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Non-native Chinese language learners' attitudes towards online vision-based motion games

Yungwei Hao, Jon-Chao Hong, Jyh-Tsorng Jong, Ming-Yueh Hwang, Chao-Ya Su and Jin-Shin Yang

Yungwei Hao is an assistant professor in the Department of Education, National Taiwan Normal University in Taipei, Taiwan. Hao specializes in instructional design, focusing on foreign language education and teacher education, and in the evaluation of instructional technology products and projects. Jon-Chao Hong is a professor in the Department of Industrial Education, National Taiwan Normal University. Hong is the founder of the Digital Game-Based Learning Laboratory. Jyh-Tsorng Jong is an associate professor in the Department of Human Development & Family Studies, National Taiwan Normal University. Ming-Yueh Hwang is a professor in the Department of Adult & Continuing Education, National Taiwan Normal University. Chao-Ya Su is an associate professor in the Department of Technology Application and Human Resource Development, National Taiwan Normal University. Jin-Shin Yang is an associate professor in the Department of Technology Application and Human Resource Development, National Taiwan Normal University. Address for correspondence: Dr. Yungwei Hao, Department of Education, National Taiwan Normal University, No. 129, Sec. 1, Road He-Ping E., Taipei 106, Taiwan. E-mail: hao@ntnu.edu.tw.

Abstract

Learning to write Chinese characters is often thought to be a very challenging and laborious task. However, new learning tools are being designed that might reduce learners' tedium. This study explores one such tool, an online program in which learners can learn Chinese characters through vision-based motion games. The learner's gestures are detected by a computer webcam, which sends the message back to the online program, and the corresponding strokes appear on the computer screen. In this way, the learner practises the correct Chinese stroke order by gesturing. For this study, nine non-native Chinese-language learners used this program to practise writing characters, and their learning strategies and attitudes towards the online program were observed. Data were collected from two self-reported surveys and interviews. The results of the study are reported here, and implications for instructional design and future development of the gestural recognition program are discussed.

Introduction

Owing to political and economic factors, Mandarin Chinese has become one of the most popular foreign languages in the last few years. Many countries have started investing significant amounts of money in programmes geared towards developing their citizens' Chinese-language competency. For one example, the Bush government in 2006 announced the National Security Language Initiative, a US$114 million plan to strengthen the teaching of critical-need foreign languages in K-12 schools. One of the languages targeted was Mandarin Chinese.

Chinese is considered one of the most difficult languages for non-native speakers to learn (Lin *et al*, 2008; Wu & Miller, 2007). One of the basic challenges for learners is learning to write Chinese characters (Everson, 1998). To learn a Chinese character, one must learn its shape as well as its sound and meaning. Chinese-written characters are composed of several strokes, and to learn them effectively the learner must learn to write each stroke in the proper order. Traditionally, native speakers of Chinese regard the learning of stroke order as an important step to

mastering the writing of Chinese characters. To help learners learn stroke order, teachers usually write the character on the blackboard or wave their hand in the air to demonstrate to the whole class the correct stroke order. According to several studies (eg, Alibali & Goldin-Meadow, 1993; Cook, Mitchell & Goldin-Meadow, 2008), gestures help learners to mentally construct and remember the series of actions involved in making the strokes—as in the learning of various other sorts of skills involving hand and arm movement.

The graphic nature of Chinese characters is complex, and the morphemic structure of the language is not common. These and other factors explain why learning how to write a Chinese character is a challenge for most non-native speakers. Because of time limitations in Chinese-learning classrooms, instructors tend to focus on the sound and meaning of each character. Regarding the visual form, instructors may demonstrate once or twice how to write the character. Non-native learners of Chinese often get practice books and copy the strokes of each character over and over by themselves until they are familiar with the stroke order. However, the process of learning to write Chinese characters is likely to be tedious for many learners, and learning materials are limited. Zhan (2002) noted that while learning materials for non-native speakers focused on pronunciation and conversation, listening, reading and writing, materials devoted to writing characters with a focus on stroke order have, by comparison, undergone much less development.

