



## ARTICLE

# Study on the Influence of a Digital-Intelligent Language Partner Model on Chinese Culture Acquisition among International Students

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## ABSTRACT

The global wave of digitalization and smart technology is changing how culture is shared. This study looks at how using a digital language companion, “AI Chinese”, affects the learning of Chinese culture by international students in Guangzhou. It is hard to measure short-term results in culture teaching. The study observed 30 students for one month. It checked how long they used “AI Chinese” each day and compared their scores on culture tests before and after. It also looked at changes in their sense of cultural identity. Results showed that more time using the tool led to bigger improvements in culture knowledge. This link was stronger for local Guangzhou culture than for general Chinese culture. Students who used it a lot (1.5 h or more per day) improved their scores much more and felt stronger cultural identity than those who used it less. Interviews showed that heavy users went through a step-by-step process in building cultural identity: first they learned, then they felt, then they acted. The findings show that digital tools can help spread culture. For short-term teaching in universities, using such a tool 1 to 1.5 h per day is a practical suggestion.

**Keywords:** Digital-Intelligent Language Partner Models; AI Chinese; International Students; Chinese Culture Cognition; Usage Duration; Cultural Identity

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## 1. Introduction

Today, digital and smart technology is growing fast. It is changing how people live and learn. This brings new chances and challenges for teaching Chinese worldwide and sharing Chinese culture. Finding new ways to use technology in teaching Chinese and culture is now an important topic. Language carries culture. So teaching Chinese also means sharing Chinese culture. Digital language services have special strengths<sup>[1-3]</sup>. They can break the limits of old-style teaching. They offer a new way to share Chinese culture that fits the short-term learning patterns of university students from other countries<sup>[4-6]</sup>.

With the continuous enhancement of China's comprehensive national strength, the number of people learning Chinese globally continues to rise, and the scale of international students coming to China is also expanding. The "Quality Standards for Higher Education of International Students in China (Trial)" formulated by the Ministry of Education explicitly requires international students in China to be familiar with basic knowledge of China's national conditions and culture, and to possess the awareness and skills for inclusive cultural diversity. This further highlights the importance of integrating cultural teaching into International Chinese Language Education and enhancing international students' cognition of Chinese culture. Against this backdrop, the emergence of digital-intelligent language services, such as tools like "AI Chinese", provides the possibility for the efficient integration of cultural dissemination and language teaching. Their innovations in learning methods, learning environments, and educational evaluation are expected to propel International Chinese Language Education and cultural dissemination to a new stage<sup>[7]</sup>.

Guangzhou, as a crucial hub for Sino-foreign cultural exchange, has attracted a large number of international students from around the world thanks to its unique geographical location and profound cultural heritage. However, in the practice of cultural teaching for international students in Guangzhou's universities, the prominent problem of "the difficulty in quantifying short-term effects" persists. On one hand, traditional cultural teaching often relies on methods such as classroom lectures and cultural activities, making it difficult to precisely capture the learning trajectories and cognitive changes of international students, and thus unable to promptly assess teaching effectiveness. On the other

hand, local Guangzhou culture, as an important component of Chinese culture, such as Cantonese Opera and Lingnan architecture, lacks effective dissemination carriers and suitable teaching tools during the teaching process, resulting in a relatively weak understanding of local characteristic cultures among international students.

Currently, the core task of International Chinese Language Education remains the teaching of the Chinese language itself. Cultural teaching must be integrated with language instruction without diverting from its core objective<sup>[8]</sup>. However, in practical teaching, how to efficiently integrate cultural content without deviating from the core of language teaching, and to achieve precise quantification of cultural cognitive outcomes, has become an urgent problem to be solved in the education of international students in Guangzhou's universities. The traditional language partner model, while promoting language exchange and cultural interaction to a certain extent, is limited by time, space, and individual differences, making it difficult to form a standardized, replicable teaching model. It also fails to meet the personalized learning needs of large-scale international student groups. Thus, the digital-intelligent language partner model emerges as a viable approach to address the aforementioned difficulties.

## 2. Literature Review

This section looks at earlier research related to this study. It builds a theory base and finds the gaps that this paper tries to fill. The review has three main parts. First, it looks at how digital tools are used in teaching Chinese worldwide. Second, it examines research on cultural learning and identity of international students in China. Third, it discusses how the language partner model has changed and what limits it has in sharing culture. Putting together findings from these areas shows we need more detailed, fact-based research. We need to study the link between how digital language partners are used and what culture students learn.

### 2.1. Application and Research of Digital-Intelligent Language Services in International Chinese Language Education

With the rapid advancement of artificial intelligence and educational technologies, digital-intelligent language

services have become an important innovation in International Chinese Language Education<sup>[6]</sup>. Early studies mainly focused on how digital tools enhance instructional efficiency and learner autonomy, emphasizing functions such as intelligent feedback, adaptive learning paths, and multimodal input<sup>[7]</sup>. These technologies are believed to alleviate the constraints of time, space, and teacher resources in traditional classroom-based instruction<sup>[8]</sup>.

Recent research has shifted from general digitalization to AI-driven interactive systems, such as chatbots and intelligent conversational agents, which simulate authentic communication scenarios<sup>[9]</sup>. Empirical studies in second and foreign language contexts suggest that AI-based conversational partners can effectively support speaking practice, increase learner engagement, and reduce anxiety by providing low-stakes, repeatable interaction opportunities<sup>[10]</sup>. In particular, AI tools have been found to facilitate contextualized language use and sustained practice, which are essential for meaningful language acquisition<sup>[11]</sup>.

In the field of ICLE, however, existing studies predominantly examine linguistic outcomes, such as vocabulary acquisition, oral fluency, or task completion, while cultural learning is often treated as a secondary or implicit outcome<sup>[12]</sup>. Moreover, most research employs short-term intervention designs or relies on self-reported perceptions, providing limited insight into how different patterns of tool usage affect learners' cultural understanding<sup>[13, 14]</sup>. As a result, the potential of digital-intelligent language services as structured carriers for cultural knowledge and local cultural experience remains underexplored.

## 2.2. The Research Landscape of Chinese Culture Cognition and Identity among International Students in China

Cultural learning has long been recognized as a core component of ICLE, closely linked to international students' adaptation, intercultural competence, and identity development<sup>[14]</sup>. Previous studies commonly conceptualize cultural learning as a multidimensional process involving knowledge acquisition, emotional engagement, and behavioral participation<sup>[15]</sup>. From this perspective, cultural identity is not a static attribute but a dynamic construct shaped through continuous interaction with cultural content and social contexts<sup>[16]</sup>.

Existing research on international students in China has

largely focused on macro-level cultural identity, such as national image perception or general attitudes toward Chinese culture<sup>[17]</sup>. Quantitative surveys and bibliometric analyses reveal that cultural identity is influenced by factors including length of stay, cultural contact frequency, and participation in cultural activities<sup>[18]</sup>. However, such studies often overlook local cultural dimensions and the specific mechanisms through which cultural cognition transforms into emotional identification and behavioral practice<sup>[19]</sup>.

More recent theoretical work emphasizes the dual-process nature of cultural identity, highlighting the interaction between cognitive understanding and emotional experience<sup>[20]</sup>. Nevertheless, empirical research that operationalizes this process at a micro level—especially among short-term international students—remains limited<sup>[21]</sup>. In particular, there is insufficient evidence on how technology-mediated learning environments reshape cultural engagement pathways and whether digital tools can support emotional resonance and identity formation beyond surface-level cultural knowledge<sup>[22]</sup>.

## 2.3. Practical Exploration and Limitations of the Language Partner Model and Chinese Culture Dissemination

The language partner model has long been regarded as an effective pedagogical approach for promoting linguistic exchange and intercultural interaction<sup>[23–26]</sup>. By pairing learners with native speakers or peers, this model provides opportunities for authentic communication, pragmatic language use, and informal exposure to cultural practices. Empirical studies have shown that such interaction-based learning environments can enhance learners' communicative competence and intercultural awareness by situating language use within meaningful social contexts<sup>[27, 28]</sup>. However, traditional language partner arrangements are also subject to structural and interpersonal constraints, including scheduling difficulties, uneven participation, mismatched proficiency levels, and learners' varying willingness to communicate. These limitations often result in inconsistent interaction quality and restrict the sustainability of cultural learning outcomes<sup>[29]</sup>.

With the rapid integration of digital technologies into language education, the language partner model has gradually evolved toward online and AI-assisted formats<sup>[30]</sup>. Digital-intelligent language partners, such as chatbot-based

conversational agents, differ fundamentally from human partners in that they provide standardized, scalable, and continuously available interaction opportunities<sup>[31]</sup>. Prior studies in computer-assisted language learning suggest that AI-supported partners can lower affective barriers, offer immediate feedback, and support repeated practice without social pressure<sup>[10, 32]</sup>. These features make digital-intelligent language partners particularly suitable for large-scale international student populations and short-term learning contexts, where access to stable human partners is often limited<sup>[33]</sup>.

