

Designing Serious Game Metrics for Family Caregivers of People with Dementia

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Abstract

The paper presents a conceptual framework and a metric instrument for assisting design and evaluating serious games for dementia family carers as the first step towards designing a game specifically designed to cater for their needs. The paper starts with a literature survey on dementia, dementia family carers and existing games for health issues. From this survey, three components of the carers' needs (health, education and social), three platforms (social marketing, social media and games) and six game contents (game play, avatar portrayal, game world graphics, sound / music and storyline) were identified, and engagement as the metric of interaction was also identified. With these, a conceptual framework was constructed, identifying the relationship amongst these elements. Based on these, the metric instrument is devised using the Goal Question Metric (GQM) method. An exploratory experiment was conducted with six health-related games and five game professionals to assess the effectiveness of the instrument. It is found that the instrument can identify the successfulness of the games in terms of satisfying the three categories of needs of the carer, i.e., health, education and social, though it was suggested that a further experiment with more participants and focusing on one game would be needed to further verify the effectiveness of the instrument.

Keywords: *Serious games, Dementia Family, Metrics Instrument, Games for Health, Social Games;*

1 Introduction

The majority of research in the area of dementia so far is focused on the dementia patients [1][2]. However, family members who become carers are also key people affected by a diagnosis of dementia [3]. The main issue is that dementia family do not get enough support, especially as dementia care might cause emotional issues for the family carers as many of them feel isolated, depressed and stressed [4] [5]. Some recent researches have expanded to games for mental health improvement, but the main research focus is still on the patients.

Games metrics are devised based on frameworks to measuring the games within different purposes in supporting dementia family members. Our metric instrument is based on the framework with three components, three platforms and engagement as its main elements. The conceptual framework is discussed alongside the carer's needs and the use of online platforms to directly support dementia family carers.

Three main approaches to support and inform dementia family were: increasing the knowledge of dementia, understanding health issues as a family carers, and encouraging communities of fellow family carers [6]. In order to provide these services, digital interventions were researched. From this research, three main themes emerged: social marketing [7], games [8][9], and social media [10]. Our conjecture is that our framework, created using the concepts found in social marketing, games and the use of social media, can help to engage users and so

help deliver the tools needed to support carers. We also believe that these features can help engage people in different platforms [11] [12].

Based on the framework, the metric instrument with metric tables was developed using the Goal/Question/Metric (GQM) method. Then an exploratory experiment was conducted with game professionals on some existing games focusing on other health issues to see if it could be used to identify the meaning of each game. This would then inform the future development of the mock up the games for testing with dementia family.

In the first stage of the research, games are the main interventions to increase the players' knowledge of the health issues facing the family members of dementia patients in general and the main carers in particular.

2 Background

This paper focuses on early-stage dementia family carers. The purpose is to investigate novel methods to support dementia family caregivers through games. In order to develop the relevant framework and set up the framework elements, this paper also includes the reviewing of existing research within three fields, namely dementia carer's needs, game's purpose and games for dementia and dementia family carers. In addition, the metric instrument is developed based on the framework.

2.1 Dementia carer's need

A diagnosis of dementia can be a very stressful and challenging time for family members, particularly for those directly assisting the member with dementia. The patient's carers play an important role in providing treatment [2].

There are various ways to support dementia carers, such as psycho-education, support and information, training courses, and involvement of other family numbers [14]. Dementia patients and carers might need psychological education and as well as a community within which to share their experiences [14]. An educational platform could encourage dementia carers to understand more about dementia and offer knowledge to assist the support group.

Social support is an important service for dementia carers [2]. Communities help carers share information and communication about their problems. This lessens the burdens of the carers regarding their physical, mental and social wellbeing[11]. Most research in this field is focused on the carer's knowledge and psychological morbidity. Additionally, psychological education could be helpful to inform them how best to cope with a potential mental health condition so as to live as good a life as possible.

2.2 Games' Purpose

The primary purpose of serious games is not entertainment [8]. For example, advergames are promotional tools for particular products[14] ; educational serious games are primarily learning tools; and games for social change have been used to raise public awareness of social issues, such as human rights, climate change and public health, and help to address these problems [15] Likewise, the field of serious games for health aims to supply education- and health-associated behaviour change by delivering messages and user experiences in an engaging and entertaining format [16]. The addition of game elements within such a given situation to increase the user's motivation and engagement is called gamification [17].

Games can be divided into various categories based on different main purposes for the family carers, i.e., health, education or social. Games for Health: These games cater for physiological or psychological needs. For example, ReachOut Orb focuses on mental finesse and wellbeing, and it helps the students improve their education and health. Games for Education (Serious games): These games facilitate interactive play that contributes to the user's learning process [18]. For instance, Endgame Eurasia is a game for understanding the complex

situation of the Syrian civil war. Social Games: These games strengthen the social connectivity of the users. This type of games could also be a useful tool to raise social awareness. For example, Homeland Guantamos. This game uses the real story of Boubacar Bahto to highlight the issues of the unfair policies of the US Department of Homeland Security.

2.3 Games for dementia and dementia family carers

The various studies for dementia using technology are focused on brain training. For example, Professor Simone Kuhn at the Max-Planck Institute of Human Development in Berlin studied the effects of video games [18]. For his research, he used a currently existing game, “Super Mario 64” (an action-adventure game). On the other hand, Magic Table is a game specially designed to help dementia sufferers. It is very popular in the care homes and has shown particularly successful results in Northland, New Zealand[19].

There are a few games designed to support Alzheimer’s disease research, such as Stall Catchers and Sea Hero Quest. Stall Catcher is a game to speed up the search for a treatment[20]. In the game, the player have to watch the real blood vessels in mouse brains by catching stalls which are clogged capillaries where blood is no longer flowing. Sea Hero Quest helps scientists’ fight dementia by tracking anonymously the players’ navigational data so that the scientists can use them to study the loss of three-dimensional navigational skills in dementia patients[21].

Additionally, there are exciting games that could potentially help family caregivers on their mental health issues [22]. For instance, Elude was created by MIT Game Lab for raising the awareness of depression, and That Dragon, Cancer was created around an autobiography of Joel’s parents that traced the story of the family’s life of caring for the 12-month-old boy with cancer.

Exciting games are used for dementia itself for brain training or physical activity. Currently, there is no game to educate carers of people of dementia and improve their wellbeing by engaging them with the game’s story. To achieve this, the design of such games could focus on presenting the health issues through the game’s story so that, during gaming, the players acquire information to improve their knowledge on health. This in turn could improve their behaviour and thoughts about the issue they are dealing with. Specifically, games can be designed to provide the basic knowledge about dementia for carers. Once carers understand dementia, they are better informed about how to live with dementia, and thus less likely to become stressed and their capacity as carers increases.

3 Conceptual Framework

Based on the review of dementia carer’s need and examples of using exiting games above, a conceptual framework is constructed to highlight the elements and the mechanisms for supporting dementia family carers through games. This proposed conceptual framework is shown in Figure 1.

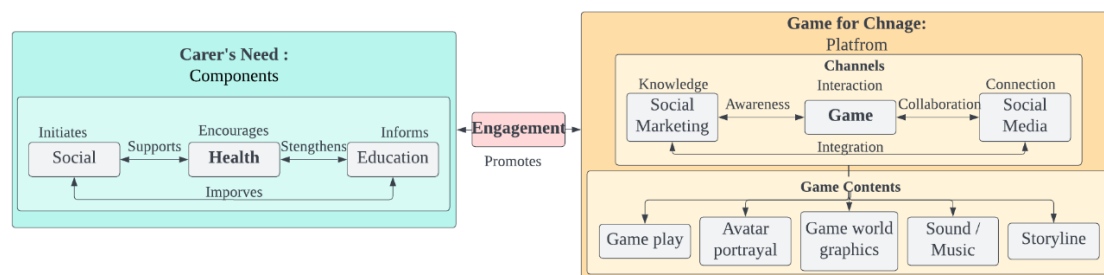


Figure 1. *Conceptual Framework: To Support Family Caregivers with Dementia.*

According to the theory of social marketing, social media and games could exert social impacts on particular issues. This is achieved through engagement. The family caregivers of people with dementia have various needs, such as the need to increase their knowledge of dementia in order to be equipped to support people with dementia and to cope with it in their lives [18], especially in the early stage. These needs are satisfied through engagement. Thus, in the conceptual framework, three main components are identified, namely the carer's needs, the game-for-change platform, and engagement, which provides the link between the carer's needs and the game-for-change platform.