The use of innovative Internet technologies to assist learning has become a trend in foreign language education (Kern & Warschauer, 2000). Studies (eg, Braul, 2006; Yang, 2001) have indicated that Internet technologies may make foreign language learning materials more accessible to learners, provide more options for learners and increase their motivation. Technological changes have shifted language teaching from structural and sequential to interactive and communicative modes (Kern & Warschauer, 2000). One of the primary goals of instructional design is to engage learners by making learning fun. In light of advances in technology, integrating digital games into the learning process is not a difficult matter for instructional designers. However, Chinese-language computer programs have not yet fully caught up with recent advances. Most Chinese language-learning programs are still didactic, memorisation-oriented and not much fun (Lin *et al*, 2008). Further, to date, there is only limited empirical research on integrating digital games into language-learning projects for non-native Chinese learners.

During the last few years, Wii technology has become popular among all age groups in the game market. Game technologies are also being integrated into learning programmes to transmit knowledge or train skills (Quiroga *et al*, 2009); this blend of education and entertainment has been dubbed 'edutainment.' However, some studies have indicated that there is little empirical research that supports the educational value of the game technologies (eg, Green & Bavelier, 2003; Quiroga *et al*, 2009). Furthermore, it is unclear whether players still enjoy playing when the element of learning is introduced into the game. Taking into consideration all these issues, our research team designed an online program featuring Wii-like, vision-based motion games to explore learners' attitudes towards the game program. The theoretical framework adopted was based on learner-centred approaches (Mayer, 2001), in which learners were engaged in interactive learning and information processing. Our focus was on whether the games enhanced the affective aspects of learning.

The goals of this preliminary study on an online game-based learning program were twofold. The first goal was to investigate nine non-native Chinese-language learners' attitudes towards an online program featuring Wii-like, vision-based motion games. Many studies in the field of foreign language education have focused on learners' learning strategies in order to devise new ways to help people learn languages more effectively (Oxford, 1990). Since in recent years the number of Chinese-language learners has been mounting rapidly, we focused on the special challenges

confronting Chinese-language learners. The second goal of the current study was to examine the learners' language-learning strategies. The program of vision-based motion games provides learners with an interactive learning environment where they can play and learn Chinese characters by gesturing or waving in the air to a webcam and by selecting the correct stroke, in the correct order. The webcam detects the motion, sends the message back to the online program, and scores performance. We next present more details on the program.

The study

The vision-based motion-game program

The online game-based program we used has embedded vision-based motion games that provide learners with an interactive learning environment. The program was produced by the Digital Game-Based Learning Laboratory, Taipei, Taiwan. See http://www.gblntnu.org/index.php for more information. The program's different sections have different contents; this study makes use of the 'game' designed for learning the stroke order of Chinese characters. For each character, the screen displays the strokes one after another, and the learner, positioned in view of the webcam, responds to the correct stroke by tracing its pattern in the air with his or her hand. The webcam detects the direction of the user's gestures and the program scores the answer. Learners play puzzle-like games, gesturing to select the correct stroke for each character. Strokes constitute characters; by selecting strokes in the correct order, program users complete a whole character.

The program used was designed by the research team and developed by a group of technicians commissioned by contract. The basic idea of the project was to create an engaging and fun way for Chinese-language learners to learn how to write Chinese characters. The research team, consisting of faculty members whose expertise included instructional design, foreign language instruction and game design, convened with the technicians regularly to check whether the development of this program, based on a prototype, was proceeding on track.

The program section employed in this project adopted the framework of Huang's (2005) study and included a few Chinese characters. Huang categorised Chinese characters into three groups: one in which characters follow basic rules; another in which they follow complimentary rules; and a third in which they follow exceptional rules. The current study used a total of 24 characters drawn from the three groups. Each time someone played the game, he or she selected one of these 24 characters in order to practise its stroke order.

The following screen shots can help to clarify the workings of the online program. Figure 1 shows the research team's projection of a laptop screen onto a 'white board' and illustrates how a player plays the game. Figure 2 demonstrates the welcome screen of the online program. A player needs to gesture in the air to the webcam to activate the red 'Start' button on the screen. After the webcam detects the player's motion, the program begins. Figure 3 displays the four choices that the program presents regarding the first stroke of a character (公) once a player has chosen this character, which is shown on the upper left side of the screen.

