

Article

The Effects of Handwriting and Typing on Chinese Character Learning in the Digital Age: Evidence from Arab Adolescent Learners

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Abstract

Handwriting and typing, as two writing modes in language learning, involve distinct information processing mechanisms and contribute substantially to the development of second language proficiency. It is unknown, though, how these two modes of writing interact with non-native secondary school learners when learning the Chinese language. A questionnaire was administered to Arab adolescents, and a quasi-experimental study was conducted in a local public secondary school to examine their attitudinal preferences toward the two writing modes, as well as the effects of handwriting and typing on Chinese character recognition. The results indicate that, in terms of attitudinal preferences, Arab adolescents show a stronger inclination toward handwriting, perceiving it to be significantly more effective than typing for memorizing character pronunciation, character meaning, and distinguishing character forms, while no differences were perceived between the two modes in written output. With regard to learning outcomes, both handwriting and typing were found to facilitate improvements in Arab adolescents' Chinese character recognition. However, typing has a better performance on orthographic-phonological association compared to handwriting. As for the orthographic-semantic association, there is no significant difference between handwriting and typing. In light of these findings, the present study advocates the adoption of adolescent-friendly instructional approaches to Chinese character teaching, with the aim of promoting engaging and efficient learning experiences for overseas adolescent learners.

Keywords

Handwriting, typing, attitudinal preferences, Chinese character recognition, Arab adolescents

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1 Introduction

In recent years, the proportion of young learners in overseas Chinese language education has increased markedly (Li, 2018). To date, Chinese language has been incorporated into the national education systems of more than 90 countries, and primary and secondary school students in overseas educational contexts now constitute a key population influencing the long-term development of Chinese language education. In the process of learning Chinese language, Chinese characters consistently represent one of the most challenging aspects for these learners. The large number of characters, their visual complexity, the opaque mappings among form, sound, and meaning (Shen, 2005; Sung & Wu, 2011), and the substantial differences between the Chinese writing system and alphabetic scripts all contribute to the difficulty of Chinese character recognition.

The digital age has brought about profound changes in writing practices. In the domains of work, education, and social communication, traditional pen and paper handwriting has gradually been replaced by keyboard typing, a trend that has also extended to primary and secondary education (Longcamp et al., 2005). With technology increasingly integrated into language learning, typing Chinese characters using electronic devices has emerged as a new form of assisted learning. Previous studies have shown that handwriting and typing exert comparable positive effects on Chinese character review and demonstrate similar influences on character recognition (Chen et al., 2016).

Since 2019, the United Arab Emirates (UAE) has incorporated the Chinese language into the K to 12 educational system. Currently, more than 73,000 students from 179 public schools, ranging from kindergarten to high school, are learning Chinese language. However, in actual secondary school classroom practice in the UAE, an overreliance on Pinyin and inefficient time-consuming repetitive tracing and copying have collectively hindered the development of students' Chinese character recognition abilities. The widespread adoption of digital learning in secondary education in the UAE, together with the growing emphasis on Chinese character instruction in the Chinese curriculum framework, has created new opportunities for addressing persistent challenges in Chinese character literacy. In 2022, the Chinese Language Curriculum Framework of Excellence was officially introduced, explicitly foregrounding the development of students' advanced digital literacy skills as a core educational objective. Building on this orientation, the Ministry of Education piloted the Chinese Comprehensive Curriculum Guide (hereafter CCCG) in 2025. Notably, for the first time at the secondary level, the CCCG formally articulated keyboard-based typing as a specific instructional requirement.

These policy shifts signal a clear institutional endorsement of digital writing practices in Chinese language education and align with recent pedagogical propositions advocating "Typing as the primary mode and handwriting as supplementary" (Chu, 2024) or "Typing as the entry point, followed by handwriting" (Lu, 2024). However, despite their growing policy influence, these propositions remain largely grounded in theoretical argumentation or adult learner research, with limited empirical validation in overseas K to 12 education contexts. In particular, it remains unclear whether prioritizing typing over handwriting is pedagogically appropriate for adolescent learners whose orthographic knowledge, cognitive control, and learning strategies are still under development.

Against this backdrop, a systematic examination of the relative roles of handwriting and typing in overseas secondary Chinese education is both timely and necessary. Addressing this gap is essential not only for evaluating the pedagogical implications of recent curriculum reforms but also for informing evidence-based decisions regarding writing-mode integration in digitally oriented Chinese language instruction. Along with the needs and predicted meanings, the study intends to compare the effects of handwriting and typing, as two different writing modes, on Chinese character recognition among Arab adolescents in the UAE. To achieve the objectives, two research questions are developed:

1. What are Arab adolescents' attitudinal preferences toward handwriting and typing as writing modes for learning Chinese characters?
2. What effects do handwriting and typing have on Arab adolescents' Chinese character recognition?

2 Literature Review

2.1 Different cognitive processes and features of handwriting and typing

Handwriting refers to a meaning-making process accomplished through fine-grained manual movements. It encompasses various forms, including pen-and-paper handwriting, stylus-based handwriting, and touchscreen handwriting. Centered on hand movements, handwriting connects multiple body parts with several functional regions of the brain, directly influencing learners' cognitive processes and learning performance. As a cognitive activity closely associated with memory, comprehension, and creativity, handwriting plays an important role in learning. In contrast, typing refers to meaning-making practices mediated by digital tools (e.g., computers, tablets, and mobile phones), in which combinations of alphabetic keys are operated to produce written output. In digital environments, typing-based production mainly includes keyboard input and speech-to-text transcription. The present study focuses specifically on pen-and-paper handwriting (referred to as handwriting) and keyboard typing (referred to as typing).

