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# Performance Study on Learning Chinese Keyboarding Skills Using the Adaptive Learning System*

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The purpose of this study was to explore the learning of Chinese keyboarding skills utilising the adaptive learning system. The study sample consisted of 180 students from the supplementary senior commercial school. Personal information forms, a Chinese keyboarding attitude scale, a computer attitude scale and Chinese keyboarding achievement testing were used for this study. A pre-test-post-test quasi-experimental design was adopted. The experiment group underwent adaptive learning while the control group took on programming learning. Results found that the adaptive learning system of learning Chinese keyboarding skills should adopt a two-parameter logistic model of the item response theory. Also, the performance of Chinese keyboarding adaptive learning is better than programming learning. Furthermore, high computer attitude group learnt better than low and females proved better than males in learning.

## INTRODUCTION

It is has been widely recommended that improving the process and efficiency of instruction can increase learning performance [1]. The educational programme must focus more intensely on how to teach the necessary skills more effectively [2]. It is possible that learning performance can be significantly improved when instruction is well adapted to the individual differences of learners [3]. Indeed, Atkinson indicated that powerful instructional strategies must necessarily be adaptive [4]. An adaptive learning strategy would seek to reference the learner's innate intelligence and the latest performances, with systematic adjustment of learning resources, thereby facilitating interaction between learners and the task of learning.

It is widely recognised today that computers are useful in the overall educational enterprise [5]. The computer is an effective instructional instrument that enables students to participate more frequently and actively in programmed learning activities.

For the purpose of providing a foundation for the effective used and acceptance of computers, research on computer software development and implementation should be ensured [6]. Computer-assisted learning, with the characteristics of feedback and interaction, possesses the potential for adapting instruction to individual differences that exist among learners and, as such, is the best instrument to realise adaptive learning.

### Keyboarding Skills

Keyboarding is the primary method of entering words, numbers and symbols into a computer [7]. The learning of keyboarding is the personal responsibility of each student; this learning process would make it easier for students to use the computer [8]. This is why keyboarding should not be viewed as a subject but rather as a skill that is useful for learning other subjects and is used across the curriculum [9]. Spavold addressed the importance of learning keyboarding skills [10].

In parallel with this, Chinese keyboarding skills have gradually become one of the most important fundamental computer skills and have become necessary to be learned. Chinese keyboarding skills include keyboard operation and Chinese word decoding; the pace of learning this skill relies on the individual differences

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that exist among learners. As such, it is suitable for adaptive computerised learning and will facilitate learning by adjusting resources to the learning differences among individuals.

Several researchers have investigated the influencing factors on the performance of learning English keyboarding skills. But no research has investigated how to improve the performance of learning Chinese keyboarding skills. Chinese keyboarding skills are the same as English, but Chinese keyboarding requires taking apart the Chinese word into several character patterns according to the decoding rule. The Chang-jei method of Chinese keyboarding is a method that is the most popular, fashionable and most widespread in Taiwan.

This study explores the performance of learning Chinese keyboarding skills using the adaptive learning system for the Chang-jei method and to investigate the influence of the learning strategy and computer attitude on the performance of learning Chinese keyboarding skills of business vocational high school students in Taiwan and investigates the influence of the learning system, the student's computer attitudes and gender on the performance of learning Chinese keyboarding skills.

## ADAPTIVE LEARNING

Guptill investigated that through the curriculum with the proper tools to monitor student performance, educators have had the opportunity to target individual needs and monitor students' progress [11]. An adaptive learning strategy can use one or more procedures to monitor and modify learning activities to adjust for the variance in the aptitudes of learner [12]. Atkinson describes adaptive learning as a process in which the sequence of the learning presentation and activities vary as a function of the learner's performance history [13].

The most direct manifestation of cognitive aptitude differences are the variations in the learning-rate. Instructional designers usually build programs that adapt to learning-rate differences through individualised pacing with repetition [14]. A computer-based adaptive learning system employs online, iterative algorithms to access an extensive database and adjust the learning environment to the unique learning characteristics and individual differences of each learner [15].

