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A Study of Digital Learning for Older Adults

Cheng-Ta Lin[1] · **Shuang-Shii Chuang**[1]

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Abstract
This study proposes interactive digital learning to help elderly individuals acquire knowledge of orchids and polish interpersonal skills. The goal is to investigate the relationship of perceived ease of use, enjoyment, self-efficacy, and social interaction with attitude by adopting the modified Technology Acceptance Model. Purposive sampling is adopted in this study. Two hundred and fifty questionnaires were sent to elderly people in Tainan, for which the response rate was sixty-four percent. First, the research framework proved that perceived ease of use and enjoyment positively influence self-efficacy. Further, we verified that self-efficacy positively influences social interaction and that both self-efficacy and social interaction positively influence attitude. This study makes two contributions to the extant literature on this topic. First, custom-made, educational digital games make older people happier and help them polish their interpersonal skills. Second, the results infer that digital learning is worth development in learning centers for senior citizens.

Keywords Perceived ease of use · Perceived enjoyment · Self-efficacy · Social interaction · Attitude · Technology Acceptance Model

Introduction

Improvements in medical technologies and public health have prolonged the human life span globally. Thus, the growing population of aging civilians has become an important societal issue. The World Health Organization (WHO) defines an elderly person as one who has reached the age of 65 and an aging society as one where 7% of the population is elderly. Furthermore, the WHO also proposes the concept of active ageing, which allows people to realize their potential for physical, social, and mental well-being throughout the course of their lives, and includes provisions for adequate protection, security, and care when it is needed. By 2015, the number of elderly users in Taiwan had increased to 2.81 million (Ministry of the Interior 2015) which was 12% of the total population and indicated that Taiwan has gradually become an aging society. Hence, helping the elderly enjoy a healthy life has become an important issue in Taiwan.

Most studies on this topic have focused on improving the learning attitude of young learners by analyzing factors including perceived ease of use, enjoyment, and usefulness. Other studies have been aimed at developing public safety for old adults, such as pill monitoring systems that remind them to take their medications on time. In addition, QuietCare smart sensor technology monitors abnormal movements and sends warning messages. Recently, the government has implemented a national health insurance policy to ensure good physical health care for old adults, but their psychological health is another relatively important issue that must be addressed.

With respect to the current situation of the domestic elderly in Taiwan, we find that most elderly people suffer from a series of physical problems related to loss of memory, depression, and a lack of self-confidence. Allaire et al. (2013) found digital games a viable activity by which to maintain cognitive functioning and happiness. Furthermore, Ijsselsteijn et al. (2007) suggested that the designs of digital games should take both easy and pleasurable elements into consideration to develop a friendly interface for older individuals. Moreover, Nintendo found that complexity is the major barrier to older people's enjoyment when playing

✉ Cheng-Ta Lin
johna02361@gmail.com

Shuang-Shii Chuang
johna0236@yahoo.com.tw

[1] Department of Business Administration, National Cheng Kung University, No. 1 University Road, Tainan City 701, Taiwan

digital games. Boot and Charness (2013) indicated that attitudes and ability are the two major factors related to elderly adoption of a new technology and that adoption of new technologies improves the quality of their lives.

The literature on this topic indicates that understanding the target users' needs and preferences, such as friendly interfaces, an enjoyable game environment, and useful information, are important factors for digital game designers (Institute for Information Industry 2011). Additionally, games equipped with feedback, clear goals, and challenges may improve the attitude of players toward knowledge acquisition and may increase self-efficacy and also improve interpersonal skills (Kiili 2005).

To better the learning attitude of the subjects in this study, we developed an interactive digital orchid game, which combines Adult Learning Theory and TAM, intended to help them learn how to grow orchids. Furthermore, with grandchildren' supports, old adult users are familiar with panel manipulation and acquire knowledge of growing orchids. Moreover, we also add self-efficacy and social interaction to examine the relationship toward attitude. It is expected that old adult users will enjoy learning in the digital game world and that they will experience improvement in both self-efficacy and social interaction as well via playing the digital orchid game. Finally, we elaborate a research framework and intend to investigate the relationship of perceived ease of use, enjoyment, self-efficacy, social interaction, and attitude for elderly users.

