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SUPPORTING SENIOR CITIZENS USING THE INTERNET IN CHINA

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China has become the second largest Internet-using country in the world, but the percentage of use by those aged above 50 is extremely low, at less than 3.5%. Although there have been many studies conducted on Internet support methods, they have focused on support for children and working adults, not for the elderly. In this paper, we first investigate senior citizens' anxiety and needs to use the Internet as well as difficulties and obstacles they often face. Next, to ease their anxieties and satisfy their needs, we propose a system called the Senior Internet Support & Learning Environment. Finally, we demonstrate the system's usability. The implications of the study are valuable: it is based on the conditions of China and highlights the differences faced in China in comparison to overseas studies. Moreover, the proposed environment can provide Internet developers with a better understanding of the situation of local senior citizens with respect to the Internet, as well as a framework for further implementing the development phase for narrowing the digital divide in China.

Keywords: China; digital divide; Internet anxiety; Internet needs; senior citizens.

1. Introduction

China, the country with the largest population of senior citizens in the world, has 144 million persons aged 60 or older in 2005, and the proportion will increase from 11.0% in 2005 to 19.5% in 2025, even to 29.9% in 2050 (China NBS, 2000; 2005), making China one of the fastest aging societies in Asia.

The Internet has been developing rapidly in China. As of December 2005, 111 million people had gone online, making China the second largest Internet-user market in the world, behind only the U.S. (CNNIC, 2006). Although the Internet penetration rate is high among the younger generation, the majority of the elderly do not seem to use it. A recent survey (CNNIC, 2006) revealed that over 71.0% of those aged under 30 years use the Internet, whereas the percentage of use by those aged over 50 years old is extremely low, at less than 3.5%. For comparison, in Japan

the figure is 15% (aged 65 and over) (MPHPT, 2003), and 27.7% in America (aged 65 and over) (eMarketer, 2005).

The digital divide (Cho *et al.*, 2003; Chen & Wellman, 2003; Zhu & Wang, 2005), as in many other developing countries, has been a major concern in China, and is most noticeable along educational and age dimensions (Zhu & Wang, 2005). In China there have been many studies conducted on Internet support methods, but most focus on support for children and working adults, not for the elderly. Consequently, there are hardly any reports and research papers on senior Internet users, especially on Internet support methods for them.

The Internet has rapidly and dramatically changed the way people live and learn. In order to encourage and help more senior citizens to enjoy their lives in the Internet age, the following issues should be considered:

(1) What anxieties and needs do senior citizens have when using or preparing to use the Internet?
(2) What implementation strategies could be suggested to meet senior citizens' Internet requirements?

In this study, firstly, we conducted a survey (in Section 4) for senior citizens of their Internet anxieties, information needs, learning needs, and support needs. Next, based on the survey results (in Section 5) and discussion (in Section 6), we propose and implement an Internet support & learning environment for seniors (in Section 7), and finally demonstrate it (in Section 8). Relating to other research (in Section 2) in other countries, the implications of the research are valuable (in Section 3): It is a study based specifically on the conditions of senior citizens in China and highlights the differences from research undertaken overseas. Furthermore, it provides Internet applications developers, planners, and designers with a better understanding of the Internet learning and support needs of local senior citizens, as well as a reference for further implementing the development phase for narrowing the digital divide in China.

2. Related Studies

2.1. *Internet anxiety*

One factor that inhibits Internet usage is "Internet anxiety," a concept that Presno proposed in 1998. Not surprisingly, people are expected to avoid behaviors that arouse nervousness. A number of studies have demonstrated a relationship between Internet anxiety and the use of the Internet. Before the Internet had widely been connected to standalone computers, a lot of careful research had been done on computer anxiety. One view of the relationship between computer anxiety and Internet anxiety is that Internet anxiety is actually a component of computer anxiety, since the Internet is usually accessed through a computer. However, some studies (Presno, 1998; Umeda *et al.*, 2005) analyzed the relationship between the two kinds of anxiety and concluded that since the Internet is a virtual world with virtual emotions, there

may be a point where the two types of anxiety diverge. We also think that there are factors unique to Internet anxiety that is not included in computer anxiety, so in our study we mainly consider Internet anxiety.

Although studies on Internet anxiety are abundant, the majority of them use college students as samples (Chou, 2003; Wada, 2003; Umeda *et al.*, 2005; Joiner *et al.*, 2005), or those based on the general public or employees in companies (Zhang, 2005; Tu *et al.*, 2005). However, there are few studies aimed at senior citizens, especially in China. The purpose of this paper is to investigate Internet anxiety as experienced by senior citizens and discuss the methods and solutions to ease it.

2.2. *Internet support methods*

Since current websites are deemed twice as difficult for seniors to use as they are for younger users (Coyne & Nielsen, 2003), it is necessary to put more emphasis on making the Web more usable for older people. There are some movements: JIS X8341 (JIS, 2004) is a guideline on information and communications equipment, software and services for seniors and people with disabilities; The term "usability" was defined in ISO9241 (ISO, 1995), and currently the ISO is developing a new standard for Web usability; WCAG (Web Content Accessibility Guidelines) was developed by W3C (W3C, 1999), which explains how to make Web content accessible to people with disabilities and to seniors. Based on these guidelines, many studies (Cockburn & Jones, 1996; Browne, 2000; Becker, 2004) aim to make the Internet and Websites easier to use.

The Web browser tool is another important factor, as Cockburn and Jones (1996) point out, since the browser is present on every page accessed. This means even relatively minor flaws can be exaggerated into serious usability problems by the frequency with which they are encountered. Therefore, many new browser tools (Dickinson *et al.*, 2005; Goto *et al.*, 2005) are being developed and designed for senior citizens and those who have difficulty operating conventional Web browsers.

To encourage more senior citizens to enjoy the Internet, besides the technology support mentioned above, social support methods, such as offering training programs to the general public and establishing community-wide public-access computer facilities, had been planned and implemented by government, non-government organizations, and non-profit organizations in several countries in recent years. Japan, which is predicted by 2008 to have a super-aging society never seen before in the world (above 21% of the population), is focusing on realizing a convenient and satisfactory life without disparities for senior citizens and disabled persons under the "e-Japan strategy." One of our former studies: "E-namokun" project (Zhou *et al.*, 2006), which provides a comprehensive social support environment comprising recycled PCs, learning courses, call center support and PC consultation, was developed through a collaboration among sixteen local lifelong learning centers, two universities, and one NPO cooperation, which is a national first in Japan. Besides actual society, some virtual society Websites in US and Europe have been

established to provide a digital community for senior citizens to communicate and find information. One of the largest Websites for seniors in the world is SeniorNet, which has benefited millions of seniors since its founding in 1986, is supported by over 240 learning centers throughout the US and in other countries, and collaborates in research on senior citizens and technology.

