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Computer-Assisted-Learning for Learning Chinese Characters

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Abstract

The purpose of this research is to facilitate the learning of Chinese characters for beginners through designing and implementing a computer-assisted-learning system on a PC. With the use of animation, graphics and sound, the origin, written form, pronunciation and usage of Chinese characters are introduced to the user. Moreover, understanding of these concepts is deepened by means of demonstration and practice. To help to enlarge the user's vocabulary, two games of building characters are provided.

Keywords: Computer-Assisted-Learning, Chinese Computing, Computer Animation, Computer Graphics, Sound Synthesis and Games of Building Characters

1. Introduction

Learning of Chinese characters plays an important role in language acquisition for Hong Kong children. Reading, writing, listening, speaking, and thinking are all closely related with words. Children cannot express themselves well without a sufficient vocabulary. But unfortunately, learning Chinese characters is no easy task. Many primary school pupils in Hong Kong have painful experience with Chinese characters. They have to write at least one page of Chinese characters daily. Most of the primary schools have dictation lesson of Chinese language weekly. The primary school students have to memorize large quantity of vocabulary for the dictation lessons. If they write a character incorrectly, they will be asked to do remedial exercise which is to copy the correct character many times over. We have found that teaching by this method is ineffective and discourages children to learn Chinese characters. The main objective of this research is to solve this problem by developing a computer software to help Chinese children learn Chinese characters.

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The learning of Chinese characters has three aspects: 1. recognition of characters, 2. acquisition of characters i.e., retaining in human memory, and 3. use of characters. The first two aspects are the basics for beginners and are therefore the fundamental concerns of our software system.

There are three factors that affect the learning of Chinese characters: 1. the frequency of use of the characters, 2. the meaningfulness of the characters, and 3. imagery value, which measures the visual effectiveness of the characters to call up associated information from the reader's memory. The Chinese characters chosen in our system are selected according to these three factors. We have selected Chinese characters which have high frequencies of use and are related to a child's everyday life. It is hoped that children will find these characters interesting and want to learn them. The characters chosen are also meaningful ones so as to enable children to retain them easily. Attention is also paid to the imagery values of these characters as characters with high imagery value are easier to learn [1].

The characters of this software are not treated individually but as components of words, phrases and sentences. The characters are also arranged in groups and clusters to help children learn effectively [2], enabling them to retrieve characters from associated characters in their long term memory during writing and reading [3]. Different media including animation, sound, music and games are used to keep the interest and attention of the young learners.

The software is user-friendly. The young learners do not need any computer knowledge to use this program. They can learn Chinese characters at their own pace and follow their own interest. It is recommended that parents and teachers accompany the young learners, providing explanations whenever necessary and participating in the games as well.

The rest of the paper is organized as follows: next section gives an overview of the entire system; followed by detailed descriptions of each of the three components: Chinese Characters, Examples of Chinese Characters and Building Chinese Characters. Succeeding sections mention the techniques required to develop the system; including graphics, animation, user interface, sound, heuristics and data storage. The last section discusses the future development of the project.

2. Software Overview

The system is called "Han 漢".

The software employs windows and mouse as its user interface. Each window performs a particular function, as revealed in Figure 1 below. To invoke a function, the user can use the mouse to position the cursor and click the button. In addition, keyboard input is also allowed. Each part of the system will now be described.