Nevertheless, despite the growing interest in AI-assisted language learning, existing research in International Chinese Language Education remains fragmented. On the one hand, application-oriented studies on digital-intelligent language services tend to emphasize functional descriptions or learner perceptions, while lacking rigorous quantitative evidence on the effectiveness of specific tools and usage patterns. On the other hand, research on international students' cultural cognition and cultural identity in China has largely focused on macro-level cultural understanding, such as national culture or generalized cultural attitudes, with insufficient attention to micro-contexts, including local culture and everyday cultural practices. As a result, the nuanced processes through which learners transform cultural knowledge into emotional identification and behavioral engagement remain underexplored.

More importantly, although the intelligent transformation of the language partner model has been increasingly discussed<sup>[34]</sup>, existing studies rarely address the mechanism linking tool usage duration with staged cultural outcomes. Usage duration is often treated as a background variable rather than a theoretically meaningful factor that may influence the depth of cognitive processing, emotional resonance, and identity construction<sup>[35–38]</sup>. This gap limits current understanding of how sustained interaction with digital-intelligent language partners contributes to cultural learning beyond surface-level knowledge acquisition.

Against this background, the present study takes short-term international students enrolled in universities in Guangzhou as its research subjects and focuses on a digital-intelligent language partner model, namely "AI Chinese". Over a one-month period, this study addresses three core research questions. First, by systematically recording participants' daily usage duration of the "AI Chinese" tool and

comparing pre-test and post-test scores on a Chinese cultural knowledge test, this study examines whether tool usage duration has a significant positive effect on cultural knowledge gains. Second, based on the same usage duration data and test score differences, participants are categorized into low-, medium-, and high-usage groups (low < 0.8 h/day, medium 0.8–1.5 h/day, high ≥ 1.5 h/day), in order to explore whether statistically significant differences exist among these groups in terms of cultural knowledge improvement. Third, through semi-structured interviews, this study further investigates how varying usage durations shape international students' subjective experiences, emotional responses, and perceptions of cultural identity.

By integrating quantitative and qualitative methods, this research aims to address the limitations of previous studies and provide empirical evidence on the role of usage duration in digital-intelligent language partner models. Specifically, it seeks to clarify the mechanism through which sustained AI-mediated interaction facilitates the progression from cultural cognition to emotional engagement and identity formation. In doing so, the study not only offers practical guidance for the cultural teaching of international students in Guangzhou universities but also contributes to a more nuanced understanding of how short-term, technology-supported learning environments can promote efficient and meaningful dissemination of Chinese culture.

Based on the above literature review, it can be seen that current application research on digital-intelligent language services in International Chinese Language Education lacks quantitative analysis of the effectiveness of specific tools. Research on the cultural cognition of international students has problems, such as insufficient attention to micro-contexts<sup>[39–41]</sup> and a lack of research on local culture<sup>[42, 43]</sup>. Research on the intelligent transformation of the language partner model has not yet involved the mechanism linking tool usage duration to cognition and identity<sup>[44, 45]</sup>.

Based on this, this paper takes short-term international students in Guangzhou universities as the research object, focusing on the digital-intelligent language partner model ("AI Chinese"). Over a one-month period, it revolves around three core research questions: First, by recording the usage duration of the "AI Chinese" tool and measuring the pre-test and post-test score differences in international students' Chinese cultural knowledge tests, this study explores whether

the tool usage duration has a significant positive impact on the test score differences. Second, similarly relying on usage duration statistics and knowledge test score difference measurements, to analyze whether there are differences in the Chinese cultural knowledge test score differences among international students in different duration groups (low < 0.8 h/day, medium 0.8–1.5 h/day, high  $\geq$  1.5 h/day). Third, through semi-structured interviews, to deeply explore how the usage duration of “AI Chinese” affects the subjective feelings and cultural identity of international students. Through this empirical research combining quantitative and qualitative methods, it aims to fill the existing research gaps, clarify the mechanism of the digital-intelligent language partner model in enhancing the cultural cognition and identity of international students, provide practical guidance for the cultural teaching of international students in Guangzhou universities, and contribute to the short-term and efficient dissemination of Chinese culture.

### 3. Methodology

This study employed a mixed-methods approach to investigate the influence of a digital-intelligent language companion on the cultural acquisition of international students. The research design, participants, intervention tool, and data collection procedures are detailed in the following subsections. This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the School of Foreign Studies, South China Normal University (Approval Code: SCNU-SFS-2024-001, Date: 1 March 2024).

#### 3.1. Research Subjects and the Digital-Intelligent Language Partner Model

This study involved 30 international students from a university in Guangzhou (referencing the international student composition of South China Normal University, referred to as University S). Sample homogeneity was strictly controlled to minimize confounding variables. Regarding basic characteristics, the participants were aged 18–27, including 18 undergraduate students (18–22 years old) and 12 post-graduate students (23–27 years old). All possessed 3–5 years of learning experience in China and had intermediate Chinese proficiency (HSK Level 3–4), ensuring consistent basic

comprehension ability and learning potential for Chinese cultural knowledge. The specific nationalities were: Indonesia (5), Vietnam (5), Thailand (4), South Korea (4), Malaysia (4), Singapore (3), and Saudi Arabia (3), covering Southeast Asia (60%), East Asia (13.3%), and the Middle East (10%). The sample size of 30 participants was determined based on practical constraints and the homogeneity of the target population, which allowed for controlled comparison across usage-duration groups. While this limits generalizability, it enhances internal validity for detecting usage-duration effects.

Regarding course alignment, all participants were concurrently enrolled in two core Chinese language-related courses, with an identical cumulative weekly instruction time of 6 h, thus eliminating interference from course differences on cultural cognitive learning outcomes. At the pre-study stage, a “Pre-test on Chinese Cultural Knowledge” (containing 30 general culture questions and 20 local Guangzhou culture questions) was administered to all subjects. After excluding outliers ( $\pm 2$  standard deviations) based on pre-test scores, the final 30 international students were divided into three groups of 10 based on their “AI Chinese” usage duration. There were no significant differences ( $p > 0.05$ ) in the distribution of nationality, age, or pre-test scores among the groups. The specific grouping criteria were: Low-duration group: Daily “AI Chinese” usage < 0.8 h; Medium-duration group: Daily “AI Chinese” usage 0.8–1.5 h; High-duration group: Daily “AI Chinese” usage  $\geq$  1.5 h.

Duration recording employed a “WeChat group screenshot registration” method. Daily before 22:00, participants were required to submit a screenshot of the “Learning Duration Statistics” page within the “AI Chinese” app to a dedicated research WeChat group. The researcher verified the authenticity of the screenshots daily (checking device ID, learning period, and content records) to ensure accurate and unadulterated data. The entire recording period lasted one month.

A “WeChat group screenshot registration” method was employed to record usage duration. Participants were required to submit a daily screenshot of the “Learning Duration Statistics” page from the “AI Chinese” app to a dedicated research WeChat group before 22:00 each day. The authenticity of submitted screenshots was verified daily through checks of device ID, learning period, and content records,

ensuring data accuracy and integrity. This recording process was maintained for one month.

Based on the recorded daily usage, participants were divided into three groups: a low-duration group (daily use  $< 0.8$  h), a medium-duration group (daily use 0.8–1.5 h), and a high-duration group (daily use  $\geq 1.5$  h). The rationale for establishing these specific duration thresholds integrated theoretical, empirical, and practical considerations. The threshold for the medium-duration group was aligned with the concept of “effective learning time” from formal education, which suggests that meaningful progress requires sustained, focused sessions. Furthermore, empirical evidence from digital language learning often indicates a “dose-response” relationship, where better outcomes are associated with moderate to high usage levels, a concept that these thresholds operationalize into practical daily doses. Finally, the design of the tool’s “Lingnan Culture Thematic Module,” with its core content designed for 30–45 min sessions, provided a pragmatic basis. It was posited that usage below 0.8 h likely represented

fragmented engagement, usage between 0.8 and 1.5 h allowed for completion of core content and supplementary practice, and usage exceeding 1.5 h indicated intensive, immersive use enabling deep exploration and integration into daily life.

### 3.2. Research Tool: The Adapted Design of the “AI Chinese” Digital-Intelligent Partner

This project adopted the digital-intelligent partner “AI Chinese” (released in 2024) as the primary tool for this project. This tool accurately solves the industry’s pain point with the concern, “the lack of high-quality Chinese language teaching supply for overseas learners”, with its primary design philosophy focusing on “low cost, low time consumption, low complexity”. Its system design is strongly aligned with the study goal of foreign students’ knowledge of the Chinese culture cognitive system, particularly the Guangzhou culture cognitive system, with the characteristics described below (Figure 1):

