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Design, Development and Evaluation of Chinese Radical and Character Tutorial by Hypermedia

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DESIGN, DEVELOPMENT AND EVALUATION OF CHINESE RADICAL AND CHARACTER TUTORIAL BY HYPERMEDIA

by

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ABSTRACT

DESIGN, DEVELOPMENT AND EVALUATION
OF CHINESE RADICAL AND CHARACTER TUTORIAL BY HYPERMEDIA

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Master of Science

This project report describes the instructional design, development and evaluation of the Chinese Radical and Character Tutorial (CRCT) project. The web-based CRCT project integrated hypermedia resources (audio, video, graphics, animation and hyperlinks) to teach undergraduate and graduate students basic Chinese radical and character recognition and writing. One-to-one test, expert review and small-group test were utilized in the formative evaluation. Statistical significance was found in the small-group test, which suggests that supplemental hypermedia material can effectively facilitate student learning of Chinese reading and writing outside of the classroom. Moreover, the qualitative data indicated that students enjoyed using CRCT's drills, feedback features and video-writing demonstrations to facilitate their learning. The web-based environment provided interaction and allowed them to practice at any time and place.

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Introduction

Mandarin Chinese, also called "Putonghua," has become an important language because of China's increasingly important role in international trade. Although Chang and Chang (2001) somewhat over-exaggerated the notion that Mandarin Chinese (here after "Chinese") unites more people than any other language, Chinese is formally spoken by a large number of people in Taiwan (2.3 million people), China (1.3 billion people), and ethnic Chinese enclaves in other parts of the world. Chinese is the third most commonly-spoken language in Canada and is the household language for more than two million Asian-Americans (Armas, 2003; People's Daily Online, 2004).

Propelled by the prevalence of Chinese, the demand for Chinese language instruction appears to be high at most universities and colleges. The number of students learning Chinese is experiencing an average 35% growth rate per year ("Learning Chinese Becoming Increasingly Popular," n.d.). During the process of learning Chinese as a second language, learner anxiety related to listening and speaking the language can be lessened with the use of *Hanyu Pinyin*, the Romanization system designed to assist Westerners with Chinese pronunciation. With respect to the memorization of Chinese characters, however, few tools or methods are currently available to alleviate the frustration experienced by many of these new students.

Chinese characters are comprised of strokes and radicals, which are the basic graphic units of writing. Chinese character-writing is considered a great art and requires diligent study for proficient use. The process of studying Chinese characters is time-consuming and tedious for most people. Learners commonly reach a point of disinterest and attempt to avoid learning how to write characters in advanced levels, due in part to inefficient teaching methodology (Yin, 2003). Students struggle to memorize character components, radicals, pronunciation and composition sequences (Yin, 2003). Instructors often weary of the resultant complaints.

Yet it is the written language, not the verbal language, which is common to Chinese dialects such as Mandarin and Cantonese. Chen (1999) indicated that learning Chinese characters is important because characters can be used across historical eras and regional dialects. After learning Chinese characters, students have the ability to communicate in writing with people of different dialects in countries such as Taiwan, Hong Kong, and China (Japanese and Koreans also understand many Chinese characters). Written language ability is often essential in business or in governmental intelligence settings.

Christensen and Noda (2002) separated knowledge into declarative knowledge (what one knows about a language), and procedural knowledge (what one can do with a language). In Brigham Young University's performance-based pedagogical approach, declarative knowledge and procedural knowledge are emphasized at a 1:4 ratio. The

effective declarative and procedural knowledge teaching pedagogy cultivates learners' language skills by facilitating authentic interaction with native Chinese speakers and near-native Chinese speakers. In procedural-based instruction, learners spend three-fourths of class time practicing Chinese speaking in authentic environments, an approach that rapidly improves their speaking and listening skills.

The declarative-based instruction occupies only one-fourth of total class time. However, during that limited period instructors need to cover grammar, cultural knowledge, structural strategies, and vocabulary usage (including Chinese radical and character practice). Instruction of Chinese characters in class takes an enormous amount of time but typically yields only minute increases in achievement. As a result, instructors often utilize most class time to cultivate learners' speaking and listening abilities. Instructors are forced to bypass Chinese radical and character instruction to preserve sufficient discussion time for cultural topics and general grammar. The limitation on class time prevents thorough introduction and explanation of written Chinese radicals and characters.

Acquisition of reading and writing skills can be accomplished more effectively on an individual out-of-class basis than is the case for verbal listening and speaking abilities. Usually learners have audio, video and printed materials for use outside of the classroom to enhance their procedural knowledge, but it is difficult to find quality supplemental materials designed to similarly assist study of Chinese reading and writing at home or in the lab

(Wang, 1999). To overcome this incongruity, learners and instructors need access to better supplemental out-of-class materials. Computer-based hypermedia supplementary material makes it possible to combine video, graphics and animation, thereby facilitating the development of incisive self-learning programs.

Many organizations have developed online or computer-based hypermedia Chinese character-training programs. These programs include *Animated Chinese Characters* (Animated Chinese Character, n.d.), *Chinchar* as developed by Yuping Wang (Wang, 1999), and *USC Chinese Character Page* (Chinese Language Program, n.d.). However, these resources do not always utilize effective instructional-design methodology and do not have content specifically tailored to meet class needs. For example, it is difficult to find an online computer-based Chinese learning tutorial which builds upon general information about Chinese radicals and characters with pedagogical practices designed to help students internalize and retain what they study. In addition, supplemental computer-based materials are not typically designed to mesh with widely-used Chinese textbooks (e.g. the widely-used *Integrated Chinese* textbook used by students at Brigham Young University).

The end result of the deficiency of stand-alone online supplemental materials to assist reading and writing is instructor stress due to the shortage of instructional time and limited student progress. Wang (1999) pointed out that insufficient in-class time and inadequate outside-class support operates to reduce students' functional knowledge of

Chinese characters, an observation that led to the development of *Chinchar*. Wang (1999) also received positive feedback about learning at an individualized time, place, and pace with *Chinchar*, and students indicated that animated-character writing made the learning process pleasant. Wang's effort suggests that self-instruction material which correlates with a textbook can help compensate for shortage of class time.

Purpose Statement

The purpose of this project was to design, develop and evaluate a Chinese Radical and Character Tutorial (CRCT) program intended to supplement Chinese textbooks. The CRCT program was designed to help students learn the relationship between Chinese radicals, characters and words. The program focuses on effectively cultivating students' knowledge about radicals and on developing their ability to recognize and produce Chinese radicals and characters. Practice drills were specifically designed to increase students' grasp of Chinese radicals and characters. Most textbooks and workbooks do not afford efficient practice drills and test questions of the kind which strengthen student association of radicals and characters with related sounds and English meanings. To overcome this deficiency, the CRCT program is written to improve students' knowledge of radicals and characters and facilitate practice which builds upon what is studied in various student textbooks and workbooks.

Instructors will only need to spend five minutes of class time to emphasize the importance of learning Chinese characters, and then assign students to practice Chinese radicals to enhance character learning with the CRCT program. Students can submit the results of their CRCT practice to demonstrate their understanding of Chinese radicals and characters or use interpersonal or email communication to ask instructors questions related to CRCT practice. Instructors can thereby assess students' efforts and understanding of the content. After identifying students' learning status, instructors can flexibly develop their lesson plans without excessive concern about students' fundamental knowledge of Chinese characters. With the help of the CRCT program, students and instructors can have more time to practice other performance operations (authentic speaking and listening abilities) in class.

Target Audience

The target audience for the CRCT program is college students who enroll in basic Chinese classes in various universities. They start to learn Chinese for the first time and major in different subject fields. Some students might be American-born Chinese who likely have some exposure to a Chinese speaking and listening environment. Ke (1998) stated that a Chinese speaking and listening background has no effect on character recognition and production. Therefore, American-born Chinese are considered to be at the same basic level of character learning as other students who do not have any Chinese

speaking and listening background. It is expected that the target audience will possess basic computer skills, including the ability to use the internet and email.

Literature Review

The literature review is organized into three parts: Chinese characters, use of hypermedia, and design principles. In the first part, I will discuss scholars' opinions concerning Chinese character learning and pedagogy, the importance of learning Chinese characters, students' learning methods, and the nature of current computer-mediated Chinese character programs. In the second part, the use of visuals in instruction and hypermedia will be evaluated with respect to their suitability for application in the CRCT project. The third part will discuss Model-Centered Instruction. I will also set forth the role of Gagne's instructional-design principles (the nine events) and Gibbon's Instructional Design as Help in the design and development approach for this project.

Chinese Characters

Chang and Chang (2001) observed that the difference between Chinese and western languages is due to their respective forms. Chinese characters do not represent ideas, but instead depict words which are described as lexigraphic (DeFrancis, 1984). Learners of Chinese are less likely to associate Chinese characters with their sounds (though native Chinese do) than is the case with students of western languages. Even though the learning

process seems arduous, Chinese character recognition ability is the key factor in improving reading and writing proficiency levels (Ke, 1998, Yin, 2003).

Chinese Writing Methods Require Knowledge of Chinese Characters

Two methods are available to produce Chinese character writing: 1) writing by hand or 2) coding via use of some type of technological input device. Comparatively speaking, writing by hand requires more labor and better memory ability to construct correct characters. Learners who need to communicate with Chinese characters greatly benefit from an ability to write in situations where technological devices are unavailable. It takes several years of practice to achieve the level of artistry required for handwritten communication and to smoothly recall written vocabulary. Consequently, students typically believe that the computer-input method can simplify the process for learning Chinese characters. In reality, even though the computer-input method can generate Chinese characters from the input of *Hanyu Pinyin* or radicals components, users of the method do not necessarily have the more sophisticated level of ability needed to generate handwritten characters solely from memory.

Two popular and effective Chinese input-coding systems for displaying Chinese characters in computer word-processing systems are categorized as the phonetic method and the graphic input method (Suchenwirth et al., 1989). The phonetic input method requires learners to know the correct pronunciation of each character. Learners cannot successfully

display characters if they do not know the associated character pronunciations with characters or possess good ability in character recognition and retention. As for the graphic input method, it requires learners "to dissect the character into components and strokes" (Suchenwirth et. al, 1989, p. 26). Unless learners are very familiar with the shapes and composition sequences of Chinese characters or radicals, they cannot conveniently utilize this method.

Although phonetic and graphic input methods can reduce the arduousness of handwriting Chinese characters, students still need to acquire a sufficient level of proficiency in character recognition and writing. Liu (2002) stated phonetic and graphic methods should not completely replace the writing of characters by hand (Liu, 2002). Learners should be subject to the rigor associated with practicing handwritten radicals and characters. With the help of a thorough and well-developed Chinese-writing tutorial, students' anxiety about learning Chinese characters can be reduced and the average learning pace can be accelerated.

To help learners acquire a comfort level with both computer input and handwriting, the CRCT program includes Hanyu pinyin, pronunciations and writing demonstrations provided by a native Chinese person. Presentations concerning the relationships between radicals, characters, and Hanyu Pinyin (sound) are made available, with an emphasis on radical recognition and character awareness.

Advantages of Learning Chinese Characters

Chao (1997) observed that beginning and intermediate students think Chinese characters are the most difficult aspect of learning the Chinese language (Chao, 2001). Chen (1999) argued that despite students' perceptions, knowledge of Chinese characters is very useful and not always difficult to acquire. However, DeFrancis (1984) challenged Chen's statements and stated that Chinese speakers spend around eight years to learn 3000 characters, while French speakers spend half that length of the time to become literate. DeFrancis (1984) emphasized it is more efficient to write standard Chinese in pinyin, instead of by characters, and pinyin is the best strategy for reducing the illiteracy rate among Chinese-speakers. Nevertheless, Chinese characters have a unique capacity to differentiate homophonous morphemes, which makes it easy to learn di-syllabic or multi-syllabic words (Chen, 1999).

Even though learning Chinese by *Hanyu Pinyin* is advocated to accelerate the learning pace, it is significant that the comprehensive Chinese-learning curriculums in Hong Kong, China, Taiwan, and other countries still require learners to memorize Chinese characters. Williams, an earlier Romanization proponent, admitted in 1851 that total abolishment of Chinese characters was unrealistic, and he urged beginners to learn radicals as familiarly as the alphabet (Chao, 2001). Chinese characters are still a common component of Chinese reading and writing and it will always be advantageous to teach

Chinese characters to students in order to enhance their written ability to communicate with native speakers. If students do not overcome difficulty in Chinese-character reading and writing, their speaking and listening skills are less likely to reach advanced language proficiency levels (Yin, 2003).

Because characters are often taught in an unsystematic manner, the character learning approaches can result in less efficiency (Chen, 1979). In order to help students improve their proficiency levels in reading and writing, the CRCT design incorporates a systematic approach to Chinese-character learning. By analytically deconstructing characters into small units (radicals or components) and showing how components are assembled to convey character meanings, CRCT reduces learner anxiety. CRCT abides by the maxim "practice makes perfect" by offering many practice opportunities. Once learners sufficiently internalize their rote knowledge they can then utilize it in future advanced learning situations.

Learner's Learning Strategies toward Character Learning

Ke (1998) surveyed beginning and intermediate learners and discovered that they favor rote repetition, because such students do not have sufficient orthographic awareness to develop effective rules for learning Chinese characters. Students with higher levels of orthographic awareness tend to develop effective strategies for learning Chinese characters by deconstructing the radicals and phonetics of the characters. Students who are aware of

this strategy tend to perform better on character recognition and production tasks (Ke, 1998). Helping students summarize, generate and deconstruct characters' reoccurring components can benefit those students in the long run (Ke, 1998).

Even though Wang (1999) found that computer-based materials helped to compensate for the lack of class instruction in Chinese characters, it appears that currently-existing computer-based materials are not the preferred choice for students who are memorizing and learning characters and radicals (Yin, 2003, Ke, 1998). To best suit students' actual behavioral tendencies, the computer-mediated material should deliver a productive pedagogical framework for implementing dynamic character-learning strategies such as mnemonic methods for radicals, phonetics and characters. Those strategies can reduce students' dependency on rote-repetition and enhance retention. In other words, a computer-mediated program should have the capacity to act as an electronic teacher offering character-learning strategies to lessen students' rote repetition and "create a meaningful and interactive environment for language learners" (Hsu & Gao, 2002).

The CRCT program is organized in a way that facilitates learners' mnemonic conceptualization of characters. This is achieved through regular association of each character with its components. CRCT provides practice drills with interactive feedback to scaffold students' learning and to encourage them to imitate the expert's writing demonstrations with a pencil and notepad.

Chinese Character Pedagogy

Chinese characters are constructed by radicals (frequently-used basic components), phonetics and sub-components (Xiao, 2002). Learners often struggle to associate the sound of a Chinese word with its written form (Lin, 2000). Lin (2000) stated that even though it is a challenge for Chinese learners to match the sounds and written forms of Chinese words, sound and character identification association and character writing cannot be neglected in Chinese teaching.

CFL scholars recommend the following pedagogical tactics for overcoming the difficulty of Chinese character (words) recognition and production:

Segregation from integrated activities and context. Teaching of Chinese characters should be segregated from integrated textbooks and classroom instruction in order to facilitate a separate pace, accord sufficient instructional attention, and provide orthographic information (Xiao, 2002).

Radical and phonetic instruction. Some scholars believed *Hanyu Pinyin* and Chinese characters should be taught at the same time (Zhang, 2001). During this step instructors should focus on simple characters and other components which frequently appear (Xiao, 2002). Such components would include 214 “primitive” radicals and phonetic components (Chao, 2001). Phonetic encoding plays a significant role in Chinese learning. Yang (2000) stated that at least eighty percent of the characters are compound characters

with phonetic and meaning components (radicals). Learners who are very familiar with the primitive components will also be much more competent in recognizing individual characters (Yang, 2000).

A potential opposing view to Zhang would hold that it is necessary to learn *Hanyu Pinyin* before tackling character acquisition. It should be noted that CRCT can readily be used as a resource by scholars and instructors who hold to either view.

Development of character analysis and orthographic awareness. Students ought to be trained to analyze, assemble, and deconstruct characters by utilizing their knowledge of configuration rules (i.e. left-to-right, top-to-bottom, etc.) and radical components (Zhang, 2001; Xiao, 2002). This skill is needed to analytically deconstruct complicated characters by their radicals and thereby achieve enhanced memorization and orthographic awareness. Learners can expect to build their visual familiarity with the intra-character orthographic units (Xiao, 2002). Word association awareness helps accumulate the vocabulary knowledge which is, in turn, the basis for second-language acquisition (Lin, 2000).

Regular review of characters in context. Instructors need to present characters with fewer stokes before introducing complicated characters with many strokes, and should emphasize recognition before replication (Chao, 2001). In addition, presenting characters in proper context is a critical element for success. Walker (1996) stated that students should only be requested to practice characters which are provided with the context necessary to

enable association with the matching meanings and usages (cited in Chao, 2001). In order to place Chinese characters in long-term memory, students need to repeat the characters through their mental processes from time to time (Chao, 2001; Zhang, 2001). Thus, Chao (2001) emphasized that the instruction needs to encourage regular review of previously-learned characters in context. Students also need tips on how to physically fashion the written Chinese characters they will be practicing in handwritting (Chao, 2001).

The CRCT program conforms to the aforementioned pedagogical principles in its provision of character and radical instruction. For example, the program preserves the recommended separation of character teaching from integrated textbooks and classroom instruction. Primitive radical and phonetic information is folded into guidance about construction rules and orthographic requirements. However, because the CRCT program is for basic learners without any previous Chinese knowledge, there will likely not be significant context for most students to use in reviewing radicals and characters.