In this study there were nine participants (three males, six females). The research team gathered participants by posting invitation notices around campus, and 15 people, all students at Chinese-language centres in Taipei, volunteered to participate in the study. Six volunteers were rejected because they had studied Chinese for more than 2 years, which was beyond the scope of the study. The participants who were selected had been studying Chinese for less than 3 months and were not familiar with most of the 24 characters used in the study. Each participant was paid US$15 to participate. The research team invited each participant to come to a computer lab on campus to play the stroke-learning game. Using a blackboard, the primary researcher first showed the participants how to write each character. Afterwards, this researcher sat behind the participants and recorded their progress as they practised the order of strokes in the online program; the

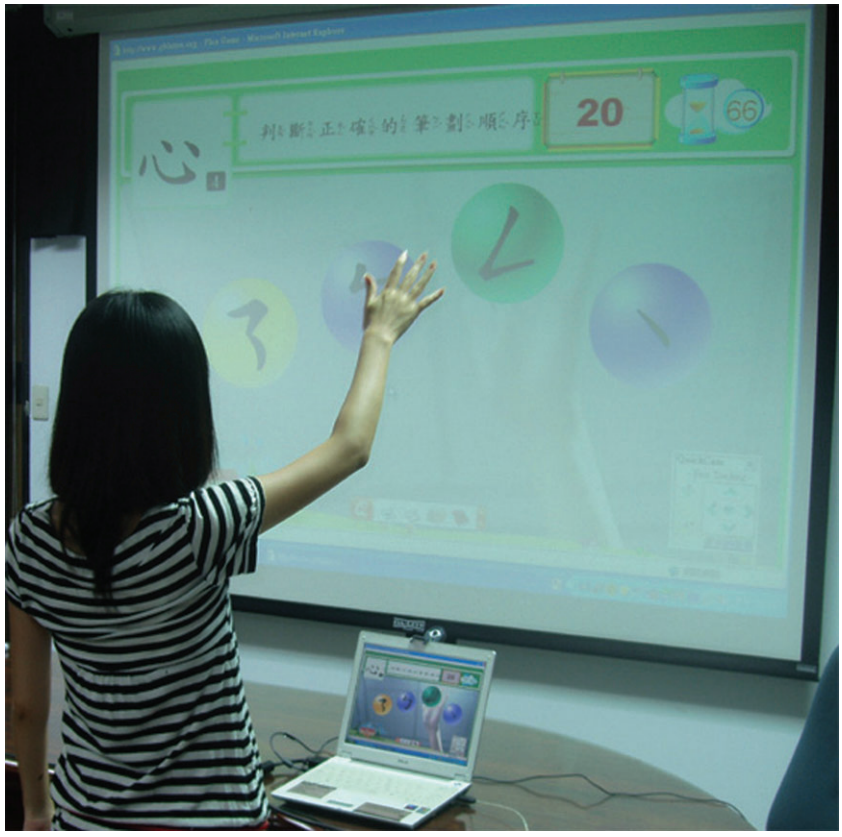

Figure 1: How a player plays the game

researcher also observed participants' reaction to the task. The participants played the game with the 24 characters one character after another; the screen shots (Figures 1–3) illustrate the process in more detail.

After the game, the primary researcher conducted individual interviews, and two surveys were also taken. In all, each participant spent about 1.5 hours with the researcher. Interviews were conducted in a semi-structured format, focusing on the participants' feelings about the game-based online program. Borrowing from Nielsen's (1993) concept of usability testing, other interview questions concerned the interface and the interactivity of the online program. One survey contained seven items, which focused on learner attitudes towards the online program (see Table 2 for the survey details). The survey items were meant to ascertain whether the learners liked this type of learning. For a survey item such as 'The vision-based motion game was a good way to learn Chinese', participants answered using a 5-point Likert scale on attitudes ranging from 'strongly agree' to 'strongly disagree'.