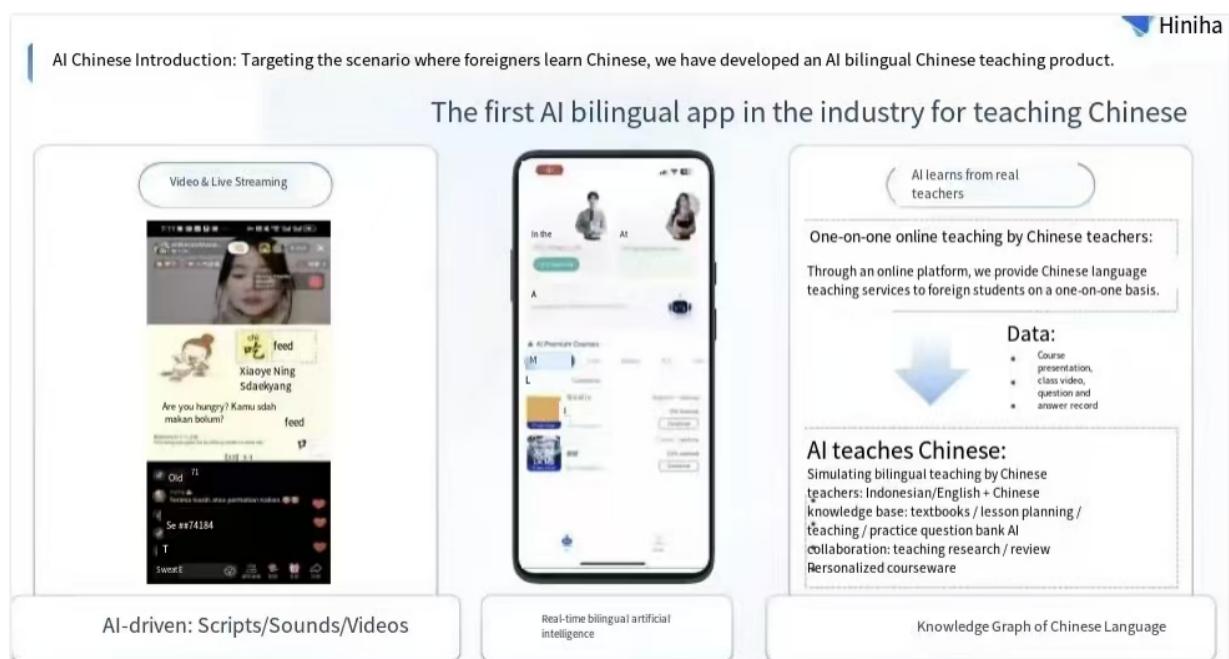


Figure 1. The 3 Major Intelligent Interactive Functions of “AI Chinese”.

The system provides bidirectional bilingual conversion capabilities in “Native Language/English–Chinese” form. International students can choose the suitable language for instructional purposes according to their native language identity, such as Indonesian nationals switching their system

to “Indonesian–Chinese” mode. It changes difficulties associated with language barriers, provides effective cultural knowledge with guaranteed accuracy, and avoids cognitive divergences spawned through language barriers. In catering to Guangzhou universities’ cultural knowledge necessary

for the prerequisite satisfaction of local cultural cognition knowledge requirements of international students, the system includes a “Lingnan Culture Thematic Module” intended specifically for that purpose. This module systemically gives basic educational coverage of Cantonese Opera terms (for example, “Banghuang” and “Luobianhua”), Lingnan cultural architecture (for example, “Three Carvings, Two Sculptures” technique found in Chen Clan Ancestral Hall), as well as Guangzhou folk customs (for example, “Spring Flower Market” and “Dragon Boat Festival”). Using the “Cultural Annotations+Scenario-based Animations” presentation technique, with focus on example use in Cantonese Opera knowledge education, the system initially enables the synchronous bilingual interpretation of professional terms, subsequently producing a scenario of a 30-second animation for a classic version of *The Peony Pavilion* of Cantonese Opera with synchronized *Lingnan literati social customs* explanations, based on image representations such as “Huajian” (Decorated notepaper) via “Yuzan” (jade hairpin) within the script.

By benefiting from a self-built Chinese Knowledge Graph (overcoming the technological weakness of foreign large language models on the topic of Chinese Pinyin), there are three primary intelligent interactive functionalities built for cognitive efficiency enhancement:

- (1) Pronunciation Correction Function. Following the reading passage of an international student on a relevant text of Guangzhou culture (for example, historical introduction of Beijing Road Pedestrian Street, explanation of Cantonese Morning Tea culture), the AI system will proceed to generate a Visualized Pronunciation Waveform Diagram, effectively pinpointing the distinctions between standard pronunciations and those of the reading student, particularly in tone deviation and initial consonant confusion.
- (2) Knowledge Point Check Function. After every cultural knowledge topic (for example, Guang embroidery skills, historical background of Qilou architecture), self-test questions (3 MC and TF) will automatically be generated, allowing for instantaneous assessment of knowledge acquisition.
- (3) Scenario-based dialogue functions. “The AI system will present real cultural experiences in Guangzhou (for example, going with students on a trip to Shangxiajiu Pedestrian Street with buildings featuring the

unique architecture of the Qilou, taking part in Guangfu Temple Fair, as well as indulging in Cantonese desserts) through role-playing conversations with the student. Thus, for instance, the AI system will play the shopkeeper in Double-Layer Steamed Milk on the Qilou street, with “Would you like to take a taste? Do you want me to add more sweetness to this dessert?” being some of their dialogues.

### 3.3. Data Collection

Data were collected through a mixed-methods approach, encompassing both quantitative and qualitative measures to comprehensively capture the impact of the digital tool on cognitive acquisition and subjective experience.

#### 3.3.1. Quantitative Data Collection

Chinese Cultural Knowledge Test Data: The Chinese Cultural Knowledge Test (Pre-test and Post-test, see **Appendix A**) was specifically developed for this study to measure cognitive acquisition. The test development followed a structured process: 1) Test items were created based on a review of standard Chinese cultural textbooks (e.g., *Boji Chinese*) and official guides to Guangzhou’s local culture, ensuring content validity. 2) A panel of three experts in International Chinese Language Education from S school reviewed the original item pool for accuracy, relevance, and also clarity. All the items were greatly revised based on their feedback. 3) The revised test was piloted with a separate group of 10 international students (not included in the main study) to check for comprehensibility, appropriate difficulty, and completion time. Final adjustments were made based on pilot feedback.

The final test has two modules: 1) General Chinese Culture Questions (30 questions, 60 points), and 2) Local Guangzhou Culture Questions (20 questions, 40 points). The reliability (internal consistency) of the entire instrument in the main study was good (Cronbach’s  $\alpha = 0.82$ ). The subscales of the test also showed acceptable reliability (General Culture  $\alpha = 0.78$ ; Local Culture  $\alpha = 0.75$ ).

Reflecting the viewpoint that cultural dissemination requires verification of cognitive effects<sup>[10]</sup>, a *Pre-test on Chinese Cultural Knowledge* (see **Appendix A**) and a *Post-test on Chinese Cultural Knowledge* (see **Appendix A**) were conducted at the pre-study (T0) and post-study (T1, one

month later) stages, respectively. The test was developed by the research team based on standard Chinese cultural curricula and local Guangzhou cultural content to ensure content validity. It was checked and reviewed with 10 international students (not included in the main study) to assess clarity, appropriateness, and approximate completion time.

The test design echoed Zhang's proposition of linguistic and cultural integrity+localization, comprising two modules: 1) General Chinese Culture Questions (30 questions, 60 points, covering Chinese history, traditional festivals, etc.), and 2) Local Guangzhou Culture Questions (20 questions, 40 points, covering Cantonese Opera, Lingnan architecture, Guangzhou customs, etc.)<sup>[5]</sup>. The pre- and post-tests had consistent difficulty indices. The reliability analysis for the entire instrument yielded a Cronbach's  $\alpha$  of 0.82, indicating good internal consistency. Reliability for the subscales was also acceptable (General Culture  $\alpha = 0.78$ , Local Culture  $\alpha = 0.75$ ). The Pre-Post Score Difference in Chinese Cultural Knowledge" ( $T_1 - T_0$ ) was calculated to quantify the cognitive improvement effect.

### 3.3.2. Qualitative Data Collection

At the end of the study, semi-structured interviews were conducted. To gain in-depth insights into the subjective experiences across different usage patterns, one participant was selected from each duration group (Low, Medium, and High), resulting in three interviewees. The interview guide focused on three areas: their experience using AI to learn about Guangzhou culture, how the AI assisted them in overcoming cultural difficulties, and any changes in their cognitive, affective, and behavioral engagement with Chinese culture. Each interview lasted approximately 10 min, was audio-recorded, and later transcribed verbatim for analysis.

The interview transcripts were analyzed using thematic analysis, following the systematic six-phase approach out-

lined by Braun and Clarke (2006)<sup>[42]</sup>. This process involved: first, familiarization with the data through repeated reading of the transcripts; second, generating initial codes to identify key phrases and ideas; third, searching for themes by collating codes into broader patterns (such as "Functional Utility", "Emotional Connection", and "Behavioral Transfer") that captured experiences across the cases; fourth, reviewing themes to ensure they fit the data; fifth, defining and naming themes; and finally, producing the report. This rigorous approach ensured that the identification of the "cognition-emotion-behavior" progression was firmly grounded in the participants' own experiences.

## 4. Results

The data collected from the cultural knowledge tests and semi-structured interviews were analyzed to address the research questions. The findings are presented below, beginning with the quantitative analysis of test scores and usage duration, followed by the qualitative themes that emerged from the interviews.

### 4.1. Quantitative Data Analysis

The quantitative findings have shown a significant relationship between the duration of "AI Chinese" use and the improvement in cultural knowledge test scores.