Literature Review

Adult Learning Theory

Thorndike et al. (1928) defined adult learning as a professional domain of practice from the perspective of behavioral psychology. Andragogy (Knowles 1980), which is a new label for adult learning (Knowles 1968), is distinguished from pedagogy. Davenport (1985) categorized andragogy into a theory of adult education, adult learning, adult learning technology, and methods and techniques for adult education. Meanwhile, the theories of adult development in adult education include theories of cognitive development, humanistic psychology, and theories of lifespan development (Sandlin et al. 2011). Furthermore, adult learning is internally motivated and self-directed learning (Knowles 1984). Adult learners learn best because they adopt self-directed learning that incorporates personal experience and readiness to learn into the acquisition of desirable knowledge and improvement in literacy skills (Schecter and Lynch 2011) and applies them in real world practice (Merriam 2001). Thus, adult learning and problem-based approaches work well with adult learners. They help learners develop new knowledge to build on what they already know and practice (McKenna and Walpole 2008).

Digital Learning

Shulman (1986) argued that teachers should perceive the level of students' cognition, motives, and interest in incorporating content knowledge (CK) to develop proper pedagogical content knowledge (PCK) for learners. Mishra and Koehler (2006) integrated technology into pedagogical content knowledge (PCK) and proposed technological pedagogical content knowledge (TPACK), which contains seven categories, including content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), technological pedagogical content knowledge (TPACK). Even though providing students with integrated knowledge and a pedagogical approach is important, so is arousing pupils' interest in learning. Davis (1989) proposed through the Technology Acceptance Model, in which perceived ease of use, enjoyment, and usefulness are viewed as influencing attitudes toward learning. Previous studies have also proposed that how well students are doing under seven flow conditions with feedback might impact their attitude toward learning (Csíkszentmihályi 1975; Schaffer 2013). Angeli and Valanides (2009) explored performance assessments as feedback to embed into courses, and Mishra and Koehler (2006) introduced TPCK into the educational research field. Hence, we developed an digital orchid game with features including perceived ease of learning, enjoyment, and instant feedback on performance to enhance and improve the self-efficacy, social interaction, and learning attitude of old adults' subjects under consideration in this study.

Technology Acceptance Model

This study mainly relies on the Technology Acceptance Model (Davis et al. 1992) as the theoretical foundation by which to explore the acceptance of digital games in an elderly population. The Technology Acceptance Model originated from the Theory of Reasoned Action. Furthermore, perceived usefulness and ease of use in the model have been proven to have a positive influence on both attitude and intention (Venkatesh and Morris 2000). Furthermore, motivation is separated into two categories, intrinsic, and extrinsic. Perceived usefulness is defined as an extrinsic motivation; however, intrinsic motivation includes fun, play, and enjoyment (Davis et al. 1992). Additionally, enjoyment also plays an important role in attitude and intention in the Technology Acceptance Model (Grant 1991). However, we add two elements, self-efficacy and social interaction, in this study. Greater self-efficacy has been proven to have

a positive relationship with experience (Bandura 1982). In addition, social interaction not only improves interpersonal relationships, but also improves players' attitude toward entertainment (Sellers 2006). According to the above review, prior studies have focused on technology acceptance in the younger generation in areas such as computer technology, information technology, and on-line games. To our knowledge, only a few studies have discussed the use of digital games for old adults; therefore, we develop a digital game about growing orchids for elderly subjects within a framework intended to examine the effects of perceived ease of use, enjoyment, self-efficacy, and social interaction on attitude.

Perceived ease of use

Davis (1989) indicated that perceived ease of use has a positive influence on attitude. Al-Gahtani and King (1999) suggested that perceived usefulness, ease of use, and comparative advantage have a positive influence on attitude and intention. Lu et al. (2005) indicated that perceived usefulness and ease of use have a positive influence on attitude toward mobile technology. Other studies have verified the relationship between perceived ease of use and attitude in mobile medical systems (Wu and Wang 2005). Tung and Chang (2008) explained that perceived usefulness and ease of use have a positive influence on attitude and intention in online learning. However, Chang and Tung (2008) suggested that perceived ease of use and self-efficacy are key elements related to students' behavioral intentions toward an online learning course. Meanwhile, Venkatesh and Davis (1996) suggested a relationship between perceived ease of use and self-efficacy. Hence, we adopted the concept of perceived ease of use to develop a friendly, interactive interface, easy-to-access platform, and ease of learning for digital games intended for elderly users.

Enjoyment

Enjoyment refers to hedonic experiences (Csikszentmihalyi 1975). Play, fun, and enjoyment are regarded as intrinsic factors that have a positive influence on attitude (Davis et al. 1992; Nysveen et al. 2005). Prior studies have verified that vivid on-line interactive content and interfaces cause buyers to enjoy the online purchase process (Wan 2000). In addition, self-efficacy and social interaction arouse users' motivation to play digital games because the environment is enjoyable (Tseng 2001). In conclusion, if designers want to develop interesting games for old adults, large fonts, interesting contents, and interactive interfaces must be taken into consideration when designing digital games for grey users.