The second survey, used to measure the frequency with which Chinese-language learners used each of various language-learning strategies, incorporated the Oxford Strategy Inventory for Language Learning (SILL, Version 5.1; Oxford, 1989). So far, there have been only a few studies investigating non-native speakers' Chinese-learning strategies, and these mainly use self-created instruments to assess learning strategies (eg, Hayes, 1988; Shen, 2005). As our research team was intensely aware of validity-related issues, we chose the SILL for this study because this is a measurement tool that has been widely accepted and validated in the field of foreign-language

Figure 2: The welcome screen of the online program. Screen transcription: (1) Top of the screen: 'Judge the correct order of Chinese strokes'. (2) Right hand, top of the screen: the number shows the score. (3) Middle of the screen: 'Please adjust your webcam so that it captures your body movement. Raise your hands to the level shown by the screen'. (4) The red button reads, 'Start'. There are two numbers on the right-hand side of the screen. The number in the rectangle refers to the score. The number in the small bubble refers to the time (seconds) spent

education (eg, Griffiths, 2003; Hsiao & Oxford, 2002; Oxford & Nyikos, 1989). The SILL is an 80-item survey, measuring six themes related to language-learning strategies (memory strategies, cognitive strategies, compensation strategies, metacognitive strategies, affective strategies and social strategies). The survey items adopted the 5-point Likert scale, ranging from 'always or almost always use the strategy' to 'never or almost never use the strategy.' The Cronbach's alpha of the SILL has been measured in several studies, and the alpha in most of the studies is above 0.90 (Oxford & Nyikos, 1989).

Descriptive statistics were used to present the quantitative data gathered from the survey of learner attitudes towards the online program. Another descriptive analysis of the participants' responses to the SILL was conducted in order to shed light on the strategies that the participants used most and least often in learning Chinese. To analyse the qualitative data from the interviews, the researchers used micro-analyses of the grounded theory methodology and conducted open and axial coding (Strauss & Corbin, 1998). A series of codes were extracted from the interviews and then grouped into similar concepts. Based on these concepts, categories were generated, and their relationships across the qualitative data were examined. The findings were utilised to support the survey analyses.

Results

Six of the study's participants were not familiar with the Chinese characters used in the game, while three participants had been studying Chinese for almost 3 months and had learned a few of the characters in the game. All participants performed well in the vision-based motion game and received full or almost full scores in the game. There was no significant difference in the

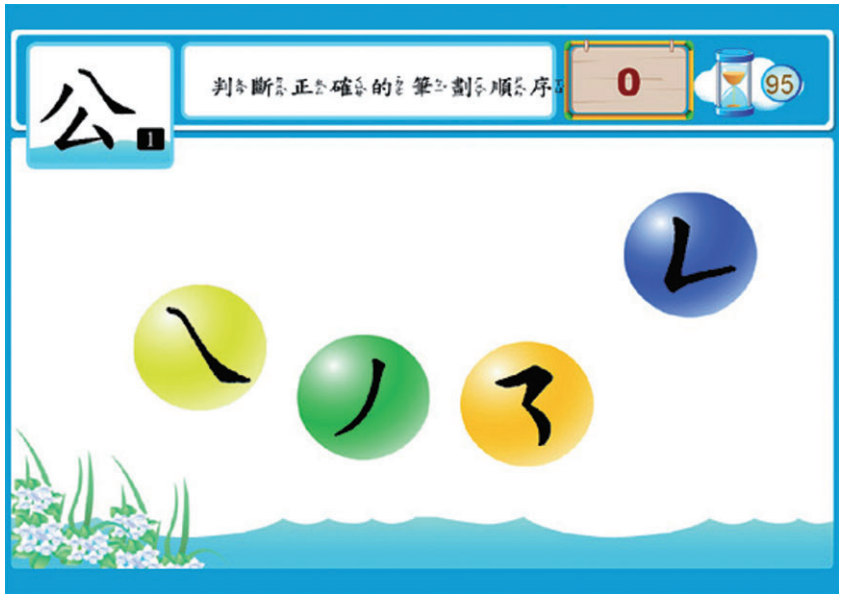

Figure 3: To write the character presented here (公) on the upper left side of the screen, the learner has four choices (presented in the middle of the screen) for the first stroke of the character. Screen transcription: (1) Middle, top of the screen: 'Judge the correct order of Chinese strokes'. (2) Right hand, top of the screen: the number in the rectangle shows the score. (3) Left hand, top of the screen: '公', one of the Chinese characters presented to the learner/ game player. (4) The middle part: the four bubbles contain four choices of strokes for the player to choose from