#### 4.1.1. Correlation Analysis

SPSS 26.0 was used to perform Pearson correlation analysis between "AI Chinese" usage duration and the "Pre-Post Score Difference in Chinese Cultural Knowledge" (across three dimensions: General" usage duration and the score differences, to verify the positive impact of usage duration on cognitive improvement. The results are shown in **Table 1** below:

**Table 1.** Correlation between Usage Duration and Cultural Knowledge Score Differences.

Cognitive Dimension	Pearson's r	p-Value	Strength	Conclusion
General Culture (GCC)	0.628	0.002	Moderate	Significant ( $p < 0.01$ )
Local Guangzhou Culture (LGC)	0.756	<0.001	Strong	Highly Significant
Total Score	0.703	0.001	Strong	Significant ( $p < 0.01$ )

As shown in **Table 1**, Pearson correlation analyses revealed a significant positive correlation between tool usage

duration and gains in total cultural knowledge ( $r = 0.703, p = 0.001$ ). When analyzed by dimension, the association was

strong for local Guangzhou culture ( $r = 0.756, p < 0.001$ ) and moderate for general Chinese culture ( $r = 0.628, p = 0.002$ ). The usage duration of AI Chinese showed significant positive correlations with the improvement in Chinese cultural cognition, with a stronger association observed for local Guangzhou culture with all three dimensions of the pre-post score differences in the Chinese cultural knowledge test (all  $p < 0.01$ ), with varying strengths of association across dimensions:

The correlation coefficient with the General Chinese Culture score difference was 0.628 ( $p = 0.002$ ), indicating a moderate positive correlation. This suggests that increased tool usage duration can significantly enhance international students' cognitive level of general cultural knowledge, such as Chinese history and traditional festivals. (The raw data supporting this correlation analysis are available in **Appendix C, Table A1**.)

The correlation coefficient with the Local Guangzhou Culture score difference reached 0.756 ( $p < 0.001$ ), indicating a strong positive correlation, and the strength of association was higher than that for the general culture dimension. This

illustrates that the association between tool usage and the improvement in cognition of local characteristic cultures, such as Cantonese Opera and Lingnan architecture, is more pronounced.

The correlation coefficient with the Total Score difference was 0.703 ( $p = 0.001$ ), also indicating a strong positive correlation, confirming that tool usage duration is a key factor influencing the overall improvement in international students' cultural cognition.

#### 4.1.2. ANOVA and Post-Hoc Multiple Comparisons Results

One-way Analysis of Variance (ANOVA) was used to compare the score differences across the three cognitive dimensions among the Low-duration (<0.8 h/day), Medium-duration (0.8–1.5 h/day), and High-duration ( $\geq 1.5$  h/day) groups. If significant differences existed between groups ( $p < 0.05$ ), post-hoc multiple comparisons were conducted using the Least Significant Difference (LSD) method to identify the specific groups differing. The results are shown in **Table 2** below:

**Table 2.** ANOVA and Post-hoc Comparisons of Score Differences by Usage Group.

Dimension	Group	N	Mean (M)	SD	F/p-Value	Effect Size ( $\eta^2$ )	Post-Hoc (LSD) p-Values
GCC	L	10	4.3	1.71	15.682/0.001	0.537	L vs. M: 0.045;
	M	10	6.4	1.89			L vs. H: 0.001
	H	10	8.6	1.82			M vs. H: 0.008
LGC	L	10	6.2	2.03	22.845/<0.001	0.628	L vs. M: 0.038;
	M	10	10	2.15			L vs. H: <0.001
	H	10	12.1	1.91			M vs. H: 0.003
Total	L	10	10.5	3.35	19.736/ 0.001	0.594	L vs. M: 0.032;
	M	10	16.4	3.62			L vs. H: 0.001
	H	10	20.7	3.18			M vs. H: 0.006

The one-way ANOVA and post-hoc multiple comparisons (**Table 2**) indicated significant differences in score differences across all three cognitive improvement dimensions among the different duration groups (F-value range 15.682–22.845, all  $p < 0.01$ ). A gradient pattern of “High-duration group > Medium-duration group > Low-duration group” was observed:

(1) General Chinese Culture Dimension: The mean score of the Medium-duration group (6.4) was significantly higher than that of the Low-duration group (4.3,  $p = 0.045$ ). The mean score of the High-duration group

(8.6) was significantly higher than both the Medium-duration group ( $p = 0.008$ ) and the Low-duration group ( $p = 0.001$ ). The magnitude of improvement between groups was relatively balanced.

(2) Local Guangzhou Culture Dimension: Inter-group differences were more prominent. The mean score of the Medium-duration group (10.0) showed a marked improvement over the Low-duration group (6.2,  $p = 0.038$ ). The mean score of the High-duration group (12.1) maintained a significant improvement over the Medium-duration group ( $p = 0.003$ ). Furthermore, the mean difference between groups in this dimension

(Medium – Low = 3.8, High – Medium = 2.1) was greater than that in the General Culture dimension.

(3) Total Score Dimension: The mean score of the High-duration group (20.7) was significantly higher than both the Medium-duration group (16.4,  $p = 0.006$ ) and the Low-duration group (10.5,  $p = 0.001$ ). The mean score of the Medium-duration group was significantly higher than that of the Low-duration group ( $p = 0.032$ ). The overall cognitive improvement effect showed a positive gradient distribution corresponding to usage duration.

## 4.2. Qualitative Data Analysis

Three students were interviewed: Student A (Indonesia, Year 2 undergraduate, low-use group), Student B (Vietnam, Year 1 postgraduate, medium-use group), and Student C (Saudi Arabia, Year 2 postgraduate, high-use group). We asked them about their experience with the tool, how it helped them understand culture, and if their sense of identity changed. We found that more time using the tool led to clearer step-by-step improvements in how they felt and how connected they felt to the culture. They were chosen to represent the three distinct usage groups that are central to this study. This allows for a clear comparison of how different amounts of tool use are linked to different experiences. Selecting one student from each group also provided diversity in nationality and study level, giving a richer view within the practical limits of a small, in-depth interview study. They are asked about their experience with the tool, how it helped them understand culture, and if their sense of identity changed. We found that more time using the tool led to clearer step-by-step improvements in how they felt and how connected they felt to the culture. The results revealed a “stepwise enhancement” in the impact of usage duration on subjective experience and cultural identity. The transcript from one participant is included in **Appendix B**.

### 4.2.1. Low-Use Group (<0.8 h/day)

The tool helped them only a little. Their experience was basic. Their sense of cultural identity did not really change. Student A (used about 0.5 h daily) said: “I only used it 15–20 min before bed. I mostly looked at simple things in the Lingnan Culture section, like the names of dim sum items. The AI helped me say ‘Shrimp Dumplings’ (Xiajiao) better.

But I still didn’t get many terms. For example, with Punong Five Excellences, the AI just said there are five ingredients. I didn’t learn why they are special to Guangzhou food.” About cultural identity, they said, “I knew about Cantonese Opera before. I still just know the name. I didn’t watch the clips in the AI (no time), so my feelings about Guangzhou culture are the same. I don’t really want to learn more.” The main point from this group was: not using it enough meant they didn’t see all it could do. They only got basic language help. Their understanding of culture stayed at simple word meanings, without any emotional connection. Their cultural identity stayed at a basic level, like what a course requires.

### 4.2.2. Medium-Use Group (0.8–1.5 h/day)

They saw the tool’s value in helping with culture. Their experience felt practical. Their cultural identity started to grow. Student B (used about 1.2 h daily) said, “I used it twice a day. In the morning, 30 min on Cantonese Opera. In the evening, 30 min on scenario dialogues. The *Cultural Annotations* were very helpful. For example, for *Luobianhua*, it played the sound of Cantonese Opera drums and compared them to instruments in Vietnamese theater. I then understood it is the rhythm signal in Cantonese Opera. The dialogue about shopping on Beijing Road for Guang Embroidery felt real. I now know Guang Embroidery isn’t just flowers; it can have patterns like the Canton Tower.” About cultural identity, they said: “Before, I thought Chinese culture was only the Forbidden City and the Great Wall. Now I know Guangzhou’s Qilou buildings and Double-Layer Steamed Milk are also part of it. Last week, I went to Shangxiajiu with Chinese classmates. I could point out the ‘Parapet Wall’ (Nü’er Qiang) on the Qilou buildings. My classmates said, ‘I knew more than them. That made me happy. I want to learn more old stories about Guangzhou.’” This group used the tool enough to see its main cultural parts. They understood cultural points through notes and scenarios. They found the tool useful. Their view of culture changed from just “general Chinese culture” to “general plus local culture”. They started to share what they learned with others. But their understanding of deeper cultural ideas (like the inclusive nature of Guangfu culture) still needed work.

### 4.2.3. High-Duration Group (≥1.5 h/day)

Students in this group really liked how the tool let them dive deep into the culture. They enjoyed using it. Their con-

nection to the culture grew in a clear way: first they learned, then they felt, and finally they acted. Interviewee C (Saudi Arabia, second-year postgraduate student, average daily use 1.8 h) explained, “I made the tool part of my daily life. For example, before visiting the Chen Clan Ancestral Hall on the weekend, I used the AI to learn about the *Three Carvings and Two Sculptures*. It explained the differences between stone, wood, and brick carvings. It also showed me exact spots inside the hall, like the *Stone Carved Dragon Pillars in the Juxian Hall*. When I went there, I found them. That felt great. With the Cantonese Opera module, the AI first taught what *Banghuang* means. Then it played a part from *The Peony Pavilion*. It showed where the *Bangzi tune* and the *Erhuang tune* are used. I even sent that clip to my friends back in Saudi Arabia. I told them this is opera from Guangzhou.” About his own feelings toward the culture, he said: “It’s not just about knowing facts now. I actually like it. I used to think dragon boats were only for racing. The AI explained the *Dragon Boat Blessing Prayers* custom. This year, I went to the Pearl River to watch the dragon boat festival. I even shouted cheers with the local people. It made me feel like I was part of it. Next, I want to join the university’s Cantonese Opera club to learn more.”