3. Approach

As a developing country, although the economic reforms have brought economic growth with great speed to China, we must not forget that there is a wide gap between it and other countries and it is vital to strengthen the development of the social foundation and narrow this gap. Moreover, China's population is enormous and it is practically impossible to provide every citizen with sufficient support from public facilities, especially for senior citizens who are equated with being old, unproductive and incompetent, often becoming the forgotten group (Ministry of Civil Affairs of China, 1996). Therefore, we claim that, different from other countries, the support methods for senior citizens in China should consider not only the support from the social foundation but also the effect on senior citizens' self-improvement and support from the circle of their friends and family. That is, besides real social support foundation, a web-based environment including self-learning and support from virtual world is also needed.

Some countries such as North America, Europe and Japan, have recognized Internet anxiety, developed many Websites specifically for senior citizens, and brought a social foundation to maturity. However, such work can hardly be found in China, nor has much research effort been expended in this field. Therefore, it is significant to conduct this research and find a suitable solution to easily using Internet for senior citizens in China.

The main aim of this study is to determine Internet anxiety and Internet needs of senior citizens, and then propose a system to ease anxiety and satisfy the needs to help them enjoy the Internet. Therefore, the study's approach includes:

(1) A survey of Internet usage status for seniors;
(2) A system to simplify Internet enjoyment for more seniors basing on the survey results; and
(3) A demonstration to verify the system.

The survey and the proposed system will provide Internet applications developers, planners, and designers with a better understanding of the Internet learning and support needs of local senior citizens. The demonstration can give a reference for further implementing the development phase.

In the study, research participants are seniors who are either Internet users or who want to use Internet in the near future. Most developed countries accept the chronological age of 65 years as the definition of "elderly," and the United Nations (UN) criterion for being "elderly" is 60 and above. However, in the study, considering

that in some areas of China the actual retirement age year has been brought forward to 50 (for females) and 55 (for males), we deemed it necessary to consider those people, both retirees as well as pre-retirees, who want to gain a wider perspective as they are approaching retirement soon and their responses will reflect future needs of senior citizens. Hence, the intended subjects of the survey and demonstration were those aged 50 or more.

4. Survey

4.1. *Questionnaire design*

The questionnaire used to gather data for this study, which comprises 6 sections and 24 questions, is explained as follows:

Section I. Demographic Information: This section consists of three questions pertaining to the respondents' background information including gender, age group, and family status. We have not used educational background and income questions because all our respondents lived in the city and were not remarkably different in these two aspects.

Section II. Physical Health Condition: Age-related disability was identified as one of the main barriers to adopting the Internet. This section comprises three questions aimed at understanding the subjects' physical health condition, including "eyesight," "precision of movement," and "memory and understanding" (Coyne & Nielsen, 2003). Since senior citizens' perceptions of their own health conditions are critical to their willingness to be involved in social activities, their answers are in fact their self-perception of their physical health condition. The rating scale is "good," "satisfactory," and "poor."

Section III. Internet Usage and Experience: This section covers six questions concerning the senior citizens' Internet usage and experience, such as: online experience, Internet usage frequency, primary purposes (multiple selections), major online activities (multiple selections). For clear comparison of our results with those of other studies, the answer items used are the same as in the CNNIC survey.

Section IV. Information Needs: Questions in this section are used to gather the information needs of the senior citizens. There are two questions: "What kind of Internet information do you like to read?" and "How do you find useful Websites containing this information." The list of response choices was considered with various other studies (MPHPT, 2003; Chong & Theng, 2004; Zhou *et al.*, 2006; CNNIC, 2006).

Section V. Internet Anxiety: The first part in this section lists the aspects that Internet users are most unhappy with when using an Internet browser and Websites. The second part concerns Internet anxiety. The question items were referred to in other studies (Wada, 2003; Umeda *et al.*, 2005), and considering the aspect of senior citizens, at last eight question items were decided from these studies. All question

items were scored on a five-point Likert-type scale from "totally agree" scored as 5 to "totally disagree" scored as 1.

Section VI. Support and Learning Needs: Questions in this section are used to gather information on the support and learning needs of the senior citizens who are using Internet or plan to use it. The questions relating to support are: "When encountering a problem, what kinds of support do you want?" and, "Do you feel anxious when receiving such support?" In the learning part, subjects were asked whether they want to learn more Internet knowledge and about obstacles they have met. The response would determine whether the senior citizens held positive or negative feelings toward the Internet. The options for reasons were based on the various findings on the main barriers against Web adoption by the senior citizens.

4.2. *Subjects*

In the survey, most of the participants are living in Shijiazhuang city, the capital of Hebei province, whose Internet usage percentages of local population, domain names and Websites are somewhat average level in China (CNNIC, 2006). The participants were reached through two channels:

(1) The first channel consisted of senior citizens from Hebei Senior University, an informal university organization open only to senior citizens. Established in 1987, it provides a variety of learning courses, lectures, services and benefits to promote the continued growth and development of retired senior citizens.
(2) The second channel was parents of the authors' acquaintances. For comparison, none of them have participated in any social learning organization to take any courses.

4.3. *Data collection and analysis*

It was crucial that the questionnaire format and wording were designed in ways that could be easily understood by senior citizens. To ensure the questionnaire speaks the user's language, a pilot survey (five seniors) and interview (two seniors) were conducted before the actual questionnaire was administered. Based on the feedback from the pre-test, several modifications were made.

Data collection was conducted from January 15, 2006 to March 30, 2006. Participants could answer on a printed questionnaire sheet, or by visiting the homepage we developed for this survey. In total, 103 valid questionnaires (76 on paper and 27 on the homepage) were obtained. We appreciate the organization's (Hebei Senior University) dedicated work: 52 questionnaires in total were collected. The remaining 51 participants received detailed explanations and individual guidance by supporters (authors and acquaintances), providing useful data from their questionnaires. All of the questionnaires were carefully checked and their validity was confirmed.

Of the 103 questionnaires returned, 22 were from non-Internet users, so Secs. 3, 4, and 5 were not answered by them. The other 81 were Internet users and completed the forms fully. The results comprised a mix of both genders, with 59 (57.3%) of males and 44 (42.7%) of females. These subjects were aged from 50 to 55 with 29 (28.2%) of the total, 23 (22.3%) were 56 to 60, 25 (24.3%) 61–65 years old, 18 (17.5%) 66–70 years old, and 8 (7.8%) were over 71 years old. In addition, 34 (38.6%) lived with their family, 26 (29.6%) lived with their spouse and in a tight relationship with their family, and 28 (31.8%) lived with their spouse. When asked to rate their own physical health condition, above half the respondents thought of themselves as having "satisfactory" health.