Table 1: Participant demographics and attitudes towards the online program

Participant	*Nationality*	*Sex*	*Age*	*Degree*	*Months studying Chinese*	*Attitude*
A	Spanish	Male	28	BA	2	3.43
B	Finnish	Male	32	MA	3	2.71
C	German	Female	35	BA	1	4.14
D	American	Female	20	Undergraduate	1	3.86
E	Japanese	Female	25	BA	3	3.86
F	S. Korean	Male	35	MBA	3	4.14
G	S. Korean	Female	24	BA	1	2.29
H	S. Korean	Female	29	MBA	2	3.14
I	S. Korean	Female	30	MS	2	3.14

The attitudes towards the online program were coded as follows: 'strongly agree' as 5, 'agree' as 4, 'neutral' as 3, 'disagree' as 2, 'strongly disagree' as 1.

participant rate of gesture to time spent. As for attitudes towards learning Chinese, all participants stated that Chinese would help them in their current jobs and/or future careers. Table 1 presents participant demographics.

The survey data show that most of the participants had above-neutral attitude levels towards the online program. Other information about participants' background is indicated in Table 1. Among the nine participants, two participants (B and G) had below-neutral attitude levels towards the program, and two other participants (C and F) 'strongly agreed' that they benefited from the program. Table 1 includes the attitude mean scores, and Table 2 presents the mean scores and the standard deviation scores of the seven survey items measuring the participants' attitudes towards the program.

Table 2: The mean (M) scores and the standard-deviation (SD) scores of the seven items measuring participant attitudes towards the online program

	M	*SD*
Q1. I am satisfied that I learned from this experience.	3.44	1.01
Q2. I felt comfortable in the game-based online environment.	3.33	0.87
Q3. The vision-based motion game was a good way to learn Chinese.	3.78	0.97
Q4. I liked learning Chinese characters via the vision-based motion games.	2.78	1.30
Q5. I'm satisfied with the way that the vision-based motion game supported my Chinese learning.	3.22	0.67
Q6. I enjoyed learning Chinese characters that way.	3.11	1.36
Q7. The vision-based motion-game learning experience was easy for me.	4.22	0.67
$n = 9$ Total:	3.41	0.65

Data were coded as follows: 'strongly agree' as 5, 'agree' as 4, 'neutral' as 3, 'disagree' as 2, 'strongly disagree' as 1.

Table 3: The M and SD scores of participant learning strategies

	Memory strategies	*Cognitive strategies*	*Compensation strategies*	*Metacognitive strategies*	*Affective strategies*	*Social strategies*	*Mean*
A	2.53	3.32	3.88	4.06	3.14	3.44	3.40
B	3.4	3.96	3.88	3.69	2.86	3.67	3.57
C	3.4	3.92	3.75	4.06	3.43	4.11	3.78
D	3	3.36	3.75	3.38	2	3.11	3.10
E	2.73	3.48	3.88	3.06	3.86	4	3.50
F	3.33	3.68	3.25	3.75	3	3.78	3.47
G	4.13	4	4.38	4.19	4.29	4.67	4.27
H	3.47	3.6	3.5	3.88	3.29	3.56	3.55
I	3.47	3.6	3.5	3.88	3.29	3.56	3.55
	$M = 3.27$ $SD = 0.47$	$M = 3.66$ $SD = 0.25$	$M = 3.75$ $SD = 0.32$	$M = 3.77$ $SD = 0.36$	$M = 3.24$ $SD = 0.64$	$M = 3.77$ $SD = 0.45$	($n = 9$)

Data were coded as follows: 'always or almost always use the strategy' as 5, 'generally use the strategy' as 4, 'use the strategy somewhat' as 3, 'generally do not use the strategy' as 2, 'never or almost never use the strategy' as 1.

