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Where Can Technology Take 21st Century Chinese Language Learning and Teaching?

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Abstract

This paper explores the transformative role of technology in Chinese second language learning (CSL), bridging the gap between research and teaching implications through an overview of existing research, with added specific insights from the author's own work over two decades focusing on communicative approaches to teaching and learning CSL. It examines three areas where innovative uses of technology impact on Chinese language learning in and out of the classroom: digitally-supported pedagogy for authentic, student-centred learning; theory-driven research using corpora and eye-tracking; and virtual immersion during residence abroad. Findings demonstrate how mobile-assisted learning, flipped classrooms, and corpus-informed instruction have been successful in enhancing communicative competence and learner autonomy. Eye-tracking studies assist teachers in understanding cognitive processes underpinning character recognition and reading fluency; evidence gathered during the COVID-19 pandemic offer nuanced insights into identity, confidence, and conversational proficiency developed during virtual residence abroad. The paper argues for a paradigm shift in CSL, advocating for training in digitally-literate pedagogies reflecting learners' sociocultural realities. It concludes by urging integration of generative AI tools to support personalized learning and interactional competence, positioning technology not as a replacement for real-world engagement but as a catalyst for inclusive, resilient, and plurilingual language education in the global "digiverse."

Keywords: technology, language teaching, Chinese as a second language

技术将引领 21 世纪汉语教学走向何方？

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摘要：本文旨在探讨技术在汉语作为第二语言（CSL）学习中的变革性作用，通过梳理现有的研究成果，结合作者二十余年来聚焦汉语交际教学法的研究经验与观察，搭建理论研究与教学实践之间的桥梁。研究重点剖析了三类创新技术应用对课堂内外汉语学习的影响：以学生为中心、面向真实交际场景的数字化教学法；基于语料库与眼动追踪技术的理论驱动型研究；沉浸式海外虚拟留学项目。研究结果表明，移动辅助学习、翻转课堂和语料库辅助教学等模式能有效提升学习者的交际能力与自主学习素养；眼动追踪研究可以帮助教师深入理解汉字识别与阅读流畅性背后的认知过程；新冠疫情期收集的实证数据，为探究虚拟海外学习模式下学习者的身份认同、自信心和会话能力发展提供了详实且多维的视角。文章呼吁 CSL 领域的范式革新，倡导开展基于数字素养的教师培训，创新更贴合语言学习社会文化现实的教学手段，整合生成式 AI 工具以支持个性化学习和互动能力培养。文章强调，技术并非真实互动场景的替代品，而是全球数字多元文化背景下，构建更具包容性及韧性、多语言融合之语言教育生态的催化剂。

关键词：技术；语言教学；汉语作为第二语言

1. Introduction

This paper presents insights drawn from modern current models and practices that impact Chinese second language acquisition (SLA), particularly in relation to instructed classroom or study abroad contexts. Like some classic approaches to SLA, research into Chinese second language (L2) acquisition does not always bridge the gap to create teaching or "real-world" impact. This paper, along with others cited here, offers a valuable opportunity to do so, specifically in relation to use of technology and communicative skills, using research evidence derived from nearly two decades of working in theoretical and practical applications of SLA to L2 Chinese. Many teachers of L2 Chinese may feel under pressure to "jump into digital," facing a rapid rise in learners wanting to acquire the language in more authentic, communicative ways using contemporary digital tools, just as in everyday life—this shift could be challenging for teachers trained in traditional classroom methods and highly formalized assessment expectations. Recent studies suggest that teachers of Chinese as a second language (CSL) may lack training or confidence in adopting innovative technology (Gao, 2020; Zhao et al., 2020). Clear research evidence can, therefore, be helpful for teachers to better understand the complex processes of learning and using Chinese, and engage with novel technological tools in their own teaching practices, whether navigating pragmatics and sociocultural nuances in online communication or using apps to provide personalized feedback on characters and tones. This paper aims to illustrate how research and learning in CSL can intersect, with a specific focus on three areas or themes in recent research, using technological tools to investigate critical questions on how to support learners' Chinese acquisition journey and boost CSL learning outcomes in and out of the classroom. For each theme, I first present a scoping review of existing research in the field, with implications for new trends in CSL, and then add evidence from research from my own projects, to illustrate a specific aspect in which technology brings innovative or novel insights into our understanding of CSL.

Recent decades have shown an exponential growth of global interest in learning Mandarin Chinese (henceforth Chinese, unless specified otherwise). Such growth includes an interest in communicative and task-based approaches to teaching and learning (Wright, 2019, 2020). The first area discussed here relates to the growth of digitally-supported teaching and learning activities, such as use of Mobile-Assisted Language Learning tools (Kan et al., 2018; Kan & Tang, 2018) which can provide new ways to boost motivation and improve individualized learning (Shi & Kan, 2023; B. Xu, 2024), or by creating self-access resources to support teachers in increasing communicative interaction in classtime by using a "flipped classroom" approach (J. Wang et al., 2018).

Second, technology-based research also has shed important light on other novel directions to understand acquisition processes, e.g. using corpora as baseline reference tools to support teaching, e.g. by creating a frequency dictionary (Xiao et al., 2009), or to track developmental trajectories, whether in large-scale cross-sectional comparisons of different proficiency cohorts, or in small-scale exploratory longitudinal studies of individual variation in grammatical or collocational knowledge (e.g., Sun, 2023; J. Xu, 2019). Other methods include using psycholinguistic eye-tracking methods to gain insights into character learning and reading fluency (An et al., 2024; Stickler & Shi, 2014; Wright & Wang, 2023).

Third, we turn to ways to use technology for tracking L2 Chinese acquisition in virtual contexts, by looking at language development during study abroad in the era of being "permanently on, permanently connected" (Vorderer et al., 2017). We present findings from a recent investigation of the "Virtual Year Abroad" experienced by UK Chinese language degree students during the pandemic, where digital teaching and interaction with Chinese hosts was provided, but travel to China was impossible (Wright et al., 2025). Using qualitative interview data, we illustrate that, in some ways, the virtual year abroad was less of a problem than predicted in terms of developing accuracy and fluency. However, the experience also had a profound impact on students' confidence and identity as Chinese speakers, particularly for those from less privileged backgrounds, with a range of implications for the future of "real" study abroad as an expected requirement for successfully acquiring Chinese.