Self-Efficacy and Attitude

Previous studies indicate that efficacy beliefs, which influence how we think, feel, and implement projects, are the driving force that instigates motivation (Bandura 1982). Self-efficacy is also defined as when individuals have the ability to overcome difficulties and complete assigned tasks (Bandura and Ozer 1990). Additionally, it has been verified that students with greater levels of self-efficacy involve themselves more frequently in social interactions with peers in order to complete assigned homework (Compeau and Higgins 1995). Another study suggested that social interaction and self-recognition are motivations to play games (Tseng 2001). Another study on this topic revealed a positive relationship between self-efficacy and attitude among university students (Wu and Tsai 2006).

When individuals gain knowledge through playing digital games, it directly transfers personal experiences into a databank. The more knowledge that people have in their individual databank, the greater their self-efficacy they will have. Owing to the reviews above, we make the first and second hypothesis as follows:

H1 The more perceived ease of use that elderly users feel toward digital orchid game, the greater the self-efficacy they will have.

H2 The more enjoyable feelings that elderly users have when playing the digital orchid game, the greater self-efficacy they will have.

Social Interaction and Attitude

Social interaction, which relies on continuous communication (Mead 1934), is an information and resource channel among human beings (Chen et al. 2008). Participants' attitudes and behaviors are explicit messages to affect others unintentionally (Chartrand and Bargh 1999) and the manner of attitude formation may result from direct experiences of social interactions (Fazio and Zanna 1981). In social influence paradigms, attitudes and interaction are broadly discussed in social settings (Prislin and Wood 2005) and the support from families, relatives, friends, and neighbors has been labeled as social support of social interaction (Brown 1974). Thus, intensive or long-term social interactions may gradually influence people's existing thoughts. Hoogen, Ijsselsteijn, and Kort (2009) indicated that the functions of digital games, multi-player facilitation of social connections, motivation toward participation in rehabilitation, and social support develop both real and virtual social interactions and improve attitudes toward technology acceptance. Other studies have suggested that mobile devices not only provide users with

more opportunities to participate in learning activities (Roger et al. 2005), but also increase social interaction (Markett et al. 2005) and collaboration (Lai and Wu 2006; Schwabe and Goth 2005).

Overall, physical degeneration and changes in social roles cause pessimism in aging people. However, intensive social interactions with families and friends may make elderly users feel relaxed, stable, and happy. In this study, we aim at the valuation of the benefit of social interaction by users. Thus, it acts as crucial roles to encourage those elders to engage in social interactions through inviting friends to be players and sharing the experiences on growing virtual orchids on the platform of multiplayer game. Therefore, we make the following hypotheses:

H3 More knowledge obtained from the digital game will lead to greater self-efficacy and more intensive social interactions among elderly users.

H4 Greater self-efficacy in elderly users resulting from knowledge obtained from the digital orchid game will lead to an improved attitude toward learning when playing digital games.

H5 Greater social interaction resulting from playing the digital orchid game will improve the interpersonal skills and attitude of old adults toward playing digital games.

Methodology

This section introduces the case study, research design, interviews with nine experts, and the development of the framework for this study. The operational definitions used for the questionnaire, target sampling, and return rate are provided. SPSS and AMOS are used as statistical tools to verify the hypotheses. Finally, we implement another interview with 13 elderly users to gain a further understanding of their attitude toward the digital orchid game.

Case Introduction

The combination of the explosion of technology and digital games has cultivated a popular digital game industry in the younger generation. However, there have thus far been few suitable games designed for old adults. According to observations, an increasing number of older people are using computers and smart phones in their daily lives. Therefore, we suggest interactive and educational digital games for elderly users as a brand-new educational market. Additionally, functions involving training in physical exercise, learning mechanisms, and social interaction can help old adults become physical healthy and improve their interpersonal skills. Furthermore, we discovered that most retired people like to grow plants. Therefore, in order to help them learn about the care of orchids, including such things as watering, and proper temperature, humidity, and heat, we developed a digital orchid game shown on Fig. 1.

Research Design

We designed two-stage experiments for this study. In the first stage, we did a literature review and interviewed nine experts (one doctor, three professors, one deputy manager, two game designers, and two elderly users) in order to develop the research framework. In the second stage, after subjects had 2 months of experience with the digital orchid game, we also conducted another interview with 13 elderly users.