Handwriting integrates online signals from visual perception, motor control, and kinesthetic feedback, which are tightly interconnected in both temporal and spatial dimensions. By contrast, typing essentially involves visual discrimination of the 26 letters on the keyboard (Longcamp, 2005), during which temporal and spatial continuity is disrupted (Mangen, 2014). When writing by hand, learners' attention is focused on the emerging written traces under the pen tip, whereas during typing, attention continuously shifts between the screen and the keyboard. Longcamp et al. (2008) found that handwriting activates multiple brain regions, including executive areas, visual imagery areas, and motor control areas, whereas typing primarily activates executive areas. Consequently, handwriting may confer greater advantages than typing in letter recognition tasks.

Scholars have expressed differing views regarding the characteristics of handwriting and typing. Some researchers argue that handwriting not only benefits letter recognition but also facilitates word recognition (Cunningham & Stanovich, 1990). Longcamp (2005) maintained that handwriting enhances children's performance in letter reading, a finding supported by Mangen et al. (2015) as well, who reported that learners were able to accurately recognize letters learned through handwriting.

On the other hand, some studies have reported no significant differences in letter or word recognition between handwriting and typing (Vaughn et al., 1992; Ouellette & Tims, 2014; Kiefer et al., 2015), suggesting that keyboard input may facilitate language acquisition. From a theoretical perspective, typing involves a series of processes, including transforming visual information into phonological codes, forming chunking patterns, and analyzing and retrieving appropriate lexical items, all of which may support the development of language skills (Zhang, 2021). However, other researchers have argued that, compared with handwriting, letters produced through typing are more prone to mirror-image confusion, which may reduce recognition accuracy (Longcamp et al., 2008).

Language acquisition is impacted by both handwriting and typing in terms of their characteristics and cognitive processes, and their benefits and drawbacks have been extensively explored. For researchers who are learning or teaching Chinese, which was regarded as a specific Asia logographic language, the different influences of handwriting and typing also become a heated topic.

2.2 Chinese L2 learners' attitudinal preferences toward handwriting and typing

Attitude refers to a learner's relatively enduring psychological tendency to evaluate learning objects or activities positively or negatively (Ajzen & Fishbein, 1977), and it is characterized by a certain degree of stability across contexts. With the rapid development of digital technologies, an increasing body of research has examined learners' attitudinal tendencies toward handwriting and typing in the process of Chinese character learning. Jiang and Zheng (2015) found that although approximately 80% of second language learners of Chinese reported an unwillingness to abandon handwriting practice, as many as

90% of them held more positive attitudes toward learning Chinese through pinyin-based typing. Some learners have also complained that handwriting often involves mechanical copying of characters without deeper cognitive engagement, with attention sometimes focused more on producing visually perfect forms than on character recognition itself (Zhang, 2021). In contrast, a considerable number of learners show a preference for using keyboard input in classroom settings (Han, 2020) and perceive typing to be easier than handwriting (Zhang, 2021).

A survey involving Chinese language learners and teachers from six English-speaking countries further indicated that students generally hold positive attitudes toward typing Chinese characters, recognizing its long-term benefits for character recognition. During the typing process, embodied cognition rooted in sensorimotor experiences is activated, which may facilitate Chinese character learning. However, this facilitative effect is not as direct as that of handwriting, and handwriting remains the most effective strategy for learning Chinese characters (Zhang, 2024).

It should be noted that most existing studies on learning attitudes have focused on adult learners. For learners at the secondary education level, cognitive, affective, and social development is still in progress, which makes it difficult for them to form a comprehensive understanding of the target culture (Genesee & Hamayan, 1980). Learning attitudes are value judgments that are typically shaped through accumulated learning experiences. For secondary school students in particular, learning attitudes exert a direct influence on learning behaviors and are more likely to be derived from immediate classroom experiences rather than from deeper autonomous choices or cultural identification (Genesee & Hamayan, 1980). Therefore, it is necessary to investigate Arab secondary school students' attitudinal tendencies toward different writing modes.

2.3 The effects of handwriting and typing on Chinese character recognition among Chinese L2 learners

Chinese characters, which are logographic symbols, and their units of visual perception, pronunciation, and meaning are different from Arabic's phonetic writing system. The reading and writing orders of Chinese and Arabic are likewise distinct, which increased Arabic learners' difficulties. Chinese characters are formed using radicals and strokes that are tangentially linked to their meaning or pronunciation, making it challenging for beginners who are unfamiliar with the Chinese language to extract accurate meaning or pronunciation from characters alone (Lu et al., 2019). What's worse, non-native learners have difficulties adapting to the conventional Chinese character teaching approach, and take two years to understand Chinese character structure instead of seeing them as pictures randomly assembled (Lu, 2002; Wang & Zhao, 2005). The Chinese Language Committee (2009, as cited in Lu et al., 2019) noted that learners always struggle with Chinese characters due to their orthographic nature, which raises the load of retrieval and retention.

Figure 1

Example of Chinese Pinyin Typing



However, keyboard-based computer technologies have made it possible to learn Chinese characters through typing. Typing characters via pinyin or other input methods is both simple and efficient, and while it enhances learners' Chinese character recognition abilities, it also reduces cognitive load at the initial stage of character learning and promotes learning motivation (Yang et al., 2017; Xu & Ke, 2020). In pinyin-based keyboard input, learners typically enter pinyin without tonal markers and then select the target character from a list displayed on the screen (see Figure 1). Pinyin input methods generally operate in two modes: a single-character input mode, in which learners type the pinyin of an individual character and select the corresponding character, and a chunk-based input mode, in which learners type the full pinyin or the initial letters of a word or phrase and then choose the correct characters from the candidate list.