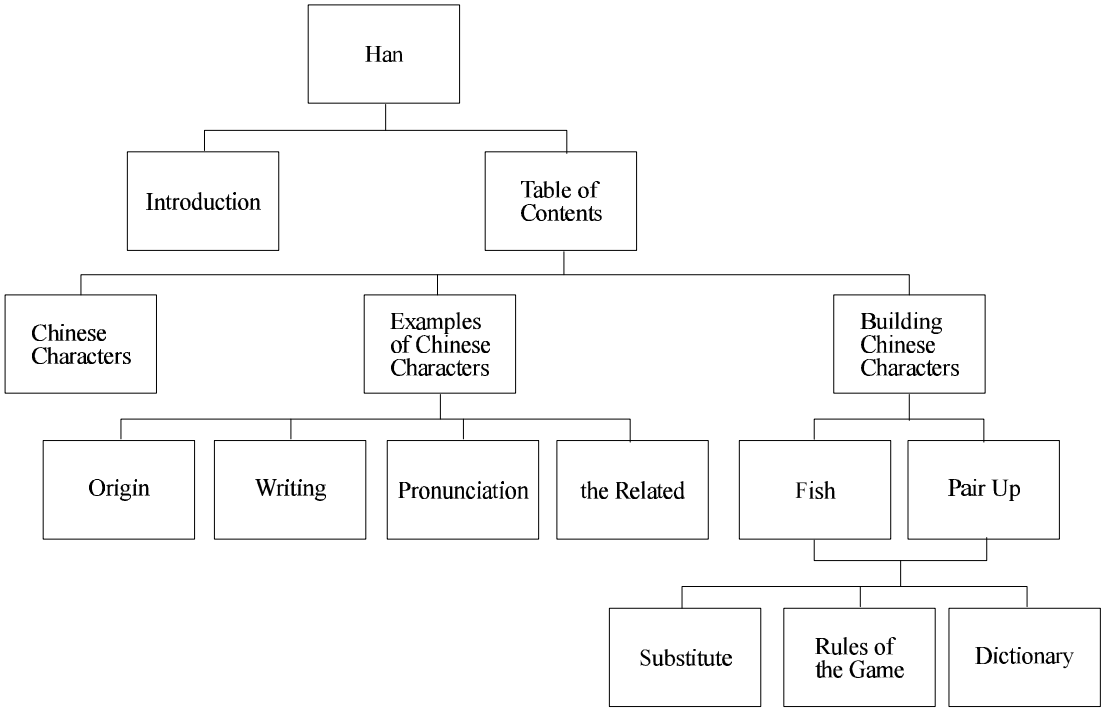

Figure 1 Han's Windows

2.1 "Introduction 介紹"

This part precedes the main body and briefs on the whole research project.

Accompanied with a rhythmic melody, the caption, "Han~ Computer-Assisted-Learning for Learning Chinese Characters" commences the system. Next come the preface and the acknowledgments of ours. Finally, words from the authors (See Figure 4) end this part.

For the sake of convenience, the user can skip this part by pressing any key.

2.2 "Table of Contents 目錄"

This part follows the "Introduction" part and on the window, this part displays three components of the system: "Chinese Characters", "Examples of Chinese Characters" and "Building Chinese Characters" (See Figure 5).

2.3 "Chinese Characters 漢字"

This part contains a number of pages, explaining the concepts of

Chinese characters. Students have full discretion to go through any pages according to their own progress (See Figure 6). The contents cover the origin, evolution, building, stroke writing and character writing of Chinese characters.

2.4 "Examples of Chinese Characters 字例"

This part gives examples of Chinese characters. It consists of a total of 42 lessons (See Appendix i). In each lesson, one Chinese character (which is called the *Theme Character*) will be used to explain the notions of origin, stroke sequence, pronunciation and related characters.

The selected characters are typical examples of Chinese characters; namely, **人、心、手、足** and others. The selection are based on [4]. To provide a useful index, these characters are categorized into five groups: Human Body, Animal, Nature, Tool and Others (See Figure 7).

2.4.1 "Origin 由來"

This part uses vivid drawings to arouse the interest of the students to learn. Animation portrays how the Theme Character evolves from hieroglyphics to its present form. For example, in the lesson『**人**』, the body of a walking cartoon figure gradually transforms into the character **人** (See Figure 8).

2.4.2 "Stroke Sequence 筆順"

In this part, students can switch between demonstration and practice.

For demonstration, the software depicts the writing of each stroke of the Theme Character; for example, showing the character『**木**』from 『一』to『十』to『才』to『**木**』 (See Figure 9).

For practice, the software draws the Theme Character in outline and thereafter each stroke of the character is associated with a button. If the student presses the buttons in the correct order, the software will draw the character stroke by stroke. Upon completion, the correct writing will be demonstrated again. However, during practice, if the wrong button is pressed, no response will come from the system.