Furthermore, within the carer's needs, three additional components are identified, namely education, health and social, and their goals and relations highlighted. The game-for-change platform is further subdivided into channels and game contents. The channels consists of three components, namely social marketing, game and social media, and their roles and relations highlighted. The contents of the game including: Game play, Avatar portrayal, Game world graphics, Sound/Music and Storyline. The crucial role of engagement in promoting the achievements of the goals and the fulfilment of the roles are then highlighted.

A. Carer's Need

Whilst there is a wealth of exciting research and support for dementia, there is still not enough for carers specifically. The main problems are: 1) Limited platforms or services unavailable. There are many exciting services for carers but it is hard to find the right support at the right time. 2) Psychological problems. Dementia caring is hard work and carers may feel isolated and stressed. 3) Not enough knowledge of dementia itself [23]. Carers might not understand dementia particularly well, or that everyone is affected differently. The game can be used by the dementia carer as a platform to understand dementia, to increase their knowledge and reduce their stress. Through the game, a social platform can emerge, such as an online platform or an expansion of existing offline local communities.

B. Game-for-Change

Game-for-Change platform consists of twos part, namely channels and game contents. The details are described below:

a. Channels

Social marketing can be related to various bodies of knowledge, for example, psychology, sociology, anthropology and communication theory. There is a quantity of research related to the use of social marketing to promote public health, health communication, environment, transportation, finance, etc [24]. Social marketing provides the knowledge and social impact in the marketplace. Games constitute an interactive tool to communicate with target audiences. Interactive games can be used as an entertainment tool to increase learning, exploratory and participatory behaviours. The aim of this particular game is to provide the platform needed for an enhanced understanding of dementia.

b. Game Contents

There are many research methods for game analysis. The analysis of games by contents are focused on the user experience in the game environment. The message and information about dementia can be delivered through the gameplay [25]. Avatar portrayal gives meaningful messages about their health by personalisation, appearance and behaviour of the character [26]. The graphics in a game shows a realistic environment [27]. The game's background music and sounds can enhance the learning process. For example, voice-over can be used to explain dementia to the players [28].

Thus, through engagement, the game-for-change platforms satisfies the carer's educational, health and social needs by increasing the carers' community size and improving their knowledge of relevant health issues.

4 Metrics Instrument

This session describes the metric methodology and development of the metric instruments such as metric table and GQM (Goal Question Metric).

4.1 Metric Methodology

The metric instrument is based on the framework within two tables. 1. Metric table based on the framework elements (shown in Appendix A). 2. GQM table create from the first metric table (Shown in Appendix B).

A. Purpose

The purpose of the metric instrument is to measure the framework elements' reliability. The GQM table is used for the software metrics to structure and devise this instrument.

B. Method

Metric developed based on the elements of carer's needs (health, education and social) identified in the framework and elements identified in the contents of game-for-change platforms (Channels: social marketing, social media and game; Game contents: gameplay, Avatar portrayal, game world graphics, sound/ music and storyline) are shown in Appendix A.

The metric instrument is devised using the Goal Question Metric (GQM) method to construct measurements for testing a selection of games in Appendix B. The GQM table with the reverse-worded questions was used to ensure reliability.

C. Procedure

The metric instrument was created by framework within two steps. Firstly, a metric table was set up according to the framework in Appendix A. Secondly, GQM table was set up based on metric table in Appendix B.

4.2 Development the Metrics Instrument

A. A Metric Table

The metric table was developed based on the framework elements. In game-for-change channels (social marketing, social media and games) are the tools which is distributed in the metric instrument. The metric for game contents in Table 1. The scope and focus of the evaluation of these framework elements are described below.

Table 1. *Metric for game contents*

Game Contents	Question Code	The goals of the metric instrument
Gameplay	GP_Gamesupport	Game support with more than one purpose
	GP_Message	Game feedback, message and information links with the game purpose
	GP_Collaboration	Game combines with other platforms
Avatar Portrayal	AP_Avatar	Avatars give the meaning message
Game world graphics	GW_Realism	Game world shows a realistic environment
Sound/ Music	SM_Background music	Including the voice and sound supports the game with more meaning
Storyline	SL_Compelling	Storyline keeps the player engaged in the game

Game play

Game play is about the game's relevance to knowledge and skill transfer, as well as the extent of engagement, immerse and motivation through the game [25]. Game play is further divided into three subgroups, namely support, message and collaboration. Game support is linked with game purpose; Game message includes game feedback and message driver for play; Game collaboration is the game's connection to and cooperation with other platforms. The parameter of gameplay in Table 2.

Table 2. Parameter of gameplay

Parameter		
Game Support: with more than one support)	Message: Game feedback, message and information links with the game purpose	Collaboration: Game combines with other platforms
Game educates players to increase their knowledge of health	Give the message/ information as education components to achieve changes in health behaviour	Game collaboration with education components to help players understand the health issues
Social media as an online community to support health	Game's message/ information links with community to support health	Game links with social support to discuss player's health issues
Game as a platform to engage players and improve their health	Community encouraging players to discuss the game's message /information and improve player health	Game uses engagement to improve health
Social elements in the game to support the community to spread the knowledge	The game's message / information links with communities to encourage player education	Game collaboration with social media to increase the size of communities to encourage education components
The game shows multiple ways to solve the problems, and also involve other players' views	Game's message/ information can be discussed with other players	Game engages players to inform educate component
Social marketing with game to raise awareness	Game's message / information encourages the player to produce social components	The game provides a chat room, game community, email/messaging, 'buddy list' or link to a social networking website

Avatar Portrayal

Avatar representation is about the personalisation, appearance and behaviour of the character [26]. The player may be able to modify their avatar by gender selection and features. Characters/avatars are selected by character gender such as asexual, androgynous, multi species, etc. The portrayal/avatar are customised by allowing the user to choose clothing and physical appearance such as formal, traditional, culture, western, eastern, etc. The behaviour of the avatar is usually determined by the avatar's role and personality trait [29]. For example, male characters could be strange and female characters could be spies, etc. The parameter of Portrayal are depicted in Table 3.

Table 3. Parameter of avatar portrayal

Parameter	
Avatars give the meaning message	Game gives the message for changing health behaviour through avatar characteristics
	Avatars engage other players, as group effect attempting to change health behaviours
	Using avatars to engage communities and improve health
	Using the avatars links with social platforms to encourage player education
	Avatars can be social components to engage users and inform education
	Avatar portrayal to engage player produces social components

Game world graphics

This concerns the graphics in a game, including the colours, shapes, etc. Different colours and shapes can show different emotions. Game world realism is about how realistic the scenes are depicted graphically, such as the showing of shadows or life- like characters [29]. The parameter of Game world graphics are depicted in Table 4.

Table 4. Parameter of Game world graphics

	Parameter
Game world shows a realistic environment	Game world shows real life or real situations involving the health issues
	Game world with real community support to change health behaviours
	Game world engages people with health behaviours
	Game's world presented to real life and using the social community to inform education
	Game world gives information that would be useful in real life.
	Game word encourages similar types of player to produce communities

Sound / Music

This concerns the background music and sound effects of the game. Normally within a game, users can choose different sound effects or music [28]. The parameter of Sound / Music Table 5.

Table 5. Parameter of Sound / Music

	Parameter
Background music including the voice and sound supports the game with more meaning	Background voice gives meaningful health messages
	Game can share the players' voice to support health
	Background music can encourage players to improve their health
	Social voice encourages players to get knowledge
	Background voice/ music can encourage players to get knowledge.
	Background music/ sound is able to encourage players to produce communities

Storyline

This is related to the storyline which gives the game its meaning. It will give the game a purpose and help in the development of the game. For example, if the aim is to have a successful farm, the players will need to learn how to grow different types of vegetables or flowers and how to deal with the markets' needs. The parameter of storyline in Table 6.

