Teaching Chinese characters to first and second graders during the first covid-19 school closure in China: an observational study

Ziyu Zhou[1,3] · Steve Graham[2] · Tien Ping Hsiang[1]

Abstract

The COVID-19 pandemic disrupted education around the world, resulting in the implementation of different forms of remote instruction. The present study provided a description of one interesting and unique approach to providing such instruction by analyzing 144 language arts lessons designed and implemented by 61 distinguished and experienced teachers in Xiangzhou, China. The lessons were used to teach first and second grade students the pronunciation, meaning, recognition, and writing of simplified Chinese characters. These lessons provide a possible model for teaching Chinese characters in the future. The 144 lessons were delivered synchronously through live video interactions with two to four students, while other students were able to access them simultaneously at home via an internet device or on TV (the lessons were accessed 2.1 million times). Lessons were taught four to seven times a week, and teachers devoted 58% of lesson time to teaching characters: 69% and 46% of lesson time was spent teaching characters in grades one and two, respectively. A large number of recommended behaviors for teaching characters (77 out of 80 behaviors assessed) were applied across the 144 lessons, but a relatively small number of teaching behaviors (14) were used in each lesson. This typically included two behaviors for teaching character recognition and four behaviors each for teaching pronunciation, meaning, and writing of characters. Congruently, 6.32, 5.83, 5.49, and 3.78 min per lessons were used to teach character pronunciation, writing, meaning, and recognition, respectively. Character instruction in these lessons was coherently and logically designed, but all live interactions between teachers and students were teacher directed. Directions for future research are presented and implications for practice discussed.

✉ Steve Graham
steve.graham@asu.edu

1   Faculty of Education, University of Macau, Macao, China

2   Mary Lou Fulton College of Education, Arizona State University, Tempe, AZ, USA

3   Lecong First Experimental School, Foshan City, Guangdong Province, China

A new virus, SARS-CoV-2, was identified by medical researchers at the end of 2019. This highly contagious and frequently lethal virus spread quickly around the world, impacting virtually all aspects of daily life (Reimers, 2022). To slow the spread of the virus and protect its citizens, countries implemented a variety of preventive mechanisms in the Spring of 2020, including quarantines, mask mandates, handwashing recommendations, and social distancing (Esposito et al., 2021). Another strategy that was applied broadly was moving in-person learning at schools to remotely delivered instruction (e.g., online, radio, television) or providing some combination of remote and in class instruction (Hodges et al., 2020). Most countries implemented this strategy of emergency remote instruction in March or April of 2020 (UNESCO, 2020).

The sudden cancellation of in-person instruction in schools presented an extraordinary educational challenge. The move to emergency remote instruction provided a mechanism for ensuring students were still educated (Di Pietro et al., 2020), but many educators expressed concerns about the effects of this sudden transition on both teaching and student learning (e.g., Daniel, 2020). As schools around the globe moved from in-person to emergency remote instruction in 2020, evidence began to accumulate that students spent less time learning and received poorer instruction than they did before the COVID-19 pandemic began (e.g., Blikstad-Balas et al., 2022; Crosson & Silverman, 2022; Di Pietro et al., 2020; Huber et al., 2020). The effects of school closures were also evident in students' academic achievement. A meta-analysis by Hammerstein et al. (2021) found a median drop of -0.10 standard deviations for mathematics and -0.09 for reading before and after remote instruction was implemented in the Spring of 2020.

The emergency remote instruction students received during the school closures of 2020 differed across and within countries (UNESCO, 2020). For example, in China where the current investigation took place, school districts enacted multiple forms of what was referred to as "Postponement of School without Suspension of Learning" between February and August of that year (Ministry of Education, 2020). In Beijing, Shanghai and Xi'an, local education agencies organized teachers to record online lessons in advance, which were then delivered asynchronously to students at regular intervals (e.g., Zhu et al., 2020). In other places in China, real-time online interactive instruction was provided to students (Guangzhou Tiyudong Education Group, 2020), whereas in other locales like Macao, China teachers provided both asynchronous online learning lessons as well as real-time online instruction via audio and/or video (Hsiang et al., 2022).

Study purpose

While emergency remote instruction took many forms during the Spring of 2020, we currently know very little about how asynchronous, real-time, or other types of lessons were taught to students during this period in China or elsewhere. It is

important that we gain a better understanding of how students were taught during the lockdowns that occurred as a result of COVID-19 so that we can be better prepared to address such school disruptions now and in the future. This can provide us with information about the range of possibilities for addressing sudden lockdowns that occur as a result of pandemics or other catastrophes, providing insights into what learning outcomes are privileged in such situations and how critical skills are taught to students.

The present study addressed these issues, at least in part, by analyzing 144 Chinese language arts lessons developed and delivered by grade one and two teachers in the Xiangzhou School District, Zhuhai City, Guangdong Province from February 17 to May 15, 2020 (13 weeks). The approach applied by this school district was both interesting and unique. We focused specifically on how these teachers taught the pronunciation, meaning, recognition, and writing of simplified Chinese characters. Unlike the asynchronous recorded teaching lessons commonly used in other parts of China, the Xiangzhou School District used synchronous live teaching. During each lesson, two to four students were taught a Chinese language arts lesson through a live video interaction, while other students were able to watch the lesson simultaneously at home via an internet device or on TV.

An added benefit of analyzing these 144 lessons was that they were taught by experienced and distinguished teachers. Distinguished teachers were considered to be especially effective and this was recognized by awarding them honorary titles as "Subject Leaders" or "Famous Teachers". Only 5% and 1% of all teachers, respectively, can be awarded these honorary titles. The 61 teachers who developed and delivered these lessons had at least five years teaching experience, held a Bachelor's or Master's degree, were qualified to work as a head teacher, evidenced proficient knowledge of principles and methods for teaching Chinese language arts, and were judged to be effective instructors. Additionally, all 144 lessons were subjected to a strenuous peer review process to ensure they were efficient and effective. This included self-evaluation and review by the teacher who constructed the lesson, a second review and revision by a team of teachers from the teacher's school, an additional review and revision by the leader of this team of teachers, and a review and any needed revisions by the subject-area leader in the School District office.

Analyzing these lessons to determine how Chinese characters were taught was advantageous for four reasons. First, we are aware of only one study (Hsiang et al., 2022) that examined the teaching of Chinese characters by primary grade teachers during the COVID-19 pandemic. Hsiang et al. (2022) surveyed 313 grade one to three teachers in Macao about how they taught the pronunciation, meaning, recognition, and writing of traditional Chinese characters during emergency remote instruction in the Spring of 2020. Almost three-quarters of the teachers indicated they applied a variety of instructional strategies to teach Chinese characters during this period, but they only taught a lesson about Chinese characters once every three to four weeks. Even so, the teachers indicated they devoted 97 min of time each week teaching characters. This inconsistency in number of reported lessons and reported instructional time may be a consequence of methodology. Teachers may have interpreted survey items about time spent teaching each week as time spent teaching when they offered a lesson. The current study

avoids the potential subjectivity of self-report data by directly observing and coding teaching behaviors and teacher/student interactions when Chinese characters were taught during each lesson.

Second, the Chinese writing system is complex. There are about 6400 characters in modern Chinese (Hsiang et al., 2021), and students in the elementary grades in Mainland China are expected to learn to read about 3000 characters and write 2500 simplified characters (Ministry of Education, 2022). Chinese is also a complex logographic and morpho-syllabic writing system. A character can represent a word or meaning element that can be used to construct multi-syllabic words (Tse et al., 2007). Individual characters are constructed with strokes, but can include components (cluster of strokes that form radicals) and shape. Most Chinese words are made of two or more characters. These characters include horizontal, vertical, and enclosure structures (Wang & Leland, 2011). A small difference in the position of a stroke can change the meanings of a character. The recognition, meaning, and construction of Chinese characters is further complicated by a large number of homophones and polyphones (Kong, 2020). Consequently, it is critical that young children learning to read and write Chinese are provided with sufficient opportunities and quality instruction when learning these skills. The present study provided a window into how the pronunciation, meaning, recognition, and writing of Chinese characters were taught by experienced and distinguished teachers. The instruction of such teachers can provide a possible blueprint for teaching Chinese characters not just during the pandemic but during typical in-school instruction as well.

Third, additional pandemics and the need for emergency remote instruction are likely in the future. In fact, school closures and shifts to online or hybrid instruction still occur as a result of the COVID-19 pandemic (Skar et al., 2022). As a result, it is important to study how schools responded to the educational challenges of this pandemic in order to better prepare for the next one, including examining how Chinese characters were taught online by distinguished and experienced teachers whose lessons were evaluated and vetted as was done in Xiangzhou. The study of how these teachers taught Chinese characters can also provide important insights into teaching Chinese characters more generally because it makes visible the instructional procedures skilled and effective teachers apply when teaching these skills.

Fourth, this is not the first study to examine how Chinese characters are taught to primary students on mainland China. Even so, studies examining such instruction several years prior to the pandemic did not apply an objective and systematic tool for describing such instruction. Instead, they applied qualitative methods to describe the teaching of Chinese characters in a relatively small number of selected classrooms (Hsiang, 2021). This is the first study to our knowledge to apply a detailed observational tool to objectively determine how Chinese characters are taught to young children across a relatively large number of teachers and lessons. The development of such a scale was not only needed to examine how Chinese characters were taught during emergency remote instruction, but its development provides a tool for examining the teaching of Chinese characters during regular in-school instruction as well. While we would have preferred to compare the findings from this study with prior observational studies conducted several years before the COVID-19 pandemic, this was not possible. Thus, the current study describes an innovative approach for

teaching Chinese characters during emergency remote instruction and describes the teaching behaviors the 61 teachers applied to implement their lesson plans.