A descriptive statistical analysis was carried out on the raw data using an MS-Excel spreadsheet and the statistical software SPSS. Incomplete questionnaires were included in the analysis whereby missing data was ignored. This was because the omitted questions only comprised a small portion of the entire questionnaire and the available data could provide valuable information from the research questions.

4.4. *Limitations of the survey*

There are several limitations to this survey. First of all, participants sampled all lived in the city, meaning country users were not considered. Furthermore, a convenient sampling approach was used instead of random sampling, so it was hard to determine the probability that any particular population element has been included in the sample. Finally, the proportion of the sample from Hebei Senior University was 50.5%, resulting in a positive influence on the learning willingness aspect. Nevertheless, the data collected in this study provided some useful insights into the support and learning methods for senior citizens, and could serve as inputs for a more comprehensive survey in the future.

5. Survey Results

5.1. *Internet anxiety*

Regarding Internet anxiety, we used eight question items that 78 users answered. All question items were scored on a five-point Likert-type scale from "totally agree" scored as 5 to "totally disagree" scored as 1. To investigate the scale's factor structure, we conducted a series of exploratory factor analyses using Promax rotation on those eight items (KMO = 0.698, $p < 0.001$). As a result, the following three factors were elicited (Table 1):

$F1$: "Internet ability anxiety" (questions 1, 3, 6, 8) was interpreted as the factor related to a lack of Internet knowledge and ability to search for or select appropriate information (Cronbach's alpha = 0.762);

Table 1. Result of factor analyses for Internet anxiety.

Question Items	Mean	SD	$F1$	$F2$	$F3$
1. I become uncomfortable when hearing technical terms about Internet.	4.16	0.97	.672	.197	.065
2. I become uneasy that I cannot find trusted information.	3.68	0.97	−.146	.831	.277
3. The Internet has too much information and I become irritated.	3.97	0.99	.764	−.028	.201
4. I become uneasy that personal information may leak onto the Internet.	3.90	1.17	−.027	.885	−.165
5. I become uneasy that the computer will become infected when using the Internet.	4.32	0.97	.242	.703	−.077
6. If something happens, I will get into trouble because I won't know how to resolve the problem.	4.14	1.02	.935	−.122	.101
7. I want to obtain information from paper sources rather than from the Internet.	2.24	0.88	.192	.021	.931
8. Since the Internet is progressing rapidly, I worry that I will be left behind.	4.10	0.97	.625	.013	−.429
Mean			4.09	3.97	2.24
SD			0.75	0.85	0.88

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.
The higher the mean scores, the higher the anxiety.

$F2$: "Internet reliability anxiety" (questions 2, 4, 5), was interpreted as the factor relating to strain and anxiety in exchanging information on the Web, such as viruses, security and privacy (Cronbach's alpha = 0.757);
$F3$: "Internet acceptability anxiety" (question 7) was interpreted as the factor dealing with social acceptability.

From the table we can say that senior citizens have more "Internet ability anxiety" (Mean = 4.09) and "Internet reliability anxiety" (Mean = 3.97). However, we found they have less "Internet acceptability anxiety" (Mean = 2.24), which means most respondents consider it was as common an occurrence to obtain information from the Internet as from other medias such as newspaper.

A Pearson's correlation test showed that there was a positive relationship between the "ability anxiety" and "reliability anxiety" ($r = 0.49$, $p < 0.05$). It is easy to understand that seniors who had little prior Internet knowledge or ability will easily experience reliability anxiety. However, the correlation of "ability anxiety" to "acceptability anxiety," and "reliability anxiety" to "acceptability anxiety" was extremely low. It may be explained that in spite of low Internet ability and unreliability of the Internet, seniors have accepted the Internet as a familiar part of modern society, and would like to face the challenges the Internet presents.

Moreover, we conducted one-way ANOVA to analyze the Internet anxiety factor among users for different attributes. We found that there were no statistical

differences between males' anxiety factors and females' factors, though the females' scores were higher overall than those of males. Furthermore, no statistically significant difference was found among different age groups. The relation between health and Internet anxiety were also analyzed. We found that there were no differences between people with good health and those with poor health regarding "reliability" and "acceptability" anxiety, but in terms of the "ability anxiety" factor, there was a very large difference between them. People with good "eyesight," ($F = 6.15$, $p < 0.01$) good "precision of movement," ($F = 6.03$, $p < 0.01$) and good "memory and understanding" ($F = 4.32$, $p < 0.05$) felt less "ability anxiety" than people with poor health.

The participants were from two groups. The one from Hebei Senior University had a variety of courses (Note: learning courses are varied and not limited to Internet/Computer courses) but once a course is chosen the learners follow a fixed schedule, while the other group did not attend any learning course with other people. The results ($F = 10.25$, $p < 0.01$) indicated that those actively participating in courses at social facilities expressed less "Internet ability anxiety" than those who did not. This result suggests that social and public communities have a positive effect on easing senior citizens' ability anxiety. In terms of reliability and acceptability, there was no statistical difference between the groups.

We also analyzed the Internet usage frequency and usage experience (long user or short user) among the users. The results showed that the more time spent on the Internet, the more pleasure users had from it ($F = 3.39$, $p < 0.05$). There was also a reduction in Internet anxiety ($F = 2.81$, $p < 0.05$) deriving from more use. Moreover, users who had more than one year of Internet experience ($F = 6.72$, $p < 0.001$) had more desire to use Internet than those who had little Internet experience.

When asked the question, "Do you want to learn more Internet knowledge or not?" 84.1% answered "yes," strongly indicating that most users had positive feelings toward the Internet. We tested there was no statistical difference between users who answered "yes" and "no" in terms of the three anxiety factors, nor were there statistical differences between senior university participators and others who were not.

In summary, senior citizens have "Internet ability anxiety" and "Internet reliability anxiety", especially those suffering poor health, those who do not attend social facilities, and Internet novices. However, despite these points, they did consider that they would like to obtain information from the Internet just the same as from other media sources. Furthermore, most of them want to learn more Internet knowledge to be able to face its challenges.

5.2. *Internet needs*

5.2.1. *Information needs*

To identify the Web-based information needs of senior citizens, we examined three related factors based on the questionnaire responses. These are (1) Topics of

interest: Web information that senior citizens would like to know more about; (2) Information-finding methods: How to find useful Websites and information sources; and (3) Internet services: services commonly used by senior citizens. All these were multiple-choice questions, with 88 users answered them. The results are listed in Table 2.