Researchers have reported mixed findings regarding how handwriting and typing influence Chinese character recognition. Lyu et al. (2021) conducted a comparative analysis of 27 empirical studies and provided a systematic review of the differential effects of handwriting and typing on Chinese character learning in both first and second language contexts. Their findings indicate that typing shows certain advantages in phonological recognition and orthography–phonology mapping, and that this advantage is more pronounced in Chinese than in English. In contrast, handwriting practice significantly enhances second language learners' abilities in orthographic recognition and orthography–semantics mapping, exerting positive effects at both the single-character and lexical levels.

Owing to its ease of operation, immediate feedback, and high input efficiency, typing has received increasing recognition in instructional practice. A growing body of research suggests that typing is either superior to or comparable with handwriting in terms of Chinese character recognition. A longitudinal instructional study by Zhang (2021) provides empirical support for the potential of typing. Based on tracking data from 108 beginner-level learners of Chinese as a second language, the study found that the typing group outperformed the handwriting group in sentence-level character recognition and single-character memory. Building on this earlier work, Zhang (2024) further compared three learning modes: typing only, balanced handwriting and typing, and speech enhanced typing, and found that all groups performed similarly in character accuracy and lexical recognition. Similarly, Li (2022), in a semester-long instructional experiment conducted at a U.S. university, reported that at both elementary and intermediate proficiency levels, learners in the typing group and the handwriting group demonstrated comparable performance in character recognition. These findings suggest that handwriting and typing may be equally effective, and that differences in writing mode do not necessarily constrain the development of learners' character recognition abilities.

Nevertheless, despite the apparent advantages of typing in facilitating orthography–phonology mapping, its limitations in supporting orthographic structure awareness and visual representation learning should not be overlooked, as these limitations may affect learners' overall mastery of Chinese characters. Zhang and Min (2019) pointed out that when using pinyin-based input, learners are only required to enter the phonological form of a character, without engaging in the complete process of stroke generation. This mode of input may weaken learners' awareness of character structure, thereby negatively influencing long-term character memory. In addition, Lyu et al. (2021) emphasized that the absence of direct stroke-level practice in typing makes learners more susceptible to recognition difficulties when encountering visually similar characters, complex characters, or low frequency characters.

Some scholars have highlighted the advantages of handwriting, arguing that handwriting strengthens orthographic representations of Chinese characters, particularly in terms of character form recognition and component structure awareness (Hsiung et al., 2017). Through a series of experiments, Guan et al. (2011, 2015) demonstrated that handwriting training significantly improves learners' abilities in orthographic recognition and orthography–semantics mapping. Neuroscientific evidence further suggests that handwriting enhances grapheme–morpheme mapping, that is, the establishment of robust links between a character's written form, its pronunciation, and its meaning, thereby facilitating character recognition and the integration of form, sound, and meaning (Guan et al., 2011, 2015; Lu et al., 2019). From a motor perspective, handwriting promotes the formation of long-term motor memory for Chinese characters through movement planning, thereby optimizing spelling memory (Tan et al., 2005). However,

other studies have reported no significant correlation between character recognition performance and the amount of time spent on daily handwriting practice (Siok & Liu, 2018).

At the same time, some studies have failed to confirm the superiority of handwriting in Chinese character learning. Lu et al. (2019, 2024) found that learners who did not receive handwriting training outperformed those who practiced handwriting in vocabulary recognition tasks, and that handwriting practice did not yield significant effects in delayed post-tests. Similarly, Qian (2025) reported that, compared with handwriting, a no-handwriting condition improved character learning efficiency by 23%, with the time saved allowing learners to more effectively encode the orthographic, phonological, and semantic properties of characters. Taken together, these studies suggest that typing is sufficient to support Chinese character learning across multiple dimensions and is not necessarily inferior to handwriting.

Overall, no clear consensus has yet been reached regarding the effects of handwriting and typing on Chinese character recognition, and existing research has largely focused on adult learners of Chinese as a second language. Moreover, much of this research has been conducted in laboratory settings, which often lack ecological validity. In contrast, writing modes are primarily employed in authentic classroom contexts, where their use and effects may differ substantially from those observed under controlled experimental conditions. The inconsistencies reported in previous findings may be attributable to variations in research design, intervention duration, learners' language backgrounds, and task types.

Under these circumstances, the present study focuses on Arab adolescents and employs a combination of questionnaire surveys and classroom-based experiments to examine their attitudinal tendencies toward handwriting and typing, as well as the effects of these two writing modes on Chinese character recognition performance.

3 Methodology

This study adopted a mixed-method design. First, a questionnaire was administered to secondary school students who had experience learning Chinese characters through both handwriting and typing, in order to explore their preferences and attitudes toward these two writing modes. The findings from the questionnaire informed the design of a subsequent quasi-experimental study, which aimed to examine whether students' perceptions corresponded with their actual learning outcomes. In this design, the quantitative experiment served as the primary method, while qualitative data from open-ended responses were embedded to provide contextual insights (Creswell & Clark, 2017).

3.1 Questionnaire

This study refers to the research design of Jiang and Zheng (2015) to develop a questionnaire for Arab adolescents. The questionnaire includes two parts: basic information and attitude tendencies. The attitude tendencies are composed of a five-point Likert scale and an open-ended question composition, the scale contains 5 dimensions (1 means completely disagree, 5 means completely agree), and is used to investigate 7 aspects: the importance of learning Chinese characters, the role of typing on Chinese character learning, and the role of handwriting on Chinese character learning, the advantages of typing, the advantages of handwriting, reasons for choosing typing, and reasons for choosing handwriting. Open-ended questions and answers included 3 questions such as "Why do you prefer handwriting?". Students answered the questions in English. The authors delivered questionnaires to students in secondary education level (Grades 7-12) at UAE governmental schools where the Chinese language is regarded as a Subject B, and eventually collected 68 valid questionnaires. Although students are at different educational stages, since Chinese is a Subject B and has only 1.5 hours of class time per week, high school students in grades 11 and 12 are still at the elementary stage, so it can be considered that the subjects of the questionnaire distribution are all at the elementary level. Among them, there are 4 students in Grade 7, 9 students in Grade 8, 22 students in Grade 9, 1 student in Grade 10, 9 students in Grade 11, and 23 students in Grade 12.