Shorter, adaptive learning systems can adapt to each student's performance and help students avoid the frustrations of boredom caused by too difficult or easy materials. The aim of adaptive learning is to support the learner's learning process by individualising the learning event [16].

## Computerised Adaptive Testing

The adaptive learning system is a combined use of an adaptive algorithm to select items and latent trait theory to estimate personal ability [17]. The main kernel is based on the principle of Computerised Adaptive Testing (CAT). CAT is a technologically advanced method of assessment in which the computer selects and presents test items to examinees according to the estimated level of the examinee's ability. If the individual's answer is right, the next item should be more difficult; if it is wrong, the next item should be easier [18]. Vispoel recommend that CAT was more reliable and less administrative time was spent when feedback was provided [19].

Item Response Theory (IRT) plays an important role in CAT when estimating the examinee's ability level and selecting items. IRT is a statistical theory consisting of a family of models that express the probability of observing a particular response to an item as a function of certain characteristics of the item and of the ability level of the examinee. It is said that the examinee's performance on a test can be predicted and a successful item response model provides a means of estimating scores for examinees on the traits.

IRT consists of a family of models, with the most frequently used being one, two and three parameter logistic models. The three-parameter model contains item parameters of difficulty, discrimination and guessing. The two-parameter model sets the guessing parameter to 0, while the one-parameter model has the guessing parameter at 0 and the discrimination parameter to 1.

Hulin, Drasgow and Pearsons found that if the guessing parameter was near 0, then it was suitable for the two-parameter logistic model [20]. Because there are so many guessing situations for Chinese word decoding, its guessing parameter is near 0 and is suitable for the two-parameter logistic model. The probability that an examinee with ability level q answer item i correctly is given as Eq.1 for the two-parameter logistic model, where a, b denoted as discrimination and difficulty parameter, D=1.7 is a scaling factor.

$$P_i(\theta)=\frac{e^{Da_i(\theta-b_i)}}{1+e^{Da_i(\theta-b_i)}}=\frac{1}{1+e^{-Da_i(\theta-b_i)}} \quad \text{(Eq.1)}$$

For the main procedure of the Chinese keyboarding adaptive learning system, there are five basic components for carrying out the procedure of computerised adaptive practising. The procedure is shown in Figure 1.

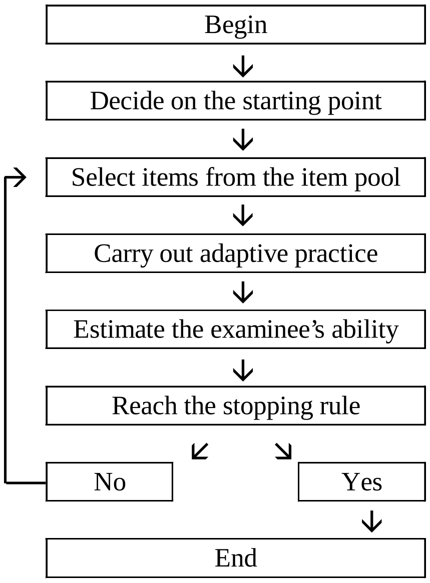


Figure 1: Procedure of computerised adaptive practising.

There are five basic components for carrying out the CAT procedure. These are:

- *Deciding on the starting poin*t. Hulin, Drasgow and Parsons suggested that: in a relatively homogeneous examinee population (eg high school seniors) it is reasonable to administer an initial item of moderate difficulty [20].
- *Constructing the item pools.* Item pools are files of various suitable test items that are coded by subject area, instructional level, instructional objective measured and various pertinent item characteristics [21]. The construction of the item pool in this study was based on item parameter estimates obtained from actual Chinese keyboarding testing administered to large samples of 530 examinees.
- *Selecting items from the item pool.* Lord used the maximum information item select method in conjunction with the maximum likelihood in ability estimating [22]. The maximum item selection strategy selects the item by calculating the value of the item information (see Eq.2) for each item in the item bank. It then picks those items that have the largest value of information.