Expert's Evaluation of Current Chinese Character Computer-Mediated Materials

Hsu and Gao (2002) critiqued the existing computer-assisted Chinese character learning programs which are well-known to teachers of Chinese: *Write Chinese*, *Chinese Characters Primers*, *Animated Chinese Characters*, and *USC Chinese Character Page*. After utilizing eight criteria (components) to evaluate computer-assisted Chinese character learning material, they concluded there are some improvements desired. Well-designed and

technically-adequate instructional materials need to be integrated with Chinese character pedagogy (Zhang, n.d., Hsu & Gao, 2002). For example, radical and phonetic-inductive approaches, mnemonic devices, and usage analysis should be included to facilitate learning.

Hsu and Gao (2002) evaluated current computer-assisted Chinese character materials to see if they contain the following eight elements (criteria):

Pronunciation. Each Chinese character or radical has its own Roman letters (*Hanyu Pinyin*) representing its unique sound. Presentation of a character or radical should be accompanied with pronunciation in order to increase students' memorization.

Pronunciation comparison. Many characters or radicals have similar sounds. Pronunciation comparison is an advisable mnemonic method.

Radical information. The radicals in the new characters should be specifically identified in order to help students deconstruct Chinese characters. Radical identification can be considered to be part of effective character-learning strategy.

Character meaning. Each Chinese character has its specific meaning, and Chinese words are constituted of various combinations of characters. Liu (1991) went so far as to assert that over ninety percent of Chinese words are formed with two or three syllables (characters). A word can present different meanings from its formed Chinese character. When introducing a new Chinese word, the meaning of its Chinese characters should be

introduced along with pronunciation, because there is a strong correlation between being able to pronounce a word and being able to identify its meaning (Yang, 2000).

Character morphology. Chinese words do not have obvious present, past and future tenses, (e.g. the English words "give," "gave," "giving," "given," and "will give"), but there are certain rules of syntax used to set forth a word, tense, structure, or sentence (Packard, 2000). The introduction of morphology and structure can help learners to analytically separate Chinese words and use them correctly.

Character usage. Some Chinese characters can serve as a noun, verb or adjective, depending upon the applicable situational context. Chinese words can be classified into different parts of speech on the basis of morphological features, distribution, and function (Liu, 1991). Correct character usage needs to be mentioned.

Character-writing demonstration. Chinese characters are written by means of different strokes executed in certain stroke orders. Learners should be encouraged to write the strokes correctly so that they can write Chinese characters artistically and efficiently.

Writing practice and testing. Writing practice is considered the most complicated and expensive function to facilitate. Additionally, many users do not have equipment needed for writing practice, such as digital pen or tablet.

The eight evaluated criteria from Hsu and Gao (2002) not only serve as content-development elements for the CRCT project, but are also utilized herein to evaluate the

following three Chinese character computer-assisted materials: *Animated Chinese Characters*, *USC Chinese Character Page* and *Chinchar*.

Materials Review

Utilizing the developmental elements provided by Hsu and Gao (2002), I reviewed advantages and disadvantages of three computer-assisted (online) programs: *Animated Chinese Characters*, *USC Chinese Character Page* and *Chinchar*. The results of this review are set forth below.

Animated Chinese Characters (Animated Chinese characters. n.d.). Animated Chinese Characters provides a reference dictionary function. Users can choose a specific character by utilizing their *Hanyu Pinyin* to view the character writing demonstration. In addition, the website allows learners to learn characters in specific categories such as cities, countries, numbers, surnames, etc. The English meanings of the Chinese characters under these categories are provided. Learners can click on the particular categories and specific characters to view the animated character-writing demonstrations. The *Animated Chinese characters* program is easy to access online at any time and place. It is offered free of charge and provides animated character-writing demonstrations to benefit users.

There are five major weakness associated with the *Animated Chinese Character* program. First, there is no sound, *Hanyu Pinyin*, or pronunciation comparisons to support learners' recognition of the characters. Second, there is no radical-related information to

help learners deconstruct the character for achievement of better retention. Third, character meaning, morphology and usage are not provided on a complete basis. Fourth, even though the character animated writing demonstration is provided, it progresses too fast and without native Chinese writer (expert) demonstration. The animated writing demonstration is too small and shown on the far right corner of the page, which is hard to attract users' attention. Even though learners can see the stroke order, they cannot see how to start and end each individual stroke. Fifth, there are no practice or test questions to help the learners become familiar with the content or to access if they have learned anything.

USC Chinese Characters Page (Chinese language program, n.d.). USC Chinese Characters Page contains forty important radicals and all characters which are subjected to special attention in the textbook *Integrated Chinese.* Each radical and character has computer-animated writing demonstration. Learners can easily search for a written demonstration of each character by alphabetically following a *Hanyu Pinyin* or lesson sequence. The capability of this free web-based learning program includes the *Hanyu pinyin*, sounds, and English translations associated with the radicals and characters. In each character demonstration the main radical is specifically marked in a different color to increase learners' memorization. In addition, users can learn how Chinese words are formed by characters. Learners can conveniently access and download the content from the website, and the overall scheme is quite user-friendly.

Some drawbacks are discovered when assessed in light of the eight criteria set forth by Hsu and Gao (2002). For example, even though pronunciation is provided in the USC webpage, pronunciation comparison is not accompanied by presentation of a mnemonic method. Character usage and morphology are not presented in a complete way. The USC webpage contains some computer-animated instruction which is not accompanied by any explanation to guide learners. There are no drills to allow students to practice what they have just learned. In other words, the focus of this program is information-based only and does not incorporate pedagogical assistance. None of the writing demonstrations on the USC Chinese Character Page are performed by native Chinese or other experts. Learners cannot visualize the hand movements needed to write the Chinese characters. Slow writing animation takes enormous time to view the complete character writing.

Chinchar (Wang, 1999). Fifty percent of the content in Chinchar followed the textbook called *Introductory Chinese*. Chinchar embodies a help function, *Hanyu pinyin*, and radical categories in order to enable learners to search for particular characters. There are *Hanyu Pinyin* and sounds which allow learners to associate Chinese characters with corresponding sounds. Learners can learn the stroke orders for every character by accessing video-animated demonstrations and studying the usage and evolution of each character. Chinchar also extends a “scaffolded Writing Pad” to enable learners to trace character

writing with a computer mouse and verify whether they are performing the writing correctly.

Chinchar appears to have been deliberately designed to account for the eight criteria recommended by Hsu and Gao (2002), with the exception of pronunciation comparison. Chinchar appears to be the best and most suitable Chinese writing material relative to the other aforementioned programs. The demonstration of stroke order along with pronunciation, the morphology and usage of characters, and the writing practice if affords serve to garner positive accolades for Chinchar as an instructional tool for Chinese writing. Wang (1999) surveyed the usability of Chinchar and received positive feedback.

There are three concerns regarding Chinchar. First, even though Chinchar overcame the challenge of building a capability to allow learners to practice Chinese characters, the effectiveness of practicing Chinese characters by mouse clicking or dragging is questionable. In other words, can training for authentic Chinese character-writing be accomplished by mouse clicking or dragging instead of by handwriting? There is apparently no evidence that students can transfer the skill of writing Chinese characters by mouse dragging into the task of handwriting characters. Second, Chinchar has not yet been available for public use. Therefore, not all target audience can use it at any time and any place. Since the program cannot be accessed through the internet, it does not appear likely that the challenge of feasibility and convenience will be overcome anytime soon. Third,

Chinchar content is only tailored specifically for the textbook *Introductory Chinese*, which many universities (such as Brigham Young University) do not use.

CRCT draws upon the lessons learned from reviewing other software in the field. CRCT is a web-based design for public use and combines language information with sound pedagogical methodology and effective demonstrations. This combination will allow CRCT to effectively serve a large population of learners.

CRCT focuses on helping students memorize and internalize a radical's shape and pronunciation and also teaching students how to associate Chinese characters with constituent components. Therefore, only six of the eight criteria from Hsu and Gao (2002) were included in the CRCT scheme: pronunciation, pronunciation comparison, radical information, character meaning, writing demonstration, and practicing and testing. Two criteria, character morphology and usage, were not included in the current CRCT design, because these aspects are more advanced and might overwhelm the beginning Chinese learners CRCT is primarily designed to assist.

Visuals in Instruction and Hypermedia

Visuals in Instruction

During World War II, the U.S. armed forces successfully used motion pictures and other visuals in instruction efforts (The Columbia Encyclopedia, 2001). The early audio-visual concept has been widely expanded in hypermedia computer programs. Visual

materials can be found as photographs, overhead transparencies, video, graphics, animation, diagrams and slides. They are commonly seen in commercial advertisements and instructional materials to communicate both concrete and abstract concepts and catch the audience's attention. Visual depiction plays an important role in contemporary instruction.

Heinich, Molenda, Russell, and Smaldino (1999) believed that visuals could conceptualize ideas, motivate learners, hold attention, simplify information and facilitate instruction. They noted that visuals can be used to communicate across boundaries created by language and culture. Visuals currently are widely utilized in computer-based materials to convey instructional content.

Hypermedia

In recent years hypermedia with visuals has been widely applied in various ways to support second-language acquisition (SLA) instruction. As Liao (1999) summarized, several scholars reported significant gains for hypermedia over non-hypermedia in instruction for a variety of fields. Thus, hypermedia has become increasingly important in providing material for language instruction and other fields of study. Hypermedia encompassed the technique to link more formats such as visuals, hypertext, etc (The Columbia Encyclopedia, 2001).

Chinese learners, however, are not highly enthusiastic about hypermedia instructional materials, perhaps because of inadequate teacher guidance, inadequate

awareness of existing learning materials, the questionable quality of Chinese language software, and insufficient cultural preparation for the self-access environment (Ihde & Jian, 2003). Ihde and Jian (2003) found that Chinese learners showed less excitement for web learning than learners of other languages, because students rely on instructors' recommendations. In addition, Chinese characters are not always successfully displayed on web browsers (Ihde and Jian, 2003).

Hypermedia material should provide convenient supplementary material for teachers who wish to admonish Chinese learners to practice with a self-teaching regimen (Ihde & Jian, 2003). To optimize the quality of Chinese learning programs, pedagogy and sound design should be well coordinated (Zhang, n.d.; Ihde & Jian, 2003). As Dillon (2000) states, hypermedia must be designed for usability, including consideration of effectiveness, efficiency and satisfaction. When designing hypermedia materials, designers need to take account of learners' contextual and performance levels (Dillon, 2000).

The CRCT program not only utilizes hypermedia techniques on the World Wide Web, it also incorporates effective Chinese-language pedagogy and instructional strategy. Therefore, teachers can focus on activities for personal communication and interaction with the help from the CRCT program out of the class. By utilizing hypermedia, the CRCT program achieves four advantages which assist Chinese character and radical learning, as listed below:

Learner-centered instruction. The CRCT program provides learner-centered instruction. Liu (2002) stated that hypermedia material facilitates learner-centered instruction because it allows the learners to choose, skip, or replay any segments of learning materials according to their ability levels and preference. Students are no longer third-party listeners following a fixed schedule, but participants in their own learning process (Zhang, n.d.). Students can self-manage their learning progress and practice their learning strategies as long as they have resourceful materials. Visual, audio and graphic instructional materials make distance and self-directed learning possible and enriched learners' linguistic and cultural knowledge (Antonsen, 1997).

Hypermedia systems are considered an effective way to support self-managed and distance-learning, because such systems present material as an interconnected network (Muller-Kalthoff & Moller, 2003). Backer and Dwyer (1994) stated that hypermedia can not only facilitate student-centered instructional settings but can also create motivating and active learning environments (cited in Liaw, 2001).

Instant feedback. The interactivity of hypermedia allows instant feedback (Zhang, n.d.) which can be provided immediately after students finish practices or test items (Liu, 2002). The CRCT project permits constructive feedback during students' exercising drills.

Time-space convenience. Chamot (1987) noted that second-language learners made a conscious effort to apply mental strategies adapted for learning situations in and out of the

classroom. With the help of the CRCT program, learners can profoundly improve radical and character recognition and retention by practicing lessons as many times as needed at any time.

Enriching learning activities and advanced discussions. Hypermedia provides a realistic, authentic and non-linear learning environment which encourages students to explore related knowledge and promotes interdisciplinary learning activities (Liao, 1999). Learners can navigate through content to obtain in-depth knowledge. Kinzer and Risko (1998) emphasized that hypermedia can enrich and integrate contextual knowledge which is not sufficiently available from textbooks or class lectures. The CRCT program has native Chinese writing demonstration step by step. Students are allowed to rewind and forward the video as many times as they wish. The CRCT utilizes visuals to enhance users' understanding of character composition and deconstruction. Students can discuss specific questions about radical and character writing with teachers, and they are expected to acquire the ability to generalize their knowledge of radicals and characters for future Chinese lessons.

Model-Centered Instruction and Principles of Instructional Design

Gagne, Briggs, and Wager (1992) stated that the purpose of instruction is to help people learn. Students should develop new knowledge, skills, or attitudes and interact with the arranged learning environment, including methods, media and equipment (Heinich et al.,

1999). The demonstration of acquired learning occurs when student knowledge is retrieved in an interactive setting and then evaluated against a defined standard of performance (Keirns, 1998). Instruction should "help" by affording learners agency in their interactions with the program (Gibbons et al., 2005).

To help learners, the CRCT project employs the theories of Model-Centered Instruction and Gagne's nine events. CRCT's incorporation of these design theories is discussed in further detail in the sections below.

Model-Centered Instruction

The abstract operational principles of Model-Centered Instruction (MCI) are (a) the learner, (b) the model, (c) the companion, and (d) the strategically-sequenced problems (Rogers, Hsueh & Gibbons, 2005). Rogers et al. (2005) stated that the model asks learners to respond by taking action, thereby creating an interactive learning environment. The companion (augmentation) is a messenger which will scaffold user progression, coach learners to take action, and communicate with learners (Rogers et al., 2005). The augmentation provides timely help to remind learners to send commands and appropriately react during the learning process. Forms of augmentation can include the message box, helpful tips, instance feedback, and so forth.

The model. The model is to present the primary skills and knowledge students should gain after learning with instructional material (Rogers et al., 2005). The CRCT

model visualizes the concept of relationships between characters and components. A series of skills (tasks) include: (a) deconstructing Chinese characters into individual components, (b) analyzing components by examining their meanings and sounds, and (c) associating characters' meanings and sounds.

Learners. Learners can interact with the computer as individuals or as groups (Rogers et al., 2005). In the CRCT project, the target audience include beginning learners of Chinese. Instructors also can utilize CRCT as a teaching aid in class. After learning with CRCT, learners are expected to successfully demonstrate three primary skills, as set forth in the Model section above.

The companion (Augmentation). Designers need to depict learners' perceptions and conceptual flows which emerge during use of the instructional materials (Rogers et al., 2005). Helpful augmentation features can intercede at opportune junctures to meet the learners' needs. Augmentation features of CRCT include: (a) helpful explanations concerning components, radicals, characters and Chinese words, (b) drills to allow learners' practice, (c) (hyperlink) text guidance for proper use of the program, and (d) instant feedback based on learners' responses to practices.

The strategically-sequenced problems. Practice items were divided into three main categories: radical memorization, character association drills, and writing performance. Radical memorization includes the matching of radical shapes with English meanings and

sounds. Radicals are very helpful prior knowledge for those who wish to complete the Character Association Drill. The Character Association Drill was designed to help students associate characters with correct English meaning and sounds. Learners were told to practice alone with the assistance of the expert's writing demonstrations. Test questions assessed skills the students were practicing with the CRCT program.

Principles of Instructional Design and Instructional Design as Help

Even though the learning process is internal, it can be influenced by external stimuli (Gagne et al., 1992). Those externally-designed events can facilitate the internal learning process. Through deliberate arrangement of external events, rapid and obstacle-free internal learning can gradually be achieved. Gagne et al. (1992) advocated nine events to aid learners to achieve target objectives. These nine events include: (a) gaining attention, (b) informing the learner of the objective, (c) stimulating recall of prerequisite learning, (d) presenting stimulus material, (e) providing learner guidance, (f) eliciting performance, (g) providing feedback, (h) assessing performance, and (i) enhancing retention and transfer. Gibbons et al. (2005) examined and expanded upon Gagne's nine events with their notion of instructional design as "help." The nine events, as expanded upon by Gibbons et al., are described in more detail below.

Gaining attention. Stimulus change and various appeals to students' interests can attract learners' attention. Even though the skill of gaining attention is a teacher's art, media

such as computer animation, graphics and movies can gain students' attention and transform the dullest task into an adventurous and interesting event (Geoffrion & Geoffrion, 1983). Keller and Burkman (1993) suggested everyday language and conversational tone should be used to provide interesting stories or examples to learners. Besides, presenting an exercise in the beginning can create a learning desire and simulate learners' interest (Keller & Burkman, 1993).

Gibbons et al. (2005) suggested that gaining attention is not a single event, but is instead a continuous experience between learners and instructor (designers or programs). The CRCT program applies the model by employing questions designed to gain learners' attention up front. The model provides the overarching paradigm for the CRCT instructional content vis-à-vis the overall learning objectives. Helpful augmentation materials guide the learners by affording continuous practice drills and helpful explanations.

Informing learner of the objective. Instructional designers should not simply assume that students will know the objectives of the lesson. Lesson objectives should be explicitly explained to learners. Objectives can be communicated in words or pictures. In computer-based lesson design, objectives can state in simple terms what the student will have accomplished once he or she has learned the material (Gagne et al., 1992). Of course, if a learner disagrees with the stated objectives, he or she can make an informed decision about whether to continue with CRCT, the specific features of CRCT, or the particular college

class which is utilizing CRCT. In other words, the CRCT's menu was aligned with the instructional objectives and provided learners options and choices needed to either browse CRCT or leave CRCT, according to their individual opinions about the lesson objectives.

