Socially-enhanced Variants of Mobile Bingo Game: Towards Personalized Cognitive and Social Engagement among Seniors

Chien-Sing Lee, Shanice Wei-Ling Chan, Sheng-Yee Guy
Department of Computing and Information Systems
Sunway University, Malaysia.
chiensingl@sunway.edu.my, 15049190@imail.sunway.edu.my, sheng.g2@imail.sunway.edu.my

***Abstract* - Elderlies often feel isolated or disregarded. This may lead to depression, lack of cognitive and social engagement. This project thus aims to engage the elderlies through three variants of a mobile bingo game application designed based on Norman's usability principles. This paper presents the design and development of three variants of the mobile bingo game to suit the needs of senior citizens. User testing outcomes on user experience, usability and cognitive load are positive.**

***Keywords* - variants, bingo game, elderlies, cognitive, social engagement**

I. INTRODUCTION

Malaysia is going to be an aging country by 2035, when 15% of its population will consist of those aged 60 and above [1]. They slowly become frail and physically challenged. It is also generally accepted that some elderlies are neglected or isolated in terms of communication with the younger generations or social activities due to their lack of pace physically and mentally. Hence, some may be facing depression or loneliness but have nothing or no one to confide in.

A research was conducted on the elderlies located in Sepang, Selangor state in Malaysia alone and it concluded that 7.6% elderlies were facing depression [2]. Depression has become widespread and reported to have reached as high as 48.8% in the community and 67% in nursing homes [3]. Furthermore, as majority of the elderlies are not tech-savvy, they are unable to relish in the wonders of mobile entertainment and a lack of social connection with people in general and with family [4].

When the elderly percentage increases, so does the need for old folks' homes. Apart from being separated from family and home, many experience similar boredom

Hence, many senior citizens (especially those in old folks' homes) require assistance be it mentally, emotionally or physically. However, most nursing centres are not managed properly as they are not able to pay attention to nor trained to tend to each individual, especially those with Dementia or Alzheimer's disease [5]. Technology and telecommunication can liberate the current situation.

A. Problem Statement

Playing games traditionally can help address the above problems. Digital games should not only bring benefit to them in the way of convenience and appeal, but also to make possible social connections. Statistics [6] show that elderlies who maintain social interactions have a much lower chance of declining in health. This may ease their depression/aggression by allowing them to enjoy.

Many technology creators produce mobile technology that are tech-savvy and posh, which may excel in terms of attracting the younger generations and working adults. However, the current issues faced nowadays is that the elderlies have problems in learning how to utilize mobile devices. It is reported that 77% of senior citizens require assistance from someone else in the process of setting up their device alone [7]. Furthermore, elderly brains learn, but maybe too much [8]. As most software these days are designed to support younger users, mobile interfaces may come off as intimidating and complicated and may result in demotivation.

B. Objectives

The goal for this project is to provide entertainment/engagement and to alleviate the elderlies' depression, loneliness and anxiety by creating variants of a bingo app. We scope the key problem to the interface design.

[9] highlights that learnability is sometimes more important than usability as some applications would require embedded features such as Google map. This however, requires good design of affordances. As such, we will apply and functions to cater to

Although derived from gambling, Bingo is popular among children, teenagers and the elderlies [10]. Bingo relates to the elderlies in a way that they can obtain numerous benefits such as sharpening their cognitive abilities, encouraging them to be more socialable (which reduces depression and anxiety) while preserving physical health. Moreover, by being a part of a bingo community, it provides an opportunity for the elderlies to stay acquainted with family and friends.

C. Contribution

Together with another related project, i.e., a Web and augmented-reality enhanced mobile application [11], images are shared interchangeably, creating modularity, extensibility and hopefully, personalization and greater sustainability. Both works are loosely coupled aimed at generating big data and to enable more meaningful analytics. The latter is presented in another paper, one of which is in the IEEM 2017 conference.

II. RELATED WORK

Mobile applications need to go through usability tests to ensure they are both efficient and error-free. According to Norman [12], a standard application should involve several aspects of mobile games' usability such as consistency, visibility, affordance, mapping, feedback and constraints. Nielsen's usability tests however, cover efficiency, satisfaction, learnability, memorability and errors.