Regarding the topics of interest of senior citizens, the most popular topic was news (71.59%), just like for other age groups from the CNNIC survey results, but the topics of shopping, finance, and fashion were lower than those of other generations. The most interesting find is that learning/reading (27.27%) is higher than the average level (CNNIC 9.1%), which means that senior citizens want to learn more things in their leisure time.

As for the factor of information-finding methods, unlike other generations, who use Internet keywords and directory search functions in the majority, senior citizens would rather get recommendations of useful Websites or information from friends, family, and acquaintances (54.55%). These results suggest that there was some association between the respondents' Internet competency and the information-finding methods.

As for the factor of Internet services, overall the respondents' main uses of the Internet were to seek information and surf the Net (84.09%). They also used email (29.55%) and chat (19.32%). This demonstrated that senior citizens also want to communicate with others online to enrich their lives during retirement.

Table 2. Topics of interest, Internet services and Information-finding methods answered by senior citizens.

(1) Topics of Interest

News	Health	Amusement	Gov't/Society	Food	Learning/Reading
71.59%	65.91%	39.77%	32.95%	30.68%	27.27%
General	Weather/traveling	Fashion	Shopping	Finance	
17.05%	12.50%	7.95%	5.68%	5.68%	

(2) Information Finding Methods

Hear from friend, family and acquaintances	54.55%
Use the keyword search function (such as Google, Baidu)	50.00%
Save favorite and frequent Websites in the computer	26.14%
Hear from television, newspapers, and advertisements	22.73%
Use the directory function (such as Yahoo directory)	13.64%
Other	1.14%

(3) Internet Services

Browser	E-mail	Chat	Net Phone	Net Game	Online Movie	Net Shopping	Blog	Other
84.09%	29.55%	19.32%	14.77%	12.50%	7.95%	5.68%	4.55%	3.41%

5.2.2. *Learning needs*

The results also revealed that 84.1% of the senior citizens surveyed want to learn more Internet knowledge. When asked about which factors were obstacles, 97.09% answered that there were many factors that disturb learning. The main reason was health (69.90%) because the ability of memory and understanding typically deteriorate. From the second reason: " There are no suitable learning materials," (39.81%) we convinced that developing learning materials considering senior citizens needs and physical attribute is necessary thing to promote learning. Besides it, the lack of social learning courses (30.10%), social facilities (30.10%), and guider/instructor (33.01%) were very serious reasons.

5.2.3. *Support needs*

(1) Web Interface Design

As for Web interface design and usability, users had some complaints such as the flickering words and pictures that easily cause weariness (30.23%), the font size is too small to see (26.16%), there is too much content on one page (23.26%), the Web links are not easy to distinguish (11.63%), and so on. Therefore, it is necessary to put more emphasis on usability and accessibility design to change the current layout of Web pages and make it easier for older people to understand.

(2) Internet Browser Tool

Of the 78 people who answered the questions on this topic, 85.89% used IE (Microsoft Internet Explorer) as the Web browser. They met several difficulties such as: 1. there are too many unused functions (59.26%); 2. the pointer is too small to find easily (24.07%); and 3. the buttons are too small to operate (15.74%). These replies indicate that conventionally designed browsers are likely to create additional problems for seniors. It is necessary to note that aging is associated with a narrowing of the visual field and slower movement, so the interfaces designed for seniors should take into account these attributes.

(3) Social Support Method

To identify which support methods are suitable for senior citizens in China, two questions were asked, with 94 users answering (Table 3).

Regardless of whether their lifestyle involves living with their family or not, most seniors still want support from their family and friends. One reason is that since service costs are higher, seniors would rather obtain support from family and friends rather than from computer companies. On the other hand, they worried somewhat that this may impose on others. Meanwhile, they also worried that they could not find a suitable guide to solve their Internet-related problems, thus they would be in a bind when new difficulties arise. Some of these senior citizens, consequently, would like to choose to learn and find solutions by themselves. Therefore, we claim that the support method for senior citizens in China should consider the effect of senior citizens' self-learning and support from a circle of their friends and family.

Table 3. Questions and answers in terms of support needs.

Question 1: Which support methods do you want?	
Support from family and friends	94.68%
Learn and find solutions by self	28.72%
Support from a public facility	24.47%
Support from a computer company	15.96%
Others	2.13%
Question 2: Is there anything to worry about when using the support methods?	
I cannot know which expert can solve my problem fast	58.51%
I worry whether new problems will occur.	43.62%
The service cost is high	40.43%
I fell it will bother others	38.30%
I fell it will take much time	26.60%

6. Discussion

In this section, we discuss the survey results and give solutions to help senior Internet beginners use the Internet. The findings of our survey and analysis revealed the following:

- Senior citizens experience "Internet ability anxiety" and "Internet reliability anxiety," especially individuals with poor health, those who do not visit social facilities, and Internet novices. However, most still want to gain more Internet knowledge and face its challenges;
- Senior citizens have special information, learning, and support method needs. Also, they tend to encounter significant obstacles including the difficulty of finding useful sites, trouble using browser tools, unfriendly Web interface design, and the limitations of existing support methods.

A lack of learning experience and support methods increases the likelihood that older adults will have negative experiences, which is a significant factor in Internet and computer anxiety (Todman & Drysdale, 2004). Conversely, more encouraging experiences and effective support engender a more positive attitude to computers and the Internet (Danowski & Sacks, 1980; Morris, 1992). In the section, we discuss two aspects of the findings: learning and support. "Learning" can improve ability, and "support" can reduce access difficulty. By integrating both learning effects and support functions, more people can be helped to enjoy their lives in the information age.

6.1. *Learning environment for senior citizens*

Our most interesting finding is that senior citizens have a positive attitude toward learning about and using the Internet even though they have experienced Internet anxiety and obstacles. In the survey, 84% participants answered "yes" to the question, "Do you want to learn more about the Internet?" We also interviewed some

participants about their motivation for learning and using the Internet. Answers varied: "It is very interesting, and it can enrich my retirement;" "I am trying to communicate with my young family living in another country;" "I do not want to be helpless in the information age," and so on.

Society continues to advance as technology enters the mainstream and Internet use becomes commonplace. The value of Internet use, especially as it relates to enhancing the quality of life and satisfying special needs, is becoming an important matter in people's minds. Senior citizens are no exception (McMellon & Shiffman, 2002; White *et al.*, 2002; Saunders, 2004). Moreover, there is also evidence that computers and the Internet can contribute to positive physical health. Using the Internet to interact with others may help reduce loneliness, pain, the amount of medication needed to treat ailments, and even the rate of suicide among seniors (Philbeck, 1997). Some surveys (MIC, 2000) reported that one of the main incentives for senior citizens to use the Internet was to maintain their health.