Interview with Experts and Elderly Users and Results

The purpose of the interview was to explore key factors related to the adoption of digital games from the perspective of old adults. The interview included one doctor specializing in geriatrics and gerontology, three experts in the orchid field, two individuals majoring in computer science, one individual majoring in marketing, and two elderly users, as shown in Table 1.

After interviewing the nine experts, we determined five scopes of study, including perceived ease of use, enjoyment, self-efficacy, social interaction, and attitude. The results

Fig. 1 Content of orchid game

Table 1 Background of nine experts ($n=9$)

No.	Background	Title	Experiences
EX1	Geriatrics and gerontology	Doctor	13 years
EX2	Orchid	Professor	25 years
EX3	Orchid	Associate professor	25 years
EX4	Orchid business	Chief technical officer	30 years
EX5	Information technology	Director	15 years
EX6	Game design	Project manager	10 years
EX7	Marketing	Deputy manager	8 years
EX8	Elderly user	Retired	3 months experiences
EX9	Elderly user	Retired	No experience

Table 2 The results of the expert interviews ($n=9$)

Scope	Issues	Users' experience
Perceived ease of use	Comparative advantage	8/9
Enjoyment	Enjoyable game	7/9
Self-efficacy	Game self-efficacy	5/9
Social interaction	Interpersonal skills	7/9
	Social support	5/9
Attitude	Acceptance of digital games	6/9

indicate that eight of the experts (88%) agreed that the digital orchid game is easy to use. Seven experts (77%) enjoyed playing the digital game. Five experts (55%) believe that memory improvement increases self-efficacy and that social interaction leads to improved interpersonal skills and social support. Seven of the experts (77%) indicated that they felt that digital orchid game improved their interpersonal skills, and five (55%) felt that digital orchid game would lead to social support from family and friends. Finally, six of the experts (66%) demonstrated higher interest in orchids and interest in continuing to play digital games. The detailed information is shown in Table 2. Based on this information, we developed the research framework for the empirical study.

Research Framework

The five major constructs of model in this study were developed by interviewing nine experts (see Fig. 1). We kept ease of use, enjoyment, and attitude from the TAM and added two constructs, self-efficacy, and social interaction, to develop old adult users Technology Acceptance Model framework.

Definitions and Measurement of Constructs

Six items for perceived ease of use (Davis 1989), social interaction (Hoogen et al. 2009), enjoyment (Nysveen et al. 2005), and attitude (Davis et al. 1992) were developed, separately. Finally, there were seven items for self-efficacy (Bandura 1982). The operational definitions are shown in Table 3.

Sample and Procedure

Our sample comprised elderly users over 65 years old. Two measurements were adopted during different periods to avoid common method variance. First, two stages for filling out the questionnaires were in different period, respectively. Second, discriminant validity was verified for each construct. We only had 40 responses for the pilot study for examining consistency and developing corrected semantic and syntax. The survey took place in Tainan City, Taiwan from September 1 to October 11, 2014. Two hundred and fifty questionnaires were filled out in Tainan City, and 160 valid responses were obtained, thus providing a response rate of 64%.

Analysis and Results

Initially, a framework including ease of use, enjoyment, self-efficacy, social interaction, and attitude were developed. Then, SPSS and AMOS were adopted as the statistical tools to examine the validity and reliability of each construct.

Validity and Reliability

The criteria for validity and reliability are as follows: KMO > 0.5, communality > 0.5, eigenvalue > 1, factor loading > 0.6, Cronbach's alpha > 0.7, and item-total correlation > 0.6. Dependent variable: The four items on attitude have factor loadings of 0.91, 0.91, 0.73, and 0.79 ($\alpha=0.90$). Independent variables were determined based on the literature review. The five items in perceived ease of use have factor loadings of 0.74, 0.81, 0.82, 0.85, and 0.83 ($\alpha=0.90$). The four items for enjoyment have factor loadings of 0.78, 0.80, 0.85, and 0.87 ($\alpha=0.89$). The three items were