I finish by calling for work in the rapidly emerging world of Generative AI (GenAI) in language education, to ensure scholars, students and teachers can prioritize effective AI literacy to befit the requirements of a globally connected multilingual and pluricultural digital world ("digiverse"). This requires active engagement between researchers and practitioners on developing the best-quality digitally-supported pedagogic skills to fit 21st century L2 Mandarin learners' communicative needs more flexibly and adaptively.

2. Technology in language learning

2.1 Rise in technology-supported Chinese language learning and teaching

While technology has been used to support language acquisition and teaching for decades, there has been exponential growth in recent years in different kinds of technological tools and applications to language learning in general, and for Chinese language learning specifically. The opportunities for technology use have risen in parallel with the huge global growth in demand for Chinese language learning—recently estimated at around 25 million worldwide (Gong & Lai, 2024).

Mandarin Chinese is now frequently ranked along with English as the most important global language to learn in educational and business strategic reviews in Asia, across the Middle East and in the Global South (Kaufman, 2025). In the UK, Chinese is currently ranked fourth most important language in terms of strategic importance (Collen, 2023). The Mandarin Excellence Program (MEP) is one example of recent initiatives aiming to significantly increase the number of young people in England achieving fluency in Mandarin Chinese (Institute of Education of University College London, 2023). The program is delivered by the Institute of Education Confucius Institute for Schools, hosted at University College London in partnership with the British Council, and is funded by the Department for Education. The MEP has already enrolled approximately 10,000 students across 71 schools in England (Institute of Education of University College London, 2023). Alongside face-to-face teaching in classrooms, MEP students are also offered digital tools, such as apps like Chairman's Bao for self-study, and supporting immersive cultural experiences through actual or online collaborations with partners in China.

Chinese is also the fourth most popular language studied at university, with around 1,500 students enrolled on degree programs, as well as around 5,000 students on various adult education providers including the 29 Confucius Institutes around the UK (Collen, 2023).

Students' motivation for learning Chinese varies widely, as for any language, but alongside global economic opportunities offered by the rise of China on the world stage, the intrinsic intellectual and cultural attraction of Chinese has also been identified, with learners talking of the "kudos" or pride in mastering the language (Wright, 2019; Wright et al., 2022). Some initiatives demonstrated effective use of technology for Chinese language learning, e.g. using online Tandem Learning (Kan et al., 2013), but in other cases, the rapid rise in classroom and immersive experiences available for Chinese initially outstripped pedagogic training and communicative resources designed to suit learners' needs, whether technology-based or not (Wright, 2019). Many teachers found themselves relying on traditional "language first" teacher-centered approaches (Jin & Cortazzi, 2011), and communicative learning goals were not always embedded in teaching and assessment (J. Wang et al., 2025). However, a more established trend is emerging among teachers interested in more communicative authentic tools, and increased take-up of technology to support teaching and learning (Wright et al., 2022), supported by the growing ubiquity of digital tools and apps, as well as increasing access to live online communication platforms.

2.2 Research into Computer-Assisted Language Learning

Computer-Assisted Language Learning (CALL), like so much second-language (L2) work, tends to focus on L2 English learners, but outcomes have been widely found to boost good learning strategies in any language, e.g. by supporting more self-directed active learning, boosting motivation, reducing cognitive load, and increasing self-efficacy (Moffat, 2022). For Chinese second language acquisition, research has emerged during the last two decades on how technology can be used to boost specific aspects of Chinese language development (Shi & Kan, 2023; B. Xu, 2024) both in and out of the classroom. Clear benefits of using interactive Mobile-Assisted Language Learning (MALL) or apps for Chinese as a Foreign Language (CFL) can boost learner engagement and support formal course learning. Studies have found benefits of using apps for listening, pronunciation, vocabulary and character learning, reading and support for translation (e.g., Kan & Tang, 2018). While CALL/MALL had sometimes seemed like a marginal area of interest for Chinese SLA or CFL, this became mainstream during the recent pandemic, pushing all language teachers to take emergency measures to turn their classes online, often with great success, whether in sustaining motivation and engagement, or specific aspects of Chinese acquisition and skills development (D. Wang & East, 2020; Zhao et al., 2020).

Rather than creating chaos, research suggests that many teachers and students managed the shift to the "new normal" relatively successfully. Evidence of successful adaptation to online format including speaking success (Peterson, 2021). Despite the supposed specific Chinese challenges of learning tones and characters, compared to say English or alphabetic non-tone languages, hybrid or online-only was found to be successful. Indeed, in the launch special issue of the International Journal of Chinese Language Teaching, focusing on online Chinese Foreign Language learning (CFL), D. Wang and East (2020), working in a New Zealand CFL university-level context, found as many as 48% learners would prefer to remain hybrid -"it's so nice! Everything is more flexible." Similar outcomes were observed by Zhao et al. (2020) in the UK, and Gao (2020) in Australia, who found little or no difference in online compared to in-class success in learning characters for beginner learners. Zhang (2020), working in Denmark, found teachers' beliefs relatively positive, seeing hybrid or online

learning as offering “clear potential” (p49), though needing a “change in mindset” if normalized. But, as reported in these papers, researchers and practitioners noted the many pressures around sustaining effective online teaching, including lack of technical skills, need for training and appropriate and equitable access to technological tools and online resources for both teachers and students. Shi and Kan (2023) pull together a timely collection of useful research and practitioner studies to illustrate use of technology in CFL, e.g. to improve motivation, support authentic language practice in live online collaborative learning. Other contributions include tips on redesigning curricula and adapting assessment for online/hybrid contexts. The collection finishes with a review on use of interactive Robots for Language Learning (RALL) -in an era where ChatGPT and other GenAI tools are updating so rapidly, this is a helpful paper to support teachers to become more familiar with this newly emerging technology.