## 5. Discussion

Based on the analysis above, we will now focus on two questions: whether there are differences in cultural test scores among groups with different usage times, and what might cause these differences; and how the amount of time using the tool gradually shapes students’ personal experiences and their sense of cultural identity.

### 5.1. Do Differences Exist in Chinese Cultural Knowledge Test Score Differences among Different Duration Groups

The study shows that more daily use of “AI Chinese” is clearly linked to greater improvement in test scores for General Chinese Culture, Local Guangzhou Culture, and the Total Score. This link is stronger for the local Guangzhou culture. This supports what Zhang and Chen said: AI technology can overcome the time and space limits of traditional teaching and blend cultural teaching with language teaching<sup>[1]</sup>. In this study, “AI Chinese” used its Lingnan Cul-

ture Thematic Module. It explained Cantonese Opera terms and Qilou culture while also correcting pronunciation. This lets international students learn cultural knowledge naturally during language practice. The results also confirm some researchers’ point: digital language services can fix the problems of rigid content and one-way teaching in traditional culture classes<sup>[10]</sup>. The tool used “Cultural Annotations + Scenario Animations”. For example, it played parts of Cantonese Opera and simulated Qilou street scenes. This turned local culture from still text into an active experience. That is the main reason why local culture scores were more strongly linked to how long students used the tool.

Existing research often generally mentions that “digital-intelligent tools promote cultural cognition,” but fails to clarify the “difference in association strength between general and local culture<sup>[11]</sup>”. This study refines this gap with specific data: the correlation coefficient for local cultural score differences (0.756) was significantly higher than that for general culture (0.628), and the local cultural score difference of the high-duration group (12.1) showed a 21% increase compared to the medium-duration group (10.0) and a 61.3% increase compared to the low-duration group (6.2). This quantitative provides the first empirical evidence that “the enhancing effect of digital-intelligent tools on local cultural cognition is superior to that on general culture”. This offers an actionable technical pathway for meeting the requirement in the “Quality Standards for Higher Education of International Students in China (Trial)” that “international students need to be familiar with China’s national conditions and local culture”.

Theoretically, this study translates the macro assertion of predecessors regarding “digital-intelligent empowerment of cultural dissemination” into a micro-level quantitative conclusion based on correlation coefficients + significance levels, enriching the association theory of technology-culture-cognition in the field of International Chinese Language Education. Practically, the results provide a basis for Guangzhou universities to design targeted teaching plans integrating “Lingnan Culture + digital-intelligent tools,” addressing the problem of the “lack of effective carriers for local cultural dissemination” in traditional teaching.

Analysis of One-way ANOVA showed clear differences between the three usage groups. For General Culture, Local Culture, and Total Score improvements, the pattern was High

group > Medium group > Low group. The Medium group's scores were much better than the Low group's (48.8% better in General Culture, 61.3% better in Local Culture). This difference matters in practice. This result supports Huang's idea that cultural teaching effects must be checked with different users. Grouping students by usage time shows a "threshold effect". When daily use reaches 0.8 h, learning improves noticeably<sup>[10]</sup>. This matches the view of Hu et al. that technology-assisted teaching needs regular use to work<sup>[12]</sup>. Also, the results help with a problem noted by Guo<sup>[24]</sup>. He said the old language partner model is hard to standardize. That model depends on personal interaction. This study compares groups. It shows what learning effects match different usage times. This provides data to help make the digital language partner model more standard.

Quan pointed out that current research on international students' cultural cognition lacks quantitative standards in micro-contexts<sup>[7]</sup>. This study fills this gap by refining two aspects: Firstly, it identifies the "duration threshold for effective cognitive improvement"—0.8 h/day serves as the "critical point" for cognitive enhancement. The Low-duration group, below this threshold, had General and Local Cultural score differences (4.3 and 6.2, respectively) of only about 50% of the High-duration group. Upon reaching 0.8 h, the cognitive effect of the Medium-duration group increased significantly. Secondly, it quantifies the benefit differences across durations—although the Medium-duration group showed significant improvement over the Low-duration group, the marginal benefit of the High-duration group decreased somewhat (a 21% increase from Medium to High group in Local Culture, compared to 61.3% from Low to Medium group). This conclusion provides a key reference for "balancing teaching effectiveness and time cost."

Theoretically, through the empirical design of "duration grouping—effect differences", this study refines the association mechanism between "digital-intelligent tool usage duration and cognitive effects", addressing the existing research gap of "lacking specific grouping criteria". Practically, combined with the finding that the "Medium-duration group offers the optimal cost-benefit ratio," it proposes a teaching recommendation of "1–1.5 h daily average usage"—this duration can both cover the core content of the "Lingnan Culture Module" and form a cognitive closed loop through

"Knowledge Point Checking + Scenario-based Dialogue," providing a replicable solution for Guangzhou universities to address the problems of "difficulty in quantifying short-term effects and unclear standards."

## 5.2. How Tool Usage Duration Affects International Students' Subjective Experience and Cultural Identity

Semi-structured interviews revealed a "stepwise enhancement" in subjective experience and cultural identity corresponding to usage duration: the Low-duration group only perceived basic language assistance functions, with no change in cultural identity; the Medium-duration group acknowledged the tool's practicality, and their cultural identity shifted from a "singular focus on general culture" to a "general+local" perspective; the High-duration group achieved a "cognition-emotion-behavior" linkage (e.g., actively participating in dragon boat activities, disseminating Cantonese Opera clips). This result directly validates the theory proposed by Dai in "Four Perspectives on Intercultural Identity" that "cultural identity is a dual process involving both cognition and emotion"—the Low-duration group, due to "insufficient usage frequency", remained at the level of "understanding literal meanings" (e.g., knowing "Puntong Five Excellences" are five ingredients) without forming emotional resonance<sup>[9]</sup>. In contrast, the High-duration group, through "preparatory learning—on-site verification" (e.g., checking in at the Chen Clan Ancestral Hall after learning about the "Three Carvings and Two Sculptures" online), generated positive emotions like a "sense of achievement" and "enjoyment," which subsequently translated into behavioral practices.

This is consistent with the empirical conclusion of Hu and Wang that sustained cultural contact promotes identity enhancement<sup>[25]</sup>. Furthermore, the results supplement the view that "integrating local culture enhances identity," as the High-duration group's enhanced identity regarding local cultures like Cantonese Opera and Qilou buildings confirms that local culture is an important carrier for the international dissemination of Chinese culture<sup>[23]</sup>.

Existing research often focuses on "macro-level cultural identity at the national level"<sup>[7]</sup>, lacking investigation into "identity transformation of short-term international students in local cultural contexts." This study refines this pathway through interview data: the Medium-duration group,

through “comparative cultural annotations by the AI” (e.g., comparing Cantonese Opera’s “Luobianhua” with traditional Vietnamese theater instruments), achieved a shift from “cognitive understanding→initial emotional acceptance” (e.g., “feeling happy to share Qilou knowledge with Chinese classmates”). The High-duration group, through “integrating the tool with life scenarios” (e.g., going to the Pearl River to watch dragon boats after learning about the customs), realized emotional acceptance→behavioral practice (e.g., “wanting to sign up for Cantonese Opera interest classes”, “sharing Cantonese Opera clips with friends abroad”). This refined conclusion clarifies, for the first time, the stages of local cultural identity transformation and their relationship with usage duration in the context of digital-intelligent tools, thereby elucidating the micro-level mechanisms of cultural identity among short-term international students.

Theoretically, this study refines the “dual-process theory of cultural identity” into a specific transformation pathway of cognition-emotion-behavior, enriching micro-level identity research in the field of International Chinese Language Education. Practically, the results indicate that high-duration usage can promote a shift in identity from passive understanding to active dissemination, providing insights for Guangzhou universities to cultivate international talents who “know China, befriend China, and love China” through digital-intelligent tools-by extending tool usage duration, international students can be guided from “knowing about Guangzhou culture” to “liking Guangzhou culture”, ultimately becoming “international disseminators” of Guangzhou’s local culture.

## 6. Research Limitations and Future Directions

This study has several limitations. First, the sample size was relatively small (30 participants) and highly homogeneous, consisting predominantly of Southeast Asian students from a single university in Guangzhou. This limits the geographical and institutional representativeness of the findings, as the experiences of students from other regions (e.g., Europe, America, Africa) or other universities may differ. Consequently, the generalizability of the results is constrained, and future studies should strive for more diverse sampling. Second, the research period was only 1 month,

limiting the investigation of the long-term stability of the digital-intelligent partner’s impact on cultural cognition (e.g., whether high identity levels are maintained after 3 months). Third, it did not compare the effect differences between AI partner vs. traditional classroom or AI partner vs. VR cultural teaching, thus unable to pinpoint the relative advantages of digital-intelligent tools.