$$Ii(\theta)=\frac{a_i^{2}}{(e^{(1.7ai(\theta-bi))})(1+e^{(-1.7ai(\theta-bi))})^{2}} \quad \text{(Eq.2)}$$

- *Estimating the examinee's ability.* Two methods for the estimating ability have been used frequently in computer adaptive testing: maximum likelihood estimation and Bayesian estimation. The maximum likelihood ability estimation was accomplished by Newton-Raphson iterations and consisted of a numerical method for determining the maximum of a non-linear equation.
- *Reaching the stopping rule.* When the estimated ability or an expected stopping criterion is reached, the practice is terminated. Two stopping rules were used in this study: to stop when no items remained in the pool or to stop when the standard error (see Eq. 3) associated with the current θ estimate dropped below the value of 0.3.

$$SE(\theta)=\frac{1}{\sqrt{I(\theta)}} \quad \text{(Eq.3)}$$

## GENDER DIFFERENCES

Some literature discussed sex-related differences in response to computers and revealed that males and females are exposed to computers differently [23]. A meta-analysis of studies of gender differences in computer-related attitudes found that the largest differences were generally found for high school students [24].

While the explanation for gender differences on computing has varied among researchers, there is general agreement that if such differences persist, they will produce inequalities in educational attainment and occupational achievement between men and women [25].

Sutton reported that females are more likely to take a utilitarian approach to a computer [26]. The result of Hall's study on keyboarding in a self-contained fourth-fifth grade classroom showed that the mean speed score for the girls was 21.17 gross words per minute, and the mean score for the boys was 18.5 gross words per minute [27]. So, gender is one of factors that have been associated with the performance of learning Chinese keyboarding skills.

## COMPUTER ATTITUDE

Contemporary research indicates that computer use can lead to positive attitudes towards both computer use and schooling [28]. Meunier indicated that learning achievement at the computer was strongly related to personality differences [29].

Mitra and Steffensmeier demonstrated that much of the evidence suggested the claim that computer attitudes are actually predictors of individual learning differences [30]. Loyd and Munger indicated that both male and female students with more positive attitudes towards computers and calculators performed better than those students who had more negative attitudes [31].

## METHOD

According to the principles of CAT and IRT, this study adopted the two-parameter logistic model, developed an item parameter examination program and used the ASCAL program to estimate the difficulty and discrimination parameter of frequently used Chinese words. This study aggregated all the item parameters and constructed an item pool of frequently used Chinese words for the Chang-jei Chinese keyboarding method.

Once this was done, adaptive computer-assisted learning software was developed along with experimental instruction materials. The main part of adaptive computer-assisted learning software is the Chinese keyboarding adaptive learning system based on the principle of CAT and IRT.

The study sample consisted of 180 students (137 female and 43 male) of the Supplementary Senior Commercial School affiliated to the National Taichung Institute of Technology who were learning Chinese keyboarding skills. Those students were aged from 15-18 years old.

Instruments used in this study included a Personal Information Form, a Chinese keyboarding attitude scale, a Computer Attitudes Scale and the Chinese keyboarding achievement testing software.

### Computer Attitudes Scale

The Computer Attitudes Scale was developed for assessing business vocational high school student's computer attitudes. Four dimensions of attitudes were represented in terms of:

- Computer anxiety;
- Computer liking;
- Computer usefulness;
- Computer confidence [32].

This instrument consisted of 20 items and used a four-point Likert-style response format. This made a higher score indicative of higher levels of computer confidence, computer liking, computer usefulness and lower levels of computer anxiety. See Table 1 for the results.

Table 1: Results for the Computer Attitudes Scale.

| Dimension | Cronbach α | Loading factor |
|---|---|---|
| Computer anxiety | 0.91 | 45.6% |
| Computer liking | 0.85 | 10.1% |
| Computer usefulness | 0.81 | 5.5% |
| Computer confidence | 0.84 | 5.0% |
| Total scale | 0.95 | |

### Chinese Keyboarding Attitude Scale

The Chinese keyboarding attitude scale was developed to assess the student's Chinese keyboarding attitudes at the business vocational school. Five dimensions of attitudes were represented in terms of:

- Chinese keyboarding anxiety;
- Chinese keyboarding liking;
- Chinese keyboarding usefulness;
- Necessity of Chinese keyboarding curriculum;
- Chinese keyboarding confidence.