2.4.3 "Pronunciation 讀音"

This part adopts the demonstration-and-practice model as well.

For demonstration, the Theme Character is pronounced through the external speaker (See Figure 10).

For practice, the software produces different pronunciations for the Theme Character, and students have to judge whether they are correct.

This part is conducted in Cantonese, which is the dialect spoken by over 90% of the population in Hong Kong.

2.4.4 "The Related 相關"

This part applies the principle of association to increase the student's vocabulary.

Firstly, the Theme Character is displayed with three other related characters, from which the student chooses one character to proceed. For example, if the Theme Character is 『手』, then 『打』、『操』 and 『扣』,which are all related to『手』, will be displayed (See Figure 11).

Secondly, once a related character is chosen, three phrases containing the chosen character are given, from which the student chooses one. For example, if 『打』is chosen by the student, then 『打鼓』、『打電話』and『一打』will be offered to the student.

Finally, a sentence using the selected phrase will be displayed to illustrate its usage. For example, for the phrase『打鼓』, the sentence 『那兒敲鑼打鼓地真熱鬧』 will be shown.

2.5 "Building Chinese Characters 拼字"

This part consists of two games -- "Fishing" and "Pairing Up". The idea of these games is based on the left-right orthographic characteristic of Chinese characters, whereby complex characters are built from simpler character pieces. For example, the piece『虫』can combine with the piece 『青』to form the character『蜻』[5]. But of course not all pairs of pieces can combine to form valid characters. The purpose of the games is to improve the student's ability to tell the valid characters from the invalid ones.

2.5.1 "Fishing 釣魚"

Each player is given five pieces. He, in turn, baits the fish on board and then draws a bait from the pack. If the baits on hand cannot catch a fish, he puts one of his baits onto the board. The more the fish he catches, the higher the scores he obtains (See Figure 12).

2.5.2 "Pairing Up 配對"

In this game, each player is given seven pieces. He, in turn, draws a piece from the pack; or matches the piece just given away by the other player with one of his own. In either case, the player has to put one of his pieces onto the table. The player who can first pair up his pieces into four characters will win the game (See Figure 13).

For both games, players are provided with three aids -- "Substitute", "Rules of the Game" and "Dictionary".

2.5.3 "Substitute 代替"

A blank piece represents a wild card, which the player can designate to represent any suitable piece. For example, the piece『鳥』can combine

with a blank piece to form the character『鳴』 by substituting a 『口』 for the blank (See Figure 14).

2.5.4 "Rules of the Game 規則"

This part states the rules of the playing game (See Figure 15).

2.5.5 "Dictionary 字典"

Players can look up this part to check the validity of character formed by combining two pieces. Moreover, if the character is valid, its meaning will be detailed (See Figure 16).

2.6 "Help 說明"

This part, which can be invoked at any time, describes the functions of the current window and provides instructions to users who need help (See Figure 17-18).

3. Design and Development of the Software

3.1 Developing and Operating Environment

"Han" runs on personal computers. It was written in the C language, using Turbo C 2.0 compiler of the Borland International Inc. [6].

For the hardware, it requires an IBM 286 / 386 or compatible, which has to be equipped with a 40M hard disk, an AD converter with external speaker, an EGA / VGA display and a mouse.

For the software, it requires the MS-DOS version 3.3 operating system.

3.2 Technology Required

The technology required for the development of the software can be summarized into six areas.

3.2.1 Computer Graphics

Turbo C graphics library [6] provides the most fundamental drawing facilities such as plotting pixel and drawing rectangles.

More sophisticated drawing are accomplished by accessing the registers and invoking the interrupts, which are built on the EGA / VGA display interface. These include direct reading and writing the Video Memory Planes and adjusting the RGB values of the colors [7].

Besides, bitmaps are frequently used for graphics rendering to achieve a higher picture quality. A picture on paper is first scanned into a TIFF file by a scanner. The file is then processed by an image editor [8], which removes the flaws existing on the crude picture and makes further enhancements such as coloring the black and white image. Finally, the bitmap is loaded onto the memory planes for display during run time. This process is depicted in Figures 2 below.

