose of this approach was to determine whether there was any difference in the accuracy rate under different settings: either with part of the syllable provided or without. Therefore, the accuracy of initials and finals was calculated in two settings: either with finals or initials provided or without. In other words, for initials, Setting 1 means finals were provided and Setting 2 means nothing was provided, and, for finals, Setting 1 means initials were provided and Setting 2 means nothing was provided. The accuracy of tones was calculated in three settings: Setting 1 where an initial was provided, Setting 2 where a final was provided, and

Setting 3 where nothing was provided. The results of participants' perceptions of initials, finals and tones in different settings are summarized in Table 4, 5, and 6 respectively.

Table 4 Initials accuracy rates among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	Setting1 M (SD)	Setting 2 M (SD)	Setting1 M (SD)	Setting 2 M (SD)	Setting 1 M (SD)	Setting 2 M (SD)
Group 1 (Training in class) n=12	57.6 (13.2)	60.2 (9.9)	78.0 (17.2)	80.7 (11.2)	80.7 (11.2)	79.9 (11.2)
Group 2 (Training outside class) n=5	68.2 (11.1)	63.6 (19.5)	73.6 (10.9)	75.5 (11.9)	79.1 (12.7)	81.8 (5.6)
Group 3 (Traditional instruction) n=9	48.0 (20.4)	55.1 (11.7)	78.8 (13.3)	80.3 (11.8)	74.2 (12.7)	76.8 (14.1)

Table 5 Finals accuracy rates among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	Setting1 M (SD)	Setting 2 M (SD)	Setting1 M (SD)	Setting 2 M (SD)	Setting 1 M (SD)	Setting 2 M (SD)
Group 1 (Training in class) n=12	64.8 (20.2)	46.2 (22.3)	77.7 (22.3)	72.7 (16.6)	85.2 (16.5)	75.8 (18.1)
Group 2 (Training outside class) n=5	60.9 (13.5)	48.2 (22.4)	70.0 (6.9)	68.2 (12.4)	84.5 (8.3)	68.2 (14.0)
Group 3 (Traditional instruction) n=9	65.7 (17.5)	40.4 (14.5)	81.3 (14.5)	72.7 (16.9)	85.9 (12.1)	70.7 (18.6)

Table 6 Tones accuracy rates among the groups across the three tests

Groups	Pre-test			Post-test			Delayed Post-test		
	Setting 1 M (SD)	Setting 2 M (SD)	Setting 3 M (SD)	Setting 1 M (SD)	Setting 2 M (SD)	Setting 3 M (SD)	Setting 1 M (SD)	Setting 2 M (SD)	Setting 3 M (SD)
Group 1 (Training in class) n=12	61.0 (29.1)	65.2 (27.0)	66.3 (22.6)	88.6 (11.5)	85.6 (12.2)	85.2 (12.6)	85.6 (12.5)	89.0 (7.6)	87.5 (11.3)
Group 2 (Training	45.4 (48.1)	45.4 (44.9)	53.6 (42.9)	90.0 (8.1)	90.9 (9.6)	89.1 (10.0)	91.8 (9.9)	94.5 (3.8)	93.6 (6.9)

outside class) n=5									
Group 3 (Traditional instruction) n=9	55.6 (22.8)	53.5 (31.1)	58.1 (28.2)	82.3 (18.4)	83.8 (17.2)	79.8 (12.9)	79.3 (17.9)	77.3 (21.9)	75.3 (21.9)

The breakdown into initials, finals and tones followed a similar trend. Each group showed an improvement in their accuracy in perceiving the segments and tones immediately after the training period. Mixed measures ANOVAs were conducted with two within-group factors: time, and setting, and one between-group factor: group (training method). The results also showed a similar trend: the main effect of time was significant with initial ($F(2, 22) = 31.37$, $p < .001$), finals ($F(1, 23) = 44.55$, $p < .001$), and tones ($F(2,22) = 21.06$, $p < .001$). There were no significant differences between the groups in perceiving initials, finals, and tones. These results indicate that participants from all groups improved their perception significantly over time, however, this improvement did not differ significantly among the groups. However, the numerical values on the delayed post-tests show that the two groups that used applications either retained or improved their accuracy, whereas the traditional instruction group showed some decrease in their perception of initials, finals (in the setting of "initials provided"), and tones.

All of the groups showed similar accuracy in perceiving initials and tones in different settings, i.e., when either part of a syllable was provided or was not. However, the accuracy in perceiving the finals did show a significant interaction between time and setting ($F(2, 22) = 8.95$, $p = .001$.): participants from all groups increased their accuracy in perceiving the finals over time, but, although the accuracy rates were still higher with Setting 1 than with Setting 2, this increase was significantly greater in the setting in which initials were not provided (Setting 2) than in the setting in which they were provided (Setting 1). And, the performance of the two online application groups on the delayed post-test, in particular, showed that they had retained their improvement.

In summary, results from both the overall perception accuracy and the breakdown into categories of initials, finals, and tones show that there was significant improvement after the training, whether it was received through online application or traditional instruction. However, as indicated by the results of the delayed post-test, the groups that used online applications as the training method not only retained their improvement but showed further progress. Although this difference was not significant, the trend was observed across all the sub-categories. As for the settings in which the initials and tones were elicited, there was no significant difference between them. However, the setting did have a significant impact on the perception of finals: the accuracy was significantly higher when initials were provided than when they were not. However, the online applications helped them improve more in the setting without initials than in the one with initials provided.

5.2 Results in the Production Tests

In the three production tests, participants read aloud a list of 44 Chinese syllables and recorded their readings. Each syllable was rated separately by initials, finals, and tones on a 5-point Linkert scale. The overall production scores of each group across the pre-test, post-test, and delayed post-test are reported first followed by performance scores which are broken down into specific categories: initials, finals, and tones.

The results of the overall performance of the three groups across the three production tests are summarized in Figure 2 and Table 7. The raw scores were based on a 5-point Linkert-scale. They were transformed into percentages to make them comparable with the perception accuracy rates. The results indicate that all of the groups improved their overall production of Chinese syllables over time. The traditional instruction group showed a greater increase on the post-test than the two groups that used online applications. However, the two groups that used online applications showed a greater improvement than the traditional instruction group on the delayed post-test.

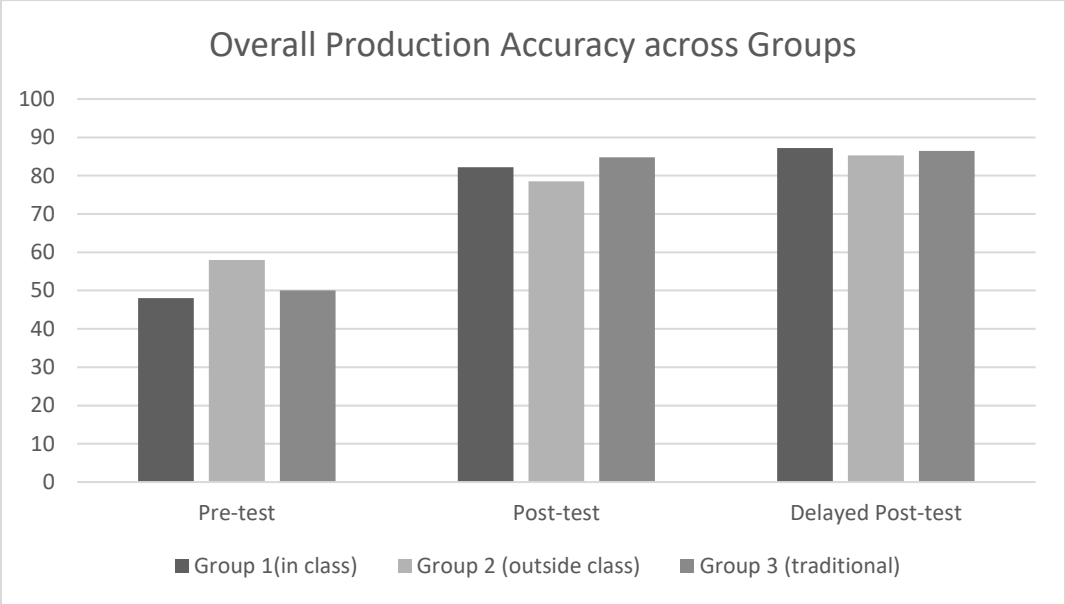


Figure 2 Production scores (%) among the groups across the tests

Table 7 Production scores (%) among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Group 1 (Training in class) n=12	48.0	17.4	82.2	11.6	87.2	6.9
Group 2 (Training outside class) n=5	58.0	14.5	78.5	9.3	85.3	6.4
Group 3 (Traditional instruction) n=9	50.0	17.1	84.8	10.9	86.5	7.7

In order to see whether the differences among the groups within each test and across the tests were statistically significant, a mixed measures ANOVA was conducted with the within-group factor having three levels: pre-test, post-test and delayed post-test and with group as the between-subject factor. Since Mauchly's Test of Sphericity was significant ($p = .003$), adjusted values from Greenhouse-Geisser corrected analysis are reported here. There was a significant main effect of time: $F(1.42, 22) = 151.16$, $p < .001$. The results of pair-wise comparisons show that the production scores from the post-test and the delayed post-test were significantly better than the pre-test ($p < .001$). The scores on the delayed post-test were significantly better than those on the post-test ($p = .012$). However, there was no interaction effect between time and group: $F(2.85, 44) = 2.19$, $p = .11$. The results indicate that all of the groups did better after the training, and their improvement continued after the training. However, the improvement across the tests did not differ significantly among the groups.

The production scores from each category – initials, finals, and tones – were also calculated. Since the results from each category were different, they are reported here one after another. Each initial, final, and tone from each syllable was rated on a 5-point Linkert scare. An average score was calculated for each participant regarding their pronunciation of the initials, finals, and tones on each test. The purpose of doing this was to gather more details about their production and their improvement after their training in order to determine whether their progress was even across these categories. The results of participants' production of initials are summarized in Table 8.

Table 8 Scores on production of initials among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Group 1 (Training in class) n=12	49.2	14.7	84.9	9.9	85.9	8.4
Group 2 (Training outside class) n=5	63.7	12.1	80.1	9.7	84.6	4.4
Group 3 (Traditional instruction) n=9	48.8	17.0	87.9	8.0	85.6	7.1

All of the groups showed an increase in their production scores on the post-test. The groups that used online applications (Group 1 and Group 2) showed less improvement on the post-test given immediately after the training than did the group who received traditional instruction (Group 3). However, both online application groups showed some improvement on the delayed post-test, whereas the traditional group showed some decrease. A mixed measures ANOVA was conducted with one within-group factor: time (three levels: pre-test, post-test, and delayed post-test) and with group as the between-group factor. There was a significant main effect of time: $F(2, 22) = 74.71$, $p < .001$. There was no significant main effect of group ($F(2, 23) = .164$, $p = .85$. However, there was a significant interaction effect: $F(4, 44) = 2.77$, $p = .038$. These results indicate that participants from all groups increased their scores in pronouncing the initials over time, but this increase was significantly different among groups over time, as discussed above.

Table 9 Scores on production of finals among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Group 1 (Training in class) n=12	47.8	16.1	78.9	15.4	84.5	8.6
Group 2 (Training outside class) n=5	52.4	12.2	72.9	8.1	81.8	7.3
Group 3 (Traditional instruction) n=9	50.3	18.9	80.0	12.2	84.9	9.1

The results of participants' production of finals are summarized in Table 9. All of the groups showed improvement in their pronunciation scores on both the post-test and the delayed post-test. The group that used online applications in class (Group 1) and the traditional instruction group (Group 3) showed equal improvement in their scores, whereas the group that used online applications outside of class (Group 2) showed less improvement. The reverse trend was observed on the delayed post-test: the groups that used online applications, especially the one that used them outside of class, showed more improvement. A mixed measures ANOVA was conducted with one within-group factor: time (three levels: pre-test, post-test, and delayed post-test) and with group as the between-group factor. There was a significant main effect of time: $F(2, 22) = 72.41$, $p < .001$. There was no significant main effect of group: $F(2, 23) = .09$, $p = .911$. There was no significant interaction effect between time and group: $F(4, 44) = .77$, $p = .552$. These indicate that participants from all groups showed a similar improvement pattern on their finals pronunciation over time.

Table 10 Scores on production of tones among the groups across the three tests

Groups	Pre-test		Post-test		Delayed Post-test	
	M	SD	M	SD	M	SD
Group 1 (Training in class) n=12	47.1	24.9	82.7	16.4	91.2	10.6
Group 2 (Training outside class) n=5	58.1	20.8	82.7	13.1	89.5	9.2
Group 3 (Traditional instruction) n=9	51.0	21.0	86.5	18.6	88.9	13.7

The results of participants' production of tones are summarized in Table 10. Similar to the scores on finals, the scores on tone production also increased among all groups on both the post-test and the delayed post-test. Both the group that used online applications in class and the traditional instruction group showed equal improvement right after the training, whereas the group that used online applications outside of class showed less improvement. However, both groups that used online applications showed greater improvement on the delayed post-test than the traditional instruction group did. A mixed measures ANOVA was conducted with time as the within-group factors at three levels, pre-test, post-test, and delayed post-test, and with group as the between-group factor. There was a significant main effect of time: $F(2,22) = 51.62$, $p < .001$. There was no significant group main effect or interaction effect between time and groups. These results indicate that

participants from all groups improved their production of tones significantly over time; however, this improvement did not differ significantly among the groups.

In summary, both the overall production accuracy and the breakdown of initials, finals, and tones indicate a significant improvement after training, whether it was through online applications or traditional instruction. However, compared with the traditional instruction group, the groups that were trained using online applications showed a more robust retention trend as indicated by their performance on the delayed post-test. Although this difference was not significant, the trend was observed across all the sub-categories.

5.3 Results of the Two Groups that Used Online Applications in Different Contexts

The results from the previous two sections include the two groups that used online applications but used them in different contexts. One group (Group 1) of participants used them in class under the instructor's guidance. The other group (Group 2) used them outside of class as assignments, and completed a self-study report. The results of their perception and production of Chinese syllables accuracy tests are re-presented in Figures 3 and 4 for readers' convenience.

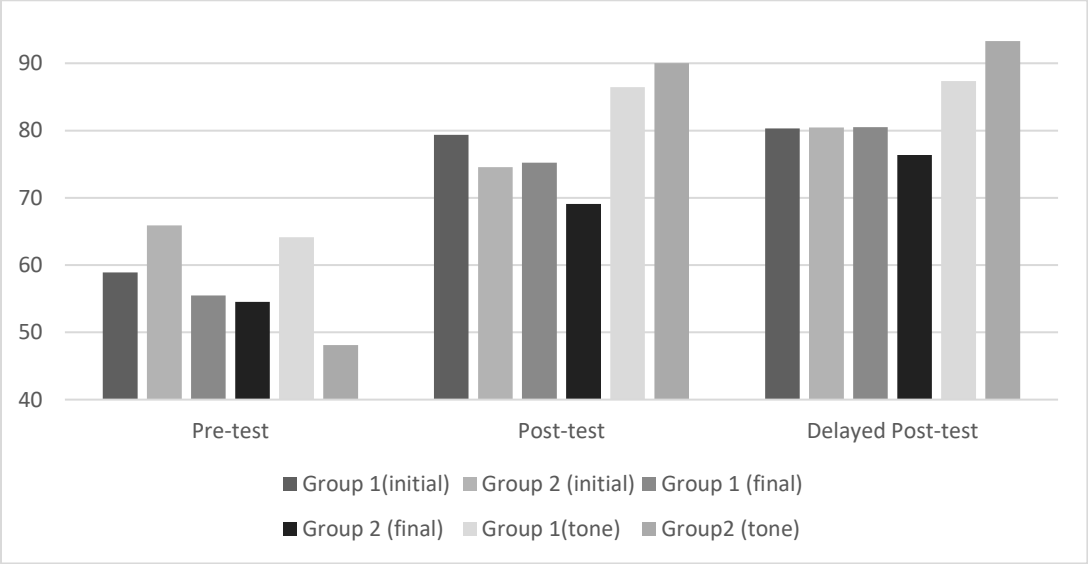


Figure 3 Perception of Chinese syllables between the two groups using online applications

As for perception, the descriptive data show a very similar improvement in both groups' accuracy over time, except for the accuracy improvement on tones exhibited by Group 2, which started at a lower rate and increased more dramatically than that of Group 1. A mixed measures ANOVA was conducted with two within-group factors: time (three levels: pre-test, post-test, and delayed post-test) and category (three levels: initial, final, and tone). There was no significant group main effect ($F(1, 15) = .066$, $p = .801$) or interaction effect among time, category, and group ($F(2.013, 12) = 3.141$, $p = .057$). The two groups showed no significant difference in their improvement in accuracy across the initials, finals, and tones over time.

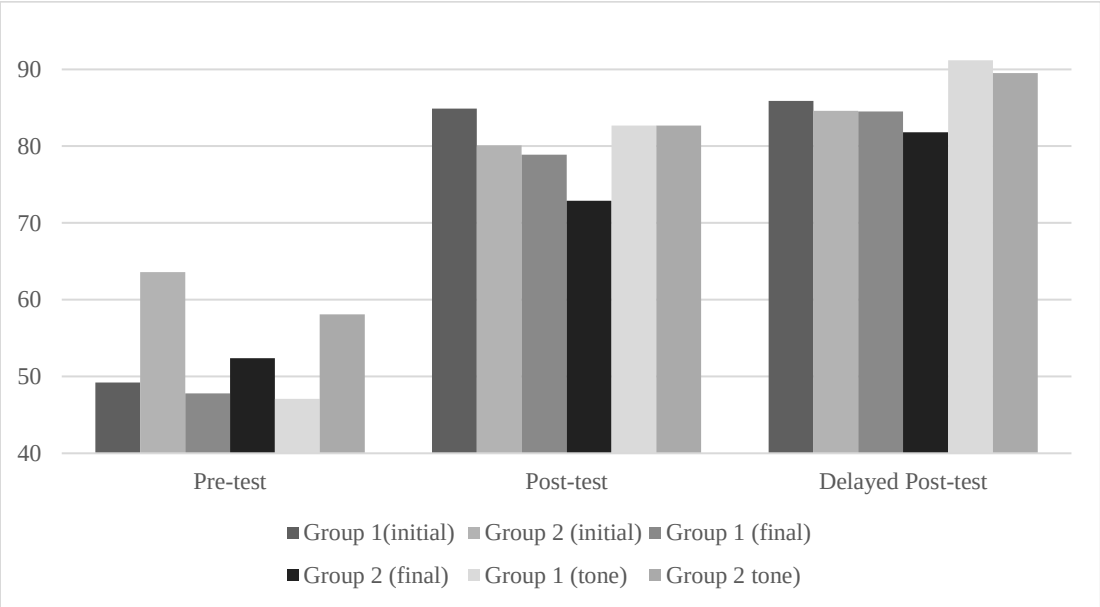


Figure 4 Production of Chinese syllables between the two groups using online applications

The descriptive data from their production of the Chinese syllables show a slightly different pattern than that of their perception. Both groups improved their pronunciation of initials, finals, and tones after the training, and retained their improvement or continued improving after the training. However, as indicated on their post-test, Group 1 showed greater improvement on their initials and tones than did Group 2. A mixed measures ANOVA was conducted with two within-group factors: time (three levels: pre-test, post-test, delayed post-test) and category (three levels: initial, final, and tone). There was no significant group main effect ($F(1, 15) = .066$, $p = .800$) or interaction effect among time, category, and group ($F(2.259, 12) = .758$, $p = .491$). However, there was a significant interaction effect of time and group: $F(1.304, 14) = 4.407$, $p = .040$. The results indicate that the Group 1 showed a significant improvement on the post-test than did Group 2.

In summary, both groups showed a similar pattern in their improvement in perceiving Chinese syllables, including initials, finals, and tones. However, Group 1 showed greater improvement in pronouncing Chinese syllables after the training, especially in pronouncing initials and tones. Group 2 did not improve as much as Group 1 but continued improving their pronunciation as shown on the delayed post-test.

5.4 Feedback from Participants on Their Experience with Online Applications

A survey was conducted to collect feedback from participants who received training using the online applications. Though the survey asked about participants' previous experience using online applications and computer technology in learning foreign languages, the main focus of the survey was on participants' experience with the online applications used in the present study, including their thoughts on the setup of the applications, their opinions about using these online applications, and their suggestions for improving their experience. See Appendix C for a complete list of the survey questions.

The analysis of their responses shows that about a quarter of the participants (23.5%) had never used any technology in learning a foreign language. Those who had used some technology, indicated that it was used occasionally. Only 30.8% of the participants indicated that they used some technology to learn foreign languages every day. Participants' experiences in using the online applications are summarized in Table 11. Overall, the participants had a pleasant experience with the online applications used in this study and were particularly happy with the instant feedback they received from both applications.

Table 11 Participants' feelings about using the online applications

Feelings about using online applications	Score*
Overall feeling	3.71
The set-up of online applications	3.65
The instant feedback provided	4.24

* The scores are based on a 5-point Linkert scale: from 1 being very unhappy to 5 being very happy

Participants' opinions on using online applications to learn Chinese syllables, including Pinyin, were also collected. They were asked to indicate to what extent they agreed with the statements listed below in Table 12 in which table their responses are also summarized.

Table 12 Participants' opinions on using the online applications

Statements	Score*
1. The online practice is very interesting.	3.41
2. The online practice is effective in helping me master pronunciation and Pinyin.	4.00
3. The online practice is hard for me.	3.18
4. The online practice helps me establish better connections between Chinese sounds and Pinyin.	4.18
5. The online practice familiarizes me with Chinese syllables.	4.06
6. I feel that, after listening to numerous Chinese syllables, I can pronounce them better.	3.82
7. I would recommend online practice to other learners of Chinese.	4.06
8. I hope to learn about other websites so that I can do more practice on my own.	4.18

*The scores are based on a 5-point Linkert scale: from 1 being strongly disagree to 5 being strongly agree

Overall, participants gave positive feedback on using online applications. They agreed that the online practice was interesting, easy, and effective in helping them master Chinese pronunciation and match sounds with Pinyin. They also perceived the online perception practice as helpful to their pronunciation. They would recommend using online applications to other learners of Chinese and would like to know about more online resources for learning pronunciation. The majority of the participants (88.2%) indicated that they either would or probably would use these applications in the future on their own.

Participants were also asked to indicate their preference between using online applications or using traditional class instruction to learn pronunciation. Their responses are summarized in Table 13.

Table 13 Participants' opinions on online applications vs. traditional instruction

Statements	Score*
1. I prefer online practice to in-class practice led by the instructor.	2.00
2. I prefer online practice to traditional workbook exercises after class.	2.71
3. I prefer using online practice in class with my teacher around to help.	3.47
4. I prefer using online practice on my own after class.	3.41

*The scores are based on a 5-point Linkert scale: from 1 being strongly disagree to 5 being strongly agree

The data show that participants were not enthusiastic about replacing in-class practice led by instructors with using online applications nor did they want to use online applications in place of traditional assignments outside of class. As for the context of using these online applications, whether in-class or outside of class, they showed a more or less neutral attitude.

An open-ended question was used to collect suggestions from participants about online applications. Some participants stated that they would like to hear about more online applications that work similarly. Some expressed a wish that the applications would provide easier access because the websites seemed a bit confusing at first. Some participants indicated that the pronunciation was hard to understand and would prefer for it to be articulated more clearly. One participant expressed a specific wish for a feature that would quiz users on the syllables they had had difficulty with.

6. Discussion

The goal of the present study was to investigate the effectiveness of online applications in helping L2 Chinese learners acquire the Chinese pronunciation system, including matching sounds with orthography. Specifically, the present study explored: a) if using online applications helped learners improve their perception of Chinese initials, finals, and tones; b) if online applications helped learners improve their production of Chinese syllables; c) if the context in which online applications were used had an impact on their effectiveness, and d) if online applications were well received by learners. It was not the goal of this study to explore whether online applications are significantly better than traditional instructor-led training and should then replace in-class instruction, but rather to explore their effectiveness and acceptance among learners so that they can be used as an extension of in-class training to meet the challenge of what has been identified as a lack of instruction time that can be designated for pronunciation training. In the following section, the results will be discussed based on the research questions the present study set out to answer.

6.1 Impact of Online Applications on Learners' Perception of Chinese Syllables

The first research question addressed the effect of online training in helping participants improve their perception of Chinese initials, finals, and tones. The results indicated that all the groups improved their perceptions of Chinese syllables significantly

after the training. There was no significant difference among the three groups' perceptions on either the post-test or the delayed post-test. However, the numerical results showed that the two groups that used online applications were better able to retain their improvement than the group that received traditional in-class instruction. The same pattern was found when their perception was tested using tokens that had been broken down into initials, finals, and tones. A similar pattern was also found in Xu et al. (2019), where the group that used an online application for tone perception training showed continued Tone 2 perception accuracy improvement whereas the group that received in-class traditional training stopping improving after the training session ended. It seems that the use of online applications has a more lasting effect than traditional in-class instruction. We would argue that this lasting effect is related to the fact that the two groups received more Chinese syllable input within the same amount of time (15 minutes) and also received more feedback on their practice from the online applications.

Some other common patterns were also identified. When focusing on the setting in which participants were required to provide the whole syllable – initials, finals, and tones – all of the groups had the most difficulty with the finals. Although the average perception accuracy of finals increased from 44.93% on the pretest to 71.21% on the post-test, and remained 71.55% on the delayed post-test, of the three categories, it still had the lowest accuracy rate. The group that used online applications in class achieved the highest accuracy on the delayed post-test (75.2%). Another related finding was that the setting of the task did have a significant impact on the accuracy of perceiving finals. On the delayed post-test, all groups did significantly better when the initials were provided than when they were not provided. Their accuracy was around 85% in the former setting and 71.6% in the latter. Participants' perception of initials and tones was more balanced in both settings. These findings are consistent with previous studies. Neri et al. (2006) found that L2 Dutch speakers' pronunciation of consonants improved without specific training, but their pronunciation of vowels did not improve at the same pace. Munro and Derwing (2008) discovered that L2 speakers of English with L1 Chinese or L1 Slavic had difficulty pronouncing English vowels even after being immersed in the target language for a long time. Bent et al. (2007) and Thomson (2011) both suggested that instruction in vowel pronunciation should be prioritized since vowels contribute more to speech intelligibility than consonants and are thus more beneficial in enabling learners to communicate intelligibly.

6.2 Impact of Online Applications on Learners' Production of Chinese Syllables

The second research question explored whether online applications, which are comprised of perception practices only, would also help improve participants' pronunciation of Chinese syllables. The results showed that all the three groups improved significantly with their pronunciation after the training, no matter what type of training they received. However, the numerical data from the post-test after training indicate that the group that received traditional instruction in class did better; they had higher scores in their pronunciation than the two groups that used online applications, especially the one that used online applications outside of class. However, by the time of the delayed post-test, the two groups that used online applications had caught up with and even exceeded

the performance of the traditional instruction group. The advantage of the traditional group on the post-test is not surprising: the participants did, after all, receive more production practice in class and more instant feedback from the instructor which clearly improved their pronunciation. However, the fact that this group failed to maintain its advantage on the delayed post-test seems to indicate that the online applications, used in class or outside of class, had a beneficial if delayed impact on participants' pronunciation.