Table 3 Operational definitions of constructs

Operational definitions
Perceived ease of use: Sources: Davis (1989), seven-point Likert scale
EOU1: The digital orchid game is easy to learn
EOU2: The digital orchid game has a learning platform that is easy to use
EOU3: Elderly users easily and vividly experience growing orchids while playing this game
EOU4: The digital orchid game interface is easy
EOU5: The interactive model of the digital orchid game is easy to understand
EOU6: The acquired knowledge from the digital orchid game can easily transfer into growing real orchids
Social Interaction: Sources: (Hoogen et al. 2009), seven-point Likert scale
SI1: The digital orchid game is a multiplayer game
SI2: Discussing knowledge of growing orchids with others polishes our skills when playing digital orchid game
SI3: The digital orchid game can become a conversation topic
SI4: I can invite other people to play the digital orchid game with me
SI5: I can share information obtained by playing the digital orchid game with others
SI6: I can exchange my experiences with growing orchids with others while obtaining knowledge by playing the digital orchid game
Enjoyment Sources: Nysveen et al. (2005), seven-point Likert scale
EJY1: It is interesting that the digital orchid game helps us experience growing a virtual orchid
EJY2: It is interesting to experience an orchid growing
EJY3: Controlling orchid growing conditions is interesting
EJY4: Playing the digital orchid game can help us enjoy learning how to take good care of an orchid
EJY5: Playing games and obtaining knowledge satisfies me
EJY6: I enjoy the process of growing an orchid in virtual reality
Self-efficacy: Sources: (Bandura 1982), seven-point Likert scale
SE1: The digital orchid game helps us understand the growth process of an orchid
SE 2: The digital orchid game helps us learn the skills necessary to grow an orchid
SE 3: The digital orchid game provides us with a memory-training program
SE 4: Playing the digital orchid game is the first step to learning how to use a computer
SE 5: Playing the digital orchid game helps us kill time
SE 6: Playing the digital orchid game can be an interface leading to interactions among people
SE 7: The digital orchid game is a tool for obtaining new knowledge
Attitude Sources: (Davis et al. 1992), seven-point Likert scale
ATT1: I have intentions to play the digital orchid game
ATT2: I will recommend that others play the digital orchid game
ATT3: I will play the digital orchid game to learn how to grow orchids
ATT4: Before growing a real orchid, I will start by learning the information in the digital orchid game
ATT5: I will grow an orchid using the knowledge I got from the digital orchid game
ATT6: I will continue to be concerned about the development of the digital orchid game

preserved in social interaction have factor loadings of 0.85, 0.93, and 0.93 ($\alpha = 0.93$). The three items SE1, SE2, and SE7 in self-efficacy have factor loadings of 0.87, 0.88, and 0.78 ($\alpha = 0.88$), respectively, as shown in Table 4. The confirmatory factor analysis indicated a good model fit for which the values were CMIN/DF = 1.67, NFI = 0.91, RFI = 0.90, IFI = 0.96, TLI = 0.95, CFI = 0.96, and RMSEA = 0.06.

The convergent validity of a construct can be evaluated by two criteria: composite reliability and average variance extracted, which are required to be higher than 0.6 and 0.5, respectively (Fornell and Larcker 1981). The values for composite reliability were 0.90, 0.89, 0.93, 0.88, and 0.90. In addition, the values of the AVE were 0.65, 0.68, 0.81, 0.71, and 0.70. Both the CR and AVE were higher than 0.6 and 0.5, respectively, as shown in Table 4. Hair argued that the square root of the AVE should be at least 75% higher than the correlation coefficients among the constructs (Hair et al. 1998). The diagonal values were 0.82, 0.83, 0.90, 0.84, and 0.83, which were all higher than the correlation coefficients, as shown in Table 5. Thus, the constructs showed good discriminant validity.

Results of the Research Model

The VIF values were below 10 (Neter et al. 1996), which verified that there was no issue of multi-collinearity in the research model. In addition, the values for the Structural Equation Models showed good model fit, which were as follows: CMIN/DF = 3.15, NFI = 0.83, RFI = 0.81, IFI = 0.88, TLI = 0.86, CFI = 0.88. The results of the regressions indicated that perceived ease of use had a significant influence on self-efficacy ($\beta = 0.48$, $p < 0.001$), so Hypothesis 1 was

Table 4 Validity and reliability

Construct	Items	Factor loading	α	CR	AVE
Ease of use	EOU2: The digital orchid game has a learning platform that is easy to use	0.74	0.90	0.90	0.65
	EOU3: Elderly users easily experience growing orchids while playing this game	0.81			
	EOU4: The digital orchid game interface is easy	0.82			
	EOU5: The interactive model of the digital orchid game is easy to understand	0.85			
	EOU6: The acquired knowledge from the digital orchid game can easily transfer into growing real orchids	0.83			
Enjoyment	EJY1: It is interesting the orchid game helps us experience growing a virtual orchid	0.78	0.89	0.89	0.68
	EJY3: Controlling orchid growing conditions is interesting	0.80			
	EJY5: Playing games and obtaining knowledge satisfies me	0.85			
	EJY6: I enjoy the process of growing an orchid in virtual reality	0.87			
Social interaction	SI1: The digital orchid game is a multiplayer game	0.85	0.93	0.93	0.81
	SI4: I can invite other people to play the digital orchid game with me	0.93			
	SI5: I can share information obtained by playing the orchid game with others	0.93			
Self-efficacy	SE1: The digital orchid game helps us understand the growth process of an orchid	0.87	0.88	0.88	0.71
	SE 2: The digital orchid game helps us learn the skills necessary to grow an orchid	0.88			
	SE 7: The digital orchid game is a tool for obtaining new knowledge	0.78			
Attitude	ATT1: I have intentions to play the digital orchid game	0.91	0.90	0.90	0.70
	ATT2: I will recommend that others play the digital orchid game	0.91			
	ATT3: I will play the digital orchid game to learn how to grow orchids	0.73			
	ATT6: I will continue to be concerned about the development of the orchid game	0.79			