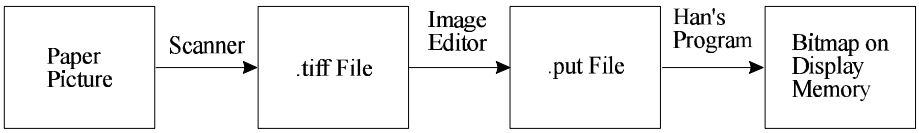

Figure 2 Bitmap Manipulation

Actually, Chinese display is also an application of bitmap. However, some character bitmap can simply be obtained from existing Chinese software [9]. The sizes of the character bitmap used in this software include 24x24 and 40x40 pixels.

Fading is applied as a transition effect. Each window will fade in before the next one appears. To achieve the effect, each time the RGB values of an image colors is reduced by one third until the image completely vanishes.

3.2.2 Computer Animation

The animation used in this software is prepared by the Computer-Aided-Animation. This software uses two basic concepts for animation -- Object-Oriented Graphics and Linear Interpolation [10].

Object-Oriented Graphics represents a picture by a number of graphical objects. Common examples of objects are lines, circles and bezier curves. Each object has several attributes associated with it such as its position, color and size. Hence, to play back an animation is to advance the attributes of all the concerned objects at a particular time order. For example, if a large rectangle located at point A changes into a small rectangle at point B, its position and size attributes are modified accordingly.

Linear Interpolation uses mean values to determine the attributes of an object (in particular the size attribute) between two time instances. For example, when a rectangle moves from point A to point B, its size during the movement will vary linearly with its distance from point A.

3.2.3 User Interface Management

WIMP is the abbreviation for Window, Icon, Menu and Pointing device. Since software using WIMP as interface is easy to learn and operate, WIMP sets the trend of current software developments. Our system also employs part of the WIMP interface, including window and mouse.

Our experience is that programming with pointing device is not a difficult task because adequate service routines are available on the BIOS [11] and the mouse driver.

3.2.4 Sound Synthesis

To meet different hardware requirements, this software uses two different sound channels.

PC internal speaker has a

simple structure. Its frequency can be arbitrarily modified; however, its amplitude must be fixed. It is only suitable for producing monotonous music.

AD converter [12] can transform analog signals for audio equipment into digital signals for computers and vice versa. To record and produce sounds at will, two steps are involved. First, sound is recorded from a microphone and digitized at a high sampling rate (10,000 Hz in our system). The digitized samples are fed to a software for noise filtering. The resulting samples are then stored in the computer. To reproduce sounds, the samples are retrieved and transmitted to a speaker through the AD converter. Since AD converter can produce sounds of high accuracy, it is used for pronunciation demonstration in our system.

3.2.5 Artificial Intelligence

Since the computer has to compete with the users in the games of Building Chinese Characters, a certain degree of intelligence is built into the system. A heuristic is designed for each game. Provided with the available information, the heuristics attempt to make the best move by inference. In addition, factual data are maintained. They provide information for the system's decision making. An example of factual data used in decision making is the frequency of each character piece to form valid characters.

3.2.6 Data Storage

Since animation, processing bitmaps and sound synthesis require enormous amount of data, storage often becomes the bottleneck in the system's performance. One obvious solution of course is to upgrade the hardware but in view of the stringent budget of the primary schools in Hong Kong, we have decided to alleviate the problem by software and trade time for space.

For the main memory, our strategy is to retain most of the working data on hard disk and load them into main memory only when necessary. Inevitably, this reduces the execution speed of the system.

For the hard disk, our system makes use of other compressing software to pack up the data files and unpack them as needed. One lesson on a Chinese character in our system takes up about 20KB on disk. Using data compression, the size is cut down to half, i.e. 10KB. Again, this slows down the file access time since data have to be expanded upon retrieval.