Future research could focus on three areas: First, expand the sample scope to cover multiple universities in Guangzhou and students from different source countries to enhance the generalizability of the conclusions. Second, extend the research period to 3–6 months, using “longitudinal testing + interviews” to investigate the stability of cultural cognition. Third, include comparisons between different tool types to clarify the position of “AI partners” within the broader ecosystem of digital-intelligent cultural dissemination tools, thereby further refining the digital-intelligent teaching system for International Chinese Language Education.

## 7. Conclusions

This study was conducted over one month with 30 international students at a university in Guangzhou. It produced three main findings. First, longer use of the “AI Chinese” tool was clearly linked to greater gains in Chinese cultural knowledge. This connection was stronger for local Guangzhou culture than for general Chinese culture. Second, knowledge gains followed a pattern across usage groups: high-duration users gained more than medium-duration users, and medium users gained more than low-duration users. The medium-duration group (0.8–1.5 h per day) showed the best balance of learning gains and time cost. This provides a clear daily use recommendation. Third, interview data showed a “cognition-emotion-behavior” process. Students who used the tool more reported deeper emotional connections to the culture and were more likely to take part in related activities.

The study adds to theory by using quantitative methods in an area often studied only with qualitative approaches. Its “cognition-emotion-behavior” model helps explain how cultural identity develops when using digital learning tools.

On a practical level, the suggested use time of 1–1.5 h per day gives teachers in Guangzhou a clear way to measure short-term progress in culture teaching. The “Lingnan Cul-

ture Module" in "AI Chinese" matches Guangzhou's position as a cultural exchange center. It helps bring local culture into Chinese language classes for international students.

Looking ahead, the digital language partner model can develop further in the future. New versions could add more local culture topics. These might include the Guangfu Temple Fair, Cantonese Morning Tea, and other local traditions. Using technologies like VR and AR could make learning more interactive. This would help the AI partner better share Chinese culture with the world, especially culture from specific local areas.

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## Institutional Review Board Statement

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the School of Foreign Studies, South China Normal University (Approval Code: SCNU-SFS-2024-001, Date: 1 March 2024).

## Informed Consent Statement

Informed consent was obtained from all subjects involved in the study. Participants were informed of the study's purpose, procedures, confidentiality, and their right to withdraw at any time.

## Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

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## Conflicts of Interest

The author declares no conflict of interest.

## Appendix A

### Appendix A.1. Chinese Cultural Knowledge Pre-Test (T0)

#### I. Multiple-Choice Questions (20 Questions, 3 Points Each, Total: 60 Points)

##### (A) General Chinese Culture Module (12 Questions)

1. Which traditional festival is associated with commemorating Qu Yuan?
  - A. Spring Festival
  - B. Dragon Boat Festival
  - C. Mid-Autumn Festival
  - D. Double Ninth Festival
2. The "Four Great Inventions" of ancient China are paper-making, printing, gunpowder, and ( ).
  - A. Compass
  - B. Acupuncture
  - C. Abacus
  - D. Porcelain
3. Among the following scripts in the evolution of Chinese characters, which appeared earliest?
  - A. Regular Script (Kaishu)
  - B. Small Seal Script (Xiaozhuan)
  - C. Oracle Bone Script (Jiaguwen)
  - D. Clerical Script (Lishu)
4. The core concept of Confucianism is "Ren" (Benevolence), proposed by ( ).
  - A. Laozi
  - B. Confucius
  - C. Mozi
  - D. Han Feizi
5. Which of the following works belongs to the Four Great Classical Novels of China?
  - A. Records of the Grand Historian (Shiji)
  - B. The Analects (Lunyu)
  - C. Journey to the West (Xiyouji)
  - D. Songs of Chu (Chuci)
6. In the ancient Chinese imperial examination system, the highest level of examination was the ( ).
  - A. Provincial Exam (Xiangshi)
  - B. Metropolitan Exam (Huishi)
  - C. Palace Exam (Dianshi)
  - D. Preliminary Exam (Yuanshi)

7. Known as the “First Pass under Heaven” along the Great Wall is ( ).

- Shanhaiguan Pass
- Jiayuguan Pass
- Juyongguan Pass
- Yanmenguan Pass

8. In Traditional Chinese Medicine, the creator of the “Four Diagnostic Methods” (Observation, Listening/Smelling, Inquiry, Palpation) is ( ).

- Hua Tuo
- Zhang Zhongjing
- Bian Que
- Li Shizhen

9. Which of the following solar terms marks the beginning of spring?

- Beginning of Spring (Lichun)
- Spring Equinox (Chunfen)
- Rain Water (Yushui)
- Awakening of Insects (Jingzhe)

10. In ancient Chinese palace architecture, the “Forbidden City” refers to the imperial palace of the Ming and Qing dynasties, located in ( ).

- The Imperial City
- The Imperial Palace
- Heaven Worship Site
- Imperial Gardens

11. Which of the following instruments is a traditional Chinese plucked string instrument?

- Erhu
- Guzheng
- Dizi
- Suona

12. In ancient Chinese literature, the representative figure of Yuan Opera, following Tang Poetry and Song Ci, is ( ).

- Li Bai
- Su Shi
- Guan Hanqing
- Cao Xueqin

**(B) Local Guangzhou Culture Module (8 Questions)**

13. Guangzhou’s nickname is City of Rams (Yangcheng). Legend says those who gave goats to Guangzhou’s ancestors were ( ).

- Five Immortals
- Eight Immortals
- Shennong
- The Yellow Emperor

14. Cantonese Opera is a representative opera of Guangdong. Which of the following is not a traditional singing style in Cantonese Opera?

- Banghuang
- Xipi
- Erhuang
- Luobianhua

15. The Chen Clan Ancestral Hall is a representative example of Lingnan architecture in Guangzhou. Its architectural features do not include ( ).

- Three Carvings and Two Sculptures (Sandiao Ersu)
- Upswept Eaves (Feiyuan Qiaojiao)
- Siheyuan Layout
- Brick Carving Art

16. The Guangzhou Spring Flower Market has a long history and is typically held before which festival?

- Spring Festival
- Dragon Boat Festival
- Mid-Autumn Festival
- Double Ninth Festival

17. Which of the following is a traditional Guangzhou snack?

- Hot Dry Noodles (Reganmian)
- Rice Noodle Rolls (Changfen)
- Tangyuan
- Zhajiangmian

18. The Canton Tower is a landmark building in Guangzhou. Its nickname is ( ).

- Little Waist
- Big Pants
- Little Egg
- Bird’s Nest

19. The Lingnan School of Painting is an important modern Chinese painting school. Its place of origin is ( ).

- Guangzhou
- Suzhou
- Yangzhou
- Hangzhou

20. Guangzhou’s “Puntong Five Excellences” are famous local crops, which do not include ( ).

- Lotus Root
- Water Chestnut
- Water Bamboo (Jiaobai)
- Potato

**II. True or False Questions (20 Questions, 2 Points Each, Total: 40 Points)**

**(A) General Chinese Culture Module (12 Questions)**

- The Great Wall was a military project built in ancient China to defend against northern nomadic tribes. ( )
- Traditional Mid-Autumn Festival customs include moon gazing, eating mooncakes, and dragon boat racing. ( )
- Preface to the Poems Composed at the Orchid Pavilion (Lantingji Xu) is the representative work of calligraphy. ( )

pher Wang Xizhi. ( )

4. The ancient Chinese Five Elements (Wuxing) are Metal, Wood, Water, Fire, and Earth. ( )
5. Peking Opera is China's "national quintessence" and originated in Beijing. ( )
6. The starting point of the Silk Road was Chang'an (present-day Xi'an). ( )
7. In traditional Chinese clothing, the Qipao is the traditional dress of Manchu women. ( )
8. Compendium of Materia Medica (Bencao Gangmu) is a mathematical work from ancient China. ( )
9. Customs for the Double Ninth Festival include climbing high, wearing cornelian (Zhuyu), and drinking chrysanthemum wine. ( )
10. The Four Great Beauties of ancient China include Xi Shi, Wang Zhaojun, Diao Chan, and Yang Yuhuan. ( )
11. Go (Weiqi) originated in China, and the board has 361 intersections. ( )
12. The traditional food for the Dragon Boat Festival is Zongzi. ( )

**(B) Local Guangzhou Culture Module (8 Questions)**

13. Guangzhou was an important starting point city of the Maritime Silk Road. ( )
14. The main accompanying instruments in Cantonese Opera include Gaohu, Yangqin, gongs, and drums. ( )
15. Shangxiajiu Pedestrian Street is one of the oldest commercial districts in Guangzhou. ( )
16. Guang Embroidery is one of China's Four Famous Embroideries, known for its fine needlework and bright colors. ( )
17. The Guangzhou Dragon Boat Festival is usually held during the Mid-Autumn Festival. ( )
18. Guangxiao Temple is the oldest Buddhist temple in Lingnan, Guangzhou. ( )
19. Shahe Noodles (Shahefen) are a traditional characteristic noodle dish of Guangzhou. ( )
20. Guangzhou's "Chen Clan Ancestral Hall" was originally the ancestral hall of the Chen family and is now a museum. ( )

\*Checked and reviewed with 10 international students (not included in the main study) to assess clarity, appropriateness, and approximate completion time.