Using the SILL, we measured six categories of language-learning strategies used by the participants. Table 3 presents the levels of use of the six learning-strategy categories and the mean and standard deviation scores. According to Oxford (1990), high use of a learning strategy has a mean range between 3.5 and 5.0, medium use has a mean range between 2.5 and 3.4, and low use has a mean range between 1.0 and 2.4. Among the nine participants, Participant G made the most use of all types of learning strategies, and Participant D used the fewest learning strategies, especially affective strategies. Among the six strategies, memory strategies and affective strategies were used least by the nine participants, but the use levels of the least-used learning strategies still reached the medium-use mean range.

From the interviews, a few general tendencies or attitudes emerged regarding user perspectives on their program-based efforts to learn the characters (discussed in Table 4). The nine participants agreed on the importance of stroke order when learning a Chinese character. They pointed out that stroke-order instruction was not available in their own classes and that they usually searched on their own for resources related to this subject. The participants regarded the game-based program as a good supplement to classroom activities. They felt that the game was most appropriate for beginners, and in general, they agreed that the dynamic visualisation of the stroke order of characters was helpful to them. Most participants felt comfortable gesturing or

Table 4: Categories regarding user perspectives on learning the characters through the program

Categories	*Concepts*
Content	Recognise the importance of stroke order. Regard the game-based program as a supplement to classroom activities.
Instructional design	The vision-based motion game was most appropriate for beginners. The dynamic visualisation relieved cognitive load.
Interface	Participants liked the colourfulness of the logos on the web site. The program should be sensitive and accurately detect the body movements of the players.
Interactivity	The program should provide players with more user control. The game should offer a collaborative multiplayer mode.

waving in the air as they played the game; some said that moving their body helped them pay attention to the learning task and facilitated their cognitive processing: for example, recalling the order of the strokes and reducing the so-called cognitive load (Cook *et al*, 2008; Sweller & Chandler, 1991). In terms of usability, a range of issues related to interface and interactivity was mentioned. Four participants mentioned that they liked the colourfulness of the website's logo and that it lent a particularly light-hearted and pleasant tone to the game. Then, more than half of the participants complained about their frustration with the program's inability to detect their body movements accurately. All participants agreed that the program should be more sensitive to, and thus more accurately detect, the players' movements. Regarding interactivity, three participants recommended that the program provide players with more user control by, for example, allowing users to decide the speed and difficulty level of the characters. The participants suggested that the game allow for multiple players, thus incorporating more interactivity in the learning process. They thought that allowing players to play collaboratively would make the learning process more dynamic and interesting.

Discussion

In general, the participants did not agree unequivocally that they liked learning Chinese characters by using the vision-based motion games. Most of them commented that the game-based learning experience was easy and that it might be best suited for a basic-level curriculum for beginners or children. However, in fact this program was originally designed for adult learners. Participants described the program as being a way of practising just for fun. These responses again show that the participants tended to think the program was mainly for students at beginning or lower levels of Chinese-language learning. On the other hand, some participants indicated that the movements the game required indeed helped them remember the stroke order of the characters and reduced the cognitive load of character-learning. These responses suggested that learning the Chinese language is or should be a comprehensive activity, one that involves the body as well as the mind. As Bloom (1956) emphasised, learning consists of cognitive, affective and psychomotor domains. Therefore, when designing their plan of instruction, Chinese-language teachers and instructional designers might do well to integrate different domains of learning into their curricula and pedagogical practice. Educators might not only provide learners with opportunities for drills and communicative practices and strive to improve their learning motivation but also incorporate bodily motor processes into language-learning activities.

