

Designing a Serious Game for Dementia Awareness

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Designing a Serious Game for Dementia Awareness

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Abstract

The world's population is ageing. With increases in life expectancy, more and more people are being diagnosed with dementia. Governments and societies are faced with the challenges of providing treatment and care for a growing number of people with memory loss. As serious games have increasingly become a powerful tool for learning, they offer great opportunities to raise awareness about dementia.

The aim of this thesis is to design a serious game for dementia awareness that lets players communicate with a person suffering from dementia. The goal of the game is to let players experience the severe effects the condition has on a person in a risk free environment. A prototype was developed using non fiction material. The game provides a means for interaction with a chatbot that was designed to simulated a woman with dementia. Real documents were integrated into the game and are used to help the character remember past events. Three different types of minigames were developed to provide fun variations of gameplay. The main challenge lies in providing an enjoyable experience while trying to convey how frustrating it can be to speak to a person with dementia.

Results from expert reviews show that players are interested in the idea of the game and that some areas need further improvement, especially concerning the interactions with the chatbot. The evidence suggests that the entertainment aspect is essential for the game. Furthermore, players were able to correctly list the symptoms of dementia after play.

Kurzfassung

Unsere Gesellschaft ist geprägt von einer Alterung der Bevölkerung. Durch die immer höhere Lebenserwartung steigt auch die Anzahl der Personen die mit Demenz diagnostiziert werden. Regierungen und Gesellschaften müssen sich der Herausforderung stellen für eine wachsende Anzahl an Personen zu sorgen, die nicht mehr selbstständig leben können. Da Serious Games immer effektiver werden und erfolgreich genutzt werden können um Wissen weiterzugeben, bieten sie eine wichtige Gelegenheit um das Bewusstsein für Demenz in der Bevölkerung zu erhöhen.

Ziel dieser Arbeit ist die Entwicklung eines Prototypen für ein Serious Game, das Spielern eine Möglichkeit zur Kommunikation mit einer demenzerkrankten Person geben soll. Spieler sollen so erfahren, welche Effekte die Krankheit auf eine Person hat und wie sie mit ihr effektiv kommunizieren können. Ein erster Prototyp wurde entwickelt und erlaubt es Spielern mit einem Chatbot zu interagieren, der die Anwesenheit einer älteren, demenzerkrankten Frau simuliert. Zusätzlich können Spieler diverse nicht fiktionale Materialien wie Bilder, Briefe, Passkopien und Personalausweise benutzen um die Frau in die Vergangenheit zurückzusetzen: sie erinnert sich so an vergangene Ereignisse und der Spieler kann dadurch mehr über sie in Erfahrung bringen. Es wurden drei verschiedene Arten von Minigames entwickelt, die dazu gedacht sind eine Abwechslung zum Hauptteil des Spiels zu bieten und den Spaßfaktor zu erhöhen. Die Herausforderung liegt darin ein unterhaltsames Spiel zu gestalten, das Spielern zeigen soll wie frustrierend es sein kann mit einer demenzerkrankten Person zu sprechen.

Das Spiel wurde einer Evaluation unterzogen. Expert Reviews haben gezeigt, dass die Idee des Spiels gut ankam. Allerdings gibt es noch einige Elemente die als verbesserungswürdig eingestuft wurden. Die Ergebnisse haben gezeigt wie wichtig der Spaßfaktor ist um die Motivation der Spieler aufrecht zu erhalten. Spieler konnten die Symptome von Demenz richtig aufzählen nachdem sie das Spiel gespielt hatten.

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Introduction

1.1 Motivation and Problem Statement

In recent years, one of the main challenges our society has to overcome is an ageing population. With ever increasing life expectancies, people are faced with a greater number of age related health problems and therefore there is a constantly growing number of cases of dementia. Worldwide, it is estimated that in 2011, 35,6 million people were afflicted with dementia [85].

As even the most simple tasks become a challenge, people with dementia require greater care taking which often affects the entire family. This puts a large burden on friends, relatives and caretakers and very often the relationships can suffer from the shifting roles: the partner becomes the caretaker and the person that one knew so well is now turning more and more into a stranger. In many cases, relatives that are taking care of their dementia afflicted loved-ones are described as “hidden patients” because of the sheer amount of stress involved [76]. More often than not, people know what it means for someone to have dementia, but lack the knowledge and the understanding of the profound effects the disease has on people lives. It is therefore really important to raise awareness about the disease.

There is a significant number of serious games and health games that address various aspects of dementia and games that have been designed primarily for entertainment purposes such as WiiFit, WiiSports and Big Brain Academy are being used for physical and cognitive training [58]. However, there is a lack of games that raise awareness on dementia and that inform about the severe effects the condition has on peoples lives. This work tries to fill this gap by aiming at developing a serious game which will enable the player to learn to communicate with someone with memory loss and get a glimpse of the rich history of a person who’s mind has been clouded by a fog of dementia.

The overall aim of this research is to explore ways for people who are curious or concerned with the disease to experience the severe effects the condition has on a person in a risk free envi-

ronment. Additionally, this work will focus on finding out how a video game can have a social impact through digital storytelling and how it can give players a chance to engage in a person's life story in a playful manner. Finally, this work will examine different aspects about the design process in order to create a meaningful and fun experience for players. The main challenge lies in creating a fun game around the concept of communicating with someone with dementia.

1.2 Expected Results

The expected outcome of this work is a prototype for a serious game aimed at friends, relatives and caretakers of those afflicted with dementia and provide them with a better understanding of the disease. The idea is for players to communicate with a virtual character that has dementia and in doing so to develop empathy towards this person. The virtual character in the game will be inspired by a real person who has been suffering from dementia for the last five years. This person has led an incredibly rich life and her past experiences will serve as a basis for content for the game. The goal of the game is to take the virtual character home and the player has to find out more about this person's life and what "home" means in the character's eyes.

The game will feature a chat bot that enables the player to communicate with the virtual character through means of choosing from a list of keywords and questions. This will allow the player to experience the difficulties one has when communicating with dementia patients and how to overcome those hurdles. Therefore, the answers will reflect the behaviour of people in this condition and the answers won't always make sense. The virtual character will often repeat itself or invent new words and sometimes won't say anything at all. The virtual character will relive moments of the past as if he or she were travelling back in time and the player will accompany the virtual character on these journeys in order to find out more about the character's past. To achieve this, an Artificial Intelligence (AI) will be implemented that reproduces this state of confusion and the random shifts in past time periods. Development of this AI will be presented in a separate master thesis by Daniela Ramsauer.

In addition, a more traditional game mechanic will be implemented in order to present the player with photographs, letters and other non-fiction documents which he or she will be able to study and analyse. The player will have to solve various puzzles and mini games in this part of the game in order to progress. An inventory system will be realized in order to store all the documents the player has discovered. A device will display additional information such as time period specific background information or information on various topics that are connected to the virtual character's past.

The goal of the game is for players to uncover the rich past of the virtual character and to understand how to communicate with a person that has dementia. The game is designed as an emotional experience and we expect players to learn something valuable in engaging on a human level with this difficult but important topic.

Furthermore, the game prototype will be reviewed by students of computer science. The re-

sults of these expert reviews will be used in future work to enhance the prototype in order to create a fun and meaningful experience for players

1.3 Relationship with Media Informatics

One of the main areas of research of Media Informatics is finding new ways for human computer interaction. In developing our serious game, we hope to create a bond between the player and the virtual character by employing a unique form of digital storytelling. This type of research is taught in courses such as Interface and Interaction Design, Building Interaction Interfaces, Beyond the Desktop as well as Project Oriented Research and Design Methods. Additionally, game design theory and practice is taught in the course of Explorative Design.

CHAPTER 2

Dementia

“Dementia is a syndrome – usually of a chronic or progressive nature – in which there is deterioration in cognitive function (i.e. the ability to process thought) beyond what might be expected from normal ageing.” [84]

Dementia is a syndrome which affected 35.6 million people in 2011 with 7.7 million new cases every year [85]. This number will have doubled by 2030 and tripled by 2050. The most important risk factor for dementia is an increasing age as a 90 year old person has a 50% greater chance of developing a form of dementia than a person at the age of 60 [25]. Figure 2.1 shows the projected number of people living with dementia and compares high income countries to low and middle income countries.