Table 6. Parameter of Storyline

	Parameter
Storyline keeps the player engaged in the game	Game story educates the player and change health behaviour
	Game story with the social components to keep the players engaged
	Game story is able to encourage players to improve the health
	The storyline is entertaining enough to keep the player interested in the game, using plot twists, conflict and interesting characterization
	Game story can engage players, informing the education components
	Game story engages players, increasing the size of the person's community

B. The instrument applied to the game (GQM table)

The GQM measurement within three levels are conceptual level (goal), operational level (question) and quantitative level (metric). This research focuses on the conceptual level. The operational level is the quality of questions used to specific goals. The quantitative level is a set of metrics to answer the questions [30].

In this paper, describe the three main goals such as health, education and social. Engagement is a main element that promotes between the carer’s needs and the game-for-change. Thu, in each elements of the carer’s needs will involve with “engagement”. The goals of the metric instrument for carer’s need in Table 7.

Table 7. The goals of the metric instrument for Carer’s need

Elements	Question Code	The goals of the metric instrument
Health	H1	To evaluate how education strengthens the health element
	H2	To evaluate how social media supports the health element
	H3	To evaluate how engagement improves the health element
Education	E1	To evaluate how the social element encourages the education component
	E2	To evaluate how engagement assists the education element through informing the players
Social	S1	To evaluate how engagement is achieved through the use of the social component

Health

This is to measure how and to what extent a game can increase the carers’ ability to manage their lives better with improved health and wellbeing. It also includes how the online community can allow people to benefit from openly discussing and sharing their respective experiences. The goals of the metric instrument in health, see in Table 8.

Table 8. Goal and Metric in Health

Sub Goal	Metrics
To evaluate how education strengthens the Health component	While playing, I gained new knowledge from the game’s message/information section about how to improve health.
	* The game’s message/ information does not give enough information about health issues.
	* While playing, I don’t feel the game educated the player about the health issues.
	Adjusting the characteristics of the game’s avatars could change the players’ health behaviour.
	I felt the game was related to real life situations which involve health issues.
	* I don’t think building a realistic environment is necessary to help understand the health issues the game is trying to indicate.
	The game’s background music / sound got in the way of understanding the health issues.
	The game’s background narrator or commentator gave supporting information about the health issues.
	After I play through the game’s story, I understand more about health issues.
	* After I play through the game I do not think I will change my health behaviour.
Evaluate how social media supports the Health element	Playing the game in combination with social media platforms can help support people with their health issues.
	* I don’t think using the online community will be able to support people with their health issues.
	The game allowed me to link with communities to discuss the health issues.
	* The game does not facilitate the with community members to discuss the health issues.
	Using an avatar whilst playing the game helps to bring me closer to the community.
	I feel that by using my avatar within the community helps me to change my health behaviours.
	I think the game world encourages players to seek out real-world communities to find support for their health issues.
	In the game, I was allowed speak to other people about health issues.
	I felt the game story made me interested in finding out more about health.
	* Whilst playing the game, I don’t focus on the game story.
Evaluate engagement improve Health element	I think the social aspects of the platform help to engage with other people to improve health.
	* The platform did not allow engagement with the community in order to improve health.
	* I did not find the game engaging enough to improve healthy behaviour.



	While playing, I found the game elements (avatars, graphics and music) can change our behaviours.
	While playing the game I found the game elements (avatars, graphics and music) can engage people with the health issues.
	* Whilst playing the game, the game world encourages people to engage on health issues.
	* when playing the game, the background music does not help engage people in the health issues.
	While playing, I felt motivated by the game story to improve my health behaviour.

* reverse-worded questions

Education

This is to measure how a game can be used to enhance the players’ knowledge about dementia by conveying useful and informative messages during the game. The goals of the metric instrument in education, see in Table 9.

Table 9. Goal and Metric in Education

Sub Goal	Metrics
Evaluate Social component encourages Education component	I found the social platform associated with the game helped me discuss issues with the communities.
	* I don't think the game provides new things to learn.
	I felt the social platform associated with the game increased the size of communities through which I can discuss the issues.
	I found using an avatars helped me connect with social media.
	I found using the asocial media platform associated with the game enabled me to get more information.
	I found that the game world represents real life issues.
	I found that the game world involving social communities allowed me to be informed about the issues.
	I think the background music and sound helped be related to the education.
	The background narrator or commentator supplying more information.
	I felt the game used plot twists, conflict and interesting characterization to make it more interesting.
To Evaluation engagement informs education component	I found the game shows different ways to handle real life issues.
	The game's message is interesting enough to discuss with other people.
	* I don't think the gameplay can engage people to get new knowledge.
	I found the avatar can motivate other players to discuss issues.
	The game world graphics and background music give new knowledge about the real world.
	* I don't feel the background music and sound will help motivate people to obtain new knowledge.
After I play a game, I would discuss the issues with other players.	
After I played a game, through discussing the issues with other players, I made friends.	

* reverse-worded questions

Social

This is to measure the effectiveness of the social components. The game can be linked with websites, social media or local communities to create a supportive environment which promotes sharing and open discussions of the issue. The goals of the metric instrument in social see in Table 10.

Sub Goal	Metrics
Evaluate engagement produces social component	I found the game can raise social awareness of the issues.
	I think social is very important in game's element
	* I don't think the game's social component help raise awareness.
	I think the game's message and information lead to people becoming involved in the community.



* I don't feel the game's social media encouraged players to get deeply involved with each other
The avatar and game world helped me to connect with other players of similar styles of avatars.
* I don't feel the game world helped players grow the size of the communities.
I think the background music and sound helped to link with other players in the game.
I found the game story helped me to discuss similar interesting issues with other players.
I found that discussing similar interesting issue with players helped increase the size of the community.

Table 10. *Goal and Metric in Social*

* reverse-worded questions

The full outcomes of the GQM with fifty-six Likert items within three main goals are shown in Appendix B. Thus, following the methodology of GQM, a metric table and the corresponding metric instrument are devised. The metric table is set based on the framework elements within the components and platforms connect with game content, and the metric instrument is devised for the evaluation of the framework elements in further exploratory experiments, where it is used to test the effectiveness of the games designed to meet the health, education and social needs of dementia family carers.

5 Exploratory Experiment

The stage of exploratory experiments was testing existing games with game professionals. This stage demonstrated the metric's reliability whilst eliciting the industry professionals' point of views. This study involved the metrics applied to the evaluation of framework elements on a existing games to collect feedback on how to address elements form the framework in an actual game. The metric survey was used to get game developers, designers and researchers to use the metrics with six games and analyse the results to see if they could use the metrics reliably with a total of thirty responses from five participants. This study was focused on the games themselves.

Most of the games for dementia focused on brain training (cognitive training). This research focuses on the caregivers instead. Thus the games were chosen from the games for change related to health issues, especially for family caregivers.

The chosen ones were:

- Re-Mission : The game is designed to aid a young patient's psychological health; it is made to help cancer patients and their families understand the positive ways to fight cancer with different treatments.
- Cancer game : This game displays the symptoms and causes of cancer, and gives knowledge of healthy behaviours.
- Sea Hero Quest : This is an Alzheimer's research game used to assist the global research into dementia.
- Life in Spin : This game gives practical support and advice to young adult carers. Game-play is set around balancing caring and other daily activities in everyday life.
- The Dysphagia Game : This game was developed with the NHS; it gives knowledge of dysphagia.
- NHS Nene CCG : This game shows the NHS services for different health situations to help people and carers when they are unwell.

The data collection and analysis were done through correspondences with game professionals in the game industry. The data were collected from the set of metrics in the questionnaires in the correspondences. Their feedbacks were measured by a set of metrics created to assess how the games followed the principles of the framework. The data were analysed using the SPSS statistics software.

5.1 Results of applying metrics to the games

The normality tests were used to check the participants' data for normality, and the results are shown in Table 11. The Kolmogorov-Smirnov and Shapiro-Wilk tests had significant results ($p < 0.05$), indicating that data were not normally distributed with regards to Health_Education, Health_Engagement and Social_Engagement. A t-test was therefore not considered appropriate to compare the means, since such test would assume that the sample distributions of the data are normal. For this reason, an alternative non-parametric test was used to compare the means, as this does not presume the data distribution to be normal.

The results were significant with regards to the Health_Education, Health_Engagement and Social_Engagement correlations. The majority of the games were focused on one purpose, while other purposes could exist as additional supports.

