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Using Games as an Effective Intervention for Supporting Families Living with Dementia

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Abstract

This paper explores the role of games in supporting dementia family caregivers during the pre- and early stages of the disease. It provides a comprehensive review of existing studies that focus on support mechanisms for both dementia patients and their caregivers, with a specific emphasis on games designed for this purpose.

This paper outlines a research study conducted in two experiments. The first experiment involved conducting separate focus groups to explore how technology can assist older adults during the COVID-19 pandemic and its aftermath. Group A consisted of 9 participants from the UK, while Group B comprised 8 participants from Taiwan. The aim was to gather insights and perspectives from different cultural contexts. The second experiment of the study involved testing games with dementia family caregivers to assess their effectiveness and identify areas for refinement and improvement. A total of 20 participants took part in this experiment. By conducting focus groups and game testing with participants from different regions, this research aimed to gather diverse perspectives and insights, enhancing the validity and applicability of the findings.

The findings of this project extend beyond the scope of dementia care and have implications for addressing various long-term health conditions. Games platforms have the potential to serve as effective tools for supporting communities that provide care for individuals with dementia. They offer opportunities for promoting self-understanding, accessing relevant resources, and facilitating informed decision-making within the context of health journeys.

Keywords: Serious Games, Dementia families, Social Interaction, Mental Health, Family Caregivers

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1. Introduction

In the modern era, games have transcended their traditional role as mere sources of entertainment and have found diverse applications across various fields. They can be categorized into Social Games, Games for Health, and Serious Games (Educational Games) based on their intended purposes. Our objective is to develop a game prototype that caters to the specific needs of the market.

The focus of this research is to explore how games can provide support for dementia carers, specifically targeting early-stage dementia and family carers. The diagnosis of dementia poses significant challenges for the entire family, and reaching, educating, and promoting positive behavioural goals among patient carers can be facilitated through a combination of social marketing and gaming techniques [1]. Existing research in this area primarily revolves around the dementia condition itself, with limited support available for caregivers [2].

This research marks a new frontier in the gaming industry by combining practical and theoretical research,

which can serve as a knowledge base for a specific, innovative project that has the potential to stimulate strategic research worldwide. Games are not just for entertainment, but they can also be utilized as problem-solving tools and for acquiring new knowledge. Designing an appropriate game is the first step towards providing the technological tool required by dementia carers to increase their knowledge of health issues. The methodological advantage of this project lies in the fact that games provide a means for self-understanding and self-learning. The theoretical advantage is that advances in game technology can contribute to social and health support by catering to individual needs. The primary benefit of this project is the enhancement of the quality of life for individuals and communities, including improved health and wellbeing.

2. Literature Review

Literature review focused on three principal domains: Firstly, reviewing exciting services support for people with dementia and their family caregivers. Secondly, exploring the game for dementia and family caregivers. Finally, will conclude with a comprehensive summary and problem statement.

2.1. Support People with Dementia and Family Caregivers

The aging of the world's population is accelerating. The rate of dementia in countries around the world is constantly increasing, which has become a significant issue discussed worldwide. Suppose a family member is diagnosed with dementia. In that case, it will be a big challenge for dementia itself and the family numbers, including ignorance of the disease, unfamiliarity with the medical system, negative emotions, social pressure, and economic pressure.

2.1.1. Dementia Care

There are many options for people with dementia for different stages and needs according to each family situation is unique. There are four primary types of care for people with dementia, which will be discussed in detail below:

In-Home Care: In-home care comprises a wide range of services provided in the home setting, which enables individuals with dementia to continue living in their own home [3]. In-home services can be categorized into four types, namely: 1). Companion services: These services include general supervision, recreational activities, or companionship visits. 2). Personal care services: This category involves assistance with personal care, such as bathing, dressing, toileting, eating, exercising, and other related activities. 3). Homemaker services: These services focus on housekeeping, shopping, meal preparation, and other similar tasks. 4). Skilled care: Skilled care is provided by licensed health professionals and is typically geared towards wound care, injections, physical therapy, and other medical needs.

Adult Day Centre: Adult day centres primarily offer individuals the opportunity to engage in social activities and participate in various programs within a safe environment [4]. The benefits of adult day centres extend beyond providing support for individuals with dementia, as they also offer respite for caregivers, enabling them to take much-needed breaks and balance their caregiving duties with other responsibilities.

Long-term Care: Long-term care offers a variety of services to assist the elderly with their medical and non-medical needs [5]. In the United Kingdom, long-term care can be provided in their own homes, care homes, day-care centres, organizations, or charities. Care homes and day-care centres can be operated either by the local government or the private sector. Bupa is one of the private healthcare specialists in the UK, offering services such as private medical insurance, health clinics, and care homes. On the other hand, non-profit organizations and charities primarily support the local citizens, particularly in terms of social services. These social services provide assistance for individuals with dementia and their friends, family, and caregivers, aiming to enhance their sense of well-being through social activities and daily living support [6].

Hospice Care: Hospice care is designed for individuals in the final stages of dementia and their families [7]. The services provided include 1) medical care to alleviate symptoms and pain, 2) counselling for emotional and spiritual support, 3) respite care to provide relief to caregivers, and 4) support for families in various ways.

2.1.2. Dementia-friendly City

"Dementia-friendly cities" aim to create a supportive environment where people with dementia are understood, respected, and cared for. Over the past decade, several cities in the UK have begun creating dementia-friendly communities, such as York [8], Manchester, Southampton, and others.

In York, the definition of a dementia-friendly community includes three main contributions: 1) ensuring that people with dementia feel safe in their locality, community, or city, 2) providing access to the local facilities they are used to, and 3) helping them maintain their social network. Key strengths of dementia-friendly cities in York include the human scale, historic resonance, friendly people, hospitality culture of a tourist city, a variety of cultural, leisure, and spiritual resources, a good range of housing and neighbourhoods that offer quality lifestyles, and a choice of transportation options.

In Manchester, various initiatives have been implemented to create a dementia-friendly city. For example, the University of Manchester has undertaken many research programs related to dementia-friendly cities [9]. Additionally, the Valuing Older People (VOP) team was formed in 2003, based in Manchester City

Council's Public Health Unit [10]. VOP has developed a 10-year plan to make Manchester "A Great Place to Grow Older".

The research group at the University of Southampton, focusing on dementia, maintains strong collaborations with the NHS, social care services, and the older adult communities. Additionally, there is significant support from local government and non-profit organizations, particularly within the private sector. For instance, the Alzheimer's Society's "Singing for the Brain" program in Southampton and the Dovetail Centre's Memory Support Group [11] are notable examples.

To enhance the city in the future, five key challenges need to be addressed:

(i) Increasing awareness and understanding of dementia.
(ii) Promoting a consistent and supportive response from general practitioners, healthcare professionals, and social care providers.
(iii) Improving customer service, especially in larger corporate companies where technology and speed are prioritized.
(iv) Encouraging a slower pace of life and better utilization of quiet and green spaces.
(v) Creating a welcoming environment for people with dementia to access and enjoy all the facilities that the city has to offer.

2.1.3. Family Caregivers of People with Dementia

Caring for people with dementia is one of the most challenging roles, and support for family caregivers is often lacking [12]. Although the need for support for family caregivers has been recognized for some time, it is still often lacking. With an aging population, the demand for health and social care services is increasing, and people are increasingly turning to the internet for information and support.

Four themes of interrelated needs emerged from family caregivers of people with dementia, as discussed in a study by Bressan, Visintini and Palese in 2020 [13].

(i) Being supported: The majority of family caregivers need support in various ways. This support can come from other family members, community events, adult day centres, and more.
(ii) Receiving accessible and personalized information: Family caregivers require accurate and timely information. Different stages of dementia necessitate different forms of support. For instance, during the early stages of dementia, caregivers may need basic information on finding support.
(iii) Being trained and educated to care for their loved ones with dementia: Knowledge is essential for family caregivers, as it helps them enhance their understanding, coping abilities, and caregiving skills.
(iv) Finding a balance: Family caregivers require support to maintain a balance between their caregiving responsibilities and personal lives.

2.2. Game Design

Game design session discussed two main research theories such as MDA framework (Mechanics, Dynamics, and Aesthetics) and Serious game. MDA is an important framework in game design which includes the fundamental components. Serious games discussed the valuable insights.

2.2.1. MDA Framework

Games are entertainment tools collaboration of designers and teams of developers, and enjoyed by players. The MDA Framework, introduced by Hunicke, Leblanc, and Zubek in 2004 [14], offers an approach to game design.

Mechanics encompasses the specific components of the game, including data representation and algorithms. It is concerned with the technical aspects that constitute the game's internal workings. In addition, mechanics also refer to "the different actions, behaviors, and control mechanisms available to the player in a game context" [14][15]. According to Marczewski (as cited in Kim, 2015), game mechanics are "a distinct set of rules that dictate the outcome of instructions within the system with an input, a process, and an output." Together with the game's content, such as levels and assets, the game mechanics support the overall gameplay dynamics [14].