The term dementia is used to describe a group of disorders which have similar symptoms but different causes [25]. People that are afflicted with the disease suffer from deterioration in memory, thinking, behaviour and the ability to perform everyday activities. These symptoms are accompanied by impairments of judgement, reasoning, problem solving skills, learning capacity, comprehension, calculation and in impairments in language, communication and social skills. People slowly lose the capability of living independently. The loss of short term memory prevents them to engage effectively in social activities [5]. These circumstances often result in changes in personality and other symptoms include depression, anxiety, delusions, suspiciousness and compulsive behaviours [85] and also lead to deterioration in emotional control, social behaviour, or motivation [84]. The effects are social isolation and deprivation of a ‘normal’ life with a wide range of social interactions. There are many forms of dementia of which we will describe the most common in section 2.1.

Currently, there is no treatment and no cure that diminishes the effects of dementia but a person afflicted with the disease can live long after being diagnosed. Typically, when a diagnose is made it is at a relatively advanced stage of the disease [85]. Therefore, an early diagnose is important. Drug treatments may temporarily improve the symptoms associated with memory loss. We will

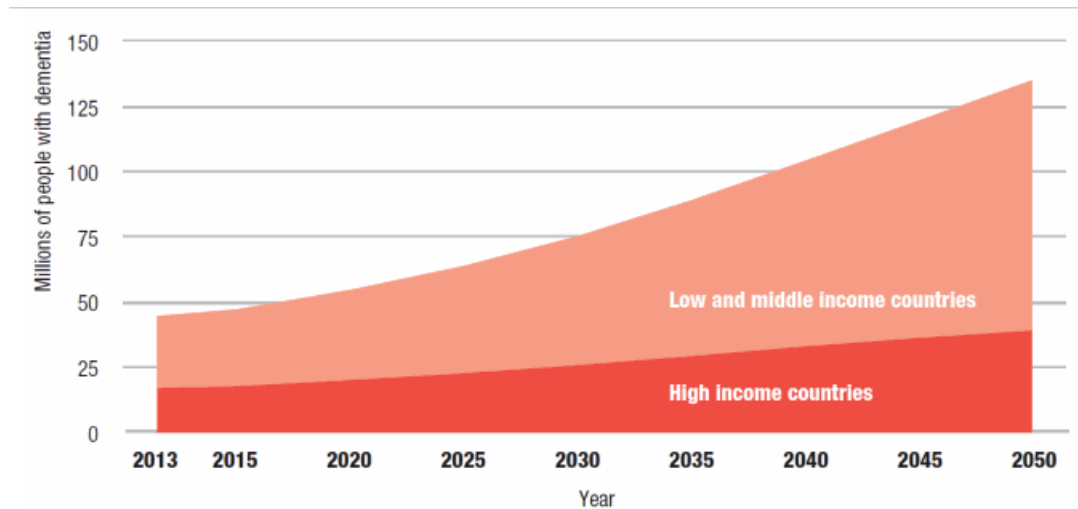


Figure 2.1: Projected prevalence of dementia in high income countries and low and middle income countries [10].

discuss dementia treatment and care further in section 2.2.

The family remains the cornerstone of care [85] for people who have been diagnosed with dementia and have lost the ability to live independently. Having a case of dementia in the family can have a serious impact on the social network surrounding the person, notably the immediate family members, neighbours, co-residents and friends. The impact of dementia will be discussed in section 2.3.

Patients often need to reside in long term care settings in order to receive assistance even for their most basic needs. Our society has to face the challenges that are tied to an ageing population. As more and more people become affected by dementia, global welfare systems will have to adapt in order to provide care for a growing number of people with memory loss. The social implications of dementia on a global level are undeniable. Therefore it is important to raise awareness and increase the public understanding of dementia in order to improve the lives of people living with the condition and their caregivers. In section 2.4 we will discuss the public knowledge of dementia.

Stages of Dementia

The effects of dementia can be classified into early, middle and late stages [85] [76] where the early stage describes the first year or two, the middle stage the second or fourth to fifth years and the late stage the fifth year and after.

The early stage is often overlooked as the symptoms accompanying dementia are associated with the natural part of ageing [85]. Because the progression of dementia is gradual, it is difficult to identify the early stage and when it begins. Symptoms include forgetfulness, especially the short term memory is affected. Communication also becomes increasingly difficult as words tend to be forgotten. Getting lost in familiar places can be observed as well as losing the sense of time. Decision making is impaired and complex household tasks can no longer be performed. Mood and behaviour changes, a lack of motivation and a decrease in activities such as hobbies, anxiety or depression may be observed and anger and aggression may surface on occasion.

The middle stage of dementia manifests itself by more and more limited capabilities of afflicted people [85]. Memory loss becomes more prominent as recent events and people's names are often forgotten. Difficulties with time and space are more apparent as getting lost at home becomes a habit. Problems in the household are no longer limited to simple tasks as help is required for personal care as well as other household tasks. People in this stage become increasingly dependent on their caregivers. Their behaviour evolves as wandering, repeatedly asking questions, sleeping problems and hallucinations become more frequent. They can also display inappropriate behaviour as their sense of reality becomes more clouded.

In the late stage of dementia, a person's life is reduced to total inactivity and dependence [85]. People in this stage are disconnected from time and space and have serious problems understanding what is happening around them. Familiar faces such as family members and friends are no longer recognized. Their need for personal care increases even more as they are unable to eat on their own. They suffer from impairments in mobility as they may no longer be able to walk without assistance. Aggressions towards caregivers can be observed as well as non-verbal agitations such as kicking, hitting, screaming and moaning.

Living in the Past

A very prominent symptom that people with dementia exhibit is that they often tend to "live in the past", meaning that they relive moments of their past as if they were truly there and this has great consequences on their behaviour [22]. With the disease progressing further and further, these effects become more and more severe. Their lives become more and more determined by their remaining memories, they have conceptions and conventions that are stuck in their mind and they behave accordingly: e.g. they might search for their parents or travel to work. Living in the past might give them a sense of well being and security. Trying to convince them that their view of reality is incorrect might prove problematic because they could consider this as a threat. Therefore it could be advantageous to engage them on an emotional level instead of contradicting them. For instance, one could ask them about their work or their parents.

2.1 Dementia Subtypes

The most common types of dementia are Alzheimer's Disease (AD), Vascular Dementia (VaD), Frontotemporal Dementia (FTD), Dementia with Lewy Bodies (DLB) and Dementia in Parkin-

son's Disease [20]. It is likely for an individual to have a combination of different causes of dementia since mixed pathologies are more common than pure ones [85]. The distinction between different types of dementia is difficult to diagnose. Table 2.1 shows an overview table of the characteristics of the different types of dementia.

Alzheimer's Disease (AD)

The most common type of dementia is Alzheimer's Disease (AD) with approximately 60-70% of cases [20]. AD is characterized by a slow, gradual progression. It causes the number of nerve cells in the brain to reduce increasingly and the brain shrinks [23]. Activities such as language and physical movement become more and more difficult because the nerve cells essential for these activities are impaired and cannot be replaced. Early stages of dementia are typically characterized by forgetfulness, difficulties finding the right words and problems working things out. Depression can also be identified as well as changes in mood. It is also in the early stages of AD that some people that are affected are aware of their condition and realize that they need help while others are not. Awareness declines as the disease progresses.

In later stages of AD memory loss becomes more and more prevalent with short term memory being affected at mid stages of the disease and long term memory at late stages. People also have difficulties processing new information and learning new skills [23]. Changes in behaviour can be observed more easily and people start to have difficulties with simple tasks and everyday activities, the need for care increases. Whereas early stages of AD are characterized by word finding problems, mid stages can be described with limited language activities due to problems in semantics, pragmatics (social use of language) and reading comprehension. Delusions, hallucinations, agitation and repetitive behaviours are also observed in mid stages of AD. In the late stage, language is limited to affective responses only and visuospatial behaviour to ambulation, sleep and eating. People also lose their sense of time and space e.g. they might get dressed in the middle of the night under the assumption that it is early in the morning. Meeting new people as well as new surroundings may confuse them and it is even possible that they forget familiar faces such as family and friends.

Vascular Dementia (VaD)

Another, less frequent form of dementia is Vascular Dementia (VaD). This dementia subtype represents 15-30% of cases [20]. VaD is characterized by an abrupt and stepwise progression. The disease starts out with small blood vessels in the brain becoming blocked [23] leading to nearby brain cells to be deprived from oxygen and dying subsequently. Small strokes in the brain cause VaD. Similarly to AD, VaD causes the person to undergo changes in personality and to suffer from problems in language and functioning. The exact symptoms vary and depend on the areas of the brain which are affected by the tiny strokes. As more and more areas of the brain become impaired the disease progresses and has bigger and bigger effects on the person's memory, speech and thinking capabilities. Some focal symptoms can be observed early on, others at later stages. Risk of further strokes can be reduced through therapies but there is no

cure to diminish the effects of VaD. VaD also cause visual field deficits. The effects on a persons life can be severe causing depression, agitation, anxiety and apathy.

