Teaching Chinese characters to students in grades 1 to 3 through emergency remote instruction during the COVID-19 pandemic

Tien Ping Hsiang[1] · Steve Graham[2] · Zhisheng Wang[1] · Chuang Wang[1] · Gustaf B. Skar[3]

Abstract

The current study examined how Chinese characters were taught by primary grade teachers in Macao during online instruction resulting from the COVID-19 pandemic (i.e., emergency remote instruction). A random sample of 313 first to third grade teachers in public and private schools were surveyed about their instructional practices. Most teachers surveyed (72%) reported they taught a lesson about Chinese characters once every 3–4 weeks during emergency remote instruction, and 83% and 81% of teachers indicated they assigned homework for writing and reading characters, respectively, at the same rate. On average, they reportedly spent 97 min per week teaching students to write, read, and understand the meaning of new characters, devoting equal time to each of these skills. They also indicated students practiced writing and reading characters in class for 40 min per week. They further noted students were expected to spend 35 min a day practicing writing and reading characters for homework. While teachers reportedly used a variety of instructional practices for teaching characters ($M = 30.38$), the typical teacher applied less than one-half ($N = 64$) of practices assessed. Teachers reported use of asynchronous (online learning activities which can be completed at other times) and synchronous (real-time videos and audio/text) teaching methods and perceptions of adequacy of technical support predicted reported teaching practices. The findings from this study raise questions about the teaching of Chinese characters in Macao during emergency remote instruction.

Keywords Handwriting · Writing · Reading · Word meaning · Chinese characters

At the end of 2019, a new virus, SARS-CoV-2, was identified and spread across the globe quickly. The virus impacted almost all aspects of daily life, presenting

✉ Steve Graham
steve.graham@asu.edu

Extended author information available on the last page of the article

unprecedented educational, public health, economic, and social challenges.[1] To slow the impact and spread of SARS-CoV-2, countries across the world took various actions including the use of quarantines and masks. Education in many countries moved from in class instruction to emergency remote instruction (Hodges et al., 2020). This typically involved remotely delivered instruction (e.g., online, radio) or some combination of remote and in class instruction (e.g., Di Pietro et al., 2020; Fauzi & Khusuma, 2020; Kirshner, 2020). In Macao (a Special Administrative Region of the People's Republic of China), where the current study took place, this transition to remotely delivered instruction began February 5, 2020 and lasted into May of that year. The Macao SAR Government issued the "Self-study Plan for Students", suspending in class instruction and replacing it with online instruction (Education and Youth Development Bureau, 2020a).

The cancellation of in class instruction in Macao as well as across the globe in the ensuing months presented an extraordinary educational challenge. An estimated 1.5 billion students across the globe were affected (Dimov & Dobreva, 2020). Even though education had been impacted by other health related disasters in the past (see Howard & Howard, 2012; Sprang & Sillman, 2013), an educational disruption of this magnitude had never occurred before (Dimov & Dobreva, 2020; Winthrop, 2020). The COVID-19 pandemic resulted in a crises-prompted and temporary move into distance education for most schools, but it differed from more traditional distance education in expectations, planning, accessibility, and possible learning outcomes (Bergdahl & Nouri, 2021).

While emergency remote instruction provided a means to ensure that students continued their education (Di Pietro et al., 2020), concerns about its effects on learning were expressed by many educational experts (e.g., Daniel, 2020). As more data became available, these concerns appeared to be justified. For instance, Lewis et al. (2021) reported that students in the United States made gains in reading and math during the pandemic, but at a lower rate than students did before the pandemic began. Similarly, Skar et al. (in press) found that first grade students in Norway had lower scores for writing quality, handwriting fluency, and attitude towards writing following emergency remote instruction than first grade students in the same schools tested a year earlier before SARS-CoV-2 emerged.

Other researchers questioned the quantity and quality of instruction students received during emergency remote instruction (the focal point of this study). For example, Huber et al. (2020) indicated that weekly learning time during emergency remote instruction was 4–8 h less than when students attended school in person in Austria, Switzerland, and Germany. In an interview with 4642 parents in Norway, Blikstad-Balas et al. (in press) found that a majority of grade one to four students had little contact with their teachers during emergency remote instruction, and the time devoted to instruction was restricted.

The current study examined a specific aspect of instruction during emergency remote instruction: teaching of Chinese characters to primary grade children in the

---

[1] (https://www.who.int/news/item/13-10-2020-impact-of-covid-19on-people's-livelihoods-their-health-and-our-food-systems).

city of Macao. To our knowledge this is the first study to examine how Chinese characters were taught to children in the Greater China Region during the subsequent online instruction that occurred as a result of the COVID-19 pandemic. We focused specifically on how often and how much time teachers spent teaching primary grade children to write, read, and understand the meaning of Chinese characters during emergency remote instruction (opportunity to learn). We further examined the types of instructional practices teachers reportedly used to teach students these skills (quality of instruction). Finally, we examined if reported teaching time and use of instructional practices were predicted by the methods teachers indicated they used to deliver online instruction and their perceptions of the adequacy of the technical support they and their students received during emergency remote instruction. Factors that potentially moderator the teaching of Chinese characters during the pandemic have not been examined previously.

Opportunity to learn and quality of instruction

In his seminal Model of School Learning, Carroll (1989) proposed that school learning is a function of time. More specifically, learning was a consequence of time needed to learn and time spent learning. This theoretical model further proposed that school learning was influenced by the characteristics of instruction, including opportunity to learn (in class and via homework) and the quality of instruction provided, as well as the characteristics of learners (aptitude, perseverance, and ability to understand instruction). Carroll's model, especially his tenets about opportunity to learn and quality of instruction, provided the theoretical underpinnings for this investigation.

The Chinese writing system is complex

It is essential that young children learning to write and read Chinese characters are provided with sufficient opportunities and quality instruction to learn these skills. One reason for this is that learning to write and read Chinese is a complex task. There are at least 6400 characters in modern Chinese, and about 3500 characters account for 99% of the words in popular reading material. Elementary grade students in Macao are expected to learn to read about 3000 characters and write 2000 characters (Education and Youth Development Bureau, 2016; Hsiang et al., 2021).

Not only are young children expected to learn how to write, read, and understand the meaning of a large number of characters, Chinese is a complex logographic and morpho-syllabic writing system that relies on strokes and radicals to construct individual characters that go on to make up words. The character is the basic linguistic unit of Chinese, representing a syllable in spoken language. A character may represent a word or a meaning element (morpheme) used to construct multi-syllabic words (Tse et al., 2007). Chinese words are commonly constructed of two or more characters. Individual characters are formed with strokes, but also include components (cluster of strokes that form radicals) and shape. Compound 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 (e.g., 王 [king or a family name], 玉 [jade]; 午 [noon], 牛 [cattle]) (Ho & Siegel, 2016; Kong, 2020). The recognition, meaning, and construction of Chinese characters is further complicated by a large number of homophones (different characters making the same sound, but with different meanings) and polyphones (character with multiple pronunciations; Kong, 2020).

As the examples above illustrate, learning to write and read Chinese is not an easy task. This requires ample opportunities to learn and the use of effective instructional practices. While data on how often and how much time primary grade teachers in Macao typically spend teaching Chinese characters is limited, a qualitative study conducted by the first author of the current investigation in 2021 (Hsiang) found that in 2019, just before February to May 2020 emergency remote instruction was instituted, 15 teachers in first and second grade indicated they taught five to seven Chinese language arts classes per week, with each class ranging from 35 to 45 min. This instruction focused on teaching lessons from the adopted language arts textbooks, with 1–1.5 lessons taught a week, with each lesson lasting 3–5 class periods. During each class, they further indicated that one-third to one-half of this time was spent teaching Chinese characters.

At a minimum then, teachers in Hsiang (2021) taught a lesson on Chinese characters at least once a week, spending a minimum of 40 min a week doing so (3 lessons a week [minimum number of days teaching a lesson] × 40 min a lesson divided by one-third time spent teaching characters during lessons). Maximally, they taught 1.5 lessons a week, spending a maximum of 140 min a week doing so (7 lessons a week [maximum number of days to teach 1.5 lessons] × 40 min a lesson divided by one-half time spent teaching characters). We used these estimates as touchstones for interpreting data from the current study.

Writing and reading Chinese characters is essential to students' development

It is also critical that adequate time and effective practices are allocated to teaching young children to write, read, and learn the meaning of Chinese characters due to the importance of these skills to students' success in and out of school. Understanding text in any language involves recognizing and accessing the meaning of words (or characters and combination of characters in Chinese), whereas writing depends on transcribing ideas into letters and words (or characters and combination of characters in Chinese). While reading and writing involve more than decoding and transcription (see theoretical models by Graham, 2018 and Kim, 2020), these foundational literacy skills capture the fundamental principles underlying the Simple View of Reading (Kendeou et al., 2009) and Writing (Juel, 1988). Text cannot be understood if students are unable to quickly and easily recognize and access the meaning of words (or characters), and writing is constrained for students with slow and laborious handwriting (or character production).

Consequently, events such as the COVID-19 pandemic and the resulting lockdowns that occurred in Macao and across the Greater China Region may impede

children's development in learning to write, read, and understand the meanings of Chinese characters. This is especially the case if the resulting school lockdown and move to online instruction resulted in limited opportunities to learn Chinese characters or led to truncated use of effective instructional practices. This can have both immediate and far reaching consequences for impacted students in terms of their progress as writers and readers of Chinese (Yeung et al., 2017). It may also influence their success in school, at work, and communally, because writing is an effective learning tool, it has become a common tool at work, and it is used broadly to communicate and connect with others (Graham, 2019; Hsiang & Graham, 2016; Hsiang et al., 2018). Proficiency in learning to read, write, and access the meaning of Chinese characters is considered an essential learning competency for children in Macao and the Greater China Region (Education and Youth Development Bureau, 2016; Ministry of Education of the People's Republic of China, 2012).

Predictions concerning opportunity to learn and quality of instruction

We anticipated that the primary grade teachers in Macao that we surveyed in this study would report they devoted limited attention (time and number of instructional sessions), using multiple but a limited range of instructional practices, to teach Chinese characters during emergency remote instruction. We based these predictions on previous research (e.g., Blikstad-Balas et al., in press; Huber et al., 2020) as well as recommendations made by the government to teachers and schools. This included informing schools that students should learn in a relaxed manner, without the pressure of tests and examinations, and that it was not necessary to maintain the typical pace of instruction (Education & Youth Development Bureau, 2020a). Schools were also told that during emergency remote instruction that emphasis should be placed on solidifying skills previously learned before the lockdown occurred. These recommendations were aimed at reducing school, parent, and student stress and complications in implementing online instruction. It is likely, however, they impacted how teachers taught their students to learn to write, read, and understand the meaning of Chinese characters.

Possible moderating influences of online teaching methods and technical support

The COVID-19 pandemic and emergency remote instruction occurred at a time when many teachers were not prepared to apply online learning effectively. For instance, one-fourth of principals in countries participating in the Organization for Economic and Co-operation Development (OECD) assessments just prior to the COVID-19 pandemic indicated student learning was hindered by a shortage or inadequacy in digital tools (Schleicher, 2020). Teachers in this OECD survey expressed the need for training in use of such tools, and close to 50% of them did not allow students to apply them in class.

This was also the case in Macao when emergency remote instruction was enacted from February to May, 2020. Given the rapidity with which instruction in Macao (and elsewhere) moved from in class to online, the government and schools had little time to prepare teachers for this transition. The government did initiate the recommendations described earlier (e.g., it was not necessary to maintain previous pace of instruction), an online learning platform to support teachers (which included online instructional videos for teaching and materials submitted by teachers), and counseling services for students (Education & Youth Development Bureau, 2020a).