2.3 A CALL-based Approach for Flipped Classroom Teaching

However, even before opportunities arose from live or synchronous online learning, asynchronous resources were becoming more commonly used, either locally created and stored by individual teachers and institutions, or more widely on a global scale e.g. through the emerging range of Massive Open Online Courses (MOOCs). Such resources could be used to support a “flipped classroom” approach (Låg & Sæle, 2019), providing self-access online learning materials designed to prime later in-class activities, reducing the need for teacher-centered presentation of information and increasing student-centered activities. By using the flipped approach in L2 classrooms, asking students to acquire linguistic knowledge such as grammar rules or vocabulary before class, teachers could plan to reduce class time spent on presenting information and have more time to practice in communicative interactions. Using flipped teaching to increase class talking time thus offers the predicted benefit of improved oral proficiency, which can often be a challenge in language classrooms, given common pressures of limited time, large class sizes, or an emphasis on written skills, e.g. for exam preparation (Wright, 2018). In theoretical terms, psycho-social models of active learning can be used to predict the likely advantages of flipped instruction. Active learning promotes greater learner autonomy, self-efficacy, and engagement, which can contribute to improved language proficiency. By shifting passive learning activities outside the classroom, provided all learners have access to the technical resources and tools required, flipped teaching approaches can free up time for more interactive and engaging activities during class time, fostering a more conducive learning environment (J. Wang et al., 2018).

J. Wang et al. (2018) was one of the first studies to analyze use of MOOC-supported flipped classrooms for beginner L2 Chinese learners’ oral proficiency development, led by Professor Wang Jun, one of China’s foremost Chinese SLA researchers and educators, based at Shanghai Jiao Tong University. Professor Wang adapted his existing task-based class textbook for beginner Chinese into MOOC format, delivered on the Coursera MOOC platform. In our study, we aimed to determine whether providing access to MOOC-based materials before classes could outperform traditional classroom-based instruction in terms of oral proficiency development. The study involved 42 students from non-sinosphere L1 backgrounds with no prior knowledge of Chinese, who were enrolled in a semester-long beginner-level Chinese language course at Shanghai Jiao Tong University. Teaching took place on campus for 15-18 hours a week over 16 weeks. Participants were typically aged 20-35, learning Chinese as a third language. Participants were randomly assigned to either the experimental group, which received flipped instruction, or the control group, which followed traditional classroom

methods. We employed a mixed-methods design, combining quantitative and qualitative data collection techniques. The primary quantitative measures included pre-tests and post-tests assessing oral proficiency, while qualitative data were gathered through surveys and interviews to capture learners' perceptions and attitudes towards the flipped classroom model. The experimental flipped instruction group utilized Professor Wang's MOOC instructional videos and quizzes to prepare specified grammar and vocabulary as preparatory homework ahead of class. In-class time included some checks and drill practice, then about 45 minutes of the 3-hour lesson was spent on interactive activities, such as role-plays and collaborative discussion. The control traditional classroom group received teacher-led instruction in the same specified grammatical and vocabulary materials during class, followed by the same drills and interactive activities as the experimental group; homework was to revise the day's materials from the textbook. Time freed up by the flipped preparation allowed time spent on the interactive activities in the experimental group to double (on average 45 minutes), compared to the traditional class (on average 25 minutes). Oral proficiency was evaluated on speech samples collected during speaking assessments conducted mid-course (after 5 weeks) and end-course (after 12 weeks) speaking assessments, and analyzed using objective linguistic measures of complexity, accuracy, and fluency (CAF), based on existing literature (e.g., Skehan, 2009). We found that learners in the flipped classroom significantly outperformed those in the traditional classroom in terms of oral proficiency by the end of the course. This was particularly evident in measures of speech fluency, where the flipped group demonstrated faster speech rate and fewer pauses. The advantage in complexity (length of sentence) and accuracy (lexical and grammatical), while present, was less pronounced. Other benefits for the flipped classroom group included evidence of progressing through the syllabus at a faster rate, requiring 25% less time to cover the same units, compared to the traditional classroom group. This suggests that flipped instruction can also enhance learning efficiency, allowing learners to achieve oral proficiency in a shorter period. In addition, in the qualitative data, the flipped classroom group reported spending more time in out-of-class activities and exhibited more positive attitudes towards the course.

Our study has some limitations, especially in the mixed findings for complexity and accuracy, which we suggest may be due to the limited speech output which very early learners like our beginners can manage, and indicating that further refinements are needed in how to operationalize oral proficiency in early levels needs. In addition, CAF measures tend to downplay improvements for Chinese language samples, since the original measures for calculating accuracy and complexity were based on English and other Western languages which have different morpho-syntactic features. As technology continues to improve for example in automated measures of speech proficiency (Wright & Tavakoli, in press), or of grammatical complexity (e.g., Lu, 2017), this is a future trend to reassess how technological tools can be used to assess progress at all levels across different aspects of language knowledge and skills. However, this study was one of the first to demonstrate the value of using technology to implement flipped instruction in L2 Chinese language classrooms, suggesting that technological resources, used in specific and targeted ways, can be a valuable tool in enhancing language acquisition, even for complete beginners.

3. Technology in theory-driven research

We turn now to reviewing recent trends in technology-based research investigating theoretically-driven questions around developmental trajectories in Chinese SLA, focusing on two particular areas with useful applications for teaching and learning Chinese for authentic communicative purposes.