Dynamics encompasses the real-time behavior of game mechanics, as they interact with player inputs and the outputs of other mechanics over time. It is concerned with how the game unfolds and reacts to the player's actions. An example highlighted by Kim (2015) is the dynamics of time pressure and opponent play, which contribute to the creation and support of the aesthetic of challenge.

Aesthetics concerns the positive emotional responses that players experience when interacting with the game system. It encompasses the feelings, moods, and overall experience that the game intends to evoke during gameplay. According to Kim (2015) [15], aesthetics encompasses the "diverse goals of games and the elements of enjoyment." To further explore the concept of what makes a game enjoyable and the various forms of enjoyment it encompasses, Hunicke et al. (2004) [14] have identified several categories of aesthetics that relate to the objectives or purposes of the game. Categories of Aesthetics [14] includes: Sensation (Game as sense-pleasure), Fantasy (Game as make-believe), Narrative (Game as drama), Challenge (Game as obstacle course), Fellowship (Game as social framework), Discovery (Game as uncharted territory), Expression (Game as self-discovery), Submission (Game as pastime).

2.2.2. Serious Game

Professor James Paul Gee introduced a set of principles aimed at designing educational games that are effective in their purpose. These principles can be classified into three main categories: empowered learners, problem solving, and understanding [16]. These game design principles have been widely employed in various research studies to

enhance the effectiveness and impact of educational games [17].

The first category, empowered learners, focuses on motivating learners to engage with the game. This can be achieved through principles such as co-designing, customization, forming identity, and manipulation. By allowing players to make decisions, customize their experience, and take on new identities within the game, they gain a sense of control and empowerment. The ability to manipulate objects in the game world further immerses players and enhances their involvement.

The second category, problem solving, is discussed in terms of seven principles. The first principle emphasizes the importance of presenting well-ordered problems that guide players in the early stages of the game, enabling them to develop strategies that will help them tackle challenges later on. The concept of "Pleasantly Frustrating" is also introduced, highlighting that optimal learning occurs when there is a balance between challenge and enjoyment, often referred to as the state of “flow” [18].

The third category, understanding, is addressed through two principles: system thinking and meaning as action image. System thinking involves helping players understand how each element of the game fits into the broader context or genre. This promotes a deeper understanding of the game mechanics and their interconnectedness. Meaning as action image, on the other hand, leverages players' prior experiences with other games to convey meaningful messages and themes.

Overall, Gee's principles provide a framework for designing learning games that empower learners, foster problem-solving skills, and promote deep understanding. By incorporating these principles, game designers can create educational experiences that are engaging, challenging, and meaningful for players, preparing them for the future.

2.1.3. Games for dementia and Family Caregivers

People with dementia are living longer and may require proper support for their physical and psychological needs. As the population ages, it is important to consider how to care for these individuals in the future [19].

Technology is emerging to provide existing care that can maintain their health [20]. However, the challenge for technology in supporting the elderly is to consider affordable and appropriate technologies to assist future dementia care, which outlines some of the technologies currently available and describes the many challenges to the integration of such technologies [19].

It is important for people living with dementia to remain active and continue their daily routines. Several types of games have been suggested for people with dementia, including Jigsaw Puzzles, which can increase cognitive scores in seniors with dementia [21]. Dominoes, which provides therapeutic mental stimulation [22] , and Bingo, which is a meaningful activity for older adults and can help with their cognitive level [23].

While there are exciting games for dementia, they are limited to family caregivers, particularly those related to dementia. A few examples of games related to carers include: (a) [That Dragon, Cancer], an immersive, narrative video game telling the story of Joel Green's fight against cancer, based on the Green's experience of raising their son Joel, (b) [Life in a Spin], which offers practical support and advice for young adult carers, allowing players to learn how to balance caring with their daily life, and (c) [The Dysphagia Game], developed with the NHS, which provides knowledge of dysphagia mainly for professional caregivers.

2.3 Summary and Problem Statement

Dementia affects millions of people worldwide. It is characterized by cognitive decline, including memory loss, difficulty communicating, and changes in behaviour and personality. The primary support for individuals with dementia is facilitating their integration into society. However, the COVID-19 pandemic has presented unprecedented challenges and risks for people living with dementia [24]. The restrictive measures and social isolation enforced during the pandemic have led to an increased likelihood of neuropsychiatric disturbances among individuals with dementia [25]. Despite the declaration by the WHO chief in 2023 that the COVID-19 pandemic is no longer a global health emergency, its effects continue to impact older adults, including those with dementia [26].

Dementia not only affects individuals with the condition but also has a profound impact on their entire family, particularly the primary caregiver [27]. Assuming the caregiving role can be challenging and demanding, often leading to caregiver burnout.

Providing accurate and timely information is crucial, especially during the pre- and early stages of dementia, to support family caregivers. During this period, caregivers may experience frustration, a lack of information, and uncertainty about how to effectively fulfil their caregiving responsibilities [28]. Offering the right resources and guidance becomes essential in helping them navigate this journey as caregivers.

Thus, this study designs a game namely [Make a Cup of Tea] targeting family caregivers of individuals with dementia in the pre- and early stages. The purpose of the game is to help people understand dementia as a crucial and significant first step. The research experiment consists of two phases. Firstly, a focus group will be conducted to understand the needs of older adults and how COVID-19 has affected their social lives. Secondly, prototypes of the game (Make a Cup of Tea) will be tested with family caregivers to refine the game before its release in the market. This research is a multidisciplinary study that incorporates collaboration with various disciplines and engages with society.

3. Games Design for Family Caregivers of People with Dementia

[Make a Cup of Tea] is designed for family caregivers who are dealing with patients in the pre- and early stages of dementia. The game consists of five mini-games that need to be completed in order to make a cup of tea. These mini-games are designed to convey the five key messages about dementia as propagated by the organization Dementia Friends [1][29]. The five key messages are as follows:

(i) Dementia is caused by diseases of the brain.
(ii) Dementia is not limited to memory loss; it can also affect thinking, communication, and daily tasks.
(iii) It is possible to live well with dementia.
(iv) Dementia is not a natural part of aging.
(v) There is more to a person than their dementia.

3.1. Game Content

In these five stages, players will need to acquire five key tools for making a cup of tea, such as a cup, water, tea bag, sugar, and milk. Each step will have its own game message (according to the Dementia Friends' five key message), and also give suggestion and suggestions for people caring for dementia patients. Each stage is described in detail below:

Step One

- Tool: Cup
- Message: There is more to a person than their dementia.
- Game Type: Customize the Cup Avatar - The different designs featured on the cups exemplify the fact that individuals have distinct personalities. 1. Select the colour of the cup. 2. Choose an emotional expression for the cup. 3. Personalize the cup by selecting an image that reflects your interests.
- Suggestion: Let the people with dementia retain their identity/personality.

Step Two

- Tool: Water
- Message: Dementia is not a natural part of aging.
- Game Type: Speed Game - The normal aging process is shown through slower movements. As the player catches drops in the game, the age of the character increases, resulting in a slower movement. The score is determined by the number of drops caught. Once the player reaches a score of 100, the input keys start swapping around intermittently. For example, pressing the left key may occasionally make the character move right, and vice versa. During this period, a confused icon is displayed to indicate the key swap.
- Suggestion: Normal age-related changes in cognition can happen, but confusion and memory loss are NOT part of the healthy aging process. To looking after dementia needs more patience.

Step Three

- Tool: Tea Bag
- Message: Dementia is caused by diseases of the brain.
- Game Type: Brain Training Game - People with dementia may experience difficulty in remembering things. Adopting a healthy lifestyle and consuming non-alcoholic beverages can reduce the risk of developing dementia. The player needs to find the matching tea bag hidden under the cards, similar to the game of Pairs. Consumption of alcoholic drinks, which are detrimental, triggers the appearance of additional cards, while good cards cause the number of cards to decrease.
- Suggestion: One common cause of dementia is Alzheimer's disease. Individuals who adopt a healthy lifestyle, especially from mid-life onwards, are less likely to develop Alzheimer's disease. This means engaging in healthy habits such as regular physical exercise, maintaining a healthy weight, not smoking, consuming a balanced diet, and moderate alcohol consumption.

Step Four

- Tool: Sugar
- Message: Dementia is not limited to memory loss; it can also affect thinking, communication, and daily tasks.
- Game Type: Message Game - People with dementia find it difficult to comprehend communication. The sense of taste of individuals with dementia often undergoes changes, with a preference for sweet flavours being common. In this game, the player's objective is to locate a specific item displayed at the bottom of the screen within a scattered collection of objects on the screen. The score is based on the number of items successfully found within the given time limit.
- Suggestion: People with dementia may find it difficult to communicate or convey their thinking. They need others to be more patient with them, and to understand their needs.