Research questions and predictions

This study examined how the experienced and distinguished grade one and two teachers in Xiangzhou taught the 144 Chinese language arts lessons they designed and delivered during emergency remote instruction in the Spring of 2020. It examined their teaching behaviors for the following research questions:

1. What was the average amount of time spent teaching Chinese characters? (RQ1)
2. What was the average amount of time spent teaching the pronunciation, meaning, recognition, and writing of Chinese characters? (RQ2)
3. What teaching behaviors were applied when teaching Chinese character pronunciation, meaning, recognition, and writing and how much time was devoted to their use? (RQ3)
4. What types of classroom interactions occurred when Chinese characters were taught and how much time was devoted to these interactions? (RQ4)
5. What were the characteristics of common approaches used to teach the pronunciation, meaning, recognition, and writing of Chinese characters? (RQ5)

The current study provided a window into an interesting and unique approach to teaching Chinese characters during emergency remote instruction. The resulting description of how Chinese characters were taught using this approach has the added benefit of providing potentially useful insights into teaching these skills during subsequent lockdowns and more generally because experienced and distinguished teachers developed and delivered this instruction. It is important to keep in mind that the study is descriptive, and we cannot make claims about whether the instruction observed here was better than instruction delivered before the COVID-19 pandemic.

The decision to focus on how the pronunciation, meaning, recognition, and writing of Chinese characters were taught in the assembled 144 lessons was based on theoretical models of reading and writing. A common assumption in theoretical models of reading (Coltheart et al., 2001; Perfetti et al., 2005; Plaut et al., 1996), is that learning new words involves acquiring information about their pronunciation, meaning, and orthography. These three constituents are also important when composing text (Graham, 2018), but writing involves an additional constituent: learning how to write letters (or characters in Chinese). As a result, our analyses examined how teachers taught character pronunciation, meaning, and orthography, with orthography divided into two skills, character recognition and writing (see Xu, 2012).

We anticipated that the teachers who constructed the 144 lessons would devote considerable time (or opportunities to learn) to teaching Chinese characters (RQ1). During the school closure in 2020, it was expected that first and second grade

teachers in Xiangzhou would teach Chinese language arts four to seven times a week. Given the complexity of Chinese characters and the large number of characters students are expected to learn each year (Hsiang et al., 2021), we predicted teachers would devote a considerable proportion of each lesson to teaching characters (one-third to one-half of the lesson). Because the pronunciation, meaning and orthography of Chinese characters are connected (Liu et al., 2003; Shu et al., 1995), we predicted teachers would spend similar amounts of time teaching each of these types of knowledge (RQ2).

In analyzing how Chinese characters were taught in the 144 lessons, we examined the use and duration of 80 different teaching behaviors (RQ3). These were commonly recommended practices for teaching Chinese characters (Dai, 1999; Dong, 2015; Hsiang et al., 2022; Hu & Zhou, 2020; Jiang, 2018; Liu, 2014; Pan, 2012; Shen & Zhao, 2015; Xu, 2012), and their application in the analyzed lessons provided one indication of lesson quality. We predicted that teachers would apply a variety of these teaching behaviors when teaching character pronunciation, meaning, recognition, and writing, but that a relatively small number of teaching behaviors would consistently be used to teach each of these different types of knowledge. This prediction was consistent with other studies examining the teaching of Chinese characters (e.g., Hsiang et al., 2021, 2022) as well as studies examining the teaching of literacy skills more broadly (e.g., Graham, 2019).

We predicted that the interactions observed in the 144 lessons would mostly be teacher directed (RQ4). The lessons were delivered via a live video interaction to two to four students in a synchronous manner. While it was possible for the students participating in live lessons to interact with each other, they were not physically in the same space. This likely limited the amount of interaction that took place among students. Additionally, the teacher was unable to directly interact with students at home learning in front of a screen, and these students had no means of interacting with each other. This may have further limited teachers use of student to student interactions in lessons because it was not possible for all students to engage in such behaviors.

In terms of common approaches teachers used to teach the pronunciation, meaning, recognition, and writing of Chinese characters (RQ5), we anticipated that teachers would use a coherent and logical approach to teaching these different forms of knowledge (providing another indication of instructional quality). The 144 lessons were designed and delivered by experienced and distinguished teachers who would likely provide such instruction.

Methods

Teachers

The setting for this investigation was the Xiangzhou district in mainland China. This district includes 84 primary and secondary schools. These schools served 133,473 students (District Statistics Bureau of Xiangzhou, Zhuhai, 2020). The lessons evaluated in this study were created and delivered by 61 teachers in 33 public primary

schools in Xiangzhou School District. Fifty-four of these teachers were female (89%). Thirty of the teachers taught grade one (49%); the remaining teachers taught grade two (51%).

The 61 teachers (all the grade 1 and grade 2 Chinese teachers) were part of a larger sample of about 300 teachers (all teachers of various grades and subjects) selected by the Xiangzhou School District. These teachers were tasked with designing and delivering live online lessons during emergency remote instruction. The lessons covered all subject areas. The 300 teachers were chosen from the approximately 12,000 teachers in the Xiangzhou School District (District Statistics Bureau of Xiangzhou, Zhuhai, 2020). All 300 of these teachers had taught for at least five years, and each had obtained an evaluation as a Second-Grade teacher (Zhuhai Evening News, 2020; Zhuhai Government, 2007). This Grade designation indicated the teacher had a Master's or Bachelor's degree and they were: (1) qualified to work as a head teacher, (2) proficient in their knowledge of principles and methods for teaching, (3) and effective teachers. A Second-Grade designation was higher than a Third-Grade designation (i.e., junior college degree, basic knowledge of teaching principles and methods, and ability to teach and guide students), but lower than a First-Grade designation (i.e., Doctoral or Master's degree, solid knowledge of principles and methods for teaching, effective teacher, and achievements in guiding and training Third-Grade designated teachers; Ministry of Human Resources and Social Security & Ministry of Education, 2015). Forty-three of the 300 teachers had the honorary title of Subject Leader (only 5% of teachers can be elected to this title), and 28 had the honorary title of Famous Teachers (only 1% of teachers can be elected to this title; Xiangzhou Government, 2006; Zhuhai Evening News, 2020). We were not able to determine if any of the 61 teachers who developed and delivered online Chinese language arts lessons for grades 1 and 2 were a Subject Leader or Famous Teacher.

Lessons: design and delivery

In the Xiangzhou district of China, emergency remote instruction was initiated for the first time in the Spring of 2020. This occurred for a total of 13 weeks (February 17 to May 15, 2020). To facilitate the teaching of Chinese language arts in grades one and two during this time, 144 lessons were designed and taught on-line (72 lessons for each grade). These lessons were designed by the 61 teachers described above, with each teacher preparing at least one lesson but no more than six lessons. The 144 lessons were used to teach Chinese language arts instruction to grade one and two students in the Xiangzhou School District. They were also the source for the observations conducted in this investigation.

In designing the lessons, teachers were directed to devote the first 12 lessons at each grade level to reviewing and consolidating knowledge that had been taught to students before emergency remote instruction was implemented. In the remaining 60 lessons at each grade level, new material was taught, but six of these 60 lessons were devoted to reviewing material presented in prior lessons. Each lesson was designed so that it was connected to the previous lesson, whether or not these two lessons were taught by the same teachers. Teachers were directed to base their lessons on the Chinese language arts textbook used by all first and second grade teachers in the

District as well as mainland China. This served to facilitate the process of coordinating and connecting the 72 lessons at each grade level. In the grade one textbook, recognition and writing instruction was provided for 293 and 159 characters, respectively. In the grade two textbook, recognition and writing instruction was provided for 346 and 202 characters, respectively (Ministry of Education, 2016a, 2016b). The characters taught in the 144 lessons involved simplified Chinese characters.

In order to ensure that each of the developed lessons were efficient and of high quality, a four-step review process was implemented. One, the teacher who developed a lesson evaluated it. Two, a team of teachers from the school of the teacher who developed the lesson conducted a second review. Three, the leader of this teacher team conducted an additional review. Four, the subject leader at the District office conducted a final review. Revisions to the lesson were made at each step of this processes as needed (Liu et al., 2020).

When each lesson was delivered online, it involved a teacher and two to four students who participated in the lesson. These students interacted with the teacher in real time by video. And at the same time, other students studying at home could watch the live lessons according to the uniform schedule, but they could not interact with the teacher. The lessons were developed so they could be used with all first and second grade online Chinese language arts classes in the Xiangzhou School District. After a lesson was presented live in the mornings (by the Internet and TV), it was posted the same day on an official website (https://weike.xzjkp.cn/Home/Index/index.html) where it could again be revisited by teachers and students. This website is also the way we aquired these courses. Every afternoon, the Chinese teachers of each class in each school provided guidance, assigned homework and asked students to correct homework by using social media (i.e., Wechat Class Butler/Banjixiaoguanjia) based on the live lessons taught in the morning (Zhuhai Evening News, 2020). The lessons were also available to students from other districts. It was estimated that the lessons in all subject areas were accessed by 2.1 million people (Liu et al., 2020).

At the elementary school level in China, it is recommended that subject area lessons are 40 min in duration (Ministry of Health & Standardization Administration, 2012). For lessons delivered online during emergency remote instruction, the General Office of the Ministry of Education and the General Office of Ministry of Industry and Information Technology (2020) indicated 5 min of every 40-min lesson should include a five-minute break to reduce eyestrain and promote physical well-being.

Observational procedures

Our observational instrument assessed teachers' behaviors during the 144 Chinese language arts lessons. This included coding how often and for how long they engaged in 80 separate behaviors for teaching the pronunciation (i.e., oral reading), meaning, recognition, and writing (i.e., handwriting) of Chinese characters as well as how often and for how long specific teacher-student interactions and student–student interactions occurred.