Predictions concerning moderating influences of online teaching methods and technical support

We anticipated that teachers who used the following methods to deliver online instruction when teaching Chinese characters would reportedly spend more time teaching these skills and apply more instructional practices when doing so. This included asynchronous instruction (i.e. online learning activities that students complete on their own within a specific time frame) and real-time online learning activities (i.e., synchronous instruction) involving the use of videos or audio/text materials to teach Chinese characters. While we expected that these practices would be applied infrequently given the rapidity that instruction moved from in class to online as well as the administrative directions from the government that it was not necessary for teachers to maintain the typical pace of instruction (Education & Youth Development Bureau, 2020a), we anticipated that teachers who reportedly applied these asynchronous and synchronous learning activities more frequently were better prepared to deliver online instruction during emergency remote instruction, and this would lead to them spend more time and use more instructional procedures when teaching their students to write, read, and understand the meaning of Chinese characters.

We further expected teachers who were more positive about the technical support they and their students received during emergency remote instruction would reportedly spend more time and use more instructional procedures to teach Chinese characters than teachers who were less positive about such support. Teachers' beliefs serve as a catalyst for action, how much effort is applied, and what resources and tools are used when teaching (Graham, in press; Fives & Buehl, 2012). While we predicted teachers would view the technical support provided as inadequate because of how quickly emergency remote learning had to be actualized, we did anticipate that teachers who more positive about such support would devote more time and resources (instructional practices) to teaching Chinese characters than teachers who were less positive.

Research questions

In order to determine how often, how much time, and what instructional practices primary grade teachers in Macao reportedly applied to teaching Chinese characters during emergency remote instruction as well as determine if these practices were predicted by reported use of methods for delivering online instruction and teachers' perceptions of technical support, we asked the following three questions:

1. How often were Chinese characters taught and how much class and homework time were devoted to such instruction? (RQ1)
2. What instructional practices did teachers use to teach the writing, reading, and meaning of Chinese characters? (RQ2)
3. Did reported methods for delivering online instruction and teachers' perceptions of technical support predict the amount of time teachers reported spending teaching Chinese characters during class and via homework as well as the number of practices applied when teaching the writing, reading, and meaning of characters? (RQ3)

To assess students' opportunities to learn Chinese characters during emergency remote instruction (RQ1), we asked teachers a series of questions about how much time they devoted during online classes to teaching the writing, reading, and the meaning of characters as well as how much class time was devoted to practicing writing and reading characters. Because opportunity to learn also involves homework time (Carroll, 1989), teachers were further asked to indicate how much time students were expected to practice writing and reading Chinese characters outside of class. To gauge the frequency of instruction, teachers were asked to indicate how often they taught a lesson on characters and how often homework was assigned to practice writing and reading them.

To assess quality of instruction (Carroll, 1989), we asked teachers whether they used 64 different instructional practices to teach student how to write, read, and understand Chinese characters (RQ2). The practices assessed were drawn from previous studies examining how decoding and encoding skills are taught effectively (Graham et al., 2008a, 2008b; Hsiang & Graham, 2016; Hsiang et al., 2018, 2020; Miao, 2002).

We also asked teachers a more general question about how they taught Chinese characters. There is a debate among scholars about the value of presenting characters in isolation or context, although there is not enough research presently to recommend one approach over the other (Lam, 2011; Li, 2020). An isolation approach focuses on teaching individual characters and expanding characters into words. In this case, characters are initially presented and taught before they are introduced in context. With a context approach, a target character or word with multiple characters are presented in a sentence or longer text. Typically, the sentence is read and the meaning of the word discussed, and students learn how to write the word and use it in text (Lam, 2011; Wang & Leland, 2011). The potential value of the isolation approach is that it offers explicit instruction on the structure and form of each

character (Chen, 2008; Ho & Siegel, 2016; Hung & Huang, 2006; Kong, 2020; Lu, 2000; Wu, 2010). Supporters of the context approach counter that knowing the meanings of specific characters does not automatically lead to knowing the correct meaning of a word, and they argue that learning a Chinese word in context can facilitate learning its correct meaning (Wang & Leland, 2011). Other scholars contend that a hybrid approach is best (Chiu & Lin, 2008; Liu & Liu, 2020; Tse et al., 2007; Wang & Leland, 2011), where students analyze individual characters within the context of words based on morphological and orthographic rules. We anticipated that teaching characters in context would be more common than the isolation or hybrid approach because textbooks used to teach characters in Macao uniformly emphasize the former (Hsiang et al., 2021).

Finally, to determine if teachers' reported use of asynchronous and synchronous (videos and audio/texts) methods of online instruction and perceptions of the adequacy of technical support predicted opportunity to learn and quality of instruction, we examined if these variables collectively accounted for unique variance in reported time spent teaching/practicing characters, reported homework time practicing characters, and number of instructional practices teachers reportedly used when teaching the writing, reading, and meaning of characters (RQ3). To examine the predictive effects of reported use of online teaching methods and perceptions of technical support, we first controlled for variance due to teachers' efficacy to teach Chinese characters, their attitude towards teaching these skills, their preparation to teach them (pre-service, in-service, and personal), size of their class, and their experience teaching primary grade students. This added greater precision to our analyses, as these control variables were correlated with how teachers reportedly taught literacy in other studies (e.g., Graham, 2019).

Methods

Participants

A random sampling procedure, stratified by school and grade levels, was used to identify 338 grades 1 through 3 Chinese language arts teachers from a population of 400 teachers in 59 public and private primary schools in Macao Special Administrative Region of the People's Repubic of China (Macao SAR, Education & Youth Development Bureau, 2020b). Not included in this sample were special education teachers. We selected 338 teachers to survey, as this provided a sampling error of less than 5% for the most common type of Likert-item in the survey (which contained six response options), using a 95% confidence level, assuming a return rate of 50% (Dillman, 2000). Of the 338 teachers who received the survey, 313 were returned. Six surveys were eliminated because teachers did not teach writing or most of the survey was not completed. This resulted in a return rate of 91%, narrowing sampling error to ± 2.5%.

Thirty-five percent of teachers taught first grade, 32% second grade, and 32% third grade. Teachers were mostly female (93%). Nine percent of participating teachers had obtained an Associate degree, 82% a Bachelor's degree, and 9% a Master's

degree. Most teachers (94%) taught at a private school that had joined the free education system. Another 7% of teachers taught at public schools, and 6% of teachers at private schools that had not joined the free education system. The language of instruction was Chinese in 90% of schools (Cantonese was almost twice as prominent as Mandarin), and English was the medium of instruction in the remaining schools, except when teaching Chinese language arts (which was taught with a Chinese language). On average, teachers had taught primary grade children for 7.77 years ($SD = 7.33$), and their classes averaged 30.61 students ($SD = 7.33$). Number of years teaching primary grades and class size did not differ by grade (both ps > 0.143).

Survey instrument

Demographic information

The survey included six sections. The first section asked teachers to provide information about their teaching situation and themselves. This included grade taught, instructional language used in the classroom, number of students, type of school (public, private), gender, years teaching primary grade students, highest education degree completed, and preparation to teach Chinese characters. For preparation, teachers were asked to rate their level of pre-service, in-service, and personal preparation on a four-point Likert-type scale ranging from none (score of 1.0), minimal (score of 2.0), adequate (score of 3.0), and extensive (score of 4.0). These items provided descriptive information, and the items on years teaching, class size, and preparation (preservice, in-service, and personal) served as control variables in the analysis for RQ3.

Opportunity to learn Chinese characters

Time

The next section of the survey focused on how much time teachers spent teaching Chinese characters per week during emergency remote instruction. This included three questions asking teachers to indicate the number of minutes a week in class spent teaching students to write, read, and understand the meaning of Chinese characters. It also included two questions about how many minutes per week students spend practicing reading and writing Chinese characters in class. Two additional items asked teachers to indicate how many minutes each day students were expected to complete homework to practice writing and reading Chinese characters at home.

A factor analysis of the seven items described above using responses from the current study yielded two factors (based on an analysis of the Scree plot and eigenvalues greater than 1.0). When the data were rerun using an oblique rotation, the first factor, class time teaching and practicing characters (eigenvalue = 3.52; coefficient alpha = 0.85), accounted for 50% of the variance. Factor loadings for the five items that constituted this factor were in class time teaching the writing (0.94), reading

(0.94), and meaning (0.94) of characters as well as in class time practicing writing (0.52), and reading (0.55) of characters. The second factor, homework time practicing characters (eigenvalue = 1.33; coefficient alpha = 0.76), accounted for 19% of the variance. Factor loadings for the two items on this factor were: homework writing characters (0.88) and homework reading characters (0.90). Scores for each factor were the average scores of all items loading on that construct. The average scores for items on these two factors, class time teaching/practicing characters per week and homework time practicing characters per week, served as outcome variables for RQ3.

Frequency

Teachers completed three additional items asking them to report how frequently they taught a lesson on Chinese characters, assigned homework to practice writing Chinese characters, and assigned homework to practice reading Chinese characters. Teachers responded to these three items using an eight-point Likert-type scale that included the following descriptors: never (score of 0), once every several months (score of 1), once a month (score of 2), once every 3 weeks (score of 3), once every 2 weeks (score of 4), once a week (score of 5), several times a week (score of 6), and every day (score of 7). Higher scores indicated the activity occurred more often. No factor analysis was conducted with these items as they were just used for descriptive purposes.

Quality of instruction for teaching Chinese characters

The third section of the survey included items that assessed teachers use of 64 recommended practices for teaching Chinese characters (see Table 1). These items were adapted from reviews and studies by Graham et al. (2008a, 2008b), Hsiang and Graham (2016), Hsiang et al. (2018, 2020), and Miao (2002). This section also included a question asking if Chinese characters were usually taught before discussing a text to be read, while discussing a text to be read, or both were done about equally. All 65 of these questions were all answered as yes or no.

Twenty-eight of the items presented in Table 1 focused specifically on instructional practices for teaching students to write Chinese characters (i.e., practices for teaching writing of characters), eight items centered on learning to read Chinese characters (i.e., practices for teaching reading of characters), and 15 items involved teaching the meaning of Chinese characters (i.e., practices for teaching meaning of characters). The remaining 14 items involved two or more of these purposes (e.g., praising students for their performance when learning characters). The purpose of each item is designated in parentheses in Table 1, and items that focus solely on writing, reading, or math are numbered (e.g., W1, R1, M2).