Step Five

- Tool: Milk
- Message: It is possible to live well with dementia.
- Game Type: Historical Game - Game Story: People like to talk about the past. In this game, the player is presented with multiple-choice questions about historical events. Upon answering questions correctly, the player is awarded milk, which is then

[1] https://www.dementiafriends.org.uk

used to top up their tea. The player must obtain the appropriate amount of milk to fill their tea. Examples of historical questions include: Which two countries fought in the Hundred Years War? In 1594, which London theatre company did William Shakespeare join? What year did World War 1 commence?

- Suggestion: A general non-drug approach often helps to alleviate the symptoms of dementia. This approach involves social interaction, music, reminiscence, exercise, or other meaningful activities for the individual. It is typically implemented before considering additional drug treatments, especially antipsychotics.

3.1. Game Purpose

The purpose of the game is to explore how games can support dementia caregivers and has three main objectives: Health, Education, and Social.

The game aims to provide a platform for the transfer of knowledge about dementia and offer suggestions for family caregivers to improve their health behaviour, such as managing their negative emotions. This falls under the Health objective.

The Education objective involves increasing the player's knowledge about dementia through the game's story and information while also providing suggestions on how to care for people with dementia.

The game also has a Social component, which is achieved through raising awareness of dementia and allowing players to discuss these issues. The study fully supports the need for dementia caregivers to connect with both an online social network and the local community to help engage people and discuss their problems while also supporting each other.

[Make a Cup of Tea] was designed as a mock-up game to test with dementia family caregivers, representing the game concept. There are various details that require improvement. In this research stage, the game serves as the main platform but can be further integrated with social platforms, both online and local communities, to provide comprehensive support for dementia family caregivers.

4. Research Methodology

This study includes Experiment I: Focus Group with older adults to understand their needs, particularly when they are faced with the COVID-19 pandemic and how it affects their social life. Experiment II: Game Testing is conducted with family caregivers to assess the reliability of the prototype game [Make a Cup of Tea] for potential users. The objective of these experiments was to refine the game prototypes and improve their usability for family caregivers of individuals with dementia in the pre- and early stages.

4.1. Experiment I: Focus Groups

Purpose: This investigation aimed to understand the impact of COVID-19 on older adults, allowing them to provide direct and in-depth discussions about their feelings and situations. The focus groups were conducted in two groups: A - people in the United Kingdom, and B - people in Taiwan.

Method: The participants were individuals aged over 65 years old. The focus groups involved general open-ended questions focused on two main topics:

How do you feel about COVID-19?
How has COVID-19 impacted your life?
Did you use more technology during COVID-19?
Did you learn to use new technology during the COVID-19 pandemic?

Procedure: The studies were conducted through online meetings for the focus groups. Each group had a 1-hour discussion that allowed everyone to share their ideas. The questions were open-ended. At the end of the discussion, participants were invited to add additional topics related to their lives.

Data collection and analysis: The data was collected from older adults. The software NVivo 11 for Mac was used to assist in the analysis.

4.2. Experiment II: Testing Prototypes Game

This experiment aims to test the game with twenty participants, who are family caregivers of people with dementia, using qualitative research methods. The minimum sample size calculated was fifteen participants, as shown in **Figure 1** using G*Power. Given the study's focus on a broader, observable effect, a large effect size of 0.8 was chosen, along with an alpha value of 0.05 and a power value of 0.8, in line with general practice [30]. While the convention for alpha is 0.05, in exploratory fields, 0.1 is sometimes used, which would require a sample size of 16.

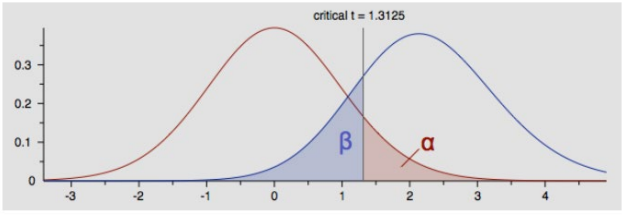

Figure 1. G*Power statistical test

Purpose: The purpose of this study was to assess the reliability of the game for dementia family caregivers using qualitative methodology.

Method: The participants were British dementia family caregivers. The survey questions were developed based on the instrument used in the previous experiment with experienced gaming professionals.

Procedure: The participants were asked to play the game or watch a video for five minutes, and then complete the respective questionnaire (**Appendix A**).

Data Collection and Analysis: Over thirty dementia family caregivers participated in the study, and qualitative data was collected from them. The data collected was used to determine the reliability of the game, particularly for those involved in pre- or early-stage dementia.

5. Result

5.1 Experiment I: Focus Group

The focus groups consisted of two small groups: Group A with 9 participants from the United Kingdom and Group B with 8 participants from Taiwan. The participants were asked open-ended questions to express their thoughts and feelings.

5.1.1. Group A

In the focus group A research, there were 6 females and 3 males, totalling 9 participants. Among them, 3 participants were over 90 years old, 2 participants were 65 years old, 1 participant was 66 years old, 2 participants were 72 years old, and 1 participant was 77 years old, as shown in **Table 1**.

Table 1. Participants in the UK

Code	Age	Gender
GB01	90	F
GB02	65	M
GB03	77	F
GB04	72	F
GB05	92	M
GB06	93	F
GB07	66	F
GB08	65	M
GB09	72	F

The focus group discussion was centred around three themes such as emotional, social and technology. The emotional theme had two codes, while the social theme had four codes, as shown in **Table 2**.

Table 2. An initial list of aspects identified from focus group (A)

Category	Theme	Code (number of occurrences)
Covid-19 effect to older adult in the United Kingdom	Emotional	Miss (2)
		Worried (2)
	Social	Difficult to shop (1)
		Indoor (2)
		Travelling (1)
		Holiday (1)
	Technology	Learned (3)
		Video Call/Massage(3)
		Email (1)

Emotional Theme

The emotional theme within the two code such as "miss" and "worried". These are negative emotion which will discuss below.

For the code "miss" the participants are miss their family numbers. However, they do phone or video call.

- GB01: I miss seeing my family. Although they phone me. It is not quite the same, as a being with them.
- GB07: I miss my grandchildren.
- There are two participants who mention "worried". They worried about themselves, family numbers and whole situation in the world such as economy.
- GB 05: The economy is collapsing and the great harm that this is going to do to the population, that's what worries me more than anything else
- GB 08: I am worried about my family this village where many people died and about the situation in the entire world.

Social Theme

In the social theme with four code difficult to shop, indoor, traveling and holiday.

The participant GB02 mention that it is difficult to go for shopping.

- GB 02: It's difficult to shop now, it takes a lot longer.

There are two participants GB06 and GB09 mentioned that, the most time they are "indoors".

- GB 06: Being unable to move around in the way that I would have down in the past, like having to be indoors all the time which means staying in the house the whole day long.
- GB09: Easter is three days of celebrations with family and friends but this year. It was solitary time spent indoors with TV for company.

There are two codes are similar meaning such as "travelling" and "holiday".

- GB07: I'm fed up of not traveling. Tough times, hopefully once the vaccine starts offering protection the world will go back to normality.
- GB02: The thought of a holiday. Impossible at this time. other than that, we carry on.

Technology Theme

During the pandemic, older adults have learned to utilize technology to connect with their friends and families. Three participants specifically mentioned their increased knowledge and usage of technology.

- Participant GB4 stated, "Yes, a lot more. I learned to use Zoom and Teams."
- Participant GB6 shared, "I used to email my grandchild, and now I have learned to use Zoom for church meetings."
- Participant GB7 expressed, "I craved seeing people, not technology... I learned Zoom but hate it... I learned from my children to use Marco Polo, which is a video messaging mobile app."
- Participant GB7 mentioned that while she previously used emails, she has now also learned to use online video call platforms such as Zoom.

5.1.2. Group B

The focus group in Taiwan also discussed two themes: emotional, social and technology. Within the emotional theme, there were six codes identified, and within the social theme, there were two codes. These are presented in **Table 4**.

Table 3. Participants in Taiwan

Code	Age	Gender
TW01	72	F
TW02	66	M
TW03	69	M
TW04	67	M
TW05	89	F
TW06	67	F
TW07	78	F
TW08	69	F

Table 4. An initial list of aspects identified from focus group (B)

Category	Theme	Code (number of occurrences)
Covid-19 effect to older adult in the Taiwan	Emotional	Nervous (3)
		Anxiety (2)
		Sad (1)
		Depress (1)
		Feel down (1)
		Afraid (5)
	Social	Extra Careful (1)
		Cancelled (1)
		Video Call (3)
	Technology	New Devices (2)

Emotional Theme

The emotional theme includes six negative emotions: Nervous, Anxiety, Sad, Depress, Feel down, and Afraid.

Three participants mentioned feeling nervous.

- TW01: "I'm nervous".
- TW02: "I felt nervous …"
- TW03: "At the beginning of the epidemic, I was very nervous..."