Table 5 Discriminant validity

	Ease of use	Enjoyment	Social interaction	Self-efficacy	Attitude
Ease of use	(0.82)				
Enjoyment	0.74***	(0.83)			
Social interaction	0.76***	0.74***	(0.90)		
Self-efficacy	0.61***	0.71***	0.62***	(0.84)	
Attitude	0.78***	0.79***	0.80***	0.69***	(0.83)

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

supported. Secondly, enjoyment had a positive influence on self-efficacy ($\beta = 0.78$, $p < 0.001$); therefore, Hypothesis 2 was supported. Thirdly, self-efficacy had a positive influence on social interaction ($\beta = 0.80$, $p < 0.001$); hence, Hypothesis 3 was supported. Finally, we also found that self-efficacy and social interaction had positive influence on Attitude ($\beta = 0.62$, $p < 0.001$) ($\beta = 0.33$, $p < 0.01$), respectively. The results of the research model are shown in Fig. 2. Finally, H1, H2, H3, H4, and H5 were all supported, as shown in Table 6.

Interviews with 13 Elderly Users

Background of 13 Elderly Users

Interviews were held 2 months after old adult subjects experienced the digital game. Thirteen elderly users were interviewed. There were 5 males and 8 females ranging in age from 65 to 73. The timeframe of the interview was controlled to approximately 20 min for each user. Only five of the subjects had prior computer experience, and four users had experiences with using Wi-Fi; however, only one female had experience with playing Game Boy. The result is shown on Table 7.

The Results of Interviews with 13 Elderly Users

This study was aimed at five scopes of study including perceived ease of use, enjoyment, self-efficacy, social interaction, and attitude. Thirteen elderly users participated in the interview process. Seven users (53%) indicated that they experienced perceived ease of use of the digital orchid game. Ten users (76%) experienced feelings of enjoyment while playing the digital game. Self-efficacy is composed of memory improvement and knowledge acquisition. We found that eight users (61%)

