DOCUMENT RESUME

ED 454 835 IR 020 814

| | |
|---|---|
| TITLE | ICCE/ICCAI 2000 Full & Short Papers (Special Education). |
| PUB DATE | 2000-11-00 |
| NOTE | 27p.; In: Learning Societies in the New Millennium: Creativity, Caring & Commitments. International Conference on Computers in Education/International Conference on Computer-Assisted Instruction (Taipei, Taiwan, November 21-24, 2000); see IR 020 792. Some figures contain very small and illegible type. |
| PUB TYPE | Collected Works - General (020) -- Speeches/Meeting Papers (150) |
| EDRS PRICE | MF01/PC02 Plus Postage. |
| DESCRIPTORS | Chinese; *Computer Uses in Education; *Educational Technology; Elementary Secondary Education; Foreign Countries; Higher Education; Instructional Effectiveness; Keyboarding (Data Entry); Mild Mental Retardation; *Special Education; Word Recognition |
| IDENTIFIERS | China; South Korea; Technology Integration |

ABSTRACT

This document contains the following full and short papers on special education from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction): (1) "Automated Quantitative Extraction Method of Aesthetic Impression from Color Images Using the Tone in the HLS Muncell Color Space" (Toshinori Yamasaki, Tetsuo Hattori, and Yukihiro Matsubara); (2) "Present State and Future Direction of Woman Informatization Education in Korea" (In-Hwan Yoo, Chul-Hyun Lee, Soo-Bum Shin, and Tae-Wuk Lee); (3) "Research on Teaching Da-Yi Chinese Keyboarding by Using Adaptive Input Interface" (Ming-Chung Chen, Hwa-Pey Wang, and Lih-Ching Chen Wang); and (4) "The Effectiveness of Integrating Adaptive Computer Device and Stimulus Fading Strategy on Word-Recognition for Students with Moderate Mental Retardation" (Ming-Chung Chen, Tien-Yu Li, Hwa-Pey Wang, and Kou-Ping Yang). (MES)

# ICCE/ICCAI 2000 Full & Short Papers (Special Education)

# Proceedings

## Content



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# Automated Quantitative Extraction Method of Aesthetic Impression from Color Images using the Tone in the HLS Muncell Color Space

**Toshinori Yamasaki, Tetsuo Hattori and Yukihiro Matsubara**
*Faculty of Engineering, Kagawa University*
*Hayashi-cho, Takamatsu, Kagawa 761-0396 Japan*
*Yamasaki ( hattori, matsubar)@eng.kagawa-u.ac.jp*

The students acquire a visual literacy through learning the coloring systematically in the fine arts subject. This paper describes an extraction method for the aesthetic impression of the paintings based on the tone in the Muncell color space for fine arts subject. The impression, which the human being gets from the paintings, depends on the motif, the composition and the coloring. Here, we discuss the evaluation method of the paintings by the computer based on the tone that includes the lightness (intensity) and the saturation (vividness). We perform the evaluation experiment of the paintings that have a unique coloring. The evaluation result approximately resembles the impression of which human being is moved. This method is also useful for retrieving the image database using the ambiguous key words like the impression words.

Keywords: **aesthetic impression of paintings, color tone, color harmony, visual literacy, fine arts subject, image retrieval system**

## 1 Introduction

Fine arts subject educates the ability of the sense beauty, that is, a visual literacy through recognizing a form and a color. For training such a visual literacy, it is important for the students to understand the nature of color systematically. Visual literacy that is the aesthetic judgment ability becomes the basis of the expression and the appreciation activity in the fine arts learning. The students acquire the visual literacy by experience through repeated practice of painting the picture. On the other hand, there are the empirical rules about the composition and the coloring in the art. As for the color harmony, Ostwald, Muncell and Moon Spencer are well known.

Recently, the multimedia database spreads widely with the development of the network technology. In the multimedia database retrieval, it is useful that we can refer database using the impression words and the ambiguous feeling words in addition to the key words. Recently, an image database retrieving by impression words as beautiful, balmy is reported [1-5].

We report the extraction way of the aesthetic impression degree of the paintings based on the Moon Spencer's color harmony theory [6]. However, in the Moon Spencer's way, we can estimate the degree of the beauty as the numerical value but we cam not know the detail impression like the dark, light, bracing impression which each painting gives. In this study, we describe more concretely the way of extraction the aesthetic impression of the paintings based on the tone in the HLS Muncell color space.

## 2 The tone and the systematic color names

We call a suitable coloring the color harmony. In the color harmony theory, Ostwald, Muncell and Moon Spencer are well known. Also, a color system is established by JIS (Japanese Industrial Standards) and

PCCS (the Japanese Color & Coloring System).

Here, we use the tone in the Muncell HLS space for estimating the impression of the paintings more precisely. We express a color by the word, which shows the impression of the color like the light green, the dark green. There is a difference between bright and dark, strong and gentle, vivid and muddy in the same color, same hue. We call this difference the tone (Lightness and Saturation). The tone is a concept of the lightness L and the saturation S being compounds and shows an impression of the color, which doesn't depend on the hue well. As the tone has an each image, it is easy to connect the tone the psychological effect of the color. We can evaluate the feeling impression of the paintings by extraction the tone from the image data. In this paper, we adopt the PCCS tone for evaluating the impression of the paintings [7]. The PCCS defines the tone in the lightness L and the saturation S in the Muncell color space and gives color system as the tone and the hue. The PCCS classifies into 12 kinds of tones in each hue and packs the same tone of the every hue. Figure 1 shows the classification of the tone.

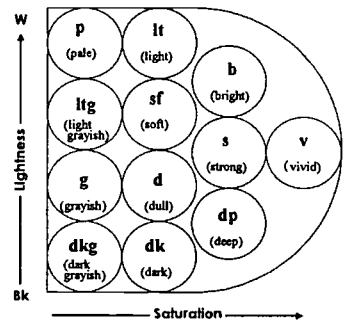


Figure 1 Tone (Lightness – Saturation)

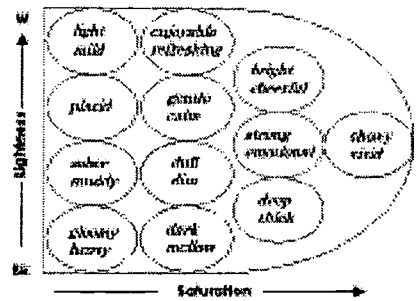


Figure 2 Systematic Color Names

The tone image is defined by the systematic color names in the PCCS color system. The systematic color names is the color expression way that gives a modifier according to each fundamental color like white, red and blue. It sets a way of combining a fundamental color name and modifier. The modifier in PCCS includes an adjective, which shows the hue difference like the tinge of red, green. On the contrary, it has no word, which shows only lightness or a saturation. The bright impression includes not only the high intensity but also the vivid saturation. The mild impression means the high lightness and low saturation. Figure 2 shows the systematic color names of the tone space.

## 3 Evaluation of the aesthetic impression

After getting the image data through the scanner, we extract the impression feature of the paintings. Figure 3 shows the outline of our method. The resolution and the size of the image data is 120 [pixels/inch] and 640*512 [pixels] respectively. The image data is a full color, bit map.

The image data has RGB color component and doesn't connect with the color sense of the human being straight. Also, it is difficult to adjust the color tone in the color synthesis. Here, we convert the RGB to the HLS value in the Muncell color space, which fits for the color sense of the human being. Mucell color system shows the color as the three components, H (Hue), L (Lightness) and S (Saturation), and is used widely in the coloring. Figure 4 shows the Muncell HLS color space. We get the H[0,360], L[0,1], S[0,1] values through the conversion of the RGB[0-255] value.