This instrument consisted of 20 items and used a four-point Likert-style response format. This made a high score indicative of higher levels of Chinese keyboarding confidence, necessity of Chinese keyboarding curriculum, Chinese keyboarding usefulness, Chinese keyboarding liking and lower levels of Chinese keyboarding anxiety. Results are shown in Table 2.

Table 2: Results for the dimensions of Chinese keyboarding attitude.

| Dimension | Cronbach α | Loading factor |
|---|---|---|
| Chinese keyboarding anxiety | 0.84 | 42.0% |
| Chinese keyboarding confidence | 0.82 | 10.5% |
| Necessity of Chinese keyboarding curriculum | 0.80 | 6.5% |
| Chinese keyboarding usefulness | 0.87 | 5.7% |
| Chinese keyboarding liking | 0.95 | 5.1% |

### Analysis

A Chinese keyboarding testing software was used to assess student's performance of learning Chinese keyboarding skills; it was developed and widely used in Taiwan by the Chinese Computer Technical Foundation Association for Chinese students in Taiwan [33]. In testing, each student should test twice and on each sub-test spend ten minutes. After testing, the computer can sum up the total amount of time of Chinese keyboarding and score it automatically. The internal consistency of this testing software and all testing documents expressed by the K-R 20 coefficients ranged from 0.60 to 0.95.

The experimental design of this study was of the pre-test-post-test quasi-experimental design. During the experimental period, the class was regarded as the unit and randomly grouped. The experimental group adopted adaptive learning while the control group took on programming learning.

Initially, a pre-test was administered that consisted of a Personal Information Form, a Chinese keyboarding attitude scale, a Computer Attitudes Scale and Chinese keyboarding testing software to collect information about gender, Chinese keyboarding attitudes, computer attitudes, and to determine the entry level of learning Chinese keyboarding skills.

After one semester's learning Chinese keyboarding skills with Chinese keyboarding CAL software and teacher instruction, the Chinese keyboarding attitude scale and the keyboarding achievement testing post-test were administered. The Chinese keyboarding achievement scores for speed were expressed as words per minute with speed and accuracy automatically computed by the Chinese keyboarding testing software.

The data were analysed using an SPSS statistical package. The student t-test analyses were applied to test the difference of the performance of learning Chinese keyboarding skills between different genders. MANCOVA was applied to test the difference of the performance of learning Chinese keyboarding skill between different computer attitude and different learning system. Analysis of covariance can improve the precision of a research design by employing a pre-existing variable that is correlated with the dependent variable [34]. Covariance analysis should match the same assumptions of variance analysis, such as normality, independence of observations, homogeneity of variants, and match the assumption of homogeneity of within-class regression coefficient analysis of covariance.

## RESULTS

Table 3 shows the results of multivariate covariance analysis for different learning strategy towards the performance of Chinese keyboarding skill learning and Chinese keyboarding attitude. The learning strategy did significantly affect the performance of learning Chinese keyboarding skills and Chinese keyboarding attitude (Wilks'$\Lambda$ = 0.85, $p < 0.05$). Analysis of univariate covariance indicates that there was a significant difference in the performance of learning Chinese keyboarding skills and Chinese keyboarding attitude between different learning strategies ($F$ = 30.24, $p < 0.05$; $F$=5.96, $p < 0.05$).

A *post hoc* comparison of different learning strategies towards the performance of learning Chinese keyboarding skills shows that the adaptive learning group (N=89, mean=25.42) was higher than the programming learning group (N=91, mean=18.34). For the different learning strategy towards the Chinese keyboarding attitude, the adaptive learning group (N=89, mean=2.44) was also higher than the programming learning group (N=91, mean=2. 21).