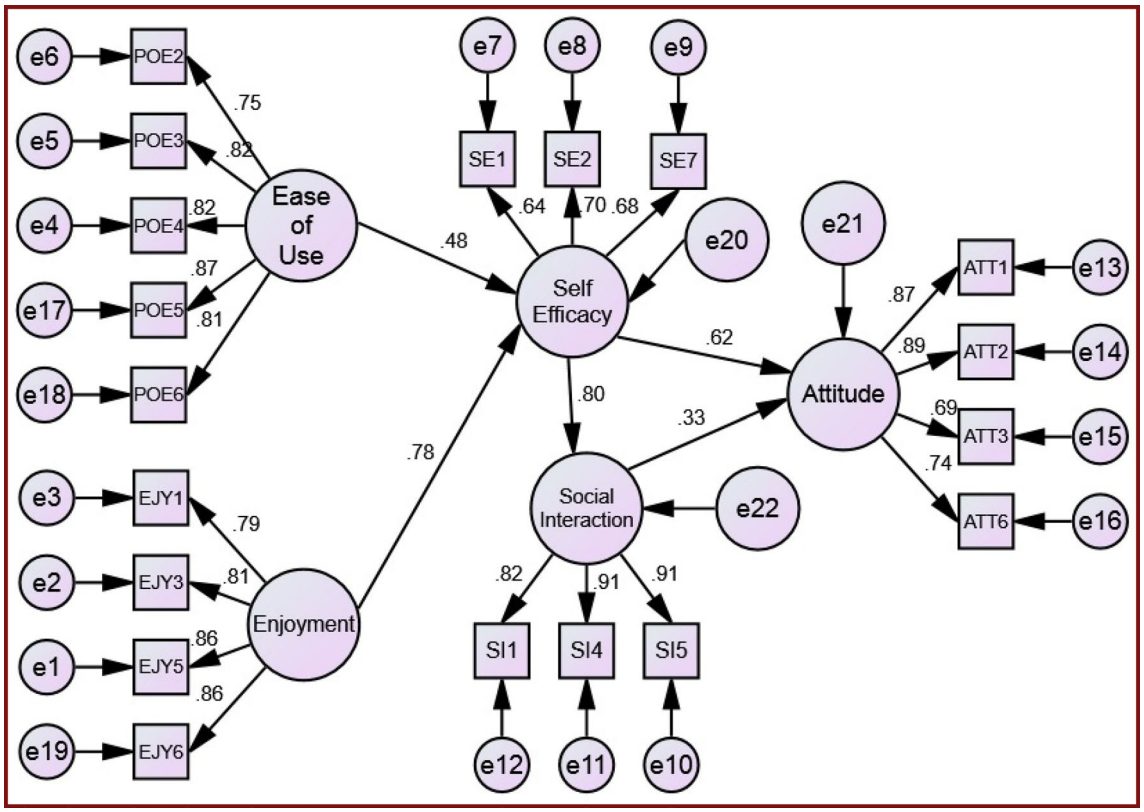

Fig. 2 The results of the framework

Table 6 Results of the hypotheses

	Hypotheses	Results
H1	The more perceived ease of use that elderly users feel toward digital orchid game, the greater the self-efficacy they will have	Supported
H2	The more enjoyable feelings that elderly users have when playing the digital orchid game, the greater self-efficacy they will have	Supported
H3	More knowledge obtained from the digital game will lead to greater self-efficacy and more intensive social interactions among elderly users	Supported
H4	Greater self-efficacy in elderly users resulting from knowledge obtained from the digital orchid game will lead to an improved attitude toward learning when playing digital games	Supported
H5	Greater social interaction resulting from playing the digital orchid game will improve the interpersonal skills and attitude of old adults toward playing digital games	Supported

experienced memory improvement, and twelve (92%) acquired knowledge. Social interaction comprises both interpersonal skills and social support. Ten users (76%) expressed that they had polished their interpersonal skills, and seven (53%) experienced social support from their family and friends. Finally, there were seven users (53%), who demonstrated higher interest in the digital orchid game and indicated that they plan to continue playing digital games. The detailed information is shown in Tables 8 and 9.

Conclusions

The interactive orchid game has changed old adults' attitude toward digital games in this research model through perceived ease of use, enjoyment, self-efficacy, and social interaction. We will discuss the relations among the following four aspects: (A) perceived ease of use and self-efficacy, (B) perceived enjoyment and self-efficacy, (C)

Table 7 Background of interviewing individual elderly users ($n = 13$)

No.	Gender	Age	Computer experience	Digital game experience	Job	Living status (with)
1	Female	73	No	Wii	Retired	Husband and son
2	Female	67	No	No	Retired	Husband, son, and grandson
3	Male	65	No	No	Retired	Wife
4	Male	72	No	No	Retired	Son
5	Female	71	No	No	Retired	Daughter
6	Female	66	No	No	Tailor	Alone
7	Male	68	Yes	Wii	Work	Wife, son, grandson
8	Male	73	Yes	Wii	Retired	Family
9	Female	68	Yes	No	Retired	Family
10	Male	66	Yes	Wii	Retired	Wife and son
11	Female	68	No	No	Work	Family
12	Female	72	No	No	Retired	Family
13	Female	66	Yes	Game boy	Work	Family

Table 8 The results of user interviews ($n = 13$)

Scope	Issues	Users' experience
Ease of use	Comparative advantage	7/13
Enjoyment	Enjoyable game	10/13
Self-efficacy	Knowledge acquisition	12/13
	Memory improvement (*Extra findings*)	8/13
Social interaction	Interpersonal skills	10/13
	Social support (*Extra findings*)	7/13
Attitude	Acceptance of digital games	7/13

self-efficacy toward social interaction and attitude, and (D) social interaction and attitude.