Training effects from perception transferred to production have been found in previous studies as well (Bradlow et al.,1997; Thomson, 2011; Wang et al., 2003). An explanation for the observed transfer effect from perception to production could be that, with a large amount of input, learners develop a better perceptual system, which consequently enables them to better monitor their own production.

6.3 Impact of Context (in Class or outside of Class) on the Training Results

The third research question explored whether the context in which the online applications were used had an impact on the training effects. Results from both the perception task and the production task showed a very similar pattern of improvement over time in two of the groups which improved greatly on the post-test and increased their perception accuracy on the delayed post-test. However, when it came to pronouncing the Chinese syllables, the group that used the online applications in class showed significantly greater improvement on the post-test than the group that used the online applications outside of class. The significant difference was mainly seen in initials and tones. This finding is counterintuitive to some extent. The group that used online applications outside of class received traditional instruction in class, which included production practice and corrective feedback from the instructor. It was expected, therefore, that they would demonstrate better production than the group that used online applications in class, which included perceptual practice only. It could be a matter of skewed data due to the small number of participants in the group or it could be an indication of the strong effect transferred from perceptual training. Further research is needed to gain a better understanding of the exact cause. However, on the delayed post-test, the difference between the two groups disappeared: both groups showed improvement with the one that used applications outside of class showing even more. Previous meta-analysis studies on PI or CAPT compared the effect size in different training contexts. Lee et al. (2015) found that lab-based training had a greater effect than classroom-based training (0.95 vs. 0.79). Because, however, no studies, to the best knowledge of the authors, have explored the impact of the context of training involving an outside-of-classroom setting, no comparison of results can be made at this time.

6.4 Learners' Experience with and Perception of Online Applications

The last research question focused on participants' experience in using the online applications. The results from the survey showed overall positive feedback from the participants. They evaluated the perceptual practice with the online applications as moderately difficult. They felt that the practice helped them not only become more familiar with Chinese syllables and but also improved their production of same. Most of the

participants agreed that these online applications should be recommended to other L2 Chinese learners. They also showed interest in learning about other online applications designed to help them with pronunciation: about half of the participants set speaking skills as their primary goal in learning Chinese. They liked the instant feedback feature both applications provided, but expressed a wish for the applications to test them based on errors they made. It was also highly encouraging to discover that the majority of participants expressed a willingness to continue to use these applications in their future studies. At the same time, the majority of the participants indicated their preference for instructor-led in-class practice over online applications. The writers were not discouraged by this preference, since the goal of this study was not to recommend that in-class instruction be replaced but, rather, to find an effective way to extend in-class instruction.

7. Conclusion and Instructional Implications

Overall, the present study concludes that using online applications can help students improve their perception of Chinese syllables as effectively as traditional instruction and practice led by instructors in class. The groups that used online applications trended more toward gain retention and continued improvement on their perception of initials, finals, and tones after the training than the group that received traditional practice in class. All groups, regardless of the type of training they received, improved their production after training. The group that received traditional instructor-led instruction manifested more improvement right after the training than did the two online applications groups. However, this advantage was not retained. Whether the applications were used in class with an instructor's guidance or independently outside of class, no difference in the improvement of participants' perception was found. And, though using online applications in class resulted in better improvement in production right after the training, this advantage was not retained either after the training ended.

Based on the results from the tasks as well as an analysis of the participants' survey answers, the writers would suggest that online applications can be used outside of class as an effective supplementary aid for students in their quest to master the Chinese pronunciation system, including their perception of initials, finals, and tones. Although these online applications only provide perceptual practice, their high quality input can still help develop learners' perceptual system and thus their production. The present study only employed four 15-minute training sessions with the online applications over a two-week period. In a regular curriculum, it is recommended that the use of online applications be assigned for a longer period (30 minutes, for instance) and at a more frequent pace (three times a week, for instance). Based on participants' feedback, it is also suggested that students be provided with more options of similar online applications so that they can choose one that best fits their own needs or learning styles.

8. Limitation and Future Studies

Despite the authors' efforts to recruit as many participants as possible, the number participants involved was small and that was one of the limitations of the current study.

The exclusion of several participants due to incompletion of either a training section or a test further reduced the number. Furthermore, since this study used convenient samples, the distribution of participants in each group was not even. Caution must be exercised when interpreting the results, especially when the big variance within each group is taken into consideration. All of the above may have reduced the power to detect any significant difference among the groups. The findings may not be the same if a larger sample is used. Although this study included a comparison group, it was not a control group in the strictest sense since this group received traditional instruction. However, as part of regular instruction, it was impractical or, as Lee et al. (2015) pointed out, even "unethical to withhold treatment for the sake of experimental control" (p.363).

Another limitation that must be noted is the lack of strict control over the extra time the two online application groups may possibly have spent using those online applications on their own. At the beginning of the study, we encouraged both online application groups to complete, and only complete, the assigned tasks in order to make the time spent on Pinyin practice comparable among the groups. The group that were assigned online applications to use outside of class were asked to report the time they spent on those applications and they reported a time period similar to the required time 15 minutes each. This limitation, to some extent, resulted from the nature of the present study: a study conducted in a non-laboratory setting. In the future, maybe a lab-based training study can show the effects more precisely.

Two aspects can be further explored for future research. The first is the role of feedback embedded in online applications. As Rogerson-Revell (2021) points out, "accurate and timely feedback is essential" in CAPT to help learners acquire pronunciation. This was also echoed in participants' feedback when they indicated that the instant feedback was helpful. However, during the training, we noticed that some students showed frustration when, after several attempts, the feedback continued to indicate an error without pointing out which specific component was wrong. This begs the question: Would the training effect improve if more adequate and accurate feedback were provided? The second aspect to examine is the training on finals, the syllable segment which seems to be a stumbling block in both perception and production among L2 Chinese learners. The existing online applications mostly train learners' pronunciation holistically, without focusing on any specific segments. Many scholars have called for more collaboration "between pedagogic and technical experts" in designing CAPT tools (Rogerson-Revell, 2021). Thus, the kind of online applications that can be designed and employed to facilitate learners' acquisition of Chinese finals is certainly worthy of future consideration.

References

Arteaga, D. L. (2000). Articulatory phonetics in the first-year Spanish classroom. *The Modern Language Journal*, *84*(3), 339-354.

Baker, W., & Trofimovich, P. (2006). Perceptual paths to accurate production of L2 vowels: The role of individual differences. *International Review of Applied Linguistics in Language Teaching*, *44*(3), 231-250.

Bent, T., Bradlow, A. R., & Smith, B. L. (2007). Segmental errors in different word positions and their effects on intelligibility of non-native speech: All's well that begins well. In O. S. Bohn & M. J. Munro (Eds.), *Second language speech learning: The role of language experience in speech perception and production: A festschrift in honor of James E. Flege* (pp. 331-347). John Benjamins.

Beutner, M. (2001). Using computer assisted interactive feedback to enhance natural pronunciation of Chinese tones by non-native learners of Mandarin Chinese. [Unpublished doctoral dissertation]. Ohio University.

Bradlow, A. R., Pisoni, D. B., Akahane-Yamada, R., & Tohkura, Y. (1997). Training Japanese listeners to identify English /r/ and /l/: Some effects of perceptual learning on speech production. *Journal of the Acoustical Society of America, 101*, 2299-2310.

Chun, D., Jiang, Y., Meyr, J., & Yang, R. (2015). Acquisition of L2 Mandarin Chinese tones with learner-created tone visualizations. *Journal of Second Language Pronunciation, 1*(1), 86-114.

Collins, L., & Munoz, C. (2016). The foreign language classroom: current perspectives and future considerations. *The Modern Language Journal*, 100(S1), 133-147.

Everson, M. E. (2011). Best practices in teaching logographic and non-Roman writing systems to L2 learners. *Annual Review of Applied Linguistics, 31*, 249-274.

Flege, J. E. (1995). Second-language speech learning: Theory, findings, and problems. In W. Strange (Ed.), S*peech perception and linguistic experience: Theoretical and methodological issues* (pp. 229-273). York Press.

Godfroid, A., Lin, C., & Ryu, C. (2017). Hearing and seeing tone through color: An efficacy study of web-based, multimodal Chinese tone perception training. *Language Learning*, *67*(4), 819-857.

Hu, M. (2009). Phonological awareness in Mandarin of Chinese and Americans (UMI 33665544) [Doctoral dissertation, Auburn University]. ProQuest Dissertations.

Isaacs, T. (2009). Integrating form and meaning in L2 pronunciation instruction. *TESL Canada Journal*, *27*(1), 1-12.

Jongman, A., Wang, Y., Moore, C. B., & Sereno, J. A. (2006). Perception and production of Mandarin Chinese tones. In P. Li, L. Tan, E. Bates, & O. J. L. Tzeng (Eds.), *The handbook of East Asian psycholinguistics: Volume 1, Chinese,* (pp. 209-217). Cambridge University Press.

Lambacher, S., Martens, W., Wakehi, K., Marasinghe, C., & Molhot, G. (2005). The effects of identification training on the identification and production of American English vowels by native speakers of Japanese. *Applied Psycholinguistics*, 26, 227-247.

Lee, J., Jang, J., & Plonsky, L. (2015). The effectiveness of second language pronunciation instruction: A meta-analysis. *Applied Linguistics, 36*(3), 345-366.

Levis, J. (2007). Computer technology in teaching and researching pronunciation. *Annual Review of Applied Linguistics*, 27, 184-202.

Li, Y., & Xu, H. (2018). Using online applications to help Chinese learners learn Pinyin [Conference session]. ACTFL 2018 Convention, New Orleans, LA, United States.

Lin, H., & Lin, C. (2010). Perceiving vowels and tones in Mandarin: The effect of literary phonetic systems on phonological awareness. In L. E. Clements & C.-M. L. Liu (Eds.), Proceedings of the 22nd North American Conference on Chinese

Linguistics (NACCL-22) & the 18th International Conference on Chinese Linguistics (IACL-18). Vol 1 (pp. 429-437). Harvard University.
Mahdi, H. S., & Khateeb, A. A. A. (2019). The effectiveness of computer-assisted pronunciation training: A meta-analysis. *Review of Education, 7*(3), 733-753.
Morin, R. (2007). A neglected aspect of the standards: Preparing foreign language Spanish teachers to teach pronunciation. *Foreign Language Annals, 40*(2), 342-360.
Munro, M. J., & Derwing, T. M. (2008). Segmental acquisition in adult ESL learners: A longitudinal study of vowel production. *Language Learning*, 58, 479-502.
Neri, A., Cucciarini, C., & Strik, H. (2006). Selecting segmental errors in L2 Dutch for optimal pronunciation training. *International Review of Applied Linguistics in Language Training*, 44, 357-404.
Neri, A., Cucchiarini, C., Strik, H., & Boves, L. (2010). The pedagogy-technology interface in computer assisted pronunciation training. *Computer Assisted Language Learning, 15*(5), 441-467.
Olsberg, M., Xu, Y., & Green, J. (2007). Dependence of tone perception on syllable perception. *Proceedings of 8th Annual Conference of the International Speech Communication Association (Interspeech 2007)* (pp. 2649-2652). Curran Associates, Inc.
Pytlyk, C. (2011). Shared Orthography: Do shared written symbols influence the perception of L2 sounds? *The Modern Language Journal*, *95*(4), 541-557.
Rochet, B. L.(1995). Perception and production of second language speech sounds by adults. In W. Strange (Ed.), S*peech perception and linguistic experience: Theoretical and methodological issues* (pp. 379-410). York Press.
Rogerson-Revell, P. M. (2021). Computer-Assisted Pronunciation Training (CAPT): Current Issues and Future Directions. *The RELC Journal*, *52*(1), 189-205.
Saito, K. (2012). Effects of instruction on L2 pronunciation development: A synthesis of 15 quasi-experimental intervention studies. *TESOL Quarterly, 46*(4), 842-854.
Sharma, B., Liu, C., & Yao, Y. (2015). Perceptual confusability of Mandarin sounds, tones, and syllables.Unpublished conference presentation. ICPhS, https://api.semanticscholar.org/CorpusID:31632891
Shei, C. (2014). *Understanding the Chinese language: A comprehensive linguistic introduction*. New York: Routledge.
Thomson, R., & Derwing, T. (2015). The effectiveness of L2 pronunciation instruction: A narrative review. *Applied Linguistics, 36*(3), 326-344.
Thomson, R. I. (2011). Computer assisted pronunciation training: Targeting second language vowel perception improves pronunciation. *CALICO Journal, 28*(3), 744-765.
Wang, Y., Spence, M. M., Jongman, A., & Sereno, J. A. (1999). Training American listeners to perceive Mandarin tones. *The Journal of the Acoustical Society of America*, *106*(6), 3649-3658.
Wang, Y., Jongman, A., & Sereno, J. (2003). Acoustic and perceptual evaluation of Mandarin tone production before and after training. *Journal of the Acoustical Society of America*, 113, 1033-1043.

Xu, H., Li, Y., & Li, Y. (2019). Using online applications to improve tone perception among L2 learners of Chinese. *Journal of Technology and Chinese Language Teaching*, *10*(1), 26-56.

Zhang, H. (2018). Current trends in research of Chinese sound acquisition. In C. Ke (Ed.), *The Routledge handbook of Chinese second language acquisition* (pp. 217-233). Routledge.

Appendix A
Perception tasks used in the pre-test, post-test and delayed post-test

I. Please listen to the recording, and write down the initial and the tone for the syllables you hear. Each syllable will be read three times.

1. ___un	2. ___ai	3. ___ong	4. ___iu	5. ___ian	6. ___ i
7. ___ai	8.___iu	9. ___uo	10. ___u	11.___ao	12.___un
13.___eng	14.___ao	15.___ue	16. ___ian	17.___üe	18.___eng
19.___ong	20.___u	21.__uo	22. ___i		

Answers:
1. chun1 2. zhai1 3.nong2 4.xiu4 5.bian3 6.bi1 7.zai4
8. qiu2 9.zuo3 10. qu4 11.chao3 12.cun2 13. deng4 14. cao2
15. jue2 16.xian1 17. nüe4 18.reng1 19. zhong4 20.ju1 21.ruo4 22.di2

II. Please listen to the recording, and write down the final and the tone for the syllables you hear. Each syllable will be read three times.

1.b ___	2. q___	3. j___	4. r___	5. q___	6. x___
7. n___	8.b___	9. ch___	10. d___	11.z___	12.n___
13.z___	14.c___	15.r___	16. zh___	17.d___	18.ch___
19.x___	20.j___	21.c__	22. zh___		

Answers:
1. bi1 2.qu4 3.jue2 4.reng1 5.qiu2 6.xian1 7.nüe4
8.bian3 9.chun1 10.di2 11.zuo3 12.nong2 13.zai4 14.cun2
15.ruo4 16.zhai1 17.deng4 18.chao3 19.xiu4 20. ju1 21.cao2 22.zhong4

III. Please listen to the recording, and write the initial, the final and the tone for the syllables you hear. Each syllable will be read three times.

1. _____	2. _____	3. _____	4. _____	5. _____	6. _____
7. _____	8_____	9. _____	10. _____	11_____	12. _____
13_____	14. _____	15. _____	16. _____	17. _____	18. _____
19. _____	20. _____	21._____	22. _____		

Answers:
1.qian2 2. chi4 3.rong3 4.cuo1 5.nü3 6.jian4 7.zao1
8.cheng2 9.ci3 10.run4 11.jiu3 12.xu2 13.zong1 14.beng3
15.bai2 16.zhun3 17.diu1 18.xue3 19.zhao4 20.nuo2 21.dai3 22.que1

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Appendix B
Production task

Please read and record the following syllables in order (1, 2, 3…). Save your recording by your full name as an .mp3 or .wmv file, and then submit the file to the Blackboard/Canvas site:

1.biǎn	2.zhāi	3.běng	4.diū	5.xú	6.zāo	7.jiǔ
8.cún	9.dèng	10.cáo	11.rēng	12.nóng	13.bī	14.jiàn
15.zuǒ	16.bái	17.zhào	18.cǐ	19.zhòng	20.nǚ	21.xiù
22.dǎi	23.rùn	24.quē	25. chǎo	26. nüè	27. cuō	28. qiú
29. zài	30. dí	31. ruò	32. rǒng	33. chì	34. nuó	35. jū
36. qián	37. chūn	38. xiān	39. xuě	40. jué	41. qù	42. chéng
43. zōng	44. zhǔn					

Appendix C
Survey used to collect participants' feedback on using online applications

Dear students, please share your experience on learning Pinyin with us. Your feedback is anonymous and will only be used to improve our curriculum. Thanks!

1.How long have you been using computer technology, i.e. computer, software, websites, and applications etc. in your foreign language studies? (circle one)

Never; less than 6 months; 6 months to a year; 1-2 years; 2-3 years; more than 3 years

2.How frequently do you use websites or applications to study foreign languages by yourself (not as part of a class)? (circle one)

Never; once a year; once a month; every 2-3 weeks; every week; 2-3 times a week; every day

3.How frequently do you use websites or applications to study foreign languages as part of a class?

Never; once a year; once a month; every 2-3 weeks; every week; 2-3 times a week; every day

4.You have been required to use some websites (www.pinpractice.com; https://sla.talkbank.org/pinyin/) to practice Pinyin recently. Do you think you will continue to use these websites on your own in the future when you are not required to do so?

Yes; Maybe; Probably not; No

Why?_____.

5.What Chinese skills are you most interested in learning?

Listening; Speaking (including Pinyin); Reading; Writing (including characters)

6. **According to your experience, using the websites** (www.pinpractice.com; https://sla.talkbank.org/pinyin/) **to practice Pinyin, makes you feel** (circle all that apply):

Very happy/ somewhat happy/ neither happy nor unhappy/ unhappy /very unhappy

- **The set-up of the online exercises** (the format of the practice, the way to input your answer, etc.) **makes you feel** (circle all that apply):

Very happy/ somewhat happy/ neither happy nor unhappy/ unhappy /very unhappy

• **The instant feedback you get after you input the answer, makes you feel**:

Very happy/ somewhat happy/ neither happy nor unhappy/ unhappy /very unhappy

• **The holistic experience of using a website to practice Pinyin, makes you feel**:

Very happy/ somewhat happy/ neither happy nor unhappy/ unhappy /very unhappy

7. **To what extent do you agree with the following statements?** (circle one)

   - **The online Pinyin practice is very interesting**.

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

   - **The online Pinyin practice is efficient in helping me master Pinyin.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

   - **The online Pinyin practice is very hard for me.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

   - **The online Pinyin practice helps me establish better connections between Pinyin and Chinese sounds.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

   - **The online Pinyin practice familiarizes me with Chinese syllables.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

   - **I feel that, after listening to numerous Chinese syllables, I can pronounce Pinyin better**.

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

   - **I like the feedback I get in the Pinyin online practice.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

- **I don't think feedback is necessary in the online Pinyin practice.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

- **I prefer online Pinyin practice to in-class practice led by the instructor.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

- **I prefer online Pinyin practice to traditional workbook exercises after class.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

- **I prefer using online Pinyin practice in class with a teacher around to help.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

- **I prefer using online Pinyin practice on my own after class.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

- **I would recommend online Pinyin practice to other learners of Chinese.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

- **I hope to learn about other websites so that I can do more Pinyin practice on my own.**

Strongly disagree (1), Disagree (2); Neither agree nor disagree (3); Agree (4); Strongly agree (5)

8. What change would you like to see to improve your experience with online Pinyin practice?

Teacher Agency in Adapting to Online Teaching during COVID-19: A Case Study on Teachers of Chinese as an Additional Language in Macau
(教師發揮能動性以適應 2019 冠狀病毒病期間的在綫教學：基於澳門對外漢語教師的個案研究)

Gong, Yang
(龔陽)
University of Macau
(澳門大學)
frankgong@um.edu.mo

Fan, Chun Wai
(范進偉)
University of Macau
(澳門大學)
andyfan@um.edu.mo

Wang, Chuang
(王闖)
University of Macau
(澳門大學)
wangc@um.edu.mo

Abstract: The COVID-19 university closure forced a rapid transition and adaptation to online teaching. This paper reports on a case study that examined teacher agency in response to online teaching from February to September 2020. In the study we collected multiple data from three teachers of Chinese as an additional language, including semi-structured interviews, institutional documents, and field notes, to investigate their exercise of agency in adapting to online teaching. The analysis revealed that the participants displayed strong agency to build digital competence and develop student-centered pedagogy at different stages. At the same time, the shift to online from classroom-based teaching allowed them an opportunity to transform existing practices and seek innovative pedagogy, such as a hybrid model blending asynchronous and synchronous online teaching. This study also suggests the influence of flexible and collaborative institutional culture and teacher professional digital competence in shaping the participants' agency in addressing the diverse challenges of online teaching. These findings offer insights into the value of an agency-oriented approach to professional learning and development in educational change. Educational stakeholders should pay more attention to the dynamic interaction between educational institutional systems and teacher agentic practice.

摘要：2019 冠狀病毒病引發的大學關閉迫使教育持份者需要快速轉變為並適應在綫教學模式。本文采用案例研究的方法，考察 2020 年 2 月至 9 月間澳門孔子學院的教師如何發揮能動性以回應在綫教學的轉變。我們對該孔子學院三位對外漢語教師能動性的發揮進行了半結構化訪談和參與式觀察，並分析了相關的文件資料。研究分析表明，他們在建構自身數位技能和發展以學生爲中心的教學法過程中表現出强大的能動性。同時，從課堂教學到在綫教學的轉變使他們有機會改變現有的教學實踐，並尋求教學法的創新。本研究還表明，靈活和協作的制度文化及教師的數位技能對他們發揮能動性以應對在綫教學的各

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

種挑戰具有重要影響。這些發現對於教學變革中教師的專業學習和發展提供了以能動性為導向的視角。基於以上發現，我們建議教育持份者應當更加關注教學體系和教師能動性之間的互動。

Keywords: Teacher agency, online teaching, teacher digital competence, Chinese as an additional language, COVID-19 pandemic

關鍵詞：教師能動性、在綫教學、教師數位技能、對外漢語教學、2019 冠状病毒病

1. Introduction

According to the United Nations (2020), the COVID-19 pandemic has caused the severest disruption of the global education system in history, with nearly 1.6 billion learners in more than 190 nations/regions being affected by the end of August 2020. In order to suppress the spread of the virus and prevent national or local outbreaks, many governments enacted a number of rules and measures such as closing down educational institutions to minimize infection rates and protect learners within the community.

Due to the suspension of face-to-face classes during national lockdowns, many governments across the world required educational institutions to deliver online courses exclusively (e.g., Mainland China, Bao, 2020; Hong Kong SAR, Moorhouse, 2020; UK, Bryson & Andres, 2020; Germany, König, Jäger-Biela, & Glutsch, 2020; Europe, North America, Asia, South America, and the Middle East, MacIntyre, Gregersen, & Mercer, 2020; Australia, Scull et al., 2020). In other words, the traditional delivery of teaching in school classrooms or on university campuses shifted overnight to teaching remotely. In these circumstances, teachers were immediately tasked with a rapid transition to online delivery, and many encountered significant challenges in adapting to this new normal (König et al., 2020).

Existing studies on teaching during the COVID-19 pandemic have mainly indicated the extant difficulties or obstacles teachers faced (e.g., MacIntyre et al., 2020) and explored the instructional strategies they adopted (e.g., Bao, 2020). However, the specific process of teachers' transformation and adaptation from face-to-face to virtual instruction remains an under-examined area (König et al., 2020; United Nations, 2020). In particular, little attention has been paid to teachers' engagement with "the dramatic changes due to the COVID-19 pandemic" (Scull, Phillips, Sharma, & Garnier., 2020, p. 3) and their efforts to cope with the emerging demands of online teaching, even though they are increasingly considered to be "active agents" (Lasky, 2005, p. 900) in response to educational change.

There is an explicit tendency in educational research to depict teachers as agentic professionals when educational systems or ecologies are undergoing change (Priestley, Biesta, & Robinson, 2015). Teachers are not "pawns" during educational change, but rather "active agents, whether they act passively or actively" (Lasky, 2005, pp. 900–901). Previous studies have revealed that teachers generally tend to enact agency towards

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

different forms of change such as educational reform, including resistance, ambivalence, and approval (e.g., Simpson et al., 2018; Tao & Gao, 2017). At the same time there is an intricate relationship between teacher agency and teacher identity, with teachers more likely to recognize and make what they do into "a meaningful profession rather than just a job" (Priestley et al., 2015, p. 149) if they have a sense of being able to enact agency. In this regard, more studies are needed to examine teachers as active agents or agentic professionals who develop professionally as they adapt to online teaching in the midst of the COVID-19 pandemic, especially in contexts where they might lack sufficient resources, guidance, or training. To this end, the present research reports on the professional development experiences of three teachers of Chinese as an additional language in a Confucius Institute at a university in Macau, who underwent instructional conversion from traditional face-to-face classes to emergency online language teaching in response to the COVID-19 pandemic.

The first local warning regarding the COVID-19 pandemic was raised in Macau on 5 January 2020, and the first domestic case was confirmed on 4 February 2020 (Bian, Yao, & Bian, 2020). Between 22 and 23 January 2020 the Macau government initiated a suite of prevention and control rules and regulations such as the postponement of the commencement of the next academic semester to 10 February or later, and then on 30 January 2020 made the decision to postpone all on-campus classes until further notice (GOV.MO, 30 January 2020). Educational institutions were temporarily closed down and students were informed that they must engage in learning via online education in accordance with a policy of "keeping learning amid class suspension" (in Chinese "停課不停學") throughout Macau. Language teachers in Macau universities had to transform to online teaching and implement new pedagogical approaches to address students' learning needs. Consequently, their experiences related to organizing efficient activities via this new mode of delivery must have changed substantially, with individual language teachers needing to practice agency to support students' online language learning. However, how language teachers adapted to this emergency remote teaching has yet to be studied, although their experiences of, responses to, and strategies for coping with disrupted teaching can greatly affect the quality of language education (Gong, Gao, & Lyu, 2020; Gong, Lai, & Gao, 2020; Gong, Lyu, & Gao, 2018; Ma, Gong, Gao, & Xiang, 2017). Therefore, this study attempts to examine how teachers of Chinese as an additional language responded to this dramatic educational change due to COVID-19 through the exercise of agency.