To review the various types of Bingo games, we looked at those at the Play Store where users all over the globe provide their feedback [13]. The games were downloaded and installed for testing. Then, we compared using both usability principles. We choose to design mainly based on Norman's principles because they cater to our objectives of designing for the elderlies by increasing/improving affordances.

The proposed solution would consist of attractive interfaces with minimal yet clear instructions or texts to provide easy navigation. After researching on reviews and feedback provided by users of various age groups, it is important that the game does not charge users money for in-game products as the main objective of this development is to provide emotional and mental assistance to the elderly through virtual entertainment instead of earning profit. Furthermore, the game would be made offline so that there is no need or requirement to constantly connect to the Internet, thus reducing cost.

III. METHODOLOGY

A. Chosen Methodology for Bingo App

The methodology chosen for this project is the Agile Software Development Methodology (Fig. 1) [14]. The reason is because of quality control. Before the Bingo app is finalized, there is room for constant testing throughout the process of creation therefore reducing risks of errors, giving the developer an early heads-up. Similarly, it also promotes error prevention and is flexible enough to fulfil the clients' needs regardless of whether the development cycle has already started or not.

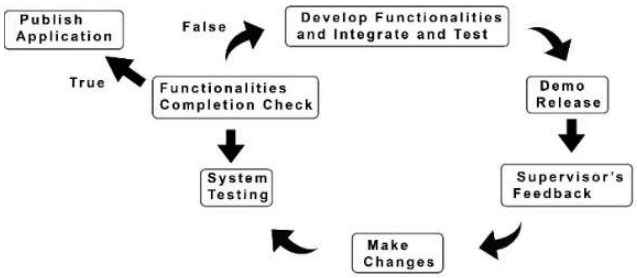

Figure 1. Agile software development methodology

B. Graphical user interface design

The interfaces designed for this game is by following Norman's mobile usability principles. The game's GUI is based on [15]. The following describes how:

- consistent in design as every button will direct the user to the appropriate interface using the same transitioning patterns. These are important as having a consistent interface and system flow creates consistency and this helps users to know what to expect or how to carry out a task;
- visibility is clear and precise. All navigations are available on the interfaces with no decorations to the fonts and button, providing clarity. Clarity is critical to the elderlies as it becomes easier for them to navigate and achieve their objective for each task. This prevents frustration and increases the level of ease when using the application;
- mapping is represented by the interaction on the player side and interaction on the system side (dual-player game) and the winning patterns working at the backend. Mapping leads to immediate understanding, reducing cognitive load in terms of having to grasp the idea of how a function is used or activated;
- affordance is through the mapping and thus navigational buttons will be made to look more 3D in comparison to the rest of the graphics. This eases the user's experience in finding where the clickable objects are. This is important because it provides strong clues on how things should be operated and act as signifiers. Moreover, it was discovered that it is more optimal for elderlies if interfaces were simple in terms of intuitive operation and usability [16].
- The constraints are the amount of levels new or existing users can access. They are not allowed to play levels that are too high before completing the previous stages. For example, user would not be able to play level 2 if they cannot cope with level 1.

II. SYSTEM DESCRIPTION

The main menu is presented in Fig. 2.

Figure 2. Main menu

By tapping on to the 'New Game' button, the user will be led to the following interface (Fig. 3). Once started, the timer of 3 minutes will start counting down. Every time the user manages to highlight the matching cell as the number currently displayed in 'Current Number', the next number to be called will then be displayed.

Figure 3. Three variants of the bingo game

The game will not start unless the user chooses to start the game. There are three different variants (Fig. 3) developed based on object-oriented analysis and design. Across the three variants, five winning patterns at each level work at the backend. The system monitors the user's interaction time and graduates the user from one winning pattern to the next, always ensuring user success.