Teaching behaviors

To develop observation items, we examined the literature to identify common instructional procedures used to teach the pronunciation, meaning, recognition, and writing of Chinese characters. We also viewed all 144 online video lessons four times to determine additional specific instructional activities that might be needed. All told, 80 specific instructional behaviors for teaching Chinese characters were identified (see Table 1). Seventy-seven (96%) of these 80 instructional activities were taken from an earlier survey examining the teaching of Chinese characters (Hsiang et al., 2022) as well as expert recommendations for teaching these skills (Dai, 1999; Dong, 2015; Hu & Zhou, 2020; Jiang, 2018; Liu, 2014; Pan, 2012; Shen & Zhao, 2015; Xu, 2012). The remaining three items were developed through viewing the videos before the start of formal coding. These instructional behaviors were not included in the survey or expert recommendations described above. They included the following three behaviors (see Table 1): (1) "Teachers use recipes to emphasize the key points of handwriting" (w4, i.e., "注意竖提不出头, 右边两横向上斜。一撇长长写舒展, 别忘最后一笔点。" ["Note that the '' is not written out of the head, and the right two '一' upward sloping. The '乀' should be written long and spacious, and don't forget the last '丶'."]) (2) "Students write modern characters based on ancient characters" (w18, i.e., "Do you know all these symbols? There are six mysterious symbols in all. Take out your paper and pencils, guess and write them down.") And (3) "Teachers guide students to memorize the orthography by recalling the pronunciation in the text" (ro7, i.e., [the teacher showed the incomplete sentences in the *Three-Character Classic*: ___之初, 性___善, ___相___, 习___ ___。 ___ ___教, ___ ___迁, ___ ___ ___, 贵___专。] "If you cannot recognize these characters, please recite the entire sentence and think about their positions, and match their pronunciation and orthography."). For all 80 teaching behaviors, we developed a definition, and identified examples and non-examples. These are available from the first author upon request.

Observational levels There were four levels of observation for coding teaching behaviors (see Fig. 1). The first level of observation involved determining if instruction was provided in these 144 Chinese language arts lessons, no matter what the teacher was teaching. Instruction was not provided when the class was taking a break, teacher and students were engaged in eye or physical exercises, (recommended by the district to elevate eye strain during online lessons), or the teacher announced the end of the lesson but the video was still running.

If it was determined that instruction in Chinese language arts lessons was provided at the point of observation, the second level of observation determined if: (1) Chinese character instruction was the focus of teaching or (2) non-Chinese character instruction was the focus of instruction. Chinese character instruction included all teaching behaviors where pronunciation, meaning and orthography (recognition and handwriting) of Chinese characters were taught or practiced. This included the teaching of characters during listening, speaking, reading or writing activities. All other teaching behaviors were coded as non-Chinese character instruction. This included teaching behaviors designed to enhance students'

Table 1 Teaching behaviors applied by grade one and two teachers

Item	Grade 1				Grade 2				Grade 1 & 2				t-test	
	Time	%	M	SD	Time	%	M	SD	Time	%	M	t	df	Sig (2-tailed)
26 teaching behaviors for character pronunciation														
Students read characters (words) aloud without Pinyin (p1)	101.68	18.94	1.40	1.77	96.73	25.52	1.34	2.24	198.42	21.81	1.38	0.155	142.000	.877
Students read a text aloud with Pinyin (py15)	88.37	16.66	1.23	1.61	87.23	23.01	1.21	2.12	175.60	19.30	1.22	0.050	142.000	.960
Students read a text aloud without Pinyin (p2)	82.22	15.27	1.13	1.65	60.90	16.06	0.85	1.75	143.12	15.73	0.99	0.986	142.000	.326
Students read characters (words) aloud with Pinyin (py14)	69.67	13.13	0.97	1.39	59.50	15.69	0.83	1.48	129.17	14.20	0.90	0.590	142.000	.556
Teachers model reading characters (words) aloud (p3)	67.23	12.67	0.93	1.91	30.15	7.95	0.42	0.79	97.38	10.71	0.68	2.111	94.845	.037
Teachers compare polyphones (p9)	56.10	10.57	0.78	3.73	19.58	5.17	0.27	0.68	75.68	8.32	0.53	1.134	142.000	.259
Teachers model reading a text aloud (p4)	47.35	8.93	0.66	1.25	23.15	6.11	0.32	0.78	70.50	7.75	0.49	1.935	119.263	.055
Teachers compare homophones or characters with similar pronunciation (p8)	31.13	5.87	0.43	1.83	30.25	7.98	0.42	2.24	61.38	6.75	0.43	0.036	142.000	.971
Teachers use the phonetic radicals to teach the pronunciation (p6)	35.52	6.69	0.49	1.91	5.75	1.52	0.08	0.42	41.27	4.54	0.29	1.793	77.790	.077
Teachers introduce the words with the light tone (p11)	19.15	3.61	0.27	1.66	2.12	0.56	0.03	0.16	21.27	2.34	0.15	1.203	72.287	.233
Teachers compare polyphones (p9)	19.83	3.74	0.28	1.30	0.00	0.00	0.00	0.00	19.83	2.18	0.14	1.798	71.000	.076
Teachers play the audio of a text to model the pronunciation (p5)	3.52	0.66	0.05	0.25	14.12	3.72	0.20	0.74	17.63	1.94	0.12	−1.597	86.945	.114
Teachers introduce the change of tones (p10)	14.57	2.75	0.20	0.82	1.20	0.32	0.02	0.11	15.77	1.73	0.11	1.905	73.560	.061
Teachers use songs to teach pronunciation (p7)	13.95	2.63	0.19	0.81	0.00	0.00	0.00	0.00	13.95	1.53	0.10	2.030	71.000	.046
Teachers discuss the classification of Pinyin syllables (py8)	13.73	2.59	0.19	1.39	0.00	0.00	0.00	0.00	13.73	1.51	0.10	1.168	71.000	.247
Students spell or read syllables aloud (py5)	9.67	1.82	0.13	1.14	0.00	0.00	0.00	0.00	9.67	1.06	0.07	1.000	71.000	.321
Students read initials or finals aloud (py1)	9.50	1.79	0.13	0.81	0.00	0.00	0.00	0.00	9.50	1.04	0.07	1.383	71.000	.171
Teachers model reading aloud initials and finals (py2)	8.45	1.59	0.12	0.73	0.00	0.00	0.00	0.00	8.45	0.93	0.06	1.364	71.000	.177

Table 1 (continued)

Item	Grade 1				Grade 2				Grade 1 & 2				t-test	
	Time	%	M	SD	Time	%	M	SD	Time	%	M	t	df	Sig (2-tailed)
Teachers compare initials, finals and whole-syllable with similar pronunciation (py3)	4.13	0.78	0.06	0.49	0.00	0.00	0.00	0.00	4.13	0.45	0.03	1.000	71.000	.321
Teachers compare the Pinyin symbols with similar orthography (py10)	3.53	0.67	0.05	0.42	0.00	0.00	0.00	0.00	3.53	0.39	0.02	1.000	71.000	.321
Teacher compile the rules for marking four tones into pithy formula (py4)	3.38	0.64	0.05	0.40	0.00	0.00	0.00	0.00	3.38	0.37	0.02	1.000	71.000	.321
Teacher model spelling or reading Pinyin syllables (py6)	2.93	0.55	0.04	0.25	0.00	0.00	0.00	0.00	2.93	0.32	0.02	1.364	71.000	.177
Teachers use songs to teach pronunciation (py7)	2.43	0.46	0.03	0.29	0.00	0.00	0.00	0.00	2.43	0.27	0.02	1.000	71.000	.321
Teachers use songs to teach the special rules for spelling Pinyin (py13)	1.53	0.29	0.02	0.18	0.00	0.00	0.00	0.00	1.53	0.17	0.01	1.000	71.000	.321
Teachers use pictures to teach the orthography of Pinyin symbols (py11)	1.43	0.27	0.02	0.17	0.00	0.00	0.00	0.00	1.43	0.16	0.01	1.000	71.000	.321
Teachers use songs to teach the orthography of Pinyin symbols (py12)	1.15	0.22	0.02	0.14	0.00	0.00	0.00	0.00	1.15	0.13	0.01	1.000	71.000	.321
22 teaching behaviors for character meaning														
Teachers use the Six Principles Theory of Chinese Script to introduce the meanings (m1)	111.82	23.61	1.55	2.72	60.67	19.17	0.84	1.71	172.48	21.83	1.20	1.876	119.737	.063
Teachers use pictures to explain the meanings (m4)	72.52	15.31	1.01	1.68	58.68	18.55	0.82	1.15	131.20	16.61	0.91	0.801	142.000	.425
Teachers summarize a group of words according to meanings (m2)	49.00	10.35	0.68	2.46	52.53	16.60	0.73	1.84	101.53	12.85	0.71	−0.136	142.000	.892
Teachers explain how to consult a dictionary (m18)	61.38	12.96	0.85	4.76	9.62	3.04	0.13	1.13	71.00	8.99	0.49	1.248	79.041	.216
Teachers explain the meanings by composing words (m13)	38.50	8.13	0.53	1.01	29.42	9.30	0.41	0.77	67.92	8.60	0.47	0.842	142.000	.401
Students use characters to compose words (m19)	42.43	8.48	0.56	0.84	20.15	6.37	0.28	0.85	62.58	7.92	0.43	1.974	142.000	.050

Table 1 (continued)