Learners benefit from participation in the selection of roles and goals (Gibbons et al. 2005). CRCT does not yet have the technical capacity to allow learners to choose their roles. However, CRCT does list objectives (goals) for the learners so they can understand what they are expected to accomplish while using the program. Even though learners can freely choose any sequence for practice, suggested guidelines help them to successfully and efficiently utilize the program.

Stimulating recall of prerequisite learning. Students learn most effectively by relating new concepts to previously-acquired knowledge. Keller and Burkman (1993) observed learners "tend to notice and understand things which confirm or build upon their existing knowledge base" (p.10). They also stated that simple verbal descriptions can help connect new instruction to prior knowledge and skills. Gibbons et al. (2005) suggested instructional designers should discover learners' experiences (e.g. cultural and academic background) and help learners recognize and respond to what they have learned.

The target audience for the CRCT program normally does not have significant prior knowledge of character components (radicals), characters and Chinese words. To

successfully recognize and generate characters, students must know radical shapes and sounds. Learners are provided with relevant explanations when they practice with the model.

Presenting stimulus material. Stimulus presentation emphasizes features that determine selective perception (Gagne et al., 1992). Important information or concepts should be emphasized by an array of different prominent texts or noticeable features. Gagne et al., (1992) stated that the use of a variety of examples can make the learning of concepts and rules more stimulating for learners.

Gibbons et al. (2005) believed that events four (presenting the stimulus material) through eight (assessing performance) should be combined into a "conversational flow." Their observation implies such notions as making a presentation, providing drills with feedback, and scaffold strategies with recommendations (Gibbons et al., 2005). The CRCT employs model-centered instructional design by using helpful explanations to facilitate the interaction between the learners and the program. In addition, critical concepts and information are emphasized by means of noticeable colors and animation.

Providing learner guidance. Providing guidance serves to afford cues for retrieval, which can help learners to maintain efficient progress (Gagne et al., 1992). Providing guidance is not simply revealing answers, it is instead the suggestion of a line of thought which will lead to a new rule or truth. The strategy of providing adaptive guidance is to

afford a little guidance at a time and allow the students to draw on incremental assistance as much as needed.

The CRCT program provides guidance by affording helpful tips and explanations at timely moments. CRCT also provides direction concerning how to navigate the program, as well as other helpful forms of assistance.

Eliciting performance. At this stage, learners must have sufficient guidance from the instructional material to permit internal learning. Learners should be convinced that they have learned new knowledge when they can apply the rule in new situations. It is acceptable and desirable to request learners to demonstrate their ability to apply new knowledge in new situations (Gagne et al., 1992).

Learners are asked to practice with the CRCT program to become familiar with what they have just learned. Even though there are no conceptual or elaborative questions to test users' knowledge, learners are required to write radicals and characters and to select the correct sounds and meanings of previously-unencountered characters by making inferences from their components. This requires problem-solving on their part.

Providing feedback. Providing feedback can establish reinforcement. Mason and Bruning (n.d.) asserted that the main advantage of hypermedia instruction is the ability to provide immediate feedback. Informative feedback for correct and incorrect responses should be provided after eliciting students' performances (Gagne et al., 1992).

Keirns (1998) noted that "wording for correction and remediation needs to be frank but positive" for encouraging learners (p.62). He suggested to try phrasing like "Let's look at that another way," etc (p. 62). In the CRCT program feedback for answers is presented immediately after a learner responds to a question. Corrections are simple and direct. If users answer correctly, positive feedback will appear to commend their performance. Incorrect answers result in a corrective admonishment.

Assessing performance. Assessing performance serves to enhance retrieval and reinforcement. This step reveals to the student whether the desired learning has occurred. Students should be told whether mastery has been achieved and what next step is required for further learning.

Learners' memorization of radicals and characters will be tested, as will be their recognition of previously-unencountered characters and writing of radicals and characters.

Enhancing retention and transfer. The degree of variety for new tasks (novel application) should be carefully taken into account to ensure the transfer of learning. Varied and novel problem-solving tasks should be designed to continue learners' cognitive development (Gagne et al., 1992).

Gibbons et al. (2005) suggested that in addition to patterns of rehearsal, repetition, and integration, learning schemes should provide framing for the strategic messages. The CRCT program presents users with a comprehensive overview before delving into

fundamental or hierarchical subcomponents. After users memorize each English meaning, sound, and shapes associated with particular radicals, various character association drills can be followed to enhance learners' abilities to transfer their knowledge of radicals into novel situations.

Project Description

To encourage learners who are independently learning Chinese characters, the program contained interesting, motivating, effective self-instruction material. The Chinese Radical and Character Tutorial (CRCT) afforded self-learning opportunities by means of videos, graphics, animation, narrative introduction, drills, testing, and instant feedback.

Design and Development Process

A widely-known systematic approach, ADDIE (Analysis, Design, Development, Implementation and Evaluation) was adapted for use in the CRCT project production.

Analysis

The CRCT program was designed for students who are just starting to learn basic Chinese. There is no prerequisite for student recognition of Chinese radicals and characters or writing ability. Beginning learners typically acquire knowledge of *Hanyu Pinyin* at the onset of their classroom instruction, and learn some simple verbal sentences or greetings. This background can accelerate use and assimilation of the CRCT content.

An original script and prototype were developed in summer 2004 in order to better

understand (a) the needs and preferences of the target audience, and (b) the target audience's interest in the concept of an integrated scheme of audio, video and animation (as illustrated in Appendix A). This original prototype, Chinese Character Writing Tutorial (CCWT), contained similar functions to the present CRCT program. However, CCWT provided only narrative instruction concerning general concepts about Chinese characters, not specific skill-building content or exercises.

A survey questionnaire as contained in Appendix B was distributed in summer 2004 to collect target opinion and feedback from the target audience. Survey results indicated that students found the animations and video instruction about Chinese characters to be interesting and motivating. All fourteen students involved expressed a belief that the CRCT program would provide a productive and pleasant alternative method for learning Chinese characters outside of the classroom. The students expressed interest in seeing the completed program.

However, one student commented that the animation design was too simplistic and seemed to be geared more toward children. As a result of this feedback, the interface design was reexamined and the substantive content and stylistic content of the CRCT program were significantly altered.

The history and background of Chinese characters was initially included to help motivate and persuade learners. After subsequent consultation with Dr. Paul Merrill,

however, this material was eliminated so that the instruction could be made as concise and skill-focused as possible.

Design

The Design approach, which was based on model-centered instruction and focused on model, augmentation and interface design, was integrated with Gagne's nine events in order to formulate the design objectives for the CRCT program. By viewing expert demonstrations of writing radicals and by deconstructing characters into radicals, students can imitate the expert performances and perform the depicted skills. Drills are the means for providing interaction between the CRCT program and the learners. Learners can refine their performances by receiving customized feedback responses from the program and adjusting accordingly. Students control the speed of their learning and self-guide themselves through the CRCT program according to their own needs.

All of the aforementioned expected learning outcomes are incorporated as instructional objectives in the following section titled "Product Objectives." Although no formal evaluation instruments were used in relation to the design process, expert feedback was obtained on a routine basis from faculty such as Dr. Paul Merrill.

Development

Storyboard, models, augmentation, script, and interface were implemented during the development process. Major task items were divided into detailed, discrete and

manageable assignments. Dr. Paul Merrill (the instructional-design expert) and Dr. Matthew Christensen (the subject-matter expert) were consulted to examine the product and instructional content. Media such as computer programs, video and audio resources were utilized to produce the first functioning prototype of the program. Four one-to-one tests were conducted to elicit basic feedback from users (more detail concerning the tests is provided in the "One-to-One Test" section below).

Implementation

Implementation refers to the process of applying the CRCT program in a real-world context involving the target audience. The CRCT program was placed on web-site space sponsored by the Instructional Psychology and Technology (IP&T) Department so that users could gain access to the program. Several technical problems such as platform and browser interface incongruities were discovered and resolved after the third one-to-one test was conducted.

Another obstacle encountered involved the inaccessibility of the target audience for the small-group test (i.e students enrolling in the basic Chinese class (CHIN 101)). The Chinese 101 class was not offered in spring 2005, when the small-group test had to be conducted. As a result, 17 alternative student participants who were interested in learning Chinese radicals and characters, but had not enrolled in the Chinese 101 class or gained other prior knowledge, were recruited to take the small-group test instead.

Evaluation

As mentioned previously, evaluation is conducted in four stages: analysis, design, development, and implementation. Small-group formative evaluation was utilized to assess the average level of user ability and effectiveness for the group. Tessmer (1993) noted that formative evaluation improves the learning effectiveness of instructional materials. He asserted that the purpose of formative evaluation is not to prove or validate the effectiveness of instructional design, but to be part of the instructional design.

Product Objectives

Objectives are used to design instruction, clarify instructional intent and establish procedures for evaluation and testing (Robert & Bassett, 1977). Instructional design objectives for the CRCT program are identified in connection with customized situations and expected performance under those varied circumstances. The following are instructional design objectives for the CRCT program:

1. Given previously-encountered radicals, the learners will be able to identify the corresponding English translation.
2. Given previously-encountered radicals, the learners will be able to identify the appropriate *Hanyu Pinyin* and sound.
3. Given *Hanyu Pinyin* and the sound of previously-encountered radicals, the learners will be able to identify the associated radicals.

4. Given the English meanings of previously-encountered radicals, the learners will be able to write the radicals correctly.
5. Given the English meanings of previously-encountered characters, the learners will be able to write the characters correctly.
6. Given unfamiliar Chinese characters which are constructed from previously-encountered radicals, the learners will be able to identify the corresponding English translations by extrapolating from their components (radicals).

Product Description

The CRCT project was built from computer software which included *Macromedia Flash 2004*, *Microsoft FrontPage XP* and *Adobe Photoshop 7.0*. Flash was used because it has the capacity to integrate and support Chinese scripts, QuickTime movies, graphic animation, and hypermedia resources in SWF "Shockwave Flash" format. The SWF file format can not only reduce file sizes for QuickTime movie clips, it can also permit comments and instruction appearing during the movie clips. *Microsoft FrontPage* and *Notepad* were utilized to write the HTML coding needed to embed SWF movie files. This method enables the SWF movies to be displayed full-screen and prevents unpleasant blank pages for users who have browsers which do not support SWF files. Because Chinese scripts can encounter glitches in some browsers and platforms, some of necessary Chinese radicals and characters were created in JPG format with the use of *Adobe Photoshop 7.0.*

The CRCT program consists of three sections: (a) introduction, (b) tutorials, and (c) drills. The Introduction includes goals and purposes, provides "what do you need" guidance, and discusses the use of CRCT. The Tutorial section includes three tutorials: characters, components and radicals. Character and component tutorials have audio narration discussing characters and components. The Radical Tutorial utilizes only a silent subtitle description, due to the time constraints governing the CRCT programming timetable. The complete audio and subtitle scripts can be found in Appendix C. The Drills section includes radical and character association drills to help learners identify previous-encountered radicals and learn to associate radicals and characters.

Each section allows learners to navigate from any point in the progression sequences according to their interests and individual mastery of the content. The non-sequential design permits learners to proceed in customized progressions instead of rigid sequences. The interface is separated into two main frames: the left frame contains links to the content, and the right frame provides both introductions and instruction, as shown in Figure 1.

Figure 1. Screen shot of the two main frames.

Below is a detailed description of the three sections.

Introduction

The introduction is divided into three subsections: a) goals and purposes, b) what do you need, and c) using CRCT. Content details are described below.

Goals and Purposes. Students are informed that the CRCT program will help them to acquire specific skills: breaking characters into individual components, understanding the meanings and sounds of Chinese components, recognizing the shapes of radicals and characters, memorizing proper pronunciations for radicals and characters, and correctly writing radicals and characters.

Ideally, of course, future CRCT users will already have some basic listening and speaking skills as well as rudimentary knowledge of *Hanyu Pinyin* before they begin to learn characters.

What Do You Need? The CRCT program incorporates movie-clips which can be around 200 KB in size. Users with slow computer systems can experience delayed or sluggish movie and animation displays. Viewers are therefore advised to use a high-speed internet connection and to turn on their computer speakers. Additionally, viewers are informed about the existence of *Hanyu Pinyin* as an outside resource method which is recommended for concurrent use in learning and practicing the pronunciation of characters and radicals which are presented by CRCT (CRCT itself does not utilize or present specific *Hanyu Pinyin* methodology to viewers). Learners are also put on notice that they will need to have paper and a pen/pencil when practicing writing with the aid of CRCT.

Using CRCT. Student viewers are advised to sequence their use of CRCT in the following order: (a) character tutorial, (b) component tutorial, (c) radical tutorial and then radical drills, and finally, d) character-association drills. Learners can follow the hyperlinks in the "Using CRCT" page or indulge their own individual preferences by clicking on the links in the left frame, as depicted in Figure 1 above.

Tutorials

Tutorials provide crucial basic instruction concerning radicals and characters. This section was mainly created with SWF files incorporating graphics, audio dialog, text, animation, and movie clips. Detailed description of the three tutorials is set forth below.

Character Tutorial. The character tutorial presents an overview of the conceptual framework for CRCT instruction, including an explanation regarding the definitions and interrelationships between Chinese words, characters, and components (radicals and phonetics). Animation is used to depict the model for a) deconstructing words into characters, b) deconstructing characters into components, and c) categorizing components into the phonetic or radical classifications. The character tutorial is divided into six chapters which provide seven "helpful explanations" to elaborate upon important concepts. "Helpful explanation" fulfills an augmentation role, scaffolding viewer progression to ensure learners thoroughly understand the concepts presented.

Figure 2 shows the first page of the Character Tutorial, which provided instruction on how to use the tutorial interface. To make the SWF file user-friendly, the "space bar" on a computer keyboard interacts with the program to control the "play" and "stop" functions for the movie clips.

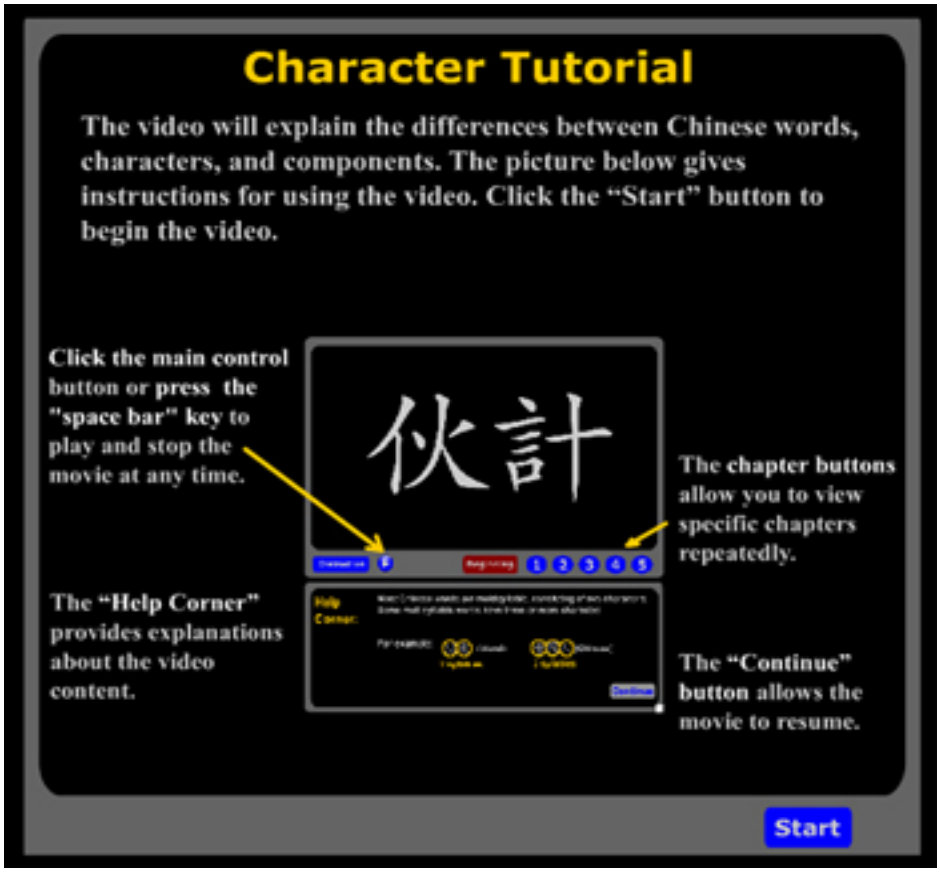

Figure 2. Introduction page of Character Tutorial.

To help learners browse and review specific chapters containing the SWF movie clips, the specific activated chapter-control button turns a red color to indicate the viewer's current location. Figure 3 depicts one page from Chapter 3.