Frontotemporal Dementia (FTD)

Frontotemporal Dementia (DLB) is prevalent in 8-20 % of cases [20]. The functioning of the brain's frontal and temporal lobes is reduced due to cell damage, which also leads to tissue shrinkage [6]. These lobes control planning and judgement, emotions, speaking and comprehension of the spoken word as well as certain types of movement. Progression of FTD is slow and gradual. In early stages of FTD, the cognition capabilities of patients are impaired by selective and sustained attention deficits which are greater than those observed in cases of AD. Language capabilities are intact in early stages but people tend to repeat themselves and repeat what other people are saying in later stages of the disease.

Dementia With Lewy Bodies (DLB)

Prevalence of Dementia with Lewy Bodies (DLB) is estimated at 20-30% of cases [20]. Tiny protein depositions in nerve cells of the brain that interrupt the action of chemical messengers and interrupt normal brain activity. They are called Lewy Bodies [23]. Progression of DLB is slow and gradual. Similarly to AD and dementia in Parkinson's disease, DLB causes memory loss, impairments of language and reasoning. The main difference is that people suffering from DLB are not constantly affected by these symptoms and there can be fluctuations in their attentive capabilities and their state of confusion. In early stages of DLB, cognitive capabilities are intact but similarly to AD, they are gradually impaired. Their abilities change frequently and can diminish or increase almost by the hour resulting in people being able to accomplish a specific task and loose this capability midway through the activity. Other people may misinterpret this process as laziness because they lack the understanding of the effects the disease can have on a person. Areas of the brain affected control balance, vision and visual recognition, resulting in difficulties moving, frequent falls, slowness, stiffness and tremors. People suffering from DLB can experience visual hallucinations, delusions and, in early stages, depression.

	Alzheimer's Disease (AD)	Vascular Dementia (VaD)	Frontotemporal Dementia (FTD)	Dementia With Lewy Bodies (DLB)	Dementia in Parkinson's Disease (PD)
Prevalence	60–70% of cases 13 million in United States	15–30% of cases	8–20%	20–30%	18–40% of Parkinson's persons
Onset	Slow, gradual progression	Abrupt, stepwise progression	Slow, gradual	Slow, gradual	Slow, gradual, and fluctuating
Cognition	Memory deficits: word finding (early) Short term (mid) Long term (late) Executive dysfunction (early)	Focal symptoms: Some early; others late	Variable	Intact (early) Gradually fluctuating Similar to AD	Similar to DLB Fluctuating cognition
Language	Intact: mild word finding (early) Semantics, pragmatics, reading comprehension, and perseverative (mid) Affective responses only (late)	Mild executive dysfunction; severe in Binswanger's (early) Focal language deficits variable Co-occurs with extrapyramidal symptoms, gait problems, paresis, and facial weakness	Selective and sustained attention deficits (early) Greater deficits than AD	Attention (early) Executive dysfunction (early)	Executive dysfunction (early)
Visuospatial Behavior	Progressive decline Personality and mood changes (early) Delusions, hallucinations, agitation, and repetitive (mid) Ambulation, sleep, and eating (late)	Visual field deficits Depression, agitation, anxiety, and apathy (early)	Intact (early) Profound early changes in mood, personality, and social conduct	Verbal fluency deficits (early) Otherwise intact (early) Similar to AD	Less language impairment than AD Early pragmatic deficits Extrapyramidal symptoms: resting tremor, bradykinesia, and cogwheel rigidity
					Depression, mood changes Medication-related delusions and hallucinations

Table 2.1: Characteristics of Common Dementia Subtypes [20].

Dementia in Parkinson's Disease (PD)

Dementia develops in 18-30% of people with Parkinson's disease. The causes of the disease are still unknown. The dopamine carrying neurons are gradually deteriorated in the brain of a person affected by PD. "This has the effect of causing severe movement disorders, such as bradykinesia, rigidity, and tremor" [50]. Onset of Dementia in PD is slow, gradual and fluctuating [20]. The symptoms accompanying dementia in PD resemble those of DLB more than they resemble those of AD. Persons with PD have slow fluctuating cognition when compared to people with AD. Among the symptoms, executive function impairments can be observed and people suffer less from deficits in verbal and logical memory and have less language impairments. People with dementia in PD exhibit depression, mood changes, anxiety, agitation and hallucinations. Visual hallucinations, delusions, delirium and sleep deprivation are also experienced as side effects of treatment with dopaminergic drugs causing psychosis and nightmares. These symptoms can be reduced by adjusting dosages or changing drug types.

2.2 Dementia Treatment and Care

As most cases of dementia including AD are progressive, there is no cure and no treatment that prevents or slows down the progression of the disease [7]. It is possible to improve symptoms caused by dementia through drug treatments. Because there is no cure, it is all the more important that an effective network of care is established for people with memory loss. Early diagnosis is important to help the person become involved in making decisions about their future care. In their guide *Caring for someone living with Dementia* [23], Bupa Care Services recommend that one should always only see the person first and the disease second: "Separating the person from the condition will help you to treat them as an individual and with respect." It is important to remember that the behavioural changes that people with dementia are undergoing are not their fault and they are trying to cope with these new conditions as best as they can.

Enabling a person with dementia to maintain a sense of identity and letting the person find out what his or her limitations are and where they need help is really important, particularly in the early stages of dementia [23]. In concentrating on the things people can still do instead of the areas where they need help, one can increase their confidence.

Many people suffering from dementia live in care homes, where the staff is specialized in caring for them. Some people in the later stages of dementia live in hospitals, where they are usually admitted due to another illness [12]. More and more people live at home with their loved ones caring for them. If they are confident that they can provide a means of care, they need to ensure that nursing services are provided by the community in order to support them. The integrated caregiving system is presented in figure 2.2 and shows which levels of the system are closest to people with dementia.



Figure 2.2: The integrated caregiving system [85].

Common Core Principles for Supporting People with Dementia

The Department of Health for the United Kingdom has developed a set of principles in order to establish a guideline for providing care for people with dementia [34]. These principles were developed in collaboration of employers, people with dementia, caregivers and provider organizations and their goal is to “enable workforce development for any member of staff working in health or social care with people at any stage of dementia, from the earliest signs to the fully diagnosed condition”. They can be used in any setting and doing so creates a general understanding of dementia. It enables caregivers to provide better care by increasing their confidence when working with people affected by memory loss and provides a basis for better communication between the two. The principles are defined as follows:

Principle 1 Know the early signs of dementia.

Principle 2 Early diagnosis of dementia helps people receive information, support and treatment at the earliest possible stage.

Principle 3 Communicate sensitively to support meaningful interaction.

Principle 4 Promote independence and encourage activity.

Principle 5 Recognise the signs of distress resulting from confusion and respond by diffusing a person's anxiety and supporting their understanding of the events they experience.

Principle 6 Family members and other carers are valued, respected and supported just like those they care for and are helped to gain access to dementia care advice.

Principle 7 Managers need to take responsibility to ensure members of their team are trained and well supported to meet the needs of people with dementia.

Principle 8 Work as part of a multi-agency team to support the person with dementia.

Communication therapies

Communicating with people who suffer from dementia is difficult. Slowly but surely they lose their memory and their ability to organise their thoughts and express themselves. As they start to lose more and more of their memories, the past and the present become increasingly similar and begin to merge together. This creates additional challenges for family members and friends who are already experiencing problems when trying to communicate with their loved ones. Alternative communication approaches have been developed in order to facilitate communication with people with memory loss and to give them the support and trust they need [8]. The following two therapies, the *validation therapy* and the *reminiscence therapy*, are examples of these approaches.

Validation Therapy

The validation therapy emphasises on entering and acknowledging a person's reality instead of trying to bring them back to our reality [76] [8] and "it is based on the principle that even the most confused behaviour has some meaning for the person" [61]. After severe memory loss, a person can no longer employ intellectual thinking and make sense of the present. It is likely for that person to go back to the past to relieve past experience or to escape the present over which he or she has little control. For instance, if people with dementia become agitated at the same time everyday because they think that their mother is going to pick them up it won't be helpful to tell them that their mother died long ago which will only cause them to become more agitated and distressed. Through validation, one could tell them that their mother is running a bit late while finding another activity to offer them in the meantime. This will hopefully calm them down so that they become less agitated as their feeling and thoughts have meaning for them and their dignity and self-esteem are maintained.