To examine the scale validity and reliability of three hypothesized scales (i.e., practices for teaching character writing, reading, and meaning), we employed

Table 1 Percent of teachers who used specific instructional practices for teaching Chinese characters during emergency remote instruction

Practices	N	Percent	Practices	N	Percent
Students correct handwriting mistakes (w1)	266	86.9	Students copy each character several times (w10)	262	85.3
Teacher models reading aloud a text (r1)	239	77.9	Use written words to explain character meaning (m5)	226	73.6
Introduce the radical of the character (w/m)	222	72.3	Students use a character to compose words (m6)	220	72.1
Explain characters with pictorial representation (m1)	220	71.7	Students use a character to write sentences (m7)	213	69.4
Model pronunciation of characters (r2)	211	69.0	Students write a character without Pinyin support (w11)	210	68.4
Model stroke sequence (w2)	203	66.1	Discuss the character structure to help students write it correctly (w12)	198	64.7
Students correct malformed strokes (w3)	196	63.8	Praise student for performance (w/r/m)	194	63.4
Explain the meaning(s)of characters in context (m2)	191	62.4	Students orally use characters to make sentences (m8)	190	62.1
Model the writing of stroke forms (w4)	189	62.0	Students read aloud texts in class (r5)	189	61.8
Students read aloud characters (r3)	185	60.7	Use Chinese etymology to introduce characters (m9)	184	60.1
Orally explain meaning of characters (m3)	182	59.3	Compare homophones (w/r/m)	172	56.0
Change one component/radical to learn characters (m4)	167	54.4	Discuss character structure to help students write it beautifully (w13)	161	52.4
Compare characters/radicals/components to prevent stoke errors (w5)	153	49.8	Assign online homework (w/r/m)	145	47.2
Display examples of best handwriting (w6)	144	46.9	Introduce a character's multiple uses (m10)	142	46.3
Students read aloud texts individually (r4)	139	45.3	Students trace characters with fingers (w14)	138	45.0
Students say stroke names in characters (w7)	137	44.6	Ideal focus distances for reading and writing (r/w)	136	44.3
Teach sitting position for writing (w8)	133	43.3	Use Six Principles Theory of Chinese Script (w/r/m)	132	43.1
Use paper with larger line space (w9)	131	42.7	Use picture books to teach characters (w/r/m)	129	42.3
Teach characters in groups (w/r/m)	128	41.7	Students trace characters in blocks (w15)	125	40.7
Teacher explains the character's composition (w16)	123	40.1	Students identify best formed characters (w22)	121	39.4
Student reinforced for performance (w/r/m)	120	39.1	Teach proper pencil grip (w23)	117	38.2
Teach how to position paper when writing (w17)	108	35.3	Require a certain kind of pen or pencil (w24)	108	35.2
Assess with online game-based platform (w/r/m)	105	34.2	Students share recordings of them reading text with teachers (r7)	100	32.6

Table 1 (continued)

Practices	N	Percent	Practices	N	Percent
Use an anagrammatic game to teach character meaning and construction (w/m)	99	32.2	Students consult dictionaries to gain information about characters (m13)	98	32.0
Students write a paragraph from memory (w18)	95	30.9	Students correct incorrectly used characters (r/m)	94	30.7
Use meaningful texts to introduce characters (r/m)	93	30.3	Students draw the ancient script forms (w25)	90	29.3
Students use several assigned words to write text (m11)	89	29.0	Students use idiom(s) to make sentences (m14)	88	28.7
Students complete dictation exercise to write characters (w19)	84	27.4	Students correct grammatical errors (m15)	78	25.4
Model how to consult a dictionary for information about characters (m12)	75	24.5	Model stroke and sequence for left-handed person (w26)	70	22.8
Teach proper left-handed pencil grip (w20)	68	22.1	Highlight left-sided components of a character structure for left-hander (w27)	67	21.9
Teach proper left-handed paper position (w21)	58	18.9	Teach left-handed students proper position for placing hand while writing (w28)	56	18.2
Use classic books to teach characters: reading is more important than writing (r6)	47	15.3	Students use Cangjie input method to type characters (w/r)	23	7.5

w = procedure for teaching how to write character; r = procedure for teaching how to read character; m = procedure for teaching how to obtain character meaning

the Rasch model (sometimes referred to as a one-parameter item response theory model).[2] The Rasch model (Rasch, 1980) is commonly expressed as:

$$ln\frac{P_{ni1}}{P_{ni0}} = \beta_n - \delta_i,$$

where ln is the natural logarithm, P_{ni1} is probability for person n to succeed on item i (with P_{ni0} being its inverse). β_n is the estimated ability of person n, and δ_i is the estimated difficulty of item i. In this instance, though, β_n can rather be thought as the willingness to engage in writing instruction tasks (with higher estimates indicating more willingness), and δ_i as the difficulty for an activity to be chosen (with higher measures indicating an activity less probably chosen).

Modelling data using the Rasch model has several advantages. First, it is possible to disentangle person and item measures, which enables the researcher to analyze aspects of persons and items irrespective of the other. The disentanglement also includes conditional standard errors for each person and item, as well as an estimate of the fit of each person and each item to the proposed model. Further, the person and item estimates are expressed on an interval scale, making the interpretation of–in this case–willingness, and difficulty more intuitive; a measure twice as high indicates a 100% difference. Since we were interested in examining if teachers reported use of practices for teaching the writing, reading, and meaning of Chinese characters were each predicted by the online learning tools teachers reportedly applied when teaching characters during emergency remote instruction and the supports that teachers and students received, the expression of teacher scores on an interval scale was particularly attractive.

To assess the validity of each measure (e.g., practices for teaching writing of characters), we investigated the "fit statistics," which are Rasch model indicators of data–model-fit. The outlier-sensitive fit statistic ("outfit") has an expected value of 1.00. Significantly high outfit values (i.e., values > 1.3; Bond & Fox, 2015) indicate "misfit," or that an item may not fit the supposed underlying construct as well as other items, with significant outfit values > 2.0 indicating items that contributes to distorting the measure (Wright & Linacre, 1994). For difficult items, high outfit indicates that teachers expected not to engage in the instructional practice has done so anyway. For less difficult items, high outfit indicates teachers expected to engage in the instructional practice has not done so. Significantly low outfit values (i.e., values < 0.75) indicate "muted" items contributing with little information. Muted items are generally perceived to be of less concern.

Validity was also assessed by reviewing the ordering of items according to their measures. For example, if an item that should be difficult is easy, this might suggest that the item is poorly worded or respondents have chosen a response to the item on grounds other than that their actual use of the practice.

---

[2] We had included eight items asking teachers about the adaptations they made for weaker students when teaching characters during emergency remote instruction. These items did not represent a valid and reliable scale when subjected to the Rasch analysis. As a result, they are not included in this paper.

Table 2 IRT for practices for teaching writing of characters scale

Item	N	p-value	Logit	S.E	Outfit	Discrimination
W28	307	0.18	1.95	0.19	0.77	0.56
W21	307	0.19	1.88	0.18	0.49	0.61
W27	306	0.22	1.58	0.17	0.59	0.62
W20	307	0.22	1.56	0.17	0.57	0.64
W26	307	0.23	1.51	0.17	0.63	0.64
W19	307	0.27	1.12	0.16	1.05	0.53
W25	307	0.29	0.97	0.16	0.85	0.55
W6	306	0.31	0.86	0.16	1.14	0.46
W18	307	0.31	0.85	0.15	1.70*	0.41
W24	307	0.35	0.55	0.15	2.59*	0.28
W17	306	0.35	0.54	0.15	0.74	0.60
W23	306	0.38	0.34	0.15	0.76	0.61
W22	307	0.39	0.26	0.15	0.73	0.63
W16	307	0.40	0.22	0.15	0.97	0.53
W15	307	0.41	0.18	0.15	1.26	0.48
W9	307	0.43	0.05	0.14	2.38*	0.40
W8	307	0.43	0.01	0.14	0.66*	0.65
W7	307	0.45	−0.08	0.14	0.72	0.62
W14	307	0.45	−0.10	0.14	1.16	0.51
W5	307	0.50	−0.41	0.14	0.95	0.55
W13	307	0.52	−0.57	0.14	0.88	0.57
W4	305	0.62	−1.18	0.15	0.77	0.59
W3	307	0.64	−1.30	0.15	0.66	0.60
W12	306	0.65	−1.36	0.15	0.85	0.55
W2	307	0.66	−1.46	0.15	0.63	0.60
W11	307	0.68	−1.62	0.15	2.07*	0.31
W10	307	0.85	−3.08	0.19	2.81*	0.33
W1	306	0.87	−3.27	0.20	1.01	0.37
Reliability	R_p	Person separation	R_i	Item separation	α	
	.88	2.76	.98	8.09	.92	

SE standard error; R_p person reliability; R_i item reliability

*$p < 0.05$

To assess reliability of each measure (e.g., practices for teaching reading of characters), we investigated the "person reliability" (R_p) and "item reliability" (R_i), which are Rasch equivalents to Cronbach's alpha, and the person and item separation statistic, which can be interpreted to indicate the number of groups that persons (i.e., teachers) and items can be separated into. We further examined item discrimination (a Rasch analysis generated point-biserial measure). Traditionally, values below 0.25 are considered poor indicators of discrimination and indicate the item

Table 3 IRT for practices for teaching the reading of characters scale

Item	N	p-value	Logit	SE	Outfit	Discrimination
R6	307	0.15	3.26	0.22	5.10*	0.18
R7	307	0.33	1.50	0.16	2.05*	0.32
R4	307	0.45	0.51	0.16	0.62*	0.59
R3	305	0.61	−0.69	0.17	0.53*	0.67
R5	306	0.62	−0.77	0.17	0.52*	0.66
R2	306	0.69	−1.42	0.18	1.03	0.52
R1	307	0.78	−2.38	0.20	1.27	0.46
Reliability	R_p	Person Separation	R_i	Item separation	α	
	.66	1.39	.99	9.19	.77	

SE standard error, R_p person reliability, R_i item reliability

*p<0.05

Table 4 IRT for practices for teaching meaning of characters scale

Item	N	p-value	Logit	S.E	Outfit	Discrimination
M12	306	0.25	1.95	0.18	0.98	0.48
M15	307	0.25	1.87	0.17	1.17	0.43
M14	307	0.29	1.59	0.16	1.07	0.49
M11	307	0.29	1.56	0.16	1.28	0.50
M13	306	0.32	1.30	0.16	2.00*	0.40
M10	307	0.46	0.32	0.15	1.00	0.54
M4	307	0.54	−0.21	0.15	0.96	0.51
M4	307	0.59	−0.54	0.15	0.93	0.55
M9	306	0.60	−0.60	0.15	1.02	0.51
M8	306	0.62	−0.72	0.15	0.84	0.55
M2	306	0.62	−0.74	0.15	0.99	0.62
M7	307	0.69	−1.26	0.16	1.04	0.47
M1	307	0.72	−1.44	0.16	0.94	0.54
M6	305	0.72	−1.47	0.16	0.74	0.58
M5	307	0.74	−1.60	0.17	0.68	0.60
Reliability	R_p	Person separation	R_i	Item separation	α	
	.80	1.99	.98	7.76	.87	

SE standard error, R_p person reliability, R_i item reliability

*p<0.05

may be problematic. We chose to retain or delete items on a scale based on an overall judgement, consulting both fit and reliability statistics.

Tables 2, 3, and 4 present *p*-values for items on each scale, along with outfit statistics and the logit measure for each item. They also present Rasch reliability

indices, and Cronbach's α for the scale. Items are ordered in descending difficulty order. The three scales were used as outcome measures for RQ3.

Practices for teaching writing of characters

For the practices for teaching writing of characters scale, we identified five items that demonstrated a misfit (W9, W10, W11, W18, W24), and one item that demonstrated an overfit (W8). However, none of these items displayed overly low discrimination (see Table 2). The difficulty of the items followed an expected pattern with item W28 (teach left-handed students the proper position for placing hand while writing) being most difficult, and item W1 (students correct handwriting mistakes) being easiest. The reliability estimates (R_p = 0.88; Person separation = 2.76; R_i = 0.98; Item separation = 8.09; Cronbach's α = 0.92) indicated that it was possible to reliability distinguish between use of practices and item difficulty.

Practices for teaching reading of characters

The scale, practices for teaching reading of characters, exhibited some problematic traits (see Table 3). Item R6 (use classic books to teach characters) evidenced a gross misfit, and low discrimination (0.18). We suspected this to be a result of the very low p-value (0.15) with accompanying high logit value indicating a slim probability for teachers to indicate they used this practice. Since so few teachers chose it, it did not contribute much to the measurement of teachers use of instructional practices to teach reading of characters. Item R7 (students share recordings of them reading text with teacher) also evidenced misfit, but demonstrated acceptable discrimination. Three items (R3, R4, and R5) evidenced overfit. Nevertheless, the difficulty ordering of the items was in accordance with our expectations. The reliability estimates for persons (teachers) were not high (R_p = 0.66; Person separation = 1.39), whereas reliability estimates for items was high (R_i = 0.99; Item separation = 9.19). Consequently, it was possible to reliably separate items, but not persons to a great extent. Cronbach's α was 0.77, which is acceptable. Excluding the most problematic item from the scale (R6) did not increase reliability estimates. While the fit and reliability statistics could have been stronger, the ordering of the items, and the fact that no item was negatively discriminating, led us to retain this scale for our analyses.