2. Literature Review

2.1 Online Teaching during the COVID-19 Pandemic

The benefits of information and communication technology (ICT) have profoundly transformed education. Its role lies not only in breaking spatio-temporal limitations and promoting the fairness of education (Passey et al., 2018), but also in enhancing learner-centered instruction and engaging learners in the learning process (Chapelle, 2008; Ertmer & Ottenbreit-Leftwich, 2013; Gong & Lai, 2018; Zheng, Lin, & Kwon, 2020). The COVID-19 pandemic accelerated this digital transformation, and the integration of ICT

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

into education gained even more significance at all levels of education. At the same time, however, the sudden transformation to remote teaching and learning via online platforms brought various challenges and difficulties to users (e.g., learners, teachers, policymakers, parents, etc.), changed their beliefs and concerns regarding online education, and stimulated innovation and creativity within the education sector (Chen et al., 2020; Quezada, Talbot, & Quezada-Parker, 2020).

Since the outbreak of COVID-19 in the early spring of 2020, the increasing number of studies on teachers' online teaching have mainly concentrated on their coping experiences of and instructional strategies for the remote delivery of courses, and potential factors accounting for their mastery of core challenges during campus closures. For instance, by examining the improvisation journey of learning platforms (from proximate learning to blended learning to online delivery) caused by school and university closures, Bryson and Andres (2020) argued that teachers should adopt different approaches to optimize students' extensive and intensive online learning experiences. Specifically, extensive support should include providing appropriate learning resources and guidelines for students, and intensive support should be related to deepening students' interactions with their peers and instructors. The authors called for a hybrid educational model blending synchronous with asynchronous instruction to facilitate students' online learning experiences and embrace new educational forms.

Similarly, based on observations of online teaching at a university in China, Bao (2020) classified six instructional strategies to support students' learning experiences through screens, including preparing emergency plans for unexpected issues, dividing teaching content into smaller units to promote students' learning efficacy, turning down the instructional pace for students' engagement, working with teaching assistants to enhance instructional quality, facilitating students' active learning outside of class, and blending online teaching and offline learning effectively. In another study, MacIntyre, Gregersen, and Mercer (2020) surveyed 634 language teachers from different nations/regions to investigate their coping strategies when facing stressors and problems caused by the emergency transition to online teaching during COVID-19. In particular, the language teachers reported adopting more active coping strategies than avoidant ones (e.g., disengagement, substance abuse, and denial) to accept and adapt to the educational change. At the same time, however, there was a close relationship between their coping strategies and psychological outcomes like anxiety, sadness, anger, etc.

Researchers have also paid attention to factors that affected teachers' conversion to online teaching during COVID-19 campus closures. König et al. (2020) conducted a quantitative inquiry into how early career teachers tackled the challenges of delivering lessons in online settings. This inquiry reported that the teachers' digital competence, such as their technological pedagogical knowledge (TPK), significantly predicted COVID-19 online teaching quality, measure by aspects such as maintaining social contact with and providing task differentiation to students. In another study on English-as-a-foreign-language (EFL) teachers' cognition about online teaching in Chinese universities during the pandemic, Gao and Zhang (2020) found that limited information technology literacy, insufficient network conditions, and ineffective class management could hinder the

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

teachers' successful online teaching. An adequate understanding of students' learning needs and online teaching practice seemed to benefit the EFL teachers' ICT literacy.

Although some work has been conducted on language teachers' transitions and adaptation to online teaching during the COVID-19 pandemic, the results concerning this issue mainly relate to teachers in contexts where English is taught as a first or additional language (e. g., Gao & Zhang, 2020; MacIntyre et al., 2020). Findings among different language teachers from other language teaching contexts, like teaching Chinese as an additional language, may be different and deserve separate attention. At the same time, even though these studies have to some extent reported various challenges/factors that teachers experienced in the online environment during COVID-19 from a macro-level viewpoint (mostly using quantitative data), they have not addressed social, educational, and program-level complexities in relation to language teacher conversion to online teaching platforms. For example, teachers' adaptive process may emerge in specific educational cultures and interact with their individual differences such as personal knowledge, learning and teaching experience, and professional commitment. In addition, like most of the previous studies conducted since the mandatory school and university lockdown due to COVID-19, general research on teachers' adaptation to online teaching has paid little attention to the agentic choices or actions they take when reacting to different challenges and factors in this dramatic educational change.

2.2 Teacher Agency in Educational Change

Recent literature emphasizes the importance of viewing teachers as agents in response to educational change (Priestley et al., 2015; Tao & Gao, 2017; Yang, 2021). The discussion of agency starts with the view that "human beings have the ability to influence their lives and environment while they are also shaped by social and individual factors" (Lasky, 2005, p. 900). According to Priestley et al. (2015), three main conceptualizations of agency have been founded on different assumptions: agency as capacity, agency as variable, and agency as phenomenon/practice (also see Feryok, 2012; Tao & Gao, 2017).

Taking a sociological approach, the notion of agency mainly focuses on "the individual exercise of power" (Feryok, 2012, p. 97) in social action, negotiating the contextual influence (e.g., social structure) on the development of the agent. Other researchers take a more complex view of agency and define it as an "emergent phenomenon—something that is achieved by individuals, through the interplay of personal capacities and the resources, affordances and constraints of the environment by means of which individuals act" (Priestley et al., 2015, p. 19). In the same vein, Lasky (2005), taking a sociocultural perspective, interpreted agency as people's practice in social settings with available cultural tools.

Additionally, agency is shaped by relationships and achieved within particular contextual conditions, including past experiences, current possibilities, and future prospects. Based on the views of agency provided by the existing literature, we feel it is essential to conceive of agency as agentic perspectives and actions in response to contextual resources and constraints in particular situations, rather than merely as a capacity and characteristic of the individual or primarily as a personal social action. Hence,

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

our inquiry makes use of the conceptualization of agency as a phenomenon/practice. Seen in this way, teacher agency refers to teachers' "agentic choices and actions" (Tao & Gao, 2017, p. 347) within the opportunities and constraints of local educational systems.

Teacher agency plays a pivotal role in facilitating student learning and teacher professional development. Studies on teacher agency generally tend to examine teachers' responses to issues and challenges during educational change, and have identified its close connection with teachers' emotions (Miller & Gkonou, 2018), professional identity (Buchanan, 2015; Kayi-Aydar, 2015), knowledge of curriculum and pedagogy (Sloan, 2006), and adaptive strategies (Lai, Li, & Gong, 2016; Miller et al., 2020). For instance, Tao and Gao (2017) interviewed eight English teachers during curricular reform in a Chinese university, and found that they demonstrated agentic choices and actions to adapt to the new curriculum in different individualized ways. However, their exercise of professional agency was directed by identity commitments and mediated by prior experiences and resources. Similarly, Buchanan's (2015) study on nine teachers' professional identity in a context of educational reform in northern California, USA reported that the construction of teachers as agentive professionals was shaped by reform contexts and discourses, especially the local school culture. In particular, the teachers mostly used an avoidant coping strategy (resistance) when their identity conflicted with the accountability and values related to "quality teaching and learning" (p. 715).

Billett (2006) argued that individuals at work exercised agency through making choices about what to engage in and taking actions with different degrees of engagement to continually shape and reshape their own professional trajectory. Moreover, teacher agency generally has different manifestations with multi-levelness and context specificity (Eteläpelto, Vähäsantanen, Hökkä, & Paloniemi, 2014), and thus researchers have called for more research to examine its nature and links with teacher professional development in different professional contexts, especially during educational changes (Tao & Gao, 2017; Vähäsantanen, 2015).

Specifically, in light of the educational change caused by the COVID-19 pandemic, studies are needed to explore how teacher agency was exercised to address issues of teachers' professional development in online teaching. However, existing research on teachers' transitions from face-to-face instruction to online teaching has mostly paid scant attention to the agentic choices and actions they take in specific circumstances when reacting to different resources and challenges. Also, there have been few studies investigating the interaction between teacher agency in adapting to online education and individual differences, such as learning backgrounds, personal experiences, and emotions, particularly during COVID-19 campus closures.

The notion of teacher agency will help us to understand teachers' experiences of online instruction adaption when responding to the challenges presented by COVID-19. With this in mind, the present research aims to address the following question:

> RQ: How did teachers of Chinese an additional language enact agency in adapting to online teaching during the COVID-19 university closures?

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

3. Methodology

A case study approach (Stake, 1995) was adopted in the present study since this approach allows researchers to understand the multifaceted concept of teacher agency and the dynamic process of agency exercise within a complex, real educational context (Yin, 2003). At the same time, teachers' holistic adaptation to online teaching in response to the changes caused by the COVID-19 pandemic warranted an instrumental case study design (Stake, 2005). The research approaches presented below have been developed in the process this participatory project over one year, with the participation of three teachers of Chinese as an additional language at a Confucius Institute in a university in Macau.

3.1 Research Context

This study was situated in Macau, which was a Portuguese colony for more than 100 years before being handed over to China in 1999. According to the most recent population census in Macau, taken in 2011 (DSEC, 2011), 92.4% of the total population in Macau are ethnic Chinese, 1.5% are ethnic Portuguese, and 6.1% is composed of other ethnic groups such as Indonesian, Filipino, Vietnamese, European, and so on. Cantonese (83.3%) and Portuguese (0.7%) are the official languages of Macau, but Putonghua, the national lingua franca of the People's Republic of China (PRC), is also increasingly used, especially in the tourism and business industry (Botha & Moody, 2020). Consequently, the rising numbers of ethnic workers directly involved in the tourism and business sector highlight proficiency in Putonghua as an important type of capital, and many people make efforts to enhance their Putonghua proficiency through informal courses.

To address this learning need, since 2018 the Confucius Institute in the Macau university involved in the study has offered part-time elementary, intermediate, pre-advanced, and advanced Putonghua courses for non-ethnic Chinese adult learners who originally come from different countries/regions and who use Putonghua as an additional language in Macau. From the teacher participants' self-reports, we noted that the courses were taught in a classroom setting before the global outbreak of COVID-19, but they had shifted to exclusively online teaching and learning since the beginning of February 2020.

3.2 Participants

Because the exercise of agency can be affected by past and present experiences (Eteläpelto et al., 2014; Lai et al., 2016; Tao & Gao, 2017), this study involved teaching staff members at the Confucius Institute who had different working experiences, responsibilities, and roles. Following an initial visit and an introduction to the study both verbally and in writing by the first author, three teachers volunteered to participate in this study: one program coordinator, and two volunteer teachers. As can be seen in Table 1, the participants were heterogeneous in terms of their personal background demographics, such as their age, language background and prior experience. Consent was obtained prior to the interviews and observations, and all the participating teachers were assured of confidentiality and anonymity.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Ms. Li (program coordinator): She earned a BA degree in mainland China in the 2000s. Afterwards she worked as a teacher of Chinese as a foreign language at a college in the USA, and also obtained an MA degree with specialization in Teaching Chinese as a Foreign Language. Ms. Li was the only full-time university instructor in the Institute. As a program coordinator, she was responsible for supervising the teaching routine and quality of all the Chinese courses, and she also had different managerial roles such as training novice teachers and teaching assistants, assigning instruction tasks for volunteer teachers, and addressing learners' feedback.

Ms. Liu and Ms. Zhao (volunteer teachers): They were recruited as full-time Chinese teachers through the Centre for Language Education and Cooperation (formerly known as "Hanban"). During the COVID-19 campus closures Ms. Liu was teaching elementary courses and Ms. Zhao was teaching intermediate and pre-advanced courses.

Table 1 Participants' profiles

Name	Age	Gender	Language background	Education experience	Work experience
Ms. Li	38	Female	Putonghua, English	BA in Chinese Language and Literature MA in Teaching Chinese as a Foreign Language	Chinese language teacher in the USA
Ms. Liu	28	Female	Putonghua, English	BA in Chinese Language and Literature MA in Second Language Acquisition	No
Ms. Zhao	27	Female	Cantonese, Putonghua, English, Portuguese	BA in Teaching Chinese as an International Language MA in Teaching Chinese as an International Language	Intern Chinese language teacher in Portugal

Note: All names are pseudonyms

3.3 Data Collection

The case studies were conducted from February 2020 to February 2021. Multiple sources of data were collected as potentially appropriate to investigate the nature of teacher agency in educational change, including semi-structured interviews, participatory observations, field notes, email letters, and relevant university, faculty and Institute documents. The documents from different administrative units related to guidelines, support and even tips for online instruction during COVID-19, which were sent to university academic staff after the end of January 2020. Along with email correspondence, they helped us to make the interview questions/topics more pertinent.

A semi-structured interview format was adopted to allow the teachers to elaborate their professional experiences and personal feelings prior to, during and after their COVID-19 transition to online Chinese teaching (Holloway & Jefferson, 2000). At the same time,

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

the interviews were framed around several issues and concepts that had emerged from the prior literature; overall, the following topics were addressed: 1) perceived online education environment; 2) challenge and difficulty in online Chinese teaching; 3) teachers' perceptions of their professional role and commitment; 4) coping responses to transition to online Chinese teaching; 5) external resources and supports; and 6) achievement in COVID-19 online Chinese teaching. The interview questions/topics were first reviewed and assessed by two experts and one Chinese teacher interested in teacher agency and online language education. Then the questions/topics and the interview technique were pilot-tested with one Chinese teacher working in a Chinese as an additional language program, and the interview guide was revised accordingly. Each interview lasted approximately 50 minutes, and a total of three semi-structured interviews were conducted in the participants' native language, Putonghua, to minimize language barriers. The interviews were digitally recorded and transcribed.

In addition, six episodes of observations were collected in order to document Chinese teachers' interactions and ways of working with each other to deal with problems caused by the emergency shift to online language education (Pantić, 2017). Examples of observation situations included: the meeting room for observing teachers' meetings of planning online Chinese teaching and learning due to the COVID-19 pandemic (two meetings), teacher offices for observation of three teachers' online teaching practices (one observation session for each teacher), and the staff office for observing teacher collective lesson preparation (one observation session). Field notes of the observations were also kept to provide a comprehensive and contextualized account of the teacher participants' coping practices when confronting the challenges bought by COVID-19 online instruction (Wolfinger, 2002). The field notes were descriptive in nature, yielding a thicker description of the "professional and personal circumstances" (Lai et al., 2016, p. 14) of professional agency and enriching our interpretation of the research question, since some agentic choices and actions might not be fully reported in the interviews.

3.4 Data Analysis

Thematic analysis was carried out to analyze the data, which were hand-coded. The data were first categorized into organizational themes according to the research question and the literature on teacher agency in educational change and online teaching. Five organizational themes were used with regard to the two dimensions of adaptation to online Chinese teaching during COVID-19, encompassing professional transformation and the development of online teaching with opportunities and constraints within the context of university closures: 1) online education transition; 2) professional choices and actions under the impact of online teaching; 3) reasons for transformed and untransformed choices and actions; 4) their impact on student learning; and 5) reasons for the impact or lack thereof.

The excerpts under each organizational theme were then coded and recoded to generate concrete categorizations. Relevant documents, interview transcriptions, and observation field notes were read through five times, and bits of data that were relevant and important to the themes, or which struck the researchers as interesting, were first coded using original words. Similar codes were aggregated into analytic categories. The initial

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

coding of the analytic categories was then compared across the participants to find repeating ideas and supporting evidence in order to cross-validate the categories that emerged. For instance, "reading the user manual of Zoom", "learning to operate Zoom", and "digging into different Zoom functions" were clustered under "developing and enhancing technological knowledge", and "difficult to supervise student learning in Zoom" and "not easy for teachers to communicate with learners one to one during online teaching" were categorized under the higher-order node "contextual constraints of online Chinese education". Throughout the data analysis, annotations and memos were used to record immediate comments and reflexive thinking on the data, and these were further used to assist with data coding and categorization (Maxwell, 2005).

Due to space limitations, this paper explains the research question by presenting our interpretation of data derived from relevant documents and semi-structured interviews, supplemented with observation field notes.

Additionally, we were aware that the researchers' own beliefs and understanding may interfere with the "objectivity, reflexivity and authenticity of a research project" (Kanuha, 2000, p. 444). Therefore, participant-checking procedures were conducted after we had transcribed the interviews to ensure the accuracy of the data and the trustworthiness of the subsequent analysis (Birt, Scott, Cavers, Campbell, & Walter, 2016). One participant made minor annotations, and the other two participants returned interview transcriptions without additional comments.

4. Findings

The analysis of the data identified that the participants actively enacted agency in two primary aspects in response to online Chinese teaching during the COVID-19 university closures: learning digital skills, and enhancing student-centered online teaching. At the same time, understanding online education as an innovative opportunity, the participating teachers showed relatively strong agency in implementing new pedagogical approaches to Chinese language teaching and learning through communication and collaboration with each other. In particular, diverse innovative teaching models were used to address personal and contextual constraints at different stages of online teaching, and a blend of asynchronous and synchronous online Chinese instruction was developed as a pedagogical innovation during campus closure. It is worth noting that the participants demonstrated a few heterogeneous individualized strategies when fulfilling online teaching tasks and adapting to the transition to online Chinese teaching.

4.1 Professional Development under the Impact of Online Education: Agency Shaped by the Opportunities and Constraints of University Lockdown

Three participants reported that they had no online teaching experiences prior to the university closures caused by COVID-19, and they needed responsive adaptation and improvisation in their approaches to online Chinese teaching. The participants' accounts showed that their agentic choices and actions towards Chinese language teaching in online classes were shaped by their personal and contextual resources and constraints. Overall,

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

the participants' prior teaching experiences could not help them to respond to the various challenges they encountered in online language education, and thus they enacted agency not only to develop technological knowledge regarding online teaching and learning, but also to build up pedagogical competence to address learners' preferences and needs in a new educational setting.

4.1.1 Agency in Learning about Technological Skills

The three participants displayed strong agency in learning about technological knowledge so as to improve their practice while teaching Chinese online. The data analysis indicated that they all felt confused and stressed when they were originally confronted by the unexpected and rapid conversion to online teaching. Given that none of the participants had any technological background in online education, their unanimous and primary tangible goal was to learn about the different functions of online education platforms in terms of synchronous teaching and learning. For instance, Ms. Zhao talked about how she had learned to use online education tools, with a primary focus on their different functions:

> [1] Most importantly, I continue familiarizing myself with relevant online teaching tools. For example, I scrutinize Zoom functions and consider how to use the functions in my class. (Ms. Zhao)

This enactment of agency towards developing her technological knowledge was also reflected in her regular meetings with other colleagues, during which they "intensively dig into Zoom functions together and talk about how to integrate these functions into Chinese teaching, such as 'breakout rooms' in Zoom". The language teachers' knowledge categories extended to technological pedagogical and content knowledge (TPACK) in response to the increasing significance of the ICT transformation process in the educational system (Selwyn, 2012). During their adaptation to "forced" online teaching due to the COVID-19 pandemic, the participants' professional knowledge related to the function and operation of new technology and its applications was a basic precondition for effective online teaching (König et al., 2020). Consequently, all the participants continued to invest in mastering the core challenge of delivering Chinese courses online. At the same time, communication and collaboration among the participants seemed to play a crucial role in enhancing their technological knowledge. In other words, when confronted with online teaching challenges, they often worked together but displayed small individual differences in overcoming personal and contextual constraints and fulfilling instructional tasks.

In a similar vein, Ms. Liu recounted that rather than strictly following the previous instructional pace, the teachers in the Institute had to tackle technological issues at the beginning of online teaching. She also recalled an embarrassing moment in the online class because of her lack of knowledge of the "mute all" function:

> [2] In my first online class, I had no idea about "mute all" at all. One student was attending class in the street. When I turned on Zoom, all the noise came out, like the sound of cars. I just heard the noise, but did not know it was from which student. I became flustered at that moment. I finally found the "mute all" after a while. (Ms. Liu)

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

This experience seemed to prompt her to want to learn about the new technology, "how to use Zoom to teach". Afterwards, Ms. Liu initially learned from the Zoom User Guide sent by the university, and then talked with other teaching assistants about how to use the software. In essence, the participants' experiences of adopting digital tools involved a learning process, and their agentic choices and actions during this process were "driven by the self-perceived disjuncture" (Tao & Gao, 2017, p. 349) between their working background and the knowledge they needed for online teaching.

Notwithstanding, all three participants reported a relatively high level of adopting online teaching platforms after four to five weeks, and all were aware of the availability and convenience of online education for both learners and teachers during the periods of campus closure. For instance, Ms. Li, the program coordinator at the Institute, commented on her personal perception after mastering the core difficulty of online Chinese education: "There is a way out (literally in Chinese, 柳暗花明: where dark willows end, bright flowers come). … We did not believe we can do it at the beginning, but we make it finally." At the same time, this initial experience of mastering relevant technological knowledge enhanced the participants' confidence and competence in online teaching, after which they tended to pay more attention to student-centered pedagogical approaches in online education.

4.1.2 Agency in Transforming to Student-Centered Approaches in Online Teaching

Overall, the data analysis revealed that in the online teaching context, the participants usually transformed to student-centered instruction after a four- to five-week period of transition. Once they had successfully addressed their technological issues in terms of learning about and operating the different functions of online education platforms, they all exercised agency to support learners' access, enhance their participation, and strengthen their social and intellectual engagement in online learning (Scull et al., 2020). Poor persistence among learners has been a major challenge for teachers in online education (Ertmer & Ottenbreit-Leftwich, 2013; Lin, Zhang, & Zheng, 2017). Because of their new recognition of the differences between online and face-to-face learning, one salient change that they all perceived was that teachers needed to reduce the teaching pace to facilitate student access to synchronous instructional activities. As an example, Ms. Liu found that her learners became easily fatigued in online classes, and reduced her teaching content accordingly. Similarly, Ms. Zhao talked about how she abandoned the original instructional pace, because it led to students' poor understanding of the instructional content.

> [3] I feel it is very difficult for some students to follow my teaching in online class. In particular, for them, it is very very hard to understand some content through online learning. (Ms. Zhao)

In other words, the participants believed that students moving to online study required more time to adapt to the course progress. Moreover, the participating teachers also changed their teaching styles to stimulate student learning motivation and interest. Compared to her prior Chinese instruction, Ms. Liu reduced the number of questions she asked students in online classes, because she "worried that too much questions can decrease student self-esteem". In order to "[m]ake online instructional elements more interesting and promote student learning interest", Ms. Zhao used matching questions in her online

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

teaching instead of question-and-answer drills, which she often assigned to students in face-to-face classes. Specifically, the participants' accounts illustrated that they enacted agency via continuous reflection on and improvements in their instructional style, as required by the emerging features of students in online learning.

Ms. Li's interview response further shows that the participating teachers' instructional change was shaped by the concerns and problems that students perceived in the online learning context, namely the keen expectation that they would be able to promote their Chinese language proficiency. She highlighted the importance of daily-communication competence in enhancing student confidence in learning Chinese, and in their ongoing engagement with online classes:

> [4] We must let them (students) see their clear and significant progress in this academic term, and also they can see their progress in each aspect during online Chinese learning. (Ms. Li)

In practice, Ms. Li and her colleagues displayed strong agency in terms of student-centered curriculum planning and teaching, with significant focus on students' communication competence. Ms. Li talked about her pedagogical transitions after switching to online Chinese education:

> [5] First of all, we build an online one-to-one spoken lesson and increase its frequency later. … Secondly, we change the previous final exam form. Prior to COVID-19, each student made a presentation for the speaking test. We let students make videos right now. We encourage this speaking test form. (Ms. Li)

The flexible approaches initiated by this teaching team were designed to ensure that teachers could respond to students' core needs effectively, and enhance their engagement by increasing their learning confidence (Quezada et al., 2020; Zhang & Lin, 2021). Moreover, the participants' agentic choices and actions closed the gap between students' conventional learning and the experiences and skills needed to engage with online education, and further generated creative and innovative strategies for problem solving.

4.2 Agency as Innovation in Changing the Traditional Teaching Mode

The data analysis also illustrated that the participants in the Institute experienced two phases of online education in line with the university guidelines during the COVID-19 campus closures—the offline self-learning phase, and the online delivery phase. In particular, they sent PowerPoint slides with audio narration to students during the first two weeks of online teaching, and then shifted to synchronous online teaching based on real-time interactions with students. From the participants' accounts in relation to the asynchronous PowerPoint teaching, it can be seen that their main feelings were that this was "exhausting", "time-wasting", "confused", and "messy", while they actively enacted their agency to "make the slides with narrative details as much as possible" (Ms. Li).

According to Priestley et al. (2012), changes in education may occur as a result of engagement with innovations in teaching and learning. In practice, the challenges brought by the COVID-19 campus closures clearly necessitated educational change in terms of

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

curricular and pedagogical approaches, such as online teaching and assessment. The participants often exercised agency to reflect upon and alter their prior teaching modes, seeking innovative ways of blending their students' extensive and intensive learning experiences (Bryson & Andres, 2020). Overall, while the participants selected different resources and provided instant feedback to facilitate student learning during their asynchronous teaching, they focused significantly on small breakout sessions and opportunities for students to enhance their Chinese communication competence. Ms. Li believed that the pedagogical practice change brought by the shift to online teaching addressed issues of infrequent teacher-student communication, which could easily be a problem in face-to-face classes:

> [6] We have one one-to-one course with students every two weeks now, but we had that once a month before the COVID-19. … Students like this course very much, because they believe that this teaching mode can solve their individual learning issues and is a bespoke approach. (Ms. Li)

In addition, the participants were unanimous in their positive perceptions of retaining online one-to-one teaching, even after students were able to return to their classrooms after the campus lockdown had been lifted. More importantly, they believed that online language education is a new educational trend. As Ms. Liu reflected:

> [7] Online teaching and learning has become mainstream. It is not only for the Chinese language. Other language institutions have started online courses already. (Ms. Liu)

Table 2 summarizes the changes in the Chinese instructional model in the Institute from February 2020 to February 2021. It shows an emerging hybrid model that blends synchronous online teaching with face-to-face sessions. This shift from solely face-to-face teaching to a hybrid model, or from transferring content to designing diverse learning experiences, demonstrates the participants' agentic willingness and ability to react to challenges as they transitioned from classroom-based to online teaching.

Table 2 Education model transformation at different stages

Educational model before COVID-19 (before February 2020)	**Educational model during campus closure (from February 2020 to September 2020)**	**Educational model after campus closure (from September 2020 to present)**
	Technology-enhanced student-centered teaching	
Teaching: *face-to-face* *1) Large class teaching*: face-to-face, with focus on grammar points,	***Teaching:*** *asynchronous and synchronous online* *1) Large class teaching*: asynchronous, with focus on grammar points,	***Teaching:*** *blend of face-to-face and synchronous online* *1) Large class teaching*: face-to-face, with focus on

vocabulary, and oral Chinese practice *2) One-to-one course*: face-to-face, once a month, with focus on checking learning outcome and targeted enhancement	vocabulary, and oral Chinese practice *2) One-to-one course*: synchronous online, twice a month, with focus on checking learning outcomes and targeted enhancement	grammar points, vocabulary, and oral Chinese practice *2) One-to-one course*: synchronous online, once a month, with focus on checking learning outcome and targeted enhancement
Assessment: face-to-face, individual presentation	***Assessment***: online, video presentation	***Assessment***: online, video presentation

5. Discussion

Based on semi-structured interviews, institutional documents related to teaching and learning during COVID-19, and field notes from participatory observations, the present study has examined the exercise of agency among three teachers of Chinese as an additional language in response to their enforced transition to online teaching due to the COVID-19 campus closure. Concurring with existing research findings (Lai et al., 2016; Robinson, 2012; Tao & Gao, 2017), the study found that the teachers' adaptation to educational change was a professional trajectory. The participants demonstrated a developmental trajectory of the enactment of agency in terms of a rapid switch to online language teaching, moving from a primary focus on digital skills to a greater focus on student-centered teaching, and from traditional classroom-based teaching to a blend of face-to-face and synchronous online instruction. At the same time their professional agency was shaped by contextual constraints such as learner needs, boosted by the availability of contextual resources for online education, and strengthened by the flexible and supportive paradigm in their university context. In this regard, teacher agency in educational change should considered as part of a process of agentic choice and practice dictated by local systems and standards, not merely as an individual capacity. Educational institutions need to develop an accepting and flexible structure to encourage and allow room for teachers' pedagogical innovation and creativity in online education (Quezada et al., 2020). In addition, policy makers should build their concepts towards blended teaching, i.e., a strategic hybrid of classroom-based instruction on campus and online teaching for students at home (König et al., 2020).