Validation enables the creation of trust and a sense of security and reduces anxiety. Indeed, the chances for conflict are reduced when using the validation therapy as the dementia patient gets a sense of appreciation and attention. It has been shown that this approach has made a great contribution to dementia care situations with family member and friends expressing increased

benefits and overall a less stressful caring environment, but the effectiveness of this therapy remains to be proven.

Reminiscence Therapy

Reminiscence is a therapy that involves reviewing things from the past, such as photos, familiar objects or music, which is often a very positive and rewarding activity [8]. “Activities that don’t require the person to keep a conversation topic active—for instance, looking at photographs—can provide a structure for meaningful interactions” [5]. The person with dementia can find pleasure when being involved in reviewing their past, even if they can no longer interact verbally. This approach can also be used to distract them when becoming agitated or upset as reflecting on their past can be peaceful and provide happiness.

Typically, a “life story book” is shared between the person with dementia and family members, friends and caretakers. Details about a person’s life experience, values and beliefs are recorded in a scrapbook or photo album [11]. This life book consists of a chronological history of the person with dementia, comparable to an individual biography, and it can help people that are involved in the reminiscence therapy [18]. It acts as a visual diary, containing letters, postcards, certificates and other artefacts similar to a family album. It can also be used to develop an understanding for that person and how they have dealt with changes in their life and is actively being used in nursing homes to improve the relationships with carers.

Evidence indicates, that reminiscence therapy, “particularly when done one-on-one, can improve mood, wellbeing and some mental abilities such as memory. By talking about who they are, people with dementia can help others focus on them, and not their dementia” [11].

Dementia Village

A new approach in providing dementia care has recently been introduced with an entire village dedicated for people with memory loss. This village is Hogewey [2] in the Netherlands. The village has been designed specifically to cater the needs of people with memory loss requiring a great need for care and proposes a radical new way of providing support for people in the late stages of AD and other forms of dementia. It is therefore regarded as the first ‘dementia village’ and is completely different from a traditional nursing home [47]. The only residents that are allowed are the ones with severe dementia. 70% of residents are ambulatory but they are still included in all daily activities and they are animated to roam freely inside the village, do their own grocery shopping or meet up in a bar. Care is provided around the clock with caregivers dressed casually to blend in. The village is designed for residents to live a comfortable life and make them feel at home. Everything is set up so that residents can live a life in dignity and as close as possible to what makes ‘normal’ life. Homes are designed to portray one of seven different themes from which residents can choose and give them a sense of comfort: urban, domestic, culture, Christian, craft, Indonesian or upper-class.

2.3 Impact of Dementia

“The reactions of others can have a significant effect on the lived experience of dementia.” [51]

The social implications dementia can have can not be underestimated. On a global level, the cost of dementia treatment and care is already putting a large economic burden on our society and it needs to adapt to incorporate a large number of people requiring full personal care and round-the-clock supervision. It is estimated that “the global societal costs of dementia were US\$ 604 billion in 2010” [85] and these costs are only going to increase, as will the number of patients worldwide.

The profound effects dementia has on a person are also noticeable for the family of that person. Most people with dementia are being taken care of at home by their family members [29] [25] [85]. When a family is dealing with a loved one with dementia, it is important for them to be fully aware of the implications that the condition will have on their lives. Therefore they need to be well educated about how to take care of a dementia patient and understand the challenges associated with memory loss. It can be heartbreaking to cope with an increasingly dependent parent. Dementia care differs from other forms of caregiving in that it needs to be provided around the clock and that it involves huge physical as well as psychosocial strain for extended periods of time [25] [76]. Therefore it is very difficult to provide dementia care as it requires a lot of time and energy of the caregiver and there are no periods of relief [85]. The term “hidden patients” is often used to describe care giving family members and refers to the negative effects they experience over time, affecting their “psychological and physical health, life expectancy, quality of life and economic security” [85]. The well-being of caregivers is essential and first they need to take care of themselves in order to provide effective care. Therefore, the later stages of dementia requires assistance from professional care personnel. Dementia is also often referred to as a “family disease” [22] since the effects of the condition on one person in the family can have consequences on the entire family.

The relationships are bound to change since the roles are often reversed in a round-the-clock care scenario. Changes in behaviour are difficult to accept. The parent becomes the child and vice-versa. Boundaries are crossed, rules change, roles change. The risk for conflict is present in many situations and often results in anger towards the people in need of care. At the same time that one is so close and familiar with the person, they often appear as a complete stranger [76]. It often happens that feelings for the now impaired loved one contradict each other and that there is no one to talk to about these shifting roles. This can lead to stress and depressions on the side of caregivers.

Dementia can also lead to social isolation. Many people with the condition feel that they are being left out of the “social loop” [51]. They also often express the desire to be treated as authentic and normal as possible since they feel that because of their condition, they have lost their social status and it affects the way that others see them, not taking them seriously and not appreciating their company. It is important that they retain active relationships inside their social

networks and stay active at the same time [76]. Not only is social isolation a problem for the people having the condition, but caregivers are equally affected as more and more of their spare time is dedicated to caregiving. In fact finding a spare moment to relax can become a luxury. During the day, all their attention is focused on providing full-time care and at night the patient might wander off causing sleep deprivation. “Older spouse caregivers often become so engulfed in the caring role that their social networks and connections reduce to the point that they have very limited contact with the outside world” [25].

But there are not only negative effects to caregiving. For instance, interpersonal relationships are said to improve [32]. It can be said that “most family and friends involved in providing informal care take pride in their role, and perceive many positives” [85]. The motivations behind caregiving can vary from it being rewarding or providing a sense of meaning and self-efficacy. Positive outcomes may also include “enjoyment of the role, positive affect, satisfaction, well-being, role gain, uplifts, rewards, gratification, mastery, growth and meaning, and benefits” [29].

2.4 Public Understanding of Dementia

“Dementia is often considered to be a natural part of ageing. Sometimes the symptoms are misunderstood as being caused by evil spirits.” [85]

It is quite common for people to confuse the symptoms associated with dementia with the natural part of ageing [85] [78]. The lack of understanding is followed by fear of the disease after a positive diagnose: people don’t know what to expect and how to handle it. The perception when hearing different terms describing the same condition can vary significantly. This effect is observable when the diagnose in question turns out to be AD [76]. The term dementia is regarded as more neutral and more often than not the consequences associated with it are not understood immediately. In comparison, when patients as well as family members are confronted with the term “Alzheimer”, they often associate it to rapid degeneration of the mind along with the around the clock need for care.

The absence of a global understanding of dementia has several causes: the effects of dementia are often seen as symptoms that accompany the normal ageing process, people do not recognize the symptoms associated to dementia and they also don’t understand the risks factors that often lead to dementia [85].

There are a number of misconceptions about dementia that come from various different sources [85]: the broader community, people with dementia, their families, health and social service providers. People with dementia find it difficult to talk about their condition with friends and family for fear of loosing these friendships. Discriminations can also extend to family members giving care: e.g. Signs of neglect can be seen in poor self care or incontinence.

Another factor that influences the public understanding of dementia is the fact that the terms and the language used to describe the disease are often subject to negative associations. In fact,

people with the condition have expressed an aversion against the term 'dementia' [51] as it translates to "without mind". In their eyes, the main symptom, memory loss, should be reflected in the name as they are capable of expressing their opinions.

The misconceptions about dementia are still widely spread and a lot of work has to be done in order to raise awareness about the condition. With video game entertainment systems becoming more and more available and internet access more and more common, there is a great opportunity for the medium, and particularly for serious games, to reach the public and to educate about relevant topics and future challenges such as dementia.

CHAPTER 3

Serious Games

“The positive outcomes of gaming are often seen as merely beneficial side-effects to something otherwise solely entertaining. These side-effects are, however, becoming the main objective in the development of games now. Games in which entertainment is not the primary goal but games with a particular kind of goal. Serious games.”
[13, p. 3]

In recent years, video games have become one of the primary mediums of entertainment of our generation and have stepped up from a cultural niche to a mass market phenomenon. Games such as Grand Theft Auto V shipping 32.5 Million copies in just a few months [41] and Call Of Duty: Black Ops 2 sales reaching \$1 Billion in just 15 days [74], the games industry has proven itself to be a strong competitor next to the movie and music industries.