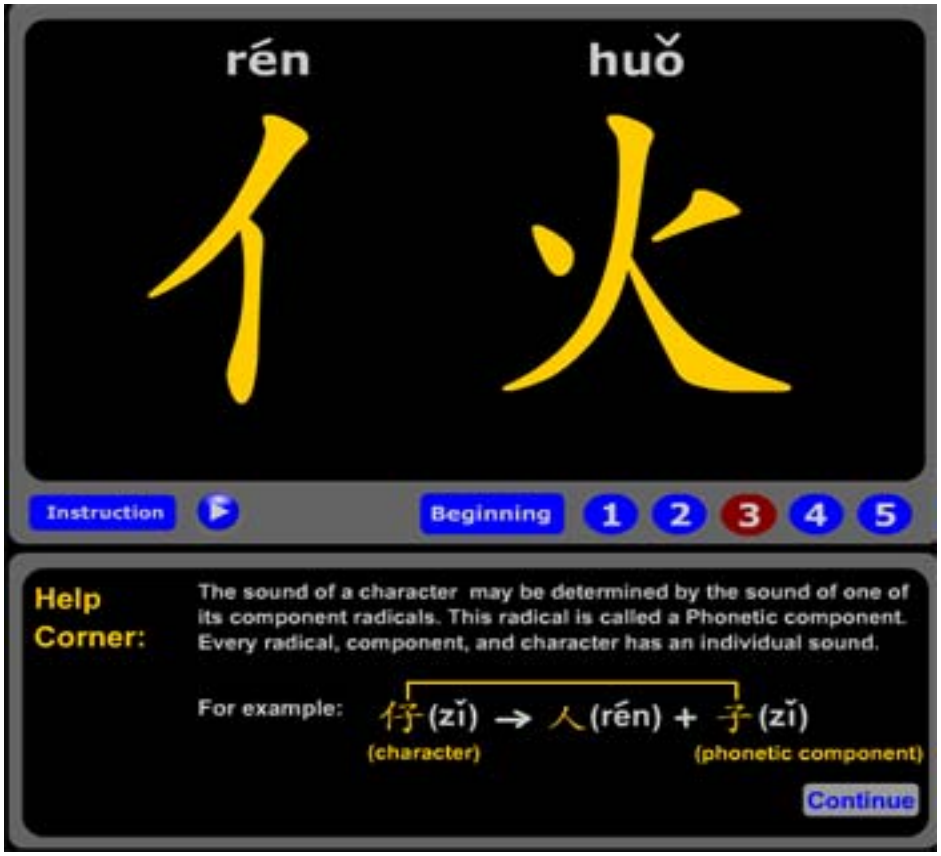

Figure 3. Chapter three of Character Tutorial.

Component Tutorial. The Component Tutorial uses simple animation to present examples concerning the differences between phonetic components and radicals and the ways in which they may be combined to form characters. The tutorial is supported with SWF movie-clip files which explain character deconstruction and composition. Use of the "space bar" controls main timelines for the Component Tutorial movie clips, and the blue-color forward and backward buttons instantly bring a viewer to the beginning or end of a specific SWF movie clip. Figure 4 shows a screen shot of one page from the Component Tutorial.

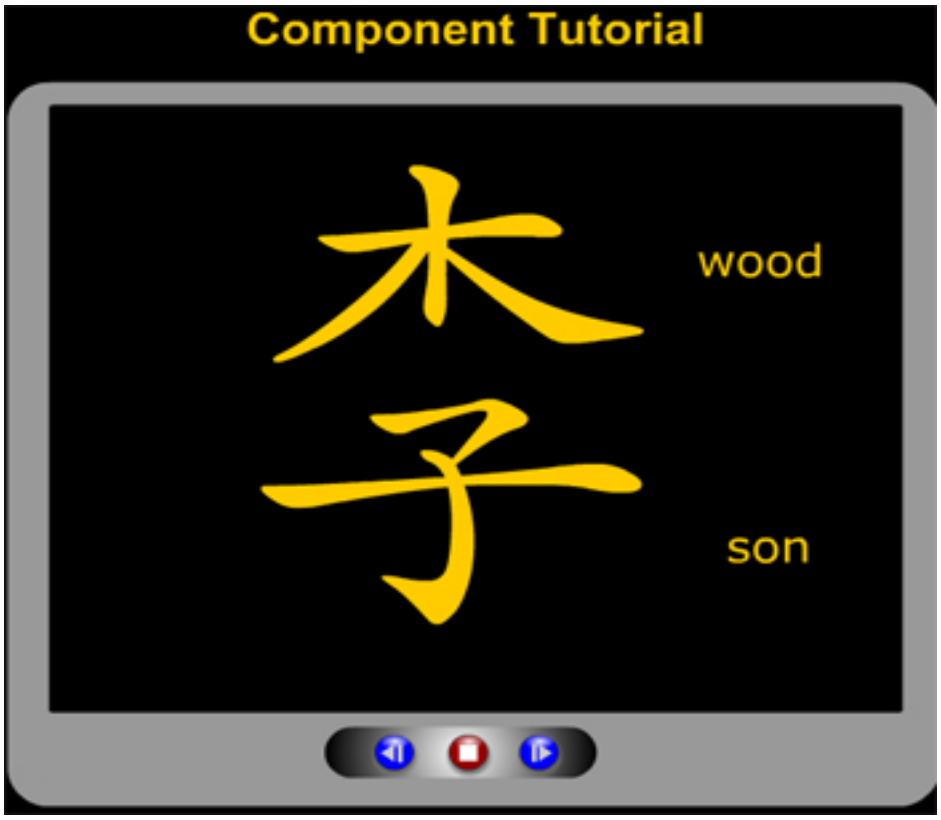

Figure 4. Screen shot of Component Tutorial.

Radical Tutorial. The Radical Tutorial begins by introducing the usage and various forms of radicals. A comparative overview discusses the similarities and differences between radicals and the English alphabetic letters with which the learners are already familiar. There are 14 frequently-used radicals listed in the Radical Tutorial. Each radical is accompanied by a movie clip of an expert conducting a handwriting demonstration. An audio-clip pronunciation aid and an English translation also accompany each radical in order to cultivate the users' ability to recognize and write radicals. Learners are required to write radicals by using a pen/pencil and paper to imitate the movie-clip writing

demonstrations. Figure 5 shows video writing demonstration, English and pronunciation of a radical, video control functions, and buttons to view other radicals' writing demonstration.

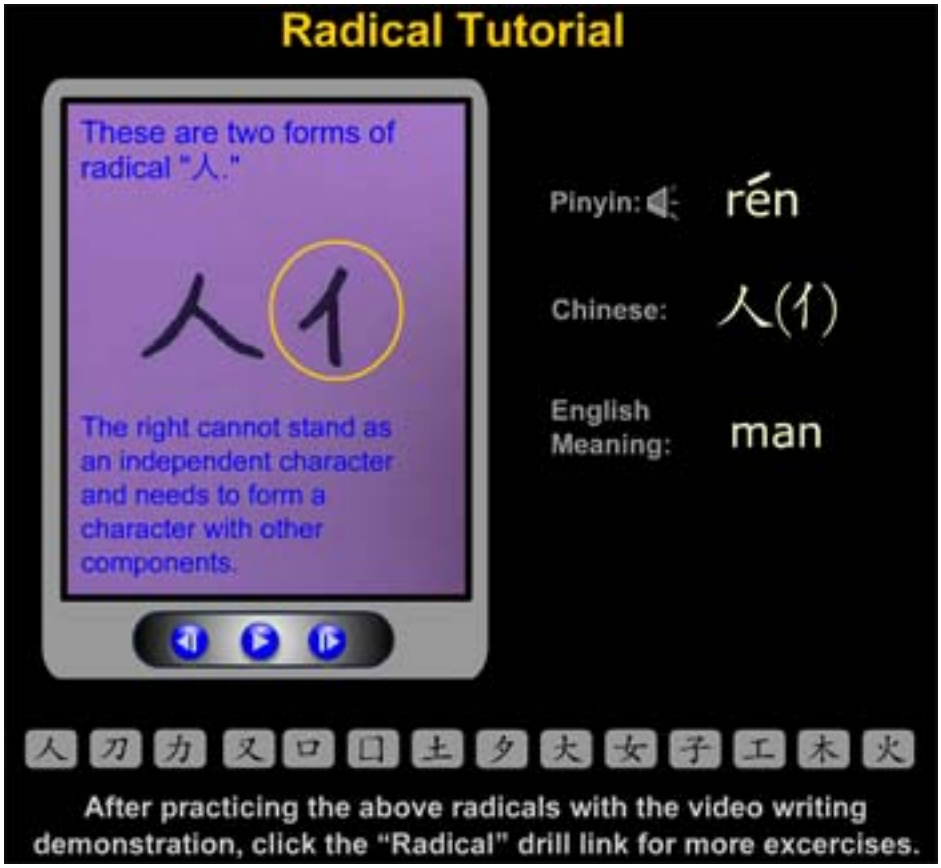

Figure 5. Radical writing demonstration.

The design of Radical Tutorial reflects an important linguistic and pedagogical precept implicit in the design of CRCT: learners need to know how to pronounce Chinese radicals. Some radicals are also characters and words, somewhat like the way "I" is both a letter and a word in English.

Even more fundamentally, CRCT characterizes Chinese language as a rich tapestry of interwoven sounds, symbols and cultural concepts. These constituent aspects of the

language are interdependent and mutual reinforce each other conceptually and definitionally. Chinese therefore is best learned by understanding the conceptual pattern and logic of the language, rather than simply memorizing what superficially appears to be a random collection of alien symbols and sounds.

Put another way, an English-learning approach analogous to CRCT's approach for Chinese would likely encourage students to learn alphabetic sounds, phonetics, and the meanings of common prefixes and suffixes. Thus equipped, a student of English can "sound out" unfamiliar words and make educated guess about word meanings.

Drills

CRCT is designed to allow students to actually practice recognizing and associating radicals and characters. Practice drills focus on various facets of these skills, including pronunciation, shape recognition and English translation. Learners are involved as active participants, not as mere passive recipients of instruction. Instant feedback from the CRCT program helps students to quickly recognize and correct their errors.

Radical Drill. The Radical Drill utilizes four different types of items: matching radical symbols with sounds without *Hanyu Pinyin* sounds provided, matching radical symbols with sounds with *Hanyu Pinyin* sounds provided, matching radical symbols with English meanings, and matching radical sounds with radical shapes. Figure 6 depicts the selection page for the Radical Drill. Students can practice specific skills according to their

individualized needs. Practice items were designed in accordance with designer learning objectives and the radicals previously presented in the Radical Tutorial.

The practice items are randomly ordered and presented to prevent learners from attempting to memorize specific questions and answers in a particular set sequence. Students can click on the answer or radio button to submit their chosen answer. The "Submit" button is available to submit the users' answers and simultaneously elicit instant feedback about the accuracy of the answer selected. If students choose the correct answer, the instant feedback will display a "yes, that's right" message. Conversely, an incorrect answer results in a feedback message which states "no, the correct answer is ____."

The CRCT is programmed to automatically tally the number of correct items against the total number of questions, thereby providing users with a raw index of their performance. Figure 7 depicts a student's practice scores (e.g. "You've got 0 out of 1") and the feedback from the program. Students can exit practice questions at any time to return to the selection page for the Radical Drill (Figure 6), as explained by the four guidance comments provided at the top of each question as depicted in Figure 7.

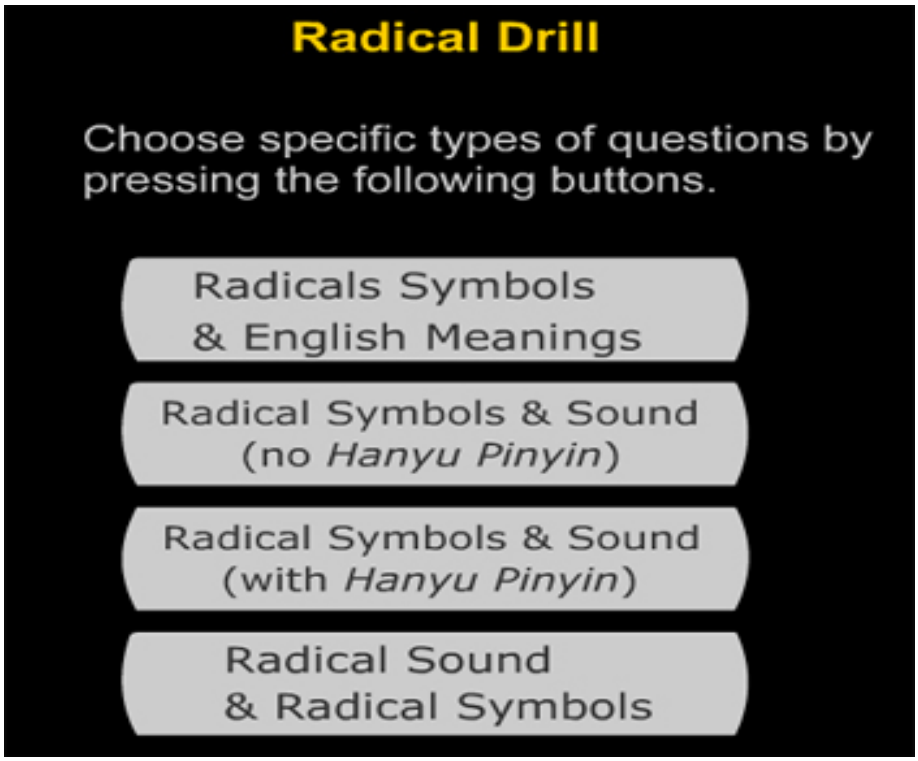

Figure 6. Selection Page of Radical Drill.

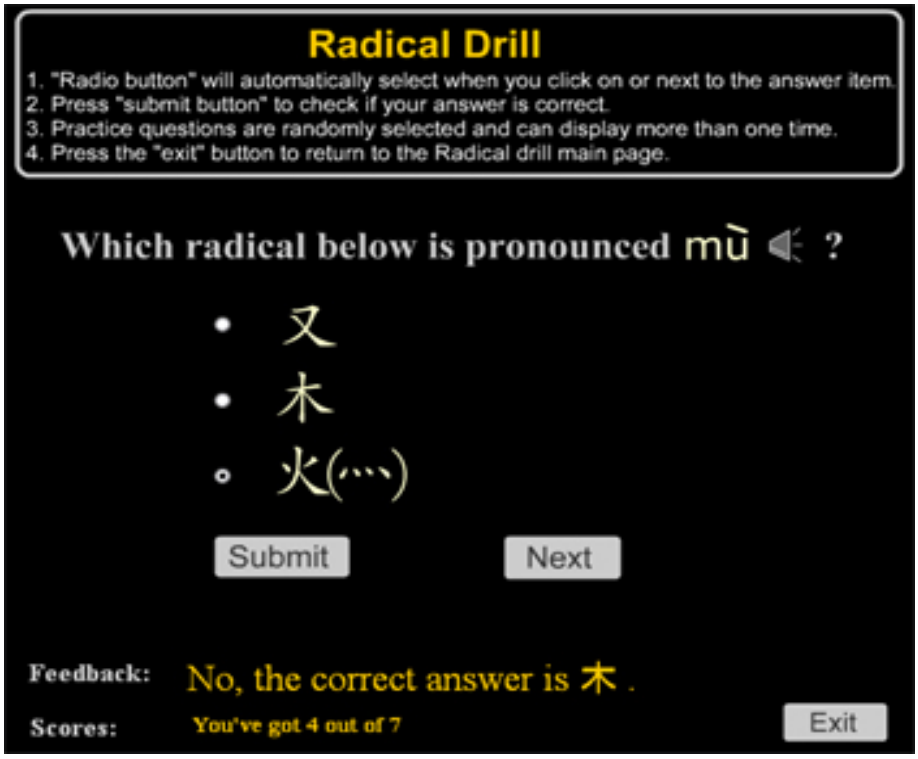

Figure 7. Radical Symbols and Sound Practice.

Character Association Drill. Like the Radical Drill, the Character Association Drill allows learners to practice associating Chinese characters with sound or English meanings of their components. Instant feedback, accumulated scores, interfaces, and all other functions were designed to be exactly like the Radical Drills. However, the Character Association Drill has only two types of question items: associate English meaning of a previously-unencountered character with its previously-encountered radicals, and associate sound of a previously-unencountered character with its previously-encountered radical. Figure 8 shows the selection page included these two items.

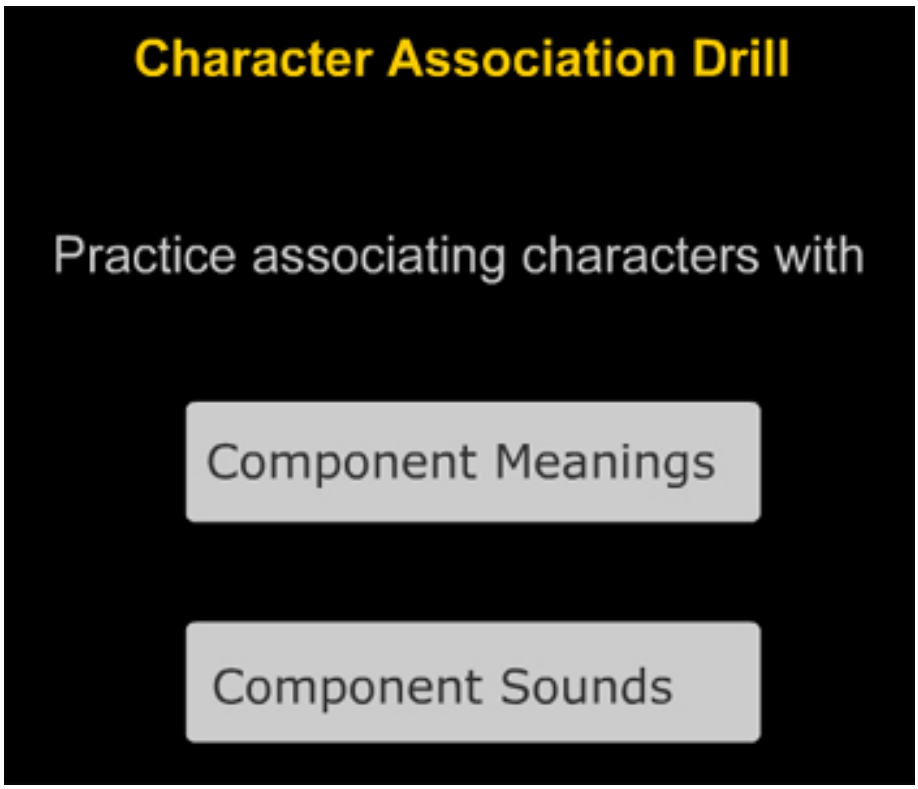

Figure 8. Selection Page of Character Association Drill.