Regarding the participants' online teaching adaptation at different stages, it seemed that mastering the instructional functions of digital tools or platforms was a major challenge at first, and later supporting diverse instructional purposes became a pressing issue. This result also echoes the findings of previous studies (Ertmer & Ottenbreit-Leftwich, 2013; Gong & Lai, 2018; Lyu & Qi, 2020), which consistently highlighted the importance of teachers' pedagogical competency in integrating ICT into language education. Thus, training in the management of online educational tools or platforms and facilitating excellent asynchronous and synchronous instructional experiences should become a crucial part of teacher professional development for language education. These can help "teachers develop practical strategies and classroom management techniques with respect to technology-enhanced learning-centered teaching" (Gong & Lai, 2018, p. 22). At the same

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

time, pre-service teachers also need to be equipped with online teaching competence, such as TPACK (Bostancıoğlu & Handley, 2018; Mishra & Koehler, 2006) to continue responding effectively to educational change in the post-pandemic era.

The findings emerging from the analysis also reveal that the participating teachers showed little variation with regard to their agentic actions in response to the rapid conversion of modules to online language teaching. This differed from the results reported in previous studies on the exercise of teacher agency in educational change, which have noted that teacher professional agency is individualized and varied across individuals (Eteläpelto et al., 2014; Tao & Gao, 2017). One possible reason behind this inconsistency might have something to do with the enactment of teacher agency in different contexts. COVID-19 forced the participants to transition to an emergency educational paradigm within a rapid period of time (two weeks in this study), and thus they tended to create broadly the same personal and pedagogical goals for their Chinese teaching. Moreover, since none of the participants had any online instructional experiences before the COVID-19 campus closure, their different personal and professional backgrounds seemed not to affect their exercise of teacher agency in online Chinese teaching. In this regard, future studies should take a closer ethnographic look at the dynamic changes in Chinese language teachers' agency in integrating ICT in the long term, especially their online teaching practices in the post-pandemic era.

6. Conclusion

The present study has investigated three teachers of Chinese as an additional language and their exercise of agency in response to the sudden transition to online teaching during a COVID-19 campus closure at a Confucius Institute in Macau. Analysis of interviews, institutional documents, and field notes suggests that the rapid adaptation to online language teaching relied heavily on teachers' professional agency to address technological and pedagogical challenges. The enactment of agency was subject to the interaction between the instructional context, including the university system, the Institute culture and student needs, and the teachers' personal resources, including professional commitment, attitudes towards online education, and competence related to a specific subject. This study offers insights into the value of turning an agency-oriented lens on professional learning and the development of online teaching during the COVID-19 pandemic, and further suggests enacting professional agency to develop pedagogical innovation in educational change not only by enhancing teachers' professional digital competence, but also by building a flexible and collaborative culture.

It should be noted that this inquiry only involved Chinese as an additional language teachers in a Confucius Institute, and any generalization of the findings to teachers in other language education settings should be undertaken with caution, although the findings do have implications for the professional development of teachers' online teaching. This research mainly focused on teachers' online teaching experiences during a COVID-19 campus closure. It would be meaningful to conduct longitudinal studies of greater duration in order to map the transition of language teachers' online teaching pedagogy, and examine the impact of COVID-19 teaching experiences on future professional development.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Although multiple data sources were adopted to enhance the trustworthiness of the research results, what was reported might be different from what was enacted in actual educational settings (Gong, Gao, Li, & Lai, 2020).

Despite these limitations, however, we believe that the findings of this research demonstrate the significance of understanding language teachers' agency in adapting to online teaching during COVID-19 university closures. At the same time, further research may pay more attention to Chinese and other language teachers' exercise of agency in educational change, and may help them to improve their professional competence to address adaptive challenges (MacIntyre et al., 2020).

Funding: This work was supported by University of Macau: [Grant Number SRG2020-00001-FED].

References

Bao, W. (2020). COVID-19 and online teaching in higher education: A case study of Peking University. *Human Behavior and Emerging Technologies*, *2*(2), 113-115. doi: 10.1002/hbe2.191.

Bian, X., Yao, L., & Bian, Y. (2020). Effective COVID-19 prevention and control in areas of ultra-dense population: Lessons from Macau SAR. *Journal of Clinic Intensive Care and Medicine*, 5, 22-25. doi: 10.29328/journal.jcicm.1001031.

Billett, S. (2006). Relational interdependence between social and individual agency in work and working life. *Mind, Culture, and Activity*, *13*(1), 53-69. doi: 10.1207/s15327884mca1301_5.

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, *26*(13), 1802e1811. doi: 10.1177/1049732316654870.

Bostancıoğlu, A., & Handley, Z. (2018). Developing and validating a questionnaire for evaluating the EFL 'Total PACKage': Technological Pedagogical Content Knowledge (TPACK) for English as a Foreign Language (EFL). *Computer Assisted Language Learning*, *31*(5-6), 572-598. doi: 10.1080/09588221.2017.1422524.

Botha, W., & Moody, A. (2020). English in Macau. In K. Bolton, W. Botha., & A. Kirkpatrick (Eds.), *The handbook of Asian Englishes* (pp. 529-546). John Wiley & Sons.

Bryson, J. R., & Andres, L. (2020). Covid-19 and rapid adoption and improvisation of online teaching: curating resources for extensive versus intensive online learning experiences. *Journal of Geography in Higher Education*, *44*(4), 608-623. doi: 10.1080/03098265.2020.1807478.

Buchanan, R. (2015). Teacher identity and agency in an era of accountability. *Teachers and Teaching*, *21*(6), 700-719. doi: 10.1080/13540602.2015.1044329.

Chapelle, C. (2008). Computer-assisted language learning. In B. Spolsky, & F. M. Hult (Eds.), *The handbook of educational linguistics* (pp. 585-595). Blackwell.

Chen, T., Peng, L., Jing, B., Wu, C., Yang, J., & Cong, G. (2020). The impact of the COVID-19 pandemic on user experience with online education platforms in China. *Sustainability*, *12*(18), 7329. doi: 10.3390/su12187329.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

DSEC. (2011). *Results of 2011 population census*. https://www.dsec.gov.mo/getAttachment/7a3b17c2-22cc-4197-9bd5-ccc6eec388a2/E_CEN_PUB_2011_Y.aspx

Ertmer, P. A., & Ottenbreit-Leftwich, A. (2013). Removing obstacles to the pedagogical changes required by Jonassen's vision of authentic technology-enabled learning. *Computers & Education*, 64, 175-182. doi: 10.1016/j.compedu.2012.10.008.

Eteläpelto, A., Vähäsantanen, K., Hökkä, P., & Paloniemi, S. (2014). Identity and agency in professional learning. In S. Billet, C. Harteis, & H. Gruber (Eds.), *International handbook of research in professional and practice-based learning* (pp. 645-672). Springer.

Feryok, A. (2012). Activity theory and language teacher agency. *The Modern Language Journal*, *96*(1), 95-107. doi: 10.1111/j.1540-4781.2012.01279.x.

Gao, L. X., & Zhang, L. J. (2020). Teacher learning in difficult times: Examining foreign language teachers' cognitions about online teaching to tide over COVID-19. *Frontiers in Psychology*, 11. doi: 10.3389/fpsyg.2020.549653.

Gong, Y., & Lai, C. (2018). Technology integration into the language classroom: Developmental trajectory of beginning teachers. *Frontiers of Education in China*, *13*(1), 1-27. doi: 10.1007/s11516-018-0001-5.

Gong, Y., Gao, X., & Lyu, B. (2020). Teaching Chinese as a second or foreign language to non-Chinese learners in mainland China (2014-2018). *Language Teaching*, *53*(1), 44-62. doi:10.1017/S0261444819000387.

Gong, Y., Gao, X., Li, M, & Lai, C. (2020). Cultural adaptation challenges and strategies during study abroad: New Zealand students in China. *Language, Culture and Curriculum*, 1, 1-21. doi: 10.1080/07908318.2020.1856129.

Gong, Y., Lai, C., & Gao, X. (2020). The teaching and learning of Chinese as a second or foreign language: The current situation and future directions. *Frontiers of Education in China*, *15*(1), 1-13. doi: 10.1007/s11516-020-0001-0.

Gong, Y., Lyu, B., & Gao, X. (2018). Research on teaching Chinese as a second or foreign language in and outside mainland China: A bibliometric analysis. *The Asia-Pacific Education Researcher*, *27*(4), 277-289. doi: 10.1007/s40299-018-0385-2.

GOV.MO. (2020, January 30). https://www.gov.mo/zh-hant/news/315523/

Holloway, W., & Jefferson. T. (2000). *Doing qualitative research differently: Free association, narrative and the interview method*. Sage.

Kanuha, V. (2000). "Being" native versus "going" native: Conducting social work research as an insider. *Social Work*, *45*(5), 439-447. doi: 10.1093/sw/45.5.439.

Kayi-Aydar, H. (2015). Teacher agency, positioning, and English language learners: Voices of pre-service classroom teachers. *Teaching and Teacher Education*, 45, 94-103. doi: 10.1016/j.tate.2014.09.009.

König, J., Jäger-Biela, D. J., & Glutsch, N. (2020). Adapting to online teaching during COVID-19 school closure: Teacher education and teacher competence effects among early career teachers in Germany. *European Journal of Teacher Education*, *43*(4), 608-622. doi: 10.1080/02619768.2020.1809650.

Lai, C., Li, Z., & Gong, Y. (2016). Teacher agency and professional learning in cross-cultural teaching contexts: Accounts of Chinese teachers from international

schools in Hong Kong. *Teaching and Teacher Education*, 54, 12-21. doi: 10.1016/j.tate.2015.11.007.

Lasky, S. (2005). A sociocultural approach to understanding teacher identity, agency and professional vulnerability in a context of secondary school reform. *Teaching and Teacher Education*, *21*(8), 899-916. doi: 10.1016/j.tate.2005.06.003.

Lin, C. H., Zhang, Y., & Zheng, B. (2017). The roles of learning strategies and motivation in online language learning: A structural equation modeling analysis. *Computers & Education*, 113, 75-85. doi: 10.1016/j.compedu.2017.05.014.

Lyu, B., & Qi, X. (2020). A review of research on technology-assisted teaching and learning of Chinese as a second or foreign language from 2008 to 2018. *Frontiers of Education in China*, *15*(1), 142-163. doi: 10.1007/s11516-020-0006-8.

Ma, X., Gong, Y., Gao, X., & Xiang, Y. (2017). The teaching of Chinese as a second or foreign language: A systematic review of the literature 2005-2015. *Journal of Multilingual and Multicultural Development*, *38*(9), 815-830. doi: 10.1080/01434632.2016.1268146.

MacIntyre, P. D., Gregersen, T., & Mercer, S. (2020). Language teachers' coping strategies during the Covid-19 conversion to online teaching: Correlations with stress, wellbeing and negative emotions. *System*, 94, 102352. doi: 10.1016/j.system.2020.102352.

Maxwell, J. A. (2005). *Qualitative research design: An interactive approach*. Sage.

Miller, A. L., Wilt, C. L., Allcock, H. C., Kurth, J. A., Morningstar, M. E., & Ruppar, A. L. (2020). Teacher agency for inclusive education: An international scoping review. *International Journal of Inclusive Education*, 1, 1-19. doi: 10.1080/13603116.2020.1789766.

Miller, E. R., & Gkonou, C. (2018). Language teacher agency, emotion labor and emotional rewards in tertiary-level English language programs. *System*, 79, 49-59. doi: 10.1016/j.system.2018.03.002.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017-1054. https://www.learntechlib.org/p/99246/?nl=1

Moorhouse, B. L. (2020). Adaptations to a face-to-face initial teacher education course 'forced' online due to the COVID-19 pandemic. *Journal of Education for Teaching*, *46*(4), 609-611. doi: 10.1080/02607476.2020.1755205.

Pantić, N. (2017). An exploratory study of teacher agency for social justice. *Teaching and Teacher Education*, 66, 219-230. doi: 10.1016/j.tate.2017.04.008.

Passey, D., Shonfeld, M., Appleby, L., Judge, M., Saito, T., & Smits, A. (2018). Digital agency: Empowering equity in and through education. *Technology, Knowledge and Learning*, *23*(3), 425-439.

Priestley, M., Biesta, G. J. J. & Robinson, S. (2015). Teacher agency: What is it and why does it matter? In R. Kneyber & J. Evers (eds.), *Flip the system: Changing education from the bottom up* (pp. 134-148). Routledge.

Priestley, M., Edwards, R., Priestley, A., & Miller, K. (2012). Teacher agency in curriculum making: Agents of change and spaces for manoeuvre. *Curriculum Inquiry*, *42*(2), 191-214. doi: 10.1111/j.1467-873X.2012.00588.x.

Quezada, R. L., Talbot, C., & Quezada-Parker, K. B. (2020). From bricks and mortar to remote teaching: A teacher education program's response to COVID-19. *Journal*

of Education for Teaching, *46*(4), 472-483. doi: 10.1080/02607476.2020.1801330.

Robinson, S. (2012). Constructing teacher agency in response to the constraints of education policy: Adoption and adaptation. *Curriculum Journal*, *23*(2), 231-245. doi: 10.1080/09585176.2012.678702.

Scull, J., Phillips, M., Sharma, U., & Garnier, K. (2020). Innovations in teacher education at the time of COVID19: An Australian perspective. *Journal of Education for Teaching*, *46*(4), 497-506. doi: 10.1080/02607476.2020.1802701.

Selwyn, N. (2012). *Education in a digital world: Global perspectives on technology and education*. Routledge.

Simpson, A., Sang, G., Wood, J., Wang, Y., & Ye, B. (2018). A dialogue about teacher agency: Australian and Chinese perspectives. *Teaching and Teacher Education*, 75, 316-326. doi: 10.1016/j.tate.2018.07.002.

Sloan, K. (2006). Teacher identity and agency in school worlds: Beyond the all-good/all-bad discourse on accountability-explicit curriculum policies. *Curriculum Inquiry*, *36*(2), 119-152. doi: 10.1111/j.1467-873X.2006.00350.x.

Stake, R. (1995). *The art of case study research*. Sage.

Stake, R. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed., pp. 443-466). Sage.

Tao, J., & Gao, X. (2017). Teacher agency and identity commitment in curricular reform. *Teaching and Teacher Education*, 63, 346-355. doi: 10.1016/j.tate.2017.01.010.

United Nations (2020). *Policy Brief: Education during COVID-19 and beyond*. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf

Vähäsantanen, K. (2015). Professional agency in the stream of change: Understanding educational change and teachers' professional identities. *Teaching and Teacher Education*, 47, 1-12. doi: 10.1016/j.tate.2014.11.006.

Wolfinger, N. H. (2002). On writing fieldnotes: Collection strategies and background expectancies. *Qualitative Research*, 2(1), 85-93. doi: 10.1177/1468794102002001640.

Yang, H. (2021). Epistemic agency, a double-stimulation, and video-based learning: A formative intervention study in language teacher education. *System*, 96, 102401. doi: 10.1016/j.system.2020.102401.

Yin, R. K. (2003). *Case study research: Design and methods* (3rd ed., Vol 5). Sage.

Zhang, Y., & Lin, C. H. (2021). Effects of community of inquiry, learning presence and mentor presence on K-12 online learning outcomes. *Journal of Computer Assisted Learning*, *37*(3), 782-796. doi: 10.1111/jcal.12523.

Zheng, B., Lin, C. H., & Kwon, J. B. (2020). The impact of learner-, instructor-, and course-level factors on online learning. *Computers & Education*, 150, 103851. doi: 10.1016/j.compedu.2020.103851.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

职前汉语二语教师教育技术接受量表研制与开发
(Development and Validation of the Pre-Service L2 Chinese Teachers' Educational Technology Acceptance Scale)

孙培健
(Sun, Peijian)
浙江大学
(Zhejiang University)
luapnus@zju.edu.cn

张军
(Zhang, Lawrence Jun)
奥克兰大学
(University of Auckland)
lj.zhang@auckland.ac.nz

摘要：基于 Davis 的技术接受模型（TAM）以及相关前人研究成果，选取汉语国际教育硕士为研究对象，采用探索性和验证性因子分析方法，初步研制了职前汉语二语教师教育技术接受量表，以期为汉语二语领域在教育技术方面的研究起到抛砖引玉的作用。研究显示职前汉语二语教师教育技术接受量表由感知有用性、感知易用性 2.0、技术使用态度与意向、技术使用经历和外部支持五大内外因素构成。其中感知易用性 2.0 在职前汉语二语教师技术接受方面具有最高解释力度；感知有用性和技术使用经历与技术使用态度与意向相关较高；外部支持也在一定程度上与技术使用有关。

Abstract: Informed by the Technology Acceptance Model (TAM, Davis, 1986) and the relevant literature review, this study serves as a preliminary attempt to develop and validate a pre-service Chinese as a second/foreign language (L2 Chinese) Teachers' Educational Technology Acceptance Scale (L2CT-ETAS). The results show that the L2CT-ETAS is composed of perceived usefulness, perceived ease of use 2.0, attitudes and intentions of technology use, experience of technology use, and facilitating conditions. Among the five internal and external factors, perceived ease of use 2.0 could explain the highest variance of pre-service L2 Chinese teachers' technology acceptance. Perceived usefulness and experience of technology use are moderately correlated with attitudes and intentions of technology use. Facilitating conditions also to a certain degree is associated with technology use. It is hoped that this study could provide insights for future research in the field of L2 Chinese teacher education.

关键词：职前汉语二语教师、技术接受、因子分析、量表研制

Keywords: Pre-service L2 Chinese teachers, technology acceptance, factor analysis, scale development

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

1. 引言

随着信息技术的发展，越来越多的教育技术应运而生，并逐渐融入到课堂教学。研究表明，技术辅助下的教学有助于提高学生课堂的参与度（Fonseca et al., 2014; Rashid & Asghar, 2016），从而改善学生的学习效果（Aubusson et al., 2014; Crompton et al., 2017）。然而，教师作为教学过程中的决策者和执行者，其教育技术的参与度和接受度等相关信念，在很大程度上决定了教育技术在课堂教学过程中的地位和作用（Nikou & Economides, 2019; Teo & Zhou, 2017; Teo & Noyes, 2014; Ertmer, 2005）。因此，以教师为出发点了解教师教育技术的使用意向变得十分必要和迫切（Marangunić & Granić, 2015）。这不仅有利于学校等相关教育机构了解教师在教育技术方面的使用情况，也有益于职前教师培训项目对其培养方案进行更具针对性的调整（Baydas & Goktas, 2017）。

此外，据中国国务院新闻办公室（the State Council Information Office of the People's Republic of China, namely, SCIO）报道，中国每年会派出上万职前和在职的汉语作为第二语言或外语（汉语二语）教师投身于全球各地的汉语教学和传播事业（SCIO，2017）。鉴于职前教师是未来教师行业的主力军，其教育技术使用的态度和信念将决定未来课堂中教育与技术的融合程度以及二者结合所产生的教学效果。因此，研究职前汉语二语教师的教育技术接受情况显得尤为重要。然而，目前针对职前汉语二语教师的研究甚少，其中一大原因可能便是缺少相关可靠的教育技术量表。同时，众多研究表明教师的技术使用情况往往受制于文化和环境（Marangunić & Granić, 2015），因此有必要研制和开发适合职前二语汉语教师的教育技术接受量表。

基于上述原因，本研究选取汉语国际教育硕士为研究对象，采用探索性（Exploratory Factor Analysis, EFA）和验证性（Confirmatory Factor Analysis, CFA）因子分析，首次尝试研制职前汉语二语教师教育技术接受量表，以期为汉语二语领域在教育技术方面的研究起到抛砖引玉的作用。

2. 文献综述

关于技术接受与使用的研究始于商科，主要基于 Davis（1986）年所提出的技术接受模型（Technology Acceptance Model, TAM）。近年来，教育领域开始意识到技术在教育中的巨大潜能，并开始大量探索课堂教学中的教育技术使用（Teo, 2012; Teo et al., 2015）。然而，诸如电脑、网络学习和移动学习等教育技术的使用情况往往取决教师的教育技术接受程度（Jeong & Kim, 2017）。近年来，虽然有关教师教育技术使用的研究受到极大关注，汉语二语领域在此却鲜有成果。

根据 TAM 理论模型，感知有用性（Perceived Usefulness, PU）、感知易用性（Perceived Ease of Use, PEU）、技术使用态度（Attitudes of Technology Use, ATU）和技术使用意向（Intention of Technology Use, ITU）是构成 TAM 模型的四大核心要

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

素（Davis，1986; Teo et al., 2018; Venkatesh & Davis，2000）。具体来说，1）感知有用性和感知易用性可以直接影响技术使用态度。研究表明，使用者对相关技术的感知有用性或者感知易用性越强，那么他们对该技术的态度就越正面，也就越愿意使用该技术（Scherer et al., 2019）。2）技术使用态度和感知有用性可以决定技术使用意向。研究显示，感知有用性和感知易用性存在正面的交互作用（Marangunić & Granić, 2015）。二者同时也是决定技术使用态度的两大重要因素（Scherer et al., 2019）。3）随着研究的深入，更多的外部变量被纳入模型的构建之中，用以完善 TAM 模型（详见 Venkatesh, 2000; Venkatesh & Davis, 2000）。例如主观规范（Social Norms, SN, 来自社会要求或压力）、外部支持（Facilitating Conditions, FC, 遇到困难是否有求助的渠道）、技术使用经历（Experience of Technology Use, ETU）和技术使用自我效能（Technology Self-Efficacy, TSE）等也常被认为与感知有用性和感知易用性密切相关（Scherer et al., 2019; Sun & Mei, 2020）。

表 1 TAM 模型核心因子构念

因子构念	概念定义
感知有用性 PU	使用者对技术软件或系统是否能够促进其工作效率和产出等方面的认知程度（Davis, 1989; Li et al., 2016）
感知易用性 PEU	使用者对软件技术或系统在使用难易程度方面的感知（Davis, 1989）
技术使用态度 ATU	使用者在使用某种软件技术或系统时主观上的积极或消极感受（Teo et al., 2018）
技术使用意向 ITU	使用相关软件技术或系统的倾向性（Scherer et al., 2019）

为揭示职前或在职教师的技术使用态度和意向，学者们基于 TAM 技术接受模型在不同的教育或文化背景下进行了大量的相关研究。例如在量表研制方面，Teo（2010a）基于 759 名新加坡职前教师的问卷调查，研制出了职前教师技术接受量表（Technology Acceptance Measure for Preservice Teachers, TAMPST）。这个量表包括感知有用性（4 个题项）、感知易用性（3 个题项）、主观规范（2 个题项）、外部支持（3 个题项）和计算机使用态度构成（4 个题项）。为了验证 TAMPST 量表，Teo（2010b）通过验证性因子分析了 193 名马来西亚职前教师的技术接受情况。虽然研究表明 TAMPST 量表在一定程度上也适用于马来西亚的教育环境，但是数据显示感知易用性和外部支持并非影响马来西亚职前教师计算机使用态度的重要因素。这一发现不仅说明教师的技术接受情况可能由于不同的教育环境而有所不同，也为 Teo 等人（2014）后续并不理想的研究结果提供了一个可能的解释。具体来说，Teo 等人（2014）利用 TAMPST 量表，调查了 969 名泰国职前教师。研究发现感知有用性、感知易用性、计算机使用态度、外部支持和主观规范这些变量只能解释 15.3%的技术接受方差。造成 TAMPST 量表解释力度较低的原因可能在于 1）被试来自不同国家与学科，而不同国家和学科对教育技术的需求也可能不尽相同；2）TAMPST 量表中的主观规范这一潜在变量只有两个题项，不符合一个因素至少需要三个题项的最低因子数要求；3）较少的因子数可能不能准确反映被试的观点，从而影响研究结果。

此外，也有不少研究开始关注中国教育环境下教师的教育技术情况。Huang 和 Teo（2020）通过结构方程模型分析了 502 名来自 30 个中国高校的教师技术使用意

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

向。结果显示中国高校教师的技术使用意向与感知有用性、技术使用态度、学校技术使用政策重要性感知有着显著关系。此外，学校文化对教师在学校技术使用政策重要性方面的感知起到关键作用。虽然学校文化与政策重要性感知被视为新的变量被纳入模型分析，但其实这两个变量与传统的社会规范不谋而合，均强调外部因素对教师技术接受和使用方面的影响。Li 等人（2019）也通过结构方程模型分析了 1423 名中国高校教师的技术使用态度。结果表明感知有用性、感知易用性、国家政策对教师的技术使用起到了积极作用。此外，社会规范对中国教师的技术使用态度也起到了一定的积极作用，而外部支持这一因素则不起作用。这可能是由于高校之间在外部支持方面本身存在较大差异，从而导致这一因素作用的消失。

除了关注中国高校教师的整体情况，相关学者也将研究聚焦于中国英语二语教师的技术使用情况。Huang 等人（2019）通过访谈对 14 名英语大学教师展开了质性分析。研究表明，英语教师对教育技术的使用整体持积极态度，认为外部支持、感知有用性、社会规范、技术热情（与技术易用性和技术使用能力有关）是影响技术接受的相关因素。这一研究结果证明了 TAM 的核心观点也适用于中国高校英语教师。Mei 等人（2018）利用结构方程模型分析了 295 名职前英语教师的对 Web 2.0（即博客、广播、媒体、云计算等）技术的看法。结果发现，职前英语教师的技术使用意向直接取决于他们的感知有用性、外部支持和 TPACK，同时又受到社会规范、技术使用自我效能和外部支持的间接影响。虽然已有学者针对中国高校教师的技术接受情况进行了探讨，但是汉语二语领域中相关的教育技术实证研究仍相对匮乏。Sun 和 Mei（2020）的研究是为数不多针对汉语教师的研究。该研究基于 331 名职前汉语教师的问卷调查，通过结构方程模型和模型对比揭示了影响该类教师技术使用态度与技术使用意向的相关因素。具体而言，感知有用性、技术使用自我效能、外部支持对技术使用态度具有积极作用。同时，技术使用经历对技术使用意向也具有积极作用。