The number of the colors in the image data is enormous for processing data by a computer. Here, we reduce the number of colors to the degree, which doesn't loose the color tone of the paintings. We divide the H, L and S to 10 and 14 respectively.

| Hue (H) | Lightness (L) | Saturation (S) |
|---|---|---|
| R | 8.5 | 14 |
| YR | 9 | 13.5 |
| Y | 9 | 13 |
| GY | 9 | 12 |
| G | 8.5 | 11 |
| BG | 8.5 | 10 |
| B | 8.5 | 10 |
| PB | 8 | 11.5 |
| P | 8 | 11.5 |
| RP | 8.5 | 12.5 |

Table 1 Maximum Values of L, S

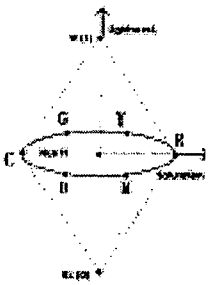


Figure 4 HLS Muncell Color Space

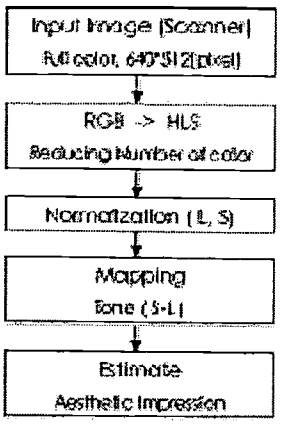


Figure 3 Outline of the Extraction Process

The maximum value of the L and the S depends on the coloring material and each hue shown in table 1. Therefore, the value range of the L and S is different according to each hue. For example, the maximum L, S value of the Red and Purple hue is 8.5, 14.0 and 8.0, 11.5 respectively. Here, we normalize the L, S value 0-10 ranges.

From the above way, we estimate the number of the pixel in the S-L tone space through mapping the image data to the tone space. We can find the aesthetic impression of the paintings by estimating the position of the mapped pixel in the tone space because of the correspondence between the tone space and the impression modifier shown in figure 2. In this experiment, we evaluate the number of the colors, which accounts for 70 % of the color area. However, we cannot estimate the impression because the distribution in the tone space becomes apart. Here, we calculate one position of the tone space from several distributed positions using the weight coefficient of each tone position.

$S = W_i S_b \qquad L = W_i L_i \qquad (1)$

Where $Wi = \sum(a_i / \sum a_i)\ \square a_i$ is the number of the occupied pixel in each color.

We estimate the impression of the paintings according to the tone index (S, L) defined in equation (1).

## 4 The evaluation experiment

The simple coloring picture is tested beforehand. As a result, the showy picture of the pure color and the gloomy picture are mapped over the v (vivid) and dkg (dark grayish) tone respectively. Typical paintings and poster works from renaissance to modern are tested in this experiment shown in table 2. Figure 5 and figure 6 shows examples of the paintings and the typical mapping result in the tone space respectively. We can evaluate the aesthetic impression of the paintings using figure 6 and figure 2. The extraction impression is listed as follows.

"Mona Lisa" (2) of Leonardo da Vinci is famous for gently smiling lady. This painting locates near dk (dark) in the tone and gives dark, mellow impression.

Monet's "Water Lily" (5) is said the mystic beauty of the surface of the water and is situated on the tone space near ltg (light grayish). We can say that the water lily has a cooled silent image.

Gogh's "Sun Flower" (8) is painted yellow strongly which he liked most. It is situated on the tone space near s (strong). From this result, we can evaluate that the impression of sunflower is strong, passionate painting.

Figure 7 shows the mapping result of the works in table 2. The above-mentioned results agree with the established reputation and the eye inspection of human being.

Table 2 Lists of Paintings and Design Pictures

| | Painter | Style | Work | epoch |
|---|---|---|---|---|
| 1 | Leonardo da Vinci | Renaissance | Virgin of the Rock | 1503 |
| 2 | Leonardo da Vinci | Renaissance | Mona Lisa | 1503 |
| 3 | Rembrandt | Baroque | Night Watch | 1642 |
| 4 | Rembrandt | Baroque | Raising of the Cross | 1633 |
| 5 | Monet | Impressionist | Water Lilies | 1903 |
| 6 | Monet | Impressionist | Flower Pot | 1903 |
| 7 | Monet | Impressionist | Popies | 1873 |
| 8 | Gogh | Modern | Sun Flowers | 1888 |
| 9 | Gogh | Modern | Self Portrait | 1889 |
| 10 | Signac | Impressionist | Saint-Tropez | 1900 |
| 11 | Renoir | Impressionist | Theater Box | 1874 |
| 12 | Renoir | Impressionist | Les Grands Boulevard | 1880 |
| 13 | Renoir | Impressionist | La Liseuse | 1876 |
| 14 | Klee | Modern | Baldgreis(Senecio) | 1922 |
| 15 | Matisse | Modern | Green Stripe | 1905 |
| 16 | Matisse | Modern | Red Room | 1947 |
| 17 | Munch | Modern | Scream | 1893 |
| 18 | Munch | Modern | Sick Chiled | 1895 |
| 19 | Poster | Design | Star Wars | |
| 20 | Poster | Design | Bug's Life | |

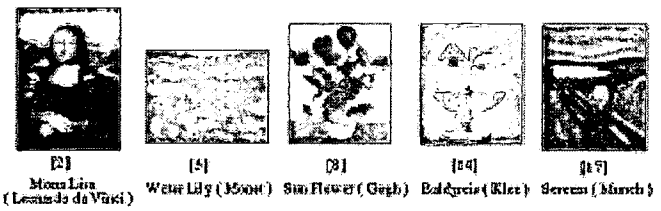


Figure 5 Examples of the paintings

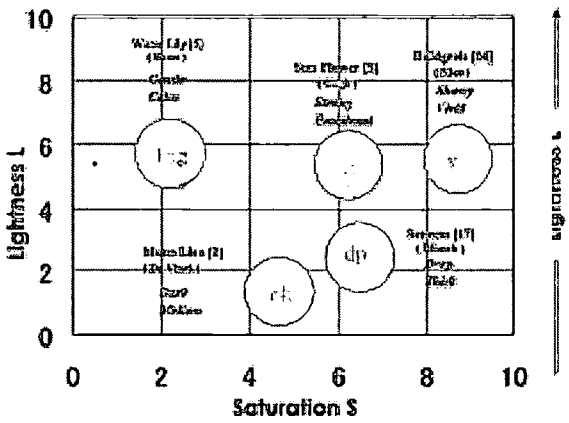


Figure 6 Mapping Result in the Tone (1)

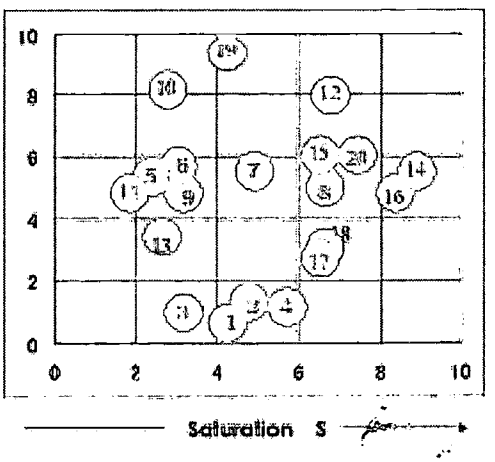


Figure 7 Mapping Result in the Tone (2)

## 5 Conclusions

We proposed the way of evaluating the beauty and impressive sense of the paintings and design pictures based on the tone in the Muncell color space. We use the tone space, which can concretely express the color impression and a corresponding systematic color names. This method suits the aesthetic impression degree evaluation by the computer because the evaluation processing doesn't depend on the hue.

After getting the image data through the scanner, we convert each RGB pixel the tone space in HLS Muncell color space. We extract the location of the paintings in the tone space by calculating the coefficient of the occupied area. The aesthetic impression is estimated by the location of the used color in the tone space.

The famous paintings from renaissance to modern are tested for extracting the impression feeling. "Mona Lisa" of Leonardo da Vinci and Gogh's "Sun Flower" is estimated as matured darkly and strongly passionate impression respectively. These results tell us that the distinction by the computer coincide with an established reputation of the paintings.