The Character Association Drill is intended to be challenging and to elicit creative student deciphering needed to associate English meanings and sounds of previously-unencountered characters with their previously-encountered radicals. To correctly answer questions, students need to utilize inductive reasoning to identify unknown character meanings and sounds by deconstructing the unfamiliar characters into different familiar components. As usual, the correct answers are instantaneously provided after a response in order to help learners correct their errors. Figure 9 exhibits the question, feedback and scores.

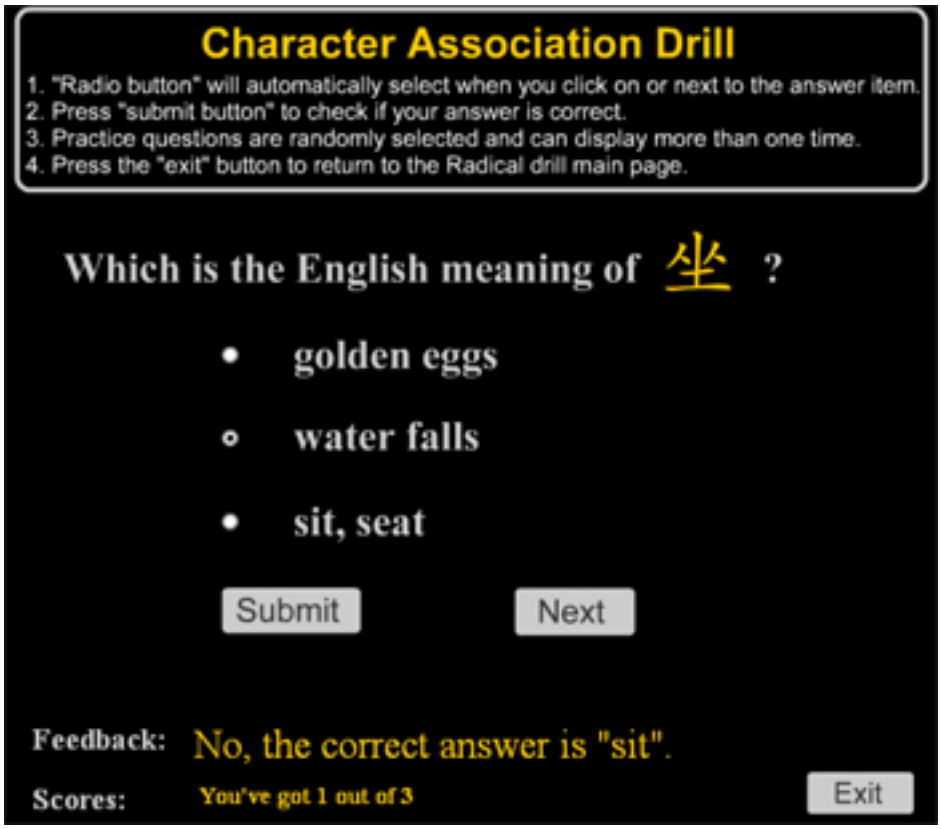

Figure 9. Characters and English meanings.

Formative Evaluation

Instructional programs typically require a long process of debugging and incremental improvement to reach a level of excellence. Continuous improvement and change is required during the design and development phase. Therefore, CRCT has been carefully evaluated from the design to the implementation stage, and can readily accommodate future expansion and enhancement. Feedback and suggestions from users and instructional experts have been central to the development for CRCT.

Formative evaluation was used to obtain thorough feedback regarding CRCT, thereby permitting assessment of program feasibility, defect rectification, and optimal enhancement of effectiveness and efficiency.

Three goals for formative evaluation were set: (a) Identify learners' attitudes and perceptions when learning with CRCT, (b) Evaluate and improve the effectiveness and quality of CRCT, and (c) Critique CRCT's strengths and weakness. Quantitative and qualitative techniques were used to achieve these evaluation goals.

I was responsible for every stage of the evaluation process and for observations of the learners' use of CRCT. I aimed to achieve rational and unbiased evaluation. To minimize personal bias and distortion, every procedure undertaken during the evaluation process was recorded and reported. As soon as the formative evaluation was finished, meta-evaluation was conducted to critique it.

Stakeholders and Audience

Grasso stated that high-quality analysis is required to "identify the audiences for the evaluation, provide information these audiences can use, and ensure that information is available in a timely way" (cited in Sridharan, 2003). To identify what information the audiences are interested in knowing, stakeholders should be interviewed or surveyed.

People who use and need the evaluation information are called "stakeholders." Their preferences have the potential to help shape the evaluation report and the finished instructional product. To evaluate the CRCT program appropriately and usefully, three important questions suggested by Sridharan (2003) were answered before performing an evaluation: (a) Who will use the evaluation? (b) What will they need from the evaluation? (c) When will they need the information?

Several potential stakeholders were identified, including the chair and committee members of the CRCT project, potential students learning Chinese characters, and teachers of basic Chinese.

Dr. Paul Merrill, the Chair of Su-Ling Hsueh's committee, served as the professional instructional designer to evaluate the program's effectiveness. He is interested in knowing how the development program was shaped to conform to appropriate instructional design methods. Questions he asked included the following: (a) Does CRCT command the attention of the learners? (b) Does CRCT clearly identify the learning

objectives? (c) Does CRCT help students recall prior learning? (d) Does the functional design of the CRCT software efficiently and effectively support the instruction content? (e) Does CRCT elicit the desired performance? (f) Does CRCT provide quality feedback concerning student performance? (g) Is the CRCT assessment scheme appropriate for evaluation of student performance? (h) Does CRCT enhance student retention and/or student ability to transfer knowledge to new settings? (i) Do CRCT learners achieve the stated designer objectives for the instruction? (j) Do CRCT users enjoy their learning experience? (k) Do the CRCT graphics, animations, videos and narrations enhance student learning?

Dr. David Williams, a member of Su-Ling Hsueh's committee, serves as a professional evaluation director. He was interested in knowing how the evaluation performance complied with his 14 basic evaluation steps set forth below.

1. Is there Background/Context/Literature information for understanding the rest of an evaluation plan or report?
2. Who are the audiences/stakeholders/information users who care about the evaluand and its evaluation?
3. What is the evaluand these people care about?
4. What issues, concerns or information needs do they have regarding the evaluand?
5. What criteria do they have for judging the evaluand?

6. What questions do they want to answer regarding how well the evaluand meets the criteria?
7. What processes and activities were used to collect data to answer the questions and compare the evaluand to the criteria?
8. What analysis procedures were used to interpret the data?
9. What reporting strategies were used to get information to information users (interim and final)?
10. What are the results or answers to the evaluation questions?
11. What recommendations does this study yield?
12. What resources were used to carry out the entire study, including team members?
13. What schedule and budget were followed (each part attached to particular questions, collection procedures, and analysis activities) and how did they compare to what was planned?
14. How did this study hold up against each of the 30 meta-evaluation standards?

Dr. Matthew B. Christensen, the Chair of the Chinese Section and a member of Su-Ling Hsueh's committee, is a professional teacher of Chinese-language pedagogical techniques. He was interested in knowing how effective the program would be in terms of reducing in-person instructional time for teachers, increasing levels of student satisfaction and attitude, and eliciting positive student performance after CRCT instruction is used.

Su-Ling Hsueh, the CRCT program developer, was concerned about learner performance, student attitudes, compliance with the requirements for the development and evaluation processes, and the overall utility of CRCT.

The target audience, which was students enrolling in basic Chinese classes, was interested in knowing whether CRCT would conveniently and flexibly assist their Chinese learning and completion of Chinese course work. They were also interested in knowing whether the character-writing demonstrations and strategic pedagogical approach would enhance memory retention.

Teachers providing instruction in basic Chinese at Brigham Young University were interested in knowing if CRCT could be conveniently integrated with their class instruction, if CRCT content is compatible with textbook content, and if CRCT content provides students with accurate information.

Evaluand

"Evaluand" is a generic term referring to whatever is being evaluated. The evaluand for this project was the CRCT program as a whole. The stakeholders' questions were analyzed, synthesized, and divided into three major evaluand components: (a) Program content and delivery, (b) Instructional design approach and method, and (c) Media usage of graphics, movie clips, and animated instruction.

Criteria to evaluate three components of the evaluand were derived from the stakeholders' expectations and questions, as described below.

Program content and delivery. Nine criteria were used to evaluate program content and delivery: (a) CRCT needed to serve as a stand-alone supplemental resource which reduces in-class instructional time, (b) CRCT objectives needed to be well-defined to meet the needs of learners and instructors, (c) CRCT needed to hold learner attention and permit convenient use at any time and place, (d) CRCT needed to enhance learner retention and transfer of knowledge by relating new concepts to previously-understood ones, (e) CRCT content needed to be accurate, comprehensive, easy to digest, and effectively organized, (f) CRCT Chinese radical and character instruction needed to be demonstrated with proper media, (g) CRCT needed to provide immediate feedback assist learning, and (h) CRCT learners needed to experience enjoyment and satisfaction from use of the program.

Instructional design approach and method. Five criteria were used to evaluate instructional design approach and method: (a) instructional design concepts needed to conform to Gagne's nine events and Gibbons' model-centered instruction, (b) instructional design and development process needed to comply with the ADDIE model, (c) instructional approaches and pedagogy needed to produce student learning, (d) assessment needs were expected to be content-related and to evaluate whether instructional objectives were achieved, (e) formative evaluation needed to be meta-evaluated and to follow Williams' 14

basic evaluation steps.

Media usage: graphics, movie, and animation instruction. Six criteria were used to evaluate media usage: (a) software and media needed to be suitable to achieve expected learning outcomes and instructional objectives, (b) media design needed to provide an artistic, aesthetically-pleasing visual environment, (c) graphics needed to be clear and to assist learning, (d) audio narration needed to provide effective information, (e) computer animation needed to help learners visualize abstract and essential concepts, and (f) instructional video presentations needed to have good quality.

Data Collection

Three types of evaluation were adapted to collect the practical information needed to improve CRCT functions and effectiveness: one-to-one testing, expert review, and small-group testing. One-to-one testing and expert review were performed during the same time period to minimize the critical path for the CRCT project. Surveys, observations and interviews were all important tools for collecting CRCT learner opinion and feedback.

Questions for one-to-one tests were based on the instructional-development needs for program improvement and were used to collect effective suggestions to improve the program rather than to statistically assess the final impact of the completed product. Survey questions for learners' attitudes and perceptions in the group-test were pre-screened by various readers for clarity only. Dr. Paul Merrill, the instructional design expert, also

scrutinized and modified the small-group test questionnaire in order to collect useful and accurate data for formative evaluation.

One-to-One Testing

The CRCT prototype was utilized to conduct a sequence of four one-to-one tests. The purpose of the one-to-one tests was to uncover information needed to revise the CRCT program. Tessmer (1993) recommended pondering questions during the evaluation planning process such as "is the instruction clear?", "are directions clear?", etc. In order to make the one-to-one usability test efficient and pertinent, a survey questionnaire was developed before the tests were conducted. Informal and non-systematic interview questions were asked on a continuous basis to follow-up on participants' responses to the two versions of the questionnaire. More details are provided in the Evaluation Questions section.

Participants. Jakob Kielsen (2000) claimed that the best evaluation results come from testing five users and running many small tests instead of conducting one elaborate usability test. However, Wager (1983) and Robeck (1965) demonstrated that they had achieved a material improvement to their original design by using two or three learners in one-to-one testing to inform their instructional revision (cited in Tessmer, 1993). Tessmer also found that Ower, Thurston and Brown (1983) obtained the same effect by using only one learner.

For the CRCT design process, four participants were sequentially selected for one-to-one tests designed to give feedback concerning the draft designs. The first three participants were graduate students who took instructional design courses in the IP&T Department and who did not understand any Chinese. The fourth and last participant was an undergraduate student who did not have any prior knowledge of Chinese.

Participants were not drawn from the students in beginning Chinese classes. One key reason for this was that the tests were conducted in April 2005 and by that time the beginning Chinese classes for the academic year were drawing to a close. The students in these classes had acquired too much knowledge for the author to be confident that the tests would genuinely reflect authentic newly-acquired knowledge. Students from IP&T program, in contrast, would not have any confounding preexisting knowledge of Chinese, but would be especially exacting about the instructional quality of the program they were evaluating.

Survey questions and procedure. Evaluation questions were arranged in two survey questionnaires. The first and second participants responded to the first one-to-one usability test questionnaire, which was designed to determine if specific CRCT functions were appropriate and effective. The first questionnaire included items such as “is the menu clear”, “is the background color comfortable”, “do buttons and animations function properly”, etc. A copy of the complete questionnaire is found in Appendix D. The second one-to-one usability test questionnaire was used to elicit feedback from the third and fourth participants

in response to general usability questions such as “do you feel challenged when learning with the program”, “could you use the program without any assistance”, “could you hear the narration clearly and informatively”, and so forth. Appendix E includes the complete questionnaire.

In addition, the evaluator (the author) prepared a blank sheet (recording log) to gather learners’ spontaneous comments and observations about their own performances. Interview questions were spontaneously utilized in reaction to the learners’ responses and the evaluator’s observations and then recorded on the blank sheet.

Data review. After every one-to-one test the draft of the CRCT program was modified before the next one-to-one test was conducted. The first two participants’ effectiveness at learning Chinese radicals and characters with the CRCT program was not assessed because at that point in time the assessment questions and content for CRCT were only partially completed. Therefore, the tests were performed on the author’s computer instead of on working site pages linked to the internet. Additionally, the purpose of the first two tests was to gather feedback about more general features about the program, such as site mapping, general conceptual flow, and technical functionality. Set forth below are the result analysis for each of the four one-to-one tests, along with the revisions made after each one of the tests.

First one-to-one test. The first one-to-test was conducted on April 8, 2005. The user

stated that the animation and graphics appropriately presented the CRCT program. He also mentioned that the CRCT software instruction was clear and easy to understand. He further stated that the background color scheme and overall design was enjoyable and aesthetically pleasing.

The user's suggestions for improvement included: (a) state the learner objectives at the beginning of the instruction, (b) slow the audio narration, (c) enlarge the radio buttons to make clicking easier, (d) change the Radical Tutorial so that it automatically plays, (e) change the questions so they are randomly-selected by question type, (f) change the menu so it has a hierarchical order, (g) add "Hanyu Pinyin" symbols next to sound buttons for the practice questions, (h) program the "spacebar" to submit the answer instead of requiring a click on the "submit" button, and (i) find a background color even more appealing than green.

In response to the users' comments, the following revisions were made: (a) stated instructional objectives clearly in the "goals and purpose" link, (b) added necessary subtitles and stop points to segment audio narration, (c) made it possible for learners to click on the answers they prefer and to automatically select the radio buttons, (d) programmed the Radical Tutorial for automatic play, (e) examined the questions so that they would be randomly-selected in a correct manner, (f) rearranged the menu into three categories (introduction, tutorials, and drills), (g) extended the question types beyond one category in

order to allow learners to match radial shapes with *Hanyu Pinyu* and sounds, (h) examined the possibility of re-programming the "spacebar" function before concluding that technical problems with the software program made any change impractical, and (i) switched from a green background to a blue background.

Second one-to-one test. The second one-to-one test was performed on April 11, 2005. The participant stated that the animation and graphics motivated him to learn and that he enjoyed using CRCT. He indicated that the instruction was clear and easy to understand and that test questions were appropriate and content-related. The user's suggestions for improving the program included (a) make the drill guidelines clear, (b) utilize hotlinks or pop-up menus to more effectively direct the learning sequence with expanded explanations, (c) remove the augmentation questions on the top of the Character Tutorial, (d) resolve the lack of clarity for the "play all" explanation in connection with the "play all" button icon, and (e) add the chapter names for certain segments of the Character Tutorial.

After the second one-to-one test, the following modifications were made: (a) a screen-shot of the Character Tutorial was inserted to provide informative tool-guides on the page, (b) hotlinks were added to help learners more easily navigate through CRCT, but the pop-up explanation menu was not added because it was excessively time-consuming in comparison to the likely marginal potential benefits, (c) augmentation questions were removed, (d) the "play all" explanation was detached, and (e) chapter names were attached

to the Character Tutorial.

Third one-to-one test. The third one-to-one test was conducted on April 14, 2005. The participant was asked to learn Chinese radicals and characters with the CRCT program and to take a separate written assessment post-test. The user scored seven points out of ten on the listening test but did not take the writing test because he ran out of time on account of personal needs. The user indicated that learning with the CRCT program was challenging but he was able to use the program without any outside assistance. He also thought the program was easy to use. He suggested that (a) Mozilla and Explorer browsers on the MacIntosh platform inappropriately shrunk the CRCT tutorial screen display, (b) chapter buttons should change colors when illustrating contemporaneously-activated chapter numbers, (c) the hierarchy order of the menu was acceptable, (d) Radical Drill should continue to include matching tasks involving both the radical shapes with sounds only and also the sounds with *Hanyu Pinyin* only, (e) the fonts were too small, (f) the program did not provide smooth and effective learning steps, and (g) the buttons should be changed to provide external links to plain-text explanations in the Character Tutorial.

Specific program revisions taken in response to the aforementioned feedback included the following: (a) revision of the computer programming scripts to make the full screen accessible for different browsers and platforms, (b) change of the chapter buttons to an automatic red color display to indicate when specific segments of the character tutorial

had been contemporaneously activated, (c) retention of the hierarchy menu order, (d) retention of the Radical Drills format, (e) use of enlarged font sizes, (f) relocation of the Radical Drill so that it would precede the Character Association Drill, and (g) use of explanation text to replace the external link buttons in the Character Tutorial.

