Part C Project Details

Needs Assessment and Applicant's Capability

Dyslexia is one of the special educational needs categories in Hong Kong, and they are believed to be the highest prevalent one. Thus, many teachers and parents desperately want to find a way to improve as much as reading and writing abilities of those children with dyslexia. Although the effects of stem-deriving instruction in improving reading of Chinese children with dyslexia have been somehow proved, the details of its effectiveness remain unclear. Such lacking will impede our understanding of how to revise or adapt stem-deriving instruction to fulfill different needs of highly heterogenous characteristics of Chinese dyslexia. Therefore, this project targets the Priority Theme "Support for Students with Diverse Needs", in particular, our project is about the adaptation of a programme and sustainable practices of intervention under the 3-tier support model for students with reading and writing difficulties. The outcomes of this project could be helpful to the teachers and parents when they would like to implement the Chinese stem-deriving instruction which is a well-known instruction in Hong Kong, and then maximize the learning effects of those with dyslexia. Teachers in the schools could refer to the outcomes of our project to adapt the designs of Chinese stem-deriving instructions and make it more effective to those with dyslexia.

All members join in this project have considerable experience in either Chinese reading/writing or the instruction to Chinese children with dyslexia. who is interested in understanding the natures and heterogeneity of Chinese dyslexia and then extend to the ways to improve their academic competence as well as quality of life, will oversee the whole procedure, including purchasing and developing testing materials, recruiting and training research assistant and student helpers, collecting data, etc. will help to look for participants and to ensure all teaching materials and measures are well-designed and age-appropriate. His research interesting is in the area of literacy acquisition and cognitive development of Chinese children. have worked together in some previous studies and projects. will help mainly on the designs of measures as well as recording the participants' responses to our interventions. He has rich research experience in conducting the measures of Chinese children's cognitive development and related problems, especially on language and literacy development and difficulties. also have collaborating experience for a few years in some studies and projects.

Goals and Objectives

This project aims to explore a better way to improve teachers' designs of Chinese stem-deriving instructions and facilitate the Chinese learning of Chinese children with dyslexia. (*Priority Theme No. 8*). As the design of the Chinese stem-deriving instruction is highly variable, it could lead to unsuitable working memory loadings on different domains for dyslexic children. This gives rise to two important questions. Could the well-controlled design of Chinese stem-deriving instruction enhance dyslexic children's character reading? If so, it will be most effective to control the working memory loading for which domain? Accordingly, two project objectives are proposed to examine these questions.

1. To examine the effectiveness of three Chinese stem-deriving instructions by comparing (1) the intragroup differences between the pretest and posttest and (2) the intergroup comparison on the posttest regarding accuracy character reading, character dictation, and vocabulary creation.
2. To compare the growth curves of taught character reading of three Chinese stem-deriving instructions.

The outcomes of this project could lead us to know how teachers could maximize the effectiveness of Chinese stem-deriving instructions in teaching Hong Kong dyslexic children's character reading, and the teachers could take the most effective principal we find in this project to design the Chinese lessons for their students with dyslexia.

Targets and Expected Number of Beneficiaries

We target at 45 Hong Kong children with dyslexia in this proposed project, and they will gain the direct benefits from the refined Chinese stem-deriving instruction. Apart from these 45 Hong Kong children with dyslexia, our instructional designs will be delivered to 150 teachers and parents in persons as well as via website and other social media. For those who access the materials of our teaching methods could be the beneficiaries of this project.

Innovation

This project is among the first to take the idea of cognitive loading of learners into consideration for reforming Chinese stem-deriving instructions, which is well-accepted but somehow its effects are controversial, to improve Chinese learning of Hong Kong children with dyslexia. Additionally, teachers could also take the key concepts in this project, i.e., children's working memory loading, into consideration when they design the teaching for other groups of students or other subjects.

Conceptual Framework

Dyslexia, a major category within the spectrum of specific learning disabilities, is considered a severe and pervasive difficulty in learning to read and spell despite normal intelligence and despite the absence of sensory and neurological impairments, emotional and behavioral problems and environmental deprivation (Chung, 2016). Thus, dealing with dyslexic children's reading and writing problems can be a great challenge to teachers, especially the aforementioned problems need alternative or specially designed approaches/methods (Piotrowski & Reason, 2000). Mostly, these designs are based on the idea of remediation of deficient reading performance as well as their poor cognitive or literacy abilities. For instance, a substantial amount of evidence has demonstrated that the poor reading of children with dyslexia somehow relates to reading-related deficit, especially phonological processing (Ziegler & Goswami, 2005), in alphabetic languages, so many scholars have successfully proved, to a certain degree, that diverse phonological awareness training could lead to positive effects to general reading performance of children with dyslexia (e.g., Torgesen, Morgan, & Davis, 1992).