With the rise of video games, a particular type of games have made their mark too and become an exciting field of research: serious games. Serious games are video games designed for a serious purpose where the focus is set on positive side effects other than the pure entertainment purpose. Serious Games are used for a wide variety of applications such as “education and training, engineering, healthcare, military applications, city planning, production, crisis response” [53] and have been used to learn new “skills and knowledge, promote physical activities, support social-emotional development, and treat different types of psychological and physical disorders amongst others”. It gives people the opportunity to learn something new in a non threatening environment and in a playful manner. With internet access becoming more and more available and increasing broadband connectivity, serious games such as games for learning and training have gained new audiences [68].

In the following sections we would like to discuss the definition of serious games (section 3.1), look at the impact of serious games (section 3.2) and continue by presenting examples of serious games related to our work and to dementia in various aspects, such as raising awareness of dementia (section 3.3), serious games for Dementia Care (section 3.4), serious games for de-

	Serious games	Entertainment games
Task vs. rich experience	Problem solving in focus	Rich experiences preferred
Focus	Important elements of learning,	To have fun
Simulations	Assumptions necessary for workable simulations	Simplified simulation processes
Communication	Should reflect natural (i.e., non-perfect) communication	Communication is often perfect

Figure 3.1: The differences between serious games and entertainment games [77].

mentia prevention and rehabilitation (section 3.5) as well as interactions with virtual characters in serious games (section 3.6).

3.1 Definition of Serious Games

The exact definition of serious games often varies and depends on for which type of application it is used and in what context. Furthermore, “the term ‘serious game’ in itself is somewhat questionable. For some the expression ‘serious games’ appears to be a contradiction” [21]. How can games be serious and fun at the same time? Some might argue that in fact all games are serious as many players take the games they play very seriously [59, p. 17]. The two words appear mutually exclusive. If we take the definition of serious games being games with the primary goal of education instead of entertainment, this oxymoron seems to clear up slightly. As Michael and Chen argue, “that not only are education and entertainment *not* in conflict, but there are many places where the two overlap and where each side can use the tools of the other to achieve their goals”. Indeed, as Ritterfeld et al. suggest, “the educational component needs to be enjoyable in its own right, and the entertainment components should be closely associated with education” [69, p. 5].

On the other hand, this definition “can only be considered valid with a very broad understanding of education” [21]. As Breuer and Bente explain, there are a number of serious games that do not focus on educational aspects, but would still be considered as such e.g. art games and games for therapeutic purposes offering distractions for patients. An interesting question pointed out by Breuer and Bente is what makes a video game not serious. Any game that was specifically designed for entertainment purposes can not be considered a serious game. Figure 3.1 shows the differences between serious games and entertainment games. Entertainment games are typically tailored to audiences seeking a rich experience in an elaborate game world where the main goal is to have fun with simplified simulation processes [77]. In contrast, the focus of serious games lies on problem solving and providing meaningful experiences. Therefore assumptions for creating workable simulations need to be correct in order to teach the right skills. However, ‘non-serious’

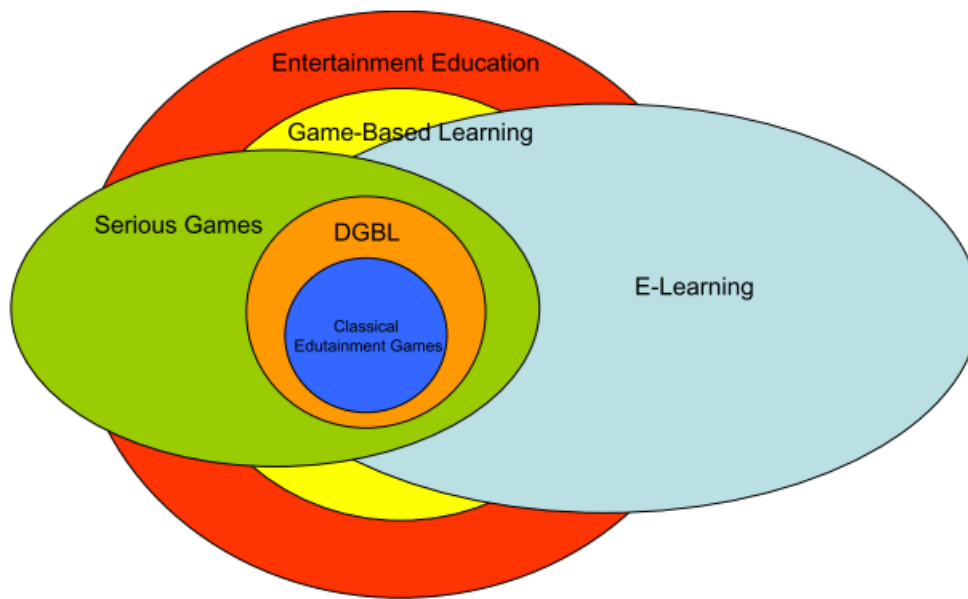


Figure 3.2: The relations of serious games to similar educational concepts [21].

games do have effects as well and are taken very seriously by their players. The learning value of entertainment games doesn't have to be designed into the games, but can be put in place by teachers that want to use the game for a specific learning goal [21]. Ritterfeld et al. propose another definition for serious games: "As a starting point we define serious games as any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment" [69, p. 6]. This definition eliminates the need draw a distinction between entertainment and educational aspects and incorporates all games that want to provide an experience beyond traditional entertainment goals.

It is not always possible to make clear distinctions from other game types. However, Breuer and Bente have established a classification of serious games and other educational concepts [21]. Figure 3.2 shows these relations to similar educational concepts such as classical edutainment games, Digital Game Based Learning (DGBL), E-Learning, Game-based Learning and Entertainment Education. Another term that is related to serious games is *edutainment* [59]. This term refers to any form of education that also wants to entertain and the term has been introduced in the 1990s. It is not only limited to video games but it is commonly used to describe games for educational purposes. One can also argue that serious games are a new branch of edutainment [21].

Another definition offered by Bakkes et al. describes serious games as "finding game-based solutions for social issues" [13]. This definition erases any boundaries as to what type of application

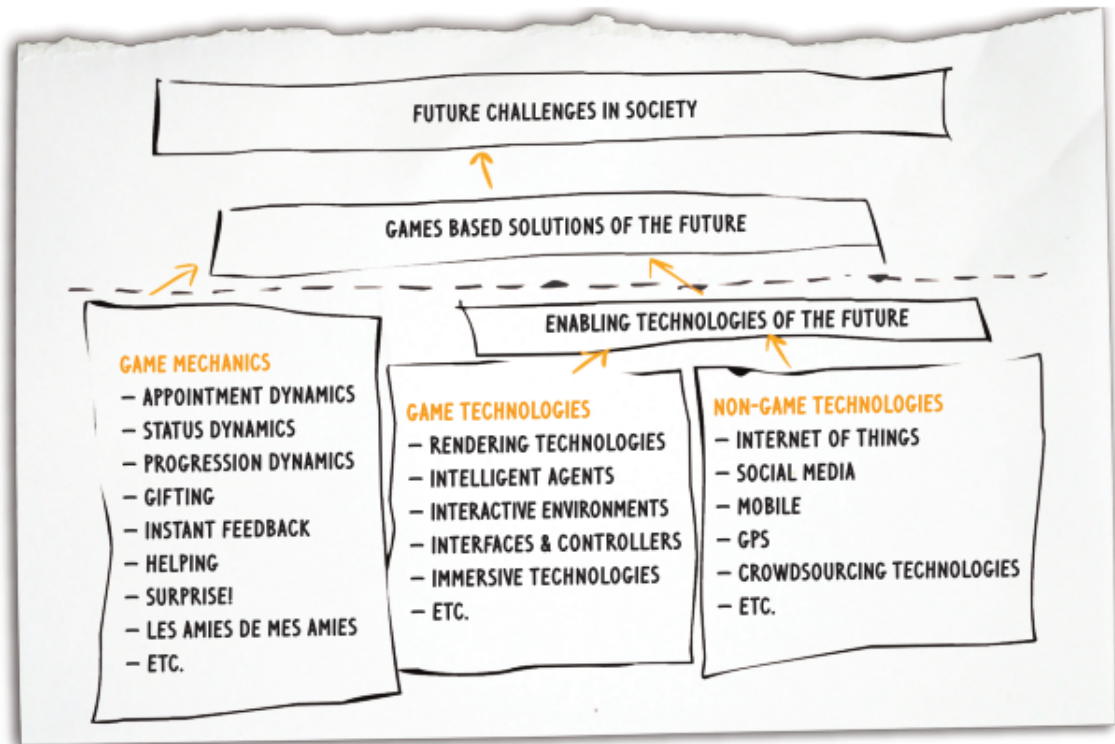


Figure 3.3: How game based technologies can be used to solve future challenges in society [13].

serious games are used for. Bakkes et al. further stress the fact that serious games are “always a means; they are a solution to a problem, not an aim in themselves. Serious games distinguish themselves from other means by the game-based character of the solutions they have to offer”. The authors refer to *game mechanics* and *enabling technologies* as the pillars of game based solutions. *Game mechanics* stands for the rules, principles and mechanisms of play disposing of “timeless and universal character” and *enabling technologies* represent the technologies traditionally associated with games. Figure 3.3 shows how game game based solutions can be used to tackle future challenges in society.