3.1 Corpora

The first aspect is the use of corpora of authentic language, providing valuable reference points of what kind of language is typically produced in different contexts (whether for first or second language users), rather than relying on textbook materials or assessment criteria. Using authentic samples from written or spoken production, teachers can compare their own learners' progress against these reference corpora, providing a solid evidence base for understanding typical learner language, e.g. which grammatical structures tend to be early or late acquired, which phrases are more frequent than others at different levels of proficiency (Xiao et al., 2009). While Chinese learner corpus research is still in its early stages compared to L2 English corpora (Iurato, 2022), the field is rapidly expanding (J. Xu, 2019). Large-scale L2 Mandarin corpora are now available for research, such as the HSK Dynamic Composition Corpus of written learner language extracted from HSK exam submissions between 1992 and 2005 (Iurato, 2022). One of the very few large-scale open access multimodal corpora of both written and spoken data is the Guangwai-Lancaster Chinese Learner Corpus (H. Xu et al., 2019) which can be used to investigate many different aspects of cross-sectional comparisons of different proficiency cohorts. Others remain more individually-focused, based on small-scale exploratory longitudinal studies (e.g., Wright, 2020; Wright & Zhang, 2014), providing more nuanced evidence of grammatical or collocational knowledge (e.g., Sun, 2023). The Guangwai-Lancaster Chinese Learner Corpus (GLCLC) has been a pivotal resource for recent corpus-based research on L2 Chinese. This corpus, a collaboration between Guangdong University of Foreign Studies and Lancaster University, comprises 1.2 million words of learner Mandarin Chinese, including both spoken and written data (Xiao et al., 2009; H. Xu et al., 2019). The corpus is fully error-tagged and covers a variety of task types and topics, making it an invaluable tool for exploring theoretical and practical issues in Chinese language acquisition whether in relation to grammatical development or lexical acquisition, such as collocations.

Xiao et al. (2009) provides a comprehensive overview of the GLCLC and its applications in L2 Chinese research. The study outlines the corpus's structure, including its balanced representation of spoken and written data, and discusses its potential for various research areas. Xiao et al. emphasize the corpus's role in investigating lexico-grammatical patterns and error analysis, which can inform syllabus design and teaching materials. The study also highlights the corpus's utility in examining the interlanguage development of learners from different L1 backgrounds, providing a rich resource for comparative studies. Looking first at studies of grammatical acquisition, one example using the GLCLC is a study by H. Xu et al., (2019)**,** focusing on the acquisition of the Chinese perfective particle *le* by L2 learners. Utilizing the spoken subcorpus of the GLCLC, the authors examine the usage patterns of *le* among learners from diverse L1 backgrounds. The study aims to identify the developmental trajectory of learners' acquisition of this particle, and to see if there is any predictable impact of transfer from learners' different L1s. The authors find that learners from all L1 backgrounds initially struggle with the correct placement and usage of *le,* often omitting it or

using it incorrectly. However, as proficiency increases, learners show a more accurate and consistent use of *le,* indicating a gradual internalization of its rules. This research highlights the importance of corpus-based studies in understanding the nuanced aspects of interlanguage development, in which L1 transfer is not always a major cause of error, and provides insights into effective teaching strategies for particles in Mandarin. Another study, by Ištvánová (2021), explores the creation of a Slovak learner corpus of Chinese and compares it with the GLCLC to look at interlanguage development and learner errors more broadly. By comparing the Slovak learner corpus with the GLCLC, Ištvánová identifies specific areas where Slovak learners face challenges, such as the use of aspect markers and sentence structure. The study emphasizes the role of learner corpora in tailoring teaching materials to the needs of specific learner groups. Ištvánová's work thus demonstrates how corpus-based research can inform pedagogical practices and improve the efficiency of language instruction.

A second area that has proved fruitful for corpus-based acquisition research with applications for teaching communicative authentic language use is on lexical development, particularly collocations in written or spoken L2 Chinese, which, like collocations in any language, can be tricky to master. Guo and Li (2016) used corpus techniques to investigate common errors in learners' use of collocations in L2 Chinese writing, using the written subcorpus of the HSK Corpus. They identified common difficulties for learners in mastering nine different noun collocation types, including Verb + Noun (e.g., 侵犯人权 *qīnfàn rénquán*: violate human rights), Adjective + Noun (e.g., 丰盛的晚餐, *fēngshèng de wǎncān*: sumptuous dinner), Noun + Adjective (e.g., 竞争激烈, *jìngzhēng jīliè*: intense competition), Number + Measure word + Noun (e.g., 一只蝴蝶, *yī zhī húdié*: a butterfly). They suggest five pedagogic activities to draw attention to more target-like collocation patterns (referring to first language corpus examples), including production in relevant contexts such as in role plays or interactive online quizzes with automated feedback, to ensure learners can apply collocations naturally in real-life scenarios with others, or use technological tools to get personalized feedback at their own pace.

Taking a more granular approach to corpus methods, using a small specially-created longitudinal corpus of written learner data, Sun (2023) tracked the development of formulaic sequences (FS) in a group of 26 learners of Chinese from a UK university. She used data taken from diaries submitted as required written coursework early on and at the end of a period of residence abroad (RA) in China. During RA, learners can expect to engage extensively with target language speakers which is usually predicted to make language production easier and more authentic for communicative purposes, by expanding their repertoire of collocations and common phrases stored as whole chunks, which can be retrieved automatically, rather than segment by segment (Segalowitz, 2010; Wright, 2020). Using mixed-methods qualitative and quantitative analyses, Sun analyzed frequency and accuracy of three types of FS - fixed, semi-fixed or free. Fixed FS were four-character idioms (e.g., 大开眼界, *dà kāi yǎn jiè:* broaden one's horizons), semi-fixed phrases were two-part conjunction phrases in which word order is fixed, but the linked elements can vary (e.g., 因为...所以, *yīnwèi...suǒyǐ*). Finally, free FS were high-frequency transitive Verb + Noun (object) collocations (e.g., 有, *yǒu:* have; 去, *qù:* go; 让 *ràng*: let/make), which the choice of following noun or noun phrase is open to change depending on the context. Sun predicted that all three types of FS would improve over time, but findings were rather mixed, with no consistent group-wide patterns of improvement, apart from fixed FS, and wide individual

variation. She noted that frequency of fixed FS doubled over time, but that if used at all, accuracy was already high, so immersion during RA seemed not to bring about any specific benefit. By contrast the semi-fixed forms and free forms increased in frequency in range of types used, but frequency of specific types used, and accuracy did not significantly improve; indeed there was clear evidence of sustained non-target forms in both semi-fixed and free form collocations suggesting reliance on L1 transfer (e.g., using single rather than both parts of connective phrases, or using L1 translation in collocations, such as *认识+故事, **rènshi gùshì,* *"recognize a story," for "know a story"). These are just a few of the many emerging corpus-based research studies which can provide useful suggestions for teachers wanting to enhance learners' authentic language knowledge, and which emphasize the critical and innovative role of corpus-based research in informing effective contemporary teaching practices.