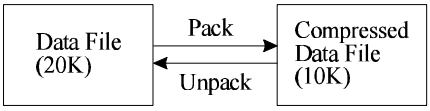

Figure 3 File Compression

Conclusion

At present, the development of the "Han" package is tentatively completed. Preliminary trials with primary school children show that the integration of animation, graphics and sound makes learning Chinese characters much more stimulating and interesting, especially for junior pupils. Majority of the pupils obtained much higher learning efficiencies in comparison with the traditional way of learning Chinese characters by dictation. Other participants also gave encouraging feedbacks. This further affirms the value of our research.

In the next stage, we are going to further expand the set of characters for learning. The character set should also be easily replaceable so that the system can be adapted to the needs of different users; for example, using traditional characters or simplified characters. We also intend to put the software to use in more primary schools and evaluate the software pragmatically for future improvement.

References

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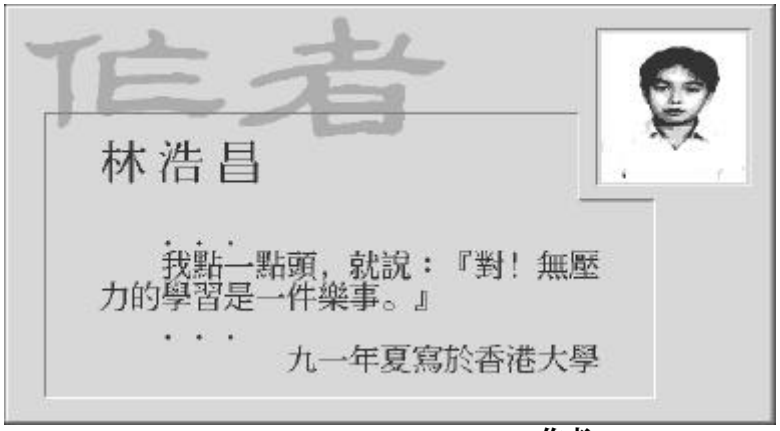

Figure 4　Words from Authors **作者**

Figure 5　Table of Contents **目錄**

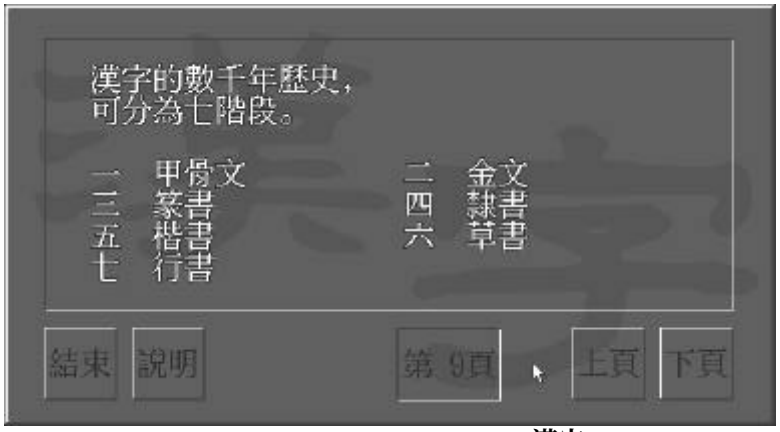

Figure 6　Chinese Characters **漢字**

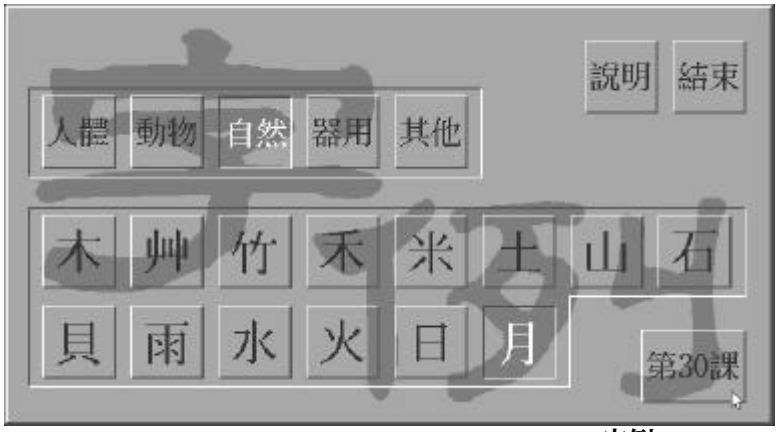

Figure 7　Examples of Chinese Characters **字例**

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Figure 8 Origin **由來** (a)