The main conclusion to draw is that there are many different definitions for serious games and they vary depending on perspectives and and interests. For this thesis, we will use the definition provided by Bakkes et al. as some of the games that we will present are not purely digital and take place in the physical world as well [37] [3].

3.2 Impact of Serious Games

“Games have power. Games have the power to teach, to train , to educate. Games have the power to bring people together-young, old, and in between. Games have

the power to reveal and build character. Games have the power to retain and promote health. Games have the power to heal.” [59]

With more and more types of applications for serious games, the question remains whether or not their use is effective or not and if the positive effects justify their usage. As Richard Clark states, ”The widespread interest in learning and motivation of serious games has not been balanced by a robust discussion about evidence for their pedagogical effectiveness” [28, p. 56]. In this section we try to find answers to the following questions: Are serious games effective and why? What is so appealing and motivating about playing games and how can they be used to teach new skills? Why are serious games fun and what keeps people playing them?

Play vs Learning

Huizinga argues that play is the basis for all culture [46]. Law, philosophy, art and other aspects of human culture, he argues, arise “in the form of play” and even such serious human activities as war bear the “formal characteristics of play”. And yes, even education. As children, we learn to play, and as we grow up, we play to learn, even though sometimes “play” doesn’t feel like ‘play’. Michael and Chen argue that in order to be able to play games, one must first learn the rules on which the game is based on [59, p. 25]. This holds true for all kind of games such as board games, social games and video games. Once the basic rules have been learned, one can master the game by refining application of those rules and using different strategies. This means that learning and play are connected even on the most basic level. For instance, Raph Koster has defined a list of skills that video games are able to teach [49]:

- Motor skills: hand-eye coordination
- Spatial relationships: 3D and 2D
- Shapes: 3D and 2D
- Curiosity: players learn to test everything, to seek out new information in unexpected places

Many games nowadays offer really complex challenges that are difficult to overcome, especially for inexperienced players [59, p. 25]. Game designers are faced with the problem of making those challenges fun in order to keep players motivated. According to Gee, game designers “have hit on profoundly good methods of getting people to learn and to enjoy learning”, making sure that the experience of learning the rules of the game are fun [40]. Papert states that the effort required to complete most complex video games can be described as “hard fun” [65]. This means that games need to be challenging without being unmanageable. As players are willing to spend long hours into completing challenging games, they are often not willing to invest the same amount of effort into learning experiences e.g. for school or professional training. Breuer and Bente are intrigued by the observation that playing games is always associated with learning and yet people enjoy investing time and resources into solving the challenges in games when they wouldn’t be willing to do so in other contexts [21]. This creates great opportunities for games to

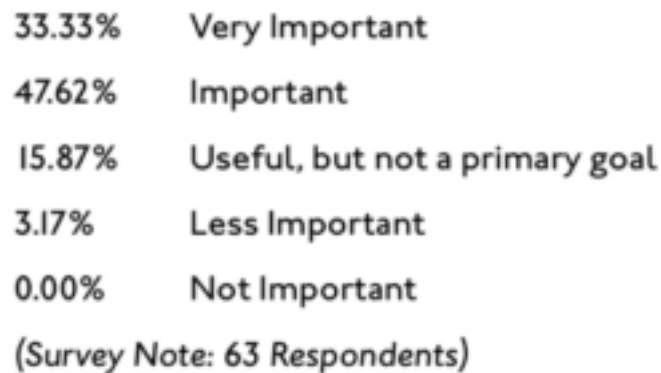


Figure 3.4: The importance of fun in serious games according to research conducted by [59].

act as a medium for teaching. Indeed, Stapleton states: “games, it would seem, provide powerful and meaningful contexts for learning” [75].

Fun in Serious Games

As serious games present great opportunities for learning, the question arises how important fun is for these games to be motivating and effective. As Breuer and Bente state, “when researching the effects and effectiveness of digital games for learning, the importance of enjoyment for/in education needs to be taken into account” [21]. However, educators and teachers are still expressing scepticism towards using games as a means of education [59, p. 40]. Furthermore, there are some topics that are not suited to be translated into a playful, fun experience. Michael and Chen mention the following example: “how important is it that a game training people on how to respond to emergency medical situations also be fun?”. During their research, they have asked several developers, educators and researches about the importance of fun in serious games. Figure 3.4 shows the results of their survey. Their findings show that over 80% of respondents have indicated fun in serious games as ‘Very Important’ or ‘Important’. Interestingly, none of the 63 respondents has said that the element of fun was ‘Not Important’. This study hardly reflects the point of view of the entire industry, it gives an indication for the importance of the element of fun in serious games.

Effectiveness of Serious Games

For serious games to have any kind of impact, the need to be effective in what they are trying to teach or what message they are trying to communicate. Up until very recently, there has been a lack of evidence supporting the idea of positive impacts in serious games. However, in 2012 Connolly et al. state “that concerns about the lack of empirical evidence in this area are starting to be addressed” [30]. But what makes a serious game effective?

Garris et al. propose a model for games and learning that takes into consideration *extrinsic*

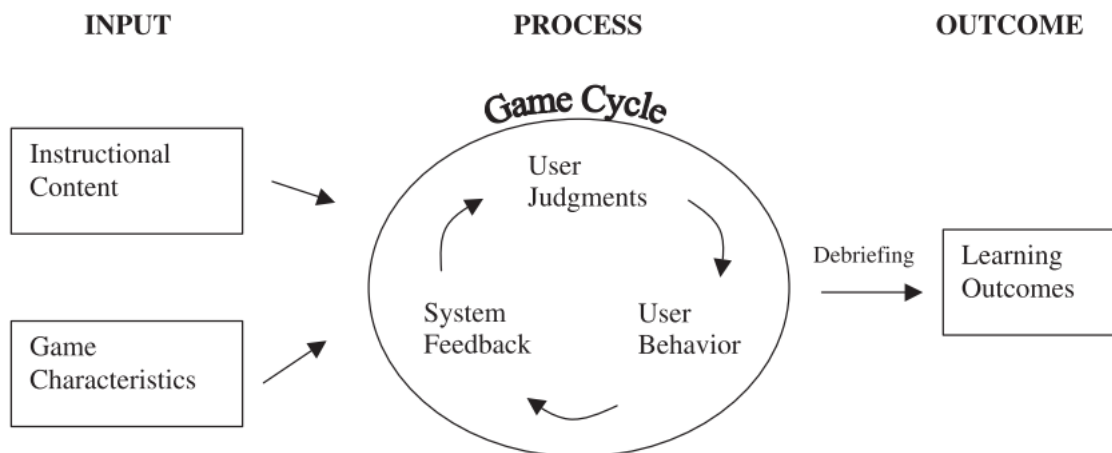


Figure 3.5: The Input-Process-Outcome Game Model [39].

as well as *intrinsic* motivations for learning outcomes [39]. The result is the Input-Process-Outcome Game Model, depicted in figure 3.5. In this model, “the goal is to develop learners who are self-directed and self-motivated, both because the activity is interesting in itself and because achieving the outcome is important”. In a first step, the objective is to design instructional content paired with game characteristics in order to trigger the *game cycle*, which represents the core component of the model. This is where user judgement interplays with user behaviour and system feedback to create a loop where the player is engulfed in the game and doesn’t want to leave it. The *game cycle* is therefore iterative, “such that game play involves repeated judgment-behavior-feedback loops” and creates “user judgments or reactions such as increased interest, enjoyment, involvement, or confidence”. The player or learner is “constructing knowledge from experience” meaning that the learning outcomes emerge from engagement in self-motivated play. The *game cycle* is closely related to the concept of *flow*, which Csikszentmihalyi defines as “the state in which people are so involved in an activity that nothing else seems to matter” [31, p. 4]. Hence, one can draw the conclusion that for games to be effective in teaching, they need to achieve *flow*, the optimal state of performance, where the players skills are matched with the right set of challenges resulting in player enjoyment and motivation.