Item	Grade 1				Grade 2				Grade 1 & 2			t-test		
	Time	%	M	SD	Time	%	M	SD	Time	%	M	t	df	Sig (2-tailed)
Teachers explain the meanings through context (m3)	32.27	6.77	0.45	1.08	28.32	8.95	0.39	0.93	60.58	7.67	0.42	0.309	142.000	.758
Students orally fill in the appropriate words according to the context of written texts (m20)	44.27	9.10	0.60	1.52	11.62	3.67	0.16	0.70	55.88	7.07	0.39	2.215	99.952	.029
Teachers compare synonyms, near-synonyms and antonyms (m16)	20.70	4.37	0.29	1.56	20.50	6.48	0.28	0.95	41.20	5.22	0.29	0.013	142.000	.990
Teacher explains the meanings directly (m9)	26.37	5.57	0.37	0.70	13.45	4.25	0.19	0.42	39.82	5.04	0.28	1.862	116.423	.065
Teachers introduce the part of speech (m17)	24.55	5.18	0.34	1.13	10.20	3.22	0.14	0.49	34.75	4.40	0.24	1.378	96.921	.171
Students use words to make sentences orally (m21)	23.20	4.90	0.32	0.73	10.30	3.25	0.14	0.52	33.50	4.24	0.23	1.696	129.091	.092
Teachers explain the meanings by relating to real life situations (m10)	13.52	2.85	0.19	0.53	11.57	3.66	0.16	0.41	25.08	3.18	0.17	0.343	142.000	.732
Students use several words to make a paragraph orally (m22)	13.45	2.84	0.19	0.94	7.38	2.33	0.10	0.76	20.83	2.64	0.14	0.591	142.000	.556
Teachers use actions or facial expressions to explain the meanings (m6)	6.13	1.29	0.09	0.24	9.38	2.97	0.13	0.53	15.52	1.96	0.11	−0.662	142.000	.509
Teachers use character raddles to explain the meanings (m11)	13.07	2.76	0.18	0.99	0.57	0.18	0.01	0.07	13.63	1.73	0.09	1.478	71.641	.144
Teachers use a video to explain the meanings (m8)	2.93	0.62	0.04	0.24	5.90	1.86	0.08	0.40	8.83	1.12	0.06	−0.748	142.000	.456
Teachers introduce multi-meaning words (m15)	2.00	0.42	0.03	0.24	5.10	1.61	0.07	0.44	7.10	0.90	0.05	-0.738	142.000	.462
Teachers use real objects or models to explain the meanings (m5)	4.52	0.95	0.06	0.39	1.08	0.34	0.02	0.09	5.60	0.71	0.04	0.997	79.087	.322
Teachers explain the meanings by making sentences (m14)	3.52	0.74	0.05	0.21	0.90	0.28	0.01	0.09	4.42	0.56	0.03	1.359	95.573	.177
Teachers use songs to teach meanings (m12)	1.17	0.25	0.02	0.11	0.00	0.00	0.00	0.00	1.17	0.15	0.01	1.306	71.000	.196
Teachers use an audio to explain the meanings (m7)	0.00	0.00	0.00	0.00	0.75	0.24	0.01	0.07	0.75	0.09	0.01	−1.349	71.000	.182

Table 1 (continued)

Item	Grade 1				Grade 2				Grade 1 & 2				t-test	
	Time	%	M	SD	Time	%	M	SD	Time	%	M	t	df	Sig (2-tailed)
14 teaching behaviors for character recognition														
Teachers use the Six Principles Theory of Chinese Script to teach the orthography (ro1)	145.77	39.07	2.02	3.74	52.53	30.77	0.73	1.61	198.30	36.46	1.38	2.701	96.406	.008
Teachers introduce a group of characters by replacing components (ro3)	88.67	23.76	1.23	3.71	37.82	22.15	0.53	1.41	126.48	23.26	0.88	1.510	91.144	.135
Students share their own ways to recognize characters (ro13)	44.43	11.91	0.62	1.04	24.67	14.45	0.34	0.76	69.10	12.71	0.48	1.806	129.828	.073
Teachers introduce characters with similar orthography (ro11)	25.50	6.83	0.35	1.15	33.47	19.60	0.46	2.78	58.97	10.84	0.41	−0.312	142.000	.755
Teachers use character raddles to teach character orthography (ro8)	31.45	8.43	0.44	1.60	3.85	2.26	0.05	0.18	35.30	6.49	0.25	2.016	72.810	.047
Teachers analyse the orthography by reorganizing the components (ro2)	21.83	5.85	0.30	0.89	10.95	6.41	0.15	0.53	32.78	6.03	0.23	1.232	142.000	.220
Teachers use pictures to teach the orthography (ro4)	27.48	7.37	0.38	1.40	2.97	1.74	0.04	0.21	30.45	5.60	0.21	2.042	74.133	.045
Teachers discuss the classification of character structures (ro10)	16.68	4.47	0.23	0.79	11.73	6.87	0.16	0.54	28.42	5.23	0.20	0.611	142.000	.542
Teachers use songs to teach orthography (ro9)	19.57	5.24	0.27	1.18	4.20	2.46	0.06	0.37	23.77	4.37	0.17	1.467	84.646	.146
Teachers guide students to recognize words in their lives (ro12)	18.38	4.93	0.26	0.70	3.45	2.02	0.05	0.28	21.83	4.01	0.15	2.332	92.810	.022
Teachers summarize the methods of word recognition (ro14)	6.38	1.71	0.09	0.22	7.67	4.49	0.11	0.39	14.05	2.58	0.10	−0.339	142.000	.735
Teachers connect the components through imagination (ro6)	4.95	1.33	0.07	0.30	1.58	0.93	0.02	0.14	6.53	1.20	0.05	1.212	100.990	.229
Teachers guide students to memorize the orthography by recalling the pronunciation in the text (ro7)	3.50	0.94	0.05	0.41	0.00	0.00	0.00	0.00	3.50	0.64	0.02	1.000	71.000	.321

Table 1 (continued)

Item	Grade 1				Grade 2				Grade 1 & 2				t-test	
	Time	%	M	SD	Time	%	M	SD	Time	%	M	t	df	Sig (2-tailed)
Teachers use actions to teach the orthography (ro5)	0.87	0.23	0.01	0.06	0.00	0.00	0.00	0.00	0.87	0.16	0.01	1.612	71.000	.112
18 teaching behaviors for writing characters														
Teachers discuss character structures (w2)	212.57	43.19	2.95	2.86	136.55	39.28	1.90	2.00	349.12	41.57	2.42	2.567	127.094	.011
Students trace or copy characters on paper (w8)	151.27	30.74	2.10	2.26	106.30	30.58	1.48	1.75	257.57	30.67	1.79	1.855	133.497	.066
Teachers demonstrate how to write characters stroke by stroke (w6)	34.80	7.07	0.48	4.36	95.90	27.59	1.33	4.82	130.70	15.56	0.91	−1.109	142.000	.269
Teachers lead students to trace characters with fingers (w7)	78.68	15.99	1.09	1.27	46.07	13.25	0.64	0.78	124.75	14.86	0.87	2.584	117.678	.011
Teachers explain the strokes and stroke sequences (w3)	65.90	13.39	0.92	1.31	41.53	11.95	0.58	0.91	107.43	12.79	0.75	1.800	126.284	.074
Teachers evaluate on students' handwriting (w11)	71.87	14.60	1.00	1.33	31.93	9.19	0.44	0.70	103.80	12.36	0.72	3.132	107.329	.002
Teachers show videos or animations to demonstrate how to write (w5)	18.12	3.68	0.25	0.64	26.08	7.50	0.36	0.96	44.20	5.26	0.31	−0.813	142.000	.418
Students write characters according to Pinyin (w14)	7.10	1.44	0.10	0.84	24.95	7.18	0.35	1.22	32.05	3.82	0.22	−1.423	125.805	.157
Teachers use recipes to emphasize the key points of handwriting (w4)	23.52	4.78	0.33	0.65	7.72	2.22	0.11	0.41	31.23	3.72	0.22	2.423	119.805	.017
Teachers teach sitting position for handwriting (w1)	21.65	4.40	0.30	0.49	8.65	2.49	0.12	0.23	30.30	3.61	0.21	2.848	100.161	.005
Students complete dictation exercise (w15)	16.93	3.44	0.24	1.50	0.00	0.00	0.00	0.00	16.93	2.02	0.12	1.330	71.000	.188
Students evaluate each other's handwriting (w13)	3.27	0.66	0.05	0.21	9.00	2.59	0.13	0.48	12.27	1.46	0.09	−1.296	98.551	.198
Students fill in the appropriate characters (words) according to the context of written texts (w16)	2.62	0.53	0.04	0.31	6.95	2.00	0.10	0.82	9.57	1.14	0.07	-0.583	142.000	.561
Students write modern characters based on ancient characters (w18)	9.42	1.91	0.13	0.78	0.00	0.00	0.00	0.00	9.42	1.12	0.07	1.421	71.000	.160
Students use characters (words) to write sentences (w17)	0.00	0.00	0.00	0.00	2.83	0.81	0.04	0.33	2.83	0.34	0.02	−1.000	71.000	.321

Table 1 (continued)

Item	Grade 1				Grade 2				Grade 1 & 2			t-test		
	Time	%	M	SD	Time	%	M	SD	Time	%	M	t	df	Sig (2-tailed)
Students share their experiences in handwriting (w10)	0.00	0.00	0.00	0.00	1.30	0.37	0.02	0.15	1.30	0.15	0.01	−1.000	71.000	.321
Students evaluate on their own handwriting (w12)	1.22	0.25	0.02	0.10	0.00	0.00	0.00	0.00	1.22	0.14	0.01	1.418	71.000	.161
Students identify the most beautifully written Chinese characters (w9)	0.00	0.00	0.00	0.00	1.10	0.32	0.02	0.13	1.10	0.13	0.01	−1.000	71.000	.321

"Time" is the total time spent on each item, in minutes

"%" is the percentage of time each item accounted for the total time each Chinese character skill (e.g., for writing)

"M" is the average of the time spent of each item in 72 lessons in grade one and two respectively, in minutes

*Statistically significant
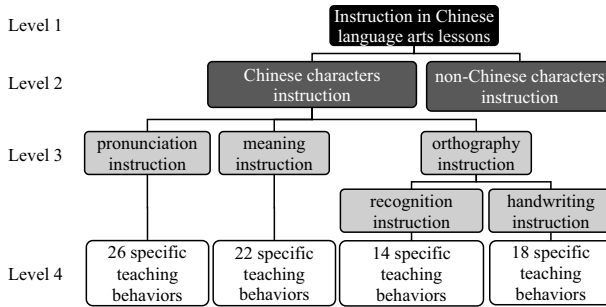
Fig. 1 Observation framework of the content and practices of teaching Chinese characters

listening, speaking, reading and writing skills, but not focused on the pronunciation, meaning and orthography of Chinese characters. It also referred to other activities not related to Chinese language. For example, teachers and students introduce themselves before the formal lesson, and teachers introduce knowledge about COVID-19 prevention.