Two participants mentioned feeling anxiety about Covid-19.

- TW04: "I feel that, though the new report, there will be anxiety in my heart."
- TW06: "...some elderly people may feel anxious. It is uneasy to stay at home and can't go out, causing great psychological damage."

Only one participant felt sad.

- TW05: "When I saw on TV that someone got it, and when I saw someone passed away, I felt very sad."

Participant TW06 mentioned feeling Depressed and Down.

- TW06: "Feel depression at home all the time."
- TW06: "It is broadcast 24 hours a day in Taiwan and often makes people feel down."

Five participants expressed fear.

- TW01: "I am afraid to go out."
- TW02: "I am afraid of death. I am afraid that my friends would get sick, and I was also afraid that my family would get sick."
- TW03: "I am old, but our government handled it very well, so although I was afraid, it would return to normal …"
- TW08: "I am afraid that the child will get (Covid-19)."

- TW06: "...waiting indefinitely for the epidemic to ease, causing a lot of fear in people's hearts."

Social Theme

There are only two codes mentioned in the social theme: Careful and Cancelled.

Participant TW01 mentioned being "careful".

- TW01: "I'm very careful when I go out. I have to wear a mask and I have to wash my hands."

Participant TW06 mentioned that their activities have been cancelled.

- TW06: "Our activities have been cancelled."

Technology Theme

There were three participants who mentioned an increase in their use of technology compared to before. The responses are provided below:

- TW01: "I have been using video calls more frequently to connect with my family."
- TW07: "I rely on video calls a lot now."
- TW08: "Although we were already familiar with technology, we have been using it more often now, especially for video calls with our families."

However, participant TW05 highlighted that using technology platforms, particularly an iPad, was a new experience for them. On the other hand, TW04 mentioned purchasing an Apple Watch to monitor their health, specifically their blood oxygen levels.

- TW05: "I have started using an iPad frequently, which is a new device for me."
- TW04: "I bought an Apple Watch to track my health information, particularly my blood oxygen levels."

5.2 Experiment II: Testing Mock-Up Game with Dementia Family Carers

During this stage, the mock-up game was tested with dementia family carers using the metric instrument. This session focuses on the results obtained from comparing the means of individual framework elements and grouped combinations. The study included twenty participants, comprising of four males and sixteen females, as indicated in **Table 5**. The majority of the participants, specifically six individuals, fell within the 65-75 age range, as shown in **Table 6**. The most family caregivers are female, and 34% of them are aged 65 or over.

Table 5. Respondent's gender of participants

Gender	Male	Female
Number of Participants	4	16

Table 6. Respondent's gender of participants

A Range of Ages	No. Participants
over 75	3
65-75	6
55-65	3
45-55	4
35-45	2
23-35	2

Normality

The data in **Appendix B** underwent normality tests using the Kolmogorov-Smirnov and Shapiro-Wilk tests. The tests indicated insignificant results ($p < 0.05$), suggesting that the data distributions were normal. Hence, it is appropriate to use a t-test [31].

Independent-Samples T-test

Responses were collected from a total of twenty participants who served as dementia family carers. In the analysis, the participants' responses to the Make a cup of tea game were compared to a null value, which was determined by the sum of "Neither" responses (which equaled 3 for each question). The mean results obtained from the participants were higher than the null value, indicating that the majority of participants either agreed or strongly agreed with the statements.

However, there were certain questions, namely H_Education_SM and E_Social_SM (as presented in **Appendix C**), where lower results were observed. These questions pertained to the impact of the game's background music/sound on understanding health issues and its role in improving knowledge of health issues. The findings suggest that the background music/sound had a limited effect on the overall gaming experience, as it was considered more of a supplementary element rather than a core component. Nonetheless, this issue will be addressed for future enhancements.

The [Make a cup of tea] game primarily focuses on the visual design, as mentioned in the game content. The unsuccessful results obtained from the independent sample t-tests were primarily associated with the background music of the game. Based on these results, it can be concluded that the sound and music in the game do not significantly impact the overall gaming experience. However, the game's ability to support dementia family carers, particularly at pre- and early-stages, was measured through various tests, including normality tests and means

tests.These tests were conducted to assess the effectiveness of the [Make a cup of tea] game in supporting dementia family carers.

Normality

Normality tests were conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests for the group factors. The results indicated significance for Health and Social factors ($p < 0.05$), as shown in **Table 7**. As a result, non-parametric tests were employed to analyse the data, as these tests do not assume a normal distribution of the data.

Table 7. Grouping Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Health_Education	.140	20	.200*	.971	20	.779
Health_Social	.226	20	.009	.916	20	.084
Health_Engagement	.120	20	.200*	.960	20	.539
Education_Social	.170	20	.134	.931	20	.159
Education_Engagement	.154	20	.200*	.982	20	.955
Social_Engagement	.145	20	.200*	.944	20	.291

*. This is a lower bound of the true significance.
Lilliefors Significance Correction

Grouping Non-Parametric Means Test

The Mann-Whitney test was performed on the grouped factors, and the results showed higher mean ranks compared to the null value (where every question was answered with "No Opinion" = 3), as presented in **Table 8.** This indicates that the participants generally agreed or strongly agreed with the statements. Each of the factors exhibited significant results ($p < 0.05$), as shown in **Table 9.**

Table 8. Grouping the Mann-Whitney Mean Rank

	Group	N	Mean Rank	Sum of Ranks
Health_Education	Null	20	13.50	270.00
	Participant	20	27.50	550.00
	Total	40		
Health_Social	Null	20	13.00	260.00
	Participant	20	28.00	560.00
	Total	40		
Health_Engagement	Null	20	13.50	270.00
	Participant	20	27.50	550.00
	Total	40		
Education_Social	Null	20	12.50	250.00
	Participant	20	28.50	570.00
	Total	40		
Education_Engagement	Null	20	12.00	240.00
	Participant	20	29.00	580.00
	Total	40		
Social_Engagement	Null	20	11.50	230.00
	Participant	20	29.50	590.00
	Total	40		

Table 9. Grouping the Mann-Whitney Significance Statistics

Test Statistics[a]

	Health_ Education	Health_ Social	Health_ Engagement	Education_ Social	Education_ Engagement	Social_ Engagement
Mann- Whitney U	60.000	50.000	60.000	40.000	30.000	20.000
Wilcoxon W	270.000	260.000	270.000	250.000	240.000	230.000
Z	-4.152	-4.397	-4.150	-4.746	-4.974	-5.337
Asymp. Sig.(2-tailed)	.000	.000	.000	.000	.000	.000
Exact Sig. [2*(1-tailedSig.)]	<.001[b]	<.001[b]	<.001[b]	<.001[b]	<.001[b]	<.001[b]

a. Grouping Variable: Group
b. Not corrected for ties.

6. Discussion

According to Experiment A, the COVID-19 pandemic has had a lasting impact on older adults, as revealed by the research experiments. In Taiwan, older adults experienced more negative emotions such as nervousness, anxiety, and depression, leading them to be more cautious during the pandemic. Conversely, in the UK, older adults faced more family-related issues such as missing their families, as well as dealing with the cancellation of holidays and travel plans.

The study found that older adults in the UK adapted by learning to use new technologies, while older adults in Taiwan, who were already familiar with these technologies, used them more frequently during the pandemic. Additionally, older adults in Taiwan acquired new devices for various purposes, including health tracking and video calling with family members. The results of the study illustrate the cultural differences between Taiwan and the UK.

In Experiment II, the [Make a Cup of Tea] mock-up game was tested with dementia family caregivers to evaluate its components of Health, Education, and Social. The results were positive and indicate that the game has the potential to support dementia family caregivers, particularly in pre- and early stages. However, the Social component was challenging to quantify due to its complexity and diverse aspects.

While [Make a Cup of Tea] is not yet ready for the market, Experiment II is a crucial step towards further research and game development.

6.1. The Refined and Expanded Game Prototypes

The game is specifically designed for individuals in the pre/early stages of dementia and their families. Its purpose is to increase awareness and understanding of the symptoms experienced during the early stages of dementia, as well as provide suggestions on how to care for individuals with the condition.

Renamed: The game formerly known as [Make a Cup of Tea] has been renamed as [Tea Time!] In British, Irish, and certain Commonwealth countries, the term "tea" is sometimes used to refer to the main evening meal, instead of using the terms "dinner" or "supper." However, this article focuses on the various types of secondary and lighter meals known as "tea." Consequently, the [Tea Time!] games are designed with three different themes, each representing the symptoms of dementia that individuals might experience. During the game, players can travel around the world, exploring their favourite flavours, while also gaining insight into the challenges faced by individuals with dementia and how to support them.

Refined Game:

The five key messages regarding dementia, advocated by the organization Dementia Friends, remain unchanged. However, improvements have been made to the game type, story, and suggestions in order to enhance the user experience. The following modifications have been implemented in each step, except for step two which remains unchanged:

Step One (cup)

- Game Type: The game type has been changed to an Emotion Game - this game tracks and records emotions. Emotions play a significant role in the lives of older adults and people with dementia often experience changes in their emotional responses.