In the aspect A, the simple interfaces, clear interactive model, and user-friendly learning platform did lower the entry barriers for old adults and make them acquire orchid knowledge easily. In the aspect B, playing the orchid game made the subjects feel senses of comfort and pleasure when they saw the orchid blossom in the digital orchid game. Thus, the seniors acquired knowledge and skills via playing a relaxing, enjoyable, and interactive orchid game. The results are in line with those of previous studies (Davis 1989). In the aspect C, the elder users continuously observe the changes in the orchids and acquire proper approaches such as watering, humidity, and temperature to take good care of orchids, so they grow beautiful orchids. The successful experience in growing virtual orchids not only provide old adults with knowledge and skills of growing orchids, but also make them gain confidence and dedicate to social interaction through sharing the knowledge of growing orchids with other senior. In addition, the increasing of self-efficacy also has changed old adults' image on playing digital games. The results were in line with those of prior studies (Ijsselsteijn et al. 2007; Knowles 1980). In the aspect D, when old adults' subjects are familiar with the orchid game, they expect to have great improvements so they turn to ask experts for advice on growing orchids. The intensive social interaction that occurred in the study context helped the subject interpersonal skills. Meanwhile, the confident elderly subjects invite friends to be new players of the game and share their previous experiences of playing the orchid game to new ones. The social interactions that took place while transferring orchid knowledge make the older adults feel proud of their achievements, improve their interpersonal skills, and change their attitude toward digital games. The results appeared to be consistent with those of prior studies (Chen et al. 2008).

In conclusion, the enjoyable and user-friendly orchid game platform attracted old adults' attention. With help from friends and family members, old adults' subjects became familiar with interfaces, acquired orchid knowledge, and increased their self-efficacy as well. Therefore, old adults' subjects gained self-efficacy and confidence and they volunteered to share their experiences of growing orchids with others. These knowledge-sharing interactions encouraged the pursuit of new knowledge and led to improvements in learning attitude. In addition, the orchid game is a communicative platform for social interaction. Through this platform, old adult players engaged in sharing orchid knowledge and

Table 9 The results of interviewing with users

Scope	No.	Content
Echo with this study ($n=13$)		
Ease of use	1, 6, 8	This game is easy to grasp and understand
	3, 4	The interface is simple and easy to grasp
	5, 7	This digital game provides old adults with easy access
Enjoyment	3, 4, 9	I feel interested when I see orchids blossom
	5, 7, 8	Playing games is fun, and I learn how to set up different conditions
	6, 12	I feel comfortable about growing orchids
	10, 13	When I meet different challenges, I feel pleased
Self-efficacy *Knowledge acquisition*	1, 2, 5	I want to learn more about computers and orchids
	3, 6, 7	Playing this game teaches me how to grow orchids
	4, 8, 11	Information on pests helps create solutions for insect control
	9, 12	I learn about growing orchids by playing this game
	10	This game helps me discover the best solutions for growing orchids
Social Interaction *Interpersonal skills*	2, 4	Discussions increase social interaction with friends
	2, 5	Playing the digital orchid game with friends increases social interactions
	3	Playing the digital orchid game with friends improves my communication I lost skill
	7	Playing games with family members increases social interaction
	8, 9	Playing this game helps old adults learn from each other
	10, 13	A shared topic causes families to have intensive social interactions
	6, 13	Intensive social interactions make them have strong ties
Attitude	1, 12, 13	I will recommend this game to my friends
	2	I will introduce this game to my friends engaging in orchid business
	5	I am interested in this game, and I want to get a perfect score
	10	I want to introduce this game to the agricultural training school
	8	Asking a family member for help increases our interactive relationship
	9	I think I need a family member to help me with this game
The extra findings of interviewing with users ($n=13$)		
Self-efficacy *Memory improvement*	1, 4	Playing the digital orchid game is a brain exercise
	3, 7	Selecting correct growing conditions enhances my memory
	5, 6	Learning how to use a computer improve my memory
	8	This game makes users think and force them to memorize
	12	Remember the processes of growing orchid enhances my memories
Social interaction *Social support*	2	Teaching family members to play digital games increases social interaction
	3	We can consult experienced experts for better answers
	4, 7	My son will help me if I ask
	8	I feel comfortable if my family instructs me on how to play a game
	8	Asking family members for help increases our interactive relationship
	9	I think I need a family member to help me with this game

in discussions of the correct procedures for growing orchids. Therefore, the more they participated in the interactive social activities, the greater improvement they experienced in terms of their interpersonal skills as well as knowledge acquisition. The results are in accordance with those of prior studies (Chen et al. 2008). Therefore, the evidence conveys an important message suggesting that custom-made and educational digital games do make old adult users happier and more confident and help them acquire knowledge, develop interpersonal skills, and change their attitudes toward digital games. Consequently, we consider that the digital orchid game is an effective design for old adults. The results of this study also suggest that old adult users is a new market for digital game industry and they also argue that different digital games could be promoted and implemented in the community colleges in Taiwan as interactive teaching aids for old adults. Moreover, we can also introduce the concept of interactive digital games to agricultural training schools for tutoring farmers.

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