Survey results showed that the greatest anxiety of Internet use by the elderly is technophobia. In China, the Internet age is less than 10 years old, and especially the last 4–5 years Internet access speed and construction have exploded. Elder people rarely had computers and Internet environments in their workplace when they were younger, and they are also significantly more likely to be inexperienced computer users. Moreover, senior learners have special needs that differ from other generations. They need slow paced, low intensity training and often prefer self-paced learning (Terry & Josie, 2004). They also want clear and explicit instructions designed to accommodate age-affected sight, hearing, and mental agility (Terry & Josie, 2004).

Many studies (Madden *et al.*, 2005; Hsu *et al.*, 2003) have proven that the Internet is a valuable source for learning and teaching materials in various courses in formal educational settings and that more and more teachers are using it in their classes. Such web-based learning systems as WebCT and Blackboard have been developed recently and introduced into more and more universities. Also, some studies have demonstrated the valuable results of using the Web to improve seniors' information literacy ability (Oermann *et al.*, 2003; Ilana *et al.*, 2005; Campbell & Nolfi, 2005). Therefore, Internet literacy ability improved not only through traditional education in schools but also using Internet-based learning methods and communicating with shared knowledge (NRC, 1999).

6.2. *Support environment for senior citizens*

In addition to supporting web-based learning for senior beginners, we also argue that other aspects need to provide appropriate and comfortable support. Analysis results showed the following barriers to senior Internet access: the difficulty of finding useful sites, trouble using browser tools, and limitations of existing support methods when meeting problems.

Information is not scarce, and most people already suffer from too much information on the Web. To address the barriers of finding useful sites, offering a navigator method (Zaphiris & Kurniawan, 2001; Bernard, 2000; Goto *et al.*, 2005) is necessary to conveniently introduce sites to find the information seniors want to see, especially in the beginning when they are not familiar with the Web. A well-constructed taxonomy will help users quickly and accurately locate the desired information, and a badly constructed taxonomy might waste time and effort without obtaining the desired information (Kanerva *et al.*, 1999). Based on the survey results of information needs (see Section 5.2.1) for seniors (that are unlike other generations), we believe that the navigator will play an important role to support finding useful information in the information sea.

The browser tool is other factor that affects Internet use. Current browser designs are particularly detrimental to the ease with which older adults "consume" information from the Web (Dickinson *et al.*, 2005). To address this barrier, a browser tool for seniors should be considered.

The limitation of existing support methods is another prominent barrier for senior citizens. In recent years, such public learning centers for seniors have developed in China, so real learning and support communities should be considered. Survey results also showed that public service facilities positively affect Internet usage. In addition to offline social communities, a web-based senior community site should be built that can ease senior worries when seeking support. Some cases, such as SeniorNet in USA and Senior Net Club in Japan, have demonstrated that web-based communities are useful methods to support seniors by resolving problems by communication among seniors.

In China, seniors' family and friends are crucial factors to help solve Internet questions. The survey showed that 94.68% of seniors need support from them. Therefore in a web-based community, younger volunteers who function as supporters are necessary. Further, retired seniors have more free time and lighter family burdens than before. Many seniors have potential wisdom concerning learning and using the Internet and greatly understand their status, so the community should also consider the power of seniors. Through the community environment, collected knowledge can be shared, well organized, and easy to access and understand.

In summary, more senior citizens must be encouraged to use the Internet, but to do so is necessary to provide support and a learning environment that can ease their anxiety and satisfy their needs. A total environment is necessary that not only includes a learning aspect but also a support aspect, such as a virtual community to communicate and get solutions, an information navigator to get suitable information, and browser tools for senior citizens that offer easy Web access. With Internet development, more and more useful services will be used, such as e-mail, chat rooms, downloads, net shopping, etc. The environment must be designed to be open so that new parts can be easily assembled at the foundation.

7. System Design and Implementation

Based on the discussion above, we propose a model called the "Senior Internet Support & Learning Environment" (Figure 1). It is comprised of four parts that are explained as follows:

(1) Web navigator site for seniors
From the survey results of information needs, the Internet information needs for senior citizens are different than other generations. Seniors also have required special methods for finding information, which explains to a certain extent that current directory websites are neither popular nor entirely suitable for seniors. We suggest building a Web navigator site especially for seniors. Directory structures are based on the survey results of Internet information needs. The navigator should also have a keyword search function because this search method is used most by senior citizens. Furthermore, because most seniors would like to receive others' advice on Internet information searching, the Web navigator should also provide a free space where users can upload their favorite site links and obtain or give advice about these links.

(2) IT learning site for seniors
We aim to provide senior citizens with an easy way to understand and access learning materials. To improve access, an online learning site is necessary. To minimize ability requirements and reliability anxiety, the learning content must focus on Internet foundation knowledge, popular Internet terms, search ability, security, and anti-virus knowledge. It is worth considering content understandability so that seniors, whose memory and comprehension often fades with time, can easily grasp the knowledge.

(3) IT community site for seniors and supporters
By providing a virtual and easily accessible space, in the IT community site seniors can ask any conceivable question while using the Internet, and supporters can discuss, answer, and provide suitable solutions to share knowledge and wisdom. The supporters include younger volunteers, IT related teachers, and seniors with higher Internet literacy.

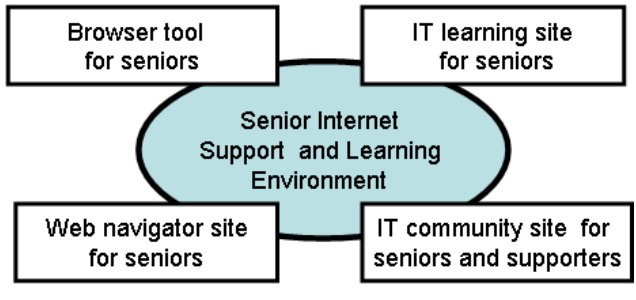

Fig. 1. Senior internet support & learning environment.

(4) Browser tool for seniors
Survey results showed that the browser tool is other factor that affects Internet use. A browser tool for seniors should consider "eyesight" and "precision of movement" to simplify Internet browsing for seniors.

The four components are not isolated; they are closely related to one another and form an integrated environment. First, the design of each must follow identical guidelines: usability and accessibility for seniors to simplify use and reduce anxiety. Design guidelines include visibility and operation improvement, and consideration of cognitive factors. Next, the information must be linked among the three Websites. That is, information generated by one site should be reused for other site. For example, if a word or phase appears in a community site, it should be given a link to an IT learning site to provide a suitable and complete explanation to ensure that seniors understand and thus actively participate in community sites. Finally, the content of the three websites should follow two select criteria:

(1) Content should ease Internet anxiety.
(2) Content should satisfy what seniors want to learn and provide support for it.