综上所述，虽然 TAM 技术接受模型已被学界广泛认可，但是由于文化环境、教育体制以及学科需求的不同，各国应开发反映各自教师群体的技术接受量表（Marangunić & Granić, 2015）。鉴于 1）现有技术接受量表如 TAMPST 的不足；2）汉语二语领域尚无技术接受量表开发研究；3）以及全球拥有众多职前或在职汉语教师，汉语二语领域有必要研制和开发相关教育技术接受量表。相信量表的研制不仅有助于推进信息技术与汉语二语教学的深度融合，而且能为汉语二语界开展教育技术相关研究奠定基础。

3. 研究设计与结果

3.1 研究对象

本研究对象是来自北京和广州四所 985 高校的汉语国际教育硕士生，采用便利抽样法（convenience sampling）收集，共计 454 名。之所以选取这几所高校主要是为了保证被试间的同质性。经过筛选，我们删除了 12 名被试：其中 7 名由于没有完

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

成问卷，以及 4 名由于年龄远超标准差而被删除。最后有效被试人数为 442 名，包括男生 56 名，女生 386 名。被试的平均年龄为 23.89 岁，标准差为 2.09 岁。被试的平均教龄为 10.89 个月，标准差为 13.8 个月。绝大部分被试利用 PPT 进行教学，少量被试还会使用微信、网盘、手机、电子白板等进行辅助教学。

3.2 数据收集工具

本研究用于数据收集的问卷包括个人基本信息和教育技术接受自我认知两部分。为了尽可能反映职前汉语二语教师在教育技术方面的自我认知，我们基于前人的问卷及相关研究（e.g., Teo, 2010a, 2010b; Teo et al., 2018; Sun & Mei, 2020），编制了由 27 个题项构成的职前汉语二语教师教育技术接受量表。该量表采用 7 度李克特量表（1 表示最不赞同，7 表示最赞同），包括感知有用性（PU, 5 项）、感知易用性（PEU, 3 项）、技术使用态度（ATU, 3 项）、技术使用意向（ITU, 3 项）、技术使用经历（ETU, 3 项）、外部支持（FC, 3 项）、技术使用自我效能（TSE, 3 项）和社会规范（SN, 4 项）。为了确保问卷的表面效度和内容效度，我们邀请了多名汉语国际教育硕士生就问卷语言的可读性进行反馈；对语言表述不明之处给予了及时修正。此外，我们还邀请了教育技术领域的相关专家对问卷所涉及的理论和概念进行评价，以确保改编的问卷能够有效可靠地反映被试的内心想法。

3.3 数据分析方法

在数据分析方面，我们采用了经典的 EFA 和 CFA 两阶段量表开发流程。我们首先通过 SPSS 24.0 对样本进行了随机平均拆分，拆分后的两个子样本分别用于 EFA 和 CFA 阶段的数据分析。通过独立样本 *t* 检验，可以发现两个子样本不存在性别、年龄和教龄上的差异（参加表 2）。EFA 阶段的被试为 221 名，其中男生 31 名，女生 190 名。被试的平均年龄为 23.82 岁，标准差为 2.23 岁。被试的平均教龄为 9.79 个月，标准差为 12.18 个月。在 EFA 方面，考虑到技术接受量表各因子之间可能存在相互作用，我们采用最大似然法和斜交旋转法对 SPSS 24.0 中导入的题项进行分析。CFA 阶段的被试为 221 名，其中男生 25 名，女生 196 名。被试的平均年龄为 23.97 岁，标准差为 1.94 岁。被试的平均教龄为 11.96 个月，标准差为 15.17 个月。在 CFA 方面，我们利用 Amos 24.0 对 EFA 阶段所得量表进行测量模型指标检验。一般来说被试量小于 250 的测量模型需满足以下指标要求：卡方与自由度（χ^2/df）比应小于 3、近似均方根误差（RMSEA）应等于或小于.08；均方根误差（SRMR）应小于.07；比较拟合指数（CFI）和 Tucker-Lewis 指数（TLI）应大于等于.95（Hair et al., 2014）。

表 2 EFA 和 CFA 两个子样本被试情况

被试	性别		年龄（岁）		教龄（月）	
	男	女	均值	标准差	均值	标准差
EFA 样本	31	190	23.82	2.23	9.79	12.18
CFA 样本	25	196	23.97	1.94	11.96	15.17
t-tests	$t(440) = .86, p = .39$		$t(434) = .74, p = .46$		$t(350) = 1.49, p = .14$	

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

3.4 EFA 结果及讨论

我们首先利用 SPSS24.0 统计软件导入所有 27 个题项，并对其进行描述性统计分析。结果显示，各题项均值在 4.33 到 6.29 之间，标准差在.75 和 1.49 之间，偏度和峰度分别在|3|和|10|之间（参见附录 1）。这说明数据基本符合正态分布，可进行后续相关统计分析（Kline, 2016）。此外，Kaiser-Meyer-Olkin（KMO）检验统计量为.83，Bartlett 球形检验结果为χ^2 = 3499.44, *df* = 351, *p* < .001，这些说明 EFA 具有可操作性（Pallant, 2016）。我们通过最大似然法和斜交旋转对导入的题项进行第一轮的 EFA 分析。结果显示 EFA 提取出了 6 个潜在变量，除了技术使用经历，其他因子构念都存在或多或少的重叠性或分散性（参见表 3）。虽然 EFA 结果并非特别理想，但是问卷的整体信度较高，Cronbach α 系数为.87。

表 3 第一次 EFA 统计分析结果

因子构念（潜变量）		1	2	3	4	5	6
技术使用经历	ETU1					.614	
	ETU2					.897	
	ETU3					.769	
感知有用性	PU1		.721				
	PU2		.696				
	PU3		.834				
	PU4		.975				
	PU5		.535				
技术使用态度	ATU1			.683			
	ATU2			.7.3			
	ATU3			.717			
技术使用意向	ITU1			.679			
	ITU2			.820			
	ITU3			.669			
技术使用自我效能	TSE1				.414		
	TSE2			.436			
	TSE3			.496			
外部支持	FC1				.628		
	FC2				.923		
	FC3				.957		
感知易用性	PEU1	.785					
	PEU2	.416					
	PEU3	.720					
社会规范	SN1	.919					
	SN2	.903					
	SN3	.467					.506
	SN4						.817
Cronbach’s α	.870						

为了让改编的量表更具统计学意义，我们根据第一轮 EFA 结果并结合平均最小偏相关（Minimum Average Partial, MAP）结果进行了相应的调整。首先，MAP 结果显示有六个潜在变量的特征值大于 1，其中根据最小平均平方偏相关值（.02247）和最小平方四次方偏相关值（.00166），均建议提取 5 个变量（O’Connor, 2000; Velicer,

1976）（参见表 4）。同时，考虑到 EFA 结果中技术使用自我效能的三个因子载荷系数都较低，其中一个因子被归类到了其他的因子构念上（参见表 3），我们决定删除技术使用自我效能的题项。这一决定不仅仅是基于上述统计结果，也符合前人相关研究结果，即感知易用性和技术使用自我效能虽然名称不同，但其实都能反映个体对技术使用的自信程度（Baydas & Goktas, 2017; Sun & Mei, 2020）。

表 4 MAP 部分特征值与平均偏相关结果

Eigenvalues/特征值	Average Partial Correlations/平均偏相关		
6.97877	root	squared	power4
4.10370	0	.08241	.02212
2.84011	1	.04732	.01024
1.66685	2	.03555	.00494
1.50236	3	.02771	.00287
1.16320	4	.02805	.00276
.93957	5	.02247	.00166
.93402	6	.02354	.00211

在删除技术使用自我效能因子后，我们通过最大似然法和斜交旋转对剩余的题项进行第二轮的 EFA 分析。结果显示 KMO 为.82，Bartlett 球形检验结果为χ^2 = 3226.93, df = 276, p < .001，说明样本符合 EFA 统计分析要求。此外，各因子的公因子方差（communality）系数在.40-.83 之间，均大于.4，说明因子对各自的变量具有较好的解释力度。最后，EFA 共提取了五个潜在变量（参见表 5）。具体来说，1）感知有用性、技术使用经历和外部支持这三类题项仍自成因子。2）技术使用态度和技术使用意向被合并成一个因子。我们将其命名为技术使用态度与意向。3）感知易用性和社会规范被合并成一个因子。通过分析这两类题项，我们不难发现感知易用性和社会规范有着密不可分的关系。比如，教育技术在学校中的使用情况、教育技术使用人数的规模大小、教育技术在媒体中的宣传情况等社会规范都会影响个体对教育技术使用难易程度上的认知和判断。鉴于二者的密切关系以及感知易用性作为在 TAM 模型中的核心因素，我们将感知易用性和社会规范统称为感知易用性 2.0。总之，感知有用性、感知易用性 2.0、技术使用态度与意向、技术使用经历和外部支持是构成职前汉语二语教育技术接受情况的五大因素，并能解释总变异量的 59.27%（参见表 5）。

表 5 第二次 EFA 统计分析及信度检验结果

因子构念（潜变量）		1	2	3	4	5	可解释方差
技术使用经历	ETU1					.614	4.758%
	ETU2					.893	
	ETU3					.765	
感知有用性	PU1		.727				12.595%
	PU2		.712				
	PU3		.832				
	PU4		.965				
	PU5		.509				
技术使用态度与意向	ATU1			.649			15.694%
	ATU2			.636			
	ATU3			.684			
	ITU1			.716			

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

	ITU2			.850			
	ITU3			.700			
感知易用性2.0	PEU1	.774					20.826%
	PEU2	.565					
	PEU3	.734					
	SN1	.877					
	SN2	.884					
	SN3	.699					
	SN4	.477					
外部支持	FC1				.616		5.394%
	FC 2				.933		
	FC 3				.942		
Cronbach's α	.862	.868	.855	.861	.877	.794	59.266%

此外，我们通过 Cronbach α 对量表的各因数及其总体信度进行了检验（参见表 3 和表 5）。结果显示，问卷总体的 Cronbach α 系数为.86，与删除前的问卷整体 Cronbach α 系数（.87）相当，均高于.70 的标准（Pallant, 2016）。感知有用性、感知易用性 2.0、技术使用态度与意向、技术使用经历和外部支持的 Cronbach α 系数分别为.86、.87、.86、.79 和.88，也都高于.70 的标准。以上证明问卷的信度整体上较稳定，不存在由于删减因子而导致问卷的整体信度产生巨大变化。

3.5 CFA 结果及讨论

为了验证 EFA 阶段所得量表的结构效度，我们采用最大似然法 CFA 对量表进行了测量模型指标检验。为了让测量模型达到最佳拟合状态，我们基于 CFA 结果将部分误差进行了相关。误差相关的原因可能是因为题项在表述上较接近造成的。经过调整，我们最终得到以下因子载荷标准化后的最佳测量模型（参见图 1）。测量模型的拟合指标具体如下：χ^2/df = 1.75、RMSEA = .058、SRMR = .068、CFI = .95、TLI = .94，所有指标均符合 CFA 指标要求，且所有因子对其潜在变量具有显著贡献。此外，我们还进行了组合信度（Composite Reliability，CR）和平均方程提取量（Average Variance Extracted，AVE）的计算。结果显示技术使用经历的 CR = .71、AVE = .46；感知有用性的 CR = .89、AVE = .63；技术使用态度与意向的 CR = .88、AVE = .56；感知易用性 2.0 的 CR = .90、AVE = .56；外部支持的 CR = .88、AVE = .71。除了技术使用经历的 AVE 略低于.50，所有指标均符合大于等于.50 的要求（Fornell & Larcker, 1981）。这说明测量模型中的所有潜在变量均具有较高的信度和效度。

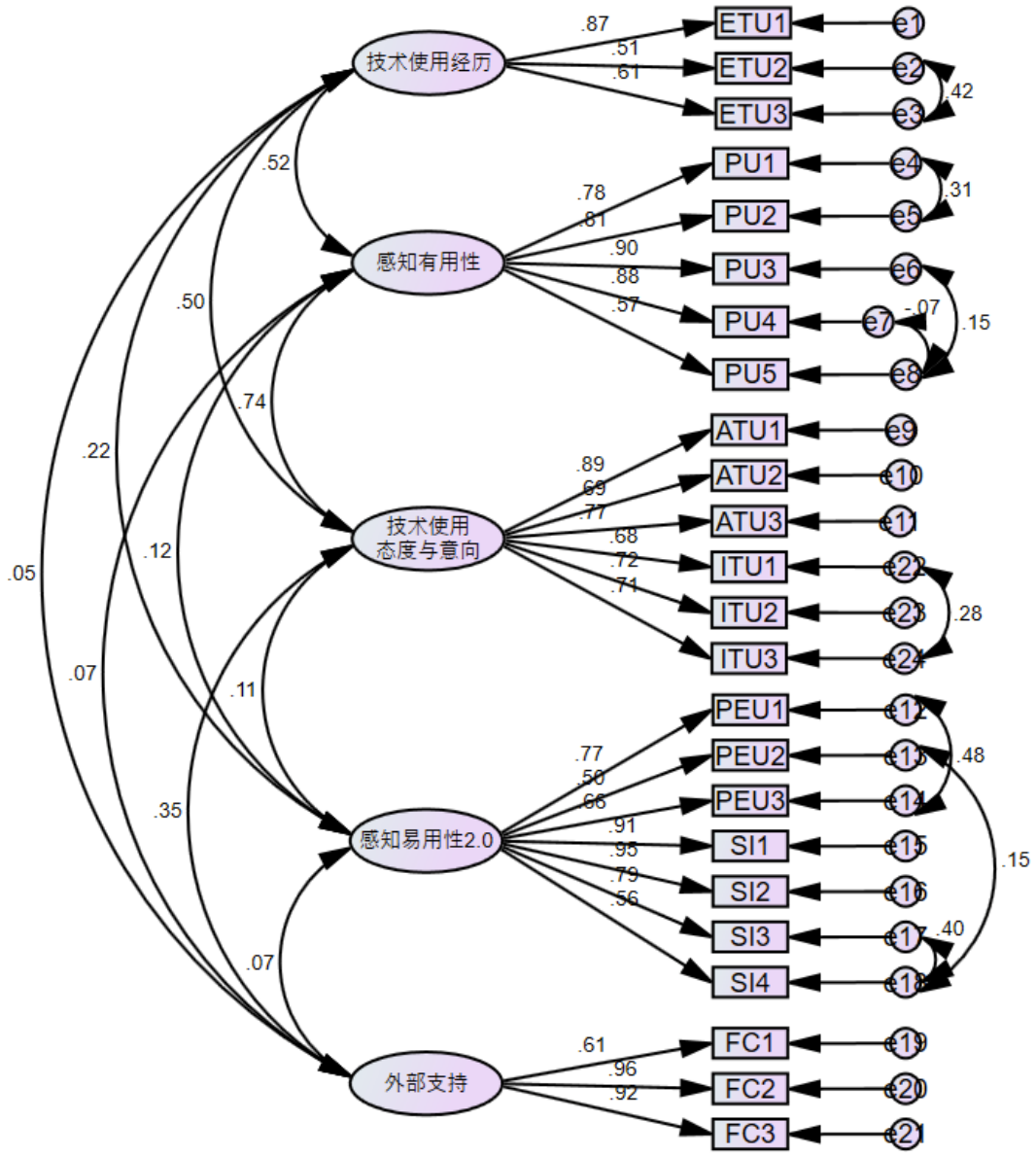


图 1　量表因子载荷标准化后的 CFA 测量模型结果

由图 1 可见，所有潜在变量的因子载荷在.51 和.96 之间，具有较高的载荷系数。也就是说，这些因子能够较好的反映相关潜在变量。在各变量的关系中，技术使用态度与意向这一变量与感知有用性的相关系数最高（.74），与技术使用经历之间的相关系数次之（.50）。这一结果不仅支持了前人的相关研究发现，即感知有用性是影响技术接受与使用的重要因素（e.g., Huang et al., 2019; Huang & Teo, 2020; Li et al., 2019; Mei et al., 2018; Sun & Mei, 2020）；同时也证明了技术使用经历对技术接受与使用的重要作用（e.g., Sun & Mei, 2020）。此外，技术使用经历也与感知有用性之间的相关系数也较高（.52），说明技术使用经历可能有助于教师对相关技术有用性的感知。

4. 总结与展望

本研究基于 Davis（1986）的 TAM 技术接受模型及前人研究成果，选取汉语国际教育硕士为研究对象，通过 EFA 和 CFA 因子分析，初步研制了能反映职前汉语二语教师教育技术接受量表（L2CT-ETAS，参见附录 2）。虽然感知有用性、感知易用性、技术使用态度、技术使用意向、技术使用经历、外部支持、技术使用自我效能和社会规范等因素构成了众多职前或在职教师的技术接受影响因素，但是这些因素并不完全适合职前汉语二语教师。本研究显示技术使用自我效能在因子载荷上相较较低且与感知易用性可能存在一定程度上的重合，二者均能反映个体在技术使用上的自信程度，因此有必要删除技术使用自我效能。此外，本研究显示使用者除了自身对技术使用的难易程度存在判断，社会环境也会影响使用者对技术难易度感知的判断，因此传统的感知易用性和社会规范可合并成感知易用性 2.0。最后，本研究显示技术使用态度和技术使用意向二者难以区分，均反映了个体对技术使用的接受程度，因此有必要进行合并。通过 EFA 和 CFA 两阶段的分析可得，感知有用性、感知易用性 2.0、技术使用态度与意向、技术使用经历和外部支持才是构成职前汉语二语教师教育技术接受的内外因素。

本研究具有以下几点启示：1）感知易用性 2.0 能在 20.83%程度上解释职前汉语二语教师技术接受情况。鉴于感知易用性 2.0 具有最高的解释力度，高校等相关机构应重视创设良好的教育技术应用条件和环境，让教师能够首先能突破心理障碍，从而迈出将教育技术与课堂教学相融合的第一步。2）感知有用性和技术使用经历与职前汉语二语教师的技术使用态度与意向相关较高。高校等相关机构应该时刻关注教师的成长，通过教育技术应用分享会、教育技术课堂观摩、教师教育技术干预研究等措施，为教师创设尽可能多的教育技术使用经历，强化教师在教育技术有用性方面的感知，从而增强教师在技术使用方面的态度与意向。3）外部支持虽然在方差解释力度以及与技术使用态度与意向这一变量的相关系数方面均不高，高校等相关机构仍需加强这两方面的工作。因为教育技术接受不是任何单方面的结果，而是多方面共同作用的结果（Scherer et al., 2019）。

本研究的意义如下：1）揭示了汉语二语领域中构成职前教师教育技术接受与使用的影响因素；2）研发了具有统计学意义的职前汉语二语教师教育技术接受量表；3）有助于高校等相关机构通过研发的量表了解职前汉语二语教师在教育技术上的认知情况；4）助力汉语二语师资培养大纲的设置与调整。

本研究也存在一定局限性。首先，本研究的样本只是来自若干高校，其研究结果的适用范围可能存在不足。因此，未来研究可以在此基础上展开大规模的研究，从而获得更具普世性的结果。其次，本研究的问卷为改编问卷。研制出的量表可能不能完全反映当前国内职前汉语二语教师技术使用的现状。未来研究通过访谈等质性手段获取职前或在职教师内心真实的想法，进而编写出更具代表性的技术接受量表。

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

致谢：本研究得到中央高校基本科研业务费专项基金资助(The study has been supported by the Fundamental Research Funds for the Central Universities)。

参考文献

Aubusson, P., Burke, P., Schuck, S., Kearney, M., & Frischknecht, B. (2014). Teachers choosing rich tasks: The moderating impact of technology on student learning, enjoyment, and preparation. *Educational Researcher*, *43*(5), 219-229.

Baydas, O., & Goktas, Y. (2017). A model for preservice teachers' intentions to use ICT in future lessons. *Interactive learning environments*, *25*(7), 930-945.

Crompton, H., Burke, D., & Gregory, K. H. (2017). The use of mobile learning in PK-12 education: A systematic review. *Computers & Education*, *110*, 51-63.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340.

Davis, F. D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and Results* [Unpblished doctoral disseration]. Massachusets Insitute of Technology.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, *53*(4), 25-39.

Fonseca, D., Martí, N., Redondo, E., Navarro, I., & Sánchez, A. (2014). Relationship between student profile, tool use, participation, and academic performance with the use of augmented reality technology for visualized architecture models. *Computers in Human Behavior*, *31*, 434-445.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th ed.). Pearson.

Huang, F., & Teo, T. (2020). Influence of teacher-perceived organisational culture and school policy on Chinese teachers' intention to use technology: An extension of technology acceptance model. *Educational Technology Research and Development*, *68*(3), 1547–1567. http://doi.org/10.1007/s11423-019-09722-y

Huang, F., Teo, T., & Zhou, M. (2019). Factors affecting Chinese English as a foreign language teachers' technology acceptance: A qualitative study. *Journal of Educational Computing Research*, *57*(1), 83–105. http://doi.org/10.1177/0735633117746168

Jeong, H. I., & Kim, Y. (2017). The acceptance of computer technology by teachers in early childhood education. *Interactive Learning Environments*, *25*(4), 496-17.

Kline, R. B. (2016). *Principles and practice of structural equation modeling*. Guilford Press.

Li, K., Li, Y., & Franklin, T. (2016). Preservice teachers' intention to adopt technology in their future classrooms. *Journal of Educational Computing Research, 54*(7), 946–966. doi:10.1177/0735633116641694

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Li, Y., Wang, Q., & Lei, J. (2019). Modeling Chinese teachers' attitudes toward using technology for teaching with a SEM approach. *Computers in the Schools, 36*(2), 122–141. http://doi.org/10.1080/07380569.2019.1600979

Marangunić, N., & Granić, A. (2015). Technology acceptance model: A literature review from 1986 to 2013. *Universal Access in the Information Society, 14*(1), 81-95.

Mei, B., Brown, G. T. L., & Teo, T. (2018). Toward an understanding of preservice English as a foreign language teachers' acceptance of Computer-Assisted Language Learning 2.0 in the People's Republic of China. *Journal of Educational Computing Research, 56*(1), 74–104. http://doi.org/10.1177/0735633117700144

Nikou, S. A., & Economides, A. A. (2019) Factors that influence behavioral intention to use mobile-based assessment: A STEM teachers' perspective. *British Journal of Educational Technology, 50*(2), 587-600.

O'Connor, B. P. (2000). SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instruments, and Computers, 32*(3), 396–402. http://doi.org/10.3758/bf03200807

Pallant, J. (2016). *SPSS survival manual* (6th ed). McGraw-Hill Education.

Rashid, T., & Asghar, H. M. (2016). Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations. *Computers in Human Behavior, 63*, 604-612.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education*, *128*, 13–35.

SCIO (2017, June 29). *Hanban sends 10,000 teachers and volunteers to teach at Confucius Institutes in various countries every year*. The State Council Information Office of the People's Republic of China. http://www.scio.gov.cn/ztk/dtzt/36048/36835/36842/36844/Document/1557043/1557043.htm [国务院新闻办公室网站.（2017，6 月 29 日）. *国家汉办每年派出 1 万名教师和志愿者赴各国孔子学院任教*. 国务院新闻办公室. http://www.scio.gov.cn/ztk/dtzt/36048/36835/36842/36844/Document/1557043/1557043.htm]

Sun, P. P., & Mei, B. (2020). Modeling preservice Chinese-as-a-second/foreign-language teachers' adoption of educational technology: A technology acceptance perspective. *Computer Assisted Language Learning*, 1–24. http://doi.org/10.1080/09588221.2020.1750430

Teo, T. (2010a). The development, validation, and analysis of measurement invariance of the technology acceptance measure for preservice teachers (TAMPST). *Educational and Psychological Measurement, 70*(6), 990-1006.

Teo, T. (2010b). Validation of the technology acceptance measure for pre-service teachers (TAMPST) on a Malaysian sample: A cross-cultural study. *Multicultural Education & Technology Journal, 4*(3), 163-172.

Teo, T. (2012). Examining the intention to use technology among pre-service teachers: An integration of the technology acceptance model and theory of planned behavior. *Interactive Learning Environments, 20*(1), 3–18.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Teo, T., Fan, X., & Du, J. (2015). Technology acceptance among pre-service teachers: Does gender matter? *Australasian Journal of Educational Technology*, *31*(3), 235–251.

Teo, T., Huang, F., & Hoi, C. K. W. (2018). Explicating the influences that explain intention to use technology among English teachers in China. *Interactive Learning Environments*, *26*(4), 460-475.

Teo, T., Khlaisang, J., Thammetar, T., Ruangrit, N., Satiman, A., & Sunphakitjumnong, K. (2014). A survey of pre-service teachers' acceptance of technology in Thailand. *Asia Pacific Education Review*, *15*(4), 609–616. https://doi.org/10.1007/s12564-014-9348-3

Teo, T., & Noyes, J. (2014). Explaining the intention to use technology among pre-service teachers: A multi-group analysis of the unified theory of acceptance and use of technology. *Interactive Learning Environments*, *22*(1), 51-66.

Teo, T., & Zhou, M. (2017). The influence of teachers' conceptions of teaching and learning on their technology acceptance. *Interactive Learning Environments*, *25*(4), 513-527.

Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometrika*, 41(3), 321–327. http://doi.org/10.1007/BF02293557

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, *11*(4), 342-365.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186-204.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

附录1：描述性统计分析结果

类别	题项概述	平均值	标准差	偏度	峰度
感知有用性	PU1 使用教育技术有助于我的教学	6.29	.77	-1.33	3.67
	PU2 使用教育技术能增强我的教学效果	6.16	.82	-1.90	2.31
	PU3 使用教育技术能提高学生的学习质量	6.02	.87	-.88	.96
	PU4 使用教育技术能提高学生的学习效率	6.14	.78	-.71	.21
	PU5 使用教育技术能增加师生之间的关系	5.61	1.16	-.78	.51
感知易用性	PEU1 我会使用教育技术如果它容易使用	6.19	.75	-1.76	9.41
	PEU2 将教育技术融入到教学对我来说不难	5.49	1.05	-.81	.80
	PEU3 我会使用教育技术如果它容易获取	6.14	.76	-1.75	9.05
社会规范	SN1 我会使用教育技术如果学校要求	6.05	.77	-1.77	8.71
	SN2 我会使用教育技术如果学校鼓励和支持使用	6.14	.80	-1.63	7.32
	SN3 我会使用教育技术如果同事们都使用的话	5.88	.98	-1.37	3.08
	SN4 我会使用技术如果它们经常在媒体中出现	5.46	1.25	-1.16	1.26
技术使用经历	ETU1 我使用过一些教育技术辅助我的教学	5.99	1.25	-2.02	4.96
	ETU2 我大概知道如何使用教育技术	5.22	1.12	-1.06	1.28
	ETU3 我有过一些教育技术使用经历	5.45	1.14	-1.19	1.53
外部支持	FC1 我会使用教育技术如果我有寻求帮助的渠道	4.90	1.24	-.57	.11
	FC2 我会使用教育技术如果学校有 IT 人员帮我	4.83	1.41	-.41	-.31
	FC3 我会使用教育技术如果有详细的使用说明	4.81	1.39	-.52	-.10
技术自我效能	TSE1 我有能力使用教育技术辅助教学	4.33	1.49	-.11	-.71
	TSE2 我有能力将教育技术融入教学	5.57	.87	-.59	.45
	TSE3 学习新的教育技术对我来说不难	5.25	1.17	-.68	.35
技术使用态度	ATU1 我喜欢使用教育技术辅助教学	5.76	.90	-.80	.98
	ATU2 探索如何运用教育技术辅助教学很有趣	5.53	1.16	-.69	.06
	ATU3 我很期待使用教育技术辅助教学	5.94	.87	-.85	1.53
技术使用意向	ITU1 我打算使用教育技术辅助我的教学	6.08	.83	-1.30	3.11
	ITU2 我想使用教育技术辅助我的教学	5.87	.98	-1.05	1.44
	ITU3 我愿意使用教育技术辅助我的教学	6.12	.78	-1.09	3.03

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

附录2：职前汉语二语教师教育技术接受量表（L2CT-ETAS）

①—最不赞同 ②—不赞同 ③—部分不赞同 ④—不确定 ⑤—部分赞同 ⑥—赞同 ⑦—最赞同

因子	题项	请选择一项打勾（√）
感知有用性	使用教育技术有助于我的教学	① ② ③ ④ ⑤ ⑥ ⑦
	使用教育技术能增强我的教学效果	① ② ③ ④ ⑤ ⑥ ⑦
	使用教育技术能提高学生的学习质量	① ② ③ ④ ⑤ ⑥ ⑦
	使用教育技术能提高学生的学习效率	① ② ③ ④ ⑤ ⑥ ⑦
	使用教育技术能增加师生之间的关系	① ② ③ ④ ⑤ ⑥ ⑦
感知易用性 2.0	我会使用教育技术如果它容易使用	① ② ③ ④ ⑤ ⑥ ⑦
	将教育技术融入到教学对我来说不难	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用教育技术如果它容易获取	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用教育技术如果学校要求	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用教育技术如果学校鼓励和支持使用	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用教育技术如果同事们都使用的话	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用技术如果它们经常在媒体中出现	① ② ③ ④ ⑤ ⑥ ⑦
技术使用经历	我使用过一些教育技术辅助我的教学	① ② ③ ④ ⑤ ⑥ ⑦
	我大概知道如何使用教育技术	① ② ③ ④ ⑤ ⑥ ⑦
	我有过一些教育技术使用经历	① ② ③ ④ ⑤ ⑥ ⑦
外部支持	我会使用教育技术如果我有寻求帮助的渠道	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用教育技术如果学校有 IT 人员帮我	① ② ③ ④ ⑤ ⑥ ⑦
	我会使用教育技术如果有详细的使用说明	① ② ③ ④ ⑤ ⑥ ⑦
技术使用态度与意向	我喜欢使用教育技术辅助教学	① ② ③ ④ ⑤ ⑥ ⑦
	探索如何运用教育技术辅助教学很有趣	① ② ③ ④ ⑤ ⑥ ⑦
	我很期待使用教育技术辅助教学	① ② ③ ④ ⑤ ⑥ ⑦
	我打算使用教育技术辅助我的教学	① ② ③ ④ ⑤ ⑥ ⑦
	我想使用教育技术辅助我的教学	① ② ③ ④ ⑤ ⑥ ⑦
	我愿意使用教育技术辅助我的教学	① ② ③ ④ ⑤ ⑥ ⑦

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Supporting Online Chinese Narrative Writing Pedagogy through Metacognitive Writing Process and Approach: A Design-Based Research
(应用元认知写作过程和方法支持在线华文记叙文写作课程的设计本位研究)

He, Fei
(贺菲)
SingChin Academy
(广州新侨学校)
hefei689@gmail.com

Lin, Chin-Hsi
(林金锡)
The University of Hong Kong
(香港大学)
chinhsi@hku.hk

Abstract: This study investigated Chinese narrative writing among 50 secondary students in Singapore. It aimed to design and orchestrate a Chinese narrative writing pedagogy (CNWP) using metacognitive writing process and pedagogical approach of making thinking visible with technology. Both quantitative and qualitative data in Design-based Research (DBR), including writing performance, course feedback questionnaires, focus group interviews and teacher's reflections, were collected. The result indicated that CNWP significantly improved students' narrative writing performance. The Chinese language teacher and most students had positive attitudes toward CNWP, as it positively affected students' writing confidence, writing strategies, and metacognition. Using design-based research, this study has detailed the process of improving CNWP and provided effective pedagogical strategies for Chinese narrative writing.

摘要：本研究通过对新加坡 50 位中学生记叙文在线中文写作情况的调查，旨在设计融入元认知写作过程和科技辅助的可见思维策略的记叙文中文写作课程。本次设计本位研究收集了量化和质化的研究数据，包括记叙文写作的表现、两次问卷调查、小组访谈以及教师反思。结果显示：该写作课程能够明显地改善学生的记叙文写作表现。中文教师和多数学生对该写作课程持有积极的态度，他们认为该课程对提升学生的写作自信、写作策略以及元认知有着积极的影响。本次设计本位研究阐明了在线写作课程改进的过程，同时也提供了一次设计本位研究课程发展的范例。

Keywords: Onilne Chinese language writing pedagogy, metacognitive writing process, making thinking visible, design-based research

关键词：在线中文写作课程、元认知写作过程、使思维可见、设计本位研究

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

1. Introduction

Narrative writing is a compulsory writing component for all Secondary One students studying Chinese in Singapore (Tay et al., 2015). Narrative writing can allow students to express their stories creatively and help students explore different characters and settings (Tienken, 2003). Narrative writing can train logical thinking and the consistent presentation of students' thoughts (Walker, 2019). Narrative writing can make an important connection between a student's personal life and the school experience (Thoughtful learning, 2021).

As Chinese is taught as a second language (L2), writing a good narrative Chinese composition is not an easy task for most students (Tay et al., 2015). Students complain that narrative Chinese writing is difficult because they do not have enough words (Leong, 1999). However, some scholars proposed Singapore students' problems in writing are not only limited and incorrect use of vocabulary, but also insufficient writing strategies (Puah et al., 2013; Wong et al., 2011). Due to students' lack of enough writing strategies, even if students have sufficient relevant words, they still think it is difficult to describe a scene in a story and design the opening of a narrative composition. Zhang et al. (2016) investigated the use of strategies by Singapore lower secondary students in Chinese narrative writing. They found students with higher writing scores adopt more high-quality writing strategies. Therefore, for Chinese narrative writing, students must have both sufficient words and writing strategies.

Another reason why students struggle with narrative writing is that teachers usually do not emphasise students' writing skills and cognition processes, yet expect students to create acceptable products (Gu, 2004). Based on my observation, L2 Chinese teachers in Singapore only provide guidance and a model essay for students to imitate when teaching narrative composition. Even if students can imitate a model essay, it is still hard for them to use the skills learned to write on other topics. When the writing topic changes, students still do not know how or what to write. Due to insufficient use of planning, evaluation, and self-monitoring strategies in the writing processes, students are not aware of their thoughts and thinking processes (e.g., Hull et al., 2011), making it difficult for them to apply their writing skills to new writing tasks. Therefore, the metacognitive writing process is important to students' writing.

To be a good writer, one needs not only task-specific knowledge and skills, but also metacognitive awareness and knowledge (Panahandeh & Asl, 2014). Metacognition in writing involves planning, evaluating, and self-monitoring of writing (Chamot & O'Malley, 1994). Panahandeh and Asl (2014) further proposed a new metacognitive process of writing — including preparation, presentation, practice, evaluation, expansion — and investigated the effect of metacognitive strategies on argumentative writing accuracy for foreign language learners. They found metacognitive strategies have a positive effect on foreign language learners' writing performance. Therefore, it is necessary to use metacognitive strategies when teaching Chinese Second Language (CSL) writing, so students can make a plan for a task, monitor their thoughts, and regulate thinking processes for narrative writing.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Over the past decade, making thinking visible (MTV), a research-based pedagogical approach developed by scholars at Harvard University (Project Zero, 2016), has been widely applied to different aspects of language learning to facilitate the use of metacognitive strategies. MTV provides thinking tools to involve students in thinking activities through thinking routines that are short, easy-to-learn, mini-strategies that extend and deepen their thinking (Project Zero, 2016). The thinking routines help students plan their writing, self-monitoring their learning processes, and self-evaluate their progress. The thinking routines can enhance students' thinking and improve their learning (Ritchhart & Church, 2020).

A growing body of research has consistently found that online approaches positively impact writing learning (e.g., Li et al., 2012; Li & Chu, 2018). With the advancement of digital technology, various online tools have emerged to support language learning. Most research focuses on wiki-based collaborative learning in writing through peer assessment and writing approach by offering Singapore students procedures that help them give peer feedback and improve vocabulary, sentences, paragraph of micro-skills (Chin et al., 2015 & Wong et al., 2011). Yet, few studies examined how MTV activities can be used in online writing and evaluate its efficacy.

The purpose of this study is to visualize the metacognitive writing process by using online MTV activities. This paper reports a design-based research project conducted to address the aforementioned gaps. The study aimed to address the following two research questions:

1) How to design an online Chinese narrative writing module that reflects the metacognitive writing process?
2) How to support Chinese narrative writing through online MTV activities?

2. Literature Review

Metacognition and writing

Metacognition is commonly defined as individuals' ability to know their cognitive functions, monitor them while they operate, and control and adjust them according to the needs of the learning process (Mitsea & Drigas, 2019). Metacognitive strategies are important in L2 acquisition (e.g., Raoofi et al., 2014). Language learners who use metacognitive strategies are able to monitor their learning, and they know how and when to employ the most relevant strategies to accomplish a given task (Anthonysamy, 2021).

Metacognition in writing involves planning, evaluating, and self-monitoring of writing (Chamot & O'Malley, 1994). Goctu (2017) noted that planning might involve brainstorming some keywords and choosing the basic tense for the writing piece, evaluating is more effectively completed by peer-evaluation and self-evaluation, and self-monitoring involves controlling the writing process while writing the text. Panahandeh and Asl (2014) further expanded metacognitive strategies, which include preparation, presentation, practice, evaluation, and expansion.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Metacognitive strategies can not only enhance language learners' confidence, but also can improve language learners' performance. Stewart et al. (2015) demonstrated that metacognition during writing is influenced by emotional factors, such as anxiety and diffidence in writing. McMullen (2009) found metacognitive strategies can improve L2 learners writing skills, which can last for a lifetime. Wang et al. (2009) found metacognitive knowledge has been recognized as a significant attribute affecting the process as well as the product in SL writing. Goctu (2017) believed metacognitive instruction could enhance students' academic writing skills and their self-awareness in learning and train students to become self-regulated learners. While metacognitive strategies are important for L2 writing, Surat et al. (2014) found 18 secondary school students in Malaysia lacked metacognitive writing skills. They suggested metacognitive writing skills should be explicit using the planning technique, drafting introduction technique, and expanding the topic sentences.

Making thinking visible

Making thinking visible is a research-based pedagogical approach that looks into how to encourage learners' engagement, independence, and understanding (Peachey & Maley, 2015). The approach emphasizes three core practices: thinking routines, the documentation of student thinking, and reflective professional practice (Project Zero, 2016). Thinking routines are specific pedagogical activities that develop students' understanding and are most frequently used in teaching (Ritchhart et al., 2011). Thinking routines have a variety of thinking prompts, such as describing, interpreting, wondering, summarizing, and reflection. This study aims to use an easy-to-learn thinking routine to involve students so L2 students can reflect on their acquired knowledge for narrative writing.

Specifically, "I used to think, and now I think," one of the thinking routines, can help learners reflect on how their thinking has changed over time (Ritchhart et al., 2011). This routine can be used whenever students' initial thoughts, opinions, or beliefs are likely to have changed as a result of instruction or experience (Ritchhart, 2016).

The thinking routines have been applied in different disciplines. Papalazarou (2015) applied MTV in English language lessons where she encouraged students to think about thinking itself and develop their metacognitive skills. Similarly, MTV has also been applied in Science (Gholam, 2019). Students have the opportunity to explore how their thinking has changed over time. Teachers think "I used to think, now I think" is an effective routine that can be used as a formative assessment and even a summative assessment tool (Gholam, 2019). Yet, few studies examined how MTV activities can be used in online Chinese writing courses and evaluate its efficacy.

Therefore, this paper will use the thinking routine to allow students to reflect on their acquired knowledge and visualize their thinking process.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

3. Method

3.1 Design-Based Research

Design-based research (DBR) is a methodology designed by and for educators who seek to increase the impact, transfer, and translation of education research into improved practice (Anderson & Shattuck, 2012). Reeves (2006) listed four sequential steps in design-based research: 1) analysis of practical problems, 2) development of solutions based on existing knowledge, 3) evaluation of the solution in practice, and 4) reflection on the design principles produced. The sequential steps of this DBR are listed in Figure 1.

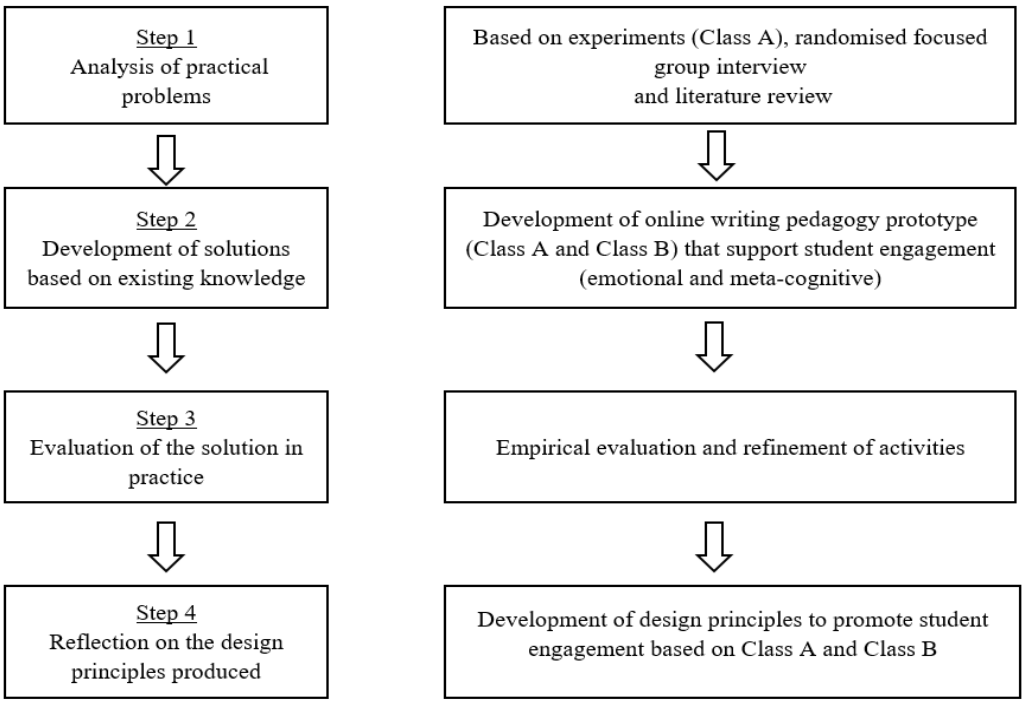


Figure 1 The four-step design-based process of the study

In Step 1, this study articulates practical problems based on an experiment (Class A) and a randomised focus group interview, and investigates new findings in the field of metacognitive strategies and MTV pedagogical approaches for narrative writing. In Step 2, based on the outcome of Step 1, this study applies the online writing teaching and learning pedagogy prototype (Class A and Class B) that supports students' engagement and increases their writing confidence. In Step 3, this study evaluates the effectiveness of the pedagogy applied in Step 2 as a potential solution to the problem. In Step 4, this study reflects on the entire project and summarizes principles for designing effective online writing pedagogy.

3.2 Participants

Participants in Phase 1 and Phase 2 included 23 students in Class A (the seventh grade class in 2020), with an average age of 13 years. Participants in Phase 3 included 27

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

students in Class B (the seventh grade class in 2021) with an average age of 13 years. All participants gave their informed consent prior to data collection.

The school was a government school and imposed Singapore's central curriculum, in which the Chinese language is a compulsory subject taught for three and one-half hours each week. At the time of the study, the students had studied the Chinese language for six years (from first to sixth grade).

The lead author taught both Class A and B and was the facilitator of this study. The main role of teaching was to design an online writing pedagogy that would guide students to use online platforms for their narrative writing. An additional role was to record and collect research data to improve the teaching pedagogy.

3.3 Data Sources

In Phase 1, the instruments included teachers' reflections and a student focus group interview to analyze practical problems based on an experiment from Class A in Step 1(see Figure 1). As the phase aimed to explore practical problems, data were not collected on students' writing performance. In Phase 2, the instruments included students' writing performance, feedback questionnaire, and focus group interview. In Phase 3, the instruments included students' writing performance and a feedback questionnaire.

Table 1 Pedagogy information of Class A and Class B

Study	Course topic	Skills for topic	Duration	Data collection	Phase
Class A	Descriptive technique in narrative writing	Describe sight, hearing, smell, taste, and touch.	70 min	Focus group interview, Teachers' reflection	Phase 1
Class A	The opening of Chinese narrative writing	Using the protagonist's name, appearance description, character portrayal, creating a basis to organize a Chinese narrative writing.	70 min	Students' writing performance and feedback questionnaire Focus group interview	Phase 2
Class B	The opening of Chinese narrative writing	Using the protagonist's name, appearance description, character portrayal, creating a basis to organize a Chinese narrative writing.	70 min	Students' writing performance and feedback questionnaire	Phase 3

For the writing performance, students were asked to write the opening of a narrative composition to bring out its theme, using the protagonist's name, appearance description,

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

character portrayal, creating a basis to organize a Chinese narrative writing. (see Table 1). Each item was worth 2.5 points, for a possible total of 10 points for writing performance in Phases 2 and 3.

3.4 Instruments

This study adopted two feedback questionnaires; the first in Phase 2 and the second in Phase 3. The contents of the two questionnaires were different. The first questionnaire was a modified version of Li's and Chu's (2018) questionnaire, the Cronbach's alpha value for which indicated overall reliability of 0.88. The feedback questionnaire in Phase 3 was modified based on responses to the feedback questionnaire in Phase 2. Both questionnaires used a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) to measure students' attitudes towards and perceptions of Chinese narrative writing pedagogy (CNWP).

The first questionnaire (Phase 2) explored whether the teaching content was of interest to students, as teaching content that satisfies students' learning interest merits further research. It also investigated teachers' role in online learning. The questionnaire included four dimensions: Meaning of learning content consisted of five items (Cronbach's alpha= 0.84); e.g., "The 'Introducing the theme directly' (直接点题) method can help me better understand how to write an essay." Effectiveness of the learning platform consisted of five items (Cronbach's alpha= 0.66); e.g., "The content of the videos on SLS attracts my attention." Learning strategies consisted of five items (Cronbach's alpha=0.60); e.g., "The 'I used to think, now I think' thinking routine helps me to reflect on and understand how my thinking has changed." The role of the teacher consisted of three items (Cronbach's alpha= 0.39); e.g., "Although learning writing skills is conducted through SLS, it is still important for the teacher to provide additional explanation and guidance."

The second questionnaire (Phase 3) explored the effectiveness of CNWP, the role of online learning tools, and the impact of metacognitive strategies. The questionnaire included three dimensions. The online learning process consisted of five items; e.g., "The polling activity allows me to recall what I have learnt on the methods of writing essay introductions" and "Through fill-in-the-blanks questions, I am able to understand the specific content required for the "introducing the theme directly" (直接点题) method, such as the name, appearance, and personality traits of the characters in my essay." Learning strategies consisted of five items; e.g., "For the editing task, checking my work after completing the task helps ensure that I do not miss out on any points" and "Self-reflection allows me to see the changes I have made in writing essay introductions." Effectiveness of the learning platform consisted of five items; e.g., "This exercise increased my confidence in writing" and "The use of SLS makes learning writing skills less stressful." The second questionnaire removed items on the role of the teacher because that role was improved in CNWP.

To gather more in-depth insights on the focused group interview, face-to-face interviews were conducted with four students from Phase 1 and Phase 2. Student interviewees were randomly selected, and their participation was voluntary. Each interview lasted approximately 20 minutes. All interviews were recorded and transcribed. The

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

interviewees were asked to share their experiences with using an online learning approach to write the opening of a narrative in Chinese, give feedback on the benefits and difficulties of the online pedagogy, and describe their attitude toward using it. The interviews were structured around the following questions: 1) What do you think is the difference between such a lesson and a normal writing lesson? 2) What do you think are the advantages of these online questions? 3) What do you think are the drawbacks of such an online lesson?

4. Design-Based Learning Application

Step 1: Analysis of practice problems

The concept of the metacognitive writing process is incorporated into this pedagogy. Metacognition in writing involves the planning, evaluating, and self-monitoring of one's writing (Chamot & O'Malley, 1994). Panahandeh and Asl (2014) further proposed a new metacognitive process of writing that consists of five steps: preparation, presentation, practice, evaluation, and expansion. First, preparation could help students identify what they knew about the contents and what gaps in their prior knowledge should be addressed. Second, the metacognitive strategies in writing were presented and explained to students. Third, students had the opportunity to practice new strategies with authentic writing activities and to begin to plan their writings according to the self-planning strategy. Fourth, students needed to check the level of their writing through self-evaluation so they could well understand what they had learned about new strategies, skills and what needed to be reviewed. Fifth, students had opportunities to transfer new strategies to a different context. This paper applies this metacognitive strategy procedure to online narrative writing pedagogy.

In Phase 1, this study designed Chinese Narrative Writing Pedagogy 1 (see Table 2) for 23 students in Class A and focused on descriptive techniques using an online learning platform. The pedagogy teaching tools consists of seven steps, i.e., take a poll, introduction concept, self-reflection, in-depth concept, planning before writing, observation before writing and paragraph writing, each of which uses different online learning tools, such as taking a poll to learn about students' prior knowledge, watching a video to draw students' attention. The facilitator provided instructions only, without explanation. Each student followed the instruction and completed this pedagogy in 70 minutes, using his/her laptop.

Table 2 Chinese Narrative Writing Pedagogy 1(CNWP1)-a descriptive technique

Metacognitive writing process	Teaching procedure	Teaching content	Teaching tool	Teaching strategy
Preparation	Take a poll (I)	Find out the previous descriptive technique (student-centered learning)	Take a poll	Students' prior knowledge

Presentation	Introduction concept (II)	Introduction new descriptive technique (teacher-centred learning)	Watch a video about the introduction concept	Paying attention
Evaluation	Self-reflection (III)	Realize what you have learned (student-centered learning)	Thinking routine "I used to think, Now I think…"	Setting goals and objectives Self-evaluation
Presentation And Practice	In-depth concept (IV)	Explain new descriptive technique and ask the question (teacher-centred learning)	Fill in the blanks	Finding out about language learning and organising
Practice	Planning before writing(V)	Make a plan to choose any of the new descriptive techniques (student-centered learning)	Multiple choice	Planning for a language task
Practice	Observation before writing (VI)	Understanding story scene from the video (student-centered learning)	Thinking routine "See think wonder"	Self-monitoring
Expansion	Paragraph writing (VII)	Using a new descriptive technique to describe the story scene in one paragraph. (student-centered learning)	Freewriting	Seeking practice opportunities

In the CNWP1 process, students first recall the description techniques used, such as action description and language description, by voting. Second, teachers play a video of a course resource produced by the Singapore Ministry of Education on what portrait descriptions are. The procedure (II) can not only make students initially understand what they have learnt, but also attract students' attention through watching one video. Third, students use the thinking routine (i.e., I used to think…, now I think…) to reflect on what they have learnt and how their thinking has shifted and changed over time. Fourth, the facilitator explains five sense descriptive technique and asks questions. Students answer the questions by filling the online blanks; to emphasize the five senses, description techniques are made up (i.e., describe sight, hearing, smell, taste, and touch). Fifth, students choose new descriptive techniques through completing online multiple-choice tools. Sixth, students watch a three-minute animated video about airport farewells provided by the Singapore Ministry of Education and deeply comprehend the video content through

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

answering See-Think-Wonder questions, which is an MTV thinking routine. Last, students use five-sense descriptive techniques to write a one-paragraph story about airport farewells through online free writing.

After CNWP 1, the lead author conducted a focus group interview to collect feedback from four students from Class A. Responding to the first interview question ("What do you think is the difference between such lesson and normal writing lesson?"), most interviewees stated they believed the lesson could help their Chinese writing. Specifically, CNWP 1 differed from normal writing lessons in that teachers first asked different types of questions that helped students understand how to write, rather than having them immediately begin writing. Oxford (1990) showed that students employ metacognitive strategies to help them coordinate their learning process by centring, arranging, planning, and evaluating their learning. In terms of the second interview question ("What do you think are the advantages of these online questions?"), students thought taking a poll could summarise the knowledge learned before the lesson, while pre-writing (see Table 2) could help them plan the writing process through multiple online choices. In their responses to the third interview question ("What do you think are the drawbacks of such online lesson?"), some students said they needed more scaffolding on self-reflection to answer the question.

Teacher reflection showed the same pattern: students could not understand how to write about their thought changes after learning without explanation from the teacher. Project Zero (2019) suggested teachers should explain to students that the purpose of this activity is to help them reflect on their thinking about the topic and to identify how their ideas have changed over time. In addition, the teacher's reflections showed that providing too many reflection sessions in one lesson period weakened the main learning target. An effective lesson required students to aim for the target, deepen their understanding (Moss and Brookhart, 2012), and reflect on the main learning target.

Step 2: Development of solutions based on existing knowledge

Based on the outcome of Step 1 (i.e., analysis of practical problems), there are three areas for improvement: cognitive processing, the learning target, and the pre-writing activities. The change from Step 1 to Step 2 consisted of moving self-reflection to after the writing task and editing, keeping one thinking routine related learning target, and adding an editing task before the writing task to follow metacognitive strategies for learning (Oxford, 1990), focus more on the learning target (Moss & Brookhart, 2012), and increase students' writing confidence (Balta, 2018). By reflecting on the teaching process, we found that when self-reflection occurred before students had developed an in-depth understanding of the concepts, students were not well prepared to answer the questions (Panahandeh & Asl, 2014).