Practices for teaching meaning of characters

For the scale, practices for teaching meaning of characters, we noted one miss-fitting item (M13: Students consult dictionaries to learn Chinese characters), but neither this nor any other item displayed troublesome discrimination values (see Table 4). The items also followed an expected pattern with item M12 (Model the procedures of consulting a dictionary through the indexing system of radicals) having the lowest p-value, and item M5 (Use written words to explain meaning) having the highest. The reliability estimates (R_p = 0.80; Person separation = 1.99; R_i = 0.98; Item separation = 7.76; Cronbach's α = 0.87) indicated that it was possible to reliability distinguish between use of practices and item difficulty.

Methods for teaching online

In the fourth section of the survey, teachers answered three questions about the online learning tools they used when teaching Chinese characters. This included how frequently they applied asynchronous online learning activities, real-time online instruction via video, and real-time online instruction via audio or texts. They used the same eight-point Likert scale described above (never to every day). These items served as separate predictors for RQ3.

Technical support

The fifth section of the survey, asked teachers specific questions about the supports they or their students received during emergency remote instruction. Three questions directly queried teachers about the adequacy of the technical support they or students received: (1) did students receive enough technical support (yes or no), did the teacher receive enough technical support (yes or no), and did the teacher receive enough training for effective distance education during emergency remote instruction (yes or no). The number of these three items a teacher answered in the affirmative served as a predictor variable for RQ3. Reliability for these three items using KR—20 was 0.74.

Two items used for descriptive purposes asked if students were able to obtain hard copies of instructional materials from their schools for online learning (yes/no) and were students able respond to tasks online (yes/no). Using a yes.no format, teachers were also asked if they had received complaints from parents about online learning during emergency remote instruction and what kinds of instructional advise/supports the government offered teachers (i.e., encourage teacher to reduce course load, focus on reviewing what was previously learned, relax teaching schedule, and provide training for distance education learning).

Teacher beliefs

The final section of the survey focused on two different teacher beliefs. One, teachers were asked four questions about their attitude towards teaching Chinese characters (e.g., I like to teach how to write characters). This scale was adapted from an attitude scale from Brindle et al. (2016) for writing more generally. Teachers answered each item using a six-point Likert-type scale, where they indicated if they strongly disagreed (score of 1.0), moderately disagreed (score of 2.), slightly disagreed (score of 3.0), slightly agreed (score of 4.0), moderately agreed (score of 5.0), and strongly agreed (score of 6.0) with the statement. A factor analysis of these items using responses from the current study yielded a one-factor solution (eigenvalue of 2.56) accounting for 64% of the variance (coefficient alpha = 0.81). The factor scores for the four items were: I like to teach how to write characters (0.82); I like to teach knowledge of Chinese characters (0.84); I like to teach students as many characters as possible (0.85), and I think learning as many characters as possible is important

for primary grade students (0.68). The score for this measure was the average of the four items, and it was used as a control variable for RQ3.

The second belief measure assessed teacher-efficacy for teaching Chinese characters. It was adapted from the personal teacher efficacy scale from Graham et al. (2001). The scale in the current study asked teachers about their confidence about their capabilities to teach Chinese characters (e.g., teaching the writing of Chinese characters). Teachers responded to the eight items on this scale with the same six-point scale used with the attitude measure. A factor analysis of these eight items using responses from the current study yielded a one-factor solution (eigenvalue of 4.635) accounting for 59% of the variance (coefficient alpha = 0.89). Factor loadings for items were: writing of Chinese characters (0.60), reading of Chinese characters (0.67), meaning of Chinese characters (0.72), using knowledge of Six Principles Theory of Chinese Script to explain characters (0.44), teaching radicals (0.61), reading aloud text in front of my students (0.62), correcting sentence and grammatical mistakes involving Chinese characters (0.59), and using information technology to teach Chinese characters (0.40). The score for this measure was the average of the eight items, and it was used as a control variable for RQ3.

Procedures

We contacted each Macao primary school principal in May, 2020 and explained the importance of the study. We also indicated that a free workshop on distance teaching of Chinese characters would be offered to schools who participated in the study. Forty-three schools agreed to participate in the study.

The 338 surveys were mailed to the participating schools. In each school, the survey was distributed to each teacher at each primary grade (i.e., 1, 2, and 3). Teachers received a packet including an introductory letter explaining the nature and purpose of the study as well as inviting them to participate in the investigation. The packet also included the survey which teachers were asked to complete as well as a stamped envelope in which to seal and return the completed survey. The introductory letter indicated we were conducting a survey to learn about how Chinese characters were taught during the COVID-19 pandemic and ensuing emergency remote instruction that followed. The letter asked teachers to answer questions honestly, and it emphasized that their responses would not be shared with other school personnel and would remain anonymous. Two trained university students entered all data into an SPSS file independently. Inter-coder agreement was 99.92%. Each disagreement was corrected.

Results

Opportunity to learn: frequency and time teaching Chinese characters during emergency remote instruction (RQ1)

Three items assessed how frequently (never to daily) teachers taught Chinese characters during emergency remote instruction. The first item revealed that participating

teachers reportedly provided lessons on teaching Chinese characters infrequently, with 41% and 31% of teachers indicating they taught a lesson on characters once every 3 weeks or once a month, respectively. With the second item, 45% of teachers indicated they assigned homework for practicing the writing of Chinese characters just once every 3 weeks, with another 38% of teachers noting this occurred once a month. The third items divulged that 46% of teachers reported assigning homework for practicing the reading of characters just once every 3 weeks, with another 35% indicating this occurred monthly. There was a statistically significant difference by grade for how frequently teachers reportedly assigned homework for practicing reading characters, $F(2, 297) = 3.95$, $MSe = 4.57$, $p < 0.044$. First grade teachers ($M = 5.30$; $SD = 0.95$) more frequently assigned reading homework for this purpose than third grade teachers ($M = 4.88$; $SD = 1.49$; $p < 0.044$).

Time was assessed in two ways. This included how many minutes each week teachers indicated they spent in their online classes teaching the writing, reading, and meaning of characters as well as practicing the writing and reading of characters. It also included how much time each day teachers expected their students would spend practicing writing and reading characters for homework. Data for all time variables are reported in Table 5, and there were no statistically significant differences by grade for any of these measures (all $ps > 0.057$).

During an average week, teachers indicated they spent 137 min teaching and practicing Chinese characters in online classes during the lockdown (see Table 5). This included 32 min teaching and 21 min practicing writing characters, 32 min teaching and 20 min practicing reading characters, and 32 min teaching character meaning. In terms of homework, students were expected to spend 20 min a day practicing writing characters and another 16 min a day practicing reading them.

Instructional practices teachers reportedly used to teach chinese characters during emergency remote instruction (RQ2)

Of the 64 instructional practices included in Table 1, the participating teachers indicated they implemented between one to all of them. On average, teachers reported applying 30 of these instructional practices (see Table 5). There was a statistically significant difference in how many instructional practices for teaching Chinese characters teachers in different grades were applied during emergency remote instruction (see Table 5), but none of the follow-up statistical comparisons were statistically significant.

Thirty-one specific instructional practices were reportedly applied by 50% or more of the teachers surveyed (see Table 1). Thirteen of these practices focused on teaching students to write characters (see below), five items involved learning to read characters (see below), and nine items concentrated on teaching the meaning of characters (see below). Three other items used by 50% or more of teachers focused on teaching the writing, reading, and meaning of characters (teach characters in groups, compare homophones, praise students for their performance), whereas an additional item addressed both writing and meaning (introduce the radical of the character).

Table 5 Time spent and instructional practices applied teaching and practicing Chinese characters during emergency remote instruction

Grades	First		Second		Third		Total	
Varaiables	M	SD	M	SD	M	SD	M	SD
Class Time teaching/practicing characters per week (N = 307)	126.64	143.38	138.61	107.96	146.19	151.94	136.78	135.77
Teaching writing characters per week	31.26	43.14	35.58	32.21	30.38	42.97	32.39	39.79
Teaching reading characters per week	29.18	38.54	34.42	31.96	33.03	42.48	32.11	37.86
Teaching character meaning per week	27.89	42.06	34.15	31.05	35.92	43.57	32.48	39.40
Practice writing characters weekly	20.03	33.70	18.64	24.76	23.80	32.61	20.80	30.69
Practice reading characters weekly	19.12	22.92	16.01	17.19	23.56	25.59	19.53	22.31
Homework time practicing characters daily (N=307)	35.41	22.50	34.53	18.99	36.16	14.73	35.36	14.73
Writing characters as homework daily	20.05	10.44	19.80	9.15	21.00	7.04	20.27	9.02
Reading characters as homework daily	16.21	13.78	15.55	11.53	15.75	10.10	15.85	11.93
Total instructional practices (N=306)*	29.00	15.41	33.64	15.51	28.26	16.71	30.38	15.98
Practices teaching writing of characters (N=306)**	13.50	7.63	14.98	7.61	12.08	8.09	13.53	7.84
Practices teaching reading of characters (N=306)	3.68	2.03	3.87	1.98	3.30	2.17	3.62	2.07
Practices teaching meaning of characters (N=306)***	6.44	3.85	8.18	3.92	7.84	4.47	7.45	4.14

Total instructional practices was based on all 64 instructional items; practices teaching writing of characters based on 28 items; practices teaching reading of characters based on 7 items; practices teaching meaning of characters based on 15 items

*Total instructional practices differed by grade, $F(2, 303) = 3.19$, $p = .044$, but none of the post-hoc analyses were statistically significant

**Practices teaching writing of characters differed by grade, $F(2, 303) = 3.42$, $p = .034$, with third grade teachers applying fewer practices for teaching writing of characters than second grade teachers ($p = .009$)

***Practices teaching meaning of characters differed by grade, $F(2, 303) = 2.303$, $p = .005$, with grade one teachers applying fewer practices for teaching character meaning than grade two and three teachers (both $ps < .016$)

Practices for teaching the writing of characters

Of the 28 items that specifically asked teachers about their use of instructional practices for teaching students how to write characters, teachers averaged applying slightly less than one half of them (13.53). Third grade teachers applied fewer practices for teaching the writing of characters than second grade teachers (see Table 5). Instructional practices most commonly applied by 50% or more of teachers (see Table 1) included: discuss character structure to help students write it correctly (w12), discuss the character structure to help students write it beautifully (w13), compare characters/radicals/components (w5), teacher models the writing of stroke forms (w4), teacher models stroke sequence (w2), students says stroke names in characters (w7), students copy each character several times (w10), students write character without Pinyin support (w11), students correct handwriting mistakes (w1), students correct malformed strokes (w3), teach sitting position for writing (w8), use paper with larger line spaces (w9), and display examples of students best handwriting (w6).

Practices for teaching the reading of characters

Of the 7 items that specifically examined instructional practices for teaching students to read characters, teachers averaged using slightly more than one-half of them (3.62; Table 5). Practices most commonly applied during the lockdown by 50% or more of teachers (see Table 1) included: teacher models reading text aloud (r1), teacher models pronunciation of character (r2), student reads aloud character (r3), students read aloud text in class (r5), and students read aloud text individually (r4).