3.2 Eye-tracking methodologies

A second area of using technology-focused research methodologies relates to eye-tracking as a way to gain insights into language acquisition, tapping implicit psycholinguistic attentional processes which are by definition invisible to learners' conscious awareness but useful for learning effectively, e.g. improving reading fluency or learning characters (e.g., An et al., 2024; Stickler & Shi, 2014; Wright & Wang, 2023). While computer-based eyetracking methodologies have been used in second-language research for around two decades (Godfroid, 2019), their use is comparatively new in Chinese SLA. I discuss three studies to exemplify how these techniques have developed in recent decades, as used in these studies to draw out specific implications for teaching and learning contexts.

In an early study using eye-tracking, Stickler and Shi (2014) investigated learners' eyegaze during synchronous computer-mediated communication (SCMC) in learning Mandarin Chinese as a second language (L2). This study was small-scale with ten participants at beginner-lower intermediate standard from western European L1 backgrounds. The activities simulated a typical online learning class for learners at this proficiency level, where a reading activity based on Chinese characters is typically supported by pinyin and images. Learners' gaze was most often drawn to the accompanying pinyin, indicating a reliance on pinyin for comprehension at this level (echoed in other findings, such as Wright et al., 2022). They followed up the experiment with interviews with both students and staff investigating their perceptions in using the tools and reflections on the challenges and difficulties during the learning activities, supported by the eyegaze data. Taking this mixed-methods socially-mediated approach to evaluating how eyegaze and attention plays a role in teaching and learning, this study provides an innovative and helpful way into how technology can support educators, particularly in how to provide better targeted support to help learners transition from pinyin to character-based reading.

A more recent study, by An et al. (2024), investigates the impact of background knowledge on reading comprehension and reading rate in L2 Mandarin Chinese learners using eyetracking methodology. The rationale for using eyetracking methodology to evaluate reading fluency in this study was based on three main justifications. First, eyetracking technology allows researchers to precisely monitor where learners focus their gaze while reading, through fixations on specific spots or regressions back to areas which require further processing. Longer fixations and more regressions on certain words or phrases

indicate which parts of the text are harder to process, leading to reduced reading fluency. Second, eyetracking offers objective data on eye movements, reducing biases associated with self-reports and observational methods, and enhancing the reliability of findings. Third, by analyzing eye movement patterns, researchers can infer cognitive load and identify which aspects of reading are challenging for L2 learners. In this study, we were interested in evaluating whether linguistic knowledge or level of background knowledge better predicted L2 reading fluency (in terms of ease and accuracy of comprehension and reading rate). Although L2 reading fluency generally improves as proficiency increases, for L2 Chinese learners with an alphabetic first language, character recognition can create additional cognitive load on reading fluency, and is argued to be a key factor in explaining individual variation or slower progress in developing reading skills, particularly at lower levels of proficiency. However, one aspect that is argued to reduce load and make reading easier, regardless of individual variation in reading skills, is familiarity of topic or level of existing background knowledge, which can support readers in guessing specific words they do not know, or in successfully grasping overall meaning even if they do not know specific words, because they know what kind of vocabulary is likely to occur. This is the main focus of the study, which compared a sample of 40 L2 Chinese learners at a Chinese Foreign Language institute in Shanghai, all with roman alphabetic first languages, and who were at various proficiency levels in Mandarin Chinese, ranging from beginner to advanced. Participants were individually assessed first by completing a pre-test questionnaire evaluating their levels of background knowledge on two common knowledge topics (cosmetics and baseball), as well as tests of vocabulary and grammatical knowledge. Then, using an Eye-Link 1000 eyetracker, participants' eyegaze patterns were measured while reading four texts, two on each topic, to track reading ease and speed; comprehension was then tested through accuracy scores on a post-reading computer-based comprehension quiz.

From their data, An et al. (2024) found that higher levels of background knowledge rather than linguistic knowledge had a clearer impact on reading comprehension, and to a lesser extent, reading rate. In other words, learners with higher background knowledge showed greater reading efficiency (seen in shorter fixation durations and fewer regressions), indicating how these learners could more quickly understand and integrate new information with their existing knowledge, regardless of proficiency level. The study demonstrates the value of eyetracking technology in providing recommendations for improving contemporary teaching practice. Rather than assume one type of reading strategy suits all equally, instructional design can be enhanced by using materials that align with individual learners' background knowledge, and by incorporating adaptive strategies which suit individual learners' needs for improving comprehension and/or speed.

Turning to another use of eye-tracking, but following on from previous research into the challenge of learning Chinese characters, Wright and Wang (2023) aimed to investigate what kind of visual attention is used to decode word meaning at the very beginner stages of learning characters. While many vocabulary teaching strategies use traditional whole-word memorization techniques, and repeated practice of stroke order through physical handwriting, nowadays, many learners use Chinese on mobiles and other devices, where the word is typed rather than handwritten, so character recognition rather than production is the top priority. We wanted to investigate whether learners would show awareness of high visual salience, such as clear stroke patterns, or could use semantically consistent cue patterns from radicals, and whether such cues could help speed up the learning process for complete beginners, especially given the findings illustrated above that many learners

struggle to reduce reliance on pinyin. We designed a self-paced computer-based word learning task using a list of twenty words which were single characters with two components: ten verbs using 扌 **hand** radical, five nouns using 犭 **animal** radical, which was judged to be visually similar to the verbal hand radical, but signifying a different functional/semantic category, and five verbs using 口 **mouth** radical, in the same functional category as verbs, with high visual salience, but less consistent semantic meaning. Using an eyetracker while participants carried out the word learning task, and the subsequent recall test, we could evaluate whether participants paid attention to the left-hand radical cues during the learning phase, and if this was connected to speed and accuracy in the recall phase. Participants were 35 English-speaking learners of L2 Mandarin on a beginners' program at a Chinese Education Institute in China, tested in their first 4 weeks of enrolment.