The impression extraction by this way is useful for the students learning how to use color arrangement in their fine arts subject.

## Acknowledgments

This research was supported by Grant-in Aid for Scientific Research on priority areas (12040229) from the Japanese Ministry of Education and Culture.

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# Present State and Future Direction of Woman Informatization Education in Korea

**In-Hwan Yoo* Chul-Hyun Lee* Soo-Bum Shin* and Tae-Wuk Lee***
**Dept. of Computer Education, Korea National University of Education*
**San 7, Darak-li, Kangnae-myun, Chongwon-gun, Choongbuk, Korea 363-791*
**E-mail:{bluenull, leesleek, ssb, twlee}@knue.ac.kr*

An informatization society, where high added value can be created through networks is different from an Industrial society where physical labor predisposes discrimination between men and women. As knowledge and information are regarded as the most important resources in an Informatization society, intelligence and emotional ability are given more importance than physical superiority. In light of this, the roles and positions of women are being newly evaluated, and the direction of the women's informatization movement has emerged as a new topic of the era. Korea places a strong emphasis on education and the percentage of women who attend University is also high. Contrary to this, the percentage of highly educated women who become working members of society is very low. These days, this problem has been recognized and education in woman informatization has actively proceeded. Taking various kinds of women's organization as the principal axis, woman informatization projects are actively unfolding. Government has also explored supporting plans in various aspects. This study explores the present state of women's informatization education and it's future direction.

Keywords: **Woman Education, Informatization Education**

## 1 Introduction

An Informatization Society is expected to be the 3F era: Female, Feeling, and Fiction. Productivity of culture,and emotions is more important than labor productivity. Instead of labor productivity, sensitivity and intuition unique to women are expected to contribute a lot to the development of an emotional business that has high added value.

As the roles and position of women are newly evaluated, the direction of the women's informatization movement is emerging as an important topic. As it becomes necessary to have women's informatization education in Korea, a new movement has emerged. In light of this, this study will explore the present state and future direction of informatization education of women in Korea.

## 2 Present State and Problems of Woman Informatization Education in Korea

The studies on women and the informatization society have been introduced in Korea since the end of 1980. Until now, works on the development of women in an informatization society have been produced intermittently. The Korean Women's Association and National Women's Convention has dealt with "Woman and Informatization Society," and attracted the attention of the society of women overall. However, systematic, continuous and comprehensive studies on women and informatization have been insufficient. Also insufficient are the studies on the concrete policy alternatives for informatizing all women in accordance with national informatization.

## 2.1 Present State of Women's Informatization Education

| Korean Women's Development Institute (http://kwdi.re.kr/) |
|---|
| ·Government investing research institute<br>·Constructs public database first in Korea in 1995.<br>·Systematizes the professional information related to women and provide it by PC communication network<br>·Construct total distribution management system on woman information and Internet service in 1997 |
| FemiNet Korea (http://www.feminet.or.kr) |
| ·Established in 1996 with the purpose of 「Woman Informatization」<br>·Study on woman informatization, education, information culture business, operation of web-site<br>·Campaign on home informatization |
| Women Link (http://www.womenlink.or.kr) |
| ·As professional woman movement organization, promote woman informatization<br>·Explore business to urge woman participation<br>·Plan the construction of DB on woman information |
| Asian Pacific Women's Information Network Center, Sookmyung Women's University (http://apwin.sookmyung.ac.kr/) |
| · Explore woman informatization project most actively among woman organizations attached to universities<br>·Construct Web-site in 1997 and provides information related to woman<br>·Hold international seminars<br>· Obtain professionalism by connecting with other inside institutions attached to university including cyber institute<br>·Obtained the position of Chair of UNESCO<br>· Play a role as main organization in woman informatization in Asia-Pacific regions including Korea and Japan. |

<Table 1> Web site of representative women institutes

First, in the case of education, several women's organizations and social education centers for women hold basic computer training and some job training programs and lectures to expand the mind-set for informatization. However, the lectures are sporadic and temporary, and job training programs are limited to extremely small areas, and the content of training focuses on PC utilization, since it doesn't have the fundamental environment necessary.

Among informatization education at government levels, the women's professional training project of the Ministry of Information and Communication has been most systematically promoted. To solve the manpower problems and to nurture women professionals in the multi-media and content fields, the Ministry of Information and Communication has carried out various supporting projects since 1998. The main projects are shown below:

### 2.1.1 Support Educational Institute Attached to Women's Universities

This project is to support educational institutes attached to Women's Universities with educational expenses. Women university students and unemployed women will be intensively trained in the fields of information communication including S/W programming, system engineering, networking, and game · animation · media in prestigious education institutions exclusively for women, to get a job or open their own business.

### 2.1.2 Support 'The House of Working Women'

It also supports the education expenses of the House of Working Women. Homemakers and ordinary women can take training courses in the field of information and communication to get a job in the House of Working Women which has its own childcare center.

### 2.1.3 Support the Foundation of the Business Incubation Center of Women's Universities

To solve unemployment and to activate the foundation of businesses by women professionals, it supports the establishment of the Business Incubation Center in women's universities. With this project, about 16,000 students and homemakers have obtained information training in 1998, and about 250 woman professionals have established their own businesses.

#### 2.1.4 Present State of Information Service and DB Building on Woman Informatization

Centered on a few women organizations and women research centers attached to universities including the Korean Women's Development Institute, FemiNet Korea, Asia-Pacific Women's Information Network Center, Sookmyung Women's University, women-related DB building and information services have been actively promoted. All these institutes have created the environment for women informatization based on the construction of N/W as an information infrastructure, and launched related education, culture and promotional projects.

In detail, 9 women's organizations out of 117, and 5 women's research centers out of 12 attached to universities that can operate social education programs besides the Korean Women's Development Institute, have operating Web Sites. Following are 4 organizations whose activities are the most active.

### 2.2 Problems in Woman Informatization Education in Korea

In Korea, accessibility to information devices is extremely different between genders. This difference of opportunity results in that of informatization and further causes severe inequality between genders as it becomes an informatization society.

A survey on Internet users by a Korean newspaper showed that the ratio of males to females among Internet users has largely changed. While the ratio of males to females from 1st to 3rd survey was 9:1, the 4th survey showed that female users had largely decreased the ratio discrepancy to 8.15: 1.85. Compared with the gender ratio among world Internet users (6.64 :3.36), that of Korea is found out to have a severe imbalance as ever[4].

Following is the concrete explanation of the problems of woman informatization in Korea[2].

First, the index of woman informatization is relatively low. Especially, that of homemakers was very low. Considering that the household is the basic unit of the nation, and responsible for enforcing social values through the supervision of the homemaker, it is a very severe problem.

Second, the number of women in higher professional training programs is decreasing, even though information training for woman at the regular or temporary training institutes is increasing quantitatively. As well, the professional training courses by temporary training institutes focus on the simple practice-oriented short-term training, reenacting the isolation phenomenon of women labor.

Third, in spite of the quantitative increase in informatization training for women, the number of women working in the information industry is being reduced. Information communication requires professional training in most fields, and it is necessary to make working environments in which women can continue to work and get in-service training even after getting married and having children.

## 3 Development Direction of Woman Informatization Education

With the advent of the informatization society, job areas divided by gender lost meaning, and accordingly women manpower can contribute to the development of society more and more. Unless fixed ideas on gender roles are discarded and replaced with a flexible way of thinking, the information estrangement of woman will become larger, and result in the loss of one axis of social development[6].
We will explore the development direction of informatization training of woman in the 21st century from this aspect.

### 3.1 Primary and Middle School Education

We would like to present the desirable direction of informatization education for girl students as follows:
First, school education should implement systematic education of information and provide as many opportunities as possible to allow girl students access to informatization education. Schools should also guide interest and instill a sense of closeness in information technology fields through the information technology related future course guidance after graduation.