According to some language researchers (eg, Naiman, Frohlich, Stern & Todesco, 1996; O'Malley & Chamot, 1990), those who use the greatest number of learning strategies can be considered good language learners. In the present study, these 'good' language learners, that is, those who tended to use the most learning strategies, also expressed the fewest positive attitudes towards the game-based learning program. On the other hand, learners who used fewer learning strategies did not exhibit either a clear preference for this program or a clear dislike of it. This finding

perhaps reflected the fact that (1) learners likely to use more learning strategies had a greater awareness of the range of possible ways to learn a foreign language, (2) game-based learning provided these same learners with a learning strategy that was neither appealing nor easy to use. For these reasons perhaps, learners likely to use many strategies articulated relatively few positive attitudes towards the program. By contrast, the learners with a more limited range of learning strategies may have had a relatively weak grasp of Chinese and may have been—for this reason—relatively open to or neutral towards the program. Both kinds of learners agreed that while learning the stroke order is important, repeatedly copying the characters via the traditional paper-and-pencil approach was a more familiar, down-to-earth approach for them.

The results of this learning-strategy survey have thrown some light on possible future directions for instructional designers. Compensation strategies were the most widely used by the nine participants, while memory strategies and affective strategies were the least widely used. According to Oxford (1990), compensation strategies help learners overcome their language–knowledge deficiencies, while learners use memory strategies to store and retrieve new information, and affective strategies to control or to moderate emotions. Recognising these individual differences, instructional designers should take into greater consideration the frequency-of-use level of different types of learning strategies when deciding which strategies to integrate into this game-based dynamic visualisation activity. In addition to supporting the most commonly used compensation strategies, instructional designers should seek ways to facilitate the least-used memory and affective strategies. Such facilitators include (1) unit-based organisation of learning materials, (2) a website-based review of materials to help learners remember what they have just learned, (3) encouragement of learners, (4) learner-anxiety reduction via an organised learning community where learners can share thoughts and express emotions related to their learning project. As researchers (eg, Cohen, 1998; Oxford, 1990; Rubin, 1987) have indicated, facilitating all types of learning strategies and processes, and providing learner support in foreign-language classrooms, can produce successful foreign-language learners.

A few limitations of this research project merit comment. There is a weakness in the program inasmuch as only a limited degree of learner control has been incorporated into it. Research studies (eg, Becker & Dwyer, 1994; Schnackenberg & Sullivan, 2000) have indicated that the amount of learner control in computer-based instruction can influence learners' motivation and performance. Future program designs will include more advanced Chinese characters and will categorise them into difficulty levels according to the number of the strokes. Furthermore, in future designs, the speed at which each stroke shows up on the screen will be under the learner's control. By integrating more elements of learner control into the program, its designers hope it can more fully meet the needs of each learner. Another limitation stems from the research design. Participant performance was not the primary focus of the study. Although none of the participants were very familiar with the Chinese characters before the study, they had different degrees of prior knowledge of the characters, making a rigorous comparison of their performance impossible. Also, the sample size was too small for the researchers to be able to generalise about the research findings. The program contained a limited number of Chinese characters, and almost all participants received full scores in the game: these facts make it difficult, if not impossible, to make significant competency-level distinctions. Other limitations came from the game-based online program. The program was unable to detect with perfect accuracy the participants' physical motions, and this was a significant limitation of the study. The technology created a kind of virtual stage; yet without a functional stage, whether virtual or not, an actor cannot perform to the best of his or her ability. In sum, the key factors underlying the efficacy of game-based learning are the instructional design, the content and the usability design. In order to create a more meaningful learning experience, the program needs a sounder pedagogical backbone, eg, the characterisation of social and collaborative participation as essential components in the learning program (Wenger, 1998); greater

breadth, depth and integration of content; and certain technological improvements, as indicated above. This study was an exploratory one. Future studies should include observations and interviews for data collection, in addition to surveys, on the use of Wii-like game programs for language learning, as well as for research into the effects that bodily motor processes have on character-learning among non-native Chinese-language learners.

Although future work is needed to expand on these findings, the present study does shed light on some non-native Chinese-language learners' needs regarding, in particular, the learning of stroke order for Chinese characters. Using knowledge of learners' needs and learning strategies, game designers can develop programs better able to teach language content effectively, and prove the value of 'edutainment.'

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