Any time it was determined that Chinese characters instruction was provided, the third level of observation involved determining if pronunciation, meaning, or orthography of characters were the focus of instruction. The observation of orthography teaching was further subdivided into teaching recognition of characters and the writing of characters.For instance, if teachers said a character aloud, used a film to explain a character's meaning, showed a character and asked students to indicate what it said, or modeled how to write a character, these were scored as pronunciation, meaning, recognition, and handwriting instruction, respectively. Observations at level 3 were not mutually exclusive. This is because Chinese characters are unified in pronunciation, meaning and orthography, which means that a teaching behavior may place emphasis on more than one of these aspects of characters. For example, when teachers analyze the phonetic radical of a phono-semantic compound character (形声字) to indicate character pronunciation and the semantic radical to indicate character meaning, they are involved in teaching the pronunciation, meaning and orthography of the character all at the same time.

Once the focus of teaching Chines characters was established (pronunciation, meaning, recognition, and writing), the fourth level of observation was to determine which of the 80 teaching behaviors (see Table 1) were enacted and for how long. Twenty-six of the teaching behaviors were specific to teaching pronunciation (15 of which involved Pinyin, numbered py1 to py15; the remaining 11 items were numbered p1 to p11). Twenty-two of the teaching behaviors focused on teaching the meaning of characters (numbered m1 to m22). Thirty-two teaching behaviors concentrated specifically on teaching the orthography of characters. Eighteen of the orthographic teaching behaviors concentrated on teaching handwriting (numbered w1 to w18), whereas 14 teaching behaviors were specific to

teaching character recognition (numbered ro1 to ro14). At each level, each observation was recorded as well as its duration in time.

Classroom interactions

To determine the types of interactions that occurred when Chinese character instruction was the focus of teaching (level 3 of teaching behaviors), we adapted procedures designed by Wu (1998) and Cheng et al. (1994). They classified types of social interactions in classroom teaching according to teacher and student interactions and student and student interactions (definition and examples of these interactions are available from the first author). Our observational instrument measuring classroom interactions included nine items (see Fig. 2). Three items assessed teacher interactions with students: teacher-individual student interaction (e.g., teacher directing two or more students, but not all students, to do something), teacher-small group interaction (e.g., teacher directing all participating students to engage in a particular activity), and teacher-class interaction (e.g., teacher directing participating students to engage in a particular activity). Five items assessed student to student interactions: individual-individual interaction (e.g., one student directly commenting to another individual student during the lesson), individual-small group interaction (e.g., a student in a subset of students [two or more] directly commenting to students in this small group), individual-class interaction (e.g., one student directly commenting to all of the students in the lesson as a group), small group-small group interaction (e.g., students in two or more groups commenting to each other), and small group-class interaction (e.g., a small group of students directing their comments to all other students participating in the lesson). A final item indicated there was no teacher or student interactions. Each interaction was recorded as well as its duration in time.

Qualitative data collection and analysis

In addition to coding teaching behaviors and classrooms interactions quantitatively, we examined the 144 lessons to obtain a more holistic picture of how character pronunciation, meaning, recognition, and handwriting were taught. The observer coded,
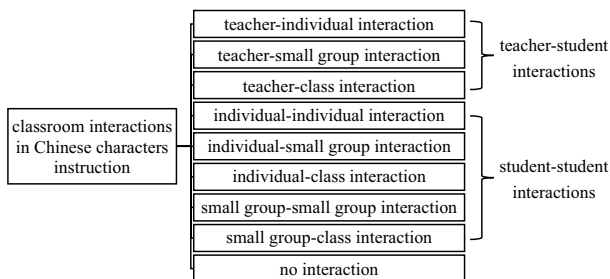

Fig. 2 Observation framework of classroom interactions in Chinese character instruction

categorized, and extracted meaningful and representative teaching clips of such instruction, and provided detailed textual descriptions of them.

Procedures

All 144 lessons were coded. When observing a video, the observer identified the teachers' various teaching behaviors and interactions using the procedures described above, and then recorded the time spent on each teaching behavior or interaction. The video could be rewound as many times as necessary to record teaching behaviors and time.

The following observation principles were followed. One, when counting the time spent on each teachers' teaching behavior, the beginning and ending times were based on the teacher's verbal introduction and summary. For example, if the teacher had completed the verbal summary of a teaching session, but the slide on the screen had not yet been switched, the end time of the teaching behavior would be the point at which the teacher completed the verbal summary. Two, the time spent on each teaching behavior included time students spent following through on the teachers' action. For example, if a teacher asked a question that focused on teaching handwriting, time for that teaching behavior included students' responses. Three, if a teaching behavior involved multiple items (see level 3 and 4 above), the time spent on each teaching behavior was recorded separately. Four, the unit of time recorded was accurate to the second (although we report time in minutes per lesson in this paper).

One observer coded each of the 144 online lessons. A second observer coded a randomly selected 20% of these lessons (14 lessons from grade one and 15 from grade two). Reliability for teaching behaviors was 92%, whereas reliability for classroom interactions was 98%. Any coding difference between the two observers were discussed and resolved.

Results

Time and instructional practices used when teaching chinese characters

Time teaching chinese characters (RQ1)

The average time devoted to instruction in the 144 Chinese language arts lessons coded was 34.20 min. The average amount of time devoted to the 72 grade one Chinese language arts lessons ($M=34.62$; $SD=5.06$) did not differ statistically ($t=1.047$, $df=142$, $p=0.30$) from the average amount of time devoted to the 72 grade two Chinese language arts lessons ($M=33.79$; $SD=4.42$).

On average, 58% of each Chinese language arts lesson was devoted to teaching characters. Characters were taught in all 72 observed grade one lessons, but only 63 (88%) of the grade two lessons. Grade one teachers spent more time teaching Chinese characters ($M=24.01$; $SD=10.12$) than grade two teachers ($M=15.50$; $SD=10.55$), $t=4.938$, $df=142$, $p<0.001$.

Time teaching pronunciation, meaning, and recognition, and writing of characters (RQ2)

When teaching Chinese characters in the 144 online lessons, teachers in grades one and two collectively spent 47% of the time teaching Chinese orthography ($M = 9.28$ min), 32% teaching pronunciation ($M = 6.32$), and 28% teaching meaning ($M = 5.49$). When teaching orthography of Chinese characters, grade one and two teachers collectively spent 63% of their time teaching handwriting ($M = 5.83$), and 41% teaching the recognition of characters ($M = 3.78$).

In comparing how much time first and second grade teachers spent teaching the various aspects of Chinese characters, the Bonferroni correction procedure was applied (Mittlehammer et al., 2000). This method is used to counteract the problem of conducting multiple comparison, controlling for family-wise error rates (i.e., Type 1 errors). With this procedure alpha is divided by the number of comparisons (for time teaching Chinese characters alpha of 0.05 was divided by five comparisons). This approach was applied across the various analyses that were conducted.

Accordingly, first grade teachers spent more time teaching Chinese orthography during each lesson ($M = 11.54$; $SD = 8.30$) than second grade teachers, ($M = 7.01$; $SD = 6.02$), $t = 3.747$, $df = 130$, $p < 0.001$. Grade one teachers spent more time on character recognition in each lesson than grade two teachers (grade one: $M = 5.18$; $SD = 6.25$; grade two: $M = 2.37$; $SD = 4.23$; $t = 3.161$, $df = 125$, $p < 0.001$), but this was not the case when teaching handwriting (grade one: $M = 6.84$; $SD = 6.00$; grade two: $M = 4.83$; $SD = 4.29$). There were no statistically significant differences between grade one and grade two teachers in the amount of time spent teaching pronunciation (grade one: $M = 7.37$; $SD = 6.72$; grade two: $M = 5.27$; $SD = 4.90$) or meaning of Chinese characters (grade one: $M = 6.58$; $SD = 5.98$; grade two: $M = 4.40$; $SD = 5.03$).

Types of teaching behaviors (RQ3)

Common teaching behaviors Teachers applied a variety of teaching behaviors to teach Chinese characters in the 144 lessons (see Table 1), but a small number of these teaching behaviors accounted for a majority of the time devoted to teaching different aspects of Chinese characters. When teaching pronunciation, five of the 26 teaching behaviors accounted for 82% of time teachers spent teaching characters in each lesson. Four of these five teaching behaviors focused on students practicing reading characters and text with and without Pinyin support (p1 [1.38 min]; py15 [1.22 min]; p2 [0.99 min]; py14 [0.90 min]). The fifth teaching behavior involved teachers modeling aloud how to read a character (p3; 0.68 min). These five teaching behaviors could not occur at the same time, allowing us to determine the percentage of time they accounted for when pronunciation was taught or practiced in each lesson.