The results of a non-parametric means test are shown in Table 12. The 30 responses from six games were compared against a null value. The null value was calculated from the sum of "Neither" (Neither = 3), which on the Likert scales was represented by the value 3. The Mann-Whitney test did not show a significant result ($p > 0.05$), meaning that the results could happen due to chances. The results did not constitute strong proof for the metrics table to be reliable. However, following discussion shows the meaning of each game in Appendix C. Based on the result of game 1 Re-Mission is focused on the health with engagement components and education components with engagement element. There were positive result of game 2 and 4 Life in Spin. However, health with social components wasn't shows successful. The compared of game 2 with game 4 had entertainment meaning to attract with players. In compliance with result, game 3 Sea Hero Quest was successful on health with education components and health component with engagement element. According result, game 5 The Dysphagia Game shows health with education and social with engagement had successful result. In addition, game 6 Brain Training Game Demonstration had unsuccessful result; nonetheless, the game had same value with null on the components of health with social which means neither. The analysis showed that the mean rank with the game itself and the null value (Null = 3 "Neither"). There are three main issues that might have affected the result. First, there are no existing items available with health education and social platforms. Secondly, social components are complex to measure as the online and real communities as well as their cultural backgrounds are involved. Thirdly, as a general exploration of the games within different purposes was conducted in this study, having the same person doing tests with six different types of games might have affected the results even though the games are all related to the public health issues.

Table 11. Normality test

	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistics	Df	Sig.	Statistics	df	Sig.
Health_Education	.159	30	.050	.881	30	.003
Health_Social	.075	30	.200*	.974	30	.649
Health_Engagement	.162	30	.044	.903	30	.010
Education_Social	.158	30	.055	.937	30	.073
Education_Engagement	.142	30	.129	.956	30	.251
Social_Engagement	.168	30	.031	.923	30	.031

Table 12. Non – Parametric mean test

		Ranks			
		Group	N	Mean Rank	Sum of Ranks
Health_Education	Null		30	27.50	825.00
	Participants		30	33.50	1005.00
	Total		60		
Health_Social	Null		30	33.00	990.00
	Participants		30	28.00	840.00
	Total		60		
Health_Engagement	Null		30	27.50	825.00
	Participants		30	33.50	1005.00
	Total		60		
Education_Social	Null		30	32.00	960.00
	Participants		30	29.00	870.00
	Total		60		
Education_Engagement	Null		30	30.50	915.00
	Participants		30	30.50	915.00
	Total		60		
Social_Engagement	Null		30	30.50	915.00
	Participants		30	30.50	915.00
	Total		60		

Test Statistics^a

	Health_Education	Health_Social	Health_Engagement
Mann-Whitney U	360.000	375.000	360.000
Wilcoxon W	825.000	840.000	825.000
Z	-1.424	-1.215	-1.446
Asymp. Sig. (2-tailed)	.154	.225	.148

	Education_Social	Education_Engagement	Social_Engagement
Mann-Whitney U	405.000	450.000	450.000
Wilcoxon W	870.000	915.000	915.000
Z	-.717	<.001	<.001
Asymp. Sig. (2-tailed)	.474	1.000	1.000

H₀: The mean ranking of each item is not different from its corresponding null value.
H₁: The mean ranking of each item is different from its corresponding null value.

5.2 Results with each game components

Below, the games are analysed by the numbers and percentages of different responses to each of the ten questions given by the five participants in responds to various components. . There are ten questions related to each of the Health_Education, Health_Social, Education_Social and Social_Engagement correlations, and eight to each of the Health_Engagement and Education_Engagement correlations. Due to the difference in the numbers of related questions, the following analysis is presented with percentages only.

Game 1 Re-Mission

As shown in Figure 2, the tests with the Health_Education and Social_Engagement correlation tests are successful, and the results with the Health_Social correlation test is negative. With the Health_Engagement correlation test, 45% responses are negative (disagree), 10% neutral (neither) and 43% positive (43% agree and 3% strongly agree). In the cases of the Education_Social and Education_Engagement correlations, there are higher percentages of positive responses (agree and strongly agree) than negatives ones (disagree and strongly disagree).

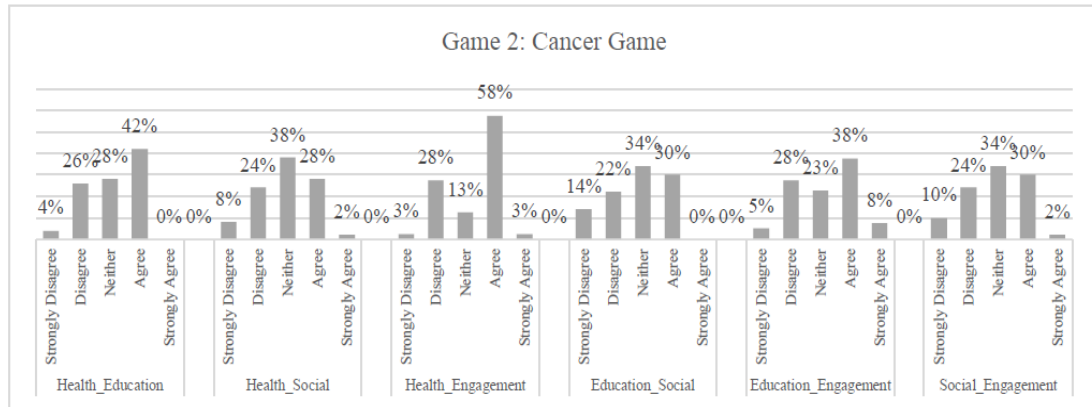


Figure 2. Percentages of responses for each correlation with Game 1 Re-Mission

Game 2 Cancer Game

With Cancer Game, as shown in Figure 3, with the Health_Education, Health_Engagement and Education_Engagement correlations, there are significantly higher percentages of positive results, especially with the Health_Engagement correlation, there are 58% agree and 3% strongly agree. With the Education_Social, Social_Engagement and Health_Social correlations, there are higher percentages for with neutral responses (neither).

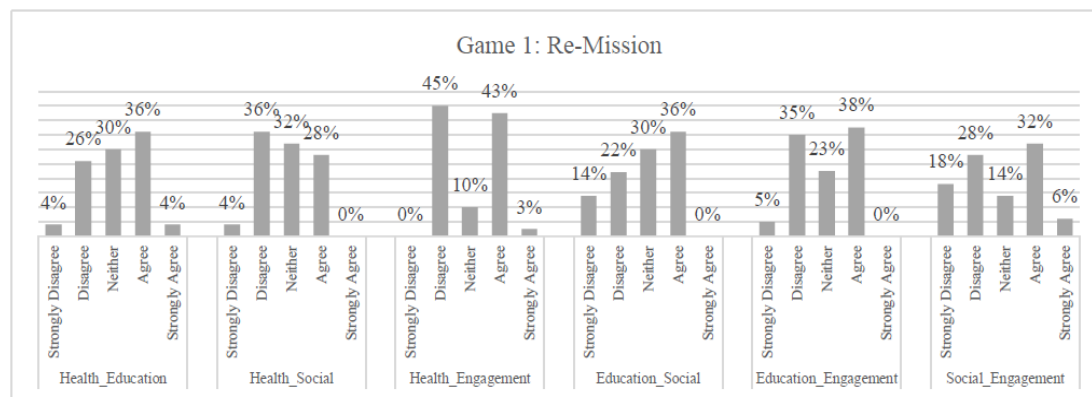


Figure 3. Percentages of responses for each correlation with Game 2 Cancer Game

Game 3 Sea Hero Quest

With Sea Hero Quest, as shown in Figure 4, there are higher percentage of positive responses for the Health_Engagement correlation (43% agree), and higher negative ones with the Education_Social (22% disagree and 14% strongly disagree) and Education_Engagement (35% disagree and 5% strongly disagree) correlations. However, the Health_Social and Social_Engagement correlations had higher neither (46%). Additionally, the Health_Education correlation had 36% negative responses (disagree and strongly disagree).