Figure 8 Origin **由來** (d)

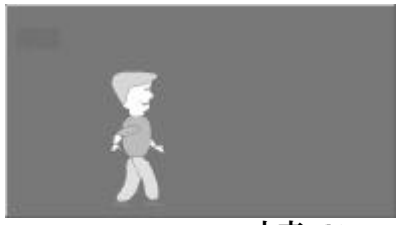

Figure 8 Origin **由來** (b)

Figure 8 Origin **由來** (e)

Figure 8 Origin **由來** (c)

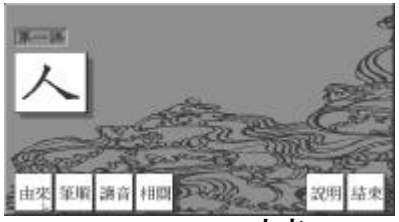

Figure 8 Origin **由來** (f)

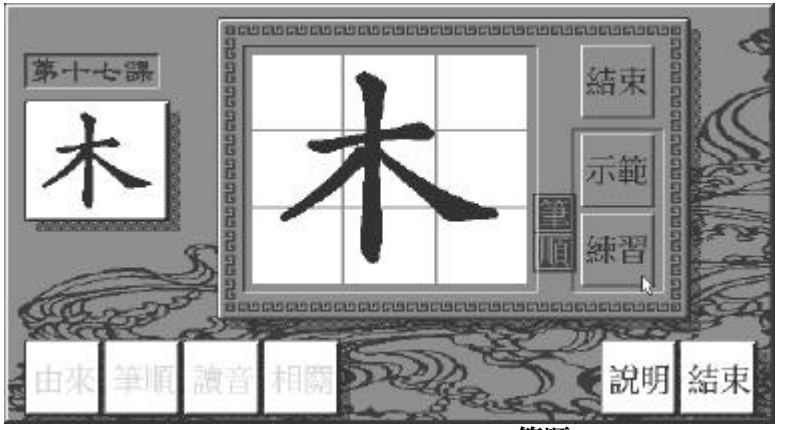

Figure 9 Stroke Sequence **筆順**

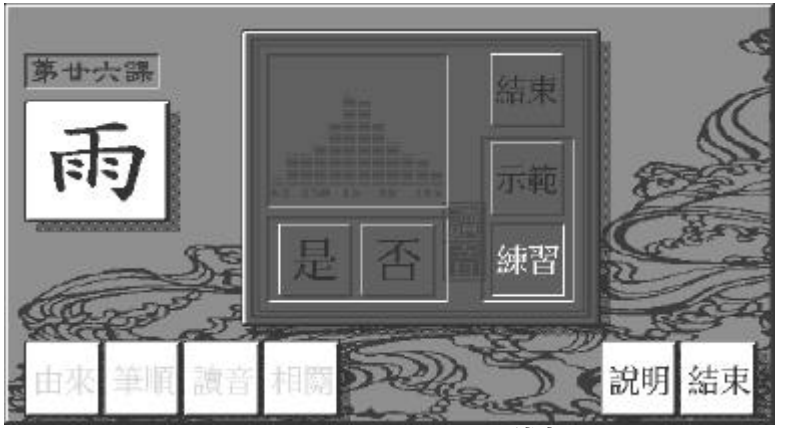

Figure 10 Pronunciation **讀音**