Before data collection, digital informed consent was obtained from all participating students in accordance with ethical research guidelines. The authors used Microsoft Forms to collect questionnaires. The reliability test used Cronbach's alpha. SPSS 30 analysis showed that the reliability was 0.936, and the coefficients of each dimension were between 0.690 and 0.843, all greater than 0.6, indicating that the questionnaire was reliable. The validity test used the KMO value, and the analysis result was 0.841, greater than 0.6. The variance explanation rates of the seven dimensions were 18.511%, 15.738%, 11.052%, 8.850%, 8.536%, 6.600%, and 4.608%, respectively. The cumulative variance explanation rate after rotation was 73.894% > 50%. This shows that all items in the questionnaire are valid.

3.2 Quasi-experimental study

Based on the questionnaire results, a quasi-experiment was conducted with Grade 7 students to examine whether students' perceptions regarding handwriting and typing were consistent with their actual learning outcomes. Grade 7 students were selected because they were at an early stage of formal Chinese character learning but had already acquired basic knowledge of Chinese characters and were familiar with digital devices. This made them suitable participants for examining the learning effects of handwriting and typing under controlled instructional conditions. Although the questionnaire included students from Grades 7-12, high school students in this context remained at the elementary level due to the limited instructional time allocated to Chinese language. Therefore, Grade 7 students could reasonably represent the general learning characteristics of the population surveyed.

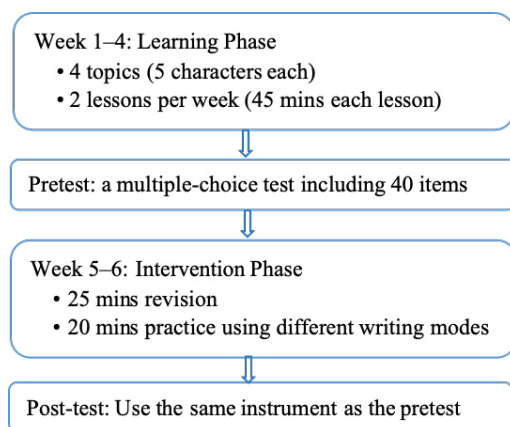
The study was conducted in an authentic educational context, where random assignment of students to classes was not feasible. To enhance internal validity, several measures were implemented to reduce the potential influence of confounding variables. With respect to prior knowledge, a pre-test was administered to all participants before the instructional intervention. Regarding learning motivation, all participants followed the same curriculum objectives, textbook, instructional sequence & time, and assessment criteria throughout the intervention period. The experiment employs a pre-post design to compare participants' performance differences after intervention.

40 Grade 7 Arab male (n=20) and female (n=20) students, aged 12 to 13 years old, participated in a 6-week quasi-experiment. They studied Chinese as a third language for one semester, since September 2022 to January 2023. The majority of Arab students grew up with digital devices, and the UAE government implemented digital education across secondary educational cycles, so the students were familiar with using the keyboard, ensuring that they had sufficient keyboard typing skills and fundamental knowledge of Chinese characters. One male teacher taught the boys' class, and one female teacher taught the girls' class.

40 commonly used characters were selected from various sources, which were Lessons 1 to 6 in the Silk Route Volume 1 and the List of Level 1 Characters-Chinese Proficiency Grading Standards for International Chinese Language Education (2021). A pilot check-up was implemented to assess students' prior knowledge of these characters. 40 characters were listed in a table (see appendix 1) on an A4 sheet, which was distributed to students, who were asked to tick the characters they knew, including both Pinyin (pronunciation) and meaning. The ticked characters (e.g., 大, 三, 人) were eliminated and 20 unknown characters were selected as targeted learning content according to the results. These 20 characters involved four configuration types, including 5 single characters (e.g., 几), 8 top-down characters (e.g., 岁), 4 left-right characters (e.g., 明), 3 outside-inside characters (e.g., 国). To ensure the effectiveness of the assessment tool developed by the researchers, a pilot sample was tested that all the 20 characters are new to the students.

The experiment was conducted in two separate classes at the same school, one for boys and one for girls, and each class was divided into two groups (handwriting & typing). The experiment was run in four phases: learning, pretest, intervention, and post-test (see Figure 2).

Figure 2

Teaching Experiment Flow*3.2.1 Learning phase*

Drawing from the curriculum and textbook, we have developed a comprehensive teaching material that effectively fulfills both experimental requirements and the termly assessment. The learning material spans over four weeks, during which 20 characters are distributed across two 45-minute sessions per week. The course syllabus covers four topics as shown in Table 1.

Table 1

Topics and Assigned Characters

Topic	Character
这是我的爸爸。 This is my father.	这 谁 爸 爱 国
你几岁? How old are you?	几 岁 他 了 也
今天星期几? What day is today?	年 今 明 天 星
你是学生吗? Are you a student?	医 学 是 老 吗

The course consisted of two 45-minute sessions per topic and each topic was divided into six parts. The following is an outline of the content of each session, which aimed to optimize students' learning experience and outcomes in a regular classroom setting.