We found that salience helped in terms of visual noticing: eyegaze was shorter with fewer fixations for characters with the 口 radical. But in terms of accuracy and speed of meaning recall, consistent semantic cues seemed to facilitate learning better, in that nouns with the 犭 radical were most accurate, with fastest recall; this echoes findings in several other languages that nouns seem "easier to learn" (Wright & Wang, 2023). While this study was very small-scale and exploratory, the use of technology serves to show how research into L2 processing can help educators adapt their practices by understanding the different ways individual learners pay attention to aspects of character formation and learnability.

4. Technology in virtual contexts

From these studies taken to illustrate the growing use of technology for different questions in Chinese SLA and innovative approaches in teaching contexts, it is clear that technology tools can provide highly insightful, detailed, reliable data to help educators shift towards more individually adaptive ways of teaching L2 Chinese, provided teachers and learners are supported in ensuring equitable access to such resources and the skills to use them well. This important aspect of planning to embed technology into teaching and learning has been seen most prominently in the recent pandemic when all classes had to shift online. As we saw in section 1, many teachers and learners managed this shift remarkably successfully, sharing many good practices, helpful tips, supported by clear research evidence.

It seems that innovative Chinese language teaching can and should aim to continue to embed technological tools in future pedagogy, focusing on some of the best practices outlined here, or in other useful reviews of the field (Shi & Kan, 2023; B. Xu, 2024). Of course, challenges about managing the exponential rise of digitalization of modern life and its impact in and out of the classroom can be seen alongside the benefits. A final aspect of language experience will now be addressed in the next section of this paper, in which we look at research outside the formal classroom setting (Wright et al., 2025), moving to the context of natural language learning through residence abroad (RA), in which more exposure to language is digitally-mediated rather than face-to-face. As technology allows us to remain "permanently on, permanently connected" (Vorderer et al., 2017), we can keep in constant contact with friends and family at home. Wright et al.'s (2025) study investigates the impact of online or hybrid learning replacing the usual study abroad year in China during the recent pandemic, setting the findings in the context of wider studies aiming to show how such research can support teachers and learners in facing the challenges of language development in the contemporary global "digiverse."

4.1 Should we still bother with Residence Abroad?

It has long been assumed that learners can and should spend time in the target country, as the best way to improve proficiency and develop more confident communicative competence in authentic interactions (Freed, 1995; Wright, 2018). For reasons of scope, I will focus here on temporary residence abroad, e.g. as part of a degree program, or to support general learning, rather than long-term residency, e.g. to join family or seek employment. Immersion during residence abroad (RA) is argued to bring wide benefits, linguistically, culturally and personally. Linguistic benefits are most commonly seen in terms of fluency and vocabulary development, though these benefits can be task-dependent (Wright, 2020). RA can also improve sociolinguistic and discourse-level interactional skills, adjusting language to fit local styles, often through strong social networks (Mitchell et al., 2017). Such interactional experience is seen as essential for improving authentic "interactionability"—i.e. more natural-sounding "conversational proficiency" (Wright et al., 2025). RA can also bring individual benefits in an increased plurilingual outlook, intercultural competence, personal growth and self-efficacy, alongside sustained improvements in language outcomes after returning home, and greater confidence in plans to continue using the language later in life (McManus et al., 2021; Mitchell & Tyne, 2021). However, research has also regularly shown that language change during RA is far from guaranteed. Ideologies and assumptions held by key stakeholders such as universities or parents around the purposes of RA, leading to high expectations pre-departure, can be very mismatched against what RA students actually experience (Trentman, 2022). It can be hard to engage with local speakers, or make local friends—encouraging rich local social networks are seen as key to positive benefits of RA, but learners can find it hard "to talk to the foreigner" (Wright & Schartner, 2013); they may stay disengaged, seeing the chance to live abroad more as "cultural consumption" rather than promoting linguistic and intercultural engagement (Wright & Peng, 2020). RA is therefore no "silver bullet" for guaranteeing linguistic or personal "transformation" (e.g., Kinginger, 2011; Peng & Wright, 2020).

Assumptions around the value of RA is therefore being increasingly challenged, not just in terms of variability in language outcomes indicated above, but also in view of increasing financial, emotional and ecological costs, particularly for student-age populations who may not always have traditionally-expected levels of financial security and resilience (Husson & Hall, 2020). In an era in which L2 Chinese learners of any age and proficiency can find online or app-based tools to support their individual needs, and use online communication platforms to interact in real time in spoken or written communication, it can be argued that it is time to de-prioritize physical RA, in favour of technology-supported equivalents. During the pandemic a number of alternatives were discussed to replace RA, in view of evidence that virtual learning can work well (e.g., Stickler et al., 2024). However, other findings suggest that actual in-country RA brings clear benefits, particularly for boosting "interactionability" or conversational proficiency (Wright et al., 2025) and student confidence in sustaining such proficiency afterwards.