Fourth one-to-one test. The fourth participant was asked to learn Chinese radicals and characters and to take the assessment questions on April 18, 2005. The user scored 20 points out of a possible 25 but could not correctly write previously-encountered Chinese characters. The learner indicated he did not feel bored when using CRCT. He found CRCT to be challenging but stated that he could learn with the program without any outside assistance. He felt the program provided good strategy and informational content, that the program effectively facilitated character learning, and that the program was easy to use.

The participant's suggestions were (a) the program did not provide smooth and effective learning steps, (b) narration was not clear and informative, (c) the explanations could be made more helpful by adding "pronunciation" next to "phonetics," (d) the last "continue" button should be changed into a "replay" in the Character Tutorial, (e) the explanation of "hui; 回" was incomprehensible, and (f) expanded explanations should be provided for the instant feedback in the Character Association Drill, rather than simply providing the correct answers.

The revisions in response to the fourth one-to-one test were to (a) remove the text

explanation in the Character Tutorial to reduce user confusion, (b) rearrange narration for the Component Tutorial, (c) explain more about phonetics, the character component which dominates determination of the sounds used for characters, (d) changed the last "continue" button in the character tutorial to a "replay" button which will allow the tutorial to start from the very beginning, (e) redesigned the example "hui; 回" to help learners understand how the sounds of character can change slightly from the sounds for its constituent components. Because of a technical difficulty with Action Script programming, the author was unable to provide expanded explanations for feedback in the Character Association Drill.

It would have been possible to conduct numerous additional one-to-one tests and to gain additional insight from each test. However, the law of diminishing returns governed the situation and the marginal gain in insight from each new test continued to shrink. The author believed that the progress achieved by focusing resources on product creation would outweigh the potential progress achieved by conducting additional one-to-one tests, and that a continued focus on testing would result in excessive opportunity costs.

Expert Review

Expert review was conducted just before performance of the first one-to-one test. A combination of face-to-face interviews and electronic mail exchanges were arranged to obtain constructive input from three experts. The subject-matter expert (SME) reviewed

CRCT for content accuracy, the instructional-design expert reviewed the instructional design process and effectiveness of the CRCT project; and the evaluation expert provided insights about planning procedures and execution of the formative evaluation.

Procedures and Analysis. The SME, Dr. Matthew Christensen, was interviewed to assess the accuracy of the substantive content, including the propriety of the distinctions drawn by CRCT during the first draft stage between Chinese words, characters, components, phonetics and radicals. At the same time, Doctor Andrew Gibbons, the creator of model-centered instruction (MCI) theory, was interviewed to ensure CRCT clearly and correctly implemented a learning model. Neither interview involved use of specific instruments or pre-planned questions; the author asked for general feedback and verification concerning the substantive content and the delivery method. The Character Tutorial was developed after the interviews with Christensen and Gibbons.

The instructional-design expert, Dr. Paul Merrill, scrutinized the effectiveness of the CRCT first-draft instructional design process, graphics, animation and movie clips to ensure conformity with sound instructional-design principles. His suggestions after review included (a) increasing the volume for the beginning audio dialog related to the radical introduction, (b) making the radical introduction more consistent with the interface, (c) providing information to indicate what specifically should be practiced in relation to the radical handwriting demonstrations, (d) syncing the audio and video timing for the movie

clip demonstrating the radical “ren”, (e) providing more explanation for those radicals which have two forms, (f) providing three types of practice for each item, (g) making the component tutorial less confusing, (h) and designing the character practice so it was more than a simple memorization test.

In response to the suggestions, the following changes were made: (a) the audio for the radical introduction was re-recorded, (b) the original 40 radical buttons were reduced in number to 14 radical buttons and the radical introduction script was revised so that it coherently matched the interface, (c) additional instructions were included to direct students to prepare a paper and pen so that they could write radicals imitating the expert’s demonstrations, (d) the audio and video tracking was synced, (e) the script was changed to elaborate upon the differences involving two forms of the same radical, (f) practice questions were changed to include three approaches (matching radical shapes with English meanings, matching a radical shape with radical sounds, and matching a radical sound with its radical shape from several variations) and to be randomly selected, (f) the script for the Component Tutorial was revised and relevant examples were presented, and (h) the character practice was changed into a Character Association Test which focused upon whether learners could transfer their knowledge of radicals to situations where the learners were asked to inductively discover the sounds and English meanings of previously-unencountered characters.

Before performing the small-group test, the instructional-design expert provided additional suggestions such as (a) remove "suggestion" from the "helpful explanations" in the Character Tutorial, (b) remove the extra "forward" and "rewind" movie control buttons in light of the fact that chapter buttons were already offered, (c) provide effective examples to connect the instruction with learners' prior knowledge, and (d) correct grammar errors and unclear instruction sentences. In response, the necessary improvements were made, so that (a) the "suggestion" word in the "helpful explanation" phrase in the Character Tutorial was discarded, (b) the "forward" and "rewind" buttons were discarded, (c) helpful examples were added, such as comparing different forms of the same radical to the English-language notion of uppercase and lowercase letters (e.g. "A" and "a"), (d) English grammar and syntax was rectified before the small-group test was performed.

Evaluation expert Dr. David Williams examined the processes and planning which had been implemented for the evaluation of both learners and the CRCT program itself. He recommended (a) describing how evaluation would be performed during the design, development and implementation processes, (b) lessening the degree of repetitiveness in the goals stated for the formative evaluation, (c) presenting the evaluation criteria in a more conspicuous manner, (d) conducting more than just two one-to-one tests and describing more clearly how those participants had been selected, (e) describing how well the project

met the evaluation standards established by means of meta-evaluation, and (f) refining data-collection instruments and procedures so they would be more trustworthy.

The responsive follow-up included (a) performance of two one-to-one tests during the development phrase, and another two one-to-one tests during implementation phrase (but no formal evaluation was conducted during the design stage), (b) amended goals for the formative evaluation, (c) clear presentation of detailed evaluation criteria, (d) participation of four volunteers in the one-to-one tests, (e) a listing of the meta-evaluation in the last section of formative evaluation, and (f) consultation with an instructional-design expert in lieu of specific standards for refining data-collection instruments and procedures.

Small-Group Testing

Small-group experimental testing of a high-fidelity CRCT prototype was conducted to assess the effectiveness and usability of the CRCT program. The small-group testing took place in a Brigham Young University computer lab on April 20, 2005. Students assessed the CRCT program online while using two different browsers (*Explorer*, *Safari*), platforms and systems (*Microsoft Windows* and *MAC OS*).

Participants. Seventeen volunteers (three graduate and 14 undergraduate students) majoring in a variety of academic disciplines at Brigham Young University were recruited to participate in the test. None of the participants had any knowledge of Chinese radicals, characters or words. The participants had not enrolled, and did not plan to enroll, in any

Chinese courses or lessons. After learning with the CRCT program, three participants reported that learning Chinese radicals and characters was "very difficult," eight participants regarded it as "rather difficult," four participants deemed it "average," and the remaining two judged it to be "rather easy."

Materials. The pretest and posttest (each contained the same 25 questions) were both designed to conform with the instructional objectives. Of the total 25 questions in the tests, 10 were listening questions, five were questions requiring association of characters' meanings with constituent radicals, and the remaining 10 questions required students to write radicals, as shown in appendix F. The highest possible total score for each test was 25 points, with each questions weighed as one point.

An attitude and perception survey was designed to collect feedback from users. The questionnaire was intended to assemble formative feedback for use in further improving the CRCT program and assessing whether the evaluand component (i.e. (I) Program contents and delivery, (II) Instructional design approaches and methods, and (III) Media usage: graphics, movie, and animation instruction) criteria had been met.

SME and Instructional Design experts questioned the motivation of the group-test participants because those participants did not harbor a serious intent to learn Chinese. In response to this concern a specific question was included to elicit student insight regarding the use of reward to enhance motivation. The attitude and perception questionnaire included

a total of 18 questions. Four questions asked about the backgrounds and attitudes of participants, five questions focused upon details related to instructional content, one question asked if the reward elicited a motivation to perform better, and the remaining questions asked about student perceptions and opinions concerning the CRCT program as a whole (see Appendix G).

Procedure. At the beginning of the small-group test, participants were informed that three grand prizes would be presented to the learners with the three highest scores (the top prize was a $20 gift certificate to a big-box retail outlet). A pretest to evaluate learns' prior knowledge was administered before the users began their use of the CRCT program. Learners were told to start the CRCT instruction on their own and to feel free to ask for assistance at any time (no one actually asked for help, but one learner did ask if the radical introduction came with audio dialog and two other learners asked if they should start CRCT by going to the top link on the left frame).

The overall instructional time for learners was in the 45 to 60 minute range. After completing the CRCT online instruction, a posttest taking 15 minutes which was identical to the pretest (the students really tried to get the answers correct this time) was administered to test the effectiveness of the instruction. When students completed the posttest, they were then asked to respond to the attitude and perception questionnaire as shown in Appendix G.

Results and Data Analysis

Data analysis was separated into quantitative analysis and qualitative analysis. Quantitative data revealed the effectiveness of the instruction, based upon an alpha level of .05 which was used for all statistical tests. Two statistical analyses comparing the difference between means and variances were performed upon the test to ascertain whether the CRCT had an effect on students learning Chinese radicals and characters. Qualitative analysis organized the students' formative feedback and perceptions.

Quantitative Analysis

The highest score on the pretest was eight out of 25 and the lowest score was two out of 25. The pretest range was therefore six. The highest score on the posttest was 21 out of 25, and the lowest score was 12 out of 25. The posttest range was therefore nine. The average gain in score (the average difference between posttest and pretest) was 12.18. The mean of the posttest was 16.41 (SD = 2.85) and the median was 17.00, while the mean for the pretest group was only 4.24 (SD = 1.56) and the median was 4.00.

As a result, the difference in the posttest mean and the pretest mean was statistically significant, t (16) = 16.371, $p < .001$. However, the fact that this difference is statistically significant does not indicate whether it is important in a practical sense. Cohen's (1988) d index was used to describe the practical significance of the observed difference in the pretest and posttest means. This statistic is defined below:

$$d = \frac{\bar{X}_{posttest} - \bar{X}_{pretest}}{\sigma_{pooled}}$$

The effect size statistic describes the size of the difference between the posttest mean and the pretest mean (i.e., the mean gain score) relative to the size of the pooled standard deviation (the average of the pretest and posttest standard deviations). In other words, this statistic describes how much larger the mean of posttest is than the mean of the pretest expressed in standard deviation units.

The value of Cohen's *d* statistic (the effect size) for the difference in the posttest and pretest means in this study is 5.16. Considering the fact that an effect size of .80 is generally considered large (Howell, 2002, p. 228; Huck 2004, pp. 182-183), the effect size for this study might conservatively be interpreted as quite large.

Heterogeneous variances were identified in the scores for the pretest and posttest. The non-normal distributions of CRCT pretest and posttest are depicted in Figures 10 and 11. Visual inspection of the pretest and posttest histograms in Figures 10 and 11 shows that the lowest score on the posttest exceeded the highest score on the pretest by four points (more than 1.7 pooled standard deviations). Careful inspection of the two figures also indicates that the posttest scores were more dispersed about their mean than the pretest scores. By squaring the standard deviations (1.56 for pretest and 2.85 for the posttest) one obtains the variances for the two groups: 2.43 for pretest and 8.12 for the posttest.

Comparing the two variances indicates that the variance of the posttest scores was 3.34 times larger than the variance of the pretest scores. With the assistance of Dr. Richard Sudweeks, a IP&T professor specializing in statistics and assessment, the Brown-Forsythe median and O'Brien's r transformation test were conducted to test whether the variance of pretest and posttest scores were significantly different. The Brown-Forsythe *W-50* test of variances (Brown & Forsythe, 1974) and O'Brien's test of variances (O'Brien, 1978, 1979) were both used to determine whether the observed difference in the two variances was statistically significant. The results of the Brown-Forsythe test was statistically significant, $F(1, 16) = 139.10$, $p < .0001$. The results of the O'Brien test was also statistically significant, $F(1, 16) = 6.124$, $p < .02$.

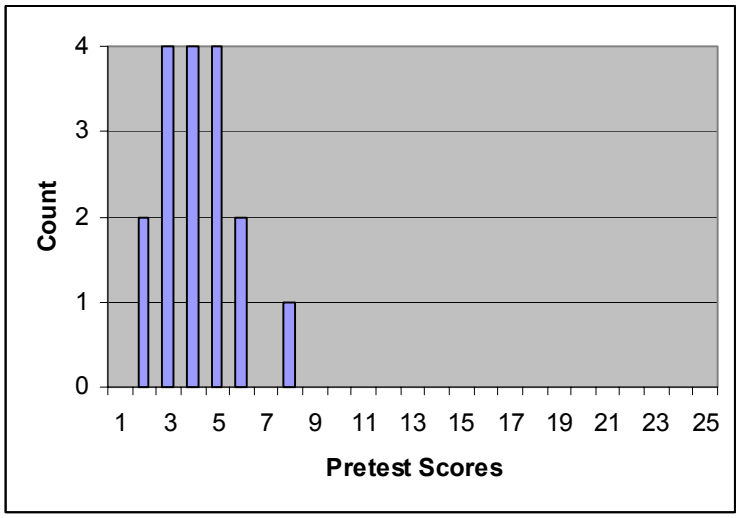

Figure 10. Distribution of pretest scores.

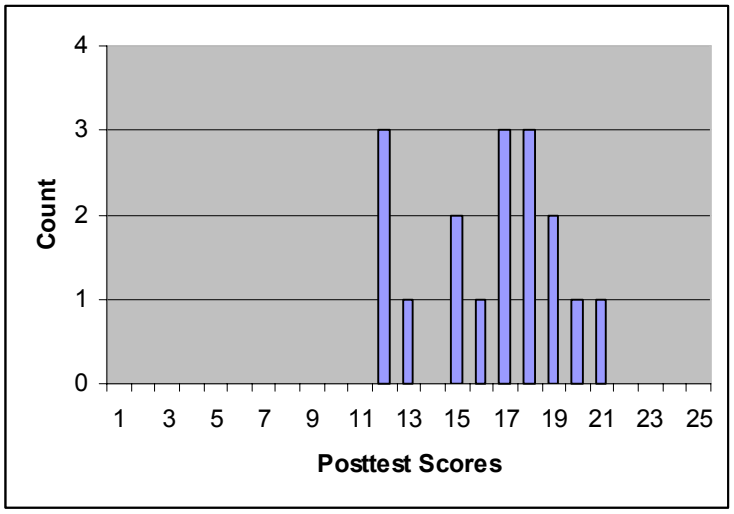

Figure 11. Distribution of posttest scores.

This variance effect provides additional evidence of the effectiveness of the instructional treatment (Howell, 1987). In other words, the treatment appears to have not only increased the mean of the posttest scores but it also appears to have increased the variability of the posttest scores. One possible explanation for the increased variance is that while all of the students learned, some of them may have learned much more than others. Consequently, there was greater dispersion in the posttest scores. This interpretation is further supported by the bimodal nature of the posttest distribution.

The statistical significance of the *t* -test, Brown-Forsythe and O'Brien's variance tests suggested that the learning occurred within a one-hour period. The web-based Chinese Radical Tutorial and Character Tutorial can effectively facilitate student acquisition and retention of radicals and characters in relation to writing the shapes, identifying equivalent English meanings, and identifying proper pronunciations. The positive result should be

encouraging for those interested in designing and developing effective hypermedia Chinese tutorials.

Qualitative Analysis

Qualitative analysis data is based on students' responses to the Attitude and Perception Survey after Posttest (see Appendix G). Detailed responses to the questionnaire are presented in Appendix H. A summary of these findings are given below.

Eleven out of 17 students (65%) stated that the use of rewards motivated them to optimize their learning and performance. This motivation helps to compensate for a possible confounding variable, namely the fact that the small-group participants were not from the target-audience students of Chinese language courses, and therefore might have lacked the motivation to perform well. Since a possible lack of motivation would tend to reduce the learning gains, a false positive result, not a false negative result, is the potential real risk.

Learners indicated that they enjoyed learning with the CRCT program. The qualitative results implied that the CRCT program as a whole meets the evaluation criteria. The qualitative analysis was organized to determine if the CRCT met the criteria evaluand components: (a) program content and delivery, (b) instructional design approaches and method, (c) media usage: graphics, movie, and animation instruction.

Program content and delivery. The following feedback related to program content and delivery:

1. Participants indicated that they could use the CRCT program without any assistance, which indicated that the CRCT program could be a stand-alone supplemental resource which can feasibly be used outside of the classroom. However, there were two students who said that they needed clearer instructions in order for them to use it without assistance.
2. Sixteen participants thought the objectives were well-stated.
3. Learners stated that each section of the CRCT program held their attention and could easily be used at any time and place.
4. At least twelve learners felt that CRCT enhanced retention and transfer by building upon their prior knowledge.
5. One student recommended a change to the order of presentation for the Radical Tutorial. A majority of the students thought the instructional content was understandable.
6. Students indicated that the CRCT media helped them understand the content better, suggesting that the Chinese radical and character instruction included the proper selection and quality of media.
7. The students felt that immediate feedback was provided to assist learning.
8. Learners indicated they experienced enjoyment and satisfaction when using CRCT.

Instructional design approach and method. Five criteria were used and addressed to

ensure that the CRCT would comply with sound instructional-design approaches and methods:

1. The instructional design concepts were derived from Gibbons' model-centered instruction. For example, the model of the program was developed and augmentation was added to coach learning on the basis of guidance from MCI. As described in the Critique section, however, some specific program functions and technical expertise were not available to implement other features which were otherwise recommended for use by the MCI design approach. Student feedback supported the notion that Gagne's nine events were met. The CRCT held user attention, informed learners of the objectives, recalled prior learning, presented stimulating materials with aesthetic colors and features, provided necessary guidance, elicited and assessed performance, provided feedback, and enhanced retention and transfer.
2. The instructional design and development process materially complied with the ADDIE model and a comprehensible description was included in the Design and Development Process section.
3. Application of instructional techniques and pedagogy yielded statistically-significant performance, as stated in the Quantitative Analysis section.
4. The assessment was content-related and effectively evaluated whether instructional

objectives were being achieved. However, the character-writing assessment was difficult because there was no specific advance warning during the group test about the impending character-writing section, as one student observed in feedback from the survey.