However, comparing to relatively consistent evidence in alphabetic languages, it is believed that Chinese children with dyslexia have more diverse deficits, including visual-orthographic knowledge, rapid naming, visual perception, and phonological awareness, (Ho & Bryant, 1997; Ho, Chan, Tsang, & Lee, 2002). Among those, visual-orthographic skills have been found to be an important factor in learning Chinese characters (Huang & Hanley, 1995) as has the connection between visual-orthographic information and sound (Ho & Bryant, 1997). Thus, many different teaching methods, which are designed to facilitate Chinese learning of those children with dyslexia, are generated by targeting this ability, such as Chinese stem-deriving instruction.

Chinese stem-deriving instruction is designed based on reforming the weakness of regular instruction in recognizing and reading Chinese characters in context, i.e., teaching students to learn new words from reading passages, is one of the main problems with teaching new characters using an unsystematic approach because the choices of new characters must fit the sequence of teaching each text (Wan, 1991). As proposed, in Chinese stem-deriving instruction, Chinese characters are taught in a group with other characters that share the same stem. This is called stem-family instruction (Lu, 2000). For instance, the teaching design involves teaching the stem "包" (/bao1/) and its extending characters with semantic radicals such that "手" (/shou3/, hand), "火" (/huo3/, fire), and "草" (/tsao3/, grass) are "抱" (/bao4/), "炮" /bao1/ (/pao14), and "苞" /bao1/ (/bao1/) are thus taught within one teaching section.

Based on the previous evidence, Chinese stem-deriving instruction is believed by some scholars and teachers to be an effective instructional methodology that can improve learning, at least at the character level, for most Chinese dyslexic children (Zhang, Wang, Wen, Qin, & Zhong, 2006). However, the difference between the effectiveness of Chinese stem-deriving

instruction and regular instruction in improving dyslexic children's character learning is under debate. More specifically, some studies have indicated that dyslexic children who learned characters via Chinese stem-deriving instruction demonstrated significant learning of characters (e.g., Lu, 2000) and even outperformed dyslexic children who learned via regular instruction (e.g., Chen et al., 2013). Contrary to this finding, other studies have reported that there was either no difference between the types of instruction or a slightly lower level of achievement for dyslexic children who had received Chinese stem-deriving instruction (e.g., Wong, Sio, & Leung, 2007; Hu, 2001; 2005).

Such discrepancy may be leaded by the designs of stem-deriving instruction itself (for a review, see Wang, 2005). Stem and extending characters are two main components of stem-deriving instruction. The stem chosen tends to be consistent across different studies because most of the studies considered high fluency to be a benchmark. Thus, the arguments regarding this component are few. However, choosing extending characters is much more complicated and inconsistent across relevant studies. Wang (2005) further argued that most stems involved in this instruction are phonetic radicals, so children receive a group of Chinese characters with similar/the same sounds may face a certain degree of difficulties to follow, especially for those with poor phonological processing. Additionally, a group of Chinese character with very similar shapes could increase the difficulties in learning, especially for those with poor visual perception. Considering the heterogenous natures of Chinese dyslexia (Wang & Yang, 2015), the considerations of adapting the details of stem-deriving instruction are necessary to be put to benefit as many of them as possible.

From this perspective of view, even though the high-frequency principle is applicable when selecting extending characters, there are three variables, namely, pronunciation, structure, and amount, that researchers must consider when selecting the extending characters (e.g., Chen et al., 2013; Hu, 2001, 2005; Lu, 2000; Wong et al., 2007; Zhang et al., 2006). So, it is reasonable to infer the necessity in providing an affordable loading to Chinese dyslexic students in each of aforementioned aspects. Furthermore, the loadings in these aspects could correspond to different working memory domains, mainly including verbal (phonological loop) and visuospatial (visuospatial sketch pad) (Baddeley, 1986).

Although such increased working memory loads may not put typically developing children's learning in jeopardy, it is highly possible to affect Chinese dyslexic children's since there is a growing body of evidence has preliminarily identified working memory deficits in Chinese children with dyslexia (e.g., Ho, Chan, Lee, Tsang, & Luan, 2004; Luo, Wang, Wu, Zhu, & Zhang, 2013; Zhu, Wang, & Wu, 2012). The problematic working memory in different domains is believed to deteriorate domain-specific skills, knowledge, and procedures (Peng, Namkung, Barnes, & Sun, 2015).