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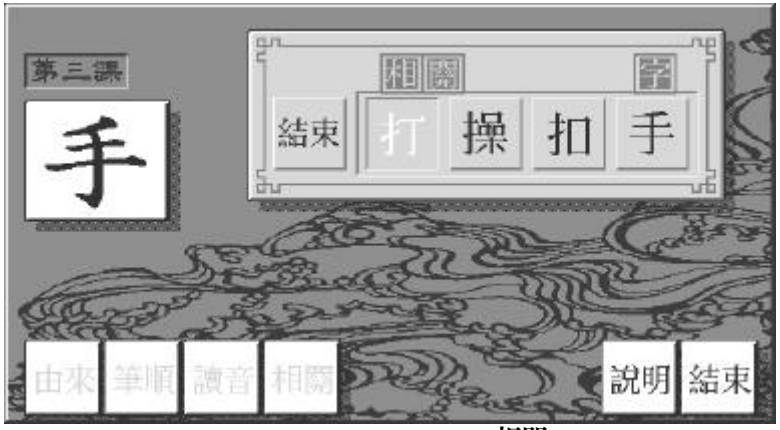

Figure 11 the Related **相關**

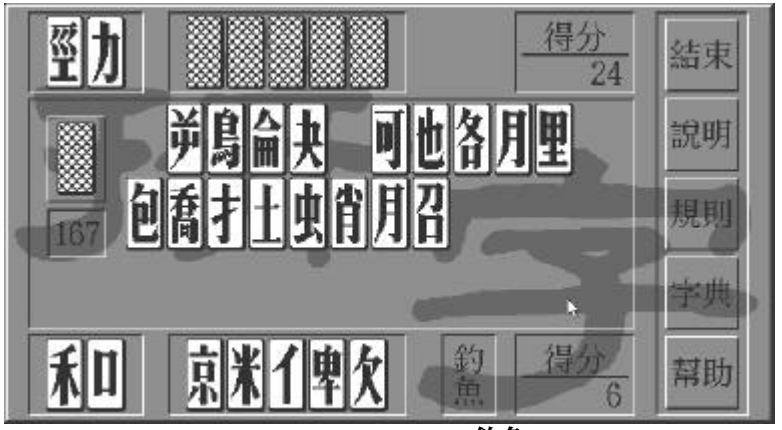

Figure 12 Fishing **釣魚**

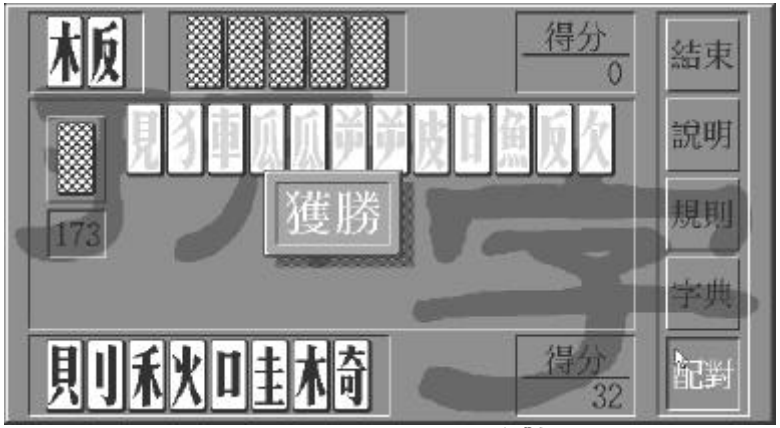

Figure 13 Pairing Up **配對**

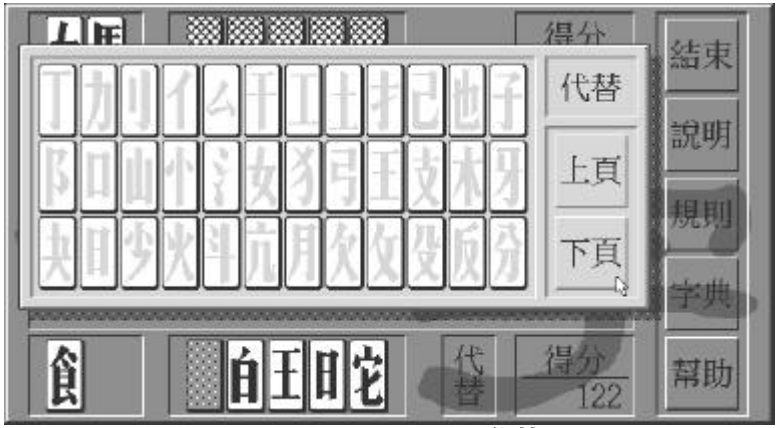

Figure 14 Substitute **代替**

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Figure 15 Rules of the Game **規則**