Step Three (tea)

- Game Type: Memory Game - Match pairs of different tea bags.
- Suggestion: In different types of dementia there is damage to different parts of the brain. However, in all cases, people with it are encouraged to get involved with social activities to maintain their health.

Step Four (sugar)

- Game Type: Attention Game: Find the correct item.
- Suggestion: People with dementia may find it challenging to communicate or express their thoughts. Caregivers need to be patient and understanding in order to comprehend their needs.

Step Five (milk)

- Game Type: Problem Solving Game - Jigsaw puzzle.
- Suggestion: People with dementia still can be themselves and live independently.

Expended Theme: The game consists of three different cultural themes: Cuppa, Fondue, and Sushi (**Table 7**). The primary theme, Cuppa, has been refined based on the previous mock-up game called [Make a Cup of Tea]. It focuses on conveying five important messages about dementia and provides suggestions for families of individuals with dementia.

Making a cup of tea is a common daily task in English culture and is generally considered an intuitive action for most people. However, memory loss and cognitive difficulties are well-known signs of dementia, which can make even simple tasks like making tea challenging. Researchers have discovered that minor mistakes while performing routine activities can be early indicators of the condition. The other themes explore specific symptoms of dementia and provide recommendations on how to support individuals with dementia for their family members.

Table 7. Game Details

Theme	**One: Cuppa**	**Two: Fundue**	**Three: Sushi**
Describe	Making tea is a daily task in English culture and is considered as an intuitive task; however, people with dementia often find it difficult and might struggle to complete the task due to brain damage. Players have to complete five mini games, each resembling an action during the process of making English tea.	Fondue is a Swiss melted cheese dish, involving dipping bread into cheese using long-stemmed forks.	Sushi is a famous dish in Japan. Do you know how many types of sushi there are? Which one do you like most?
Game	Step 1 Game Story: Emotion Game-How do you feel today? Message: There is more to the person than the dementia. Suggestion: Let the people with dementia retain their identity/personality. Step 2 Game Story: Speed Game - Move Cup to catch drop Message: Dementia is not a natural part of aging. Suggestion: Normal age-related changes in cognition can happen, but confusion and memory loss are NOT part of the healthy aging process. To looking after dementia needs more patience. Step 3 Game Story: Memory Game- Match Pairs Message: Dementia is caused by brain diseases. Suggestion: In different types of dementia there is damage to different parts of the brain. However, in all cases, people with it are encouraged to get involved with social activities to maintain their health. Step 4 Game Story: Attention Game - Find the correct item Message: It's not just about memory loss. Suggestion: People with dementia may find it difficult to communicate or convey their thinking. They need others to be more patient with them, and to understand their needs. Step 5 Game Story: Problem Solving Game- Jigsaw puzzle Message: It's possible to live well with dementia. Suggestion: People with dementia still can be themselves and live independently.	Game Story: Maze Game- Find the five items to make a Fondue Message: Disorientation of the time/place the person is in. Suggestion: Show photos, reminders, devices and other thought-provoking items to remind the person of certain important relationships and places.	Game Story: Attention Game- Finding the correct item Message: Trouble understanding visual images or spatial relationships Suggestion: People with dementia may have difficulty reading, judging distances and determining colour or contrast. It is alright to make a mistake, but they have to at least try.

Figure 2. Tea Time! Home Screen

Transforming games from 2D to Augmented Reality: The integration of augmented reality into gaming creates a highly immersive environment for users to enjoy. Augmented reality not only enhances the gaming experience but also introduces unique interactive elements for players. For instance, it enables players to develop a deeper understanding of dementia symptoms by immersing them in relevant game scenarios. In this research, [Make a Cup of Tea] is a web-based game exclusively controlled by a mouse, while [Tea Time!] offers users the opportunity to play on various tablets or mobile phone and control the game using their mobile phones or tablets.

Figure 3. A screenshot of Tea Time!

6.2. Future Work

This research is focused on the game itself for family carers of pre- and early-stages of dementia. There are various ways to proceed based on the research results. Three of the main recommended directions for future works are discussed below:

Game Testing: Games has been developed; the next stage will used the new AR games to test large number of people. In order to find out the games are reliable in the market.

Expandig Games: The research can continues expending different theme with different culture such as Taiwanese beef noodles etc. It will make games more interested and more information. Additionally, as the current design is for carers of pre- and early-stages of dementia, the next step can be expanding to carers of patients of middle or late stage of dementia.

Applied to different health issues: The research could also be applied to different health issues, especially mental health. There are many health issues which are similar to dementia. For example, Post-traumatic stress disorder (PTSD) and Schizophrenia. PTSD is type of anxiety disorder is very similar to dementia; PTSD patients can lose their memory, for example. There may be treatments for this type of mental health to help patients get back to normal life [32].: The seriousness of schizophrenia this type of mental health issue depends on how well patients can cope with it. Family and friends play an important role including listening and helping out with their daily life.

6.3. Final Remark

This research project is a collaboration between digital design, computer science, and healthcare studies, aiming to enhance the living standards of dementia patient carers through educational games. The primary focus is to educate and enlighten carers, ultimately improving their understanding and support for dementia patients. The paper explores the challenges faced by older adults during the COVID-19 pandemic and post-pandemic periods, highlighting how technology can enhance their lives and facilitate connections with family and friends.

Based on the research findings, the game [Make a Cup of Tea] was developed as a mock-up to demonstrate an ideal support system for family carers of dementia patients. The game yielded positive results, providing valuable insights for future expansion and development. Furthermore, [Make a Cup of Tea] has been refined as an augmented reality (AR) game, offering users a more immersive environment.

The impact of this research is expected to be significant in improving the quality of life, particularly for family carers of individuals in the pre- and early-stages of dementia. Playing the game will positively affect the player's well-being and overall quality of life.

Appendix A. Survey questionnaire for game professionals

The survey comprises six games and respective questionnaires. Participant will be asked to play game for five minutes and then complete the respective questionnaire, which also takes about five minutes to complete.

Instructions:
Please evaluate the following statement about the game you just played and choose how much you strongly agree, agree, neither, disagree and strongly disagree with each of the item.

Criteria:

Rating	Definition
"Strongly Disagree"	The item is either too scarce or nonexistent in the game.
"Disagree"	The item has a minor representation in the game.
"Neither"	The item presents an ambivalent perspective, neither agreeing nor disagreeing.
"Agree"	The item has a satisfactory level of presence/quality in the game.
"Strongly Agree"	The item has an outstanding level of presence/quality in the game.

Health

To evaluate how education strengthens the **Health** component

Metric applied to the game	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
G1: While playing, I gained new knowledge from the game's message/information section about how to improve my health.					
G2: *The game's message does not give enough information about health issues.					
G3: *While playing, I don't feel the game educated the player about the health issues.					
G4: Adjusting the characteristics of the game's avatars could change the players' health behaviours.					
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.					
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.					
G9: After I played through the game's story, I feel I understand more about the health issues.					
G10: * After I played through the game, I do not think I will change my health behaviour.					

Evaluate how social media supports the **Health** component

Metric applied to the game	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
G21: I think the social aspects of the platform help me to engage with other people, in order to improve my health.					
G22: *The platform did not allow engagement with the community in order to improve health.					
G23: *I did not find the game engaging enough to improve health behaviors.					
G24: While playing, I found that the game elements (avatars, graphics and music) can help change my health behaviors.					
G25: While playing the game I found the game elements (avatars, graphics and music) engage me with the health issues.					
G26: Whilst playing the game, I found the game world encouraged me to engage with the health issues.					
G27: *When playing the game, the background music did not help engage me in the health issues.					
G28: While playing, I felt motivated by the game's story to improve my health behaviors.					

Evaluate engagement improve **Health** component

Metric applied to the game	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
G11: I think playing the game in combination with social media platforms can help support people with their health issues.					
G12: * I don't think using the online community will be able to help support people with their health issues.					
G13: The game allowed me to link with communities to discuss the health issues.					
G14: *The game does not allow me to link with community members to discuss the health issues.					
G15: Using an avatar whilst playing the game helps to bring me closer to the community.					
G16: I feel that using my avatar within the community helps me to change my health behaviors.					
G17: I think the game world encourages players to seek out real-world communities to find support for their health issues.					
G18: In the game, I was able to speak to other people about health issues.					
G19: I felt the game story made me interested in finding out more about health issues.					

G20: * Whilst playing the game, I did not focus on the game story.					