Practices for teaching the meaning of characters

On average, teachers reportedly used less slightly less than one-half (7.45; Table 5) of the 15 instructional procedures for teaching the meaning of characters that were included on the survey. Grade one teachers used fewer of these practices than grade two and three teachers (Table 5). Practices for teaching character meaning most commonly applied during lockdown by 50% or more of teachers (see Table 1) included: teacher uses Chinese etymology to introduce characters (m9), teacher explains the meaning of characters with pictorial representations (m1), teacher explains the meaning of characters in context (m2), teacher orally explains character meaning (m3), teacher uses written words to explain character meaning (m5), change one component/radical to learn characters (m4), students use characters to compose words (m6), students orally use characters to make sentences (m8), and students use characters to write sentence (m7).

Predicting reported teaching practices (RQ3)

We conducted five hierarchical regression analyses to determine if variance in reported *class time teaching/practicing characters per week*, *homework time*

Table 6 Means and standard deviations for control and predictor variables

Grades	First		Second		Third		Total	
Variables	M	SD	M	SD	M	SD	M	SD
Efficacy (N=306)	4.60	.58	4.63	.60	4.52	.55	4.58	.58
Attitude(N=306)	5.18	.50	5.27	.49	5.14	.49	5.19	.50
Pre-service preparation in college (N=307)	2.17	.72	2.26	.79	2.07	.71	2.17	.74
In-service preparation at school (N=307) *	2.28	.68	2.45	.72	2.20	.73	2.31	.71
Personal preparation on my own (N=304)	2.32	.59	2.35	.69	2.26	.56	2.31	.62
Years taught at grade 1–3 level (N=304)	8.60	6.72	7.88	8.14	6.60	6.95	7.72	7.31
Class size (N=306)	30.37	5.97	31.12	6.39	30.36	5.21	30.61	5.87
Perceptions of technical support (N=306)	1.51	1.19	1.61	1.10	1.54	1.19	1.55	1.16
Frequency of asynchronous online learning activities (N=305)**	5.23	1.37	5.27	1.35	4.74	1.90	5.09	1.57
Frequency of real-time online instruction via video (N=305)	1.28	2.24	1.48	2.44	1.02	2.07	1.26	2.26
Frequency of real-time online instruction via audio or text (N=305)	2.52	2.93	3.00	2.89	2.31	2.84	2.61	2.89

*In-service preparation differed by grade, $F(2, 303)=3.28$, $p=.039$, with second grade teachers indicating they were better prepared than third grade teachers ($p=.014$)

**Asynchronous online learning activities differed by grade, $F(2, 301)=3.49$, $p=.032$, but none of the post-hoc analyses were statistically significant

practicing characters daily, *practices teaching writing of characters*, *practices teaching reading of characters*, and *practices teaching meaning of characters* was related to methods for teaching online and teachers' perceptions of technical support. The predictors included teachers' reported application of asynchronous online learning activities, online instruction involving videos, online instruction involving audio or text material, and a three-item measure assessing perceived technical support (i.e., students received adequate technical support, the teacher received adequate technical support, and the teacher received adequate training to deliver online instruction).

The means and standard deviations for outcome variables are presented in Table 5. Means for predictor variables are in Table 6. On average, teachers reported they used asynchronous online learning activities once a week. While there was a statically significant relation to grade taught, no follow-up analyses were statistically significant. Teachers reported applying real time online instruction with audio/text once a month and real time online instruction with video once every several months. Sixty-six percent of teachers believed their students received adequate technical support during emergency remote instruction, with 59% of the teachers indicating they received adequate technical support for online learning during the lockdown. Just 30% of teachers reported the support they received for conducting effective online instruction was adequate. On average, teachers voiced agreement with 1.55 of these three items (Table 6).

In examining the predictive effects of methods of delivering online instruction and perceptions of technical support on each of the five outcome variables, we first controlled for variance related to seven control variables: teacher efficacy, attitudes, preservice preparation, in-service preparation, personal preparation, class size, and years spent teaching primary grades (see Table 6 for means and Means and standard deviations). As a group, teachers slightly agreed they were confident in their capabilities to teach Chinese characters, and they moderately agreed that they liked to teach them. They were less positive about their pre-service, in-service, and personal preparation to teach Chinese characters. Sixty-six percent of teachers indicate their pre-service preparation as minimal or none; 61% of teachers indicated they had minimal to no in-service preparation; and 64% of teachers noted they had undertaken minimal to no personal preparation. Efficacy, attitudes, preservice preparation, personal preparation, class size, and years teaching did not differ by grade (all p's > 0.143), but there was a statistically significant difference by grade for in-service preparation. Follow-up analyses found that third grade teachers believed they had received less in-service preparation to teach Chinese characters than second grade teachers.

Correlation among control variables were moderate to small. Self-efficacy was moderately related to attitude (0.53), and evidenced small statically significant correlations with preservice (0.20) and personal preparation (0.27). Attitudes also evidence small and statistically significant relations with preservice (0.20) and personal preparation (0.27). Additionally, small and statistically significant relations between preservice, in-service, and personal preparation were obtained (0.24–0.34). Years teaching evidenced small and statistically significant correlations with in-service preparation (0.18) and class size (0.17).

Correlations among predictor variables were modest, with only frequency of real-time online instruction with videos significantly related to frequency of real-time online instruction via audio/text (0.22) and adequacy of technical support (0.24). The only statistically significant associations between predictor and control variables involved adequacy of technical support and self-efficacy (0.14), frequency of real-time online instruction via audio/text and in-service preparation (0.17), class size with frequency of asynchronous online learning activities (0.22), frequency of real-time online instruction via audio/text (-0.22), and frequency of real-time online instruction via video (-0.21).

For each of the five hierarchical regression analyses conducted, the seven control variables were entered as a block at step 1. At step 2, the four predictor variables were entered as a block. This allowed us to determine the amount of variance collectively accounted by the four predictors once the variance due to the seven control variables was controlled. By examining the statistical significance of the betas for all variables in the full regression model at step 2, we were also able to determine if specific predictors or control variables accounted for unique variance when variance related to all other variables were first controlled.

For each regression analysis, it was necessary to eliminate 12 teachers. Three teachers did not indicate number of years teaching, two teachers did not provide information on personal preparation to teach writing, one teacher did not indicate the size of her class, two teachers did not provide information on frequency of online asynchronous learning activities, two teachers did not indicate how often real-time online instruction via video was provided, and two teachers did not indicate frequency of real-time online instruction via audio and text were provided.

When conducting each regression analysis, we examined if obtained effects were unduly influenced by outliers or multicollinearity. We did not identify any case (i.e., teacher) that exerted undue influence over the parameters of the model. In addition, multicollinearity was not an issue as control variables evidenced moderate to small correlations with each other (-0.07–0.53), whereas predictor variables evidenced only small correlations with each other (0.06–0.24). Additionally, VIF indicators for control and predictor variables were all close to 1.00, and tolerance for each variable was in acceptable ranges.

Class time teaching/practicing characters per week

As can be seen in Table 7, the control variables did not account for a statistically significant amount of variance in reported time teaching/practicing Chinese characters in class. The four predictor variables, however, collectively accounted for a statistically significant 8% of the variance in these scores. Two of the predictors made unique and statistically significant contributions to predicting reported class time spent teaching/practicing characters. Teachers who indicated they more frequently provided real-time online instruction via video noted they spent more time in class teaching and practicing Chinese characters, whereas teachers with more positive perceptions of technical support spent less time doing so.

Table 7 Regression analyses

Variable	Model 1			Model 2		
	B	SE B	β	B	SE B	β
Class time teaching/practicing characters per week (N=292)						
Teacher efficacy	4.543	15.735	.021	−1.089	15.288	−.005
Attitudes	15.493	17.735	.062	15.465	17.291	.061
Pre-service preparation	2.914	10.953	.017	5.127	10.677	.030
In-service preparation	1.815	11.748	.010	−8.141	11.556	−.045
Personal preparation	17.841	13.675	.086	20.344	13.206	.098
Size of class	−.699	1.283	−.033	.884	1.328	.041
Years taught in grades 1–3	−.182	1.047	−.011	.138	1.016	.008
Teacher and student support				−10.177	4.78	−.126*
Frequency of asynchronous online learning activities				−2.212	3.464	−.039
Frequency of real-time Online instruction via Video				11.094	2.638	.252***
Frequency of real-time online instruction via Audio/text				12.625	6.606	.114
R^2		.02			.08	
F for change in R^2		.830			6.364***	
Homework time practicing characters daily (N=281)						
Teacher efficacy	−.986	2.379	−.030	−1.096	2.368	−.033
Attitudes	.474	2.681	.013	.988	2.678	.026
Pre-service preparation	.843	1.656	.033	1.354	1.654	.052
In-service preparation	−.625	1.776	−.023	−.646	1.790	−.024
Personal preparation	.504	2.068	.016	.681	2.045	.022
Size of class	.056	.194	.018	.213	.206	.066
Years taught in grades 1–3	.106	.158	.041	.142	.157	.055
Teacher and students support				−2.410	.741	−.199**
Frequency of asynchronous online learning activities				−.020	.536	−.002
Frequency of real-time Online instruction via Video				.269	.409	.041

Table 7 (continued)

Variable	Model 1			Model 2		
	B	SE B	β	B	SE B	β
Frequency of real-time online instruction via Audio/text				−.015	1.023	−.001
R^2		.003			.04	
F for change in R^2		.132			2.734*	
Practices teaching writing of characters (N=294)						
Teacher efficacy	.594	.238	.175*	.472	.227	.139*
Attitudes	−.231	.268	−.059	−.185	.257	−.047
Pre-service preparation	.078	.166	.029	.094	.159	.035
In-service preparation	.332	.178	.119	.165	.172	.059
Personal preparation	−.263	.207	−.081	−.232	.196	−.072
Size of class	−.068	.019	−.206***	−.041	.020	−.124*
Years taught in grades 1–3	.002	.016	.008	.010	.015	.036
Teacher and students support				−0.158	.071	−.126*
Frequency of asynchronous online learning activities				.054	.052	.062
Frequency of real-time Online instruction via Video				.141	.039	.207***
Frequency of real-time online instruction via Audio/text				.344	.098	.201**
R^2		.07			.10	
F for change in R^2		2.988**			8.922***	
Practices teaching reading of characters (N=294)						
Teacher efficacy	1.075	.275	.270***	.930	.255	.233***
Attitudes	−.954	.310	−.208**	−.839	.288	−.183**
Pre-service preparation	.085	.191	.027	.041	.178	.013
In-service preparation	.419	.205	.128*	.209	.193	.064
Personal preparation	−.039	.239	−.010	−.007	.220	−.002
Size of class	−.070	.022	−.179**	−.034	.022	−.087

Table 7 (continued)

Variable	Model 1			Model 2		
	B	SE B	β	B	SE B	β
Years taught in grades 1–3	−.008	.018	−.027	.001	.017	.002
Teacher and students support				−.093	.080	-.063
Frequency of asynchronous online learning activities				.202	.058	.198**
Frequency of real-time Online instruction via Video				.152	.044	.190**
Frequency of real-time online instruction via Audio/text				.428	.110	.213***
R^2		.10			.15	
F for change in R^2		4.366***			14.023***	
Practices teaching meaning of characters (N=294)						
Teacher efficacy	.472	.261	.127	.346	.253	.093
Attitudes	− .316	.294	−.074	−.294	.286	-.069
Pre-service preparation	.017	.182	.006	.046	.177	.016
In-service preparation	.285	.195	.093	.118	.191	.038
Personal preparation	.021	.227	.006	.052	.219	.015
Size of class	− .080	.021	− .219***	− .055	.022	− .151*
Years taught in grades 1–3	.000	.017	−.001	.070	.017	.024
Teacher and students support				− .160	.079	− .116*
Frequency of asynchronous online learning activities				.014	.057	.015
Frequency of real-time Online instruction via Video				.144	.044	.93**
Frequency of real-time online instruction via Audio/text				.354	.109	.189**
R^2		.06			.08	
F for change in R^2		2.723**			6.864***	

Practices for teaching character writing, reading, and meaning were based on mean logit scores for all items for these measures (28, 7, and 15, respectively)

*p<.05. **p<.01. ***p<.001

Homework time practicing characters daily

The control variables did not account for a statistically significant amount of variance in reported daily time teachers expected students to spend practicing Chinese characters, but the four predictor variables did, collectively accounting for a statistically significant 4% of the variance in these scores (see Table 7). One of the predictors made unique and statistically significant contributions to predicting homework time: teachers with more positive perceptions of technical support expected students to spend less time practicing Chinese characters daily.