Additionally, to more intuitively reflect the changes before and after students' writing, a pre-test and post-test were added before and after the class. The curriculum process was adjusted from CNWP 1 to CNWP 2, as seen in Figure 2.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Figure 2 Curriculum changes from CNWP1 on the left to CNWP2 on the right

Step 3: Evaluation of the solution in practice

After the development in Step 2, CNWP 2 (see Table 3) and instructional materials were put into practice in the same school, first in Class A (23) and then in Class B (27) after half a year. Class A was the seventh-grade class in 2020; Class B was the seventh-grade class in 2021. Both classes of students took the same level of Chinese language courses. The writing content of CNWP 1 and CNWP 2 was different. CNWP 1 focused on descriptive technique and CNWP 2 on the opening paragraph of a narrative composition. The purpose of changing the teaching content was to increase the effectiveness of using the metacognitive writing process and pedagogical approach.

Table 3 Chinese Narrative Writing Pedagogy 2 (CNWP2)-opening paragraph

Metacognitive writing process	Teaching procedure	Teaching content	Teaching tool	Teaching strategy
Preparation	Pre-test (I)	Test students' performance. (student-centered learning)	Freewriting	Identify differences between students' learning before and after the intervention
Preparation	Take a poll (II)	Find out the previous writing experience for the opening paragraph. (student-centered learning)	Take a poll	Students' prior knowledge

Presentation	Introduction concept (III)	Introduction how to directly opening paragraph. (student-centered learning)	Watch a video about the introduction concept.	Paying attention Setting goals and objectives
Practice	In-depth concept (IV)	Answer the online question (student-centered learning)	Fill in the blanks	Finding out about language learning and organising
Practice	Planning before writing (V)	Make a plan to complete opening paragraph. Edit the first paragraph of an article. (student-centered learning)	Multiple-choice freewriting	Planning for a language task and complete a small task.
Evaluation	Self-reflection (VI)	Realize what you have learned (student-centered learning)	Thinking routine "I used to think, Now I think…"	Review goals and objectives Self-evaluation
Expansion	Post-test (VII)	Test students 'performance (student-centered learning)	Freewriting	Seeking practice opportunities

Note: The grey highlights of the table indicate the modification of CNWP2

To evaluate CNWP 2 in Class A, this study assessed students' writing performance and attitudes, which will be detailed below.

1) Class A writing performance in CNWP 2

This study conducted the Pre-test and Post-test 1 for Class A in CNWP 2. After two weeks, students completed two new topic writing tasks as Post-test 2 and Post-test 3. The title of Post-test 2 was "my new neighbor," while the title of Post-test 3 was "one of my elementary school teachers." This study adopted descriptive statistical methods and compared students' performance on writing tasks four times, as shown in Table 4. Student's ages ranged from 13 to 14 years. The data from Pre-test (Mean=4.89, SD=3.24), Post-test 1 (Mean=6.30, SD=3.68), Post-test 2 (Mean=7.93, SD=1.94), Post-test 3 (Mean=7.82, SD=2.53) showed an increasing trend in students' writing performance.

Table 4 Students' writing performance phase II (class A)

S/N	Pre-test	Post-test 1	Post-test 2	Post-test 3
Mean	4.89	6.30	7.93	7.82
SD	3.24	3.68	1.94	2.53

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

The unpaired t-test results from the pre-test (M = 4.89, SD = 3.24) and post-test 3 (M = 7.82, SD = 2.53) students' writing performance indicate that the implementation of CNWP2 resulted in a significant improvement in narrative writing, $t(22) = 4.45$, $p = .0001$. Likewise, by focus group interview, most students believed that the online writing pedagogy was easy to understand and could help their Chinese narrative writing.

2) Class A students' attitude towards CNWP2

The feedback questionnaire in Phase II investigated Class A students' attitudes towards CNWP 2, as shown in Table 5.

Table 5 The first questionnaire in phase II

Questions	Mean	SD	Reliability
Subscale 1: Meaning of learning content	4.16	0.74	0.71
Subscale 2: Effectiveness of learning platform	3.75	0.88	0.68
Subscale 3: Learning Strategies	3.97	0.73	0.65
Subscale 4: The role of the teacher	4.02	0.93	0.80

The mean values and standard deviations of the questionnaire data were as follows: Meaning of learning content (Mean=4.16, SD=0.74, Cronbach's alpha=0.71); Effectiveness of learning platform (Mean=3.75, SD=0.88, Cronbach's alpha=0.68); Learning Strategies (Mean=3.97, SD=0.73, Cronbach's alpha=0.65); The role of the teacher (Mean=4.02, SD=0.93, Cronbach's alpha=0.80).

3) Class A focus group interview in CNWP2

After the implementation of CNWP2, the lead author conducted the focus group interview to collect feedback from four randomly selected students from Class A. Based on the second interview question, students believed that taking a poll (Part I) could summarise the knowledge learned before this lesson, pre-writing (Part V) could monitor the writing process using online multiple choices, and self-reflection (Part VI) could help them visualise the thought process. From the third interview question, the students thought they needed more learning concept comments (Parts III & IV) to answer the question and could not complete this part without further explanation from the facilitator.

4) CNWP2 to CNWP3

Based on Class A's learning outcomes in CNWP2, this study put CNWP 3 into practice for Class B. Based on the outcome of the descriptive statistical analysis and the focus group interview for CNWP2, one area for improvement was identified: the role of teacher. Accordingly, this study made adjustments to Part III and Part IV (see Table 6). For example, in the CNWP3 concept introduction process, this study changed from students watching an animated video to teachers introducing concepts based on an animated video. In terms of in-depth concepts, the teacher guide students to emphasise key points from online questions so they can deeply comprehend new writing knowledge.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Table 6 Chinese Narrative Writing Pedagogy 3--opening paragraph

Metacognitive writing process	Teaching procedure	Teaching content	Teaching tool	Teaching strategy
Preparation	Pre-test (I)	Test students' performance. (student-centered learning)	Freewriting	Identify differences between students' learning before and after the intervention
Preparation	Take a poll (II)	Find out the previous writing experience for the opening paragraph. (student-centered learning)	Take a poll	Students' prior knowledge
Presentation	Introduction concept (III)	Introduction how to directly opening paragraph. (teacher-centered learning)	Watch an animated video about the introduction concept	Paying attention Setting goals and objectives
Presentation And Practice	In-depth concept (IV)	Explain how to directly opening paragraph and ask the question. (teacher-centered learning)	Fill in the blanks	Finding out about language learning and organising
Practice	Planning before writing (V)	Make a plan to complete opening paragraph. Edit the first paragraph of an article. (student-centered learning)	Multiple-choice freewriting	Planning for a language task and complete a small task.
Evaluation	Self-reflection (VI)	Realize what you have learned (student-centered learning)	Thinking routine "I used to think, Now I think…"	Review goals and objectives Self-evaluation
Expansion	Post-test (VII)	Test students' performance (student-centered learning)	Freewriting	Seeking practice opportunities

Note: The grey highlights of the table indicate the modification of CNWP3

5) Class B writing performance in CNWP3

This study conducted the Pre-test and Post-test 1 for Class B in CNWP3. After two weeks, students completed two new writing topic tasks as Post-test 2 and Post-test 3. The title of Post-test 2 was "my new neighbor." The title of Post-test 3 was "one of my elementary school teachers." This study adopted descriptive statistical methods and compared students' performance on writing tasks four times, as shown in Table 7. Students' ages ranged from 13 to 14 years. The results of the Pre-test (Mean=3.80, SD=2.44), Post-test 1 (Mean=6.94, SD=3.13), Post-test 2 (Mean=7.04, SD=2.20), Post-test 3 (Mean=7.78, SD=1.74) showed an increasing trend in students' writing performance.

Table 7 Students' writing performance phase III

S/N	Pre-test	Post-test 1	Post-test 2	Post-test 3
Mean	3.80	6.94	7.04	7.78
SD	2.44	3.13	2.20	1.74

The unpaired t-test results from the pre-test (M = 3.80, SD = 2.44) and post-test 3 (M = 7.78, SD = 1.74) students' writing performance indicate that the application of CNWP3 resulted in an improvement in narrative writing, $t(26) = 4.32$, $p = .000$.

6) Class B students' attitude towards CNWP2

The feedback questionnaire in Phase III investigated Class B students' attitudes towards CNWP2, as shown in Table 8. The second questionnaire was modified based on feedback on the first questionnaire.

Table 8 The second questionnaire in phase III

Questions	Mean	SD	Reliability
Subscale 1: Online learning process	4.06	0.66	0.73
Subscale 2: Learning Strategies	3.86	0.71	0.68
Subscale 3: Effectiveness of learning platform	4.10	0.80	0.83

The means values and standard deviations for the questionnaire data were as follows: online learning process (Mean=4.06, SD=0.66, Cronbach's alpha=0.73), learning Strategies (Mean=3.86, SD=0.71, Cronbach's alpha=0.68), effectiveness of learning platform (Mean=4.10, SD=0.80, Cronbach's alpha=0.83).

Step 4: Reflection on the design principles produced

Based on metacognitive writing process theory and both quantitative and qualitative data collected in the study, a Chinese narrative writing pedagogy was developed and revised. This study concludes five design principles to support students' online narrative writing.

a) Principle 1: Use polls to recall students' prior writing knowledge

In Principle 1, polls are used to inform the design of a pre-writing online pedagogy. Prior writing knowledge plays a vital role in students' academic achievement and should be considered in course designing and planning (Tawalbeh & Al-zuoud, 2013). Point-and-click multiple-choice questions are recommended to assess students' prior knowledge of a subject and identify common misconceptions to find an appropriate entry point for introducing a new topic (Zhu, 2007). Similarly, taking a poll is recommended because it can recall students' prior writing experience and stimulate their interest. More importantly, teachers can quickly gauge students' knowledge level.

b) Principle 2: Use authentic and contextualised videos with teachers' comments to introduce writing concepts and skills.

In Principle 2, having students watch interesting animated videos is recommended to attract their attention and introduce writing concepts and skills, as video quality directly or indirectly impacts online learning (Akçayır & Akçayır, 2018). However, based on the findings, merely providing videos may not help to learn, which is consistent with Zheng, Lin, and Kwon (2020) where they found that having outside links or multimedia materials may distract students in online courses. Therefore, teachers need to explain how the videos are connected to the learning objectives after playing them. The role of the teacher is of great importance and cannot be neglected. Therefore, teachers' guidance is integrated with videos.

c) Principle 3: Using fill-in-the-blank questions as an organizer of opening narrative writing.

In Principle 3, teachers can produce fill-in-the-blank questions to address the components of knowledge separately. It is easy to find keywords to help students understand the writing content. For instance, students could not know how to start the opening of a narrative essay, nor with what. In CNWP 3, students can comprehend the essentials of writing in fill-in-the-blank form, such as using the protagonist's name, appearance description, and character portrayal, creating the basis to organize a narrative writing opening.

d) Principle 4: Using multiple-choice tools to plan writing.

In Principle 4, this study suggests that using multiple-choice planning tools allows students to complete the writing plan more quickly and makes it easier to check whether the writing task has been properly completed. Students (L2) face many struggles in completing their writing (L1); some learners have difficulty even getting started (Al-Gharabally, 2015). Teo et al. (2014) proposed dividing complex tasks into different steps to reduce students' learning anxiety. Compared with a writing outline, using multiple-choice tools to plan writing can increase students' confidence in writing and enable them to access the writing process more easily.

e) Principle 5: Using making-thinking-visible routines to facilitate self-evaluation.

In Principle 5, this study recommends using "I used to think… Now I think…" to guide students to reflect on what they have learnt. Through designing their thinking

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

routines, students can reflect on what they have learnt and visualise their thought processes (Cheng et al., 2019). However, teachers should provide more specific hints to help students answer the question. Teachers should explain to students that the purpose of this activity is to help them reflect on their thinking about the topic and identify how their ideas have changed over time. For example, "I want to write what it is that you used to think about description techniques" or "I want you to think about how your ideas about description techniques have changed as a result of what we've been studying" (Project zero, 2019).

5. Conclusions and Limitations

This design-based research has explored ways to support students by using an online learning approach to make thinking visible for Chinese narrative writing. Through CNWP 1 to CNWP 3, a series of design principles were developed to inform the design and implementation of instructional activities for Chinese narrative writing and assess their efficacy. For example, through the teacher's observation, if we provided too many reflection tools, students would not focus on learning (Moss & Brookhart, 2012). This study suggests that teachers should choose a suitable thinking tool to help students reflect on what they have learnt. Watching videos is not enough for students to understand writing skills (Zheng et al.,2020). This study suggests that teachers provide more comments to explain the video content and connect it to the lesson objectives.

The role of the teacher is of great importance and cannot be neglected in an online learning community (Maor, 2003). The teacher directs and redirects the learners' attention toward key concepts and ideas (Bolhuis & Voeten, 2001). Like a good tour guide, a good teacher does not want anyone to miss out on the journey's highlights. In traditional writing lessons, the teacher asks students to draft a writing outline (Al-Gharabally, 2015), and students must spend time completing it. This study suggests that using multiple-choice tools to plan their writing can increase students' confidence.

This study has several limitations that must be acknowledged and makes some recommendations for future research. First, this study was conducted in a single secondary school in Singapore, so caution should be exercised when applying this research outcome in other educational contexts. Further research is required to test the design principles in different contexts (e.g., Chinese narrative writing in primary schools and junior colleges). Second, this study did not focus on specific student characteristics (e.g., gender, anxiety about Chinese writing). Further research is required to design principles to meet special student learning needs. Third, this study only focused on descriptive techniques and opening a composition for Chinese narrative writing. Further research should address writing a full Chinese narrative composition on an online platform.

Acknowledgments: This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

References

Akçayır, G., & Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, 126, 334-345. https://doi.org/10.1016/j.compedu.2018.07.021

Al-Gharabally, M. (2015). The writing difficulties faced by L2 learners and how to minimize them. *International Journal of English Language and Linguistics Research*, *3*(5), 42-49.

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research?. *Educational researcher*, *41*(1), 16-25. https://doi.org/10.3102/0013189X11428813

Anthonysamy, L. (2021). The use of metacognitive strategies for undisrupted online learning: Preparing university students in the age of pandemic. *Education and Information Technologies*, 1-19. https://doi.org/10.1007/s10639-021-10518-y

Balta, E. E. (2018). The relationships among writing skills, writing anxiety and metacognitive awareness. *Journal of Education and Learning*, *7*(3), 233-241. https://doi.org/10.5539/jel.v7n3p233

Bolhuis, S., & Voeten, M. J. (2001). Toward self-directed learning in secondary schools: What do teachers do?. *Teaching and Teacher Education*, *17*(7), 837-855. https://doi.org/10.1016/S0742-051X(01)00034-8

Chamot, A. U., & O'malley, J. M. (1994). *The CALLA handbook: Implementing the cognitive academic language learning approach*. Addison-Wesley.

Cheng, L., Ritzhaupt, A. D., & Antonenko, P. (2019). Effects of the flipped classroom instructional strategy on students' learning outcomes: A meta-analysis. *Educational Technology Research and Development*, *67*(4), 793-824. http://doi.org/10.1007/S11423-018-9633-7

Chin, C. K., Gong, C., & Tay, B. P. (2015). The effects of wiki-based recursive process writing on Chinese narrative essays for Chinese as a second language (CSL) students in Singapore. *IAFOR Journal of Education*, *3*(1), 45-59. https://doi.org/10.22492/ije.3.1.03

Gholam, A. (2019). Visual thinking routines: Classroom snapshots. *Athens Journal of Education*, *6*(1), 53-76. http://doi.org/10.30958/aje.6-1-4

Goctu, R. (2017). Metacognitive strategies in academic writing. *Journal of Education in Black Sea Region*, *2*(2), 8-9. https://doi.org/10.31578/jebs.v2i2.44

Gu, K. (2004). Investigating the process-oriented writing approach. *Journal of Anhui University (Philosophy and Social Sciences)*, *28*(6), 40-44.

Hull, T. H., Balka, D. S., & Miles, R. H. (2011). *Visible thinking in the K-8 mathematics classroom*. Corwin Press.

Leong, W. K. (1999). *Chinese language teaching and testing* (语文教学与测试). SNP Edition.

Li, X., & Chu, S. K. (2018). Using design-based research methodology to develop a pedagogy for teaching and learning of Chinese writing with wiki among Chinese upper primary school students. *Computers & Education*, *126*, 359-375. https://doi.org/10.1016/j.compedu.2018.06.009

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Li, X., Chu, S. K. W., Ki, W. W., & Woo, M. M. (2012). Using a wiki-based collaborative process writing pedagogy to facilitate collaborative writing among Chinese primary school students. *Australasian Journal of Educational Technology*, *28*(1),159-181. https://doi.org/10.14742/ajet.889

Maor, D. (2003). The teacher's role in developing interaction and reflection in an online learning community. *Educational Media International*, *40*(1-2), 127-138. https://doi.org/10.1080/0952398032000092170

McMullen, M. G. (2009). Using language learning strategies to improve the writing skills of Saudi EFL students: Will it really work?. *System*, *37*(3), 418-433. https://doi.org/10.1016/j.system.2009.05.001

Mitsea, E., & Drigas, A. (2019). A journey into the metacognitive learning strategies. *International Journal of Online & Biomedical Engineering*, *15*(14), 4-20. http://doi.org/10.3991/ijoe.v15i14.11379

Moss, C. M., & Brookhart, S. M. (2012). *Learning targets: Helping students aim for understanding in today's lesson*. Alexandria, VA: ASCD organization.

Oxford, R. (1990). Language learning strategies. In Anne B. & Jack C.R. (Eds.), *In the learning English as a second language* (pp.81-90). Cambridge University Press.

Panahandeh, E., & Asl, S. E. (2014). The effect of planning and monitoring as metacognitive strategies on Iranian EFL learners' argumentative writing accuracy. *Procedia-Social and Behavioral Sciences*, 98, 1409-1416. https://doi.org/10.1016/j.sbspro.2014.03.559

Papalazarou, C. (2015). Making thinking visible in the English classroom: Nurturing a creative mind-set. In Alan M. & Nik P. (Eds.), *Creativity in the English language classroom* (pp.37-43). British Council.

Peachey, N., & Maley, A. (2015). *Creativity in the English language classroom*. British Council.

Project Zero. (2016).*Visible thinking*. https://www.pz.harvard.edu/projects/visible-thinking

Project Zero. (2019). *I used to think…Now I think….* https://pz.harvard.edu/sites/default/files/I%20Used%20to%20Think%20-%20Now%20I%20Think_1.pdf

Puah, L.D., Tan, C. L., &Teoh, H. S.(2013). On Singapore's Chinese teaching through blog writing -- A case study based on iWrite.sg platform. *The Journal of Modernization of Chinese Language Education*, *4*(2),80-106.

Raoofi, S., Chan, S. H., Mukundan, J., & Rashid, S. M. (2014). Metacognition and second/foreign language learning. *English Language Teaching*, *7*(1), 36-49. http://dor.org10.5539/elt.v7n1p36

Reeves, T. C. (2006). Design research from a technology perspective. In J. V. den Akker, K. Gravemeijer, S. McKenney, & N. Nieveen (Eds.), *Educational design research* (pp. 52–66). Routledge.

Ritchhart, R. (2016). Making thinking visible: Using thinking routines in the classroom. https://www.nesacenter.org/uploaded/conferences/FTI/2016/handouts/Mark_Church/D_MakingThinkingVisible_Summary_TheMainIdea.pdf

Ritchhart, R., & Church, M. (2020). *The power of making thinking visible: Practices to Engage and empower all learners* (pp. 5-6). Jossey-Bass.

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Ritchhart, R., Church, M., & Morrison, K. (2011). *Making thinking visible: How to promote engagement, understanding, and independence for all learners* (pp.43-49). Jossey-Bass.

Stewart, G., Seifert, T. A., & Rolheiser, C. (2015). Anxiety and self-efficacy's relationship with undergraduate students' perceptions of the use of metacognitive writing strategies. *The Canadian Journal for the Scholarship of Teaching and Learning*, *6*(1),1-17. https://doi.org/10.5206/cjsotl-rcacea.2015.1.4

Surat, S., Rahman, S., Mahamod, Z., & Kummin, S. (2014). The use of metacognitive knowledge in essay writing among high school students. *International Education Studies*, *7*(13), 212-218. http://doi.org/10.5539/ies.v7n13p212

Tawalbeh, A., & Al-zuoud, K. M. (2013). The effects of students' prior knowledge of English on their writing of researches. *International Journal of Linguistics*, *5*(3), 156. http://doi.org/10.5296/ijl.v5i3.3330

Tay, B. P., Chee, K. C., Gong, C., Tan, G. H. (2015). An effective process for assessing and editing Chinese narrative composition: Based on observations of self and peer assessments of writing, *Journal of Chinese Language Education*, 86-104.

Teo, T. W., Tan, K. C. D., Yan, Y. K., Teo, Y. C., & Yeo, L. W. (2014). How flip teaching supports undergraduate chemistry laboratory learning. *Chemistry Education Research and Practice*, *15*(4), 550-567. http://doi.org/10.1039/C4RP00003J

Thoughtful learning.(2021). Of personal importance: How narration drives meaningful writing–*Thoughtful Learning.* https://k12.thoughtfullearning.com/blogpost/personal-importance-how-narration-drives-meaningful-writing

Tienken, C. H. (2003). The effect of staff development in the use of scoring rubrics and reflective questioning srategies on fourth-grade students' narrative writing Performance. Seton Hall University Dissertations and Theses. https://core.ac.uk/download/pdf/151526506.pdf

Walker, A. (2019, January 24). *The importance of narrative essay writing skills – Writing blog for students*. https://www.joewongcomedy.com/writing-like-a-pro/the-importance-of-narrative-essay-writing-skills/

Wang, J., Spencer, K., & Xing, M. (2009). Metacognitive beliefs and strategies in learning Chinese as a foreign language. *System*, *37*(1), 46–56. https://doi.org/10.1016/j.system.2008.05.001

Wong, L.-H., Chen, W., Chai, C.-S., Chin, C.-K., & Gao, P. (2011). A blended collaborative writing approach for Chinese L2 primary school students. *Australasian Journal of Educational Technology*, *27*(7), 1208-1226. https://doi.org/10.14742/ajet.913

Zhang, L. M., Chin, C. K.,Gong, C., Min, Y.,& Tay, B. P.(2016). An investigation into strategies used by Singapore lower secondary students in Chinese composition writing. *Journal of Chinese Language Education,14*(1),19-32

Zheng, B., Lin, C. H., & Kwon, J. B. (2020). The impact of learner-, instructor-, and course-level factors on online learning. *Computers & Education*, *150*, 1-11 https://doi.org/10.1016/j.compedu.2020.103851

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Zhu, E. (2007). Teaching with clickers. *Center for research on learning and teaching occasional papers, 22*, 1-8. https://crlt.umich.edu/sites/default/files/resource_files/CRLT_no22.pdf

© 2021 The Authors. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Read-Along Videos for L2 Chinese Learners
(给汉语为二语学习者用的“跟着读”影片)

Diane Neubauer
(杜雁子)
University of Iowa
(爱荷华大学)
diane-neubauer@uiowa.edu

Abstract: This paper reports on the use of “read-along” videos made for Chinese as a second language (L2 Chinese) learners taking Chinese language classes online. These videos make it possible for students to read along with teacher-created texts and audio support. Students may also mute the audio, pause, slow down or speed up playback, and use pop-up dictionaries while viewing to adapt to their own learning needs. I list findings in research on L2 Chinese reading instruction and development relevant to the design and use of these videos. I also describe the teaching context in which these videos are now used. Then, I recommend how to make similar videos, both from a text design and from a technological point of view, and how to coach students on more effective use of such videos. The paper closes with observations about students’ use of these videos and their application in other instructional settings, Chinese reading development, and future research.

提要：这篇文章报告如何在网课使用为汉语为二语学习者做的“跟着读”影片。这种影片让学习者能边看边听教师提供的阅读材料。学习者还能把音效静音、把影片暂停、把速度放慢加快，也可以用网上词典即时翻译不熟悉的汉字， 以便学生根据自己的学习目标和语言水平调整用法。本文先針對汉语为二语的阅读教学和发展做文献探讨。然后，分享笔者如何在教学里使用这种影片，并从文本设计和科技技术层面分享如何制作“跟着读”影片，也对于如何引导学习者更好地使用“跟着读”影片提供建议。文末探讨“跟着读”影片如何应用于其他的教学情境，分享使用这种影片的学习者在中文阅读发展的教学观察，并提出未来的研究方向。

Keywords: CALL, Chinese reading instruction, L2 Chinese reading comprehension

关键词：电脑辅助语言学习、中文阅读教学、汉语为二语阅读理解

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

1. Introduction

This paper reports on the use of recorded, "read-along" videos made available to Chinese as a second language (L2 Chinese) learners. These videos seem to hold potential usefulness for other instructors, particularly those with distance learning formats and for settings in which students find it challenging to read Chinese character texts. Read-along videos grew initially out of my classroom practice several years ago, when I taught in a high school Mandarin Chinese program. I first developed these videos as a way to provide make-up content for students who were absent on days in which a main focus of class time involved choral reading. Choral reading is any kind of whole class reading aloud from a text. I have used choral reading with my oral support to introduce a few, newly-seen characters in reading texts (Waltz, 2015; Neubauer, 2018). I began to create read-along videos because I noticed that students who missed days with such guided reading experiences later struggled to catch up unless they spent time in a similar way. Namely, they needed the time and means to make connections between the sound and meaning of recently introduced, unfamiliar words and phrases in Mandarin to how the newly-seen characters looked within a comprehensible reading text. Students could use read-along videos outside of class as that type of supplemental reading experience.

Over the past three years, read-along videos became a solution to the challenge of minimal time per week with students in elective, online classes which I teach. By providing videos online in YouTube, students could use them at their convenience. And, unlike choral reading in a classroom setting, in which students read together at the same pace, students using read-along videos can adjust use of the videos to their individual learning needs and available time. They can use videos multiple times and pause, mute, and play at different speeds using video controls built into YouTube. An added benefit of using YouTube as a platform is the ease of sharing the links to the videos and making playlists to collect a series of related videos. Other video platforms and recording methods are certainly possible as well. Students need some guidance about how to use the videos, as effective use is more than a matter of clicking play or passively watching once.

Other reading applications which have aural support have proliferated in recent years. I am glad for more resources in our field designed to provide Chinese language learners with more reading content, especially at beginning levels, but I find read-along videos to fill a role which these apps do not. I find two main differences between subscription sites and apps for L2 Chinese reading and read-along videos which I create. First, because read-along videos are made by me specifically for my students, the content is personalized. I have found that teacher-created reading allows students the benefit of background knowledge and some additional interest in the text, since they know it will be about content that is familiar and in which their ideas from class discussions may appear. A second benefit is that I can tailor the reading intentionally to include Chinese characters that are new to my students multiple times. I also am able to build in "review" characters in these videos. I have not typically found such personalized features in reading apps for L2 Chinese learners. As will be described later in this article, creating videos for my students has not been burdensome in time or technology skills. I have found the benefits to outweigh the time and skill needed to produce them.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

The structure this paper is as follows: first, an overview of some research findings relevant to aspects of the design and use of these videos; second, how I have designed and made read-along videos; then, the context for how I use read-along videos in my sequence of instruction with fully online, remote Chinese language classes. I next describe ways in which I coach new students to optimize use of these videos, including ideas students shared with me themselves. I conclude with anecdotal observations about students' reading development through these videos and suggest research possibilities for understanding and improving them. I am in the process of seeking approval from my university for an empirical study related to use of these videos.