(1) Introduction and Objectives: The class began with an introduction to the topic, and the learning objectives were presented on the board. The teacher-initiated interaction with the students by asking regular questions.

(2) Revision: This part of the session involved a review of the previous knowledge by displaying the words or dialogues learned in the last session. This step aimed to reinforce the student's memory and help them retain the previously learned material.

(3) Vocabulary Learning: New words were introduced and displayed, along with their pronunciation and English meanings. Students were asked to read aloud together several times to enhance their pronunciation.

(4) Language Practice: The teacher explained the conversation and then asked each student to answer questions. Online platforms such as Wordwall, Kahoot were used to facilitate memorization of the sound and meaning of new words.

(5) Character Recognition: In this part of the session, each character was first introduced individually, along with its pronunciation and meaning. The teacher used visual aids to make it easier for the students

to understand the characters. Once the students have comprehended the characters, encouraged them to practice vocabulary and then sentences that contain these characters. For instance, 几 - 几个 - 你有几个哥哥? .

(6) Summary: At the end of each session, students were asked to summarize the knowledge they had learned by taking notes, which aimed to reinforce their memory and understanding of the topic.

3.2.2 Pretest phase

During the pretest, participants were seated individually, and the test paper was distributed to each of them, consisting of 40 multiple-choice questions to assess students' achievement before the intervention (see Appendix 2). Half of the questions evaluated orthography-phonology mapping and the other half tested orthography-semantic mapping. The questions were reviewed by 5 experienced Chinese teachers in the UAE in order to verify the instrument's validity. In addition, the researchers conducted a pilot test with a group of ten students. After using SPSS 30, the correlation between student performance on the pre-test is $p = .718$, indicating that the assessment tool has high reliability.

3.2.3 Intervention phase

In the fifth week, two distinct training modes were conducted across two groups. The Chinese teacher allocated three teaching periods to thoroughly review and reinforce the content that had been taught over the previous four weeks. The revision session lasted for 25 minutes, followed by 20 minutes of character recognition practice. The objective was to evaluate the efficacy of the typing approach and its potential implications for learning outcomes of the Chinese character.

The process of typing in Chinese is characterized by a specific set of procedures that entail typing, recognition, and selection. The current investigation aims to explore the use of the Pinyin input method. Before the experiment, participants were mandated to install the Pinyin keyboard on their Dell laptops.

The assigned typing task was displayed independently on Google Slides, and the participants were required to complete three sections. In the first section, students were instructed to read the Pinyin and type the corresponding letters on the keyboard while selecting the intended character. Adherence to experimental protocols demanded that students refrain from copying and pasting the typing content, and each character and its associated meaning were required to be transcribed five times. Once all the single Chinese characters (6-7 characters in each period) were accurately transcribed, the task progressed to the next stage, which involved vocabulary reading and typing.

To promote a holistic approach to learning, each character was paired with two words that corresponded to its meaning, which were previously learned during regular teaching sessions (e.g., 几岁, 十二岁). In this stage, students were expected to type each word twice before proceeding to the final section. The last section required students to type sentences or dialogues that incorporated the designated characters. Guided by learning strategies, participants were required to commence by typing individual characters, then progress to words, and ultimately to sentences.

The participants were presented with characters on a printed A4 sheet and required to copy-write them into the designated box using writing tools. Stroke order was not emphasized, and each character was paired with Pinyin and meaning, and learners were asked to copy each one 5 times. The content of the second and last parts was the same as typing tasks, while the difference is the mode of practice. The teacher provided the same instructions for both handwriting and typing groups to ensure the procedures were as similar as possible and didn't interfere with the student's work on the assignment unless unacceptable errors occurred, such as a missed character.

3.2.4 Post-test phase

Post-test was administered shortly after a 3 period training. The tasks were the same as the pretest, which included the character Pinyin matching task and character meaning matching task, covering all 20 characters taught and practiced during the past 6 weeks. The former task required participants to choose visually presented pronunciation for Chinese characters, and the latter one was implemented to assess understanding of character meanings. Participants were instructed to tick the appropriate English meaning of each character.

4 Results

4.1 Attitudes of Arab adolescents towards two writing modes

The allure and distinctiveness of Chinese characters are commonly regarded as significant factors that attract learners to study them. They hold the belief that acquiring knowledge of Chinese characters can augment proficiency in other languages, hence easing contact with Chinese individuals via messaging platforms and enhancing social aptitude. Furthermore, under the effect of religious surroundings and national circumstances, while numerous students hold the belief that acquiring knowledge of Chinese characters is not directly connected to their future occupation and personal life, a subset of students also assert that knowing Chinese characters is intricately linked to their future growth and progress. Due to China's growing global influence, it is anticipated that Chinese will emerge as one of the predominant languages worldwide in the next years.

Table 2

Attitudes of Arab Adolescents towards Two Writing Modes

Type	Mode	M	SD	<i>d</i>	<i>t</i>	<i>p</i>
Phonetic Memory	Typing	3.06	1.30	-0.62	-4.17	<.01
	Handwriting	3.68	0.98			
Semantic Memory	Typing	3.25	1.26	-0.43	-2.71	<.01
	Handwriting	3.68	1.16			
Orthographic Memory	Typing	3.31	1.21	-0.43	-2.76	<.01
	Handwriting	3.74	1.19			
Characters Writing	Typing	3.47	1.20	-0.32	-1.99	.051
	Handwriting	3.79	1.07			

An independent-samples t-test was conducted and Table 2 shows that students believe that handwriting on paper is significantly better than typing in terms of phonetic memory ($p < .01$), semantic memory ($p < .01$), and orthographic memory ($p < .01$), while there is no significant difference between the two in Chinese character writing. Students are enthusiastic about handwriting because handwritten characters are more personalized. Some students express,

“I prefer handwriting over typing, although my handwriting is not excellent, I feel that through handwriting, I can more fully express myself. However, if I have to use keyboard input, I will have no problem.”