Practices teaching writing of characters

The control variables accounted for a statistically significant 7% of the variance in number of instructional practices teachers reportedly used to teach the writing of characters, whereas the four predictor variables collectively accounted for a statistically significant 10% of the variance in the number of these procedures reportedly applied by teachers (see Table 7). Five of the predictors made unique and statistically significant contributions to predicting number of practices used to teach students to write characters. More efficacious teachers as well as ones who indicated they incorporated more videos as well as audio/text into their real-time online instruction reportedly used more of these instructional procedures. In contrast, teachers with larger classes and who were more positive about technical support reportedly applied fewer of them.

Practices teaching reading of characters

The control variables accounted for a statistically significant 10% of the variance in number of instructional practices teachers reportedly used to teach students to read characters, and the four predictor variables collectively accounted for a statistically significant 15% of the variance in the use of these instructional procedures (see Table 7). Five of the predictors made unique and statistically significant contributions to predicting number of practices used to teach students to write characters. More efficacious teachers and ones who incorporated more asynchronous, videos, and audio/text into their real-time online instruction indicated they used more of these procedures. In contrast, fewer of these instructional practices were reportedly applied by teachers who had a more positive attitude about teaching Chinese characters.

Practices teaching meaning of characters

The control variables accounted for a statistically significant 6% of the variance in number of instructional practices teachers used to teach the meaning of characters, while the four predictor variables collectively accounted for a statistically significant 8% of the variance in the reported use of these instructional practices (see Table 7). Four of the predictors made unique and statistically significant contributions to

predicting number of practices used to teach students the meaning of Chinese characters. Teachers who reportedly incorporated more videos and audio/text into their real-time online instruction indicated they used more of these instructional procedures, whereas teachers with larger classes and teachers who were more positive about technical support received reportedly used fewer of them.

Additional information

Slightly more than one-half of teachers (54%) reported their students were able to obtain printed copies of instructional materials to use at home to support learning. More positively, 90% of the teachers indicated their students were able to respond to tasks assigned online. The most common communication tools teachers used to provide online instruction were WeChat (38%), Banjixiaoguanjia (12%), Zoom (11%), Google Classroom (7%), Tencent (4%), and Edmodo (2%). More than a third of teachers indicated they used other tools, including E-class (n=32); Moodle (n=13); Microsoft Teams (n=10); Powerlesson2 (n=8); YouTube (n=7); websites offered by textbook publishers (n=7); school websites (n=5); UMU (n=5); Dududaka (n=2); Wenshushu (n=2); WhatsApp (n=1), Kahoot (n=1), and Television (n=1).

When teachers asked about advise the government offered for emergency remote instruction, 91% of teachers indicated they were told there was no need to stay current with the teaching schedule (to reduce pressures placed on parents and students) and 87% added they were told that to help students review what they had learned previously. Sixty percent of teachers noted they were advised to reduce the course requirements. Seventeen percent indicated they were provided government support with unified online courses, and another 10% reported receiving training for distance education.

Some of the teachers expressed concerns in writing on the survey about online learning during emergency remote instruction. This included a lack of interaction and feedback during online learning limiting the learning of first grade Chinese learners (n=2; e.g., "Not easy to check handwriting position/process or pronunciation"); concerns about the quality of learning (n=2; "Unable to draw students' attention during online classes; Didn't know whether students studied the materials posted online or not"); and students and their parents were not willing to participate in online learning (n=1).

Slightly more than one out of every five teachers (28%) reported receiving complaints from parents about online learning during emergency remote instruction. Complaints from parents included: (1) network or equipment problems (n=46; "Unable to log in to an online account; Didn't know how to use the app/network platform; Lack of equipment such as computers/smart phones/printer; Unstable network; Unable to use specific app/network platform in Mainland China"); (2) parents didn't have enough time or the ability to assist/monitor the process of online learning (n=22); (3) opposing opinions on learning materials/ progress from parents (n=14; "Too much to learn/too difficult to learn; Homework assigned was not enough; Unable to keep up with the weekly progress; Unable to meet the curriculum standards");

(4) lower learning motivation (n = 8); and (5) concerns with health (n = 6; "Spent too much time online which raised concerns of eye damage; Worried that children might see inappropriate content").

Discussion

This study examined how primary grade teachers in Macao taught Chinese characters during a four-month period in 2020 when instruction was delivered online because of the COVID-19 pandemic. We surveyed 78% of all primary grade teachers in Macao just after this emergency remote instruction ended. Based on Carrol's (1989) Model of School Learning, we were interested in two aspects of instruction: opportunity to learn and quality of instruction.

Opportunity to learn

Frequency

We hypothesized that primary grade teachers in Macao would provide students with limited opportunities to learn Chinese characters during emergency remote instruction. Teachers' reported practices were only partially consistent with this prediction. In support of our prediction, over 70% of teachers surveyed indicated they provided a lesson where they taught Chinese characters just once every 3–4 weeks. The reported frequency with which they taught Chinese characters contrasts sharply with findings from a much smaller scale study conducted with first and second grade teachers just before emergency remote instruction was implemented in Macao (Hsiang, 2021). At a minimum, teachers in that study reportedly taught a lesson on Chinese characters at least once a week, and up to 1.5 lessons per week. Teachers in the current study who taught a lesson once every 3 weeks offered 33%–22% fewer lessons than teachers in Hsiang (2021), respectively, whereas teachers who taught a lesson once every 4 weeks offered 25%–17% fewer lessons.

The reportedly limited number of instructional sessions devoted to teaching Chinese characters in the current study are consistent with findings from an investigation in Norway conducted during a period of emergency remote instruction (Blikstad-Balas et al., in press). More than one-half of the parents completing the Norway survey indicated writing instruction was provided infrequently. If this and the present study are indicative of the frequency of literacy instruction provided during emergency remote instruction in other countries (and regions within countries), it helps explain, at least in part, why students' literacy performance was negatively impacted by the COVID-19 pandemic (e.g., Lewis et al., 2021; Skar et al., in press). A basic implication from these findings is that educational systems around the world need to become better prepared for subsequent pandemics as well as continuing returns to emergency remote instruction caused by COVID-19 and its variants. This has already occurred in Macao and other places in the Greater China Region where emergency remote instruction was reenacted due to COVID-19. Additional research

is needed to determine in this and subsequent pandemics how implemented changes in instructional delivery influence how frequently specific skills are taught. If frequency of instruction is negatively impacted, researchers need to explore the efficacy of approaches designed to mitigate such outcomes.

Time

Not consistent with our prediction that teachers would provide students with limited opportunities to learn Chinese characters were findings regarding reported time devoted to teaching/practicing Chinese characters each week. Teachers in the current study indicated they spent 97 min a week in online classes teaching character writing, reading, and meaning, devoting an equal amount of time to each of these skills. They also reported that students spent another 40 min in class practicing the writing and reading of characters. This reported time exceeds and even rivals the time teachers reportedly spent teaching characters in a smaller scale study conducted before the Covid-19 pandemic in 2019. In this earlier study (Hsiang, 2021), we estimated that teachers spend a minimum of 40 min to a maximum of 140 min teaching Chinese characters each week.

It is possible that reported time spent teaching characters during emergency remote instruction was inflated because teachers in our study interpreted questions about time spent teaching as questions about how much time they spent teaching when they offered a lesson (once every 3–4 weeks). It is also possible that they counted the same time twice or three times, as when they taught students how to write, read, and the meaning of Chinese characters at the same time. While there is no way to confirm these possibilities after the fact, these explanations, if true, are problematic as it suggests that the teaching of characters occurred infrequently in most classrooms.

Another possible explanation for why teachers in the current study indicated they devoted a considerable amount of time each week to teaching characters, but only offered lessons infrequently, is the lessons they offer do not capture all the time they devote to teaching characters. For example, as students engage in reading and writing activities and learn other literacy skills, teachers may teach or reinforce the learning of Chinese characters. When teaching students to write sentences, for example, teachers may also focus students' attention on how to write as well as pronounce one or more characters. Similarly, as students read text, the teacher may help students read characters, pronounce them, and identify their meaning.

Consequently, future studies examining the amount of time devoted to teaching characters should ask how frequently lessons are offered, how many classes are used to teach a lesson, and how much time in each class is devoted to teaching characters. In addition, it is equally important to ask how much time is devoted to teaching characters more informally at other times throughout the day. This would bring greater precision to clarifying the amount of time teachers reportedly spend teaching the writing, reading, and meaning of Chinese characters.

It is also important to note that teachers expected their students to spend 36 min a day practicing writing and reading characters at home during emergency remote instruction (3 h a week). However, they assigned such homework for writing and

reading each once every 3–4 weeks. It is possible that such homework assignments informed students they needed to engage in writing and reading practice of characters every day. We did not directly ask teachers about their homework directions. Future survey studies examining homework practices for Chinese characters need to explore not only how frequently and for how much time students are expected to practice at home, but more specifically what actual instructions are provided.

It does appear that teachers in this study placed considerable emphasis on learning at home: 3 h of practice a week at home versus 2 h and 15 min learning/practicing characters at school. This was likely due to the limited amount of time scheduled for Chinese language arts on-line. If such findings are replicated in future studies, it is important for researchers to determine if this level of emphasis on learning at home is effective and advisable.

Quality of instruction

Specific instructional practices for teaching characters

The potential impact of opportunity to learn is diminished when students are not provided with quality instruction (Carroll, 1989). In the present study, quality of instruction was examined by teachers reported use of 64 instructional practices for teaching the writing, reading, and meaning of Chinese characters. We predicted that during emergency remote instruction teachers would report they used multiple instructional procedures to teach these skills, but applied a limited number of them.

The prediction that teachers would use a variety of practices to teach characters during emergency remote instruction was supported, as the average number of instructional practices teachers reported using was 30 (out of 64). Contrary to predictions, the use of instructional practices was not overly limited for a majority of teachers, as 50% or more of them indicated they applied 31 different procedures to teach children how to write, read, and understand the meaning of characters.

Teachers also appeared to apply a relatively coherent approach for teaching characters. For example, when teaching students to write characters, the majority of teachers used Chinese etymology to introduce a character, discussed how the character was formed, modeled how to form it, and asked students to practice copying the character, use it in context, and correct mistakes in character formation. For reading, teachers reportedly modeled the correct pronunciation of the character in isolation and context and students practiced reading taught characters in isolation and context. For meaning, teachers reportedly used Chinese etymology, pictorial representations, and context to explain the meaning of characters; discussed radicals and changed radicals in characters to facilitate understanding; and asked students to compose words using characters and create sentences with them. A majority of teachers further worked with students to compare homophones, and they indicated they praised students' performance to increase motivation.

Even so, 33 instructional practices assessed were not reportedly used by 50% or more of teachers. Like practices used more commonly, these less applied practices are common in language arts textbooks in Macao (Hsiang et al., 2021) and

recommended for teaching writing, reading, and meaning (Graham et al., 2008a; Graham et al., 2008b; Hsiang & Graham, 2016; Hsiang et al., 2018, 2020; Miao, 2002). For instance, when teaching character writing during emergency remote instruction, the majority of teachers reportedly did not have students trace characters while learning them, evaluate their best formed characters, or address the needs of left-hand writers. When teaching character meaning, most teachers reportedly did not introduce the multiple uses of a character, the use of dictionaries to obtain information about characters, or correct mistakes involving meaning to provide some examples.