2. Research Background

Learning to read Chinese character texts as L2 has been noted for many years in research as challenging (Everson, 1994, 2011, 2016; Packard, 1990) and anxiety-producing (Zhao et al., 2013), particularly for those in early levels of Chinese learning. Heritage speakers of Chinese have not necessarily shown faster recognition and production of Chinese characters as compared to L2 learners of Chinese (C. Ke, 1998). Research and the field of Chinese language education have not been entirely conclusive about when and how to introduce character reading to new learners of Chinese (Everson, 1994; Knell & West, 2017; Packard, 1990; Shen, 2014; Ye, 2013). Helping students accomplish literacy in Chinese characters within the limits to time available in a Chinese program is "[o]ur major challenge" as Chinese language educators (Shen, 2013, p. 383).

However, some general findings about L2 learners' development of reading comprehension of Chinese texts do exist (S. Ke, 2020). Among Chinese as a Second Language (CSL) studies, active learning strategies and meaningful learning tasks have been found beneficial for Chinese learning and may be preferred by students (Shen & Xu, 2015). Sometimes teachers use technology apps as a way to involve students more actively in reading or character learning. However, although a variety of computer-assisted language learning (CALL) tools exists for Chinese learning, these tools are not always integrated well into instruction (Shen, 2014). In terms of more integrated approaches to reading in Chinese classrooms, repeated reading of texts has shown benefits for vocabulary recognition for heritage learners (Han & Chen, 2010). Repeated reading has also shown benefits in reading fluency and confidence among students in Chinese immersion programs (Knell & Fame Kao, 2020). CSL studies have also identified challenges for L2 Chinese readers. These challenges include recognizing characters, realizing where to segment words (which are not spaced in texts written for native speakers), and lexical access, which is interpreting a word's meaning within the context in which it appears (Shen, 2014). For beginning readers of L2 Chinese, studies have found that adding spaces between words can aid in reading fluency and comprehension with lasting effects (Bai et al., 2013). Read-along videos have been designed with such research findings in mind.

Reading comprehension can be considered at three levels: "the independent level, the instructional level, and the frustration level" (Shen, 2005, p. 1, citing Gillet & Temple, 1994). The independent level involves texts which learners can approach without support

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

from their teacher or other, more proficient learners. The instructional level of reading means that learners find the text approachable but benefit from the support of their instructor and peers to read and understand the entire text very well. The frustration level is to be avoided, but those texts may be suited to later use, when students' proficiency has increased. Frustration level texts include more new words and phrases than would allow students to read and comprehend highly, even with support in the classroom. Important aspects of Chinese language instruction therefore include choosing texts that are appropriate for students to read and understand on their own and providing enough scaffolding to render slightly more challenging texts comprehensible for students, without leading to frustration.

Read-along videos are my attempt at providing texts at the independent level, and which provide enough support for learners to use them at the instructional level, even when the teacher is not present. Their design relies on a view of Chinese character learning that begins from listening comprehension and matching familiar sound and meaning to the visual appearance of characters through experience with highly comprehensible texts in Chinese characters. In seeking aural language development first using pinyin, and later reading in Chinese characters, read-along videos follow a "process view" of reading (Everson, 1994, p. 4). In a process view of reading, learners first acquire aural language during which time pinyin is used, and later are introduced to those words in Chinese character form. Likewise, read-along videos expect that students' recognition of Chinese characters will develop in stages (Zhang & Ke, 2018). The design of the reading material is based on Cold Character Reading texts. In such texts, students encounter a limited number of newly-seen, unique characters, which correspond to words and phrases that are very familiar when heard because of proceeding auditory input. Newly-seen characters repeatedly appear throughout a multiple paragraph-long text which otherwise contains only familiar characters from prior, ample reading experiences (Neubauer, 2018; Waltz, 2015). No pinyin is shown in these texts, as the use of pinyin is limited to aural steps when a word or phrase is newly introduced. It is more typical for Chinese language instruction to focus first on character and word-level study at the same time as aural language is introduced (Shen, 2013, 2014). Read-along videos therefore diverge from that more typical approach to instruction, since they begin from aural language introduced with pinyin, and only later involve character reading. Character reading begins through a more implicit learning stage prior to any explicit character analysis or noticing of character components. Therefore, use of the read-along videos is the major way learners are encouraged to develop Chinese literacy and character recognition in my classes. Over time, it is my aim that the videos aid in building character recognition through re-exposure to a few new characters each time, and through subsequent re-occurrence of those words.

3. Design of Read-Along Videos

The features of the text of read-along videos includes purposeful sheltering of new words and phrases, with familiar words and phrases throughout forming the context in which those new words and phrases appear. Reading ranges in length, from about 400-800 characters (occasionally including the names of people or places in English). Perhaps three to four new words are seen for the first time in Chinese characters in a video, and they

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

appear many times throughout the text: approximately ten to 20 times. The reading tends to be a story, description, or other type of multiple paragraph-long, coherent discourse based on language and topics that arose during the previous class session. Appendix A contains an example of the content of a read-along video designed for the first reading text for a beginning class. See Figure 1 (below) for a screenshot from a read-along video. The golden circle in the image is how the cursor appears in the program I use to record videos, Screencast-O-Matic. Note that the font size is very large, which is intentional so that characters can be seen clearly. Spaces between words have been deliberately added to aid in word segmentation and therefore ease of comprehension (Bai, et al, 2013). The video recording contains my carefully articulated, read aloud of the text, using the cursor to coordinate with my voice as I read. Appendix B includes links to two read-along videos.

Figure 1 A screenshot from a read-along video

The steps to making read-along videos may appear numerous, but after preparing them on a nearly weekly basis, I can usually complete a read-along video in about 20 minutes, from writing to recording to starting to upload online.

1. First, I write the reading text in a Google Document. I create the text based on part of class discussion in the synchronous lesson, so I do not need to create original content for each video. I may change or drop some details or add or emphasize some parts of our discussion in the read-along video. I use the “Find” function in Google Docs to check for how many times new words appear in the text, aiming for 10-20 occurrences.
2. I then copy and paste that text into a new slideshow in the website Qwikslides (http://www.classtools.net/qwikslides/). Qwikslides automatically creates a slideshow more quickly than presentation software like PowerPoint.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

3. When the slideshow is ready, I play that one slide at a time while I read aloud and record a video using Screencast-O-Matic. While recording, I move my cursor under each word as I read it, something like a karaoke video. I use Screencast-O-Matic specifically because its cursor is visually more obvious than that in other screen recording apps. I believe that linking the sound of the Chinese words to how they look in the reading is a very beneficial aspect of these videos, so want to be sure students can easily follow visually. See Appendix B for links to video tutorials about how I create these videos and two example read-along videos.
4. Once the video is ready, I upload it to YouTube, either Unlisted or Public.
5. In more recent months, I have copied and pasted the full transcript into the information area which appears below the video window. By adding this transcript, students can also more easily access comprehension support for any words in the video, as unlike the video itself, the words in the information window can be accessed by pop-up dictionaries. Students can hover over words with a pop-up dictionary such as Zhongwen or Perapera, which show pinyin and English meaning. In a situation in which students might abuse this feature, perhaps copying and pasting the entire transcript into Google Translate, it may not be recommended. I added the transcript after students requested an easier way to double-check meaning, since that is not easy to do from the video itself. I have not found this additional scaffold to hinder their reading in Chinese.
6. I then share the link to the video with students.

4. Context for Read-Along Videos: Online Chinese Language Classes

The context in which I currently use these videos are one-hour-long, synchronous classes once per week with small groups (usually six-12 people). Most students are adults, but some are as young as 11 years old, in classes including people located in several countries. These classes are entirely elective and not associated with any school or credit-issuing institution. They could be described as “open” or “online instruction” since there is no face-to-face component at all (Goertler, 2019, p. 53). Those synchronous classes take place in Zoom meetings, usually with students on video camera view. We focus synchronous class time on aural input and interaction, using a variety of the video conferencing features in Zoom. I use a green screen and virtual backgrounds to display, talk about, and point to images. Students’ occasionally use the Zoom chat window to send me short, typed messages. I have found a physical whiteboard on the wall of my office preferable for writing new vocabulary and drawing to aid comprehension because it allows me to pause and point to those words again as they come up in discussion. During class, I take photos of the whiteboard and post these to a shared Google document for students’ later reference, if they wish (see Appendix A for an example).

I emphasize aural input during classes, with numerous opportunities for students to indicate comprehension and contribute to class discussions, which I expect prepares them for successful use of the read-along videos. My teaching approach aligns with comprehension-based communicative language teaching, including some elements from Teaching Proficiency through Reading and Storytelling (TPRS; Lichtman, 2018; Ray & Seely, 2019), MovieTalk (Murphy & Hastings, 2006), Story Listening (Mason et al., 2020),

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

and other strategies including input-based tasks. Goals for synchronous class time are developing students' listening comprehension and providing opportunities for oral interaction in the context of communicative events: greetings, story co-creation, discussion of interests and events among class members, and intercultural topics. Some occasional focus on form arises within the context of student questions or the need to clarify meaning or word usage. We usually finish class with a few minutes in which I begin to type reading material based on our class session, asking students for details to include in the reading. The shared Google document also include notes about the class and links to videos, and that Google document is where I finish typing reading material.

The second part of class consists of asynchronous reading that I make into read-along videos. I leverage the listening comprehension developed in synchronous classes in these videos. By putting literacy instruction mainly in an independently-accessed video format, students can pursue reading abilities to the degree that they wish. Since the classes are elective, there is no grading or required homework. Some learners do not have the goal of literacy in Chinese or lack the additional time per week to devote to reading; others use them very frequently and regularly. The videos can be made available either as Private videos (which only specific email accounts can access); Unlisted (which has a shareable link but cannot be found in a search); and Public (which allows search engines to find it, and YouTube to promote the video to any YouTube user). I estimate that these videos may benefit both learners' listening skills (Perez, 2019) and their reading comprehension (Taylor, 2019) since they include both complete audio voiceover and text. Some researchers have found that learners strongly prefer full captioning in videos in technology-enhanced listening (Perez et al., 2014). Though these videos were originally designed to target reading comprehension, the interactive way in which many students report using the videos may represent a new kind of digital literacy, in which visual input, aural input, and technology features form a combined experience (Reinhardt & Thorne, 2019). In my teaching circumstances, any additional work with characters or handwriting is at their initiative. I share additional ideas for students who wish to do more Chinese learning on their own, but do not require any additional self-study. I have anecdotal evidence that students who use read-along videos frequently can read aloud and understand unfamiliar texts which contain words and phrases introduced through read-along videos. Students from my classes have read aloud from new texts containing words introduced through read-along videos.

5. Coaching Students to Use Read-Along Videos

Students seem to benefit more when they take advantage of YouTube control options and do not play videos straight through. I base that observation first on overhearing my students talk at the beginning of class about how challenging their first videos felt when played at normal speed and without pausing. Students therefore need to be actively engaged in the reading process, and to recognize their own reading speed and comprehension level so that they can adjust use of the video accordingly. They also may need to be shown the tools YouTube has to make playback fit their needs well. Pausing, predicting, muting, and playing at a slower speed are all easy to do within YouTube settings. However, I have come to realize that students are not always aware of those features in YouTube or how they

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

might benefit from them while using read-along videos. I therefore suggest viewing them multiple times in different ways, for different purposes. Videos can be used with listening as a focus, played on a slower speed, pausing and thinking about the meaning, much like an audio book. The videos can also allow a focus on reading aloud with the audio, as in shadow-reading (Commander & De Guerrero, 2013). If a student has the goal of recognizing individual characters or increasing reading speed, watching multiple times may help. Using videos while muted to self-assess reading ability can also be useful.

Students have developed more ways to use the videos than I had originally envisioned. Some students always say they listen first, pausing often after hearing a slide read aloud to process the meaning. Others report that they try reading to themselves before listening to the audio, and then play and read aloud along with the voiceover, playing at a slower speed if necessary. I believe these differences may reflect different proficiency levels among the students. Their ideas also suggest that there are easy ways to differentiate use of the videos. Chinese literacy development generally proceeds in predictable ways, but we cannot expect all students in the same class to be at exactly the same developmental level (Zhang & Ke, 2018). Read-along videos can be differentiated in their use, so that students with stronger reading skills can do more predicting and muting of the sound of the words, while students who need or want more auditory scaffolding or slower speed playback can easily access those features. These videos can enable students to take control of their reading experiences and the degree of support that they wish at any given time.

6. Discussion and Conclusion

Read-along videos seem to be user-friendly and enjoyable reading and/or listening experiences. They are a tool that more Chinese language teachers may wish to consider using, especially with distance learning and beginning levels of students. These videos rely mainly on implicit development of reading skills, which does not always result in students' awareness of what they have learned. Therefore, students may need or want an outside assessment of their reading progress to "know that they know" how to read. An outside assessment, perhaps through a standardized vocabulary test or reading comprehension test like some level of the HSK, might give them a clearer sense of their progress. Such a test might also be useful for research purposes to find out more about how this kind of reading experience helps students develop character recognition.

In some teaching contexts, read-along videos may have limitations. The learners who attend my classes are mostly adults and quite self-motivated, and all have learned other languages before. For schools with younger students, teachers may need to provide more coaching and supervision to maximize benefits from this type of reading. Also, read-along videos do not directly include assessment that can be checked by the instructor. Teachers who need to provide grades may want an additional way to assess students' progress. EdPuzzle or other apps could be used, and comprehension checks through questions, drawings, or other responses could be designed. Likewise, instructors who want students to develop independent character knowledge very early may want to supplement with individual character study of some kind. I would, however, recommend any character

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

analysis or studying come *after* read-along videos rather than before, so that characters are primarily encountered within a meaningful context.

Students may also benefit from thinking about goals for each time that they use a read-along video, and for their reading long-term. For example, they may focus first on overall comprehension, relying in part on listening skills and making use of the audio track. On a subsequent view, they may aim to read on their own by muting the audio except when needing to check or confirm the sound of certain words. Teachers may want explicitly to clarify what they expect students to "feel like" while reading and that it seems to be normal not to be able fully to trace one's learning, character-by-character, from these videos. I would be surprised if read-along videos feel completely effortless, though I hope that reading with them feels like a pleasant, achievable challenge that gives a rewarding sense of accomplishment. It seems that giving students expectations for their experience, including the way that implicit learning progresses, might increase their sense of confidence in using the videos.

I hope in the future to investigate read-along videos in empirical research now in the process of seeking Institutional Research Board approval. In the future, I would like to investigate their uses among a broader range of students. How younger students and students in a more standard, credit-bearing course could use this type of video is particularly worth investigation. Results in terms of measurable reading and character recognition outcomes after a semester, year, or longer periods of time using read-along videos designed in this way could inform Chinese as a second language courses in how best to use them. How do students score on reading proficiency tests, HSK reading comprehension tests, and tests of Chinese character recognition? Lastly, how might read-along videos help students develop their compositional writing skills? Answers to these questions may help to answer whether or in what ways read-along videos might supplement or replace more typical literacy instruction in online and face-to-face instructional settings.

Acknowledgements: I wish to thank Dr. I-Huei Lee of Northern Colorado University for assistance with the manuscript. I also wish to thank those who have learned Chinese with me online since 2017. I have learned a lot about teaching Chinese online and have enjoyed working with them in class.

References

Bai, X., Liang, F., Blythe, H, Zang, C., Yan, G, & Liversedge, S. (2013). Interword spacing effects on the acquisition of new vocabulary for readers of Chinese as a second language. *Journal of Research in Reading 36*(S1), S4-S17.

Commander, M., & M. C. De Guerrero (2013). Reading as a social interactive process: The impact of shadow-reading in L2 classrooms. *Reading in a Foreign Language, 25*(2), 170-191.

Everson, M. E. (1994). Toward a process view of teaching reading in the second language Chinese curriculum. *Theory into Practice, 33*(1), 4-9.

Everson, M. E. (2011). Best practices in teaching logographic and non-Roman writing systems to L2 learners. *Annual Review of Applied Linguistics, 31*, 249-274.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Everson, M. E. (2016). Confronting literacy in Chinese as a foreign language. In P. Urlaub, J. Watzinger-Tharp, & S. K. Bourns (Eds.), *AAUSC 2016 Volume-Issues in Language Program Direction: The Interconnected Language Curriculum: Critical Transitions and Interfaces in Articulated K-16 Contexts* (pp. 159-173). Cengage Learning.

Gillet, J. M., & Temple, C. (1994). U*nderstanding reading problems: Assessment and instruction* (5th ed.). Pearson.

Goertler, S. (2019). Normalizing online learning: adapting to a changing world of language teaching. In N. Arnold & L. Ducate (Eds.), *Engaging language learners through CALL. From theory and research to informed practice* (pp. 51-92). Equinox Publishing.

Han, Z., & Chen, A. C. (2010). Repeated-reading-based instructional strategy and vocabulary acquisition: A case study of a heritage speaker of Chinese. *Reading in a Foreign Language*, *22*(2), 242-262.

Ke, C. (1998). Effects of language background on the learning of Chinese characters among foreign language students. *Foreign Language Annals*, *31*(1), 91-102.

Ke, S. E. (2020). Review of Research on Learning and Instruction with Specific Reference to Reading Chinese as an Additional Language (1976–2018). *Frontiers of Education in China*, *15*(1), 14-38.

Knell, E., & West, H.-I. (2017). To Delay or Not to Delay: The Timing of Chinese Character Instruction for Secondary Learners. *Foreign Language Annals 50*(3), 519-532.

Knell, E., & Fame Kao, S. C. (2020). Repeated readings and Chinese immersion students' reading fluency, comprehension and character recognition. *Journal of Immersion and Content-Based Language Education*, *8*(2), 230-256.

Lichtman, K. (2018). *Teaching Proficiency through Reading and Storytelling (TPRS): An input-based approach to second language instruction.* Routledge.

Mason, B., Smith, K., & Krashen, S. (2020). Story-listening in Indonesia: A replication study. *Journal of English Language Teaching*, *62*(1), 3-6.

Murphy, B., & Hastings, A. (2006). Making movies more comprehensible: The narrative/paraphrase approach. *International Journal of Foreign Language Teaching*, *2*(2), 25-27.

Neubauer, D. (2018). Cold Character Reading: A Chinese literacy strategy. *CSCTFL Report*, 37-154.

Packard, J. L. (1990). Effects of Time Lag in the Introduction of Characters into the Chinese Language Curriculum. *The Modern Language Journal*, *74*(2), 167-175. doi:10.1111/j.1540-4781.1990.tb02562.x

Perez, M. M. (2019). Technology-enhanced listening: How does it look and what can we expect? In N. Arnold & L. Ducate (Eds.), *Engaging language learners through CALL. From theory and research to informed practice* (pp. 141-178). Equinox Publishing.

Perez, M. M., Peters, E., & Desmet, P. (2014). Is less more? Effectiveness and perceived usefulness of keyword and full captioned video for L2 listening comprehension. *ReCALL*, *26*(1), 21-43.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

Ray, B., & Seely, C. (2019) *Fluency through TPR Storytelling (TPRS): Achieving real language acquisition in school* (8th ed.). TPRS Books & Command Performance Language Institute.

Reinhardt, J., & Thorne, S. L. (2019). Digital literacies as emergent multifarious repertoires. In N. Arnold & L. Ducate (Eds.), *Engaging language learners through CALL. From theory and research to informed practice* (pp. 208-239). Equinox Publishing.

Shen, H. H. (2005). Linguistic complexity and beginning-level L2 Chinese reading. *Journal of the Chinese Language Teachers Association*, *40*(3), 1-27.

Shen, H. H. (2013). Chinese L2 literacy development: Cognitive characteristics, learning strategies, and pedagogical interventions. *Language and Linguistics Compass*, *7*(7), 371-387.

Shen, H. H. (2014). Chinese L2 literacy debates and beginner reading in the United States. In M. Bigelow & J. Ennser-Kananen (Eds.), *The Routledge Handbook of Educational Linguistics* (pp. 276-288). Routledge.

Shen, H. H., & Xu, W. (2015). Active learning: Qualitative inquiries into vocabulary instruction in Chinese L2 classrooms. *Foreign Language Annals*, *48*(1), 82-99.

Taylor, A. (2019). CALL and L2 reading: Current research and application. In N. Arnold & L. Ducate (Eds.), *Engaging language learners through CALL. From theory and research to informed practice* (pp. 179-207). Equinox Publishing.

Waltz, T. T. (2015). *TPRS with Chinese characteristics: Making students fluent and literate through comprehensible input.* Squid for Brains Educational Publishing.

Zhang, T., & Ke, C. (2018). Research on L2 Chinese character acquisition. In C. Ke (Ed.), *The Routledge Handbook of Chinese Second Language Acquisition*, (pp. 103-133). Routledge.

Zhao, A., Guo, Y., & Dynia, J. (2013). Foreign language reading anxiety: Chinese as a foreign language in the United States. *The Modern Language Journal 97*(3), 764-778.

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

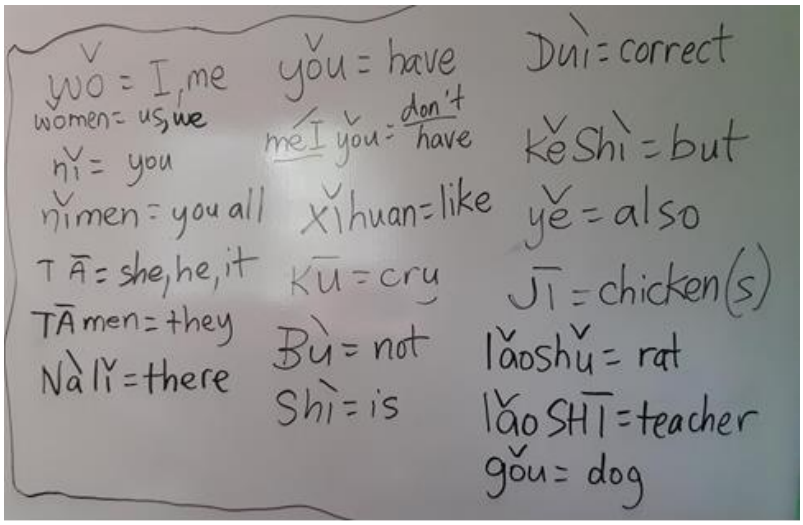
Appendix A

An example of the Google Document I make and share after each class. This example comes from the first beginning class on September 8, 2019.

2020 年 9 月 8 号
Highlights from class time:

- Getting to know how Zoom & class sessions work.
- I have… discussion, starting with Nutella.
- Live Typing.
- People shared some ideas for review/learning Chinese during the rest of the week (end of class session video).

Whiteboard photo with vocabulary that came up:



Class session video recording: [link removed]
Read-along video: http://somup.com/cqQjYVeaQA
Important for the read-along video: I do not speak at what is probably the ideal speed for a total beginner when I record these. Therefore, you will probably want to use pause, slower speed playback, and mute (to predict how it sounds) to make the most of the read-along videos. Here's a video that introduces those features in YouTube: How to Use YouTube with Read-Along Videos.
Another thing about read-along videos: I will not expect that you all have time/interest now in reading Chinese, so during class, I generally use pinyin as words come up. However, reading Chinese means reading in characters, and it's like seeing a film in color compared to watching in black-and-white. I think it's worth the time!

Here is what we started typing together:

Diane 有 Nutella.
Diane 没 有 pizza。
Diane 有 Nutella, 可是 Diane 没 有 pizza.
Bess 没 有 Nutella!
Diane 有 Nutella, 可是 Bess 没 有！
Bess 哭！Bess 没 有 Nutella.
Diane 有 Nutella. Diane 不 哭！

(You do NOT need to be able to read what's below directly - it's better to use the read-along video which has larger font size and better spacing. I type up the reading material here so I can keep track of it more easily. I don't expect you to be able to read this from here, without hearing some of the words. And the font size is too small for comfort as a new reader! I also switched around who has or doesn't have Nutella.)
Qwikslides version: http://www.classtools.net/qwikslides/87_c4H3G8
Bess 有 Nutella. Bess 没 有 pizza.
Bess 有 Nutella, 可是 Bess 没 有 pizza.
Diane 没 有 Nutella!
Bess 有 Nutella, 可是 Diane 没 有！ AIYa!
Diane 哭！ Diane 没 有 Nutella.
Bess 有 Nutella. Bess 不 哭。
Bess 喜欢 Nutella, 可是， Diane 也 喜欢 Nutella.
Bess 没 有 pizza, 可是 Bess 不 哭。
Bess 喜欢 pizza, 可是 Bess 不 哭。
Diane 也 没 有 pizza. Bess 不 哭。
可是， Diane 也 没 有 Nutella. Diane 哭 了! Diane 喜欢 Nutella!
Bess: "Diane , 你 哭 了！ "
Diane : "我 哭 了！ 我 没 有 Nutella!"
Bess: "你 喜欢 Nutella 吗？ "
Diane : "喜欢！ 我 喜欢 Nutella! 可是，我 没 有。你 不 哭。你 有没有 Nutella??"
Bess: "我 有 Nutella. 你 没 有 吗？ "
Diane : "我 没 有 Nutella！ 可是，我 喜欢。我 哭！ 哭 哭 哭！ "
Bess: "AIYa! 你 哭 了！ 我 喜欢 你，可是，我 不 喜欢 你 哭。"
"我 有 Nutella. 你 喜欢 Nutella, 我 也 喜欢 Nutella. Diane , 我 的 Nutella! 你 有 Nutella 了！ "
Diane ："WA! 你的 Nutella! 我 有 Nutella 了！ 我 喜欢！ 谢谢 你！ "
Bess: "不 谢。 我 喜欢 Nutella, 我 也 喜欢 你。"
"可是，我 不 喜欢 你 哭！ 你 有 Nutella 了。你 哭不哭？ "
Diane : "我 不 哭 了！ 有 Nutella, 我 不 哭。谢谢。我 喜欢 你的 Nutella。"
Bess："不谢，不谢。"

Appendix B

Links to video tutorials with suggestions for use and making of these videos, and two read-along video examples for different levels of students:

- Instructional video for how to use and make read-along videos: https://youtu.be/4acHV_HUl4E
- Design factors for read-along videos and similar texts: https://youtu.be/z3uN-bShC50
- Example of a Chinese read-along video (designed for first reading ever in Chinese): https://www.youtube.com/watch?v=zlLn6Be40cU
- Example of another read-along video (designed for people after about 60 hours of Chinese): https://youtu.be/rfmL6bakOPw

© 2021 The Author. Compilation © 2021 Journal of Technology and Chinese Language Teaching

© 2021. Journal of Technology and Chinese Language Teaching
© 2021 科技与中文教学
URL (网址): http://www.tclt.us/journal
Email (电子邮件): editor@tclt.us