According to cognitive load theory, to facilitate learning, the instructional methodologies should attempt to eliminate, to the greatest degree possible, working memory loadings (e.g., Rougier & Bonnet, 2016). However, it has been found that when selecting the extending characters for Chinese stem-deriving instruction, the working memory loads of different domains may increase according to their frequency or level of difficulty, which may lead to controversy regarding its effectiveness, especially for those with dyslexia who are already experiencing entire working memory deficits. Thus, to enhance the effectiveness of Chinese stem-deriving instruction for children with dyslexia, the clear relationships between and among the different domains of working memory and the different aspects of extending characters must be understood.

Verbal working memory – Pronunciation of extending characters

Unlike the assembled phonology in English, which includes the knowledge of letter-sound mapping, the pronunciation of a Chinese character is thought to be derived directly from its phonetic radical (e.g., deriving the sound of 晴 [/ching2/, sunny] from its phonetic 青 [/ching1/, green]) or indirectly from an analogy with another character having the same phonetic radical (e.g., associating the sound of 晴[/ching2/, sunny] with 清[/ching1/, clear]). The similarity of the pronunciations of the phonetic radicals and the characters is analogous to the regularity

effect in English, whereas the similarity of the pronunciations of two characters with the same phonetic radicals reflects a phonetic regularity (Ho, Chan, Tsang, Lee, & Chung, 2006).

Chinese characters can be divided into three categories based on phonetic regularity, namely, regular characters, semi-regular characters, and irregular characters (Fang et al., 1986). Regular characters are characterized by their phonetic radical, which is identical in pronunciation to the whole character. For instance, the phonetic radical of 清(/ching1/, clear) is 青 (/ching1/, green). More specifically, they use 23% of the total characters in the primary school textbooks (Shu, Chen, Anderson, Wu, & Xuan, 2003). In contrast, with respect to irregular characters, the pronunciations of their phonetic radicals are completely irrelevant when considering the pronunciations of the whole characters. For instance, whereas the phonetic radical of 法(/fa3/, law) is 去 (/chu4/, go), their pronunciations are completely different, even though they assume 15% of the total characters included in the primary school textbooks (Shu et al., 2003).

Nonetheless, apart from the regular and irregular characters and the distinct division regarding the pronunciations between phonetic radicals and whole characters, the definition of semi-regular characters is more flexible and ambiguous, and they make up 42% of all characters, thus exceeding the combination of the last two categories (Shu et al., 2003). Due to the ambiguity of semi-regular characters, this category has been divided into three sub-categories based on various components of sounds (Shu et al., 2005), namely, on-set difference (20%), rime difference (6%), and tone-difference (16%). For instance, 精(/jing1/, spirit) and 請 (/ching3/, please) are the on-set difference and rime difference semi-regular characters, respectively, for the phonetic radical 青 (/ching1/, green). Moreover, 結(/chieh2/, blend) is a rime difference semi-regular character for the phonetic radical 吉 (/chi2/, luck). Among these sub-categories, the accuracy of tone-different semi-characters was slightly worse than that for regular characters (Ho & Bryant, 1997), though tone-different semi-characters are sometimes classified as regular characters (e.g., Tzeng et al., 1995) due to partial information that is more useful for pronunciation.

The phonetic regularity of script–sound in Chinese characters is referred to as rules of orthography–phonology correspondence (OPC) (e.g., Ho & Bryant, 1997). Similar to the way children learn alphabetic scripts, Chinese children, in addition to phonological knowledge regarding specific characters stored in the memory, also acquire and construct general knowledge of OPC when reading Chinese characters. Knowledge of phonetic radicals or other components, e.g., lexical tones, has been reported to be an important correlate of reading performance in Chinese (Shu & Wu, 2006; Wang*, Liu, Chung, Yang, 2017).

The treating of a high variety of sounds simultaneously could result in a heavier loading on the verbal working memory (Mayer & Moreno, 2003) and in a lower phonetic regularity, which is denoted by a high variety of groups of character pronunciations. This may make it more difficult for readers to learn these pronunciations, especially for those students who struggle with verbal working memory, such as those with dyslexia. Moreover, it has been demonstrated that a well-controlled consistency of phonetics expedites reader learning (e.g., Lee et al., 2005). Therefore, increasing the phonetic regularity of extending characters selected in Chinese stem-deriving instruction, that is, choosing the extending characters with identical pronunciations for each stem, is considered one of the more successful approaches for decreasing dyslexic children's verbal working memory loads and improving the effects of Chinese stem-deriving instruction.