Based on these, the environment can be viewed as useful and necessary for senior citizens to learn and get support when using the Internet.

7.1. *Function design*

The real challenge of developing the system was hiding the complexity of the functionality. Companies selling commercial software normally emphasize the new functionality that it offers and measure success in terms of the new options being offered. One of the most difficult processes during system development was recognizing when our preconceptions about what was 'necessary' for the environment allowed complexity to seep into the interface designs.

Based on survey results and the model, we built a prototype system with four subsystems (Figure 2). Users can download the *browser tool for seniors* and put it on their computer's desktop. The tool's home site is turned to the Web server, where the *Web navigator site*, the *IT community site*, and the *IT learning site* are located. The four systems' functions are listed below:

• Browser tool for seniors (see Figure 3).
We developed a browser tool that focuses on the Internet Explore (IE) difficulties we surveyed (Section 5.2.3): too many unused functions, a pointer that is too small, a button too small to operate and so on. To avoid confusing senior users due to the excessive functions, the developed browser tool is designed with basic browser buttons: forward, backward, stop, home, and exit, all of which are listed on the left of the interface. We also designed a "functions" button. When clicked, more function buttons are displayed under the "functions" button, as the picture on the left shows, including enlarging font size, reducing the size, adding to favorites, showing

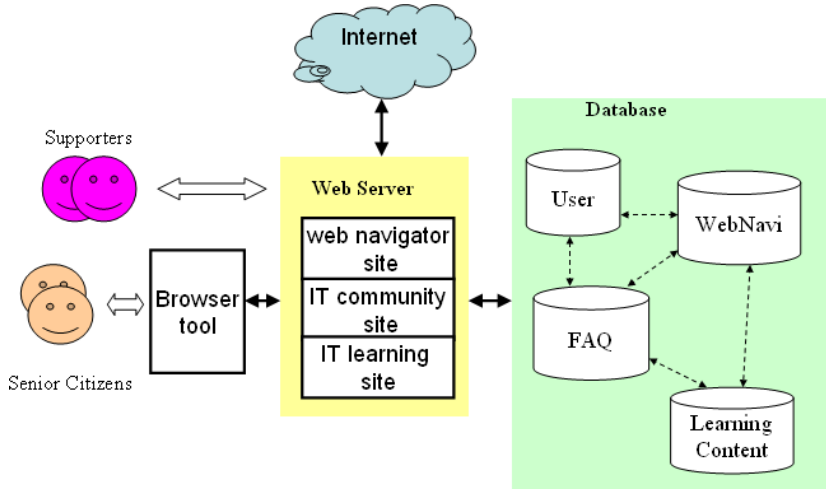

Fig. 2. System structure.

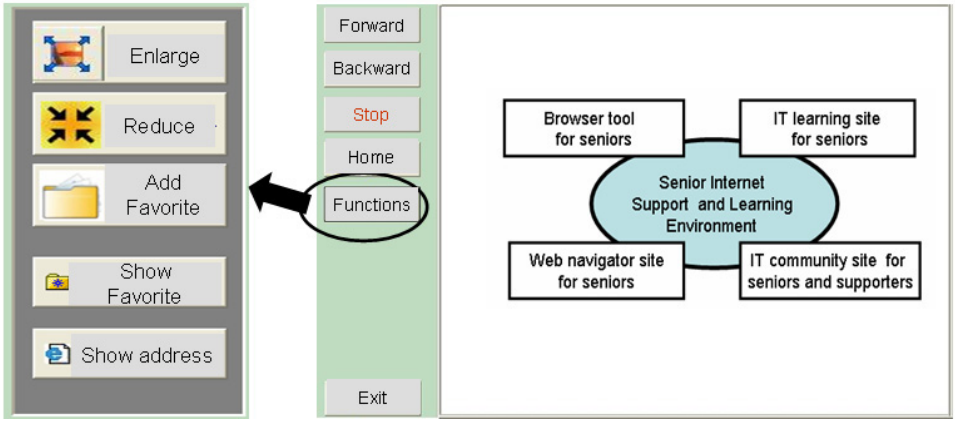

Fig. 3. Image of browser tool for seniors.

favorites, and showing address. Since these functions are not used frequently, they are designed to be hidden when the browser is opened. Moreover, the pointer is bigger than a normal IE's pointer.

• Web navigator site for seniors (see Figure 4).
We decided the taxonomy based on the survey results listed in Section 5.2.1 and also referred to other studies (Zaphiris & Kurniawan, 2001; Goto *et al.*, 2005) and public directory services websites (Yahoo, Baidu, etc.). We investigated and selected websites that contained highly relevant information for seniors. Users can reach a selected website in only three steps: choose the first level categories (picture 1 in

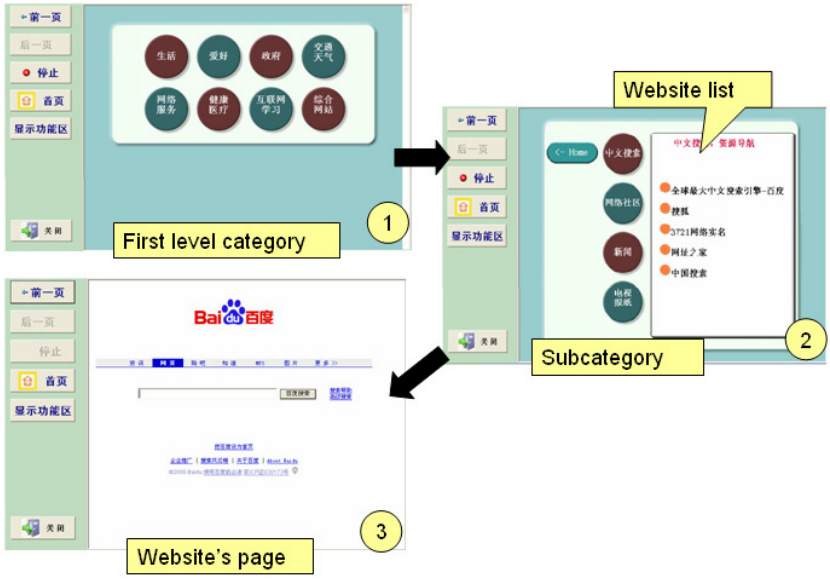

Fig. 4. Image of Web navigator site for seniors.