The variants are as follow:

- The first (Fig. 4) would be the traditional bingo game played on a 5x5 card consisting of randomized numbers from 1 to 25. Users are to tap the numbers that are currently being 'called out' by the application within a given time-frame. The time based on user testing is 3 minutes. We tested the time required on real users.
- The second (Fig. 5) is the same as the first. But instead of numbers, photos are used instead. Users can choose what photos they would like to be included in game play (travelling, movies or cooking – top three interests identified from a needs analysis survey). They can also choose to upload photos from their mobile device for game play.
- The third game (Fig. 6) is a memory game as the user will be required to remember the cell's photos behind every wrong cell they tap. The game will end after all the photos have been matched. There is no timer in this version of the game. If the cell tapped does not match the current photo being displayed, the cell will display the photo for 2 seconds before the 'current photo' changes. The cell will then flip back to being black.

Figure 4. Bingo 1 (Traditional 5x5 bingo game)

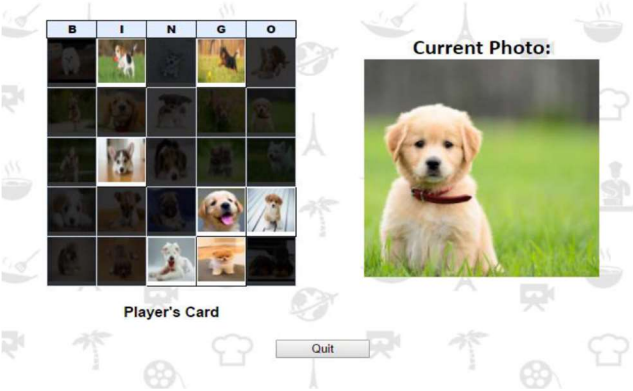

Figure 5. Bingo 2 (Traditional 5x5 bingo game with photos)

Figure 6. Bingo 3 (Memory game)

IV. USER TESTING

A. *Sample*

The sample users are aged between 60 to 80 years old. A needs analysis questionnaire is given to the seniors based on the questionnaire used in [15]. Two sessions were conducted within two weeks on the 9th and 16th of June, 2017. There was a total of twenty-three (23) senior citizens. However, only 10 filled in the user testing questionnaire. A reason is that some have prior gaming experience but the majority do not.

B. *User testing questionnaires*

Three different questionnaires were handed out to the users for testing. The first questionnaire was on product assessment inclined towards user experience, obtained from

the User experience website, the second on Norman's usability and the third on cognitive load.

C. Product Assessment

The questions with a scale from 1 to 7 for Product Assessment questionnaire are as follows

1) 1 = Annoying, 7 = Enjoyable
2) 1 = Not Understandable, 7 = Understandable
3) 1 = Creative, 7 = Dull
4) 1 = Easy to Learn, 7 = Difficult to Learn
5) 1 = Valuable, 7 = Inferior
6) 1 = Boring, 7 = Exciting
7) 1 = Not Interesting, 7 = Interesting
8) 1 = Unpredictable, 7 = Predictable
9) 1 = Fast, 7 = Slow
10) 1 = Inventive, 7 = Conventional
11) 1 = Obstructive, 7 = Supportive
12) 1 = Good, 7 = Bad
13) 1 = Complicated, 7 = Easy
14) 1 = Unlikable, 7 = Pleasing
15) 1 = Usual, 7 = Leading Edge
16) 1 = Unpleasant, 7 = Pleasant
17) 1 = Secure, 7 = Not Secure
18) 1 = Motivating, 7 = Demotivating
19) 1 = Meets Expectations,
    7 = Does Not Meet Expectations
20) 1 = Inefficient, 7 = Efficient
21) 1 = Clear, 7 = Confusing
22) 1 = Impractical, 7 = Practical
23) 1 = Organized, 7 = Cluttered
24) 1 = Attractive, 7 = Unattractive
25) 1 = Friendly, 7 = Unfriendly
26) 1 = Conservative, 7 = Innovative.

User testing outcomes are presented in Tables 1 and 2. Human tendency in such scoring is to incline towards the right. As such, more Likert scales, will be designed with the most negative on the left and the most positive on the right.