In addition, the curriculum should be reorganized to make the most of information devices in each subject. Especially, careful attention should be given to organizing the education courses, so as not to isolate girl students, including elective courses only for girl students. Going one step further, information technology should be actively utilized in girls' elective courses including housekeeping and home economics courses, which will result in natural information education.

Second, the interest of girl students should be attracted to information through various activities including information contests for girl students. Excellent students should be picked out early and guided. Before determining whether the low index of woman informatization is inborn or learned, it is judicious for the government to give the highest consideration to the informatization of girl students in the education system.
Third, information education should be presented to the parents of those girl students who guide them at home. After all, home is the starting point and the last stop of education. An Information-oriented mind-set for students can be decisively affected by their parents. Especially, the informatization education of the parents of primary students has a high possibility to produce positives effect for the students. Accordingly, it will have a profound meaning in terms of education to provide informatization education which parents and students can participate in together.

Fourth, industrial-educational cooperation should be constructed for the education of girl students. Informatization education requires high-priced equipment and high quality personnel due to its character. It is difficult to say that hardware and software infrastructure for informatization education has been established in Korea. However, universities and industries have both foundation facilities and human resources, and as a result, the personnel trained at universities can be regarded as the consumer and beneficiary. Accordingly, the industrial-educational cooperation will result in an effective system for improving the quality of the informatization education and those institutes.

### 3.2 Policy Direction for Woman Informatization Education

We would like to present the desirable policy direction for the informatization education of women.

First, it is necessary to carry out education of women's problem at an early stage. Informatization education of women is to overcome the imbalance and irrationality that has emerged from gender discrimination. Accordingly, early education of women's problems should be carried out to enable them to overcome the sense of gender discrimination from the juvenile period, and help them with fundamental problem-solving.

Second, it is necessary to select the institutions or women organizations that can act as an axis of informatization education for women, and to allow them to play pivotal roles in that education. At present, many women's organizations have actively carried out and yielded some fruit. However, in reality, there is no center of woman informatization education that can collect the capabilities of many women's organizations. Informatization centers should be selected, networks by region and by institution should be created, and systematic and reasonable informatization education of women should be carried out. This network should also be expanded as an international organization through the Internet.

Third, it is necessary to rearrange and complement the education courses to connect school education to life-time education. For this purpose, education courses for the informatization education of girl students should be rearranged, which should result in systematic and hierarchical life-time education.

## 4 Conclusions

Due to the special nature of the information industry, women's labor power of processing and creation of knowledge has retained a new evaluation. Women's delicate nature, intellectual power, and creativeness herald the creation of new value. The emergence of new jobs and concepts of working places opens the new horizon for the possibility of the woman labor force. What is important here is, however, not to be satisfied with this possibility, but to turn this possibility into reality.

Educational fever in Korea is relatively high. The rate of women who go to universities is very high. Compared with those of advanced countries, however, less women with high education have made their way into the society, and as a result, the education for women remains as the consumptive type of education.

It is time to discard the view that the informatization education of women is just one area of expansion of

women's right. Korea has to recognize the importance of utilizing the tremendous number of potential women laborers as real available manpower, and to put a large investment and sufficient support into this.

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# Research on Teaching Da-Yi Chinese Keyboarding by Using Adaptive Input Interface

**Ming-Chung Chen*, Hwa-Pey Wang** and Lih-Ching Chen Wang*****
**National Chiayi School for the Mentally Retarded*
*123, Sec 2, Shi-Shian Rd. Chiayi city,Taiwan.*
*E-mail:mtchen@blue.com.url.com.tw*
***National Taiwan Normal University*
*162, Sec. 1, E. Ho-Ping Rd. Taipei, Taiwan.*
*E-mail: hpwang@icon.ntnu.edu.tw*
****Cleveland State University*
*1860 E. 22nd Street, 1438 Rhodes Tower, Cleveland, OH 44114 E-mail: l.c.wang@csuohio.edu*

The purpose of this study was to examine the effects of teaching three students with moderate mental disability in a specialized high school in Taiwan to learn Da-Yi Chinese keyboarding by using adaptive input system. A single-subject multiple-probe baselines design across subjects was used. The students used the Unlimiter system as the adaptive input interface to learn to differentiate the locations of the Da-Yi character roots on a keyboard and to learn Chinese keyboarding with Da-Yi character roots. The result shows that all three students can distinguish the locations of the Da-Yi character roots without extra instruction and interact with the computer with Da-Yi input method. The applicability and effectiveness of teaching high school students with moderate mental disability in learning Da-Yi Chinese keyboarding was supported.

Keyword: **adaptive computer system, Da-Yi Chinese Keyboarding, special education, mental disability**

## 1 Introduction

With the rapid advancement of the Internet, our life has become more tied to the Internet and the utilization of the computer is becoming increasingly important. In daily life, people are becoming more familiar with Internet shopping and using email to communicate. In educational planning, many countries are putting emphasis on classroom computers and the Internet [5][6]. Moreover, various Internet-based learning modes are the focus of research in those countries [12][13] in hope of using the Internet to assist students to learn anytime and anywhere and are consequentially achieving the ideal of equal educational opportunity and quality education.

However, for the disabled, because of their disability in the functions of the body, senses, and cognition, it is hard for them to use the technology of computers and the Internet. Enabling the disabled in utilizing these technologies with an accessible environment is an important issue facing the educators.

The government in Taiwan views the establishment of a computer environment with accessibility for the disabled as a priority. When the Department of Education started putting the infrastructure of computer classrooms and Internet access in place in K-12 schools in 1998, it purchased a batch of computers with specialized Internet accessibility for the local school districts and special education schools in hopes that the disabled students can use the specialized equipment to learn computer skills and the Internet, thus enabling them to further their learning with the help of the computer and Internet.

Specialized computer accessories can reduce the problems that the disabled encounter in input and output so

that they can use the computer more easily. Therefore, as far as input device accessibility is concerned, the emphasis is on the input interface, for example, keyguard, touch-screen, trackball, replacement keyboard -- mini-keyboard and enlarged keyboard, etc. Although these input devices make the computers more accessible and easier to use, no matter which accessible input interface is employed, a user still has to learn a method of Chinese input to be able to use the computer in learning and communications.

Currently, four kind of Chinese input mechanisms are used: keyboarding, voice input, writing input, and optical scan. Keyboarding is the most common input method among them[4][14][15]. In fact, although the other ways are more convenient , keyboarding is more useful for individuals with more severe mental disability, since they experiences difficulty with cognition, speech, and motor skills [8][9].

Whichever input method is employed, keyboarding has to be utilized to complete the process of interfacing with the computer in Chinese. Furthermore, keyboarding, per se, is not restricted to finger typing on a keyboard. It is broadly viewed as using the key codes on the keyboard to spell characters and words. A user can input by clicking the keys with a mouse on a displayed mini-keyboard on the computer monitor, by using a replacement keyboard, by using a single on/off key in conjunction with menu scanning, or even by using Morse code. Thus, it is an important key issue to know how to help the disabled, intellectually and/or physically, to learn effective computer keyboarding that enables them to communicate with people.

There are several methods for typing Chinese characters on the computer. These input methods can be grouped into two categories: One is phonetic-coding input; the other is pattern-coding input. The former is inputting Tzu-Yin phonetic symbols or Han-Yu phonetic spelling to have the computer display the homonyms, while the latter is inputting the codes of disassembled basic character patterns, for example, Chang-Jay pattern coding and Da-Yi pattern coding to have the computer display a corresponding Chinese character. Among the current methods, Tzu-Yin, Chang-Jay and Da-Yi are most commonly used[3].