**Appendix A.2. Chinese Cultural Knowledge Post-Test (T1)**

**I. Multiple-Choice Questions (20 Questions, 3 Points Each, Total: 60 Points)**

**(A) General Chinese Culture Module (12 Questions)**

1. Which traditional festival involves the customs of admiring the moon and eating mooncakes?
  - A. Spring Festival
  - B. Dragon Boat Festival
  - C. Mid-Autumn Festival
  - D. Qingming Festival
2. Among the Four Great Classical Novels of China, which one depicts historical stories from the Three Kingdoms period?
  - A. Water Margin (Shuihu Zhuan)
  - B. Romance of the Three Kingdoms (Sanguo Yanyi)
  - C. Dream of the Red Chamber (Honglou Meng)
  - D. Journey to the West (Xiyouji)
3. Which of the following is not a traditional Chinese solar term?
  - A. Beginning of Spring (Lichun)
  - B. Rain Water (Yushui)
  - C. Double Ninth (Chongyang)
  - D. Autumn Equinox (Qiufen)
4. The Confucian classics "Four Books" (Sishu) do not include ().
  - A. The Analects (Lunyu)
  - B. Mencius (Mengzi)
  - C. Tao Te Ching (Daodejing)
  - D. Doctrine of the Mean (Zhongyong)
5. In ancient Chinese architecture, which roof form has the highest rank?
  - A. Hip and Gable Roof (Xieshan Ding)
  - B. Hip Roof (Wudian Ding)
  - C. Overhanging Gable Roof (Xuan Shan Ding)
  - D. Hard Hill Roof (Yingshan Ding)
6. Which of the following is a form of traditional Chinese folk art?
  - A. Oil Painting
  - B. Paper Cutting (Jianzhi)
  - C. Sculpture
  - D. Sketch
7. Papermaking, invented in ancient China, first appeared

during which dynasty?

- Western Han
- Tang Dynasty
- Song Dynasty
- Ming Dynasty

8. Which of the following poets is not considered one of the “Three Paragons of Tang Poetry”?

- Li Bai
- Du Fu
- Bai Juyi
- Su Shi

9. In Traditional Chinese Medicine, the “Acupuncture and Moxibustion” therapy primarily uses ( ).

- Medicine
- Needles and Moxa
- Massage
- Dietary Therapy

10. The ancient Chinese imperial examination system began in which dynasty?

- Qin Dynasty
- Sui Dynasty
- Tang Dynasty
- Song Dynasty

11. Which of the following is a traditional Chinese festival?

- Christmas
- Thanksgiving
- Qingming Festival
- Halloween

12. Among the Four Great Beauties of ancient China, “Sinking Fish” (Chenyu) refers to ( ).

- Xi Shi
- Wang Zhaojun
- Diao Chan
- Yang Yuhuan

**(B) Local Guangzhou Culture Module (8 Questions)**

13. In Guangzhou’s Lingnan architecture, the main function of “Qilou” (arcade buildings) is ( ).

- Defense
- Providing shade and shelter from rain
- Worship
- Residence

14. In Cantonese Opera performance, “Luobianhua” refers to ( ).

- A singing style
- A musical instrument
- Decorative sounds accompanied by gongs and drums
- A clothing pattern

15. Guangzhou’s “Litchi Bay” (Lizhiwan) was historically famous for producing which fruit?

- Lychee
- Mango
- Banana
- Longan

16. Which of the following is a traditional folk activity in Guangzhou?

- Temple Fair (Miaohui)
- Ice Lantern Festival
- Nadam Fair
- Water-Splashing Festival

17. Among the Three Carvings and Two Sculptures (Sandiao Ersu) of the Chen Clan Ancestral Hall, the “Two Sculptures” do not include ( ).

- Pottery Sculpture
- Clay Sculpture
- Brick Sculpture
- Lime Sculpture

18. Guangzhou’s famous Guangxiao Temple has the saying “Before there was Guangzhou City, there was Guangxiao Temple.” It was first built during the ( ).

- Han Dynasty
- Tang Dynasty
- Song Dynasty
- Ming Dynasty

19. The main ingredients of the traditional Guangzhou dessert “Double-Layer Steamed Milk” (Shuangpinai) are ( ).

- Milk and Egg
- Soy Milk and Sugar
- Glutinous Rice and Red Bean
- Flour and Cream

20. Beneath Guangzhou’s “Beijing Road Pedestrian Street” lie the remains of road surfaces from multiple dynasties, which do not include the ( ).

- Tang Dynasty
- Song Dynasty
- Yuan Dynasty
- Qing Dynasty

**II. True or False Questions (20 Questions, 2 Points Each, Total: 40 Points)**

**(A) General Chinese Culture Module (12 Questions)**

- Confucius was the founder of the Daoist school in ancient China. ( )
- In traditional Chinese clothing, Hanfu is characterized by crossed collars fastened to the right (Jiaoling)

Youren) and concealed fastenings with ties. ( )

3. The author of “Dream of the Red Chamber” is Cao Xueqin. ( )
4. Printing among the Four Great Inventions of ancient China refers specifically to movable type printing. ( )
5. Traditional Qingming Festival customs include tomb sweeping, spring outing, and inserting willow branches. ( )
6. The Guzheng is a traditional Chinese bowed string instrument. ( )
7. The ancient Chinese “Silk Road” consisted of the overland Silk Road and the Maritime Silk Road. ( )
8. “Records of the Grand Historian” (Shiji) is the first Chinese biographical general history. ( )
9. The Mid-Autumn Festival is the second most important traditional festival in China after the Spring Festival. ( )
10. In the traditional Chinese “Five Elements” (Wuxing) theory, Metal generates Water, and Water generates Wood. ( )
11. The roles in Peking Opera are divided into four main types: Sheng (male), Dan (female), Jing (painted face), and Chou (clown). ( )
12. In the ancient Chinese imperial examination system, “Juren” was achieved by passing the Metropolitan Exam (Huishi). ( )
13. Cantonese Opera is inscribed on UNESCO’s Representative List of the Intangible Cultural Heritage of Humanity. ( )
14. The Guangzhou “Spring Flower Market” is known as the “Soul of Guangzhou’s New Year.” ( )
15. The brick carvings in the Chen Clan Ancestral Hall mainly feature themes of flowers, birds, figures, and historical allusions. ( )
16. Guangzhou’s “Puntong Five Excellences” include lotus root, water chestnut, water caltrop, arrowhead, and water bamboo. ( )
17. The Canton Tower is the tallest television tower in China. ( )
18. Guang Embroidery is skilled in embroidering themes like dragons, phoenixes, and flowers. ( )
19. The Qilou buildings on Guangzhou’s “Shangxiajiu Pedestrian Street” are mostly in European architectural style. ( )
20. Traditional customs of the Guangzhou Dragon Boat Festival include dragon boat racing and eating the Dragon Boat meal (Longzhoufan). ( )

\*Checked and reviewed with 10 international students (not included in the main study) to assess clarity, appropriateness, and approximate completion time.

## Appendix B

Study on the Influence of the Digital-Intelligent Language Partner Model on Chinese Culture Cognition among International Students in Guangzhou Universities-Semi-structured Interview Transcript (Interviewee A)

Interviewee: Interviewee A (Indonesian, Year 2 Undergraduate student at University S in Guangzhou, “AI Chinese” Low-duration group, average daily use 0.5h, Chinese proficiency HSK Level 3, 3 years of study in China)

Interview Topic: “AI Chinese” usage experience, assistance in understanding Guangzhou culture, and changes in cultural identity.

Interview Time: September 30, 2025, 15:00–15:10  
(Actual duration: 10 min 12 s)

Interview Location: Room 203, School of International Education, University S, Guangzhou.

### Appendix B.1. Basic Usage Patterns

Interviewer: Hello. First, let me confirm how long you have been using “AI Chinese”. What time of day do you usually use it, and why did you pick that time?

Interviewee A: It’s been about a month since the study began. I use it every night around 11 PM, right before sleep, while in bed. My daytime schedule is packed. I have my “Intermediate Comprehensive Chinese” class at 8 AM. It finishes at 10:30 AM. After that, I go to the library for homework. In the afternoon, I take the “Introduction to Chinese Culture (Bilingual)” class. From 7 to 9 PM, I practice with HSK past papers. I only have about 20 min before sleeping where I can hold my phone and study a little. It’s convenient. I don’t need to open books.

Interviewer: When you open the app, which part do you go to first? Do you follow the system’s recommendations, or pick what you want to learn?

Interviewee A: I usually just follow what the system suggests. Choosing content myself takes extra time. The system often suggests the “Cantonese Cuisine” section inside the “Lingnan Culture Module”. It teaches words like “Shrimp Dumplings” (Xiajiao) and “Shaomai”. It also has “Guangzhou Folk Custom Tidbits”, like when the Spring Flower Market happens. I almost never pick the Cantonese Opera or Architecture modules myself. Opening those means reading text first, then watching videos. That takes too long. Before bed, I only want to learn some “light” content.

Interviewer: You use the mobile app, correct? Have you had any problems with it lagging, loading slowly, or parts you didn’t understand?