Education

Evaluate Social element encourages Education element

Metric applied to the game	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
G29: I found the social platform associated with the game helped me to discuss the health issues with relevant communities.					
G30: * I don't think the game provides new things to learn.					
G31: I felt the social platform associated with the game helped increase the size of the communities through which I could discuss the issues.					
G32: I found using an avatar helped me to connect with other people through social media.					
G33: I found using the social media platform associated with the game enabled me to get more information about the health issues.					
G34: I think that the game world represents real life issues.					
G35: I found that involving the social communities in the game world allowed me to be more informed about the health issues.					
G36: I think the background music and sound helped improve my knowledge of the health issues.					
G37: I found the background narrator/commentator supplied additional information about the health issues.					
G38: I felt the game used plot twists, conflict and interesting characterization to make it more engaging.					

To Evaluate engagement informs **Education** element

Metric applied to the game	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
G39: I found the game showed different ways to handle real-life health issues.					
G40: I think the game's message is interesting enough to discuss with other people.					
G41: * I don't think the gameplay engaged me enough for me to gain new knowledge.					
G42: I found the avatar can motivate other players to discuss the health issues.					
G43: I found the game world graphics helped me to gain new knowledge about real-life health issues.					

G44: I think the game world graphics represent real health issues					
G45: I feel the game's background music and sound can help motivate people to obtain new knowledge about health issues					
G46: After I played the game, I would discuss the issues with other players.					
G47: After I played the game, I made friends through discussing the issues with other players.					

Social

Evaluate engagement produces Social component

Metric applied to the game	Strongly Disagree	Disagree	Neither	Agree	Strongly Agree
G48: I found the game can raise social awareness of the health issues.					
G49: I think the social component are very important in the game.					
G50: * I don't think the game's social component help raise awareness.					
G51: I think the game's message and information can lead to people becoming more involved in the communities.					
G52: * I don't feel the game's social media platform encouraged players to become closer to each other.					
G53: The avatar and game world helped me to connect with other players who had similar styles of avatars.					
G54: * I don't feel the game world would help players grow the size of the communities.					
G55: I think the game's background music and sound helped motivate players to link with each other.					
G56: I found the game's story helped me to discuss similar interesting issues with other players.					
G57: I found that discussing similar interesting issues with other players helped increase the size of the communities.					

* Reverse-worded questions

Appendix B. Output of the Normality tests

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
H_Education_GP_Support	.318	20	.000	.833	20	.003
H_Education_GP_Message	.252	20	.002	.858	20	.007
H_Education_GP_Collaboration	.225	20	.009	.887	20	.023
H_Education_AP	.275	20	.000	.767	20	.000
H_Education_GW	.247	20	.002	.869	20	.011
H_Education_GW2	.266	20	.001	.832	20	.003
H_Education_SM	.375	20	.000	.720	20	.000
H_Education_SM2	.323	20	.000	.823	20	.002
H_Education_SL	.375	20	.000	.775	20	.000
H_Education_SL2	.255	20	.001	.881	20	.018
H_Social_GP_Support	.318	20	.000	.833	20	.003
H_Social_GP_Support2	.263	20	.001	.800	20	.001
H_Social_GP_Messgae	.294	20	.000	.829	20	.002
H_Social_GP_Collaboration	.279	20	.000	.807	20	.001
H_Social_AP	.238	20	.004	.868	20	.011
H_Social_AP2	.336	20	.000	.821	20	.002
H_Social_GW	.303	20	.000	.850	20	.005
H_Social_SM	.286	20	.000	.867	20	.010
H_Social_SL	.300	20	.000	.832	20	.003
H_Social_SL2	.268	20	.001	.858	20	.007
H_Engagement_GP_Support	.308	20	.000	.765	20	.000
H_Engagement_GP_Message	.413	20	.000	.608	20	.000
H_Engagement_GP_Collaboration	.252	20	.002	.858	20	.007
H_Engagement_AP	.287	20	.000	.863	20	.009
H_Engagement_AP2	.268	20	.001	.858	20	.007
H_Engagement_GW	.302	20	.000	.780	20	.000
H_Engagement_SM	.336	20	.000	.821	20	.002
H_Engagement_SL	.263	20	.001	.800	20	.001
E_Social_GP_Support	.266	20	.001	.855	20	.006
E_Social_GP_Messgae	.227	20	.008	.898	20	.038
E_Social_GP_Collaboration	.424	20	.000	.632	20	.000
E_Social_AP	.376	20	.000	.767	20	.000
E_Social_AP2	.339	20	.000	.739	20	.000
E_Social_GW	.350	20	.000	.775	20	.000
E_Social_GW2	.252	20	.002	.795	20	.001
E_Social_SM	.303	20	.000	.850	20	.005
E_Social_SM2	.271	20	.000	.853	20	.006
E_Social_SL	.284	20	.000	.773	20	.000
E_Engagement_GP_Support	.336	20	.000	.821	20	.002
E_Engagement_GP_Messgae	.300	20	.000	.793	20	.001
E_Engagement_GP_Collaboration	.233	20	.006	.887	20	.024
E_Engagement_AP	.252	20	.002	.795	20	.001
E_Engagement_GW	.275	20	.000	.864	20	.009
E_Engagement_GW2	.351	20	.000	.754	20	.000
E_Engagement_SM	.346	20	.000	.814	20	.001
E_Engagement_SL	.255	20	.001	.812	20	.001
E_Engagement_SL2	.309	20	.000	.842	20	.004
S_Engagement_GP_Support	.288	20	.000	.798	20	.001
S_Engagement_GP_Support2	.312	20	.000	.788	20	.001
S_Engagement_GP_Support3	.246	20	.003	.870	20	.012
S_Engagement_GP_Message	.333	20	.000	.768	20	.000
S_Engagement_GP_Collaboration	.297	20	.000	.841	20	.004
S_Engagement_AP	.499	20	.000	.447	20	.000
S_Engagement_GW	.317	20	.000	.843	20	.004
S_Engagement_SM	.363	20	.000	.790	20	.001
S_Engagement_SL1	.312	20	.000	.788	20	.001
S_Engagement_SL2	.230	20	.007	.809	20	.001

Appendix C. Independent-Samples T-test

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
H_Education_GP_Support	Null	20	3.0000	.00000	.00000
	Participant	20	3.8500	.87509	.19568
H_Education_GP_Message	Null	20	3.0000	.00000	.00000
	Participant	20	3.4000	.75394	.16859
H_Education_GP_Collaboration	Null	20	3.0000	.00000	.00000
	Participant	20	3.6000	.88258	.19735
H_Education_AP	Null	20	3.0000	.00000	.00000
	Participant	20	3.2500	.78640	.17584
H_Education_GW	Null	20	3.0000	.00000	.00000
	Participant	20	3.9000	.85224	.19057
H_Education_GW2	Null	20	3.0000	.00000	.00000
	Participant	20	3.5000	.68825	.15390
H_Education_SM	Null	20	3.0000	.00000	.00000
	Participant	20	2.7500	.55012	.12301
H_Education_SM2	Null	20	3.0000	.00000	.00000
	Participant	20	3.4500	.75915	.16975
H_Education_SL	Null	20	3.0000	.00000	.00000
	Participant	20	3.7500	.78640	.17584
H_Education_SL2	Null	20	3.0000	.00000	.00000
	Participant	20	3.3500	.87509	.19568
H_Social_GP_Support	Null	20	3.0000	.00000	.00000
	Participant	20	3.8500	.87509	.19568
H_Social_GP_Support2	Null	20	3.0000	.00000	.00000
	Participant	20	3.8000	.69585	.15560
H_Social_GP_Messgae	Null	20	3.0000	.00000	.00000
	Participant	20	3.4500	.68633	.15347
H_Social_GP_Collaboration	Null	20	3.0000	.00000	.00000
	Participant	20	3.0500	.68633	.15347
H_Social_AP	Null	20	3.0000	.00000	.00000
	Participant	20	3.6500	.81273	.18173
H_Social_AP2	Null	20	3.0000	.00000	.00000
	Participant	20	3.2500	.71635	.16018
H_Social_GW	Null	20	3.0000	.00000	.00000
	Participant	20	3.8000	.76777	.17168
H_Social_SM	Null	20	3.0000	.00000	.00000
	Participant	20	3.3000	.86450	.19331
H_Social_SL	Null	20	3.0000	.00000	.00000
	Participant	20	4.0000	.79472	.17770
H_Social_SL2	Null	20	3.0000	.00000	.00000
	Participant	20	3.6000	.82078	.18353
H_Engagement_GP_Support	Null	20	3.0000	.00000	.00000
	Participant	20	3.6500	.74516	.16662
H_Engagement_GP_Message	Null	20	3.0000	.00000	.00000
	Participant	20	3.3500	.48936	.10942
H_Engagement_GP_Collaboration	Null	20	3.0000	.00000	.00000
	Participant	20	3.4000	.75394	.16859
H_Engagement_AP	Null	20	3.0000	.00000	.00000
	Participant	20	3.4000	.82078	.18353
H_Engagement_AP2	Null	20	3.0000	.00000	.00000
	Participant	20	3.6000	.82078	.18353
H_Engagement_GW	Null	20	3.0000	.00000	.00000
	Participant	20	3.7500	.63867	.14281
H_Engagement_SM	Null	20	3.0000	.00000	.00000
	Participant	20	3.2500	.71635	.16018
H_Engagement_SL	Null	20	3.0000	.00000	.00000
	Participant	20	3.8000	.69585	.15560
E_Social_GP_Support	Null	20	3.0000	.00000	.00000
	Participant	20	3.5500	.75915	.16975