The authors chose Da-Yi as the input method in this study based on the reasons below:

A. The prerequisite of using Tzu-Yin input method is that one must be able to pronounce and spell out a character[7]. This is difficult for students with mental disabilities.
B. Chang-Jay input method was developed based on the character-construction rules while Da-Yi keyboarding starts with writing-stroke rules. This way, the students could keyboard with the sequence of writing.
C. Some research results show that students with mild mental disability perform worse in using Tzu-Yin keyboarding than in using Chang-Jay [10]. The students spent a lot of time learning. Students with moderate mental disabilities could learn to use the Da-Yi input method quickly.
D. Da-Yi input method may be worthwhile for students with mental disabilities to learn in the information age. But how can we assist the students in learning Da-Yi more effectively and less frustratingly?

Therefore, the purpose of this research was to explore if the students can learn to use the Da-Yi input method on the keyboard.

# 2 Research Methodology

## 2.1 Experimental Subjects and Setting

Three high school students with moderate mental disability in the Chia-Yi special school participated in this research. The subjects were selected on the basis of three criteria. First, they were capable of using verbal communication. Secondly, their emotions were stable. Thirdly, their fine motor movement, especially that of the hands, could be controlled by themselves.

Although they are too old to take an IQ test, they were all identified as having moderate mental disability when they entered this school. In order to realize the subjects' characteristics, the researchers reviewed their IEP files and interviewed their teachers. A summary of the subjects' characteristics appears in table 1.

Instruction was conducted by the researchers in the school's counseling room. A personal computer with an Unlimiter computer interface system (called the U1 system by special education educators in Taiwan) were placed on the table. The U1 system was designed by the Assistive Technology Foundation. It is a kind of programmable keyboard that can be designed by the instructor[2]. The subject sat in front of the table and operated the U1 system while the instruction took place.

Table 1 Subject's Characteristics

| Subject | Age | Grade | Gender | Experience in Computer Use? | Performance of literature |
|---|---|---|---|---|---|
| • • | 17y4m | 12th | Male | Yes | Can read and write some common words, Articulation disorder Received speech-language therapy. |
| • • | 17y11m | 12th | Female | No | Can read and write some common words, oral expression is good |
| C | 18y7m | 10th | Male | No | Oral expression is good. Can read printed words excluding his personal information, e.g. name, address.• |

## 2.2 Stimuli

### 2.2.1 Character roots instruction

There are 253 character roots in the Da-Yi input method. These character roots are divided into 40 groups depending on their attributes. The researchers chose the most frequently used 2 characters for each group, which were a total of 80 characters (see Figure 1).

### 2.2.2 Keyboarding instruction

328 words that were divided into 4 sequent groups according to the construction of the word were chosen for the keyboarding practice. These four groups are: group A "from left to right" (• ), group B "from top to bottom " (• ), group C "combination of the previous two types" (• ), and group D "from outside to inside" (• ). These words were chosen based on their frequency of use and the explicitness of the word formation. The subjects practiced keyboarding from easier character root formations to more complicated ones.

### 2.2.3 Words for generalized testing

Three groups of tests were designed. The first group contained 28 new words that were never practiced before. The second involved 21 sentences and 172 words that were practiced in the instruction period. The third group were some written articles.

## 2.4 Apparatus

This study uses a multimedia computer with a 19-inch monitor and Unlimiter, an adaptive input system. Unlimiter is a kind of programmable keyboard for which the user could design the layout to suit their purpose. In this study, the researchers designed a layout as an alternative keyboard for the subjects. The content of the layout is in Figure 2.

## 2.5 Definitions of Independent and Dependent Variables

The independent variable was the instructional design that contained the arrangement of the keyboarding practice words based on the explicitness of word formation and the use of the Unlimiter computer input system.
The dependent variables were effectiveness of learning (percentage of correctly keyboarded target words) and efficiency of learning (numbers of sessions the subject required in order to reach the master criteria).

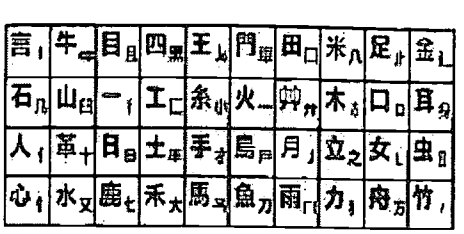

Figure 1 the table of Da-Yi character roots

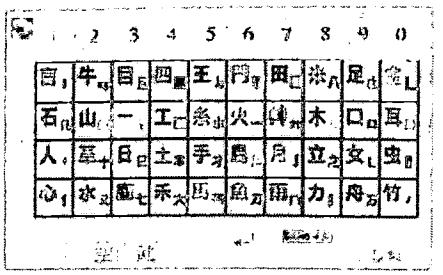

Figure 2 the layout of Da-Yi input method

## 2.6 Design

A multiple-probe baseline across subjects was used. The particular strengths of the multiple-probe baseline design were: (a) the treatment was not reversed, (b) prolonged baseline measures were unnecessary, and (c) the design permitted the evaluation of academic learning [1][11]. A constant time delay technique was selected for instruction in this study, and verbal praise was used as reinforcement.

## 2.7 Procedure

The research was divided into two steps: instruction of Da-Yi character roots followed by the instruction of the Da-Yi input method. Researchers randomly decided prior to the instruction which subjects would receive instruction. The next group of subjects received instruction when the previous student group entered the "from upper to lower" keyboarding instruction.

### 2.7.1 The instruction of Da-Yi character roots

In this step, subjects learned about the 80 Da-Yi characters roots on the layout. The subject would not go to the second step, the instruction of the Da-Yi input method, until he or she reached the master criteria, which was 90% correct responses in three continuous sessions.

### 2.7.2 The instruction of the Da-Yi input method

There were three periods of instruction. They were baseline, instruction sessions, and maintenance & generalization. During the baseline period, the subjects were measured on their accuracy of keyboarding with the Da-Yi input method. The percentage correct measured after testing each group of target words was used as the subject's baseline performance.

During the instruction sessions period, researchers taught the students the necessary keyboarding rules for the sequence of writing. The instruction started from group A"from left to right". The subject practiced and took a test with the *Microsoft Excel* software. The researchers demonstrated keyboarding the target word if the student could not keyboard it correctly in the 20-second time-delay period. The student could not advance to practicing the next group until he or she reached the master criteria, which was a 90% correct response in three continuous sessions.

In order to examine whether the subjects could maintain and generalize their keyboarding abilities, we continued to assess the subjects' performance of new words, sentences and articles without prompting.

## 2.8 Reliability

In order to assess the subjects' response accurately, we immediately recorded the results of subjects' keyboarding in *Microsoft Excel*.

# 3 Result

## 3.1 Da-Yi Character Roots

The three subjects were measured for their familiarity with Da-Yi character roots by having them indicate the target key on the layout. The results showed that all three students could indicate the 80 character roots under the researchers' order. It meant that the subjects could go to learn Da-Yi input method without supplemental learning of character roots.

## 3.2 Keyboarding- Four groups of words

The percentage of correctly keyboarded training words in the four groups during the instruction sessions for each subject is presented in Figures 3, 4, and 5. For these three subjects, it is obvious that they could learn to keyboard with the Da-Yi input method. Student A could type these four forms of words almost 100% correctly. The performance of Student B indicated that she fulfilled the criteria in every measurement except the first trial of group A and group D.

Student C only fulfilled the mastery criteria for group A. However, student C could reach the mastery criteria and learn how to keyboard with the Da-Yi input method.

According to the performance of these three subjects, we found that teaching keyboarding to moderately mentally disabled students with the Da-Yi input method using Unlimiter as an adaptive input system is a valid method, especially when student C did not recognize these characters.

The instruction was efficient. Student A reached the mastery criteria in the minimal number of sessions. Student B used three sessions for groups B and C, and four sessions for groups A and D. Student C spent three sessions on group A, four sessions on group C and group D, and five sessions on group B. They all could learn to master the keyboarding rules with the Da-Yi input method with short-term instruction.

## 3.3 Maintenance & Generalization.

### 3.3.1 New words

The subject was measured on their generalization of a group of new words after their mastery of the four groups of words with different word formations. The results are presented on table 2. They could generalize the rules of keyboarding for words not practiced before.