Table 4 displays the results of multivariate covariance analysis for different computer attitudes towards the performance of learning Chinese keyboarding skills and Chinese keyboarding attitude. The computer attitude did significantly affect performance in learning Chinese keyboarding skills and Chinese keyboarding attitude (Wilks'$\Lambda$ = 0.92, $p < 0.05$). Then, by the analysis of univariate covariance, it was shown that there was a significant difference in the performance of learning Chinese keyboarding skills and Chinese keyboarding attitude between different computer attitudes ($F$ = 5.26, $p < 0.05$; $F$ = 7.68, $p < 0.05$).

A *post hoc* comparison for different computer attitudes towards the performance of learning Chinese keyboarding skill has shown that the high computer

Table 3: Multivariate covariance analysis for different learning strategies in the performance of learning Chinese keyboarding skills/attitude.

| Source of variance | Df | SSCP A | SSCP B | Wilk's $\Lambda$ | Univariate F A | Univariate F B |
|---|---|---|---|---|---|---|
| Constant | 1 | | | | | |
| Main effect | 1 | $\begin{bmatrix} 2038.71 & 36.36 \\ 36.36 & 0.65 \end{bmatrix}$ | | 0.85* | 30.24* | 5.96* |
| Covariates | 3 | $\begin{bmatrix} 6244.13 & 122.96 \\ 122.96 & 10.71 \end{bmatrix}$ | | 0.41* | 30.87* | 32.81* |
| Within | 175 | $\begin{bmatrix} 11797.72 & 243.72 \\ 243.72 & 19.04 \end{bmatrix}$ | | | | |
| Total | 180 | | | | | |

*p < 0.05
A: The performance of learning Chinese keyboarding skill.
B: Chinese keyboarding attitude.

Table 4: Multivariate covariance analysis for different computer attitudes in the performance of learning Chinese keyboarding skills/attitude.

| Source of Variance | Df | SSCP A | SSCP B | Wilk's $\Lambda$ | Univariate F A | Univariate F B |
|---|---|---|---|---|---|---|
| Constant | 1 | | | | | |
| Main effect | 1 | $\begin{bmatrix} 8134.02 & 169.47 \\ 169.47 & 12.32 \end{bmatrix}$ | | 0.92* | 5.26* | 7.68* |
| Covariates | 3 | $\begin{bmatrix} 441.21 & 20.74 \\ 20.74 & 0.95 \end{bmatrix}$ | | 0.63* | 7.20* | 5.72* |
| Within | 97 | $\begin{bmatrix} 1809.74 & 5.42 \\ 5.42 & 2.18 \end{bmatrix}$ | | | | |
| Total | 102 | | | | | |

*p < 0.05
A: The performance of learning Chinese keyboarding skill.
B: Chinese keyboarding attitude.

attitude group (N=54, mean=24.83) was higher than the low computer attitude group (N=48, mean=18.89). For different computer attitudes towards the Chinese keyboarding attitude, it was shown that the high computer attitude group (N=54, mean=2.30) was higher than the low computer attitude group (N=48, mean=2.02).

Table 5 shows that the student's gender did significantly affect the performance of learning Chinese keyboarding skills (t value = -2.52*). It also shown that the females (M=22.93) displayed better performance than males (M=18.40).

Table 5: Student t-test analysis of the performance of learning Chinese keyboarding skill between genders.

| Variable | Attitudes | | | | |
|---|---|---|---|---|---|
| | Groups | Samples | Means | SD | t values |
| Gender | Male | 43 | 18.40 | 8.78 | -2.52* |
| | Female | 137 | 22.93 | 10.73 | |

* $p<0.05$

## DISCUSSION AND CONCLUSIONS

According to the results of literature review, panel discussion, experimental instruction and opinions of questionnaires, the main findings of this study are described briefly below.

Firstly, the system of Chinese keyboarding adaptive learning should adopt two-parameter logistic model of the item response theory. This would be consistent with Hulin, Drasgow and Pearson's finding that if the guessing parameter is near 0, then it would be suitable for a two-parameter logistic model [14]. As there are so many guessing situations for Chinese word decoding, its guessing parameter is near 0 and it should adopt two-parameter logistic model.