It was not possible to calculate a collective percentage of time for the most common teaching behaviors for character meaning, recognition, and writing. The most common teaching behaviors for these three types of knowledge could and did overlap (when this was the case, time was calculated for each behavior). For example, when teaching character writing, a teacher could direct students

to trace the character with their finger (w7), while the teachers simultaneously described the stroke sequence (w3). Even so, the most common teaching behavior for teaching character meaning and recognition was the Six Principles Theory of Chinese Script (六书) (m1 and ro1, respectively; Table 1). This approach is described in the Appendix. On average, 22% (1.20 min) and 36% (1.38 min) of the time devoted to character meaning and recognition in each lesson, respectively, involved this approach. For character meaning, only two other teaching behaviors, using pictures to explain the meaning of characters (m4; 0.91 min) and summarizing the meaning of a group of words (m2; 0.71 min), were used for more than one-half a minute per lesson. For character recognition, only one additional teaching behavior met this criterion: teacher introduce a group of characters by replacing components (ro3; 0.88 min). When teaching character writing, teachers applied six teaching behaviors most frequently: discussing character structure (w2; 2.42 min per lesson), students tracing and copying characters on paper (w8; 1.79 min per lesson), teachers demonstrating how to form characters stroke by stroke (w6; 0.91 min per lesson), teacher leading students to trace characters with their fingers (w7; 0.87 min per lesson), teacher explaining strokes and stroke sequence of characters (w3; 0.75 min), and teachers evaluating students' handwriting (w11; 0.72 min).

Teaching behaviors applied per lesson On average, grade one and two teachers used 14 different teaching behaviors when teaching Chinese characters in each of the 144 lessons. Forty-six percent of these behaviors focused on teaching Chinese orthography ($M = 6.51$), with 65% of these behaviors used to teach handwriting and the rest character recognition. Additionally, 28% of the 14 teaching behaviors observed in each lesson concentrated on character meaning ($M = 3.88$), whereas 26% involved character pronunciation ($M = 3.72$).

In comparing how many teaching behaviors grade one and two teachers applied when teaching the various aspects of Chinese characters, alpha was set at 0.01 (i.e., 0.05/5 comparisons). Accordingly, first grade teachers applied more teaching behaviors to teach Chinese orthography during a lesson ($M = 7.50$, $SD = 4.83$) than second grade teachers ($M = 5.51$, $SD = 4.07$), $t = 2.670$, $df = 142$, $p = 0.008$. When orthographic instruction was examined in terms of recognition and handwriting, grade one teachers applied more teaching behaviors to teach character recognition in each lesson ($M = 2.89$, $SD = 2.58$) than grade two teachers ($M = 1.63$, $SD = 1.93$; $t = 3.326$, $df = 132$, $p = 0.001$), but this was not the case for handwriting (grade one: $M = 4.61$, $SD = 3.51$; grade two: $M = 3.89$; $SD = 3.06$). There was also a statistically significant difference in the number of teaching behaviors first grade teachers (applied to teach pronunciation; $M = 4.47$, $SD = 2.55$) when compared to second grade teachers ($M = 2.96$, $SD = 2.33$; $t = 3.715$, $df = 142$, $p < 0.001$), but this was not the case for teaching behaviors for teaching meaning (grade one: $M = 4.38$; $SD = 2.31$; grade two: $M = 3.39$; $SD = 2.66$).

Grade differences by teaching behavior When comparing how much time first and second grade teachers spent on each of the 80 teaching behaviors observed (see

Table 1), alpha was set by dividing the traditional alpha level of 0.05 by the number of instructional practices for teaching each Chinese character skill (e.g., for handwriting 0.05 was divided by 18). As can be seen in Table 1, there were no statistical differences between first and second grade teachers in time spent on pronunciation (alpha = 0.0019), meaning (alpha = 0.0023), and recognition of characters (alpha = 0.0036). For handwriting (alpha = 0.0027), one teaching behavior was applied more often by grade one teachers than grade two teachers. Teachers in grade one evaluated students' handwriting more frequently.

Interactions between teachers and students (RQ4)

Two forms of teacher-student interactions dominated the teaching of Chinese characters. First, 49% of Chinese character instructional time in each lesson involved the teacher interacting with the class (9.67 min across grade one and two teachers combined). Second, another 39% of time spent teaching Chinese characters in each lesson involved the teacher interacting with individual students (7.68 min across grades combined). Slightly less than 2% of instructional time involved student–student interactions, with 1.20% of lesson time involving individual students interacting with the class (0.24 min across grades one and two combined) and another 0.63% of lesson time devoted to an individual student interacting with another student (0.12 min across grades one and two combined). Ten percent of each lesson involved no interaction between teacher and students or students and students (2.04 min across grades one and two). Further, the following interactions were not observed across any of the 144 lessons: teacher to small group, individual student and small group, small group to small group, or small group to class.

To examine if there were statistical differences by grade in types of interactions (teacher-class, teacher-individual, individual-class, individual-individual, no interaction), alpha was set at 0.01 (i.e., .05/5 comparisons). During a lesson, grade one teachers interacted with their class ($M = 12.10$, $SD = 6.53$) more often than grade two teachers ($M = 7.24$, $SD = 4.97$; $t = 5.030$, $df = 142$, $p < .001$). Similarly, teacher to individual student interactions were more common during first grade lessons ($M = 9.67$, $SD = 5.05$) than during second grade lessons ($M = 5.69$, $SD = 4.55$; $t = 4.972$, $df = 142$, $p < .001$). There were, however, no statistically significant differences in how many minutes were spent in first and second grade lessons in terms of individual-class interactions (grade one: $M = 0.20$; $SD = 0.48$; grade two: $M = 0.27$; $SD = 0.94$), individual-individual interactions (grade one: $M = 0.07$; $SD = 0.26$; grade two: $M = 0.18$; $SD = 0.62$), or no interactions (grade one: $M = 1.96$; $SD = 1.78$; grade two: $M = 2.12$; $SD = 2.35$).

The characteristics of common approaches for teaching chinese characters (RQ5)

In addition to examining specific teaching behaviors and in-lesson interactions, we coded, categorized, and extracted meaningful and representative teaching clips of how teachers taught handwriting, recognition, meaning, and pronunciation of

Chinese characters. This provided a more holistic representation of how these skills were generally taught.

Teaching handwriting

Of the 144 online lessons conducted, 103 (72%) taught how to write characters (i.e., handwriting). Across these lessons, teachers primarily applied an "analyze-demonstrate-practice-evaluate" approach to teaching handwriting.

Analyzing structure, strokes, and stroke sequences Almost all teachers asked students to critically analyze the structures of characters, their position on grid paper, and the key strokes needed to create them, and share their observations from these analyses (items w2 and w3, Table1). For example: "Before writing, we have to observe the structure, the middle line of the grid, and the key strokes." "Who will tell us what to pay attention to when writing?".

After students finished sharing their analyses, the teacher summarized students' observations and then re-emphasized and/or added needed points. This was illustrated in one teacher's summary: "To the right of the '晚' (evening; a surname; late; younger) is the '免' (dismiss; avoid; exempt from; not allowed; a surname), this '口' (mouth; rim; entrance; department; hole; a surname) should be written slightly flatter, and "丿" (a stroke) should be interspersed under the '日' (sun; daytime; day; time; daily), so as to this will make our characters more beautiful."

In terms of the character strokes, teachers often highlighted strokes in a character that were likely to be produced incorrectly. This was done verbally, with a picture, or through animation (see item w3, Table 1). For instance, one teacher directed students to: Pay attention to its stroke sequences. Here first write '丨', then '一' on the horizontal line, and then a long '一'."

After discussing the structures and strokes in one or more characters, some teachers led students to trace characters with their fingers and ask them to say the names of the strokes according to the stroke sequences as they traced the character (item w7, Table 1). To illustrate, one teacher told students to: "Please follow the screen and trace this character with your right hand. 丶, 丶, ㇇, ㇇, 丨, 一."

Teacher demonstration After students analyzed a character, most teachers demonstrated how to write it on a blackboard stroke by stroke. Students were directed to observe how the character was written or to follow its production by tracing the character themselves (item w6, Table 1). Some teachers also used videos to show how to write characters (item w5, Table 1). This was illustrated by this teacher: "Let's see how the calligraphy master wrote [the character]."

Practice After demonstrating how to write characters, teachers provided time for students to practice writing them in their textbooks or on grid paper. Teachers reminded students of the importance of sitting properly and holding their pen correctly (item w1, Table 1). One teacher for instance indicated: "Let's set up a good position and

hold the pen. Don't tilt your head. Your feet firmly planted on the ground. The eyes are one foot from the book, the chest is one fist from the table, and the hands are one inch from the tip of the pen." Practice writing characters during a lesson was not laborious, as students traced and copied each character once or twice (item w8).

Showing and evaluating For each lesson, the teacher had a live video connection with two to four students. After these students finished practicing writing characters, the teacher invited them to present their writing to the camera. The teacher then made constructive comments, and asked students to revise the character based on this feedback (item w11, Table 1). For example, one teacher exclaimed: "You have written a beautiful '人' (human being), the three '一' (a stroke) are not equally spaced. '金' (gold; golden; money; a surname) can be written a little bit above, and the last '一' is too close to the bottom of the grid, so you can revise it again." Some teachers introduced methods students could use to evaluate their character production (item w12, Table 1) as illustrated by this teacher: "After writing, we should evaluate our handwriting according to the three criteria: whether the characters are written correctly, whether they are written in the middle of the grid, and whether the sizes of them are consistent." Other teachers had students evaluate each other's handwriting (item w13, Table 1): "I am not going to comment this time, so please tell me in which of the strokes he has to revise?".