To highlight the strengths of the system, Table 1 presents the progression from bad to good and Table 2 from good to bad. Table 1 shows that the scores are all above 50%, i.e., above 4 except for unpredictable (with a score of 3.5). The timer merely works in the backend to gauge when to enable the user to go to the next level and not to press the user for time as in actual competitive system-user games. Hence, we find this exciting because though the challenge is not designed explicitly as a game mechanic, unpredictability is recognized as a challenge. As such, preliminary findings indicate that there is acceptance and user experience is promising.

Similarly, Table 2 shows that when there is a progression from positive to negative, the scores are within the 3.x range. This again attests that the negatives are not as negative. Results are actually rather promising.

TABLE 1. SCORES FOR QUESTIONS PROGRESSING FROM BAD TO GOOD

Questions	Criterias / Users	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	Avg	Avg of Avg
Q1	Annoying (1) – Enjoyable (7)	5	4	7	5	5	5	4	7	6	3	5.1	
Q2	Not understandable (1) – Understandable (7)	5	3	5	4	5	5	4	5	6	3	4.5	
Q6	Boring (1) – Exciting (7)	5	2	5	4	5	6	5	5	4	4	4.5	
Q7	Not interesting (1) – Interesting (7)	4	3	5	5	6	4	4	1	5	3	4	
Q8	Unpredictable (1) – Predictable (7)	4	2	3	4	5	5	4	1	2	5	3.5	
Q11	Obstructive (1) – Supportive (7)	5	3	6	4	5	6	4	5	4	3	4.5	
Q13	Complicated (1) – Easy (7)	5	3	5	6	6	6	4	6	6	3	5	4.5692308
Q14	Unlikable (1) - Pleasing (7)	5	5	6	5	5	6	4	7	5	3	5.1	
Q15	Usual (1) – Leading Edge (7)	5	4	3	5	3	5	4	5	4	3	4.1	
Q16	Unpleasant (1) – Pleasant (7)	5	4	6	5	5	5	5	6	5	3	4.9	
Q20	Inefficient (1) – Efficient (7)	5	6	6	5	6	6	5	6	5	4	5.4	
Q22	Impractical (1) – Practical (7)	5	3	5	5	5	5	5	6	4	3	4.6	
Q26	Conservative (1) – Innovative (7)	4	4	5	5	3	6	4	4	4	3	4.2	
Avg		5	4	5	5	5	5	4	5	5	3.3		
Avg of Avg		4.569230769											

TABLE 2. SCORES FOR QUESTIONS THAT HAVE A SCALE FROM GOOD TO BAD

Questions	Criterias / Users	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	Avg	Avg of Avg
Q3	Creative (1) – Dull (7)	5	3	3	5	4	6	3	1	4	4	3.8	
Q4	Easy to learn (1) – Difficult to learn (7)	3	4	7	4	3	4	5	1	3	1	3.5	
Q5	Valuable (1) – Inferior (7)	5	3	3	5	3	4	3	2	4	4	3.6	
Q9	Fast (1) – Slow (7)	5	3	6	4	6	4	4	4	4	3	4.3	
Q10	Inventive (1) – Conventional (7)	5	3	3	5	2	4	4	4	4	3	3.7	
Q12	Good (1) – bad (7)	4	4	2	4	2	3	3	2	3	2	2.9	
Q17	Secure (1) – Not Secure (7)	4	4	3	6	2	6	4	2	4	4	3.9	3.4769231
Q18	Motivating (1) – Demotivating (7)	3	5	3	6	3	3	3	1	2	4	3.3	
Q19	Meets expectations (1) – Does not meet expectations (7)	4	5	3	3	2	3	4	4	2	4	3.4	
Q21	Clear (1) – Confusing (7)	4	4	3	4	2	3	5	2	3	4	3.4	
Q23	Organised (1) – Cluttered (7)	3	3	3	3	2	4	3	4	3	3	3.1	
Q24	Attractive (1) – Unattractive (7)	3	4	3	3	3	3	4	2	3	3	3.1	
Q25	Friendly (1) – Unfriendly (7)	3	5	3	3	3	4	4	1	3	3	3.2	
Avg		4	4	3	4	3	4	4	2	3	3.2		
Avg of Avg		3.476923077											

A drill-down analysis (Table 3a) reveals that the most positive attributes are efficient, enjoyable, exciting, and pleasant. For question 26, some respondents did not fill in and thus the total responses is less than 10.