Research by Wouters et al. suggest that there are a number of positive learning outcomes that accompany serious games [86]. These outcomes are presented in figure 3.6 and can be arranged in the following categories: *cognitive skills*, *motor skills*, *affective learning outcomes* and *communicative learning outcomes*. Wouters et al. have reviewed 28 studies with empirical data and found various examples for each category which shows the wide variety of skills that can be learned through the use of serious games: “In general, serious games seem to be effective when it comes to cognitive learning outcomes. Serious games for training motor skills and attitudinal change is promising.” They concluded by stating that Finally, little evidence was found that proves the effectiveness on motivation and communicative learning outcomes.

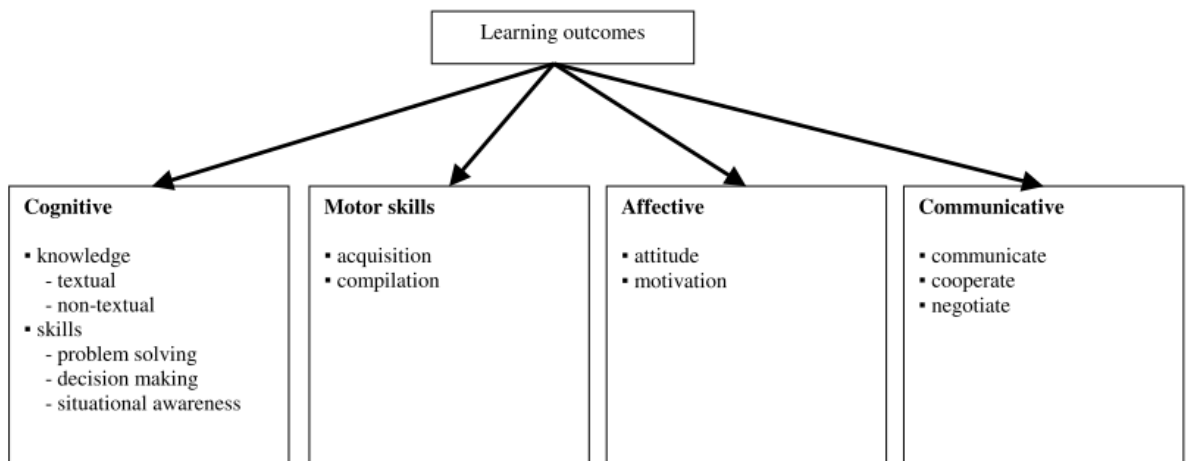


Figure 3.6: The learning outcomes in serious games [86].

The question if serious games are an effective tool for education can only be answered if the learning process of these games can be properly tracked. Therefore Bellotti et al. have stated that it is important for serious games to implement assessments to be able to monitor the learning progress and prove the effectiveness of these games [16]. The authors explain that “in-game assessment appears to be particularly suited and useful given that it is integrated in to the game logic and, therefore, does not break the player’s game experience.” If assessments become a game element in itself, the player will be able to learn by trying to solve the game’s challenges. This leads to immediate feedback and greater adaptability enabling a deeper and richer game play experience.

Evidence for the effectiveness and the positive outcomes of serious games emerges from different studies by Blunt [17], Guillén-Nieto and Aleson-Carbonell [43] and Connolly et al. [30]. For instance, research by Blunt has shown that video games can be used in supplement of university courses such as *Introduction to Business and Technology*, *Principles of Economics* and *Principles of Management*. Results show “that classes using the game had significantly higher means than those classes that did not use the game” [17]. The findings suggest that in some circumstances, learning can be increased with the use of serious games. Similarly, Guillén-Nieto and Aleson-Carbonell have studied the effects of serious games on inter-cultural communicative competences of students of business English. The authors arrive to the conclusion that, indeed, the use of a serious game can be “an effective learning tool for the teaching of intercultural communication between Spaniards and Britons in business settings in which English is used as the *lingua franca*” [43]. Further empirical evidence for the positive outcomes of serious games has been presented by Connolly et al. in their literature review consisting of 129 papers [30]. They identified “learning and behavioural outcomes including knowledge acquisition, perceptual and cognitive, behavioural, affective, motivational, physiological and social outcomes, but with the

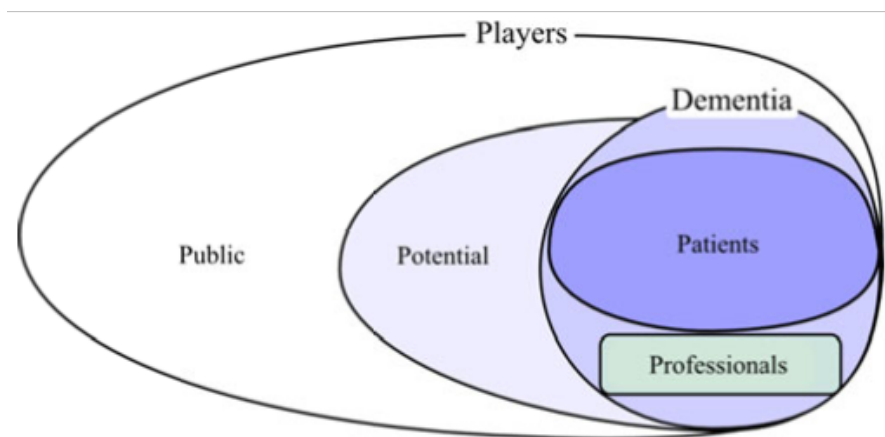


Figure 3.7: The types of players for serious games for dementia [57].

exception of soft skills” and reported that knowledge acquisition/content understanding were most frequently outcomes occurring from games for learning. It should be noted that relatively few of the papers included in their review were classified as serious games, but the authors suggest that this might be due to the fact “that there is still confusion concerning the characterization of a serious game.”

The societal impact of serious games has been analysed by Mendez et al. In their paper, the effects of a serious game to help raise awareness of the “flooding issue surrounding flood policy and Government expenditure and to increase citizen engagement through an accessible simulation” was evaluated [68]. The authors state, that “simulation-based learning seems to engage large sectors of the population.” Their findings suggest that the medium has great potential to increase awareness of important societal issues and can engage sections of the population that would otherwise not be motivated to explore them.

3.3 Serious Games for Dementia Awareness

As we have seen in section 2.4, people understand little about dementia itself. People often think they know a lot about it, but after experiencing what it is like to have the disease for themselves, they often realize that they don’t.

McCallum and Boletsis have identified the types of players for serious games for dementia [57]. According to the authors, player types consist of: *potential patients*, referring to people that have not been diagnosed with dementia but their health condition is at a critical point; *patients*, referring to people who have been diagnosed with dementia; *public*, referring to the general public that doesn’t have a first hand relationship with dementia; and *professionals*, referring to people who are affected by dementia in a professional way but are not patients themselves (e.g. academic researchers, professional practitioners, public health workers and caregivers). Figure



Figure 3.8: Impressions from the game *Alz* [26]. The game shows how familiar objects or places are often not recognized by people with AD.

3.7 shows the relationships between the different types of players and highlights the distinction between first hand experiences (patients and professionals) and second hand experiences (general public and potential patients). Games presented in this section are aimed at the public and potential patients as well as professionals.

Currently, there are not many serious games available that can be categorised as educational [57] on dementia, “presumably because of the difficulty to clearly define and cover the varied nature of the dementia disease within an educational game.” There are few games that try to convey the implications dementia has on peoples lives and educate people about the disease. The following games are examples for such experiences.



Figure 3.9: The *Virtual Dementia Experience* [37].

Game Example: Alz

Alz [26] is a short game developed by Dylan Carter for the Stencyl Jam [4]. During the few minutes it takes to complete the game, players get a sense of what it is like to live with AD. Gameplay consists of using the left and right arrow keys to walk and the space button to interact with objects. The game features changing environments, with backgrounds flickering and blurring, imitating the clouded perception that someone with dementia might suffer from. Objects appear and disappear, as well as entire environments, simulating the difficulties identifying familiar places or objects. At one point, one encounters a woman where the main character can't remember who she is. In the scene the woman calls the main character "honey" and says: "Please don't go out by yourself, dear", referring to dementia patients having the tendencies to wander around aimlessly. These aspects of the game simulate what it is like to have your memory displaced and filled with gaps. Because of the short nature of the game, it is easily accessible and there is no clear goal or challenge. Also, the game can be described as an interactive short film. This shows that serious games not always follow the rules of traditional games [59] if it helps conveying a message and that even as short as 2 minutes can be enough to learn something new. Figure 3.8 gives some impressions from the game.