Visuospatial working memory - Structures of extending characters

There is a systematic structural knowledge in Chinese that is relevant for children learning to read and write, namely, the orthographic knowledge that semantic and phonetic radicals are located in specific places in Chinese characters (Packard et al., 2006). This structural segmentation of knowledge at the character level helps readers reduce the number of processing units from more than ten thousand to a more manageable number of approximately one thousand radicals (Ho, Yau, & Au, 2003).

In Ho et al.'s (2003) model of orthographic knowledge development in Chinese, visual-orthographic knowledge of Chinese characters is consistent with its two stages: structural

knowledge and positional knowledge. Structural knowledge, which refers to the ability to separate Chinese characters into radicals, is an early stage of Chinese orthography with which most five-year-old children and primary first graders are familiar. Although there is no absolute way to segment Chinese characters into pieces, Chen, Chang, Chiou, Sung, and Chang (2011) identified eleven symbols of configurations. More specifically, structural knowledge was extracted from 6097 highly frequent Chinese characters that included 439 radicals. Among the eleven types of structural knowledge of Chinese characters, vertical combination (e.g., left-and-right and left-middle-right) accounted for 47.04% and horizontal combination (i.e., top-and-down and top-middle-down) accounted for 33.87% (Chen et al., 2011) of the total.

Compared to structural knowledge, positional knowledge in Ho et al.'s (2003) model is more complicated and consists of more detailed functions. Positional knowledge refers to the understanding of the legal positions of semantic and phonetic radicals. Children's positional knowledge development regarding semantic radicals and phonetic radicals varies considerably. For example, primary third graders demonstrate 97% accuracy with respect to semantic radicals, whereas knowledge of phonetic radicals is not demonstrated until the primary fifth grade, with students demonstrating an 82% accuracy rate (Ho, Ng, & Ng, 2003).

The increased focus on a variety of shapes simultaneously could lead to heavier loading on visuospatial working memory (Mayer & Moreno, 2003), and thus, the lower consistency of Chinese character structures may make it difficult for readers to learn these shapes. This is especially relevant for Chinese children with dyslexia as they exhibit deficient visuospatial working memory. Therefore, providing corresponding structures of extending characters selected for the Chinese stem-deriving instruction is considered another approach to decrease dyslexic children's working memory loads and improve the effects of Chinese stem-deriving instruction.

In sum, the limited capacities of working memory on different domains of children with dyslexia may limit their Chinese character learning if the teaching designs are not appropriate. Therefore, this proposed project intends to examine the effects of various Chinese stem-deriving instructions based on the considerations of working memory loading on diverse modalities. More specifically, there are three designs in this project: 1) verbal controlled Chinese stem-deriving instruction, (2) visuospatial controlled Chinese stem-deriving instruction, and (3) non-controlled Chinese stem-deriving instruction.

The verbal controlled Chinese stem-deriving instruction requires that both regular characters and tone-different semi-characters be chosen for the high regularity condition, whereas characters that belong to only the on-set different or irregular condition will be considered low phonetic regularity in this project since the proportions are smaller and they contain less phonetic information regarding rime-different semi-regular characters (Chen, Shu, Wu, & Anderson, 2003). This design is expected to help children with dyslexia better manage the pronunciation-similar Chinese characters. In contrast, the visual controlled Chinese stem-deriving instruction will involve only left-and-right and top-and-down in Chen et al.'s (2011) findings. In more detail, there will be eight subgroups, including equal left-and-right, big left-and- small right, small left-and-big right, left-middle-right, equal top-and-down, big top-and-small down, small top-and-big down, and top-middle-down modes. This design is expected to help children with dyslexia more easily manage the orthography-similar Chinese characters. Finally, this project also includes a group of participants who will receive Chinese stem-deriving instruction without specific controls to further demonstrate the effects of the controls.

Implementation Plan with Timeline

Participants

It is expected that 45 Chinese (Hong Kong) children with dyslexia will be recruited from primary schools in grades second and third in Hong Kong. In this proposed project, all eligible children with dyslexia will have a standard score of -1.5 standard deviations below average on the Chinese word reading test, i.e., the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD [II]) (Ho, Chan, Tsang, & Lee, 2007) or a later version, and will exhibit normal intelligence based on an IQ score greater than 85. All participants are

expected to be officially diagnosed with dyslexia based on the three-tier model by educational psychologists in Hong Kong. The criteria for dyslexia in the present study also involves normal or corrected-to-normal vision and hearing and the absence of attention deficit disorder with hyperactivity.

To ensure the recruitment of potential participants, the principal investigator invited and received the agreements of participation in this project from one local NGO, namely, the the South Kwai Chung Social Service Centre (南葵涌社會服務處). Moreover, the principal investigator will approach and invite more potential collaborators to participate in this study.