5. Formative evaluation was meta-evaluated and mainly shaped by Williams' 14 basic evaluation steps.

Media usage: graphics, movie, and animation instruction. The following criteria of media usage were properly satisfied:

1. Software and media were suitable for achieving statistically-significant achievement towards the expected learning outcomes. Students indicated that the video and audio assisted their learning. Repetitive practice and interaction also facilitated their learning.
2. The participants of a one-to-one test indicated that the design was aesthetic and user-friendly, so no additional follow-up questions were asked.
3. Graphics, audio narration, computer animation and video received favorable feedback from the users.

Students indicated their favorite portions of CRCT tutorial included Radical Tutorial, Radical Drill and Character Association Drill. The least favorite sections were the Character Association Drill and Character Tutorial. Interestingly, half of the group liked the

Character Association Drill, and the other half disliked it. The author speculates that some students preferred challenging questions on tests and the stretching experience of trying to transfer their knowledge. Students who disliked the drill mainly said it was because the immediate feedback did not provide sufficient guidance to help them learn the skills.

Students also indicated that the practice drills helped them learn the most, due to the repetition provided. They thought the Character Tutorial and Component Tutorial were less effective in this regard, because practice and interactive feedback was unavailable. Drills provided an interactive environment which appeared to be most effective in facilitating learning. The less-effective Component Tutorial only provided animation without interaction. Students became passive recipients of knowledge. The possible conclusion we can draw from this is that interaction should be integrated into web-based (stand-alone) design whenever practicable.

To improve any future CRCT versions, students suggested adding more examples, drills, words, and information on how to combine characters.

Meta-Evaluation

Meta-evaluation was conducted to assess whether the evaluation process met the guidelines in the Program Evaluation Standards 2nd edition. The meta-evaluation of the CRCT program was performed internally by the author. The meta-evaluated standards were chosen to meet the following four situations: defining the evaluation problem, designing the

evaluation, collecting the information and analyzing the information. Relevant standards include: (a) Utility standards: stakeholders identification, evaluator credibility, information scope and selection, and values identification; (b) Feasibility standards: practical procedures, political viability; (c) Propriety standards: service orientation, formal agreement, rights of human subjects, human interactions, complete and fair assessment; and (d) Accuracy standards: the 12 accuracy standards are all incorporated.

The meta-evaluation report showed that formative evaluation of the CRCT program generally complied with the above-mentioned relevant standards in the Program Evaluation Standards, 2nd edition. No specific scores were assigned to assess the degree of compliance. From the meta-evaluation report (see Appendix I), it is evident that the author could have provided more explanation and consideration of stakeholders identification, evaluator credibility, information scope and selection, and values identification. The cultural context for stakeholders and the evaluator was not fully explored. Because the formative evaluation was internal, the author (also the evaluator) was primarily concerned with gathering the effectiveness measures and constructive suggestions needed to improve the CRCT program within the time available. The validity and reliability of evaluation instruments and the questionnaires were not tested statistically.

Conclusion

After completion of the instructional design, development, implementation, and evaluation processes, weaknesses and strengths were discovered and recorded as follows:

Strengths

The essential strength of the CRCT program is the integrated audio, video, animation, graphics and hyperlinks it provides in order to afford a stand-alone learning environment. Learners can use the CRCT program independently from the in-class instruction. The audio, video and animation allows learners to view expert demonstrations for writing Chinese radicals and to efficiently learn Chinese characters. Audio narration was designed to provide an instructional function which would give rise to stimulating interaction between students and the step-by-step program. The video demonstration afforded expert demonstrations which students could readily imitate.

CRCT's combination of hypermedia resources makes it an interesting and motivating learning program. The CRCT program provides unlimited repetition as necessary. Students can view the instruction as many times as they wish until the learning takes hold.

CRCT is easy to use at any time and place because of its web-based design. Learning is no longer limited to classroom instruction. The web site can be provided on a complementary or low-cost basis.

The CRCT integrates effective pedagogy into its design. It does not merely function as a dictionary which simply lists information for reference use. The focus is on using effective training techniques to help students learn characters more quickly. The skills and strategies students obtain from the program are readily transferable to other settings. Understanding the logical infrastructure underlying the characters is the key for developing a generalized mental framework for learning and using Chinese characters.

Practice drills are not easy to find in web-based Chinese-reading web sites. But it is the drills which allow students to practice and utilize the knowledge they have just learned. Practice serves a function similar to having access to a companion (an instructor) who can rectify student mistakes and guide them in their learning process. Immediate feedback offers interaction needed to draw students' attention into a dynamic learning environment and help them concentrate on the concepts presented. The score feature serves as an indicator to help students view and evaluate their performance.

Weaknesses

The weaknesses of the CRCT program can be categorized into the three categories: (a) Computer Software and Programming, (b) Subject-Matter Knowledge, (c) Assessment Design. More discussion of each category is provided below.

Computer Software and Programming

Many potential features and functions which could have been incorporated into the CRCT program were omitted because of a shortage of technical knowledge and software support. For example, the randomly-selected questions in the Radical and Character Association Drills would ideally have had randomly-selected answer options as well as randomly-selected question, but the author lacked the advanced Action Script programming skills needed to achieve such a feat. Ideally, the author would have preferred to include multi-line explanations for the character-component association answers. Limits in technical skill resulted in only one line of explanation, preventing maximum optimization of CRCT from a pedagogical standpoint.

The Character Tutorial is a cursory prototype for the CRCT program and the capabilities of the CRCT concept. There should be more examples provided to foster students' knowledge in associating characters with their components. The logical method is to establish databases containing components so that students can practice assembling components to produce characters. However, database design requires more technical knowledge than the author currently possesses and can also broaden the scope of instructional design, and as a result only a few examples were provided to teach students the skills of character association.

The underlying approach of CRCT is valuable and effective. With more time, money, and resources, the full potential of CRCT could be realized. At present, CRCT does not have the complete range and flow of natural interaction that could be achieved to amplify CRCT's effectiveness.

Subject-Matter Knowledge

The relationship between radicals and components is a difficult subject that defies the clear definitions which are most amenable to web site instruction. For instance, the helpful explanation CRCT currently uses to clarify the relationship between radicals and components is state as follows: "frequently-used components are called radicals. Radicals and components have individual meanings and most of them can stand as individual characters." Chinese is a complicated language and it is difficult to identify an exact, consistent, simple rule to categorize all characters, words and components. More subject-matter experts should be consulted to render this concept most effectively for learners.

Chinese reading and writing also requires, in effect, the integrated use of several different types of skills at the same time (e.g. listening, writing and character recognition) and the completion of multi-layered tasks (e.g. memorizing the sounds of radicals, memorizing the sounds of characters, memorizing the shapes of radicals, memorizing the shapes of characters, understanding *Hanyu Pinyin*). Computer programs are not always able to teach different skills simultaneously, especially if the learning takes place in a

socially-isolated environment where the program controls need to stay simple enough to permit autonomous program use. However, CRCT does take into account the recommended criteria for evaluating computer-mediated programs which simultaneously teach multiple complex skills, as provided by Hsu and Gao (2002).

In addition, knowledge of radicals must be acquired before a student has the prerequisite knowledge needed to learn association to characters. The program teaches students prerequisite knowledge, but it is difficult to avoid presenting so much information to the learner that he or she cannot retain or assimilate it in a practical way.

Assessment Design

Overall, assessment questions were subject-related and consistent with instructional content. However, the last portion of the test questions (questions 21-25 in Appendix F) required students to write Chinese characters even though this topic received only fleeting treatment during the instruction period. These questions required students to write characters (“companion,” “spit,” “plum,” “good” and “to return”) which had not appeared in practice drills. There were no additional indicators provided to alert students that they should practice writing those characters or that they would later be asked to write them. CRCT should offer practice drills to help students become familiar with associating those characters with their radicals and to write characters correctly.

Schedule

Table 1 shows the specific tasks involving design and development of the CRCT program along with expected and actual completion date and hours. The total actual working hours for this project were 317, whereas estimated working hours were 290 hours. The additional 29 hours were attributed to development and project report preparation because numerous amendments and modifications were made. Total hours were distributed into the various tasks: project (context) analysis, design, development, implementation, evaluation, preparation for project prospectus (proposal) and project.

The huge schedule gap which existed between project analysis and prospectus preparation occurred because the author postponed the project in order to assume a heavy class load during Fall semester, 2004. Participants were expected to be students enrolling basic Chinese class in the end of April, 2005. Because the class was not offered, small-group participants were collected in the end of the Winter semester before students leaving for school break. Hence, the implementation and evaluation had to be executed earlier than originally anticipated.

Table 1

Comparison between Estimated Schedule and Actual Executed Schedule

Task	Expected Completion Date	Actual Completion Date	Estimated Hours	Actual Hours
Analysis	07/01/2004	02/01/2005	30	40
Prospectus Preparation	02/28/2005	03/05/2005	60	65
Design	03/10/2005	03/20/2005	35	30
Development	04/05/2005	04/08/2005	30	45
Implementation	04/15/2005	04/18/2005	30	30
Evaluation	04/27/2005	04/20/2005	35	22
Project report	05/16/2005	05/06/2005	70	85
Total			290	317

Budget

Table 2 sets forth the personnel labor input, along with the quantity and amount (unit rate, expected and actual quantity, estimated and actual cost) for related materials. The total cost of the CRCT program was USD $5,315.00, while the estimated budget was USD $5,835.00. The difference was achieved by using already-accessible software such as *Macromedia Flash 2004* and *Adobe Photoshop 7.0*, and by consulting with the experts for less hours than originally planned, as shown in table 2. *Macromedia Flash 2004* and *Adobe Photoshop 7.0* were installed in the lab computer of IP&T Department, and all of development projects were built there. Hours in consulting experts were reduced because experts were busy and the schedule was condensed. Experts' wages were approximately estimated.

The highest portion of the total cost was the labor hours expended by the CRCT instruction designer (author). The instructional designer not only developed and evaluated the project, but also spent unanticipated time collecting all the necessary teaching material content. However, no tangible salary was remunerated due to the fact that CRCT program was a school instructional project. Additional expenses included $40 for rewards and snacks used to motivate learners who were participating in the small-group test as shown in Table 2.

Table 2

Comparison between Estimated Budget and Actual Cost

Items	Unit Rate	Expected Quantity	Actual Quantity	Estimated Cost	Actual Cost
Instruction Design Expert	$25/hr	25	15	$625.00	$375.00
Subject matter Expert	$25/hr	15	3	$375.00	$75.00
Evaluation Expert	$25/hr	10	2	$250.00	$50.00
Instructional Designer	$15/hr	290	317	$4,350.00	$4,755.00
Macromedia Flash 2004	$100	1	0	$100.00	$0.00
Adobe Photoshop 7.0	$100	1	0	$100.00	$0.00
Photocopies	$0.05	500	300	$25.00	$15.00
Computer Printouts	$0.05	200	100	$10.00	$5.00
Snacks and rewards	$40.00	0	1	$0.00	$40.00
Total				$5,835.00	$5,315.00

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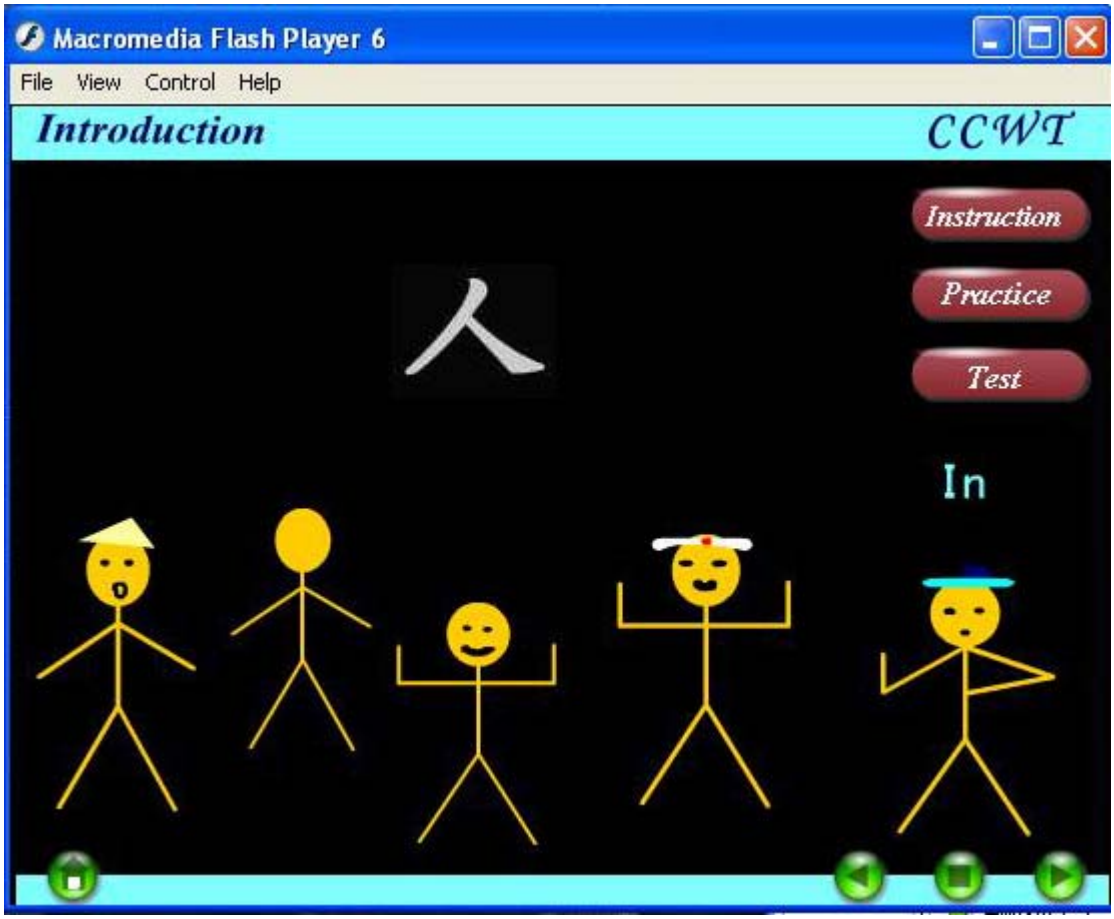
Appendix A

Samples of Original Scripts and Prototype of CRCT

Some people insist spoken Chinese is superior to the written language. However, they overlook the fact that there are several dialects and accents in different regions of China. For example, in Beijing and Taiwan, 人 (human being) is pronounced “ren”, in Canton as “yan”, in Shanghai as “nin, in Japan as “hitoh”, and in Korea as “in”. People might not be able to understand each other’s verbal speech, but they can understand the common meaning of the shared written characters. It is quite possible to see Chinese from different regions writing Chinese characters to each other in order to communicate.



Appendix B

Survey Questionnaire of Need Assessment

____ Yes	____ No	Is the program name proper? If not, suggestions: _____
____ Yes	____ No	Did the menu contain enough information?
____ Yes	____ No	Was the menu clear?
____ Yes	____ No	Were the instructions clear and easy to understand?
____ Yes	____ No	Did animated graphics help to present the program contents?
____ Yes	____ No	Did the splash page attract your attention and increase your learning desires?
____ Yes	____ No	Did the graphics and animation motivate your learning?
____ Yes	____ No	Did you enjoy the background colors and overall design?

What is your overall impression of this program?

_____

If you could improve the program, what things would you change?

_____

If you could redesign those animated graphics, what will you change to?

_____

If you could add additional information to this program, what will it be?

_____

Other comments or suggestions?

_____

_____

Appendix C

Audio Narration and Instruction Script

Character Tutorial

Chinese words can be multi-syllabic composed of 2 or more characters like this. Chinese words can also be mono-syllabic composed by 1 character like this. How do you find out the meaning of this character? How do I find out the meaning of this character? How is it pronounced? Let's analyze it! First, let's break them apart into different components. Second, let's find out their individual meanings. Third, let's examine the sounds of individual components. Fourth, we find the phonetic component and associate the sound of this component with the character. Fifth, we need to learn and remember the English meaning of this character.

Component Tutorial

Characters are composed of several basic structural parts called "character components". We combine components to derive the meaning of the character. Basically, there are two different types of components: radical and phonetic. Radicals are frequently used components to categorize and provide meaning in characters.

For example, the character "好": The left is a radical for woman and the right is the component for son. Together, they form a character meaning "good." "李": The top is a radical for wood and the bottom is the component for son. Together, they form a character

meaning “plum” or surname “Li.”

Phonetics give the sound of characters. 80% of Chinese characters are phonetic-semantic compounds. We derive the sound of Chinese characters from their phonetics. Therefore, our first reaction should be to associate the sound of Chinese characters with their phonetic components.

For example, the character “吐”. The left is “kou”, the radical for mouth, the right is “tu”, the component for earth. Together, they form a character meaning “tu” Meaning “to spit”.

Radical Tutorial

The components below are called radicals. They can be used as independent characters, or they can be combined with other components to form characters.

In a moment, you will see some radicals written in two forms, having the same meaning. This is somewhat similar to English letters, for example, A and a, B and b, C and c.