E_Social_GP_Messgae	Null	20	3.0000	.00000	.00000
	Participant	20	3.4000	.99472	.22243
E_Social_GP_Collaboration	Null	20	3.0000	.00000	.00000
	Participant	20	3.3500	.58714	.13129
E_Social_AP	Null	20	3.0000	.00000	.00000
	Participant	20	3.3000	.65695	.14690
E_Social_AP2	Null	20	3.0000	.00000	.00000
	Participant	20	3.5500	.68633	.15347
E_Social_GW	Null	20	3.0000	.00000	.00000
	Participant	20	4.0000	.72548	.16222
E_Social_GW2	Null	20	3.0000	.00000	.00000
	Participant	20	3.7500	.71635	.16018
E_Social_SM	Null	20	3.0000	.00000	.00000
	Participant	20	2.9000	.85224	.19057
E_Social_SM2	Null	20	3.0000	.00000	.00000
	Participant	20	3.6500	.87509	.19568
E_Social_SL	Null	20	3.0000	.00000	.00000
	Participant	20	3.6500	.67082	.15000
E_Engagement_GP_Support	Null	20	3.0000	.00000	.00000
	Participant	20	3.7500	.71635	.16018
E_Engagement_GP_Messgae	Null	20	3.0000	.00000	.00000
	Participant	20	4.0000	.64889	.14510
E_Engagement_GP_Collaboration	Null	20	3.0000	.00000	.00000
	Participant	20	3.4500	.94451	.21120
E_Engagement_AP	Null	20	3.0000	.00000	.00000
	Participant	20	3.7500	.71635	.16018
E_Engagement_GW	Null	20	3.0000	.00000	.00000
	Participant	20	3.7500	.78640	.17584
E_Engagement_GW2	Null	20	3.0000	.00000	.00000
	Participant	20	3.8500	.58714	.13129
E_Engagement_SM	Null	20	3.0000	.00000	.00000
	Participant	20	3.3000	.80131	.17918
E_Engagement_SL	Null	20	3.0000	.00000	.00000
	Participant	20	3.9000	.71818	.16059
E_Engagement_SL2	Null	20	3.0000	.00000	.00000
	Participant	20	3.3000	.73270	.16384
S_Engagement_GP_Support	Null	20	3.0000	.00000	.00000
	Participant	20	4.1500	.67082	.15000
S_Engagement_GP_Support2	Null	20	3.0000	.00000	.00000
	Participant	20	4.1000	.64072	.14327
S_Engagement_GP_Support3	Null	20	3.0000	.00000	.00000
	Participant	20	3.7000	.80131	.17918
S_Engagement_GP_Message	Null	20	3.0000	.00000	.00000
	Participant	20	3.9500	.60481	.13524
S_Engagement_GP_Collaboration	Null	20	3.0000	.00000	.00000
	Participant	20	3.5500	.82558	.18460
S_Engagement_AP	Null	20	3.0000	.00000	.00000
	Participant	20	3.2000	.52315	.11698
S_Engagement_GW	Null	20	3.0000	.00000	.00000
	Participant	20	3.3500	.81273	.18173
S_Engagement_SM	Null	20	3.0000	.00000	.00000
	Participant	20	3.2000	.69585	.15560
S_Engagement_SL1	Null	20	3.0000	.00000	.00000
	Participant	20	4.1000	.64072	.14327
S_Engagement_SL2	Null	20	3.0000	.00000	.00000
	Participant	20	3.8500	.74516	.16662

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of Difference	
									Lower	Upper
H_Education_GP_Support	Equal variances assumed	22.032	.000	-4.344	38	.000	-.85000	.19568	-1.24613	-.45387
	Equal variances not assumed			-4.344	19.000	.000	-.85000	.19568	-1.25956	-.44044
H_Education_GP_Message	Equal variances assumed	59.681	.000	-2.373	38	.023	-.40000	.16859	-.74128	-.05872
	Equal variances not assumed			-2.373	19.000	.028	-.40000	.16859	-.75285	-.04715
H_Education_GP_Collaboration	Equal variances assumed	54.077	.000	-3.040	38	.004	-.60000	.19735	-.99952	-.20048
	Equal variances not assumed			-3.040	19.000	.007	-.60000	.19735	-1.01306	-.18694
H_Education_AP	Equal variances assumed	30.066	.000	-1.422	38	.163	-.25000	.17584	-.60598	.10598
	Equal variances not assumed			-1.422	19.000	.171	-.25000	.17584	-.61805	.11805
H_Education_GW	Equal variances assumed	27.755	.000	-4.723	38	.000	-.90000	.19057	-1.28578	-.51422
	Equal variances not assumed			-4.723	19.000	.000	-.90000	.19057	-1.29886	-.50114
H_Education_GW2	Equal variances assumed	76.000	.000	-3.249	38	.002	-.50000	.15390	-.81155	-.18845
	Equal variances not assumed			-3.249	19.000	.004	-.50000	.15390	-.82211	-.17789
H_Education_SM	Equal variances assumed	45.265	.000	2.032	38	.049	.25000	.12301	.00098	.49902
	Equal variances not assumed			2.032	19.000	.056	.25000	.12301	-.00746	.50746
H_Education_SM2	Equal variances assumed	56.435	.000	-2.651	38	.012	-.45000	.16975	-.79365	-.10635
	Equal variances not assumed			-2.651	19.000	.016	-.45000	.16975	-.80530	-.09470
H_Education_SL	Equal variances assumed	24.455	.000	-4.265	38	.000	-.75000	.17584	-1.10598	-.39402
	Equal variances not assumed			-4.265	19.000	.000	-.75000	.17584	-1.11805	-.38195
H_Education_SL2	Equal variances assumed	47.105	.000	-1.789	38	.082	-.35000	.19568	-.74613	.04613
	Equal variances not assumed			-1.789	19.000	.090	-.35000	.19568	-.75956	.05956

H_Social_GP_Support	Equal variances assumed	22.032	.000	-4.344	38	.000	-.85000	.19568	-1.24613	-.45387
	Equal variances not assumed			-4.344	19.000	.000	-.85000	.19568	-1.25956	-.44044
H_Social_GP_Support2	Equal variances assumed	40.699	.000	-5.141	38	.000	-.80000	.15560	-1.11499	-.48501
	Equal variances not assumed			-5.141	19.000	.000	-.80000	.15560	-1.12567	-.47433
H_Social_GP_Messgae	Equal variances assumed	71.960	.000	-2.932	38	.006	-.45000	.15347	-.76068	-.13932
	Equal variances not assumed			-2.932	19.000	.009	-.45000	.15347	-.77121	-.12879
H_Social_GP_Collaboration	Equal variances assumed	19.321	.000	-.326	38	.746	-.05000	.15347	-.36068	.26068
	Equal variances not assumed			-.326	19.000	.748	-.05000	.15347	-.37121	.27121
H_Social_AP	Equal variances assumed	56.328	.000	-3.577	38	.001	-.65000	.18173	-1.01790	-.28210
	Equal variances not assumed			-3.577	19.000	.002	-.65000	.18173	-1.03037	-.26963
H_Social_AP2	Equal variances assumed	31.068	.000	-1.561	38	.127	-.25000	.16018	-.57427	.07427
	Equal variances not assumed			-1.561	19.000	.135	-.25000	.16018	-.58526	.08526
H_Social_GW	Equal variances assumed	28.585	.000	-4.660	38	.000	-.80000	.17168	-1.14755	-.45245
	Equal variances not assumed			-4.660	19.000	.000	-.80000	.17168	-1.15933	-.44067
H_Social_SM	Equal variances assumed	38.674	.000	-1.552	38	.129	-.30000	.19331	-.69133	.09133
	Equal variances not assumed			-1.552	19.000	.137	-.30000	.19331	-.70460	.10460
H_Social_SL	Equal variances assumed	13.571	.001	-5.627	38	.000	-1.00000	.17770	-1.35974	-.64026
	Equal variances not assumed			-5.627	19.000	.000	-1.00000	.17770	-1.37194	-.62806
H_Social_SL2	Equal variances assumed	62.067	.000	-3.269	38	.002	-.60000	.18353	-.97154	-.22846
	Equal variances not assumed			-3.269	19.000	.004	-.60000	.18353	-.98414	-.21586
H_Engagement_GP_Support	Equal variances assumed	76.452	.000	-3.901	38	.000	-.65000	.16662	-.98731	-.31269
	Equal variances not assumed			-3.901	19.000	.001	-.65000	.16662	-.99875	-.30125
H_Engagement_GP_Message	Equal variances assumed	192.111	.000	-3.199	38	.003	-.35000	.10942	-.57152	-.12848