Participants will be randomly and equally assigned to one of three groups (N=15 for each group), namely, (1) a verbal controlled Chinese stem-deriving instruction group, (2) a visuospatial controlled Chinese stem-deriving instruction group, and (3) a non-controlled Chinese stem-deriving instruction group. The major difference among the three groups is the chosen extending characters presented during instruction. For the verbal controlled group, for example, the extending characters' pronunciations will be controlled as very high or identical consistency, whereas the structure of extending characters will be random. For the visuospatial controlled group, the structure of the extending characters will be controlled for identical consistency, whereas the extending characters' pronunciations will be random. For the non-controlled group, both pronunciations and structures of the extending characters will be random.

Materials

The participants will be given a number of cognitive and literacy tests, including standardized tests and self-developed tasks. Student helpers in undergraduate or master level programs, working in the capacity of data collectors, will administer the tests under the supervision of the principal investigator and co-investigators. The participants will be tested individually or within their group during one or two sessions for each testing period. The participants will be given a five-minute break after every 20-minute testing period and may be assessed on separate days, if necessary. The measures will be short, fast-paced and varied to maintain a high degree of motivation and interest.

Raven's Standard Progressive Matrices Nonverbal IQ, tested by Raven's Standard Progressive Matrices, has been considered as a crucial index to the reading acquisition of children with and without dyslexia across studies (e.g., Chung et al., 2008; Wang & Yang, 2018). This is a standardized nonverbal IQ test that consists of 60 items of increasing difficulty. Each item has a target visual matrix with one missing part. The children are provided with six to eight response options and asked to select the response that completes the missing piece in the visual matrix (Raven et al., 1996). This test is used to screen participants for the study.

The Chinese Character Recognition Scale This test, developed by Huang (2001), is a standardized test in which participants read aloud the pronunciations of Chinese characters visually presented in a list. This test has been widely used to test children's Chinese character reading although in the Hong Kong context (e.g., Wang, 2017), and this aspects of performance is one of the target outcomes in this project. During the test, the participants are asked to utter or write the sounds as quickly as possible; the teachers cannot provide cues or hints to the participants. The test arrangement includes 20 lines, and each line includes ten Chinese characters, totaling 200 Chinese characters. The applicable targets of this test are first to ninth graders. Considering the large sample size in this study, the participants were given a seven-minute time limitation. Based on our sample and procedures, Cronbach's α coefficient was .75.

The Battery of the Chinese of Pupils (基本讀寫字綜合測驗) This standardized battery of tests was developed by Hung, Chang, Chen, Li, and Chen (2003) to comprehensively assess Chinese children's reading and writing skills at the character level. Although there are nine sub-tests in this assessment, only five of them are suitable for children in Hong Kong as the other three assessments include items related to Zhuyin Fuhao, which is specifically used for teaching Taiwanese children the pronunciations of Chinese characters, while the other two are

overlapped with the function of The Chinese Character Recognition Scale. The five sub-tests include (1) vocabulary creation, (2) dictation, (3) character copying (long distance), and (4) character copying (short distance). All these four aspects of performance are the target outcomes of this project. The average Cronbach's α coefficient is .87 ($p < .01$), and the split-half reliability is .90 ($p < .01$). Accordingly, this test will be used to assess the literacy performance of the participants before and after the intervention.

Curriculum-based assessment for Chinese character reading and writing A set of character reading and writing materials that test the immediate and maintained effects will be prepared for each teaching session. The stimuli in the assessment are those characters that were taught in each teaching session. To confirm the effect of the effectiveness of teaching, each set of materials will be administered twice, i.e., once immediately after teaching and again one week after teaching. These tests will be used to monitor the participants learning progress during the intervention.

Procedure

This is a 24-month project with two testing periods and two separate sections. The preparation section is expected to take six months. During this six month section, the necessary manpower will be recruited and trained by the principal investigator and the co-investigators. The next six months will be dedicated to recruiting participants. Potential participants will be recruited from schools and NGOs, and the project will be promoted through flyers and presentations. At this point, parental and school consent will be required for all eligible participants. Moreover, during this phase of the study, all participants will be screened using corresponding measurements, i.e., one non-verbal IQ test and one Chinese word reading test. The teaching resources, including the selection of the stems and extending characters, the production of the relevant teaching materials, the design of the teaching plans and research-based assessments, and the training of the intervention providers, will be determined during this period. Following this, once the background information of the participant is matched, a data collection section that includes The Battery of the Chinese of Pupils is administered. It is anticipated that this may take up to two months. Furthermore, the intervention is introduced over the following six-month period, during which time the learning progress of the students is recorded based on the researcher developed curriculum-based assessment for Chinese character reading and writing. Finally, it is estimated that another two months must be dedicated to the collection of the after-intervention data derived from The Battery of the Chinese of Pupils. Accordingly, the data collection period will span a period of 12 months.