4.2 Chinese learning challenges during online-only Residence Abroad

One recent study (Wright et al., 2025) investigated this in more detail during the recent pandemic, when borders closed, preventing in-country RA. China's policies on lockdown meant that typical RA travel for western students was impossible for at least two years. Host institutions varied in their response, but many developed effective and extensive online

support, allowing western students to continue both formal lessons and informal online interactions. We took this opportunity to create a long-term tracking study of 40 anglophone students at two stages of a Chinese degree program at a UK university. We compared Cohort A, whose planned RA year had to be entirely online, supported by classes from host institutions in Shanghai, Beijing and Taipei, but whose UK-based classes pre- and post-departure more or less returned to normal, with Cohort B, enrolling one year later than Cohort A, whose pre-departure UK classes were entirely online, and planned RA experiences were limited to one semester in Taiwan. Using data taken from speaking exams held at the end of the year following their period of RA, we aimed to investigate evidence of impact which virtual immersion had on ability and confidence in holding conversations in Chinese, in terms of naturalness or authenticity, and ease of flow, which we defined as interactionability or conversational proficiency**.** We assessed conversational proficiency using a range of measures to score temporal fluency (articulation rate and length of run between pauses), utterance sophistication (lexical range and length of utterance) and discourse fluency (use of discourse markers to indicate cohesion and pragmatic appropriateness). We also conducted individual interviews to gather qualitative data on students' reflections on their RA experiences, and the impact on their confidence in communicating effectively in Chinese. The two cohorts thus provide a cross-comparison sample to investigate how online learning impacted the move between instructed and immersed contexts pre and post RA, both linguistically, and more broadly in terms of learners' sense of plurilingual identity as Chinese speakers not just on the degree program but for their lives ahead. Our predictions were that Cohort A, as the virtual RA cohort, would show overall poorer linguistic outcomes, especially in terms of discourse-level fluency, indicating levels of conversational proficiency, and would report generally more negative experiences following the lack of in-country immersion, compared to Cohort B, who had at least some experience of actual physical RA.

Quantitative data on the speech data are reported elsewhere (Wright et al., 2025), and analyzing the full set of data from both cohorts is ongoing. Here, we focus on qualitative data from interviews with six students from Cohort A, illustrating the range of perceptions during and following Virtual RA, and indicative of the extent to which technology helped or hindered their experiences. Using a semi-structured interview protocol (based on Wright & Peng, 2020), we asked students to reflect on four key themes: their general motivation for learning Chinese and interest in the language; expectations and challenges during their studies; specific issues arising out of the virtual residence abroad and return to studies, and finally their sense of overall confidence in speaking and interacting in Chinese. Although responses varied, as expected in such an approach, we could see if patterns emerged in common in relation to students' perceptions around the virtual RA context and impact on speaking compared to other skills, levels of social and cultural engagement, their sense of being plurilingual speakers of Chinese and hopes to continue with Chinese this as part of their longer-term life goals. Interviews were conducted 1-1 online, and transcriptions were subsequently analyzed using emergent cyclic analysis (Silverman, 2014) to identify common themes and differences among the cohort. The data were thus intended to show how technology-supported long-term exposure to Chinese could support learning in and out of the virtual classroom.

In terms of general motivation for learning Chinese, our participants exhibited a high level of motivation for learning Chinese and maintaining their language skills after graduation. This enthusiasm was driven by the perception of Chinese as a unique and fascinating language,

described by students as "different," "pretty cool," and "really interesting." All participants recognized the practical benefits of learning Chinese for future opportunities. A sense of passion for the language shared across their cohort further fuelled their motivation, with both teachers and peers contributing to a supportive and encouraging atmosphere. These positive indications suggested that the virtual-only RA experience had not reduced their general motivation.

Moving to our next theme around expectations and challenges, participants were generally self-aware regarding their language goals and had developed a range of individual strategies to be proactive in their learning during and after the virtual RA. While some aspired to sound like first-language Chinese speakers, in terms of tone and more informal sociolinguistic style, others were content with their language knowledge and skills, particularly in listening and reading. The lack of travel and limited chances to gain experience of China was felt to impact on their understanding of the broader Chinese context (see more below). Despite these difficulties, students reported a strong sense of personal commitment and achievement, with at least four of the six participants finding ways to adapt to lack of travel by engaging in Chinese-speaking activities such as working in an Asian restaurant.

Next, commenting specifically on perceptions of the virtual RA, participants were realistic about the impact of COVID-19 on everyone, highlighting the importance of taking responsibility for maintaining their learning, and critical of peers who blamed the pandemic for their lack of progress once they returned to classes. However, they particularly noted a perceived lack of cultural experience. Students felt there could have been more effort by host institutions or the UK home university to create online cultural activities. Some participants managed to engage with some online cultural activities centering on festivals such as Chinese New Year, particularly where they had friends or family connections, and made efforts to watch Chinese films and TV shows. They mentioned the gap in experiencing an immersive linguistic landscape where everything is written and spoken in Chinese.

Linguistically, students had varied experiences with their virtual Year Abroad hosts in Beijing, Shanghai, and Taipei. Many students appreciated the 20 hours of classes per week from Shanghai, which were described as "really good" and "super interactive" when breakout rooms were effectively used. The teachers were praised for their excellence, and the classes led to friendships that extended beyond the virtual YA, boosting students' confidence and language skills. However, all students reported difficulties at various times in maintaining enthusiasm for learning Chinese, with one commenting on the virtual RA, in perhaps typical British understatement, as a "bit of a blip."

A second theme arose in terms of personal challenges, including feelings of loneliness and embarrassment about not being able to go in person. Students also recognized positive outcomes, such as developing independence, resilience, and patience. Some articulated clear personal gains around their increased sense of dedication and experience of taking initiatives in finding opportunities to encounter Chinese. Students reflected ongoing commitment to continue using Chinese, with at least two planning to travel to China as soon as time and personal finances allowed.

Finally, in relation to confidence in speaking Chinese, it became clear that personality and mindset played a major role. Students who were positive about their speaking abilities had been active in using digital conversation tools for both class activities and informal contact

out of class both during the pandemic and afterwards. They actively maintained digital and in-person friendships even after the pandemic, seeking to preserve their conversational proficiency through platforms like WeChat. Those who identified themselves as risk-takers were more likely to seek out chances to use the language online or in person. Others who struggled with a lack of confidence in speaking still felt overall lacking in conversational proficiency, but some reported that they had chosen to focus more on receptive skills or building up vocabulary and grammatical knowledge, and felt they grew in their abilities in using technology to support their language goals both during the online-only year, and since returning to standard classroom studies.