TABLE 3A. TOP POSITIVE ATTRIBUTES FROM TABLE 1.

Question	Attribute	4 and above	Below 4
Q20	Efficient	10	0
Q1	Enjoyable	9	1
Q6	Exciting	9	1
Q16	Pleasant	9	1
Q2	Understandable	8	2
Q11	Supportive	8	2
Q14	Pleasing	8	2
Q22	Practical	8	2
Q7	Interesting	7	3
Q13	Easy	7	3
Q15	Leading edge	7	3
Q8	Predictable	6	4
Q26	Innovative	3	2

There is consistency in findings between Tables 3a and 3b, with the top 5 attributes in Table 3b confirming the system's efficiency, enjoyability, excitingness and pleasantness (attractiveness).

TABLE 3B. TOP POSITIVE ATTRIBUTES FROM TABLE 2.

Question	Attribute	Below 4	4 and above
Q24	Attractive	8	2
Q25	Friendly	7	3
Q23	Organized	7	3
Q18	Motivating	7	3
Q12	Good	7	3
Q21	Clear	5	5
Q19	Meets expectations	5	5
Q5	Valuable	5	5
Q4	Easy to learn	5	5
Q10	Inventive	4	6
Q3	Creative	4	6
Q17	Secure	3	7
Q9	Fast	2	8

D. Norman's usability testing

So as to confirm our findings above, another study on ten seniors (not from the D'Happy Club) but within the same age group, is carried out using Norman's usability design principles. The questions for Donald Norman's questionnaire are as follows:

1) Could you navigate the application easily?
2) Are the words clear enough?
3) Are the photos clear enough?
4) Could you identify the places that you could tap easily?
5) Could you play all three (3) games easily?
6) Would you prefer the game in portrait or landscape view?
7) Would you prefer the game on your phone or on the computer?
8) What do you think about the overall design of this game?

As shown in Tables 4a and 4b, most users involved in the user testing could navigate the application easily and identify the places that they could tap easily. The words and photos available in the game were also adequate in terms of clarity. Hence, there is adequate affordance though embedded.

TABLE 4A. DATA COLLECTED FROM DONALD NORMAN'S QUESTIONNAIRE.

Users / Questions	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
U1	Yes	Absolutely Yes	Yes	Yes	Yes	Landscape	Computer	Good
U2	Yes	Neutral	Yes	Neutral	Yes	Landscape	Computer	Good
U3	Yes	Yes	Yes	Yes	Yes	Landscape	Phone	Good
U4	Yes	Yes	Neutral	Yes	Neutral	Landscape	Computer	Good
U5	Yes	Yes	Neutral	Yes	Yes	Landscape	Phone	Good
U6	Absolutely Yes	Absolutely Yes	Yes	Yes	Neutral	Portrait	Phone	Good
U7	Yes	Yes	Yes	Neutral	Yes	Portrait	Phone	Good
U8	Yes	Yes	Neutral	Yes	Yes	Landscape	Computer	Good
U9	Yes	Yes	Yes	Yes	Yes	Portrait	Phone	Good
U10	Yes	Yes	Yes	Yes	Yes	Portrait	Phone	Good

TABLE 4B. FINER ANALYSIS WITH REGARDS TO LAYOUT

Criterias / Questions	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Absolutely No	-	-	-	-	-	-	-	-
No	-	-	-	-	-	-	-	-
Neutral	-	1	3	2	2	-	-	-
Yes	9	7	7	8	8	-	-	-
Absolutely Yes	1	2	-	-	-	-	-	-
Portrait	-	-	-	-	-	4	-	-
Landscape	-	-	-	-	-	6	-	-
Phone	-	-	-	-	-	-	6	-
Computer	-	-	-	-	-	-	4	-
Good	-	-	-	-	-	-	-	10
Bad	-	-	-	-	-	-	-	-

Other than that, the users preferred the application in landscape mode, hence the game was designed in that view initially via HTML and CSS. Majority also preferred the game to be on the computer. The game is already made available on Web version. Lastly, all of the testers rated the overall design of the application as good.