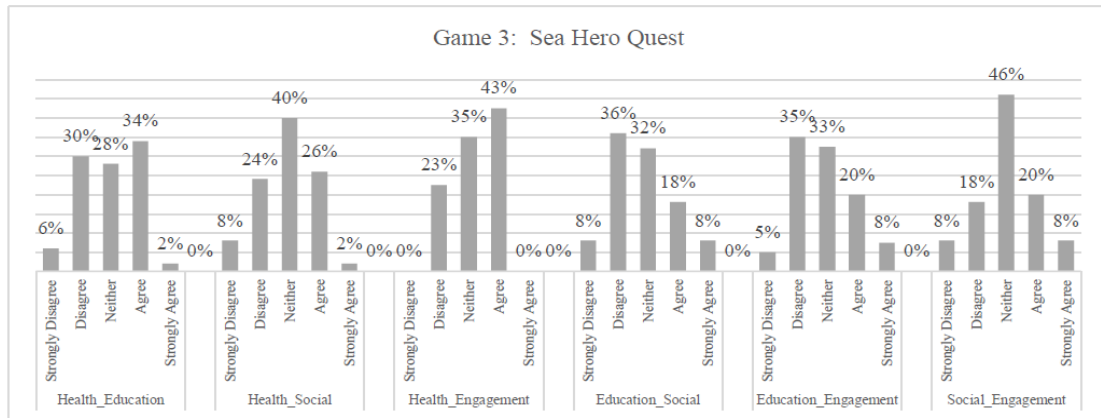


Figure 4. Percentages of responses for each component with Game 3 Sea Hero Quest

Game 4 Life in Spin

With Life in Spin, as shown in Figure 5, the Health_Education correlation had 38% positive responses and 38% negative ones. The Health_Social correlation test had 40% negative responses. The Health_Engagement correlation had 40% neutral responses. The other three correlation tests had higher combined positive responses, with 38% for the Education_Social correlation, 48% for the Education_engagement correlation, and 44% for the Social_Engagement correlation.

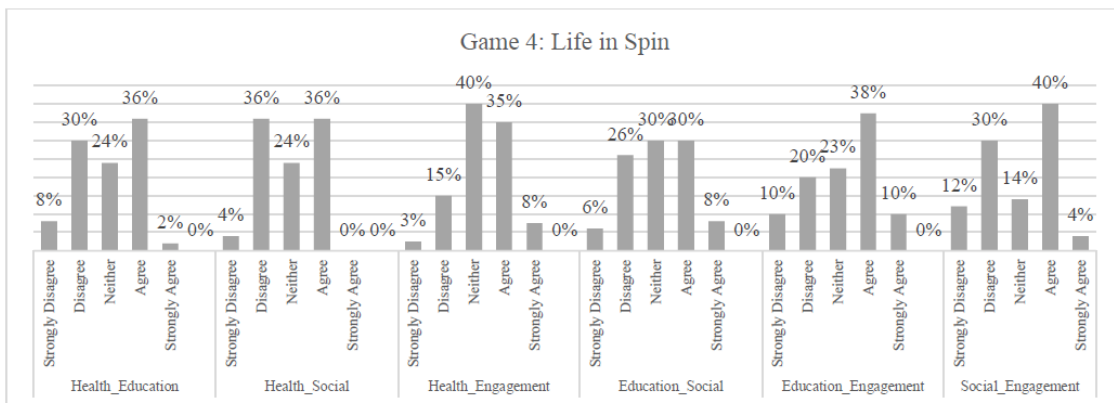


Figure 5. Percentages of responses for each correlation with Game 4 Life in Spin

Game 5 The Dysphagia Game

With The Dysphagia Game, as shown in Figure 6, there were higher positive responses for the Health_Education (42% agree and 4% strongly agree) and Health_Engagement (35% agree and 48% strongly agree) correlations. For the Health_Social correlation test, there was higher percentage of neutral responses, but percentage of the combined positive responses was a close 32%. There was higher percentage of combined positive responses (43%) for the Health_Engagement correlation test. On the other hand, there were higher combined negative responses for the Education_Social and Education_Engagement correlation tests. There was split opinion with the Social_Engagement correlation test with 38% combined negative responses and 38% combined positive ones.

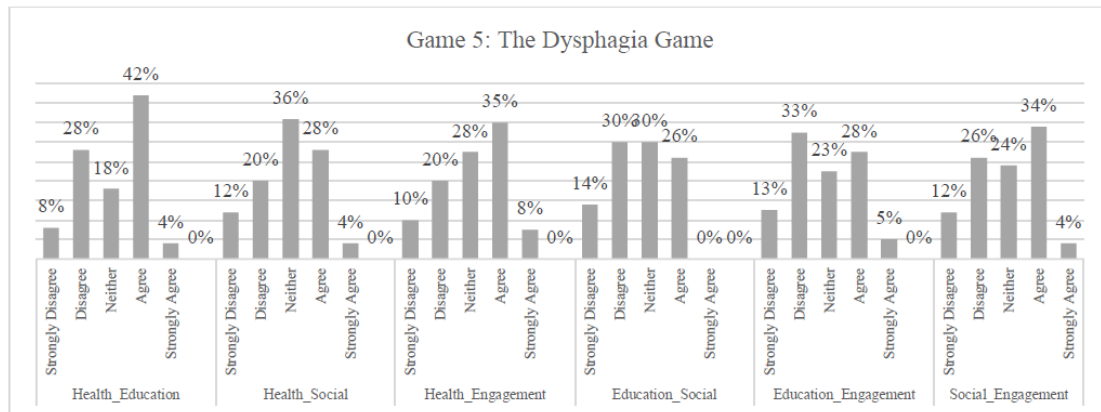


Figure 6. Percentages of responses for each correlation with Game 5 The Dysphagia Game

Game 6 NHS Nene CCG

With NHS Nene CCG, as shown in Figure 7, there were dominant 46% positive responses for the Health_Education correlation test. By Contrast, the other correlation tests received higher combined negative responses, especially the Education_Engagement and Social_Engagement correlation tests. For the Health_Social and Health_Engagement correlations tests, the responses were almost equally split into the positive, neutral and negative nonresponses.

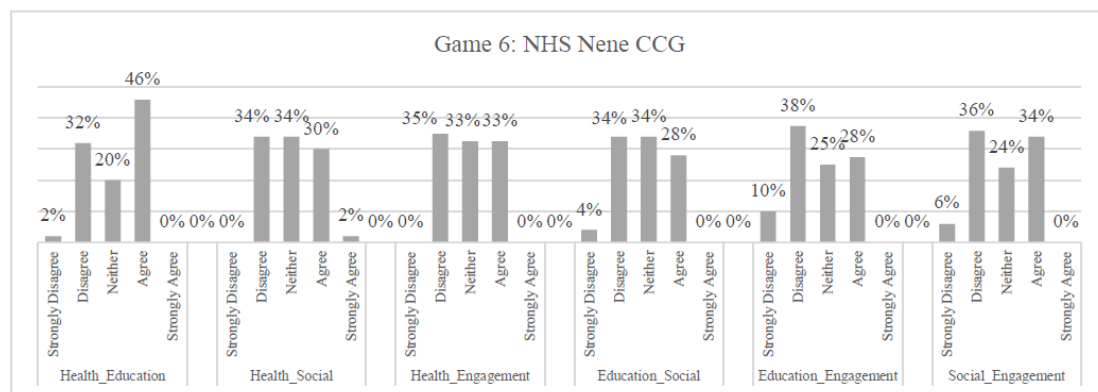


Figure 7. Percentages of responses for each correlation with Game 6 NHS Nene CCG



6 Findings

As mentioned before, exploratory experiments are done in attempt to confirm the reliability of the metric instrument in the stage of research. The findings will explain the individual games and the goal of the metric (carer's need).

These games were chosen for helping family carers with their various health issues, and their suitability for this purpose was reflected in the fact that they generally received more positive responses to health related tests. Furthermore, the primary purpose of each game is identified by the category of questions that has received the highest percentage of combined positive responses.