Design and Implementations of Chinese stem-deriving instruction

Regarding the experimental design of this project, the differences among the three groups of Chinese stem-deriving instructions will be in the consistency of the extending characters' structures and pronunciations of extending characters but not teaching approaches or steps. That is, for the non-controlled Chinese stem-deriving instruction, the structures and pronunciations of the extending characters are random.

The main teaching materials for Chinese stem-deriving instruction are stems and extending characters, and they will be selected in terms of the following principles.

- Stems: The stems of Chinese stem-deriving instruction will be selected from the textbooks of primary grades first through third and then analyzed. Thus, the participants are expected to be familiar with the stems.
- Extending characters: The extending characters will be selected by the degree of frequency and level of difficulty. The characteristics of selecting extending characters for the three Chinese stem-deriving instructions will be derived from the QEF-funded website, "A Study of Chinese Characters Recommended for the Subject of Chinese Language in Primary Schools" for meeting the participated students' current status of (un)known Chinese characters. In most cases, we expect to select the Chinese characters which are around first to third-grade difficult level.

There are two types of Chinese stem-deriving instructions designed in terms of the working memory loadings for this project. The first is the verbal controlled Chinese stem-deriving instruction that is designed to reduce the learner's verbal working memory load and thus reduce the extra cognitive loadings caused by learning the target characters with varied sounds. In this group, the pronunciations of the extending characters will be controlled and considered as very high or identical consistency, whereas the structure of extending characters will be random. In contrast, visuospatial-controlled Chinese stem-deriving instruction, which is designed to reduce the learner's visuospatial working memory load and thereby reduce the extra cognitive loadings caused by learning target characters with varied sounds. In this group, the structure of extending characters will be controlled as identical consistency, whereas the pronunciations of the extending characters will be random in the visuospatial-controlled Chinese stem-deriving instruction.

Also, the teaching approach of the Chinese stem-deriving instruction in this project is based on the original idea of (1) introducing stem and then (2) teaching extending characters (Wu, 2007). The detailed steps of this instruction are adapted and amended from Lu's (2000) teaching procedure with combination of Wu's (2007) teaching designs for radical group text teaching strategies which the contextual information of each Chinese characters is emphasized on top of the basic idea of Chinese stem-deriving instruction.

1. Five minutes for warm-up.
2. Five minutes for teaching the targeted Chinese stems.
3. Twelve minutes for teaching extending Chinese characters, including (1) writing all extending characters on blackboard (five minutes) and (2) providing meanings (pictures) for each extending character (seven minutes).
4. Ten minutes for guiding the students' discussion on creating corresponding two-character vocabularies from each extending character.
5. Ten minutes for guiding the students' discussion on putting all created vocabularies into one short story.
6. Eight minutes for assessment/evaluation.

Furthermore, to facilitate participant learning motivations and outcomes, all selected teaching materials will include not only Chinese characters/radicals but also the relevant multiple media materials, i.e., graphics and animations. Furthermore, to strengthen participant memory, all multiple media materials of the stems and extending characters will be presented by referring to their sounds, meanings, and/or sources.

In all Chinese stem-deriving instruction groups, there will be three to five participants in a small group receiving interventions from two to three intervention providers.

Regarding the intervention providers, they are all pre-service teachers who are year three or four under the education related programs in The Education University of Hong Kong. As they are expected to have some prior knowledge in teaching, they will also be trained by the principal investigator and the co-investigators by (1) introducing the theoretical background of Chinese stem-deriving instruction, (2) elaborating the details of this instruction in this project, and (3) asking them to demonstrate their teaching skills of this instruction. The former two parts are expected to take two hours, while the last one part is expected to take another two hours.

After the training of intervention providers, the preparation of teaching materials, and the participants screening, the formal training will be initiated. The participants will receive 50 minutes of instruction per session, and there will be two teaching sessions per week for a total of 16 teaching sessions over a 12-week period. Furthermore, in each teaching session, one Chinese stem will be added as core knowledge, and six extending Chinese characters will be introduced.