Unfortunately, we have no way of knowing if teachers' reported use of instructional practices in the current study reflect how they taught these skills before COVID-19. Future research needs to establish how primary grade teachers in the Greater China Region teach Chinese characters under normal conditions. Studies conducted during this or future pandemics should also question teachers about whether the instructional practices they apply differ before and during the pandemic, and if so, how and why?

Contextual vs isolation approach to teaching

We anticipated participating teachers would overwhelmingly report teaching characters in context because textbooks used to teach characters in Macao uniformly stress a contextual method (Hsiang et al., 2021). We did find that 40% of teachers reported they applied a context approach (31% used an isolation approach and another 28% a hybrid approach), but this fell far short of our expectation that most teachers would apply this approach.

It is possible that teachers did not apply the contextual approach more often because it was more difficult to do so when teaching online. It is also possible that the advice from the governments to solidify what students had learned previously resulted in teachers using an isolation approach because they believed it was not necessary to introduce characters in context since they had already done so before emergency remote instruction began. It is further possible that many of these teachers never followed the recommendations in the textbooks they used (which uniformly recommended a contextual approach), and applied the same approach before and during emergency remote instruction. While we cannot determine the veracity of these explanations, we encourage scholars to acquire data in future investigations on how Chinese characters are taught before and during future pandemics, and to query teachers about why they employ specific teaching approaches.

Lack of spaced practices when offering lessons teaching characters

It is generally agreed that learning how to write and read words (characters) fluently and correctly requires repeated teaching, practice, and review (Duke & Mesmer, 2018/2019; Graham & Weintraub, 1996). This requires a spaced practiced approach to learning. We did not specifically make any predictions about teachers offering a spaced practice approach when teaching characters via formal lessons,

but such an approach was not applied by participating teachers during emergency remote instruction when we consider how frequently they reportedly offered lessons for teaching characters (once every 3–4 weeks). This stands in stark contrast to how frequently lessons for teaching characters were offered in Hsiang (2021) before emergency lockdown occurred.

While it is possible that teachers provided space practice during the weeks when they did not offer a lesson on teaching characters, we cannot determine this based on the data collected in this study. Additional research is needed to determine if teachers reteach, provide additional practice, and review characters outside of the lesson(s) where they are introduced and reinforced. Such research should not only focus on how teachers modify instruction when forced to quickly adjust their teaching as occurred as a result of COVID-19, but if they provide instruction in learning characters that goes beyond the lessons in their textbooks. Further, efforts are needed to determine the effects of emergency remote instruction on young students' progress in learning Chinese characters and other important educational skills.

Moderating Factors

We predicted that teachers who reportedly applied asynchronous and synchronous methods more often when teaching online and were more positive about received instructional support during emergency remote instruction would indicate they spend more time teaching characters, expect their students to practice characters via homework more frequently, and apply more instructional practices when teaching the writing, reading, and meaning of Chinese characters. As expected, asynchronous/synchronous teaching methods and perceptions of instructional supports collectively accounted for unique and statistically significant variance in reported class and homework time and use of instructional practices after first controlling for teacher efficacy and attitudes, preparation (preservice, in-service, and personal), class size, and teaching experience. However, the direction of the relationships between the two sets of predictor variables (online teaching methods and perception of technical support) and the outcome variables (time and instructional practices) differed.

For all outcome variables except expected homework time, one of more of the online teaching methods made a positive, unique, and statistically significant contribution to predicting the reported teaching of Chinese characters. Teachers who indicated they applied synchronous online methods more often (teaching via video as well as audio/text) reportedly applied more instructional practices when teaching the writing, reading, and meaning of characters. Likewise, teachers who indicated they used real-time online video instruction more often reportedly spent more class time teaching/practicing characters. Lastly, teachers who reportedly applied asynchronous learning methods more frequently indicated they applied more instructional practices to teach the reading of characters. These outcomes were consistent with our contention that teachers who applied asynchronous/synchronous teaching methods more frequently were better prepared to deliver online instruction during

emergency remote instruction, and this lead them to devote more time and use more instructional practices when teaching characters.

In contrast to the positive relations observed between asynchronous/synchronous teaching methods and how characters were reportedly taught, teachers' perceptions of adequacy of technical support made a negative, unique, and statistically significant contribution to predicting all outcome variables except reported number of instructional practices used to teach the reading of Chinese characters. Teachers who were more positive about technical support received indicated they spent less time teaching/practicing characters during online classes, expected students to spend less homework time practicing characters, and applied fewer instructional practices teaching the writing and meaning of characters.

The negative relations between technical support and how teachers reportedly taught characters during emergency remote instruction were not consistent with our predictions. We anticipated that teachers who expressed more positive beliefs about the support they and their students received for emergency remote instruction would be better prepared to provide online instruction and devote more time and resources to teaching characters than teachers who were less positive about technical support received. One possible explanation for the negative relationship between perceived instructional support and reported instructional practices is that teachers who felt they and their students were better prepared for online instruction believed they did not need to devote as much time or apply as many instructional practices to teaching characters because they could deliver such instruction effectively in less time and with fewer resources. It is also possible that beliefs about adequacy of technical support were confounded with teachers' preexisting beliefs about their capabilities to deliver online instruction (not measured in this study). Teachers who were more positive about their online capabilities before the pandemic may have underestimated if technical support received had a positive effect, whereas teachers who were less positive about pre-pandemic capabilities may have overestimated the impact of technical support received.

Additional research is needed to replicate our findings concerning the moderating effects of asynchronous/synchronous online teaching methods and perceptions of technical supports as well as explore more deeply though interviews how these variables impact instruction during emergency remote instruction as well as under more normal conditions. More importantly, we need to identify additional variables that positively moderate how teaching proceeds when students are forced to rapidly switch from in person to online instruction.

Limitations

As with all studies, the current paper has a number of limitations that need to be considered when interpreting findings. One, the data is based on teachers' self-report, and it is possible that the teachers' assessment of their own behaviors were not fully accurate. Future studies of this nature would benefit from the use of observational techniques. Two, we did not have a baseline of how the teachers in this study taught Chinese characters before emergency remote instruction began. Investigations

conducted during future emergency remote instruction would benefit from collecting such data. This may prove to be challenging though because it may not be possible to predict precisely when emergency remote instruction will be provided.

Another limitation of this study concerns how we assessed time devoted to teaching Chinese characters. We asked teachers how much time they spent teaching the writing, reading, and meaning of such characters as well as how frequently such instruction was provided (daily, several times, a week, weekly, once every 2 weeks, once every 3 weeks, monthly, several times a month, and never). This allowed us to determine how much time was devoted to teaching Chinese characters and how frequently they were taught, but because of the differences in how these two aspects of time were measured, we could not indicate how long each teaching session was or precisely how frequently they occurred. We encourage investigators to explore different ways of assessing time in future studies such as this one (e.g., how long is an average teaching session and how many times during a month do you provide such lessons, or how much time each week do you spend teaching Chinese characters/ words).

The study was further limited as it only examined how teachers in Macao taught Chinese characters during emergency remote instruction that occurred as a result of COVID-19. Nevertheless, previous research examining the practices of educators in the Greater China Region show that teachers apply relatively similar instructional procedures when teaching writing in locations as diverse as Beijing, Hong Kong, Shanghai, Macao, and Taiwan (Hsiang et al., 2016, 2018, 2020). Of course, it is important for researchers to confirm that this is the case when emergency remote instruction occurs in the future.

Conclusions and Implications

This is the first study to our knowledge examining how Chinese characters were taught by primary grade teachers during emergency remote instruction in the Greater China Region. It is also the first study to examine how a large number of teachers in a particular setting (78% of primary grade teachers in Macao) taught students to write, read, and understand the meaning of Chinese characters either during or before the COVID-19. Further, it is the only study examining if the teaching of Chinese characters was moderated by how frequently teachers reported using asynchronous/synchronous online teaching methods and teachers' perceptions of the adequacy of the technical support they and their students received.

While teachers in this study reportedly spent a considerable amount of time teaching and having students practice Chinese characters during online classes and they generally applied a coherent set of practices for teaching students to write, read, and understand the meaning of characters, there are a number of reasons for concern. Over 70% of teachers offered lessons teaching characters just once every 3–4 weeks. The infrequency with which such lessons were offered raise questions about whether teachers provided students with adequate spaced practice as they learned characters during emergency remote instruction (Duke & Mesmer, 2018/2019; Graham &

Weintraub, 1996). Finally, many instructional practices recommended for teaching these skills were applied by less than 50% of the teachers.

Assuming the findings from the current study extends to other locations in the Greater China Region or other countries with different writing systems, policy makers and schools need to address the possible learning loss from less than optimal instruction. For students who received less than adequate instruction for learning foundational writing and reading skills as a result of the COVID-19 pandemic, how can the resulting loss in reading and writing skills be surmounted? This is important for the children affected because research has demonstrated that the reading and writing gains made by students during the pandemic are less than the gains made by students before it started (Lewis et al., 2021; Skar et al., in press). Moreover, it is difficult to overcome literacy issues in later grades that begin in the primary grades (Slavin et al., 1989). Possible solutions include providing extra instruction in these basic foundational skills in school during the immediate and upcoming years as well as providing extra instruction when students are not in school. In either case, this issue must be addressed or we risk the possibility of having a generation of students whose writing and reading abilities are not maximized.

Just as importantly, policy makers and schools need to determine how they will approach the next pandemic and ensuing emergency lockdown? It is not a question of whether there will be another pandemic, but when it will occur and whether countries and regions within countries are ready for it. This means there needs to be clear plans on how to proceed when this happens; teachers, students, and parents need to be prepared to implement educational procedures that will ensure the success of this plan; and a flexible approach will be needed in order to address unexpected developments and consequences.

References

Bergdahl, N., & Nouri, J. (2021). Covid-19 and crisis-prompted distance education in Sweden. *Technology, Knowledge and Learning, 26*, 443–459. https://doi.org/10.1007/s10758-020-09470-6

Blikstad-Balas, M., Dalland, C. P., Roe, A., & Klette, K. (in press). Homeschooling in Norway during the Pandemic—digital learning with unequal access to qualified help at home and unequal learning opportunities provided by the. In F. M. Reimers (Ed.), *Education and COVID-19. Disruptions to educational opportunity during a pandemic*.

Bond, T. G., & Fox, C. M. (2015). *Applying the Rasch model* (3rd ed.). Routledge.

Brindle, M., Graham, S., Harris, K. R., & Hebert, M. (2016). Third and fourth grade teachers' classroom practices in writing: A national survey. *Reading & Writing, 29*(5), 929–954. https://doi.org/10.1007/s11145-015-9604-x

Carroll, J. B. (1989). The Carroll model: A 25 year retrospective and prospective view. *Educational Researcher, 18*(1), 26–31.

Chen, C.-C. (2008). 國語文教材教法 [Teaching materials and methods for Chinese language]. 五南 [Wu-nan].

Chiu, C.-C., & Lin, M.-S. (2008). 寫字教學法對國小二年級寫字困難學生學習成效之研究 [The research of the effects of writing methodology towards the second graders with writing difficulty]. 東台灣特殊教育學報 [Bulletin of Eastern-Taiwan Special Education], *10*, 21–45. Retrieved February 2, from http://c052.ndhu.edu.tw/ezfiles/75/1075/img/237/east10-2.pdf

Daniel, J. (2020). Education and the COVID-19 pandemic. *Prospectus, 49*, 91–96.

Di Pietro, D., Biagi, G., Costa, P., Karpinski, Z., & Mazza, J. (2020). *The likely impact of COVID-19 on education: Reflections based on existing literature and recent international datasets.* Publications Office of the European Union.