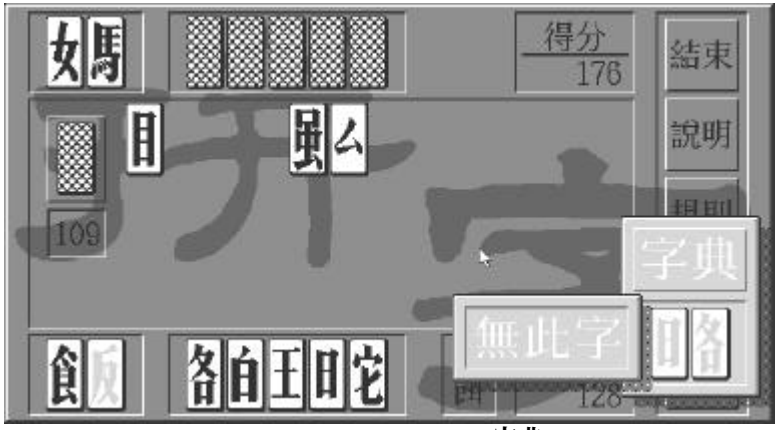

Figure 16 Dictionary **字典**

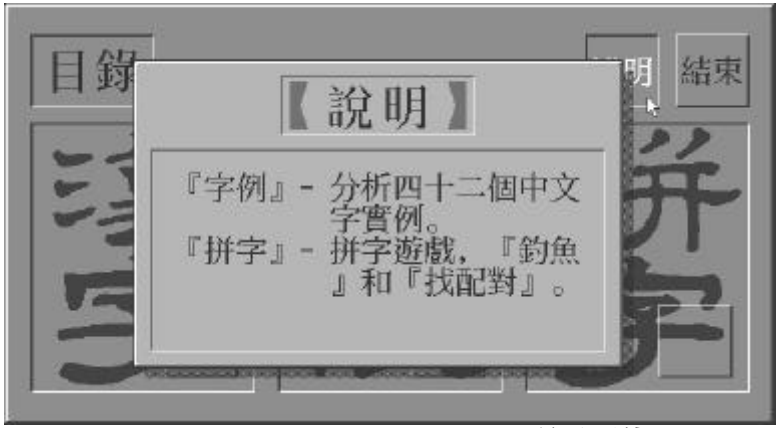

Figure 17 Help (Table of Contents) **說明(目錄)**

Figure 18 Help (Stroke Sequence) **說明(筆順)**

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Appendix i (the 42 lessons)

	主題字	相關字		主題字	相關字
1	人	休、信、作	2	心	懷、快、怪
3	手	打、操、扣	4	足	跟、跳、跌
5	目	相、省、著	6	口	名、吃、和
7	耳	聲、聚、聞	8	子	存、學、孤
9	女	好、委、妙	10	鳥	鳴、鴉、鵝
11	虫	蜜、蛋、蛀	12	牛	特、物、牽
13	羊	美、善、義	14	馬	驚、驗、驕
15	犬	猛、獨、猜	16	魚	鮮、鱗、魯
17	木	樹、機、本	18	艸	苦、落、花
19	竹	答、筆、等	20	禾	積、種、稱
21	米	料、精、粗	22	土	地、埋、坦
23	山	岸、崇、峰	24	石	磨、破、硬
25	貝	負、費、貼	26	雨	雷、露、電
27	水	漢、匯、沒	28	火	熱、照、無
29	日	明、昏、照	30	月	服、期、望
31	車	輪、輸、輕	32	舟	船、航、舵
33	田	留、由、畫	34	食	養、餘、飯
35	刀	劃、利、制	36	弓	引、強、張
37	門	開、閃、間	38	力	加、勇、動
39	小	少、尖、尚	40	一	不、上、世
41	大	失、奇、天	42	立	站、童、端