Teaching character recognition and meaning The most common method for teaching recognition and meaning of Chinese characters was the Six Principles Theory of Chinese Script (六书). Thirty-six percent of the time teachers spent teaching character recognition involved this approach, whereas 22% of the time devoted to teaching character meaning applied this method.

When using the Six Principles Theory of Chinese Script, teachers engaged in activities where they showed images of ancient Chinese characters to help students understand the meaning of pictographs (象形字), explain the abstract orthography of characters to help students understand the meaning of ideographs (指事字), analyze the composition of character components to help students understand the meaning of compound ideographs (会意字), and explain the meaning of semantic radicals to help students understand phono-semantic compound characters (形声字) (item m1, Table 1). Teachers further used the Six Principles Theory to trace the origin of Chinese characters, present ancient Chinese characters, and/or analyze the structures of Chinese characters to help students recognize orthography (item ro1, Table 1). Examples of the use of this approach include: (1) "We haven't learn '芯' (rush pith; core), but we can pronounce it directly from its phonetic radicals, so it's pronounced '心' (heart; mind; core)."; (2) " '死' (die) in the oracle bone inscription (甲骨文), its left side is a broken bone and its right side is a kneeling person, means loss of life."; (3) and "In ancient times, '乐' (music; a surname) was written in such a way (♫) that the top resembled a silk string and the bottom resembled a frame, and the overall shape of it resembled an ancient musical instrument."

Teachers also consciously guided students to grasp the rules of the Six Principles Theory in order to enhance their ability to learn characters on their own. For

example, one teacher told her students: "80% of Chinese characters are phono-semantic compound characters (形声字), which means that for 8 out of 10 characters you haven't learned, you can guess their meanings by using their phonetic radical to indicate the pronunciation and their semantic radical to indicate the meaning." Generally, teachers explained the Six Principles Theory in easy-to-understand language and did not over-analyze characters (which may make learning more difficult). However, there were a few cases where teachers misrepresented the knowledge of the theory.

It should be noted that the Six Principles Theory of Chinese Script can be used to teach some but not all Chinese characters. This is because Chinese characters evolve over time, and they become different from the original orthography and meaning of the character.

Teaching reading of characters

When teaching students how to read or pronounce Chinese characters, teachers devoted 71% of their time to reading aloud characters and texts containing the newly taught Chinese characters (items py14, py15, p1, p2; Table 1). In order to facilitate correct pronunciation, teachers repeatedly created opportunities to read aloud characters or text in multiple parts of the lesson. Before focusing on comprehending text read in class, some teachers had students read aloud the words in the text with Pinyin first, then read aloud again without Pinyin, and then read aloud the text. Some teachers combined teaching the comprehension of text with teaching character pronunciation (e.g., they flexibly arranged for students to read aloud during the explanation of text content). Other teachers combined these approaches, allowing students to correct, consolidate, and memorize the pronunciation through repeated readings. Still other teachers designed a variety of ways to guide students' pronunciation of characters they were reading by having students read together, directing students to take turns reading aloud, asking one student to read while the other followed along, and the teachers and students reading together. Further, some teachers presented reading aloud activities as a game to stimulate students' enthusiasm.

Teaching characters in motivating ways

Teaching Chinese characters in motivating ways refers to the interesting, humorous and witty ways teachers explore the unique characteristics of characters and stimulate students' interests in learning them (Dai, 1999; Dong, 2015). We provide three examples of how teachers did this.

Songs

Teachers used songs to help student learn the pronunciation, meaning, recognition, and writing of characters (items py4, py12, py13, p7, m12, ro9, w4; Table 1). These included songs written for children, jingles, and pithy formulas set to music. The songs were short and catchy, and they often presented character rules and key points in an easy to remember fashion. Further, some teachers

encouraged students to memorize characters by creating their own songs: "Lower right semicircle b, b, b; lower left semicircle d, d, d; upper right semicircle p, p, p; upper left semicircle q, q, q" ('b', 'd', 'p', 'q' here are Pinyin symbols).

Riddles With this practice, specific characteristics of Chinese characters were compiled into easy-to-understand riddles. Teachers mainly used riddles to teach character meaning (item m11; Table 1) and recognition (item ro8; Table 1). Some teachers also asked students to create their own riddles for independent word recognition: "Let's guess a riddle to warm up. '一口咬掉牛尾巴 (A bite off the tail of a cow)'; Please think about what character it is?".

Real-life connections Many teachers found ways of connecting what students were learning in the classroom to life outside of it. For example, when teaching a character, some teachers indicated the character could be found outside of the classroom, and as long as one paid attention to them, one can learn a large number of characters outside of class time: "We learn characters, not only limited to Chinese textbooks, we can also recognize characters in real life. For example, when we watch cartoons and movies at home, the words on the subtitles can also be recognized. When we go out and see the billboards, we can also recognize the words inside."

The characteristics of classroom interactions

All classroom interactions were teacher led We observed that all classroom interactions during Chinese character instruction were teacher-initiated. Teacher-class, teacher-individual, individual-class, and individual-individual interactions all occurred following teacher instructions or questions. In essence, the 144 observed lessons were fully teacher initiated and directed.

Students were provided limited opportunities to express themselves Although all classroom interactions were teacher-led, teachers consciously engaged in bilateral verbal interactions with students, at least in a limited manner. For example, teachers encouraged students to share their own way to learn Chinese characters, independently analyze the essentials of handwriting, and act as little teachers to demonstrate to the class a particular skill.

Interactions when teaching handwriting and meaning When teaching handwriting and character meaning, teacher interactions with students mostly focused on activities involving memorization (e.g., memorizing the structure of Chinese characters or the stroke sequences) or comprehension (e.g., explaining the meaning of Chinese characters to students through various practices). Less common were interactions focused on application (e.g., students using Chinese characters to compose words, make sentences, write paragraphs, fill in blanks) or evaluation (e.g., students evaluating their own or other students' performance).

Interactions with students studying at home Due to limitations in the technology, teachers could only interact with the two to four students who were participating in the live video connection. Some teachers did, however, encourage other students at home watching the video to participate in classroom activities, and they encouraged them to participate along with the two to four students connected live through the video connection. Some teachers also provided time in the video for students at home to share their responses and thoughts with their families.

Discussion

This study examined 144 language arts lessons taught by distinguished and experienced first and second grade teachers to determine how pronunciation, meaning, recognition, and writing of simplified Chinese characters were taught during emergency remote instruction at the start of the COVID-19 pandemic in Xiangzhou, China. These lessons were delivered through live video interactions with two to four students, while other students were able to access them simultaneously at home via an internet device or on TV. This is the only study we are aware of that directly observed the teaching of Chinese characters during the pandemic.

Opportunity to learn

The Chinese writing system is complex (Kong, 2020; Tse et al., 2007; Wang & Leland, 2011), and children cannot learn to read and write Chinese if they are not provided with sufficient opportunities to learn (Hsiang et al., 2021). While emergency remote instruction provided countries with a tool to ensure students were still educated during pandemic-related school closures (Di Pietro et al., 2020), many educators expressed concern that students were not provided with adequate time for learning when schools moved from in-class to remote instruction (e.g., Blikstad-Balas et al., 2022; Huber et al., 2020). Because distinguished and experienced grade one and two teachers designed and delivered the 144 language arts lessons examined in this study, we predicted that at least one-third to one-half of lesson time would be devoted to teaching characters. These teachers had the knowledge and experience to know how to teach such skills as well as understand why it was important to devote adequate time to mastering them.

As predicted, 58% of lesson time was devoted to teaching characters, with first grade teachers devoting statistically more time to such instruction (69%) than second grade teachers (46%). Grade one teachers taught Chinese characters in all 72 lessons, whereas grade two teachers taught these skills in 63 lessons (88%). It was not clear why second grade teachers devoted less time to teaching characters than first grade teachers. The textbook teachers used to guide the construction of lessons (Ministry of Education, 2016a, b) recommended teaching more characters in second than first grade. It is possible second grade teachers who designed the lessons believed older students learned characters faster than younger students, so they devoted less time to teaching them. It is also possible that second grade teachers felt more pressure to

teach other aspects of the language arts curriculum than first grade teachers, resulting in less character instruction. Future studies examining time devoted to teaching Chinese characters should ask teachers about the instructional decisions they make. This was not possible in the current study because we only had access to the lessons, not the teachers who developed them.

During the 13-week school closure in Xiangzhou, the synchronously delivered online language arts lessons were offered four to seven times a week. When four lessons were offered, 96 and 62 min a week were devoted to grade one and two lessons, respectively. This rose to 168 and 109 min, respectively, when seven lessons were offered. On average, 109 min a week were spent teaching characters across both grades. In contrast, primary grade teachers in Macao, China reported they only taught characters once every three to four weeks during emergency remote instruction (Hsiang et al., 2022). These same Macao teachers reported they spent 97 min a week teaching characters. We suspect this estimate was based on how much time they devoted to the lesson delivered every three to four weeks. Regardless, lessons offered by distinguished and experienced teachers in Xiangzhou offered a more constant and deliberate schedule of character instruction than was offered in Macao during emergency remote instruction.