Thus, with respect to the metric instrument, the purpose of each game is identified as below:

- Re-Mission is a game for education because the education related correlations received the highest percentages of combined positive responses amongst the correlations, with 40% combined positive responses for each of the health-education and education-social ones.
- Cancer game is a game for health because the health related correlations received the highest percentages of combined positive responses amongst the correlations, with 42% for the health-education one and 61% for the health-engagement one.
- Sea Hero Quest is a game for health and engagement because the health and engagement correlation has the highest percentage of combined positive responses at 43% amongst the correlations.
- Life in Spin is a game for education and engagement because the education and engagement correlation has the highest percentage of combined positive responses at 48% amongst the correlations.
- The Dysphagia Game is a game for health because the health related correlations received the highest percentages of combined positive responses amongst the correlations, with 46% for the health- education one and 43% for the health-engagement one.
- NHS Nene CCG is a game for both health and education because the health-education correlation has the highest percentage of combined positive responses at 46% amongst the correlations.

The metric of carer's needs combined with six game results shows that, there are four group with a positive results such as Health_Education, Health_Engagement, Education_Social, Socail_Engagment. The goal of the metric (carer's need) is identified as below:

- **Health_Education:** To evaluate how Education strengthens the Health component. Health_Education are generally successful in these games. The results combine these six game with 39% agree and 2% strongly agree which the positive response in Figure 8.

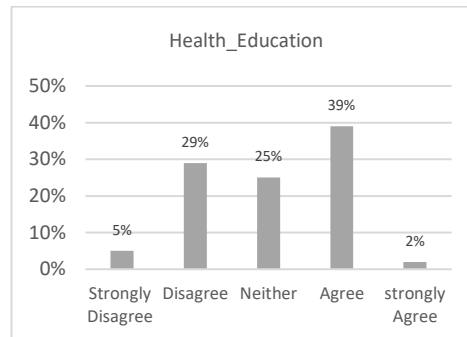


Figure 8. *Health_Education result combine with six games*

- **Health_Social:** Evaluate how Social media supports the Health element. Health_Social with 34% of Neither which is highest in Figure 9. The reason of that, the participants might not sure how it links with social elements because these games have been chosen without social media.

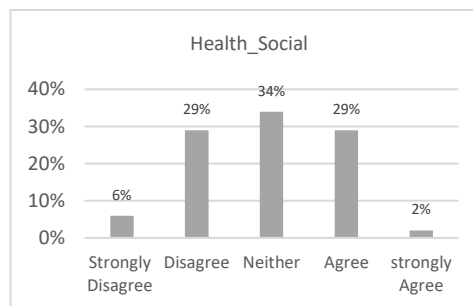


Figure 9. *Health_Education result combine with six games*

- **Health_Engagement:** Evaluate engagement improve Health element. In Figure 10. shows the positive response, the 41% of participants agree and 3% are strongly agree this the statement.

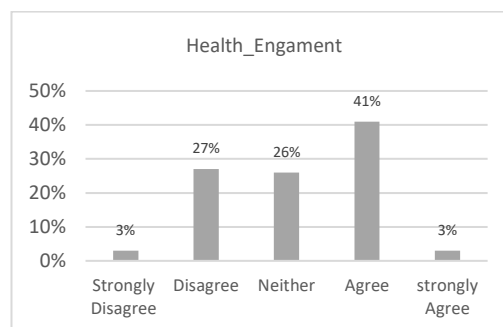


Figure 10. *Health_Education result combine with six games*

- **Education_Social:** Evaluate Social component encourages Education component. There are 38% of participants agree and 3% are strongly agree the statement which is positive response in Figure 11.

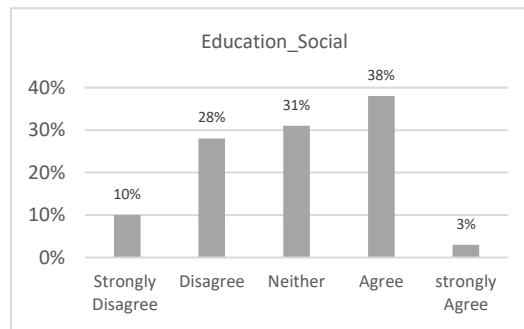


Figure 11. *Health_Education result combine with six games*

- **Education_Engagement:** To evaluation Engagement informs Education component. In Figure 12 shows that, there are 31% of participants agree and also 31% are disagree the statement.

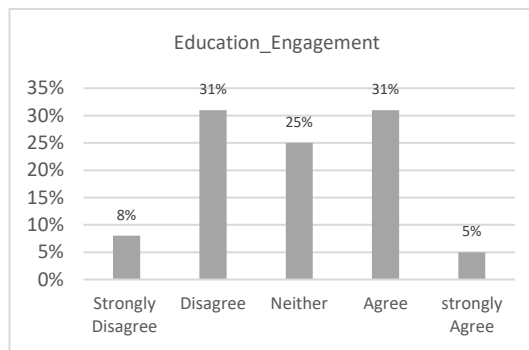


Figure 12. *Health_Education result combine with six games*

- **Social_Engagement:** Evaluate Social element encourages Education component. The positive response with 32% agree and 4% strongly agree. However, there are negative responses with 27% disagree and 11% strongly disagreed. In additional, 26% are neither in Figure 13.

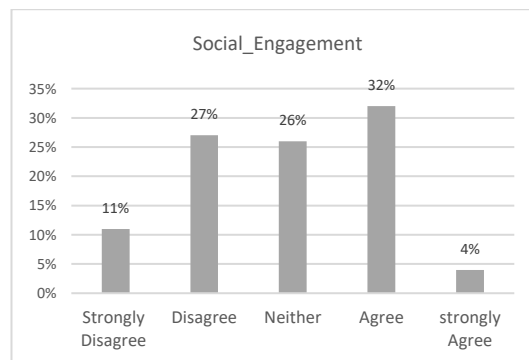


Figure 13. *Health_Education result combine with six games*

7 Discussion

In this research, a literature survey was conducted to elicit key components in the interactions between the games for change and the game players, especially the dementia carers, and a conceptual framework was constructed. Based on the framework, a metric table and metric instrument were developed. Then an exploratory experiment test on six games with five experienced game professionals was conducted.

The overall research is on supporting dementia family carers by catering for their needs with games for change. The first step of the research focused on the game itself as a platform to help patients understand themselves and provide guidance for their friends and families. The majority of the games were focused on one purpose, whilst other purpose could exist as additional support. The social component is complex. It includes online and offline aspects (i.e., real life). For example, the online social component can help the player talk to each other, or even make friends, whilst the offline element can potentially increase the size of the social community in real life. The ideal social component is a combination of both online and offline aspects as they compliment and strengthen each other. It can also constitute additional support to the key components of education and health. The social component of games for dementia family carers could include social marketing and social media, as the former has the potential to increase awareness of dementia issues whilst the latter can form a platform for sharing experiences and mutual support.

The results indicate that the social component is complex to measure and engagement is the main element to attract the players' attention and encourage their involvement in the social communities for the purposes of health and education. In the test, the game metric instrument successfully identified the meaning of each game. However, the exploratory experiment did not yield positive results with five participants testing six games as the Mann-Whitney test did not show a statistical significant result (P value greater than 0.05). The main problem was the quality of the data. Additional research is needed to further evaluate the framework by increasing the sample size and removing the potential interference from switching between games. Since a test with five professionals proved insufficient to obtain significant metric results, a further exploratory experiment would be conducted on the Cancer Game with over thirty participants to increased sample size to obtain quantitative data to establish the reliability of the metrics. The Cancer Game is chosen because, whilst it is focused on education and health, it has both online and offline social increase the size of the social community in real life. Both could compliment and strengthen each other, so the ideal social component is a combination of the online and offline aspects.

As the study is limited by time, a short-term assessment for games might have different results than a long-term assessment. However, this paper discusses the first stage of exploratory experiments. This stage focuses on testing the existing games with game professionals to confirm the realizable of metric instruments. In future experiments with larger sample sizes also will arrange to test with short-term and long-term assessments with dementia family caregivers.

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Appendix A: Metric table based on Framework elements and game content.