Dillman, D. (2000). *Mail and internet surveys: The tailored design method* (2nd ed.). Wiley.

Dimov, P., & Dobreva, H. (2020). COVID-19's impact upon the organization of the educational process in the National security system. *AIP Conference Proceedings.* AIP. https://doi.org/10.1063/5.0041865

Duke, N., & Mesmer, H. (2019). Phonics faux pas: Avoiding instructional missteps in teaching letter-sound relationships. *American Educator, 42*(4), 12–16.

Education and Youth Development Bureau. (2016). 小學教育階段中文基本學力要求(第一語文即教學語文) [The requirements of basic academic attainments in Chinese language for primary education (primary language, that is, teaching language)]. *Boletim Oficial da Região Administrativa Especial de Macau* [Official Bulletin of the Special Administrative Region of Macao], *9*, 126–137. Retrieved March 23, 2021, from http://www.dsej.gov.mo/crdc/edu/BAA_primary/despsasc-19-2016-anexo_i.pdf

Education and Youth Development Bureau. (2020a). *"Give a good anti-epidemic lesson to students at home"—a letter to the teachers of kindergartens, primary, secondary and special education schools in Macao*. Retrieved February 5, 2020, from https://portal.dsedj.gov.mo/webdsejspace/internet/Inter_main_page.jsp?id=74987

Education and Youth Development Bureau (2020b). *Statistical profile of non-tertiary education (2019/2020b)*. Retrieved May 5, 2020, from https://portal.dsej.gov.mo/webdsejspace/internet/Inter_main_page.jsp?id=8514

Fauzi, I., & Khusuma, I. (2020). Teachers' elementary school in online learning of COVID-19 pandemic conditions. *Jurnal Iqra, 5*(1), 58–70.

Fives, H., & Buehl, M. M. (2012). Spring cleaning for the 'messy" construct of teachers' beliefs: What are they? Which have been examined? What can they tell us? In K. R. Harris, S. Graham, & T. Urdan (Eds.), *APA educational psychology handbook: Vol 2. Individual differences and cultural and contextual factors* (pp. 471–499). American Psychological Association.

Graham, S. (in press). Writer(s)-within-community model of writing as a lens for studying the teaching of writing. In R. Horrowitz (Ed.), *The Routledge Handbook of International Research on Writing, Vol. II* Routledge, London

Graham, S. (2018). A revised writer(s)-within-community model of writing. *Educational Psychologist, 53*(4), 258–279. https://doi.org/10.1080/00461520.2018.1481406

Graham, S. (2019). Changing how writing is taught. *Review of Research in Education, 43*(1), 277–303. https://doi.org/10.3102/0091732X18821125

Graham, S., Harris, K. R., Fink, B., & MacArthur, C. (2001). Teacher efficacy in writing: A construct validation with primary grade teachers. *Scientific Study of Reading, 5*(2), 177–202. https://doi.org/10.1207/S1532799Xssr0502_3

Graham, S., Harris, K. R., Mason, L., Fink-Chorzempa, B., Moran, S., & Saddler, B. (2008a). How do primary grade teachers teach handwriting? A National Survey. *Reading and Writing, 21*(1), 49–69. https://doi.org/10.1007/s11145-007-9064-z

Graham, S., Morphy, P., Harris, K. R., Fink-Chorzempa, B., Saddler, B., Moran, S., & Mason, L. (2008b). Teaching spelling in the primary grades: A national survey of instructional practices and adaptations. *American Educational Research Journal, 45*(3), 796–825. https://doi.org/10.3102/0002831208319722

Graham, S., & Weintraub, N. (1996). A review of handwriting research: Progress and prospect from l980 to 1993. *Educational Psychology Review, 8*(1), 7–87. https://doi.org/10.1007/BF01761831

Ho, F.-C., & Siegel, L. S. (2016). A Study of the relationships among Chinese multi-character words, subtypes of readers, and instructional methods. *Journal of Learning Disabilities, 49*(1), 97–110. https://doi.org/10.1177/0022219414529334

Hodges, C., Moore, S., Lockee, B., Trust, T., & Bond, A. (2020). *The difference between emergency remote teaching and online learning*. Educause Review. Retrieved November 21, 2021, from https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning

Howard, P., & Howard, J. (2012). Pandemic and pedagogy: Elementary school teachers' experiences of H1N1 influenza in the classroom. *Phenomenology & Practice, 6*(1), 18–35. https://doi.org/10.29173/pandpr19852

Hsiang, T. P. (2021). *Teaching reading and writing in primary grades in Macao: A qualitative study. [Manuscript submitted for publication]*. Faculty of Education, University of Macau.

Hsiang, T. P., & Graham, S. (2016). Teaching writing in grades 4 to 6 in urban schools in the greater China region. *Reading and Writing, 29*(5), 869–902. https://doi.org/10.1007/s11145-015-9597-5

Hsiang, T., Graham, S., Wang, Z., & Gong, Y. (2021). How Chinese characters are taught: An analysis of three popular textbooks. *Technology, Knowledge and Learning, 26*, 355–381. https://doi.org/10.1007/s10758-021-09492-8

Hsiang, T. P., Graham, S., & Wong, P. M. (2018). Teaching writing in grades 7–9 in urban schools in Chinese societies in Asia. *Reading Research Quarterly, 53*(4), 473–507. https://doi.org/10.1002/rrq.213

Hsiang, T., Graham, S., & Yang, Y. (2020). Teachers' practices and beliefs about teaching writing: A comprehensive survey of grades 1 to 3 teachers. *Reading and Writing, 33*(10), 2511–2548. https://doi.org/10.1007/s11145-020-10050-4

Huber, S. G., Günther, P. S., Schneider, N., Helm, C., Schwander, M., Schneider, J. A., & Pruitt, J. (2020). *COVID-19 und aktuelle Herausforderungen in Schule und Bildung*. Waxmann. Retrieved September 19, 2021, from https://www.waxmann.com/index.php?eID=download&buchnr=4216

Hung, L.-Y., & Huang, K.-Y. (2006). 兩種取向的部件識字教學法對國小低年級語文低成就學生之成效比較 [Two different approaches to radical-based remedial Chinese reading for low-achieving beginning readers in primary school]. 特殊教育研究學刊 [Bulletin of Special Education], *31*, 43–71.

Juel, C. (1988). Learning to read and write: A longitudinal study of 54 children from first through fourth grade. *Journal of Educational Psychology, 80*(4), 437–447. https://doi.org/10.1037/0022-0663.80.4.437

Kendeou, P., Savage, R., & van den Broek, P. (2009). Revisiting the simple view of reading. *British Journal of Educational Psychology, 79*(2), 353–370. https://doi.org/10.1348/978185408X369020

Kim, Y.-S.G. (2020). Hierarchical and dynamic relations of language and cognitive skills to reading comprehension: Testing the direct and indirect effects model of reading (DIER). *Journal of Educational Psychology, 112*(4), 667–684. https://doi.org/10.1037/edu0000407

Kirshner, J. (2020). School radio: Finding innovation in reaching remote learners in Belize. *International Journal of Education & Literacy Studies, 8*(3), 90–97. https://doi.org/10.7575/aiac.ijels.v.8n.3p.90

Kong, M. Y. (2020). The association between children's common Chinese stroke errors and spelling ability. *Reading and Writing, 33*(3), 635–670. https://doi.org/10.1007/s11145-019-09981-4

Lam, H. C. (2011). A critical analysis of the various ways of teaching Chinese characters. *Electronic Journal of Foreign Language Teaching, 8*(1), 57–70.

Lewis, K., Kuhfeld, M., Ruzek, E., & McEachin, A. (2021). *Learning during COVID-19: Reading and math achievement in the 2020–21 school year*. NWEA.

Li, M. (2020). A systematic review of the research on Chinese character teaching and learning. *Frontiers of Education in China, 15*(1), 39–72. https://doi.org/10.1007/s11516-020-0003-y

Liu, Y., & Liu, D. (2020). Morphological awareness and orthographic awareness link Chinese writing to reading comprehension. *Reading and Writing, 33*, 1701–1720. https://doi.org/10.1007/s11145-019-10009-0

Lu, M. C. (2000). 基本字帶字識字教學對國小識字困難學生識字成效之探討 [The effectiveness of Chinese stem-deriving instruction on elementary students with several word-recognition difficulties]. 特殊教育研究學刊 [Bulletin of Special Education], *18*, 207–235.

Miao, J.-H. (2002). 慣用左手兒童寫字能力特性與書法美感形式表現之研究 [A research of left-handed writing students' writing abilities and arts of calligraphy]. [Master's thesis, Hsinchu Teachers College]. Retrieved February 2, 2021, from https://hdl.handle.net/11296/ev64w4

Ministry of Education of the People's Republic of China. (2012). 义务教育语文课程标准 *(2011 年 版)* [Compulsory Education Chinese Language Curriculum Standards (2011 ed.)]. Beijing Normal University.

Rasch, G. (1980). *Probabilistic models for some intelligence and attainment tests*. The University of Chicago Press.

Schleicher, A. (2020). *The impact of COVID-19 on education: Insights from education at a glance*. OECD Publishing. Retrieved September 19, 2021, from https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf

Skar, G., Lei, P., & Graham, S. (in press). Text transcription skills, writing motivation, and syntactic competence predict the quality of primary grade students' writing. *Reading & Writing*.

Slavin, R., Madden, N., & Karweit, N. (1989). Effective programs for students at risk: Conclusions for practice and policy. In R. Slavin, N. Karweit, & N. Madden (Eds.), *Effective programs for students at risk* (pp. 21–54). Allyn & Bacon.

Sprang, G., & Sillman, M. (2013). Posttraumatic stress disorders in parents and youth after health-related disasters. *Disaster Medicine and Public Health Preparedness, 7*(1), 105–110. https://doi.org/10.1017/dmp.2013.22

Tse, S. K., Marton, F., Ki, W. W., & Loh, E. (2007). An integrative perceptual approach for teaching Chinese characters. *Instructional Science, 35*(5), 375–406. https://doi.org/10.1007/s11251-006-9011-4

Wang, J., & Leland, C. H. (2011). Beginning students' perceptions of effective activities for Chinese character recognition. *Reading in a Foreign Language, 23*(2), 208–224.

Winthrop, R. (2020). *COVID and school closures: What can countries learn from past closures?* Brookings. Retrieved September 19, 2021, from https://www.brookings.edu/research/covid-19-and-school-closures-what-can-countries-learn-from-past-emergencies/

Wright, B. D., & Linacre, J. M. (1994). Reasonable mean square fit values. *Rasch Measurement Transactions, 8*(3), 370. Retrieved September 19, 2021, from http://www.rasch.org/rmt/rmt83b.htm

Wu, Z. (2010). 小学语文课程与教学 [Curriculum and instruction of Chinese language in primary education]. China Renmin University Press.

Yeung, P., Ho, C. S., Chan, D. W., & Chung, K. K. (2017). A simple view of writing in Chinese. *Reading Research Quarterly, 52*(3), 333–355. https://doi.org/10.1002/rrq.173

Authors and Affiliations

Tien Ping Hsiang[1] · Steve Graham[2] · Zhisheng Wang[1] · Chuang Wang[1] · Gustaf B. Skar[3]

Tien Ping Hsiang
tphsiang@um.edu.mo

Zhisheng Wang
zwang@um.edu.mo

Chuang Wang
wangc@um.edu.mo

Gustaf B. Skar
Gustaf.b.skar@ntnu.no

[1]   Faculty of Education, University of Macau, Taipa, Macau, China

[2]   Mary Lou Fulton Teachers College, Arizona State University, Tempe, AZ, USA

[3]   Norwegian University of Science and Technology, Trondheim, Norway