### 3.3.2 Sentence

Students were asked to keyboard 21 sentences and 172 words composed of the words they practiced. The results on table 2 indicate that the three subjects could keyboard almost 100% correctly.

### 3.3.3 Articles

Due to time limitations, student B only finished article one, and student C did not have the opportunity to type the articles with the Da-Yi input method. As the results in table 2 show, student A and student B could keyboard almost all the content of the articles although some words were never practiced.

Therefore, the three subjects could generalize the rules of keyboarding with the Da-Yi input method they had learned into new words, sentences, and articles.

Table 2 Numbers of correct inputting of the three subjects in generalization test

| | New words (n=28) | Sentences (n=172) | Article one (n=130) | Article two (n=227) | Article three (n=142) |
|---|---|---|---|---|---|
| Student A | 28 | 172 | 127 | 225 | 136 |
| Student B | 25 | 170 | 125 | | |
| Student C | 24 | 172 | | | |

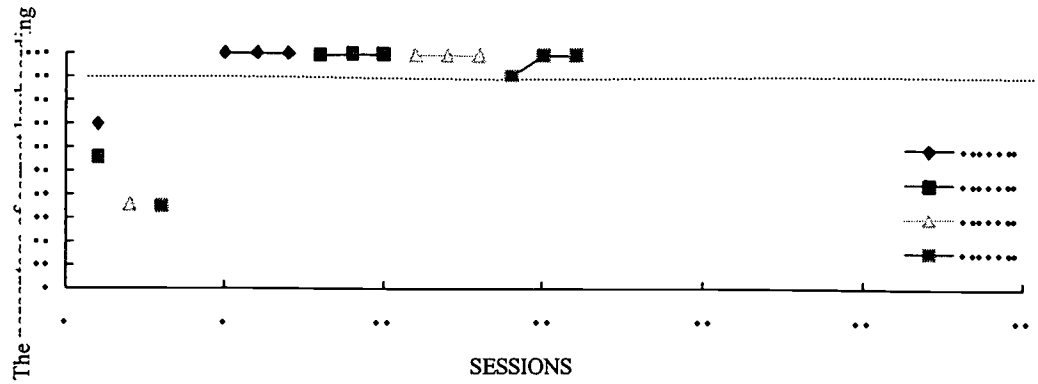


Figure 3. The percentage of correct keyboarding of the four groups of the training words with Da-Yi input method during the instruction sessions for student A

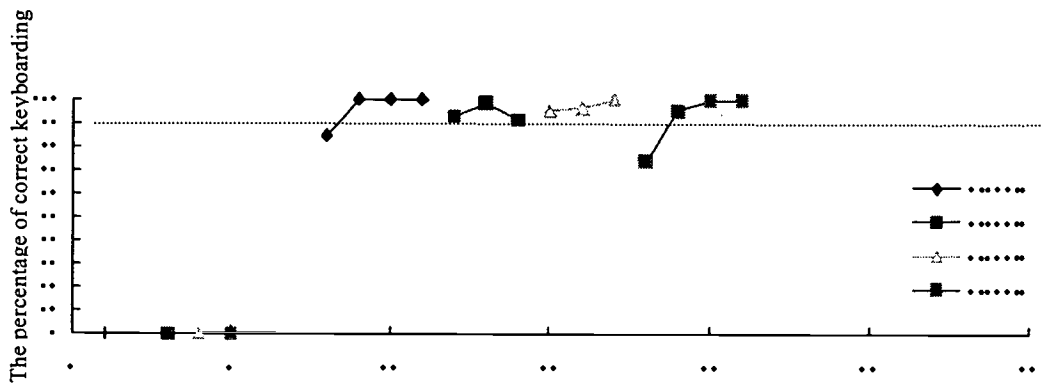


Figure 4. The percentage of correct keyboarding of the four groups of the training words with Da-Yi input method during the instruction sessions for student B

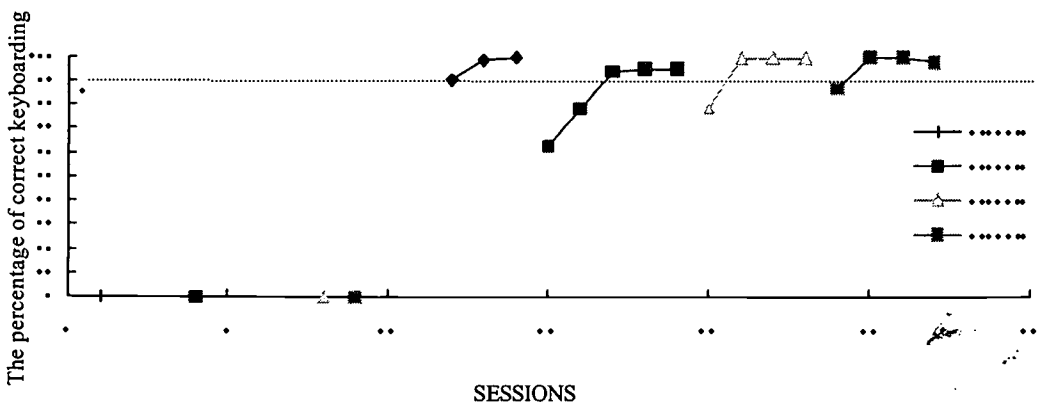


Figure 5. The percentage of correct keyboarding of the four groups of the training words with Da-Yi input method during the instruction sessions for student C

## 4 Conclusions

The purpose of this study was to examine the effects of teaching students with moderate mental disability in a special high school to learn Da-Yi Chinese keyboarding by using an adaptive input system. The results indicated that all three subjects could learn to keyboard with Da-Yi input method by using adaptive input system. In other words, it was an effective and an efficient way to teach students with moderate mental disability to learn Da-Yi input method by using adaptive input interface. In fact, using the alternative keyboard could provide the students with a simpler keyboard, but more prompts would be needed to discriminate the position of the Da-Yi character roots.

According to the result of this research, special educators may help students with moderate mental disability to learn Da-Yi Chinese keyboarding by using an adaptive input interface system as an input method.

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# The effectiveness of integrating adaptive computer device and stimulus fading strategy on word-recognition for students with moderate mental retardation

**Ming-Chung Chen*, Tien-Yu Li**, Hwa-Pey Wang*** and Kou-Ping Yang******

*National Chiayi School for the Mentally Retarded*
*123, Sec 2, Shi-Shian Rd. Chiayi city,Taiwan.*
*E-mail:mtchen@blue.com.url.com.tw*
** National Taiwan Normal University*
*162, Sec. 1, E. Ho-Ping Rd. Taipei, Taiwan*
*E-mail:tienyu@ice.ntnu.edu.tw.*
***National Taiwan Normal University*
*162, Sec. 1, E. Ho-Ping Rd. Taipei, Taiwan.*
*E-mail: hpwang@icon.ntnu.edu.tw*
****Assistive Technology Foundation*
*5F, 18-1, Sec 3, Ren-Ai Rd. Taipei*

The purpose of the study is to examine the effectiveness of the instruction method involving computer device and stimulus fading strategy on word-recognition of two fourth grade students with moderate mental retardation enrolled in a special school. A single subject multiple probe baselines design across subjects is used. The students use the U1 system as the adaptive computer interface to learn word-recognition with the picture cue fading and the word enlarging. The result shows that both two students can identify the four print words correctly, even in different fonts and in different writing ways. The advantages of the adaptive computer interface and stimulus fading strategy are supported.

Keyword: **adaptive computer system, stimulus fading strategy, special education, mental retarded**

## 1 Introduction

It is getting more important to enhance everyone's reading ability in the information age, including individuals with mental retardation. Reading is a very complex process that involves at least two components, word recognition and comprehension. Word recognition is the base of comprehension [3]. To improve the ability of word recognition has been a hot topic in literature and research [5] [6] [8].