	Parameter	Gameplay			Avatar Portrayal	Game world graphics	Sound/ Music	Storyline
Components	Question Code	GP_Gamesupport : Game support with more than one purpose	GP_Message: Game feedback, message and information links with the game purpose	GP_Collaboration: Game combines with other platforms	AP_Avatar: Avatars give the meaning message	GW_Realism: Game world shows a realistic environment	SM_Background music: Including the voice and sound supports the game with more meaning	SL_Compelling: Storyline keeps the player engaged in the game
Health	H_Education: Education Strengthen Health component	Game educates players to increase their knowledge of health	Give the message/ information as education components to achieve changes in health behaviour	Game collaboration with education components to help players understand the health issues	Game gives the message for changing health behaviour through avatar characteristics	Game world shows real life or real situations involving the health issues	Background voice gives meaningful health messages	Game story educates the player and change health behaviour
	H_Social: Social Supports Health component	Social media as an online community to support health	Game's message/ information links with community to support health	Game links with social support to discuss player's health issues	Avatars engage other players, as group effect attempting to change health behaviours	Game world with real community support to change health behaviours	Game can share the players' voice to support health	Game story with the social components to keep the players engaged
	H_Engagement: Engagement improves Health component	Game as a platform to engage players and improve their health	Community encouraging players to discuss the game's message /information and improve player health	Game uses engagement to improve health	Using avatars to engage communities and improve health	Game world engages people with health behaviours	Background music can encourage players to improve their health	Game story is able to encourage players to improve the health
Education	E_Social: Social component encourages Education component	Social elements in the game to support the community to spread the knowledge	The game's message / information links with communities to encourage player education	Game collaboration with social media to increase the size of communities to encourage education components	Using the avatars links with social platforms to encourage player education	Game's world presented to real life and using the social community to inform education	Social voice encourages players to get knowledge	The storyline is entertaining enough to keep the player interested in the game, using plot twists, conflict and interesting characterization
	E_Engagement: Engagement informs education component	The game shows multiple ways to solve the problems, and also involve other players' views	Game's message/ information can be discussed with other players	Game engages players to inform educate component	Avatars can be social components to engage users and inform education	Game world gives information that would be useful in real life.	Background voice/ music can encourage players to get knowledge	Game story can engage players, informing the education components
Social	S_Engagement: Engagement produces social component	Social marketing with game to raise awareness	Game's message / information encourages the player to produce social components	The game provides a chat room, game community, email/messaging, 'buddy list' or link to a social networking website	Avatar portrayal to engage player produces social components	Game word encourages similar types of player to produce communities	Background music/ sound is able to encourage players to produce communities	Game story engages players, increasing the size of the person's community

Appendix B: GQM table for creating the Metric

Goal		Questions	Metrics		
			G: Metric applied to the game	E: Metric applied to the evaluate of components	
Health	H1: To evaluate how education strengthens the Health component	Gameplay	How does the game support educating the player and increasing their knowledge of health?	G1: While playing, I gained new knowledge from the game's message/information section about how to improve health.	E1: I believe education in game is important to strengthen health knowledge. For example, games can educate players about understanding their health.
			How does the games message / information convey the health element?	G2: * The game's message/ information does not give enough information about health issues.	
			How does the game link up with the education element to give the player knowledge of health?	G3: * While playing, I don't feel the game educated the player about the health issues.	
		Avatar	How does the game give the message for changing health behaviour through avatar characteristics?	G4: Adjusting the characteristics of the game's avatars could change the players' health behaviour.	
		Game World Graphics	How accurately does the game environment reflect situations in the real world?	G5: I felt the game was related to real life situations which involve health issues.	
				G6: * I don't think building a realistic environment is necessary to help understand the health issues the game is trying to indicate.	
		Sound / Music	How does the game give its message through the background music and sound?	G7: The game's background music / sound got in the way of understanding the health issues.	
				G8: The game's background narrator or commentator gave supporting information about the health issues.	
		Storyline	How does the game story help the player change their health behaviour?	G9: After I play through the game's story, I understand more about health issues.	
				G10: * After I play through the game I do not think I will change my health behaviour.	
	H2: Evaluate how social media supports the Health component	Gameplay	How does the game link to social media to support health?	G11: Playing the game in combination with social media platforms can help support people with their health issues.	E2: I believe social platforms can support health (for example, communities can support health by providing information or talking therapy).
			How does the game message/information link with social communities to support health?	G12: * I don't think using the online community will be able to support people with their health issues.	
			How does the game collaborate with the social element support to improve player's health?	G13: The game allowed me to link with communities to discuss the health issues.	
			G14: * The game does not facilitate the with community members to discuss the health issues.		
			G15: Using an avatar whilst playing the game helps to bring me closer to the community.		

		Avatar	How does the game use the group effect to change health behaviour?	G16: I feel that by using my avatar within the community helps me to change my health behaviours.
		Game World Graphics	How does the game world bring in real communities?	G17: I think the game world encourages players to seek out real-world communities to find support for their health issues.

<p>H3: Evaluate engagement improve Health component</p>	<p>Sound / Music</p>	<p>How does the game allow the player to share their health experience vocally?</p>	<p>G18: In the game, I was allowed speak to other people about health issues.</p>	
	<p>Storyline</p>	<p>How does the game story keep the player invested in the game?</p>	<p>G19: I felt the game story made me interested in finding out more about health.</p>	
			<p>G20: * Whilst playing the game, I don't focus on the game story.</p>	
	<p>Gameplay</p>	<p>How does the game act as a platform to engage players and improve their health?</p>	<p>G21:I think the social aspects of the platform help to engage with other people to improve health.</p>	<p>E3: I believe engagement improves the health component, such as engaging the player deeply so they can understand their health.</p>
		<p>How does the community engage the player to discuss the message / information in the game and improve their health?</p>	<p>G22: * The platform did not allow engagement with the community in order to improve health.</p>	
		<p>How does the game engage people to improve their health?</p>	<p>G23: * I did not find the game engaging enough to improve healthy behaviour.</p>	
	<p>Avatar</p>	<p>How do the game avatars engage communities and improve health?</p>	<p>G24: While playing, I found the game elements (avatars, graphics and music) can change our behaviours.</p>	
			<p>G25: While playing the game I found the game elements (avatars, graphics and music) can engage people with the health issues.</p>	
	<p>Game World Graphics</p>	<p>How does the game world engage people with health behaviour?</p>	<p>G26: * Whilst playing the game, the game world encourages people to engage on health issues.</p>	
	<p>Sound / Music</p>	<p>What types of background music / sounds can engage players to improve their health?</p>	<p>G27: * when playing the game, the background music does not help engage people in the health issues.</p>	
<p>Storyline</p>	<p>What type of game story can engage player to improve their health?</p>	<p>G28: While playing, I felt motivated by the game story to improve my health behaviour.</p>		

Educa ti on	E1: Evaluate Social componen t encourage s Education componen t	Gameplay	How does the game spread the knowledge via the community support?	G29: I found the social platform associated with the game helped me discuss issues with the communities.	E4: I believe social media encourages education, such as communities bringing discussion of different issues.	
			How does the game provide the message / information connected with communities to educate players?	G30: * I don't think the game provides new things to learn.		
			How do social media lead to online communities to increase the size of people's community?	G31: I felt the social platform associated with the game increased the size of communities through which I can discuss the issues.		
		Avatar	How does the game use the avatars connected with the social platform to encourage players to learn?	G32: I found using an avatars helped me connect with social media.		G33: I found using the asocial media platform associated with the game enabled me to get more information.
				Game World Graphics		
		G35: I found that the game world involving social communities allowed me to be informed about the issues.				
		Sound / Music	How does the game use background music and sound to encourage players to develop new knowledge?	G36: I think the background music and sound helped be related to the education.		G37: The background narrator or commentator supplying more information.

		Storyline	How does the game story make it more entertaining, to keep the player invested?	G38: I felt the game used plot twists, conflict and interesting characterization to make it more interesting.	
E2: To Evaluation engagement informs education component	Gameplay		How does the game support multiple ways to solve the problems?	G39: I found the game shows different ways to handle real life issues.	E5: I think engagement can inform education. For example, to engage people to deeply understand the specific issues.
			How does the game give the message / information to bring people to discuss the issues?	G40: The game's message is interesting enough to discuss with other people.	
			How does the gameplay engage people in terms of the knowledge?	G41: * I don't think the gameplay can engage people to get new knowledge.	
	Avatar	How does the avatar, as a social element, engage and educate players?	G42: I found the avatar can motivate other players to discuss issues.		
	Game World Graphics	Does the game world provide useful knowledge that links with real world?	G43: The game world graphics and background music give new knowledge about the real world.		
	Sound / Music	How does the game use background music/ sound to motivate people to get new knowledge?	G44: * I don't feel the background music and sound will help motivate people to obtain new knowledge.		
	Storyline	How does the storyline engage players and increase the size of players' communities?	G45: After I play a game, I would discuss the issues with other players.		
G46: After I played a game, through discussing the issues with other players, I made friends.					
		Gameplay	How does the game apply social marketing knowledge to support game to raise awareness?	G47: I found the game can raise social awareness of the issues.	
	G48: I think social is very important in game's element				
	G49: * I don't think the game's social component help raise awareness.				