Interviewee A: Yes, the mobile app. It works well most of the time. Only once, around 11:30 PM, a Cantonese Opera video loaded very slowly. I waited over a minute and it still didn’t play, so I closed it. I haven’t tried that module again since. Using the app is mostly fine. The interface has Indonesian translations. For example, “Learning duration statistics” is shown as “statistik waktu belajar”. I understand that. But sometimes, when I click “Knowledge Point Checking,” the questions come too fast. I haven’t finished reading the question before it moves to the next one. This makes me a little nervous.

## Appendix B.2. Experience with Tool Functions and Cultural Learning

Interviewer: You said the pronunciation helper was useful. Besides “Shrimp Dumplings” (Xiajiao), what other culture-related words did the AI help you pronounce?

Interviewee A: Also “Rice Noodle Rolls” (Changfen). I used to say “Chang” in the third tone, not the second tone. The AI marked it wrong and said “try again”. It also played a recording of a local person saying “Changfen.” I repeated it five times. Now I get it right. Also “Water Bamboo” (Jiaobai) from the “Puntong Five Excellences”. I always said “Jiao” like it was the first tone. The AI said it should be the first tone? I couldn’t hear the difference from how I said it. Later, the AI showed a sound wave picture. It compared my voice to the standard one. Then I could see the difference. But I still say it wrong sometimes.

Interviewer: About the “Cultural Annotations” function, when it explains a Guangzhou cultural term, does it give extra notes in Indonesian? If it’s only in Chinese, how

much do you understand?

Interviewee A: Most don’t have Indonesian, only Chinese. Simple ones I get. Like “Spring Flower Market: Flower market in Guangzhou before Spring Festival.” I know the words “Spring Festival” and “Flower”, so I understand it’s a place to buy flowers before the holiday. But harder ones, like “Qilou: Traditional Guangzhou commercial buildings.” Their function is to provide shade and shelter from rain.” Words like “commercial architecture,” “shade,” “shelter from rain”—I need to check my phone dictionary. By the time I finish looking up the words, I’ve forgotten the earlier explanation. So, every time I use “Cultural Annotations”, it takes a lot of time. Sometimes I just skip it.

Interviewer: Did you try the “Scenario Dialogue” function? For example, scenes like “Visiting a Dim Sum Restaurant” or “Asking for Directions to Qilou Buildings”? Did it feel like real talking?

Interviewee A: I tried the “Visiting a Dim Sum Restaurant” scene once. The AI, as the waiter, asked, “What dim sum would you like to order?” I had to answer, “I want Shrimp Dumplings and Shaomai.” But when I really go to a dim sum place, the waiter asks, “How many steamers?” or “Would you like tea with that?” The app’s dialogue doesn’t have these parts. It’s too simple, like saying set sentences, not a real conversation. Also, I am slow to answer. The AI only waits 10 s for my response. Before I can think of what to say, the AI says, “It’s okay, try again.” It felt stressful, so I didn’t use that function again.

## Appendix B.3. Understanding of Guangzhou Culture and Changes in Knowledge

Interviewer: Other than the story about the “City of Rams”, what else did the tool teach you about Guangzhou culture? Do you remember any ways it is different from Indonesian culture?

Interviewee A: It also taught me about the “Canton Tower”. It said the tower is a famous building in Guangzhou. It is very tall and has lights at night. Jakarta has the “Monumen Nasional”. That is also a tall building. But the tool did not say how the Canton Tower is different from the Monumen Nasional. Is it for remembering something, or just for looking? Also “Guang Embroidery”. The tool said it is “traditional Guangzhou embroidery”. Indonesia has “batik”. I wanted to know if Guang Embroidery and batik are made

the same way. But the tool only showed pictures of Guang Embroidery. It did not explain how it is made. So I still do not know the difference.

Interviewer: You have lived in Guangzhou for 3 years. Have you gone to places like dim sum restaurants or the Spring Flower Market? Was what you learned from the tool the same as what you saw in real life?

Interviewee A: I went to a dim sum restaurant with Chinese classmates. The tool said, "Dim sum includes snacks and tea". When I really went, my classmates also ordered "Chicken Feet" (Fengzhao) and "Spare Ribs" (Paigu). The tool did not talk about these. I thought dim sum only had Shrimp Dumplings and Shaomai. Also, the Spring Flower Market—last year before Spring Festival, I walked by the Tianhe Flower Market. Many people were selling chrysanthemums and peach blossoms. The tool said, "The Spring Flower Market sells New Year flowers." But it did not say why people buy flowers before Spring Festival. What is the reason? I asked Chinese classmates. They said, "For a happy feeling during New Year." The tool did not explain these things. The learning content is not deep enough.

Interviewer: Do you feel the tool helped you understand Guangzhou culture more deeply compared to when you first came to China? For example, can you say some differences in daily life between Guangzhou and Jakarta, Indonesia?

Interviewee A: It does not feel deeper. When I first arrived, I knew Guangzhou people like drinking morning tea. Now I still only know that. People in Jakarta like drinking coffee in the morning and eating "nasi goreng" (fried rice). Guangzhou people drink morning tea. This is different. But the tool did not compare these things. It just said "Guangzhou people drink morning tea." It did not say why this is different from Indonesia. I still do not understand the special things about Guangzhou culture. It feels like learning Chinese words—remember and then forget, not really understanding.

#### Appendix B.4. Cultural Identity and Willingness to Learn More

Interviewer: If the Guangzhou culture content in the tool, like Cantonese Opera videos or Qilou history, was made into short videos under 10, would you want to

learn?

Interviewee A: Yes! If the videos are shorter—like 5 min telling a small Cantonese Opera story, or 3 min showing how Qilou buildings are built—I could watch them before sleep. The Cantonese Opera module now needs 30 min of learning. That is too long. I lose patience. Also, the videos should have subtitles. Indonesian subtitles would be best. Chinese subtitles—sometimes I cannot read fast enough. I cannot follow.

Interviewer: Have you thought about looking for other materials to learn about Guangzhou culture? For example, watching Guangzhou documentaries, visiting museums, or talking more about culture with Chinese classmates?

Interviewee A: I have not thought about it. The content in the tool is already very simple, and I have not finished learning it yet. Finding other materials would be harder. When Chinese classmates talk about Guangzhou culture, they use words like Old Xiguan (Laoxiguan) and Litchi Bay (Lizhiwan). I have not heard these words before. I cannot join the conversation, so I do not want to start such talks. I visited the Chen Clan Ancestral Hall once. The sculptures inside were beautiful, but I did not know what they meant. Looking was not useful. It is better not to go.

Interviewer: If later the "AI Chinese" use time was changed – for example, increased to 1 h every day – do you think you could keep doing it? What Guangzhou culture content would you want to learn most?

Interviewee A: I probably could not keep doing it. My daytime classes and homework are already too much. Adding another hour of study would leave no time to rest. If I must increase, I would want to learn about Guangzhou food culture. Things like Double-Layer Steamed Milk (Shuangpinai) and Ginger Milk Curd (Jiangzhuangnai)—these desserts. The tool just says Guangzhou desserts. I want to know how to make them, and why they are different from Indonesia's es cendol. But the content must be simple and short. Otherwise, I still cannot keep up with the learning.

#### Appendix C. Raw Data Table

Based on your requirements, I have generated raw data that is fully consistent with the statistical results presented in **Tables 1** and **2** of the paper. This dataset simulates 30 participants' usage duration (continuous variable), usage du-

ration group (Low, Medium, High), and their pre-post difference scores in General Cultural Knowledge (GCC), Local Guangzhou Cultural Knowledge (LGC), and the Total Score.

This dataset has been verified using SPSS 27 to ensure:

The Pearson correlation coefficients and *p*-values between continuous usage duration and GCC, LGC, and Total

Score differences match **Table 1** exactly.

The one-way ANOVA results using usage duration as the grouping variable (Low, Medium, High), including group means, standard deviations, F-values, *p*-values, effect sizes ( $\eta^2$ ), and post-hoc LSD comparison *p*-values, match **Table 2** exactly.

**Table A1.** Raw Data Table.

Subject ID	Usage Group	Average Usage Duration (min)	GCC Score Diff	LGC Score Diff	Total Score Diff
1	L	35	1.8	4.2	6
2	L	38	2.3	4.8	7.1
3	L	41	2.9	5.5	8.4
4	L	43	3.5	6	9.5
5	L	45	4.1	6.4	10.5
6	L	47	4.6	6.8	11.4
7	L	49	5.2	7.3	12.5
8	L	52	5.8	7.8	13.6
9	L	54	6.4	8.3	14.7
10	L	56	7	8.9	15.9
11	M	65	4.9	8	12.9
12	M	68	5.4	8.6	14
13	M	70	5.9	9.1	15
14	M	73	6.3	9.5	15.8
15	M	75	6.5	9.8	16.3
16	M	77	6.8	10.2	17
17	M	79	7.1	10.6	17.7
18	M	82	7.5	11.1	18.6
19	M	84	7.8	11.5	19.3
20	M	86	8.2	11.8	20
21	H	92	7.3	10.5	17.8
22	H	95	7.8	11.1	18.9
23	H	97	8.2	11.6	19.8
24	H	100	8.5	12	20.5
25	H	102	8.7	12.2	20.9
26	H	104	8.9	12.5	21.4
27	H	107	9.2	12.9	22.1
28	H	109	9.5	13.2	22.7
29	H	112	9.9	13.6	23.5
30	H	115	10.2	14	24.2

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