Figure 4), and then the subcategories interface is shown (picture 2), and select one website title under the subcategories, the selected website show (picture 3). The selection process is very simple, and the websites' contents are very suitable.

• IT learning site for seniors (see Figure 5).
We focus on content understandability so that seniors, whose memory and comprehension often fade with time, can easily grasp the information. From the learning contents' list page, users can select the contents they want to learn. If there is unclear technology, users can click to a new page that describes the word in detail and is easy to understand.

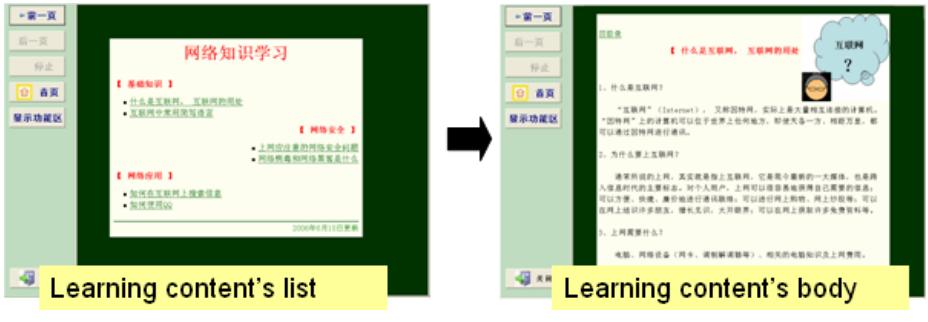

Fig. 5. Image of IT learning site for seniors.

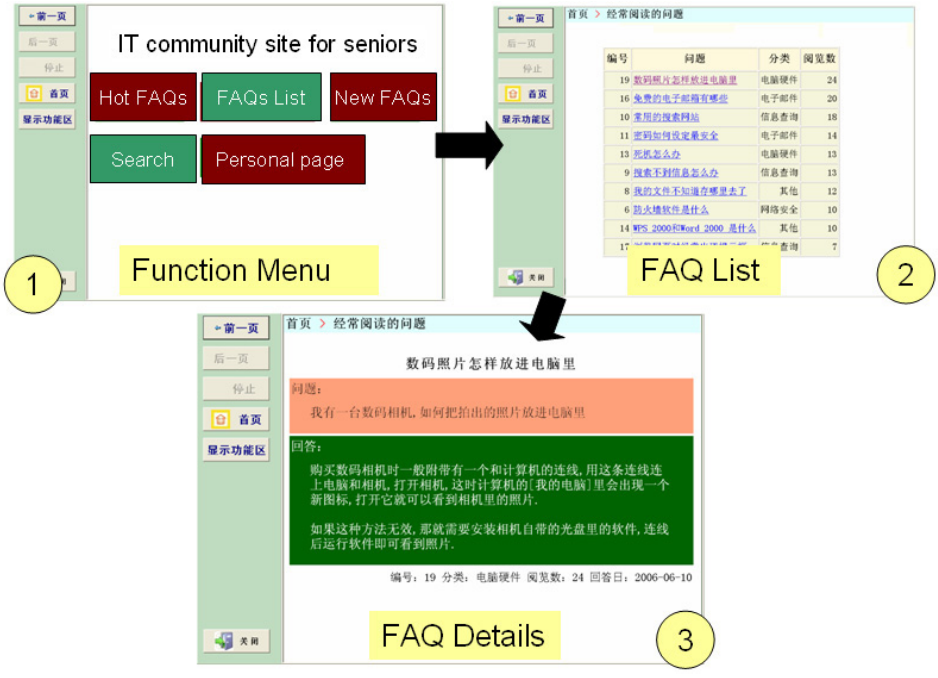

Fig. 6. Image of IT community site for seniors and supporters.

• IT community site for seniors and supporters (see Figure 6).

An IT community site concerns Internet questions and their solutions. Figure 6 shows the usage process for users. The picture 1 is the function list of frequently asked questions (FAQ) including views of FAQs by category, by date, by access number, and search. In order to let seniors easily find the solutions they have read before, we developed a "personal page" function in which read FAQs can be automatically saved. The picture 2 is the selected FAQ list, and the picture 3 is the FAQ body. All FAQs are well categorized so that users can easily find them.

Moreover, four databases, which were designed for relevant subsystems, are listed below:

- *WebNavi*: includes categories, subcategories, website's URLs, and a short description.
- *User*: includes login information for senior users and supporters.
- *FAQ*: includes the questions and their solutions. It also has access statistics that help show the most common questions.
- *Learning Content*: includes learning texts that can be easily understood by senior users. A dictionary matching seniors' language with Internet terms is also provided (Zhou *et al.*, 2006).

7.2. *Interface design*

Inappropriate interface designs are a fundamental barrier to digital inclusion: older adults find standard interfaces harder to use than younger adults, even they have computer experience (Worden *et al.*, 1997; Chadwick-Dias *et al.*, 2003). We designed the Interface based on Interface usability (Nielsen, 1994), which has five main aspects: learnability, efficiency, memorability, errors, and satisfaction. Moreover, in relation to the attributes of aging, eyesight, precision of movement, memory, and understanding typically deteriorate. If we do not consider these attributes when designing interface guidelines for seniors, they will not use the system. So we followed the design guidelines (Coyne & Nielsen, 2003; Zhou *et al.*, 2006) listed below to simplify websites for seniors:

(1) Visibility improvement: We enlarged the characters, buttons, and pointer, and chose a color for the characters and background that is easily distinguished. Moreover, the color changes when a button is clicked, so users can immediately confirm the operation.
(2) Operation improvement: To avoid missing an operation, we put more intervals between the buttons, and scroll movement is replaced by a button click. Complex and multi-operations are simplified by a single click. To avoid situations where users are distracted, we do not use pop-up windows.
(3) Consideration of cognitive factors: We aimed for a simple interface that only included the necessary, minimum functions, limited the number of buttons to eight, the hierarchy of depth to four, and the result list to ten. Moreover, the "Topic Path" is always shown at the top of the main body so that users will not get lost while browsing. In addition, we replaced technical terms with familiar expressions.

8. Evaluation

To demonstrate the system's usability, we did a demonstration test at Hebei Senior University in China. In 2004, the university built a computer room with 30 machines and began to provide computer and Internet literacy courses to the public, especially senior citizens. The Internet literacy courses were both basic and advanced. The demonstration we conducted was a basic course that ran from March 1 to June 1, 2006 and consisted of 17 two-hour lessons. Students were retired persons aged 50 to 70 whose aim was to gain skills rather than qualifications. The textbook in the course was designed for Internet beginners. We did the demonstration on June 14, 2006 (Figure 7). 24 participants used the proposed system, and 19 answered questionnaires. 8 ranged from 50 to 60 (42.1%), and 11 were from 61 to 70 years old (57.9%).