Secondly, the adaptive learning group proved to be better than the programming learning group in their performance of learning Chinese keyboarding skills. This result parallels Tennyson's findings in that computer assisted learning is augmented when utilising the adaptive strategy [35]. Other research discovered that adaptive computer practice can contribute to reaching master level and there will be a better attitude to study [36]. Dreher recommended that teachers adapt instruction to match students' learning styles to improve student motivation and allow students to reach their full potential [37]. Houtveen et al found that the pupil achieves more with a teacher who exhibits significantly high adaptive instructional behaviours [38].

Those students with high computer attitudes showed significantly better performance in learning Chinese keyboarding skills and Chinese keyboarding attitude. This result, as with the research of Rozell and Gardner, indicates that computer attitude was related to computer efficacy and task-specific performance expectations [39]. Russell also revealed the influence on learning performance of computer attitude [40]. Shermis and Lombard also found that computer attitude played a predictive role on performance [41].

Females displayed better performance on learning Chinese keyboarding skills than their male counterparts. This reflects Hall's study, which found that females typed faster than males at the mean speed of keyboarding. This is also consistent with Whitley's study that people with an aptitude for a task should expect to do well at it [42]. Females like word processing, spreadsheet and typing more than males [43].

From the results described above, this study delivers the following suggestions:

- Chinese keyboarding adaptive learning is necessary and can be implemented.
- Adaptive computer-aided learning software should be considered for development for other Chinese keyboarding methods.

Furthermore, for the purpose of collecting data to estimate the parameter of difficulty and discrimination, one could develop an item parameters examination program. This could use ASCAL to estimate item parameters and aggregate all the item parameters to created an item bank.

A follow-up study of Chinese keyboarding adaptive learning should emphasise the method of qualitative research and compare the learning performance among different recognition behaviours. It would also be of interest to investigate Chinese keyboarding adaptive learning when applied to learners of different ages, study stages and regional differences and then compare performance.

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## BIOGRAPHIES

David Wen-Shung Tai was born in July 1951 and is a Professor in the Department of Industrial Education at the National Changhua University of Education (NCUE) in Changhua, Taiwan. He completed his undergraduate degree in the Department of Industrial Education at the National Taiwan Normal University in Taipei, Taiwan, and earned his MS degree from the Department of Industrial Technology at the University of Wisconsin-Platteville in the USA. He earned simultaneously his MS degree from the Department of Computer Science at Iowa State University in the USA and his PhD from the Department of Industrial Education and Technology at the same University in 1987.

From 1987 to 1993, he was an Associate Professor at the NCUE and was awarded a professorship in 1993. From 1999 to 2001, he has been Chairman of the Department of Industrial Education. He was appointed the Dean of the College of Technology at National Taiwan Normal University as of 2001.

Prof. Tai's research experience includes engineering drawing, computer-assisted learning, spatial ability and problem solving. His latest projects include the study of promoting student spatial abilities and the problem solving abilities of orthographic engineering drawing in vocational high schools.

Tzu-An Tsai gained his BS degree in information and computer education from the National Taiwan Normal University, in 1990. He also holds an MBA from the Institute of Business and Management at the National Chiao Tung University, achieved in 1993. Dr Tsai earned his PhD in industrial education and technology at the National Chunghua University of Education in Changhua, Taiwan, in 2000.

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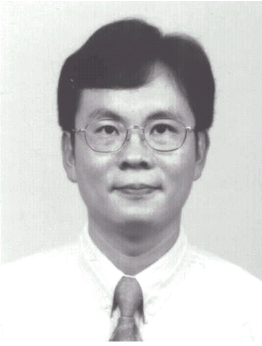

Frank Ming-Che Chen received his Bachelor degree in Economics from Soochow University, Taiwan, in 1983, followed by an MBA degree in Insurance in 1985 from Fengchia University, Taiwan. After that, he spent 12 years lecturing at college before entering the National Changhua University of Education in Changhua, Taiwan, to work on his doctorate. He is currently a doctoral candidate specialising in Human Resources Management.

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