In addition, handwriting is not limited by time and space, and “*does not require charging or remembering the position of letters on the computer keyboard.*” Finally, handwriting Chinese characters have a lasting effect on character recognition and memory. 21% of students believe that handwriting is

more helpful for Chinese character memory, including character form and meaning. On the other hand, 29.4% of students generally believe that typing is more convenient and faster, and can reduce memory burden. However, overall, students are not very positive about learning Chinese characters using typing, and express that

“the only advantage of keyboard input is that there are no handwriting errors.” and some students believe that *“if I can write Chinese characters, it means typing is not a problem, but the reverse is not true.”*

Despite the growing popularity of digital learning methods in secondary schools in the UAE, students often have a preference for learning Chinese characters by handwriting. While individuals are often influenced by their native language writing modes and Arabic calligraphy art, they tend to prefer handwriting. However, during the teaching process, most of Chinese teachers seldom encourage students to use keyboards to aid in learning Chinese characters. As a result, students continue to heavily rely on the traditional method of handwriting on paper.

4.2 Two modes of writing on the effect of Chinese character recognition

4.2.1 Entry performances between the groups

The summary of the pretest is presented in Table 3. Due to non-normal distribution of the scores, a Mann Whitney U test was conducted to examine between-group differences. It indicates that there is no statistically significant difference between the typing group ($M=9.05$, $SD=2.33$) and handwriting group ($M=9.15$, $SD=2.28$) on orthographic-phonological association ($U=203.00$, $Z=0.08$, $p=.945$). This value falls well below the threshold for a small effect size ($r=0.01$), indicating an essentially negligible difference between the two writing modes. Similarly, no statistically significant differences were found in orthographic-semantic association ($U=240.50$, $Z=1.10$, $p=.272$) across the two writing modes (see Table 3). The observed small effect size ($r=0.17$) indicates a limited practical advantage for one writing mode over the other.

Table 3

Chinese Character Recognition Pretests

Post-test	Group	N	M	SD	U	Z	p	r
Phonological Test	Typing	20	9.05	2.33	203.00	0.08	.945	0.01
	Handwriting	20	9.15	2.28				
Semantic Test	Typing	20	9.10	1.65	240.50	1.10	.272	0.17
	Handwriting	20	8.55	2.21				

4.2.2 Chinese character recognition performances after the intervention

The experiment data were analyzed by using non-parametric tests (Wilcoxon Signed Rank Test). According to the results, typing practice has a significant effect on orthographic-phonological association ($W=0.00$, $p<.001$), $r=1.07$, as well as on orthographic-semantic association ($W=2.00$, $p<.001$), $r=1.01$. On the other hand, Table 4 has indicated that handwriting practice also has a significant effect on orthographic-phonological association ($W=2.00$, $p<.001$), $r=1.01$, as well as on orthographic-semantic association ($W=0.00$, $p<.001$), $r=0.86$.

According to commonly accepted benchmarks in educational psychology, values of r above .50 represent large effects. In the present study, all effect sizes substantially exceeded this threshold, suggesting that the observed improvements were robust and consistent across participants rather than driven by a small number of individuals. The results further suggest that both writing modes were

highly effective in facilitating foundational form–sound and form–meaning mappings. The extremely large effect sizes likely reflect the strong directionality and consistency of pretest to post-test gains within a relatively small sample, highlighting the substantial practical significance of the instructional interventions.

Table 4
Wilcoxon Signed Rank Test Comparing the Pre- and Post-tests

Group	Test	Time	N	M	SD	<i>W</i>	<i>p</i>	<i>r</i>
Typing	Phonological Test	Pre	20	9.05	2.33	0.00	<.001	1.07
		Post	20	17.20	2.38			
	Semantic Test	Pre	20	9.10	1.65	2.00	<.001	1.01
		Post	20	15.60	3.45			
Handwriting	Phonological Test	Pre	20	9.15	2.28	2.00	<.001	1.01
		Post	20	15.15	3.10			
	Semantic Test	Pre	20	8.55	2.21	0.00	<.001	0.86
		Post	20	13.95	3.47			

4.2.3 Two modes on orthographic-phonological/semantic association

According to Table 5, Mann-Whitney U test indicates typing ($M=17.20$, $SD=2.38$) has a better performance on orthographic–phonological association than handwriting ($M=15.15$, $SD=3.10$), which showed significant growth ($U=280.00$, $Z=2.16$, $p=.030$). This result represents a medium effect size ($r=0.34$) which suggests that the difference between the two writing modes in phonological learning outcomes has a certain degree of practical significance. Concerning the orthographic–semantic associations, there was no statistically significant difference ($U=247.40$, $Z=1.28$, $p=.202$) between typing ($M=15.60$, $SD=3.45$) and handwriting ($M=13.95$, $SD=3.47$), a small effect size ($r=0.20$) suggesting that although the typing group obtained slightly higher mean scores than the handwriting group, the difference was limited in both statistical and practical terms.

Table 5
Chinese Character Recognition Post-tests

Posttest	Group	N	M	SD	<i>U</i>	<i>Z</i>	<i>p</i>	<i>r</i>
Phonological Test	Typing	20	17.20	2.38	280.00	2.16	.030	0.34
	Handwriting	20	15.15	3.10				
Semantic Test	Typing	20	15.60	3.45	247.50	1.28	.202	0.20
	Handwriting	20	13.95	3.47				

5 Discussion

5.1 Implication

This study aimed to investigate Arab adolescents' attitudes toward two writing modes typing and handwriting and to examine the effects of these modes on Chinese character recognition, with particular attention to orthographic–phonological and orthographic–semantic mapping.