The goal of education for individuals with mental retardation is to help them to adapt to society. So the ability of word recognition is important for them too. In Taiwan, how to teach students with mental retardation to acquire reading skill was not noticed until recently, though the curriculum guide for students with mental retardation in Taiwan has emphasized that the practical language course should help students to learn functional Chinese. However, if we want the individuals with mental retardation to integrate into the mainstream society after they leave school, we should teach them to learn to identify the functional word as early as possible.

In practical, teachers usually use pictorial cues as reading instruction strategy to reduce task complexity, increase motivation, and lead to reading success [8]. The researcher in Taiwan also found that using pictorial cue could enhance the effects of word-recognition of the students with mental retardation [10]. But Pufpaff,

Blischak, & Lioyd indicated that some researchers found these methods were ineffective [8], the main problem is that students could not transfer their attention from pictorial cue to word when picture was absent [9].

Word-recognition is a sort of skills learned by way of stimulus discriminatory learning [1]. Sometimes, it needs to add some kind of stimulus (or control stimulus, prompt) that could assist the individuals to express expected response. Once the individual could respond correctly and stably under the prompt, the prompt should be moved gradually [1]. There are two types of instructional prompts, response prompts and stimulus prompts [1]. Using pictorial cues is one kind of stimulus prompts. That may be an effective strategy that we can use pictures as a prompt to teach individuals with mental retardation to learn to identify the target words, then move the pictorial cue systematically once the individuals could differentiate the target words correctly when the pictorial cue is existing. Sue concluded that stimulus prompts was an effective instruction method on word recognition for students with moderate mental retardation after she had analyzed a great deal of related research [9]. The result of Sue's research, using stimulus fading strategy to teach the three second grade students with moderate mental retarded to learn the specific functional Chinese words, showed that the students could learn effectively and efficiently.

In the past, including Sue's study, most of the special educators who use stimulus fading strategy to teach word-recognition create the cards which were composed of picture and word according to the principle of fading. The instructors should teach and provide the feedback by themselves, and the material couldn't be reorganized. As the computer has been more available in the classroom and the Department of Education in Taiwan has begun to purchase adaptive computer devices for students with disabilities, it facilitates students with mental retardation to study through computer and related adaptive devices. The multimedia could provide the feedback automatically and multi-sensory learning opportunity, and on other hand, the adaptive computer devices could help the students to overcome the interface barrier.

In fact, technology could assist the students with disabilities to learn literature effectively [4]. So could we design a computerized instruction program that embeds stimulus fading strategy and adaptive computer device to teach students with moderate mental retardation effective and efficiently?

# 2 Method

## 2.1 Participants and setting

Two students with moderate mental retardation on the fourth grade in the Chia-Yi special school participated in this research. The participants were selected on the basis of three criteria. First, they were capable to use verbal communication. Second, their emotions were stable. Third, they had a history of experiencing difficulties in recognizing words that were taught on their classes.

The IQs were obtained from WISC-Ⅲ, which were administered by the first researchers prior to the beginning of the study. In order to realize the participants' characteristics, the researchers reviewed their IEP files and interviewed with their teachers. A summary of the participant's characteristics appears in table 1.

Table 1
Participants Characteristics

| Participant | Age | Gender | IQ(WISC-Ⅲ) | Performance of speech |
|---|---|---|---|---|
| A | 10 | Male | Full-Scale IQ:57 | Articulation disorder |
| | | | Verbal IQ 58 | Received speech-language therapy. |
| | | | Performance IQ 64 | About 4 words phrases |
| B | 11 | Male | Full-Scale IQ: | Articulation disorder |
| | | | Verbal IQ | received speech-language therapy |
| | | | Performance IQ | About 2 words phrases |

Both of the students had speech disorders and received speech therapy. Student A could answer to the

teacher's question in a short sentence, about four words. Student B was able to use 1-2 words to response teacher's questions. Although the two participants usually paid attention to the teachers on the class, and could do well on the task of picture matching, however, they could not recognize a word after the reading program.

Instruction was conducted by the researchers in the school's counseling room. A personal computer with an U1 computer interface system was placed on the table. The U1 system was designed by Assistive Technology Foundation. It is a kind of programmable keyboard that could be designed by the instructor [2]. The participant was sitting in front of the table and operating the U1 system when the instruction was proceeding.

## 2.2 Stimuli

Four functional Chinese characters were decided after the researchers discussed with the participant's teachers on the schedule of the reading program. The researchers used the editor of U1 system to create the layout of a printed page after the four target words were chosen. There were two frames on each page. All pictures and words were edited in the center of 11cm x 16cm frame. The word was printed vertically and located above the picture. According to the stimulus fading strategy, each target word was selected in 50-point, 100-point and 130-point Ming type, and the picture was set in 10cm x 10cm, 4.5cm x 4.5cm, 1cm x 1cm. Besides these three kinds of layout, there was another layout that was only 130-point words on it.

In order to avoid the participants to response to the stimuli on fixed location, each word was presented on both sides on different layout. So the researchers designed 10 pages for each fading step, 40 pages for the instruction. Additionally, the researchers designed the other 10 pages that presented the target word alone that were printed in 130-point Kai type to measure the generalization of different font, and 4 pages that was printed horizontally for testing the generalization of different printed direction.

For the purpose of multiple sensory learning, the researchers set up some functions for each frame. The computer would speak out the target word, show the picture of the target word, and then present the target word on the screen when the participant touched the frame on the layout on the U1 system during the instruction.

## 2.3 Definitions of independent and dependent variables

The independent variables were stimulus fading strategy and the using of U1 computer interface system.

The dependent variables were effectiveness (percentage of correctly identified target words) and efficiency (percentage of wrong response to mastery, and number of session to criterion).

## 2.4 Design

A multiple probe baseline across subjects was used to assess the effectiveness of integrating U1 system and stimulus fading strategy on word-recognition for the elementary students with moderated mental retardation. The particular strengths of the multiple probe baseline design were: (a) the treatment was not reversed, (b) prolonged baseline measures were unnecessary, and (c) the design permitted the evaluation of academic learning [1]. A constant time delay technique was selected for instruction in this study, and oral praising was used as the reinforcement.

## 2.5 Procedure

Each participant had two learning sessions (one was in the morning, the other was in the afternoon) each day from Monday to Thursday. In order to balance the effect sequence of instruction, researchers decided which participant would accept instruction randomly prior to the instruction, and decided the sequence of the instruction on each day after both participants attended the instruction.

### 2.5.1 Baseline

In the baseline period, the participants were tested about their familiarity with the target words. The students were asked to point out the word under researcher's order. During the baseline assessment, the researchers

did not give participants any feedback or promotion, but recorded their response. The percentage of correct response counted after testing each word five times was used as the participant's baseline performance.

#### 2.5.2 Instruction sessions

Prior to instruction, researchers divided the four target words into two groups and decided which group would be taught at the beginning. 'Hospital '(醫院) and 'drugstore'(西藥房) were taught at first, then ' an internal medicine' (內服藥)and ' an external medicine'(外用藥).

Student A attended the step one instruction. Researchers put the 50-point layout on the U1, and read the target word, then ask students A to read the word and touch the target frame. If he could touch the frame correctly in 4 seconds delay period, the researchers said" you did a good job" as the reinforcement and go on the next target word. Others, the researchers would demonstrate the correct response and ask student to do it again. The correct response would be recorded when the student did it by himself. The percentage of correct response was counted after each word was tested five times. The student would not go to the step two instruction until he reached the master criteria, 80% correct response in the continued sessions. Then the instruction procedure would repeated till the participant could discriminate group one words with no pictorial cues. Then went on group two.

The student B would attend the instruction when student A could discriminate the words of group one stably and had the same procedure.

#### 2.5.3 Maintenance and generalization

In order to examine whether the participants could maintain their word-recognition abilities, and generalize it to the different font and written direction. We continued to assess the participants' performance after the instruction sessions and presented the other layout with different font or written direction.

### 2.6 Reliability

In order to assess the participants' response accurately, we set up a function of the U1 editor to write the participant's answer into the *Microsoft EXCEL* automatically when they touch the frame of the layout on the U1.