Appendix D

First One-To-One Test Questionnaire

____ Yes	____ No	Was the instruction clear?
____ Yes	____ No	Did the menu contain enough information?
____ Yes	____ No	Was there any difficult part?
____ Yes	____ No	Did graphics and movies motivate your learning?
____ Yes	____ No	Did buttons and animation effects function properly?
____ Yes	____ No	Did the examples related to your own experience?
____ Yes	____ No	Did all practice drills appropriate and content-related?
____ Yes	____ No	Did you enjoy learning this section?
____ Yes	____ No	Did the pronunciation facilitate you?
____ Yes	____ No	Did component formation interest and aid your character learning?

If you could improve the program, what things would you change?

_____

If you could redesign the instant feedback, what would you change?

_____

If you could add additional information in this section, what will it be?

_____

_____

Comments: _____

_____

_____

Appendix E

Second One-To-One Test Questionnaire

____ Yes	____ No	Did you feel challenged when learning with this program?
____ Yes	____ No	Do you feel bored when using this program? In what way?
____ Yes	____ No	Does this program provide good strategy and information to facilitate your character and component learning?
____ Yes	____ No	Could you easily see the screen, fonts, colors and instructions?
____ Yes	____ No	Could you hear the narration clearly and informatively?
____ Yes	____ No	Is this program handy to you?
____ Yes	____ No	Could you use this program without any assistance?
____ Yes	____ No	Did this program provide smooth and effective learning steps?

What is your impression of the program overall?

_____

What was new that you learned from this program?

_____

If you could change one thing, what would it be?

_____

Comments: _____

_____

_____

_____

Appendix F

CRCT Pretest and Posttest

(Listening) Multiple-Choice:

Refer to the listening web-based test questions and write the letter in the blank which matches your chosen response. Each question has one correct answer only.

1.	**2.**	**3.**	**4.**	**5.**
6.	**7.**	**8.**	**9.**	**10.**

(Meaning Association) Multiple-Choice:

Write the letter in the box which matches the appropriate English word to the Chinese character or radical provided in the far-left column. Each question has one correct answer only.

( ) 11. 呆	A. stupid	B. water	C. bicycle
( ) 12. 你	A. forest	B. you	C. chop
( ) 13. 孕	A. to be pregnant	B. refrigerator	C. chair
( ) 14. 地	A. drink	B. old woman	C. the earth; land.
( ) 15. 叨	A. talkative	B. mood	C. burning

Hand-Writing Test:

In the blanks below, write the Chinese radical or character with a meaning similar to the listed English word or phrase.

16. man:	**21. a companion:**
17. knife:	**22. spit:**
18. woman:	**23. plum:**
19. wood:	**24. good:**
20. earth:	**25. to return:**

Appendix G

Attitude and Perception Survey after Posttest

This survey is designed to gather your opinions about the effectiveness of the CRCT program in helping you to learn Chinese radicals and characters. Please answer the following questions in the spaces provided. Thank you!

1. What is your major? _____

2. What is your year in the university?

☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior ☐ Graduate

3. Have you taken any Chinese character writing classes before?

_____ Yes _____ No (If yes, when, what and where? _____)

4. How challenging did you find it to learn Chinese Radicals and Characters? (Circle one)

1 2 3 4 5 6 7

Very Easy Rather Easy Average Rather Difficult Very Difficult

5. Does the CRCT tutorial clearly identify the learning objectives?

_____ Yes _____ No (If no, please state your reasons,

_____)

6. Could you use the tutorial without any assistance? (i.e. does the program "stand-alone"?)

_____ Yes _____ No (If no, please state your reasons,

_____)

7. Some scholars believe that presenting rewards can elicit better performance. Do you feel the offered rewards motivated you to enhance your CRCT learning performance?

_____ Yes _____ No (If no, please state your reasons.

_____)

The following questions refer to each section of the CRCT tutorial. Please re-visit the website in order to answer the following questions. Check "yes" or "no" in the spaces below to provide feedback and write your comments in the space provided.

8. Character Tutorial:

_____ Yes _____ No Did this section acquire and hold your attention?
_____ Yes _____ No Was the instruction understandable?
_____ Yes _____ No Did the animation help you to understand better?
_____ Yes _____ No Was the interface design user-friendly?
_____ Yes _____No Did this section enhance retention and knowledge acquisition?
_____ Yes _____ No Did you enjoy this section?

Comments:

9. Component Tutorial:

_____ Yes _____ No Did this section acquire and hold your attention?
_____ Yes _____ No Was the instruction understandable?
_____ Yes _____ No Did the animation help you to understand better?
_____ Yes _____ No Was the interface design user-friendly?
_____ Yes _____No Did this section enhance retention and knowledge acquisition?
_____ Yes _____ No Did you enjoy this section?

Comments:

10. Radical Tutorial:

_____ Yes _____ No Did this section acquire and hold your attention?
_____ Yes _____ No Was the instruction understandable?
_____ Yes _____ No Did the videos help you understand how to write radicals?
_____ Yes _____ No Was the interface design user-friendly?
_____ Yes _____No Did the section provide sufficient background to cope with the conceptual context of the Character Tutorial section?
_____ Yes _____ No Did you enjoy this section?

Comments:

11. Radical Drill:

_____ Yes _____ No Did prompt feedback function properly and helpful?
_____ Yes _____ No Was the direction understandable?
_____ Yes _____ No Was the interface design easy to use?
_____ Yes _____No Did drill items help you learn shape, English meaning and pronunciation of each radical?

11. Radical Drill (continued):
_____ Yes _____ No Did you enjoy this section?
Comments:

12. Character Association Drill:
_____ Yes _____ No Did prompt feedback function properly and helpful?
_____ Yes _____ No Was the direction understandable?
_____ Yes _____ No Was the interface design easy to use?
_____ Yes _____No Did drill items help you to develop the skill of associating each character's pronunciation and English meaning with its components?
_____ Yes _____ No Did you enjoy this section?

Comments:

13. Which section(s) of the CRCT tutorial did you like the best? Why?

14. Which section(s) of the CRCT tutorial did you like the least? Why?

15. Which section(s) of the CRCT tutorial helped you learn the most? How or why?

16. Which section(s) of the CRCT tutorial were least effective in helping you learn? How or why?

17. How do you feel about learning and practicing basic Chinese characters and radicals by using web-based materials, as compared to similar learning by means of a textbook or other learning materials?

18. What suggestions would you give for improving the CRCT Tutorial?

Appendix H

Results of Attitude and Perception Survey

1. What is your major?
   Two students majored in Physics and two students majored in Mechanical Engineering. The remaining students' majors were varied: Elementary Education, Economics, Aviation, Nursing, Computer Science, Nursing, Recreation Management Youth Leadership, Marriage, Family and Human Development, Exercise Science, Mathematics, Communications, Chemical Engineering, and Genetics and Biotechnology.

2. What is your year in the university?

Freshman	1 (6%)
Sophomore	1 (6%)
Junior	5 (29%)
Senior	7 (41%)
Graduate	3 (18%)

3. Have you taken any Chinese character writing classes before?

Yes.	0
No.	17 (100%)

4. How challenging did you find it to learn Chinese Radicals and Characters? (Circle one)

Very Difficult (7)	3 (18%)
Rather Difficult (6)	4 (23%)
Rather Difficult (5)	4 (23%)
Average (4)	4 (23%)
Rather Easy (3)	2 (13%)

5. Does the CRCT tutorial clearly identify the learning objectives?

Yes.	16 (94%)
No.	1 (6%) (There needs to be more instruction with whole characters)

6. Could you use the tutorial without any assistance? (i.e. does the program "stand-alone"?)

Yes.	15 (88%)
No.	2 (12%) (I would need more clear instructions about what order to do everything. Maybe more help with characters.

7. Some scholars believe that presenting rewards can elicit better performance. Do you feel the offered rewards motivated you to enhance your CRCT learning performance?

I don't know. 1 (6%)
Yes. 11 (65%)
No. 5 (29%)
Reasons: (1) It depends on if rewards are given for accurate performance or speed.
(2) I wanted to learn that was the reward.
(3) I just wanted to try my best. I wasn't motivated by the food!

Results of Questions 8-10

Questions	Character Tutorial		Component Tutorial		Radical Tutorial	
	Yes	No	Yes	No	Yes	No
Did this section acquire and hold your attention?	17	0	17	0	16	1
Was the instruction understandable?	13	4	14	3	16	1
Did the animation or videos help you to understand better?	17	0	17	0	16	1
Was the interface design user-friendly?	16	1	16	1	17	0
Did this section enhance retention and knowledge acquisition?	14	3	16	1	17	0
Did you enjoy this section?	15	2	17	0	17	0

Comments:

Character Tutorial

- I found it too cumbersome and cluttered. It is not very straight forward.
- Good job, I had fun.
- Some of the words on the quiz were only in this section, but not in the drills and I
- Couldn't remember them. This works well for explanation but not retention.
- Very fun.

Component Tutorial

- I felt lost while doing this section.
- Sweet.
- Got a little confused about what radicals and components are-what the difference is.
- I didn't realize I would need to remember the character combination in this section or the character tutorial section.
- I actually remembered some of it.

- Maybe slow it down a little!

Radical Tutorial

- Yes! This section was awesome! Add a space to practice drawing and I would be perfect!
- Awesome.
- This section was easiest to apply to the drills. They seemed the most connected.
- Maybe have sound to the instruction animation.

Results of Questions 11-12

Questions	Radical Drill		Character Association Drill	
	Yes	No	Yes	No
Did prompt feedback function properly and helpful?	17	0	17	0
Was the direction understandable?	17	0	17	0
Was the interface design easy to use?	16	1	17	0
Did drill items help you learn shape, English meaning and pronunciation of each radical?	17	0	-	-
Did drill items help you develop the skill of associating each character's pronunciation and English meaning with its components?	-	-	15	2
Did you enjoy this section?	17	0	16	1

Comments:

Radical Drill

- This was my favorite part of the website. I felt like I learned more here because I could put the sounds with the visual images.
- One click per question would be better.
- Cool.
- I loved the drills. They were fun to do. I was fun to learn.
- The drill maybe more effective if the questions were not random so commonly missed questions would pop up more. It would also be more effective if the multiple choice options changed so you can't get the question right every time by process of elimination.
- Include in the instructions that this is practice and it does not end until you choose "exit."
- I found this one especially useful.

- Random order not necessarily best. Some repeated three or more times before arriving at tone never before quizzed on.

Character Association Drill

- When were we supposed to learn these things? You asked questions we didn't know the answer to.
- It would be nice to have an introduction to all the characters and their components before the drill.
- I just didn't really understand how to derive and figure out the meaning or now the pronunciation without trial and error.
- This was harder because I did not know the characters as well I had to go back to learn more.
- I wish that more explanation had been given on the reasons.
- I was a little confused still as to which part of this set determined the sound.

Results of Questions 13-17 **(**Some students like or dislike none or more than one section)

Questions	Responses	
13. Which section(s) of the CRCT tutorial did you like the best?	Radical Tutorial	8
	Radical Drill	9
	Character Association Drill	7
	Writing	1
	Component Tutorial	1
14. Which section(s) of the CRCT tutorial did you like the least?	Character Tutorial	4
	Character Association Drill	7
	Component Tutorial	3
15. Which section(s) of the CRCT tutorial helped you learn the most?	Radical and Character Association Drills	10
	Component Tutorial	1
	Radical Tutorial	4
	The audio/video aids	1
	Sound of characters	1
16. Which section(s) of the CRCT tutorial were least effective in helping you learn?	Character Association Drill	2
	Component Tutorial	3
	Character Tutorial	3
17. How do you feel about learning and practice basic Chinese characters and radicals by using web-based materials, as compared to similar learning by means of textbook or other learning materials?	Learners can learn at their own pace	4
	Interaction	3
	Video and Sound	3
	Repetitive practice	3
	Fun and interesting	2
	Nonlinear Design	3
	Learn at any place	2

18. What suggestions would you give for improving the CRCT Tutorial?

- Use more examples in the tutorials.
- More drills and information
- Combine all elements into a simple flowing outline. Maybe break the learning up into three sections and have each section containing a tutorial and a drill.
- Make a character tutorial similar to the radical tutorial.
- Give practices in the character part or more exposure to each character.
- More information on how to combine characters to form words.
- Explain the tutorials a little more. Maybe stop the drills at certain or break it up in levels.
- More explanation on component meanings and sounds.

Appendix I

Meta-Evaluation Results

Utility Standards

U1. Stakeholders identification.

The stakeholders were identified, and their interests and roles were recorded in detail. Questions and issues concerning the CRCT program from stakeholders were listed in the formative evaluation section. However, small-group participants were not included as stakeholders.

U2. Evaluator credibility.

The evaluator is the author, who is also the instructional designer of the CRCT program. The evaluator is, to some degree, inexperienced. The potential bias based on cultural context of the author did not receive extensive examination during the evaluation. However, the supervision of an evaluation expert, Dr. David Williams, was enlisted to help maintain an adequate level of credibility and reliability.

U3. Information scope and selection.

The scope and selection of information was described in the report. For example, the evaluator listed stakeholders' questions and synthesized into three components of the evaluand. The criteria were derived and developed from the evaluand components. Potential

biases (e.g. cultural and academic bias) was not discussed, nor was there a through statement of all diverse views held by the stakeholders.

U4. Values identification.

The perspectives, procedures and rational used to interpret the findings were mentioned, but detailed information in some respects was omitted. For example, there was not exhaustive discussion about "how the evaluator counted and categorized data", "the distinction between negative and positive results", etc. In addition, the stakeholder's values could have been identified and explained in more detail.

Feasibility Standards

F1. Practical procedures.

Surveys and interviews were planned and conducted in a comfortable environment and date was pre-announced. After each one-to-one test, the program developer revised the program and conducted a subsequent one-to-one test until the CRCT program appeared to meet the learners' obvious needs and to achieve a reasonably efficient design. Small-group testing was performed in a suitable environment, and surveys used to collect user feedback were anonymous. However, cultural-context consideration of data collection methods and analysis plan was not addressed.

F2. Political viability.

No materially-important political issues have been discovered during the process of the evaluation. All stakeholders cooperated well and appeared to answer questions candidly. Due to the fact that the CRCT is an academic masters-degree project, the evaluation situation was simple and straightforward. However, the evaluator should examine cultural context among all stakeholders and report different perspectives.

Propriety Standards

P1. Service orientation.

The evaluation report and analysis improved the instructional design of the CRCT project development. The evaluation result helped stakeholders assess whether hypermedia is a good means for helping students learn Chinese radical and characters. Nevertheless, the evaluation report might not have effectively served the needs of the full range of targeted populations. For example, the target audience did not acquire a specific explanation of all the results and experimental procedures.

P2. Formal agreement.

No formal agreement has been made for this report because it was an internal formative evaluation. In addition, the instructional design (also the evaluator) planned the development schedule and performed all necessary tasks.

P3. Rights of human subjects.

Participants volunteered to participate in the survey questionnaire, and there was no obligation or compulsory force involved. All participants were remained anonymous.

P4. Human interactions.

Participants and stakeholders were treated respectfully during interviews, surveys, electronic email correspondence, and phone conversations. Participants' suggestions were carefully addressed, and necessary actions were taken to improve the CRCT program.

Accuracy Standards

A1. Program documentation.

The evaluation report included important evaluation information such as stakeholders' concerns, evaluand, quantitative and qualitative results, etc. However, the cultural background and issues of stakeholders and the evaluator were not explicitly described.

A2. Context analysis.

Clarification of the evaluation context that described that evaluation was itself a process of instructional design. The evaluation context helped with the effort to evaluate the CRCT program as a whole.

A3. Described purposes and procedures.

The purposes of the evaluation clearly defined that the formative evaluation was to provide effective feedback to improve the instruction design project. Results and procedures of one-to-one tests and small-group test were thoroughly recorded.

A4. Defensible information sources.

Although the evaluator did not perform any validity and reliability test on the evaluation data, the evaluation procedure (pretest, posttest, and survey) was noted in detail. The negative and positive feedbacks were thoroughly stated and discussed. The information from stakeholders, instructor and students were also adequately defined.

A5. Valid information.

There were no validity tests performed on evaluation instruments or the received data, but the evaluator did attempt to reveal concrete and detailed results received from the questionnaire in the small-group test to inform interpretations made by the evaluator.

A6. Reliable information.

The reliability of the questions administered to the stakeholders was not examined. No calibration was performed. However, an evaluation expert was consulted to address validity and reliability issues and minimize concerns regarding the evaluation report.

A7. Systematic information.

The data-collection methods were clearly planned and listed in the report. All data was properly recorded and analyzed, but no formal protocols were established for this

purpose. The data was not submitted to survey participants for their proofreading or their scrutiny to minimize interpretation errors.

A8. Analysis of quantitative information.

Quantitative data was analyzed with statistical procedures, including the Brown-Forsythe median and O'Brien's r transformation test. The statistical significance provided an indication that learning occurred. The validity of the data analysis was reviewed by an statistics expert. However, inter-rater validity and reliability was not tested.

A9. Analysis of qualitative information.

Qualitative information analysis was appropriately interpreted in considerable detail. Results of one-to-one tests were carefully recorded. The qualitative data from the small-group test was summarized and compared with the criteria so that evaluation questions were effectively answered.

A10. Justified conclusions.

The detailed documentation of collection data and analysis allowed stakeholders to assess the conclusions of the report. The report provided data interpretation, conclusions, recommendations and self-critique.

A11. Impartial reporting.

The report was an internal-formative evaluation which was intended to provide guidance for future instructional-design development and research related to the learning of

Chinese radicals and characters. The author was (and is) unaware of any influence, economic self-interest, or conflict-of-interest which would have the potential to materially or systematically skew or bias the author's approach to the project or the reporting of project findings.

A12. Meta-evaluation.

The formative evaluation was meta-evaluated according to the Program Evaluation Standards, 2nd edition.