The main findings indicate that students generally show a preference for learning Chinese characters through handwriting. This preference appears to stem from the stronger embodied characteristics of handwriting, which not only foster writing proficiency but also support the concurrent development of visuospatial skills through fine-grained manual movements. Handwriting facilitates the construction of spatial representations of Chinese characters, including the spatial configuration of strokes, the organizational relationships among components (radicals), and the temporal sequencing of stroke order (Zhang & Reilly, 2015), thereby contributing to the gradual formation of precise visual–orthographic representations. Learners also widely perceive handwriting as having mnemonic advantages, believing that it supports long-term retention of the form, sound, and meaning of Chinese characters.

Secondly, both handwriting and typing facilitated the process of Chinese character recognition. The effects of the two writing modes on orthographic–phonological mapping have also been substantiated in cognitive processing research (Cai & Wang, 2025). In addition, typing had a better performance on orthographic–phonological association which confirmed the previous investigations that Pinyin typing supported phonological representations and the character–phonology link (Guan et al., 2011, 2015; Lyu et al., 2021), which also had a positive impact on Arab adolescents. That is, typing facilitates the construction of orthography–phonology connections. Keyboard input activates auditory representations and, through the accumulation of extensive typing experience in Chinese, can strengthen learners’ phonological knowledge and consolidate the associations between character form and sound. Because typing is fundamentally phonology-based, it maintains a direct link to speech often characterized as “what is typed reflects what is spoken” thereby supporting learners’ practice of pinyin and pronunciation. At the same time, typing requires learners to select target characters or words on the basis of form and meaning, which further reinforces the integrated mapping among orthography, phonology, and semantics.

However, we had an inconsistent finding which differs from former results that handwriting achieved better orthographic–semantic mapping of characters (Qian & Feng, 2004; Zhou & Xu, 2013). In terms of the orthographic–semantic association, there is no statistically significant difference between handwriting and typing in Arab adolescents, which indicates that Arab adolescents’ semantic knowledge of Chinese characters is not strongly dependent on support from sensorimotor channels. Instead, it appears to rely more heavily on character-related cognitive abilities acquired during classroom instruction, including the internalization of fundamental character knowledge such as components and radicals, as well as the use of associative and inferential strategies to strengthen orthographic–semantic connections. This finding carries important implications for instructional practice. To enhance learners’ semantic understanding of Chinese characters, greater emphasis should be placed on systematic instruction in basic character knowledge. Compared with adult learners, younger learners are more likely to benefit from multimodal instructional supports, such as images, stories, videos, and digital games that reinforce form – meaning associations, rather than from an exclusive focus on writing modes alone.

5.2 Application

In the design of teaching and learning materials, it is important to align instruction with adolescents’ cognitive developmental characteristics and adhere to the principle of “recognizing more characters and writing fewer” (Jiang, 2007). Curriculum guidelines should clearly distinguish between characters to be recognized and characters to be written at different stages of learning, thereby avoiding a one-size-fits-all approach. For characters designated for recognition, instructional materials may incorporate typing-based activities, such as “Please type the following characters/words/sentences on a computer or tablet”. Such practices can help reduce learners’ cognitive load while simultaneously addressing the limitation of restricted character exposure within each instructional unit.

Although integrating typing into Chinese character learning can be beneficial, it should not replace traditional handwriting practice entirely. According to the findings of this study, typing promoted Arab adolescents’ character recognition and strengthen the orthographic and phonological association, which

also benefits the pinyin input process. Instead of mechanically reading the pinyin syllables followed by the teacher, we do suggest beginners take advantage of the keyboard when learning Pinyin, which helps reinforce the training of phonetics. Mechanical and repetitive character copying in textbooks should be carefully reconsidered, as copying without an understanding of the cultural background and structural principles of Chinese characters may constitute an inefficient use of instructional time (Allen, 2008). For characters designated for writing, inquiry-based activities can be used to guide adolescent learners in understanding character structure, strokes, and stroke order—for example, sorting characters by stroke count or categorizing characters based on structural patterns. These activities help learners construct foundational schemata of Chinese character knowledge. Writing practice can then be enriched through the integration of words, pinyin, pictorial explanations, and contextualized meanings, thereby strengthening the connections among form, sound, and meaning.

Chinese character instruction should be tailored to the learning characteristics of adolescent learners. In teaching practice, appropriate reference to the features of Arabic script may help students distinguish and understand the differences between the two writing systems. Keyboard-based activities can be leveraged for phonological training, and multimedia resources can be used to enrich typing practice. Gamified approaches may also be incorporated into character instruction, whereby repeated engagement with online typing games helps transform perceptual memory associated with typing into long-term memory. By constructing an integrated system that combines learning, play, and assessment, instruction can strengthen form–sound–meaning connections, reduce cognitive load, and foster a state of flow in character learning. Learners' intrinsic motivation can be further enhanced through engaging content and diverse modes of presentation, while external motivational strategies such as encouragement, praise, and rewards can help sustain learning engagement.

For Chinese teachers who teach overseas secondary learners, it is essential to recognize that teaching Chinese characters to foreign language learners is not equivalent to basic literacy instruction. Character recognition is a means rather than an end in Chinese character teaching. While employing multimedia animations, videos, and games to support character instruction, teachers should also build on learners' existing knowledge to construct a progressive instructional sequence from characters to words, phrases, and sentences. In addition, through continuous professional development and lifelong learning, teachers should actively incorporate up-to-date research findings into their pedagogical practices. By balancing keyboard-based activities with handwriting practice and taking learners' developmental needs and instructional effectiveness into account, teachers can better meet the learning demands of students across different age groups.