## 3 Result

### 3.1 Instruction

The percentage of correctly identifying the four target words during the instruction sessions for each participant is presented in Figures 1 and 2. For these two participants, it is obvious that instruction integrating stimulus the fading strategy and the U1 computer interface system was a effective method to teach students with moderate mental retardation to identify these four target words. Both of them could reached criterion during in each session , excepted student B in learning 'drugstore' with no pictorial cues on step four on the first time .

The results for student A ( see Figure 1) illustrate that he could identified each target word to 100% correctly in each fading step. It means that he did not have any difficulty in word-identification when the cues were faded. Contrarily, Student B encountered more problems in step 4, excepted ' an internal medicine'.

At the beginning of this study, we set up the criterion for fading the pictorial cue as participant could identify the target word correctly 80 % in 3 consecutive sessions. So there should be 12 sessions (4 steps and 3 sessions for each step) in need for the participant to reach the criterion that identifies the target word with no pictorial cue. The results in Figure 1 and 2 indicate that both of these two participants reached the criterion, excluded 'internal medicine ' for student B. It means that participants could learn efficiently.

### 3.2 Maintenance and generalization

Performance during the maintenance period shows that these two participants demonstrated great availability.

Both of them could identify the target words almost 100% correctly, excepted 'internal medicine' for student A and 'external medicine' for student B.

The outcome of the generalization is presented in table 2. two participants could identify the target word in Kia type in stead of Ming type in instruction, and recognize the word printed horizontally regardless of verticality at beginning of the instruction.

Table 2
Percentage of correct response of generalization

| Participants | Target word | Printed in Kia type | Printed in horizontal direction |
|---|---|---|---|
| A | Hospital | 100% | 100% |
| | Drugstore | 80% | 100% |
| | Internal medicine | 100% | 80% |
| | External medicine | 100% | 80% |
| B | Hospital | 80% | 100% |
| | Drugstore | 100% | 80% |
| | Internal medicine | 100% | 100% |
| | External medicine | 100% | 100% |

## 4 Conclusions

The purpose of this study was to examine the effects of integrating adaptive computer device and stimulus1 fading strategy on word-recognition for students with moderated mental retardation enrolled in 4th grade in a special school. The results indicated that both two participants could identify these four target words without pictorial cue. In other words , integrated adaptive computer input device and stimulus fading strategy could be an effective instruction method for the students with moderated mental retardation to recognize some functional Chinese characters. The results of this study is similar to Sue's study in 1992, she found stimulus fading was an effective strategy to teach students enrolled in the self-contained special class in elementary school to identify the functional Chinese characters.

According to the results of this study, special education educators can teach student to identify new Chinese characters by multi-media computerized instruction that use the adaptive computer input device, U1 system, as the interface and the stimulus fading as the instruction strategy.

Although this study indicates that participants could recognize the target words, it still could not offer enough evidences for us to realize if they could learn to identify each single word through this way. This is an issue worth exploring further.

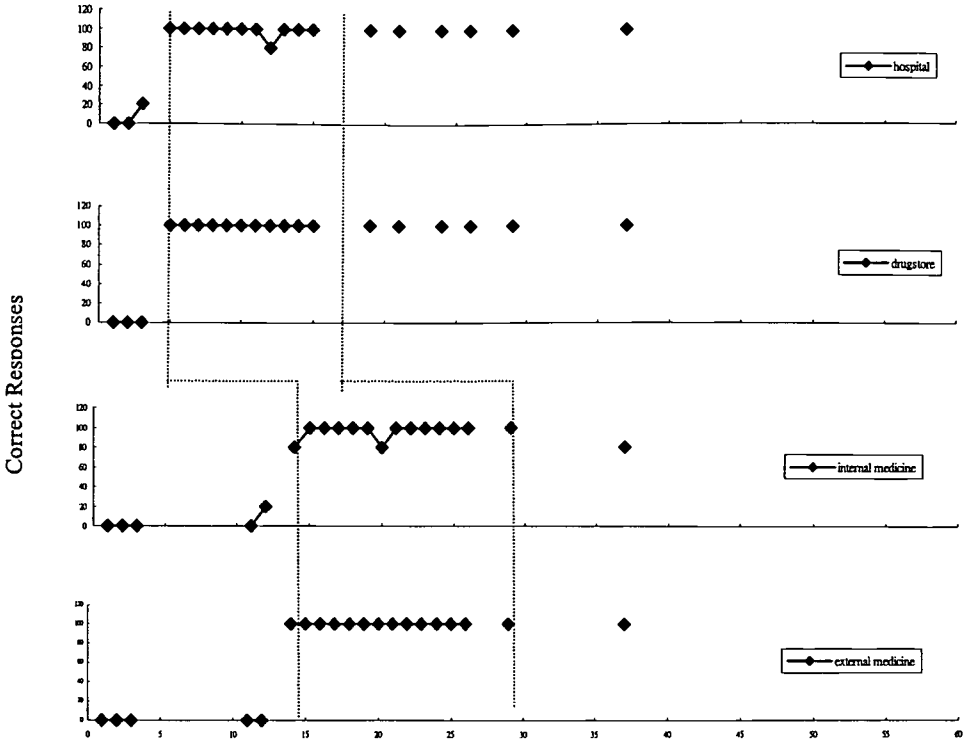


Figure 1. Percentage of correct responses during instruction period and maintenance period for student A

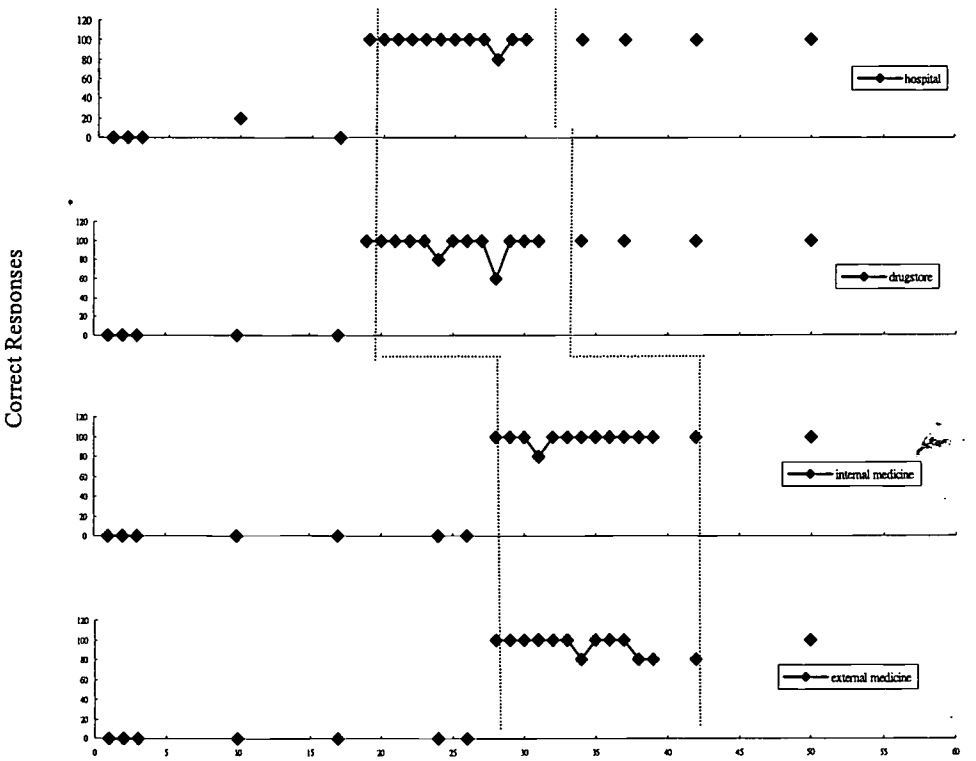


Figure 2. Percentage of correct responses during instruction period and maintenance period for student B

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