Social	S1: Evaluate engagement produces social component		Do the game message / information be able to encourage players to become involved in communities?	G50: I think the game's message and information lead to people becoming involved in the community.	E6: I believe engagement promotes social components. For example, by encouraging players to become involved in communities.
			How does the game encourage players to become deeply involved in communities which link with social media?	G51: * I don't feel the game's t social media encouraged players to get deeply involved with each other	
		Avatar	How is the avatar able to encourage players to communicate?	G52: The avatar and game world helped me to connect with other players of similar styles of avatars.	
		Game World Graphics	How does the game world help players to increase their communities' size?	G53: * I don't feel the game world helped players grow the size of the communities.	
		Sound / Music	How does the game apply background music and sound to engage people?	G54: I think the background music and sound helped to link with other players in the game.	
		Storyline	How can the game story increase the size of communities?	G55: I found the game story helped me to discuss similar interesting issues with other players.	
				G56: I found that discussing similar interesting issue with players helped increase the size of the community.	

Appendix C: Non-Parametric Means Test

Game 1 Re-Mission Ranks

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	5	6.00	30.00
	Participants	5	5.00	25.00
	Total	10		
Health_Social	Null	5	6.00	30.00
	Participants	5	5.00	25.00
	Total	10		
Health_Engagement	Null	5	5.00	25.00
	Participants	5	6.00	30.00
	Total	10		
Education_Social	Null	5	6.00	30.00
	Participants	5	5.00	25.00
	Total	10		
Education_Engagement	Null	5	5.00	25.00
	Participants	5	6.00	30.00
	Total	10		
Social_Engagement	Null	5	6.00	30.00
	Participants	5	5.00	25.00
	Total	10		

Test Statistics^a

	Health_Education	Health_Social	Health_Engagement	Education_Social	Education_Engagement	Social_Engagement
Mann-Whitney U	10.000	10.000	10.000	10.000	10.000	10.000
Wilcoxon W	25.000	25.000	25.000	25.000	25.000	25.000
Z	-.559	-.557	-.557	-.557	-.557	-.557
Asymp. Sig. (2-tailed)	.576	.577	.577	.577	.577	.577
Exact Sig. [2*(1-tailed Sig.)]	.690 ^b	.690 ^b	.690 ^b	.690 ^b	.690 ^b	.690 ^b

a. Grouping Variable: Group

b. Not corrected for ties.



Game 2 Cancer Game Ranks

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	5	4.00	20.00
	Participant	5	7.00	35.00
	Total	10		
Health_Social	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Health_Engagement	Null	5	4.50	22.50
	Participant	5	6.50	32.50
	Total	10		
Education_Social	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		
Education_Engagement	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		
Social_Engagement	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		

Test Statistics^a

	Health_Education	Health_Social	Health_Engagement	Education_Social	Education_Engagement	Social_Engagement
Mann-Whitney U	5.000	10.000	7.500	10.000	10.000	10.000
Wilcoxon W	20.000	25.000	22.500	25.000	25.000	25.000
Z	-1.671	-.557	-1.181	-.557	-.557	-.561
Asymp. Sig. (2-tailed)	.095	.577	.238	.577	.577	.575
Exact Sig. [2*(1-tailed Sig.)]	.151 ^b	.690 ^b	.310 ^b	.690 ^b	.690 ^b	.690 ^b

a. Grouping Variable: Group

b. Not corrected for ties.

Game 3 Sea Hero Quest Ranks

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	5	4.00	20.00
	Participant	5	7.00	35.00
	Total	10		
Health_Social	Null	5	6.50	32.50
	Participant	5	4.50	22.50
	Total	10		
Health_Engagement	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		
Education_Social	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Education_Engagement	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Social_Engagement	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		

Test Statistics^a

	Health_Education	Health_Social	Health_Engagement	Education_Social	Education_Engagement	Social_Engagement
Mann-Whitney U	5.000	7.500	10.000	10.000	10.000	10.000
Wilcoxon W	20.000	22.500	25.000	25.000	25.000	25.000
Z	-1.671	-1.177	-.559	-.557	-.557	-.557
Asymp. Sig. (2-tailed)	.095	.239	.576	.577	.577	.577
Exact Sig. [2*(1-tailed Sig.)]	.151 ^b	.310 ^b	.690 ^b	.690 ^b	.690 ^b	.690 ^b

a. Grouping Variable: Group

b. Not corrected for ties.



Game 4 Life in Spin Ranks

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	5	4.00	20.00
	Participant	5	7.00	35.00
	Total	10		
Health_Social	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Health_Engagement	Null	5	4.00	20.00
	Participant	5	7.00	35.00
	Total	10		
Education_Social	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		
Education_Engagement	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		
Social_Engagement	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		

Test Statistics^a

	Health_Education	Health_Social	Health_Engagement	Education_Social	Education_Engagement	Social_Engagement
Mann-Whitney U	5.000	10.000	5.000	10.000	10.000	10.000
Wilcoxon W	20.000	25.000	20.000	25.000	25.000	25.000
Z	-1.677	-.557	-1.671	-.557	-.559	-.557
Asymp. Sig. (2-tailed)	.094	.577	.095	.577	.576	.577
Exact Sig. [2*(1-tailed Sig.)]	.151 ^b	.690 ^b	.151 ^b	.690 ^b	.690 ^b	.690 ^b

a. Grouping Variable: Group

b. Not corrected for ties.

Game 5 The Dysphagia Game Ranks

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		
Health_Social	Null	5	5.50	27.50
	Participant	5	5.50	27.50
	Total	10		
Health_Engagement	Null	5	5.50	27.50
	Participant	5	5.50	27.50
	Total	10		
Education_Social	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Education_Engagement	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Social_Engagement	Null	5	5.00	25.00
	Participant	5	6.00	30.00
	Total	10		

Test Statistics^a

	Health_Education	Health_Social	Health_Engagement	Education_Social	Education_Engagement	Social_Engagement
Mann-Whitney U	10.000	12.500	12.500	10.000	10.000	10.000
Wilcoxon W	25.000	27.500	27.500	25.000	25.000	25.000
Z	-.557	.000	.000	-.557	-.557	-.557
Asymp. Sig. (2-tailed)	.577	1.000	1.000	.577	.577	.577
Exact Sig. [2*(1-tailed Sig.)]	.690 ^b	1.000 ^b	1.000 ^b	.690 ^b	.690 ^b	.690 ^b

a. Grouping Variable: Group

b. Not corrected for ties.



Game 6 Brain Training Game Demonstration Ranks

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	5	7.00	35.00
	Participant	5	4.00	20.00
	Total	10		
Health_Social	Null	5	5.50	27.50
	Participant	5	5.50	27.50
	Total	10		
Health_Engagement	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Education_Social	Null	5	6.50	32.50
	Participant	5	4.50	22.50
	Total	10		
Education_Engagement	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		
Social_Engagement	Null	5	6.00	30.00
	Participant	5	5.00	25.00
	Total	10		

**Test
Statistic
s^a**

	Health_ Education	Health_ Social	Health_ Engagement	Education_ Social	Education_ Engagement	Social_ Engagement
Mann-Whitney U	5.000	12.500	10.000	7.500	10.000	10.000
Wilcoxon W	20.000	27.500	25.000	22.500	25.000	25.000
Z	-1.671	.000	-.559	-1.177	-.557	-.557
Asymp. Sig. (2-tailed)	.095	1.000	.576	.239	.577	.577
Exact Sig. [2*(1-tailed Sig.)]	.151 ^b	1.000 ^b	.690 ^b	.310 ^b	.690 ^b	.690 ^b

a. Grouping Variable: Group

b. Not corrected