Because the pronunciation, meaning and orthography of Chinese characters are connected (Liu et al., 2003), we further predicted time spent teaching these different forms of knowledge would be similar. This was generally the case as 6.32, 5.83, and 5.49 min a lesson were spent teaching pronunciation, writing, and meaning. Only 3.78 min per lesson, however, was devoted to teaching character recognition. When developing lessons, less time may have been devoted to character recognition because teachers believed students learn how to recognize characters when they are taught to write or pronounce them. Future research needs to examine these propositions experimentally (e.g., Does character recognition improve when character meaning is taught?) and by interviewing teachers about their instructional actions and beliefs.

It must be noted that empirical evidence on how much time should be spent teaching different aspects of Chinese characters is not available. Consequently, we cannot provide a definitive statement on whether the 144 lessons analyzed provided first and second grade students with adequate opportunities to learn the pronunciation, meaning, recognition, and writing of Chinese characters. Research is needed to examine relationships between time provided to teach each of these aspects of characters and students' progress in learning them. Undoubtedly, time needed for learning will vary depending on student and contextual differences (Graham, 2018).

Quality of instruction

The potential impact of opportunity to learn depends on quality of instruction (Carroll, 1989). In this study, quality of instruction was examined by determining whether recommended practices for teaching characters were applied, and whether these practices were delivered in a coherent and logical manner. Our prediction that distinguished and expert teachers would apply a variety of recommended teaching

behaviors was supported. All but three of the 80 teaching behaviors assessed were evident in the 144 lessons. This finding suggests these lessons not only provided multiple opportunities to learn, but quality instruction as well. Similarly, primary grade teachers in the Hsiang et al. (2022) study in Macao indicated they used all 64 of the recommended practices surveyed when teaching Chinese characters during emergency remote instruction.

While the lessons analyzed in this study used many different behaviors to teach characters, a relatively small number of teaching behaviors were commonly applied in each lesson as predicted. Typically, a lesson included 14 different behaviors for teaching characters. This was appreciably lower than the 30 instructional practices Macao teachers commonly indicated they used when teaching characters to first to third grade students during emergency remote instruction (Hsiang et al., 2022). This discrepancy may be a consequence of how data was collected. In the present investigation, teaching behaviors were observed, whereas as in the earlier study teachers had to recall how characters were taught. Research is needed to determine if teachers' self-assessments of how they teach characters is consistent with their observed teaching behaviors.

When constructing and delivering their lessons, teachers typically applied four behaviors to teach the following three aspects of characters: pronunciation, meaning and writing. Two teaching behaviors were commonly used to teach character recognition during a lesson. While the teaching behaviors applied across all lessons were not identical, a small set of the same instructional procedures were frequently applied in lessons. For instance, character pronunciation in a lesson mostly involved the teacher modeling how to say a character and students practicing reading characters in isolation or text with or without Pinyin support. Learning to write a character in a lesson mostly involved discussing character structure, explaining strokes and stroke sequence, modeling how to form the character, teacher led tracing of the character, student copying and tracing the character, and teacher evaluation of characters produced. The most common behavior for teaching character meaning and recognition was the Six Principles Theory of Chinese Script. Two additional teaching behaviors were frequently used to support meaning (pictures and summarizing the meaning of a group of words), and one additional teaching behavior was frequently used to support character recognition (replacing components in a group of characters).

The frequent use of the same behaviors for teaching different aspects of Chinese characters provided additional support for lesson quality. The application of a small number of common teaching behaviors provided continuity across lessons. In the present context, this was particularly important as lessons were designed and delivered by 61 different teachers. It is also possible that the less frequent application of a wide variety of other teaching behaviors across lessons was beneficial because it provided teachers with mechanisms to respond to individual differences and made lessons more interesting by reducing somewhat the repetitive nature of lessons. Future research should examine these issues from the perspective of both teachers and students.

Quality of instruction was further evident in the collected representative examples that showed how characters were typically taught in the 144 lessons. Consistent with

our prediction, these examples illustrated that coherent and logical approaches were applied to teaching the different aspects of Chinese characters. For instance, lessons provided multiple opportunities to practice the pronunciation of new characters and supported correct pronunciation with Pinyin as well as teacher and peer support. Teaching how to write characters primarily followed an analyze-demonstrate-practice-evaluate approach, whereas the most common approach for teaching meaning and recognition relied on a coherent system for analyzing the internal structure of characters (i.e., Six Principles Theory of Chinese Script). Lessons also occasionally included songs, riddles, and real-life connections to make them more interesting and relevant.

Obviously missing from our analysis of the quality of the 144 lessons was evidence that they improved student learning. While these lessons applied recommended teaching practices in a coherent and logical manner, we were unable to collect any data on whether they enhanced the character learning of students participating in the lessons interactively or those who viewed them at home. Research is needed to determine if such lessons positively impact students' learning of characters, and whether any observed effects are related to student individual differences.

Further, the 77 teaching behaviors that teachers were observed applying represented commonly recommended practices for teaching Chinese characters. To our knowledge, there is no systematic review indicating which of these teaching practices are evidence-based and which are not. While there is evidence that teaching practices such as modeling and spaced practice enhances students' learning of literacy skills (e.g., Santangelo & Graham, 2016), it is not possible to draw any definitive conclusions about the effectiveness of the large majority of the teaching behaviors observed. This needs to be rectified by testing these methods repeatedly using scientific methods.

Implications and summary

This study examined an approach to delivering instruction remotely that was used by the Xiangzhou School District during the first wave of COVID-19 school closures in 2020. Distinguished and experienced teachers developed and delivered lessons synchronously to a small number of students, while simultaneously delivering these lessons to students at home via internet and TV. We specifically analyzed 144 Chinese language arts lessons developed by these teachers to determine if they provided a compelling means for teaching Chinese characters to first and second grade students. This was generally the case, as the lessons provided students with opportunities to learn and practice Chinese characters, applied recommended teaching procedures, and provided coherent and logical approaches to instruction. Thus, this approach to remote instruction provides a viable model for teaching Chinese characters during future school closures.

The model used by the Xiangzhou School District is not only applicable to other schools in the Greater China region, but provides a model that can be applied in other countries as well. For example, if it is clear that emergency remote instruction will occur for an extended period of time, a school district could task its most

effective teachers to design a series of coordinated lessons for teaching critical specific skills and processes. These lessons could undergo evaluation and revision by other teachers, and then be implemented synchronously, asynchronously, or both by the teachers who developed them. We would argue that the decision to use such a model should not occur at the last moment when sudden closures are forced upon schools. Instead, decisions on how to proceed should be made proactively, before school closures are mandated. This will provide school systems with more time to identify expert teachers, develop lessons that can be delivered synchronously, and determine how to evaluate the effects of this approach.

While the 144 lessons analyzed in this investigation had many positive features, they can be improved. We predicted that interactions between teacher and students would be mostly teacher directed. This was the case as all interactions in the lessons were teacher directed. This may have occurred because teachers were not comfortable encouraging other forms of interactions (e.g., student to student) in this digital format, especially since they knew other students would be watching the lesson remotely and not be able to interact with the teacher or students participating in the live lesson. It was also possible that students who were part of the live lesson did not initiate interactions because they were new to online learning and were reluctant to take the initiative in an unfamiliar situation. Nevertheless, if this approach is used to provide instruction in the future, it is important that student-initiated interactions are better facilitated.

It was not possible to determine if the instruction provided in the lessons was responsive to students' needs and interests. While we did observe that some lessons connected learning to students' lives and used songs and riddles to make lessons more interesting, this did not occur as frequently as we would have liked. The development of future online synchronous lessons to teach Chinese characters (or other skills) needs to make responsive instruction a priority.

Finally, the current study provided a window into how distinguished and experienced educators teach Chinese characters. The teachers who developed the lessons evaluated here undoubtedly possess useful knowledge about how to provide such instruction. The methods they used can serve as helpful models for other educators as they teach Chinese characters. They may also inspire researchers to scientifically test methods they view as particularly promising or effective (Graham & Harris, 2014). Some caution must be exercised in such pursuits because it is difficult to determine with any certainty which teaching behaviors should be emulated. As a result, it is important for teachers and researchers to carefully evaluate the applicability of any teaching behaviors used in these lessons before applying them for their own purposes.

Appendix—Six principles of Chinese script

The Six Principles Theory of Chinese Script refers to six ways of constructing Chinese characters, including four ways of creating Chinese characters and two ways of using characters. Four ways of creating Chinese characters provide a tool for analyzing the internal structure of characters, providing students mechanisms for

recognizing characters and determining their meaning. Chinese characters can be divided into four categories according to four different ways of creating Chinese characters: pictographs (象形字), ideographs (指事字), compound ideographs (会意字), phono-semantic compounds (形声字).

Pictographs (象形字) refer to the drawing of characters according to the shape of objects. It can be said that the pictographs are closest to the pictures. For example, "日" (sun) is a pictograph. Its ancient orthography is like " ☉". The round outline represents the shape of the sun, and the point in the middle represents the sun's rays.

Ideographs (指事字) are to add indicative symbols on the basis of pictographs (象形字) to emphasize what is to be expressed or to represent abstract concepts. For example, "旦" (daybreak) is a ideograph. The "一" added under the "日" (sun) means the sun rises from the ground, which means daybreak.

Compound ideographs (会意字) consists of two or more characters that combine their meanings to represent another concept or thing. "明" (bright) consists of the "日" (sun) and the "月" (monn). Because the sun and the moon are both bright, so the combined meaning of bright.

A phono-semantic compound (形声字) is composed of a phonetic radical (声符/声旁) which cues pronunciation, and a semantic radical (义符/形旁) which cues meanings. For example, the pronounciation of "晴" (qíng) is similar with its phonetic radical "青" (qīng) and the meaning of "晴" (sunny) is related to its semantic radical "日" (sun).

Declarations

Conflict of interest The authors have no conflict of interest and ethical standards for research were met.

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