	Equal variances not assumed			-3.199	19.000	.005	-.35000	.10942	-.57903	-.12097
H_Engagement_GP_Collaboration	Equal variances assumed	59.681	.000	-2.373	38	.023	-.40000	.16859	-.74128	-.05872
	Equal variances not assumed			-2.373	19.000	.028	-.40000	.16859	-.75285	-.04715
H_Engagement_AP	Equal variances assumed	49.468	.000	-2.179	38	.036	-.40000	.18353	-.77154	-.02846
	Equal variances not assumed			-2.179	19.000	.042	-.40000	.18353	-.78414	-.01586
H_Engagement_AP2	Equal variances assumed	62.067	.000	-3.269	38	.002	-.60000	.18353	-.97154	-.22846
	Equal variances not assumed			-3.269	19.000	.004	-.60000	.18353	-.98414	-.21586
H_Engagement_GW	Equal variances assumed	46.810	.000	-5.252	38	.000	-.75000	.14281	-1.03910	-.46090
	Equal variances not assumed			-5.252	19.000	.000	-.75000	.14281	-1.04891	-.45109
H_Engagement_SM	Equal variances assumed	31.068	.000	-1.561	38	.127	-.25000	.16018	-.57427	.07427
	Equal variances not assumed			-1.561	19.000	.135	-.25000	.16018	-.58526	.08526
H_Engagement_SL	Equal variances assumed	40.699	.000	-5.141	38	.000	-.80000	.15560	-1.11499	-.48501
	Equal variances not assumed			-5.141	19.000	.000	-.80000	.15560	-1.12567	-.47433
E_Social_GP_Support	Equal variances assumed	64.220	.000	-3.240	38	.002	-.55000	.16975	-.89365	-.20635
	Equal variances not assumed			-3.240	19.000	.004	-.55000	.16975	-.90530	-.19470
E_Social_GP_Messgae	Equal variances assumed	40.533	.000	-1.798	38	.080	-.40000	.22243	-.85028	.05028
	Equal variances not assumed			-1.798	19.000	.088	-.40000	.22243	-.86554	.06554
E_Social_GP_Collaboration	Equal variances assumed	52.196	.000	-2.666	38	.011	-.35000	.13129	-.61578	-.08422
	Equal variances not assumed			-2.666	19.000	.015	-.35000	.13129	-.62479	-.07521
E_Social_AP	Equal variances assumed	36.802	.000	-2.042	38	.048	-.30000	.14690	-.59738	-.00262
	Equal variances not assumed			-2.042	19.000	.055	-.30000	.14690	-.60746	.00746
E_Social_AP2	Equal variances assumed	85.357	.000	-3.584	38	.001	-.55000	.15347	-.86068	-.23932
	Equal variances not assumed			-3.584	19.000	.002	-.55000	.15347	-.87121	-.22879

E_Social_GW	Equal variances assumed	8.941	.005	-6.164	38	.000	-1.00000	.16222	-1.32840	-.67160
	Equal variances not assumed			-6.164	19.000	.000	-1.00000	.16222	-1.33953	-.66047
E_Social_GW2	Equal variances assumed	53.647	.000	-4.682	38	.000	-.75000	.16018	-1.07427	-.42573
	Equal variances not assumed			-4.682	19.000	.000	-.75000	.16018	-1.08526	-.41474
E_Social_SM	Equal variances assumed	14.832	.000	.525	38	.603	.10000	.19057	-.28578	.48578
	Equal variances not assumed			.525	19.000	.606	.10000	.19057	-.29886	.49886
E_Social_SM2	Equal variances assumed	64.773	.000	-3.322	38	.002	-.65000	.19568	-1.04613	-.25387
	Equal variances not assumed			-3.322	19.000	.004	-.65000	.19568	-1.05956	-.24044
E_Social_SL	Equal variances assumed	76.251	.000	-4.333	38	.000	-.65000	.15000	-.95366	-.34634
	Equal variances not assumed			-4.333	19.000	.000	-.65000	.15000	-.96395	-.33605
E_Engagement_GP_Support	Equal variances assumed	31.068	.000	-4.682	38	.000	-.75000	.16018	-1.07427	-.42573
	Equal variances not assumed			-4.682	19.000	.000	-.75000	.16018	-1.08526	-.41474
E_Engagement_GP_Messgae	Equal variances assumed	12.667	.001	-6.892	38	.000	-1.00000	.14510	-1.29373	-.70627
	Equal variances not assumed			-6.892	19.000	.000	-1.00000	.14510	-1.30369	-.69631
E_Engagement_GP_Collaboration	Equal variances assumed	55.730	.000	-2.131	38	.040	-.45000	.21120	-.87755	-.02245
	Equal variances not assumed			-2.131	19.000	.046	-.45000	.21120	-.89205	-.00795
E_Engagement_AP	Equal variances assumed	53.647	.000	-4.682	38	.000	-.75000	.16018	-1.07427	-.42573
	Equal variances not assumed			-4.682	19.000	.000	-.75000	.16018	-1.08526	-.41474
E_Engagement_GW	Equal variances assumed	37.698	.000	-4.265	38	.000	-.75000	.17584	-1.10598	-.39402
	Equal variances not assumed			-4.265	19.000	.000	-.75000	.17584	-1.11805	-.38195
E_Engagement_GW2	Equal variances assumed	23.366	.000	-6.474	38	.000	-.85000	.13129	-1.11578	-.58422
	Equal variances not assumed			-6.474	19.000	.000	-.85000	.13129	-1.12479	-.57521
E_Engagement_SM	Equal variances assumed	32.374	.000	-1.674	38	.102	-.30000	.17918	-.66273	.06273

	Equal variances not assumed			-1.674	19.000	.110	-.30000	.17918	-.67503	.07503
E_Engagement_SL	Equal variances assumed	27.925	.000	-5.604	38	.000	-.90000	.16059	-1.22510	-.57490
	Equal variances not assumed			-5.604	19.000	.000	-.90000	.16059	-1.23612	-.56388
E_Engagement_SL2	Equal variances assumed	40.852	.000	-1.831	38	.075	-.30000	.16384	-.63167	.03167
	Equal variances not assumed			-1.831	19.000	.083	-.30000	.16384	-.64291	.04291
S_Engagement_GP_Support	Equal variances assumed	29.522	.000	-7.667	38	.000	-1.15000	.15000	-1.45366	-.84634
	Equal variances not assumed			-7.667	19.000	.000	-1.15000	.15000	-1.46395	-.83605
S_Engagement_GP_Support2	Equal variances assumed	20.520	.000	-7.678	38	.000	-1.10000	.14327	-1.39004	-.80996
	Equal variances not assumed			-7.678	19.000	.000	-1.10000	.14327	-1.39987	-.80013
S_Engagement_GP_Support3	Equal variances assumed	47.456	.000	-3.907	38	.000	-.70000	.17918	-1.06273	-.33727
	Equal variances not assumed			-3.907	19.000	.001	-.70000	.17918	-1.07503	-.32497
S_Engagement_GP_Message	Equal variances assumed	13.509	.001	-7.025	38	.000	-.95000	.13524	-1.22378	-.67622
	Equal variances not assumed			-7.025	19.000	.000	-.95000	.13524	-1.23306	-.66694
S_Engagement_GP_Collaboration	Equal variances assumed	62.758	.000	-2.979	38	.005	-.55000	.18460	-.92371	-.17629
	Equal variances not assumed			-2.979	19.000	.008	-.55000	.18460	-.93638	-.16362
S_Engagement_AP	Equal variances assumed	15.211	.000	-1.710	38	.095	-.20000	.11698	-.43681	.03681
	Equal variances not assumed			-1.710	19.000	.104	-.20000	.11698	-.44484	.04484
S_Engagement_GW	Equal variances assumed	41.071	.000	-1.926	38	.062	-.35000	.18173	-.71790	.01790
	Equal variances not assumed			-1.926	19.000	.069	-.35000	.18173	-.73037	.03037
S_Engagement_SM	Equal variances assumed	22.619	.000	-1.285	38	.206	-.20000	.15560	-.51499	.11499
	Equal variances not assumed			-1.285	19.000	.214	-.20000	.15560	-.52567	.12567
S_Engagement_SL1	Equal variances assumed	20.520	.000	-7.678	38	.000	-1.10000	.14327	-1.39004	-.80996
	Equal variances not assumed			-7.678	19.000	.000	-1.10000	.14327	-1.39987	-.80013

S_Engagement_SL2	Equal variances assumed	38.775	.000	-5.101	38	.000	-.85000	.16662	-1.18731	-.51269
	Equal variances not assumed			-5.101	19.000	.000	-.85000	.16662	-1.19875	-.50125

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