Since gathering suitable experimental data was necessary before conducting the usability testing, we interviewed two teachers who took charge of the Internet courses for seniors. As a result of the interviews, 14 frequently asked questions and

Fig. 7. Demonstration in progress.

detailed answers were prepared for an "IT community site" into which were put six learning materials on internet viruses, security, Internet searches, and introduction to common software.

We investigated and selected websites that contained highly relevant information for seniors. These sites were selected based on the amount of reliable and useful information they contained. Eventually nearly 150 website links were put into eight top categories and 30 subcategories for a "Web navigator site."

All of the senior participants were Internet beginners who possessed only basic computer knowledge that had been learned from March 1, 2006. They learned how to use a keyboard and a mouse, although their operation speed was slow. They were introduced to windows Interface, the Internet, the Web, an IE browser tool, a notepad, and Chinese word input software. Before the demonstration, most could input Chinese words by notepad. In the demonstration, the instructor explained the outline of the system and how to operate the *browser tool*. The senior participants then practiced while listening to explanations. They used the system to study learning materials, ask questions, and browse other websites. The test took two hours. Finally they answered the questionnaire shown in Table 4 that had a 5-level scale ("very good," "good," "average," "not so much" and "not at all"). Twelve questions were asked concerning each part's usefulness, functions, and interface design. The high satisfaction results show the effectiveness of the proposed system. Moreover, in the interview section, we received many opinions from participants. We summarize the evaluation below:

• Browser tool for seniors

The survey results (Section 5.2.3) showed that the IE tool is very popular software (used by 85.89%), so it was chosen as the control system. Compared with IE, most participants agreed that the new browser design was user-friendly and they could easily browse the Internet. They reported that IE's toolbar and menu was confusing,

Table 4. Five-stage evaluations for proposed system (Higher score means higher satisfaction).

Browser tool	Are the tools easy-to-use compared with IE?	4.21
	Is it easy to browse homepages?	4.47
	Is the interface design suitable for seniors?	4.47
Web navigator site	Is it easy to use?	4.42
	Is the directory suitable for seniors?	4.36
	Is the interface design suitable for seniors?	4.42
IT learning site	Is learning by Internet effective?	4.57
	Is the learning content easy to understand?	4.10
	Is the interface design suitable for seniors?	4.36
IT community site	Did it help solve your problems?	4.26
	Are the contents and solutions easy to understand?	4.31
	Is the interface design suitable for seniors?	4.47

while by comparison they felt the browser tool was easy to understand and use. Concerning the difficulties of IE mentioned above (too many unnecessary functions, a pointer that was too small, a button too small to operate) most reported that the new browser tool was satisfactory.

• Web navigator site for seniors
Baidu (www.baidu.com) is the highest-ranking Chinese search engine. Its advertisements are also popular, so senior beginners are aware of it. Compared with Baidu, participants were very satisfied with our developed Web navigator's interface, taxonomy, and websites contents because they are suitable for seniors. Although Baidu has plenty of categories and websites in which users can find almost any site, its interface design and taxonomy are for general Internet users, not seniors.

• IT learning site for seniors
Participants agreed that the learning materials were suitable for beginners and that the words and content could be easily understood. Most participants complained that it was difficult to find books for senior citizens because most offer too much information for finding what is necessary or how to start learning. Some participants were using DVD materials for beginners produced by famous publishers in China, but they said the contents were already obsolete in the rapidly information age. They were satisfied with the design and the learning contents of the developed learning site, and they believed that learning the Internet would be one of their learning choices. With enough knowledge and ability, seniors can use the Internet with greater pleasure and without anxiety.

• IT community site for seniors and supporters
The survey results show that seniors were seriously worried about getting support for problems concerning the Internet and computers. So when they used the IT community site, all agreed that its Internet support method is effective and necessary. It not only can help solve the Internet problem, but it can also assuage their skepticism to the Internet and improve confidence of Internet ability. Moreover,

most participants said that they want to help others in the community site if they can obtain enough knowledge and Internet literacy.

• Interface design
Participants gave high scores to the interface design of each part. They reported that the proposed system was suitably designed for seniors. In China, since usability for seniors has been almost ignored in the development and design processes, seniors have difficulty using such systems. On the other hand, the concerns and attributes of senior users were considered in this system's interface design process, so participants were very satisfied with it.

In summary, participants recognized that the system is very useful and they want to continue to use it in the future. The demonstration proved that the proposed system effectively eased Internet anxieties, and satisfied their needs. In the future, we intend to improve and refine the system, making it more popular and easier to access. Furthermore, a large-scale, proof of concept experiment is necessary.

9. Conclusion

In this paper, first, we attempted to determine the Internet anxiety and needs of senior citizens in China through a survey. We investigated their experience using the Internet and identified three types of Internet anxiety: ability, reliability, and acceptability. Then we identified the attributes most likely to result in anxiety. The study further explored the willingness of senior citizens to learn and request support and the most frequently occurring difficulties.

We discussed the survey results and proposed the Senior Internet Support & Learning Environment, which incorporates a Web navigator site, an IT learning site, an IT community site, and a Web browser tool. The proposed environment's interface design differs from commercial systems in China in many ways, including a simplified interface, reduced clutter on the screen, reduction of terminology, and clear and simple navigation paths.

Finally, we demonstrated the proposed environment. Participants in the demonstration reported that the system simplified using, learning, and getting support from the Internet. The results confirm that the proposed environment is a very effective Internet learning and support environment for senior citizens. We believe that the proposed environment stresses their needs and will impact senior users.

Many characteristics of our proposed environment are also appropriate for other non-users. Both research and experience indicate that initial impressions are crucial in deciding whether people will persevere with the Internet. In our experience, once learners have developed confidence, they are capable of further exploration.

According to a World Bank report (Hawkins, 2002), developing countries do not have a comfortable and appropriate learning environment for Information education. Also there has been little research in the field concerning older people in China. The digital divide reflecting age will continue to grow if the situation is

not changed. The study is specifically based on the conditions of senior citizens in China, who have received clear benefits from the environment. It has integrated learning and offered a support environment and provided an encouraging, rather than intimidating, introduction to Internet use. The study also provides Internet application developers, planners, and designers with a better understanding of the Internet learning and support needs of senior citizens as well as a reference for further implementing a development phase to narrow the digital divide in China.

Certainly, further studies must be done with a broader sampling frame and larger sampling size to achieve greater reliability and generalization. Future studies should also enrich the functions and structures of the environment and implement them to help more senior citizens learn about and use the Internet.

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