E. Cognitive load testing

Based on the above positive results, we tested on the latter group of active seniors. Findings (Tables 5a, 5b and 5c) are similar as the above.

Based on the analysis and the majority's given values, the users did not require a lot of mental effort to finish the task. It was easy to finish the task, and the task that was required to complete held the user's attention. Moreover, the task that they needed to perform stimulated their curiosity and kept their attention, the tasks had relevant to the user's life and there were sufficient instructions to show the users how to perform the tasks. They were positive that they had the ability to complete the task, were confident, and that the tasks were challenging for them. Lastly, they were satisfied, and pleased with the application. Therefore, the overall pros have outweighed the cons.

TABLE 5A. QUESTIONS THAT HAVE A SCALE FROM GOOD TO BAD: 29% (STILL INCLINED TOWARDS THE LEFT SCALES, I.E., THE POSITIVES)

No.	Questions	Criterias	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	Avg	Avg of Avg
2	Degree of difficulty	Very easy (1) – Very difficult (7)	2	3	1	4	1	2	2	1	3	2	2.1	2.7
6	Customizing flexibility encourages paritiicipant to engage in activities	Strongly agree (1) – Strongly disagree (7)	4	5	3	5	1	2	2	1	1	2	2.6	
7	Good clarity for participants to clear activities	Strongly agree (1) – Strongly disagree (7)	6	7	6	7	1	1	2	1	1	2	3.4	
Avg			4	5	3	5	1	2	2	1	2	2		
Avg of Avg			2.7											

TABLE 5B. QUESTIONS THAT HAVE A SCALE FROM BAD TO GOOD (1): 76% (STILL INCLINED TOWARDS THE RIGHT SCALES, I.E., THE POSITIVES)

No.	Questions	Criterias	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	Avg	Avg of Avg
1	Use a lot of mental effort	Not at all true (1) – Very true (7)	4	2	1	4	1	3	3	1	3	3	2.5	5.31
3	Activities holds attention	Not at all true (1) – Very true (7)	5	5	6	6	6	5	6	6	5	5	5.5	
4	Task stimulates curiosity	Not at all true (1) – Very true (7)	6	7	4	7	7	5	5	4	6	5	5.6	
5	Variety of activities keep attention	Not at all true (1) – Very true (7)	5	6	6	4	5	4	5	4	6	4	4.9	
8	Task are relevant to participant's life	Not at all true (1) – Very true (7)	5	5	6	4	6	5	6	4	5	4	5	
9	Sufficient instructions for performing task provided	Not at all true (1) – Very true (7)	7	6	5	5	7	7	6	7	7	7	6.4	
10	Confident having the ability to perform task	Not at all true (1) – Very true (7)	2	1	7	4	7	7	7	7	7	6	5.5	
11	Confident in completing task	Not at all true (1) – Very true (7)	6	5	7	5	7	7	7	7	7	7	6.5	
12	Activities are challenging	Strongly agree (1) –	1	2	3	7	7	7	7	6	7	6	5.3	
13	Task	Very dissatisfied (1) – Very satisfied (7)	5	5	6	7	6	6	5	7	6	6	5.9	
Avg			5	4	5	5	6	6	6	5	6	5.3		
Avg of avg			5.31											

TABLE 5C. QUESTIONS THAT HAVE A SCALE FROM BAD TO GOOD (2): 69% (STILL INCLINED TOWARDS THE RIGHT SCALES, I.E., THE POSITIVES)

No.	Questions	Criterias	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	Avg	Avg of Avg
14	Task	Very displeased (1) - Very pleased (7)	2	2	1	-	7	6	6	7	6	7	4.9	4.81481481
15	Task	Very frusrated (1) - Very contented (7)	1	1	1	-	7	7	6	7	6	7	4.8	
16	Task	Very unpleasant (1) - Very pleasant (7)	1	1	1	-	7	7	6	7	6	7	4.8	
Avg			1	1	1	-	7	7	6	7	6	7		
Avg of avg			4.814814815											

V. CONCLUSION

Consistent with Norman's usability principles, and the Technology Acceptance Model, the simplicity of the design, ease of use and usefulness have been regarded as of primary importance. Furthermore, since all data will be stored in Firebase, we will carry out simple analytics in order to identify how to further meet the needs of the elderlies. It is especially hoped that the affordances factored in would be able to help them to have fun, subsequently, more interests and socio- cognitive- engagements and happier times.