Teachers' and Principals' Involvement in the Project

Before the recruitment of participated students, we will consult the teachers for their comments in the implementation and designs of diverse Chinese stem-deriving instructions. Furthermore, the teachers will be invited to observe how the participated students' responses

to the reformed Chinese stem-deriving instruction which will be developed by this project, and the teachers' feedback to also be seriously taken into consideration about how to amend the teaching design or deliver the instructions. Additionally, the teachers' perspective of view on the participated students' performance after the training will also collected, and that will be considered as the social validity for the effectiveness of our interventions. Finally, the principals' supports will also be sought for recruiting the participants as well as relieving the teachers to join this project.

Evaluations

To evaluate the participated students' responses to diverse intervention in this project, three approaches of evaluations will be implemented.

Firstly, we will introduce the statistical methods to examine the first research aim, including paired sample t-tests and ANCOVAs. In this case, the participants will be tested by both *The Chinese Character Recognition Scale* and *The Battery of the Chinese of Pupils* for two testing times, i.e. pretest and posttest. Paired sample t-tests will be introduced to compare the intragroup differences between the pretest and posttest performances of each group on each task and sub-task, while ANCOVAs will also be used to compare the intergroup differences among the posttest performances on each task and sub-task of the three groups when controlling for IQ and the pretest performance.

Furthermore, to obtain a more detailed picture of these interventions and examine the second research aim, *Curriculum-based assessment for Chinese character reading and writing* will be administered to all three experimental groups. To analyze the data from the curriculum-based assessments, the distribution, slopes, growths on both reading scores and writing scores of *Curriculum-based assessment for Chinese character reading and writing* cross different testing times will be observed and analyzed for performance patterns exhibited by the three experimental groups.

Secondly, apart from the inferential quantitative analysis, details of the participants' error patterns in their Chinese character reading and writing and their vocabulary creations will also be observed in all aforementioned tasks during all the instructional sessions in this project. More specifically, six error patterns for reading Chinese characters and for vocabularies will be observed according to Shu et al. (2005) and Wang* and Yang (2014), including (1) semantic errors (naming the target character as a semantically related character), (2) selective errors (naming the target character as a character that forms a highly frequent two-character compound word), (3) visual errors (confusing the target character with a visually similar character), (4) phonetic errors (naming an irregular character after the phonetic), (5) analogy errors (naming a character after another character with the same phonetics when such a pronunciation is incorrect), and (6) homophone errors (using a homophonic character to form words of the meaning character).

Another five error patterns in writing Chinese characters or vocabularies will be observed by adapting scales from Law and Or (2001) and Law, Ki, Chung, Ko, and Lam (1998), including (1) stroke errors (stroke reversal, addition, substitution, and omission of stroke), (2) radical/component errors (broken stroke of a component, slanted structure, rectangular structure, and maze structure), (3) homophone errors (using a homophonic character to replace the target character), (4) phonetically similar errors (including similar onset, rime, and tone), and (5) unrelated errors.

Finally, to further receive the participated students' and instructors' feedback and responses for the instruction in this project, an open-end semi-structured questionnaire will be introduced at the end of the intervention. The questions for the students are like "What is most valuable part you learn from this instruction?", "What is the most boring thing you think during this instruction?", "Do you feel interested in this way of learning Chinese characters?", "Do you think the instruction you receive during this period can be used in other lessons?" etc. On the other hand, the questions for the instructors are like "Which part of this intervention is most valuable?", "What is the most difficult part you meet during your instruction?", "How much time do you think you need to prepare for this intervention?", "Do you think the participated students feel more interested in learning Chinese by learning from this instruction" etc.

Sustainability

Our outcomes could provide a clearer picture on how teaching materials design of Chinese stem-deriving instruction influence dyslexic children's Chinese learning when teachers intend to use this instructional method. Moreover, the teachers could adjust the chosen extending character, such as especially their amounts and categories, to fulfill the students' working memory limits, and it is expected to lead to positive outcomes for the students in not only the early primary school ages but also any other age levels if the student's current status of their (un)known Chinese characters and vocabularies have been investigated. This kind of designs and adjustments aforementioned could be done by the teachers and will not need any further financial supports.

Promotion

The outcomes of this project will be disseminated by two approaches. First of all, we will hold three sharing seminars to promote the outcomes of this project. More specifically, there are three parts in each sharing seminar including the introduction of the goal and expected outcomes, the demonstration of the teaching plan and teaching procedure, and the presentation of teaching materials designs. It is expected to spend three hours for each sharing seminar. We anticipate inviting 50 participants, who are parents, teachers, or relevant staffs, per sharing seminar, in total 150 participants for three sharing seminars. Secondly, all teaching materials and teaching plans of Chinese stem-deriving instruction in this project will be uploaded to the website of Quality Education Fund and Department of Special Education and Counselling, The Education University of Hong Kong. Also, the copyrights of the deliverables/materials developed by this project are vested with the QEF, and they can be shared with other schools.