6 Conclusion

Handwriting and typing influence language learning in terms of their characteristics and cognitive processes, regardless of whether the target language is English, Arabic, or Chinese. The study contributed to the existing body of knowledge in the field of comparing writing modes in different languages and opened up new avenues for teaching Chinese characters in the digital age. By addressing the gaps in the literature and presenting novel ideas, this study argues that it is crucial to use adolescent-friendly teaching strategies while teaching Chinese characters to secondary school learners. The curriculum and textbook can distinguish between characters that can be read and written, and they can be used with typing practice and handwriting practice. The integrated typing practice can be used in classes to boost adolescent learners' interest in studying characters. In addition, to motivate students to learn Chinese characters more effectively, a variety of game-based learning activities and teaching–playing–assessing online apps may be developed and used in the future. This study not only provides targeted pedagogical insights for Chinese character instruction in overseas primary and secondary education, but also contributes empirical evidence from the Arab world, thereby offering practical support for Chinese language education at the K to 12 education level in Gulf countries.

Despite the contributions of the present study, several limitations should be acknowledged. First, the sample size was relatively small, consisting of 40 seventh-grade students drawn from a single public middle school in the UAE. This limited sample scope may restrict the generalizability of the findings to learners of other grade levels, or educational contexts. Second, although grade level was held constant across participants, individual differences related to gender and prior learning background could not be fully controlled. This limitation is largely attributable to the constraints of conducting experimental research in an authentic school setting. In addition, the intervention on writing modes consisted of only three 20-minute sessions. The relatively short duration of the intervention may limit the generalizability of the findings to long-term instructional contexts. Therefore, the findings of this study should be interpreted with appropriate caution. Future research is encouraged to employ larger and more diverse samples, include multiple schools and grade levels, and incorporate additional control variables or longitudinal designs to further examine the robustness and generalizability of the observed effects.

Note

1. Silk Route Series is a localized Chinese language textbook for secondary education in the United Arab Emirates, developed by a team from East China Normal University. The series consists of 12 volumes and is designed for students from Grades 5 to 12.

Appendix 1 Chinese Character Screening Test

几	大	好	今	五
师	三	多	是	不
医	国	也	我	七
你	生	谁	中	四
人	学	九	名	星
明	年	六	吗	爸
岁	的	这	天	他
了	老	期	爱	叫

* Words Recognized (Noted by teacher):

Appendix 2 Chinese Character Recognition Test

Test A

1. Read the character and choose the correct Pinyin.

爱	① sǎn	② ài	③ jiào
岁	① suì	② wǔ	③ shàng
了	① zì	② le	③ liù
老	① lǎo	② mén	③ chē
谁	① jiū	② méi	③ shuí
星	① xīng	② hǎo	③ xià
国	① hái	② guó	③ huí
也	① dà	② rì	③ yě
吗	① zhè	② ma	③ gōng
爸	① bà	② shān	③ me

2. Read the character and choose the correct meaning.

是	① love	② am, is, are	③ called
今	① six	② up	③ today
几	① how many	② past	③ father
年	① car	② I, me	③ year
天	① day, sky	② no	③ big
他	① you	② also	③ he, him
学	① study	② country	③ people
医	① one	② school	③ medical
明	① moon	② tomorrow	③ mother
这	① this	② what	③ which

Test B

1. Read the character and choose the correct Pinyin.

学	① xué	② mǐ	③ gāo
今	① fēng	② jīn	③ chá
明	① hā	② nǎo	③ míng
是	① shì	② hé	③ duō
医	① fēn	② yī	③ zǎi
他	① dōu	② huí	③ tā
几	① fēi	② nín	③ jǐ
这	① nǐ	② zhè	③ rén
年	① nián	② pǎo	③ kàn
天	① dǎ	② tiān	③ bāo

2. Read the character and choose the correct meaning.

谁	① who	② what	③ how many
国	① goodbye	② country	③ this
了	① name	② completed marker	③ mother
爸	① ten	② father	③ age
岁	① years old	② happy	③ day
也	① also	② hospital	③ sorry
老	① doctor	② she	③ old
爱	① to know	② thanks	③ love
吗	① today	② question mark	③ called
星	① study	② star	③ China

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数字时代手写与电打方式对汉字学习的影响研究 ——以阿拉伯青少年为例

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摘要

纸笔手写和键盘电打作为学习语言的两种书写方式, 涉及不同的信息加工过程, 在有效提升第二语言能力发展方面发挥重要作用。然而, 这两种书写方式对海外非母语青少年在学习汉字时的作用尚不明确。本研究针对阿联酋青少年发放调查问卷, 并在当地一所公立中学开展准实验研究, 旨在考察学习者对两种书写方式的态度偏好以及手写和电打对汉字认读效果的影响。研究结果显示, 在态度偏好方面, 阿拉伯青少年更倾向于手写方式, 认为手写在记忆字音、字义及辨析字形方面比电打更有效; 而在书写产出方面, 他们认为两种书写方式并无显著差异。在汉字认读效果方面, 研究发现手写与电打均有助于提高阿拉伯青少年的汉字认读能力。与手写相比, 电打在识字辨音方面表现更佳。而在识字辨义方面, 电打与手写之间没有显著差异, 基于上述发现, 本研究建议实施契合青少年特点的汉字教学策略, 旨在为海外青少年学习者提供更有趣且高效的汉字学习体验。

关键词

手写, 电打, 态度偏好, 汉字认读, 阿拉伯青少年

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