ACKNOWLEDGEMENT

This study is funded under the Malaysian Ministry of Education's Fundamental Research Grant Scheme. We thank Adjunct Assoc. Prof. Dr. Siew-Fan Wong for the design of the cognitive load questionnaire.

REFERENCES

[1] TheSundaily. "M'sia to become ageing population country by 2030." | [ONLINE] Available at: http://www.thesundaily.my/news/1357641 [Accessed 18 October 2016].

[2] S. Mohd Sidik. "The Prevalence of Depression Among the Elderly in Sepang, Selangor". 2004. [ONLINE] Available at: http://www.e-mjm.org/2004/v59n1/Depression.pdf [Accessed 18 October 2016].

[3] A. Rashid, A. Manan and S Rohana. "Depression Among The Elderly Malays Living In Rural Malaysia". 2010. [ONLINE] Available at: http://ispub.com/IJPH/1/2/4793 [Accessed 18 October 2016].

[4] Care Giver Stress. "5 Benefits of Technology to Share with Seniors and Their Caregivers". 2016. [ONLINE] Available at: http://www.caregiverstress.com/geriatric-professional-resources/5-benefits-of-technology-to-share-with-seniors-and-their-caregivers/ [Accessed 1 October 2016].

[5] R. Wong. No room for old folk in Malaysia. 2014. [ONLINE] Available at: http://www.theheatmalaysia.com/SOCIO-ECONOMICS/No-room-for-old-folk-in-Malaysia [Accessed 24 October 2016].

[6] Ruhani Binti Haji Zawawi. Active ageing in Malaysia. 2013. [ONLINE] Available at: http://www.mhlw.go.jp/stf/shingi/2r98520000036yla-att/2r98520000036yqa_1.pdf [Accessed 2 October 2016].

[7] J. Wakefield. "The generation that tech forgot". 2015 [ONLINE] Available at: http://www.bbc.com/news/technology-32511489 [Accessed 24 October 2016].

[8] D. Orenstein. "Elderly brains learn, but maybe too much". 2014. [ONLINE] Available at: https://news.brown.edu/articles/2014/11/irrelevant [Accessed 29 October 2016].

[9]M. Wilson. "When is Learnability More Important than Usability?" 2011. [ONLINE] Available at: http://www.uxbooth.com/articles/when-is-learnability-more-important-than-usability/ [Accessed 2 October 2016].

[10] Meko. 2016. EA's Monopoly Bingo app reviewed for iOS and Android. [ONLINE] Available at: http://casinoapp.eu/monopoly-bingo/ [Accessed 29 October 2016].

[11] S. Y. Guy, and C. S. Lee, "Web and augmented reality-enhanced portal for youths and seniors," Capstone project, Sunway University, Malaysia.

[12]K. Matz. "Donald Norman's design principles for usability". 2012. [ONLINE] Available at: http://architectingusability.com/2012/06/28/donald-normans-design-principles-for-usability/ [Accessed 24 October 2016].

[13]Bingo Bash - Android Apps on Google Play. 2016. Bingo Bash - Android Apps on Google Play. [ONLINE] Available at: https://play.google.com/store/apps/details?id=air.com.bitrhymes.bingo&hl=en [Accessed 24 October 2016].

[14]M. Kennedy. "Case Study: Applying Agile Software Methods to Systems Engineering". 2016 [ONLINE] Available at: https://www.csiac.org/journal-article/case-study-applying-agile-software-methods-to-systems-engineering/ [Accessed 31 October 2016].

[15]Don Norman. "Design of Everyday Things". 2013. [ONLINE] Available at: http://cc.droolcup.com/wp-content/uploads/2015/07/The-Design-of-Everyday-Things-Revised-and-Expanded-Edition.pdf