In terms of implications of experiencing virtual-only RA, and the value of technology for supporting learners impacted by the pandemic, we can conclude from our sample that the linguistic impact of the virtual RA was less detrimental than feared, even for speaking skills. The value of mindset, particularly agency and "grit" (Paradowski & Jelińska, 2023), proved useful in fostering online communication skills. However, virtual RA cannot fully replace actual physical RA in wider immersion benefits, especially for less confident students in developing conversational proficiency. The impact was most clearly seen in students' self-perception of their plurilingual identity and sociolinguistic confidence in conversational interactions, reporting this as “knowing what to say but not always how to say it,” wanting to be able to interact “naturally” with Chinese speakers. We argue that technology can therefore continue to play a positive role in building opportunities for practicing conversations in authentic tasks, not just to practice vocabulary or fluency. Initiatives are developing to build such tasks into classroom practices, through “collaborative online interactional learning” (COIL), and we encourage teachers and learners to embed such tasks in their learning goals in and out of the classroom. We also argue that more pre-departure and post-return training is needed to maximize opportunities to use digital interactions to support the RA experience, and build up confidence in more “risk-taking” conversational practices. Institutions can consider shorter physical in-person immersion alongside technologically-supported experiences such as COIL initiatives, fostering virtual opportunities to engage in authentic, interculturally rich conversational activities. This could have the added benefit of bringing most of the expected benefits of RA while making travel away from home more affordable and equitable. We are thus confident that technology can support institutional and learner expectations around RA benefits, finding imaginative and creative ways to gain at least some of the social and interactional skills arising from being "really there."

5. Learning Chinese in the global digiverse

We finish by taking a brief look at how technology will continue to impact on language learning and linguistic experiences in the era of globalized and ubiquitous digital communication and generative artificial intelligence tools such as ChatGPT and DeepSeek.

5.1 Avoiding risk of digital isolation

We are now seeing a rise in the digitalization of everyday life in which students in and out of the classroom can be permanently connected with family and friends (Vorderer et al., 2017), even during residence abroad (RA). It has already been observed that RA can be challenging for learners managing to break out of compatriot “home bubbles” and unable to build

confidence in speaking “to the foreigner” where the foreigner is the local host language speaker (Mitchell et al., 2017; Wright & Schartner, 2013; Zhou & Rose, 2022). As noted above, we can see that lack of authentic real-time engagement in conversations during RA may not create linguistic costs in terms of knowledge and skills, but may tend to impact on broader conversational proficiency and intercultural competence. One way forward is to encourage learners to use digital skills to develop online interactional skills and encourage social interactions online as well as in person, as seen in a recent study by Handley and Wright (2025). In this recent study, we used real-time measures of linguistic activity and social networking in both languages using the open-source Lang-Track app (Arndt et al., 2022). Our evidence suggests that online chatting in the host language can bring wider linguistic and academic benefits; although this study was not conducted on learners of Chinese, we would argue that the findings would transfer to L2 Chinese contexts. We also suggest that confidence in engaging in digital social networks in both home and host languages can bring jointly constructed benefits for fostering feelings of self-efficacy and wellbeing, which can then underpin confidence in seeking out opportunities for real-time conversations. As seen earlier in our study on virtual RA, this is an important aspect of embedding technological tools to benefit language learners’ lives in and out of the classroom.

5.2 Digital Skills

Alongside individuals using technology, e.g. to boost conversational proficiency in written or face-to-face interactions, institutions are also facing the risks and challenges of the rapid rise in generative AI tools, including in language education. Universities are increasingly seeking to ensure students and staff develop effective digital skills, particularly in relation to Generative AI (GenAI), while acknowledging the risks of over-reliance on unregulated content, whether in social media or in academic learning and assessment. In a recent study looking at implications of GenAI on general educational practices in UK universities (Kaur et al., 2025), we worked with students, staff and employers to develop a framework for training GenAI literacy, aiming to boost appropriate competence in using GenAI tools, rooted in a commitment to ensuring equitable and ethical access, and sustainable resourcing. Language teachers are also already evaluating the benefits and limitations of using GenAI tools for language education, e.g. using chatbots to provide opportunities for adaptive feedback and simulated live interactions (e.g., Handley, 2024). To my knowledge, there has not yet been much published work aimed at a global readership on use of chatbots and other similar adaptive tools for CFL and Chinese SLA contexts. This is clearly a rapidly-emerging field in which we urgently need studies bringing together researchers and language practitioners to evaluate what would be the most effective GenAI tools for teaching and learning Chinese.

5.3 Where next for technology in Chinese teaching and learning?

To conclude, as we enter an AI-ubiquitous world, we face both exciting and challenging broad issues around what language learning represents in the global digiverse. This overview of recent research into how technology can be harnessed effectively for teaching and learning Chinese is rooted in considering the value of digital tools to shape and support our goals as language learners, teachers and researchers, particularly bearing in mind the implications of personal, socioeconomic and ecological pressures on international mobility.

I would argue that we can and should ensure that technology plays a central but equitable and sustainable role in language acquisition, with a wider goal of supporting flexible and

adaptive communication needs in a well-connected, resilient, interculturally competent world. Chinese-language teachers will no doubt need additional resources and time to develop sufficient digital literacy to use technology successfully, and researchers can continue to look into new and innovative ways of using technological tools in investigating ongoing challenges in Chinese SLA. But through international webinars, open-access publications, shared teaching exemplars and other online resources, we can more and more easily find ways to share best practice in research and teaching, to ensure 21st century learners of Chinese are building the knowledge and skills needed for effective communication, able to adapt to different task demands in multiple contexts, whether face to face or online, written or spoken. We can thus all work together to ensure that technology does not replace real life but, within ethical and equitable limits, helps us all become skilled well-connected navigators of the global plurilingual digiverse.

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