Budget Breakdown (Total Amount: HK$347,200)

Staff Costs: HK$269,892

Research assistant (HK$220,500)

We propose a full-time research assistant (RA) for one-year duration of this project to assist with the implementation of this project. There are three parts of duties will be given to this RA. First of all, the RA needs to contact the schools, NGOs, and any other possible units to get the contact information of the potential participants, and s/he also needs to be responsible for earning the participants' and school sites' consent. Secondly, before the intervention, RA is expected to manage the manpower of student assistants, including recruiting appropriate students, assist the training with PI and Co-Is. During the intervention, RA will be asked to present in each session for monitoring the progress of the intervention. Finally, the RA will also be asked to enter and clean data with the help from the student assistants and also draft a report. Finally, the RA is also anticipated to help to prepare and organize the sharing seminars and the uploaded teaching materials and teaching plans. The salary for the RA is $17,500/month. Thus, in total HK$17,500 (* 1.05 for MPF) * 12 (months) = HK$220,500.

Student helpers (HK$49,392)

To prepare the teaching materials, the drawing of graphics and animations are expected to be completed by student helpers with relevant majors. It is estimated that it will take approximately 200 hours to prepare the teaching materials. Thus, 200 (hours) * 60 (* 1.05 for MPF) = $12,600. Furthermore, 45 participants will receive the instruction. Therefore, it is projected that there will be 12 small groups, each comprised of three to five students. There are 16 teaching sessions over the 12-week period, during which two intervention providers will teach together one of the 16 teaching sessions. Thus, each teaching session is approximately one hour. Therefore, 12 (groups) * 2 (approximate providers) * 16 (sessions) * $60 (* 1.05 for MPF) = $24,192.

Finally, another group of student assistants will be needed to assist the PI and RA in integrating the results of all participants as well as entering the first round data. An additional 200 hours (estimated) will be required to complete outstanding relevant tasks. Thus, 200 (hours) * 60 (* 1.05 for MPF) = $12,600.

General Expense: HK$76,372

Purchase of expendables (HK$5,008)
A budget of HK$5,008 is requested for the purchase of expendables.

Standardized measurements (HK$5,300)
Raven's Standard Progressive Matrices
Ravens Standard Progressive Matrices-Parallel Each participant will be measured using a hand book ($60) and a set of recording papers ($20). Specifically, 45 (participants) * ($60+$20) = HK$3,600

The Chinese Character Recognition Scale (中文年級認字量表)
This test costs NT$2,300 for 50 record sheets (HK$600 (~NT$2,300)).

The Battery of the Chinese of Pupils (基本讀寫字綜合測驗)
This battery of tests costs NT$4,520 for 50 record sheets (HK$1,100 (~NT$4,520)).

Researcher developed materials (HK$900)
The budget for this category involves printing fees. Specifically, 45 (participants) * $0.5 (printing fee) * 40 (pages) = HK$900.

Sharing seminar (HK$15,000)
There will be three sharing seminars to promote the outcomes and teaching materials of this project. We anticipate inviting 150 teachers and parents (50 per seminar) at a cost of $100 per attendee (HK$15,000).

Audit (HK$5,000)
A budget of HK$5,000 is requested to purchase the audit service.

Overhead: HK$45,164
We request 15% of subtotal budget (Staff Cost + Others) allocated for The Education University of Hong Kong (HK$45,164). This project will need the assistance from the manpower and resources from our University, such as Research Assistant and Student Helpers recruitments, office of Research Assistant, potential Participants contact and recruitments etc.

Contingency: HK$936
A budget of contingency (3% of Others) is also requested for spending to any unexpected item among the implementation of this project.

Asset Usage Plan (Not applicable)

Report Submission Schedule

Project Management		**Financial Management**	
Type of Report and covering period	**Report Due Day**	**Type of Report and covering period**	**Report Due Day**
Progress Report 1/11/2019 – 30/4/2020	31/5/2020	Interim Financial Report 1/11/2019 – 30/4/2020	31/5/2020
Progress Report 1/5/2020 - 31/10/2020	30/11/2020	Interim Financial Report 1/5/2020 - 31/10/2020	30/11/2020
Progress Report 1/11/2020 – 30/4/2021	31/5/2021	Interim Financial Report 1/11/2020 – 30/4/2021	31/5/2021
Final Report 1/11/2019 –31/10/2021	31/1/2022	Final Financial Report 1/5/2021 - 31/10/2021	31/1/2022

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