Game Example: Virtual Dementia Experience

Alzheimer's Australia Victoria [9] has developed a serious game called the *Virtual Dementia Experience* that lets the player experience what it feels like to live with dementia [37]. The goal is to convey the "cognitive and perceptual difficulties" that people with the condition might have when facing everyday tasks and that even the most mundane tasks can become very challenging or even dangerous. This game uses Kinect sensors, doughnut shaped mood lighting, touch screen technology and a giant projector wall that allows players to immerse themselves in the virtual world as they take control using their hands in order to complete everyday tasks in the shoes of



Figure 3.10: The simulation environment of *Into D'mentia* [3].

someone with dementia. A pair of virtual hands reflect the movements done in the real world and this allows the player to grab objects and move through the virtual world. The environment and the rules of the game can change at any given time, a feature of the game that is used to simulate amnesia. For instance, surfaces can ripple and change color at any point. Objects can also change to give a sense of what it is like not being able to distinguish between objects. Poor motor skills can also be simulated as well as dull light and sounds. Because the screen is so large, the experience occupies the peripheral and central vision of players and overrides a players sense for greater immersion. The goal of the project is to provide better care by developing empathy and a better understanding towards people with dementia. Figure 3.9 shows the game being played by a person standing in front of the large projector screen.

Game Example: Into D'mentia

Another serious game, *Into D'mentia* [3], is the result of cooperation between entrepreneurs, care institutions, universities and IJsfonstein and lets players experience what it is like to have dementia. The game takes place in a mobile unit which is a physical “interactive simulation space designed to look like a kitchen” [48]. Through the use of Virtual Reality (VR), players will experience confusion, will be unable to recognize people or won't be able carry out everyday activities. The aim is to give family members, caregivers and professionals an insight into the living environment of people with dementia in order to create more support and understanding for the disease, reduce stress and care burden and to improve relationships and well-being in general. Experiencing these symptoms through VR stimulates sympathy towards people afflicted with the disease. The experience takes about 20 minutes to complete and is inspired by real stories from people with dementia enabling authentic, meaningful and convincing simulations. Players wear a special ‘speaker vest’, which simulates their inner voice and tells them what to



Figure 3.11: Players experience the *Virtual Dementia Tour* [71].

do throughout the interactive story. The room “comes to life” using several audiovisual elements and immerses the player in the world of dementia patients. Figure 3.10 depicts the interactive simulation space of *Into D’mencia*.

Game Example: Virtual Dementia Tour

Similarly to the previous two examples, the *Virtual Dementia Tour* [71] is an experiential kit that lets people experience what it is like to have dementia. By wearing a set of goggles, the wearer sees the surroundings through a yellowish-orange haze, depth-perception and peripheral vision are diminished. Shoe inserts are used to simulate a dementia patient’s shuffling gait. Gloves will hinder the wearer to have a sense of touch and the ability to feel anything through his or her fingers. In addition, headphones that cover the entire ear play confusing sounds to simulate a dementia patient’s impaired hearing sense. Wearing these four components, a set of simple tasks is to be completed within a time frame of about 20 minutes. The goal is for people to “walk in the shoes” of someone with dementia and to experience the condition first hand. This experiment allows people to experience what it is like to have dementia. People that have tried the experiment were overwhelmed by the effects the harmless looking devices they wore had on them [45] [72], often getting distracted or lost, being all out confused and even forgetting tasks they were given to complete. Their behaviour shows a shocking resemblance to that of dementia patients. They even start talking to themselves, trying to organize their thoughts or get angry at themselves for not being able to complete even simple tasks, ending in frustration. It made people realize that people with dementia do need their help, e.g. that one needs to speak clearly in order for them to understand you because of the noise or that one has to consider their eyesight when expecting them to find something. Overall, it helped improve relationships between caretakers and the people being taken care of. Figure 3.11 shows players experiencing



Figure 3.12: Screenshots of the game *Hazel Court* [73].

the *Virtual Dementia Tour*, trying to complete the tasks that were assigned to them.

3.4 Serious Games for Dementia Care

Games that are aimed at professionals (please refer to figure 3.7) affected by dementia but not diagnosed with the disease, such as carers, are quite rare. There are few games where the primary goal is to improve the quality of care and train caring professionals to give them the tools they need to provide better support for people with dementia. Some of the examples for serious games previously mentioned such as the *Virtual Dementia Tour*, the *Virtual Dementia Experience* and *Into D'mentia* fall into this category. The serious game *What Remains* presented in [24] is strongly connected to this work. Family members of patients are asked to collect a series of images and documents about meaningful events in the patients life. Then, the images are used in a game-element to allow patients to tell stories about the images. The stories are recorded and used to enhance the caregivers understanding of the patient's behaviour, giving them an insight into their lives and increasing the overall quality of care.

Game Example: Hazel Court

Another example for a serious game for dementia care is presented by Sisarica et al. with their game *Hazel Court* [73]. The non-digital game was designed to support creative problem solving and creative thinking in dementia care and features a physical board where players move around “from room to room and explored different options of a storyline initially composed of 8 possible scenarios, depending on their choices, guided by clues and character statements provided in physical envelopes.” Players are challenged into investigating the “the reasons for the unusual behaviour of 2 residents of *Hazel Court*”. In the case of the playtest, the residents are called Mr and Mrs Black. Results from the playtest indicate that all 4 groups had successfully created new ideas from the process of play. These findings were used to create a digital version of the

game, which has not been tested yet. Figure 3.12 presents screenshots of the digital version of the game.

3.5 Serious Games for Dementia Prevention and Rehabilitation

“Games give people the feeling that there is something new to discover. It is often the first time our target group has played a computer game. Play is a fun way of giving the senior responsibility in his or her own process of recovery.” [13, p. 27]

As we have seen in section 2.2, there currently is no cure or treatment that reduces or eliminates the effects of dementia. However, serious games have seen a wide application in the health domain, “targeting changes in health-related behaviours” [57]. Games to improve the physical health of the elderly are numerous [54], but the amount of games targeted specifically at dementia prevention and rehabilitation is not as large. Several video games have been developed with the goal of diminishing the health decline of people with dementia and improving the quality of life of the people affected by helping them to maintain their autonomy and their social relationships, and promote a relaxed state of mind [14]. Other games that were purely developed for entertainment purposes such as Wii Fit, Wii Sports and Big Brain Academy have also been used for health applications [58] and have paved the way for new types of serious games such as Exergames [44] and games for health [57] that are being used to provide players with opportunities to improve rehabilitation and disease prevention. Indeed, physical and social activity can delay cognitive decline and these games have positive effects on the users health and cognitive functions. Figure 3.7 shows the types of players for serious games for dementia. Games presented in this section are aimed at patients as well as potential patients.

There are numerous examples for games for dementia prevention. In their research, McCallum and Boletsis have found several examples that illustrate how serious games can be used for preventive purposes [57] by focusing on cognitive, physical or social/emotional stimulations: Brain Age, Big Brain Academy, Lumosity, Posit Science, CogniFit, Complete Brain Workout, SmartBrain Games, WiiFit and Wii Sports. Another example is presented in the *Eldergames* project [38], a prototype aimed at elderly users in order to train their cognitive functions such as memory, reasoning, selective attention, divided attention, and categorization.

Serious games for rehabilitation purposes are also prevalent [57]. Games such as MasterQuiz, MinWii, eMotiva have been proven to have an effect on cognitive impaired patients. Bouchard et al. have developed an untitled cooking game that is specifically designed for patients with AD and that can help users to train their four cognitive spheres while keeping the element of fun and being interactive, safe, and easy to use [19]. Martins et al. have developed another example for a serious game aimed at patients with intellectual disabilities, promoting their memory, decision-making time, capacity of observation, learning and applying knowledge capacities [55].



Figure 3.13: Screenshots from the serious game *Lebensnetz* [64]. Left: portfolio with profile picture selection; Right: the canvas filled with elements of the players' 'life network'.

Game Example: Lebensnetz

The game *Lebensnetz* is a serious game that was developed to maintain and increase the mental, physical and social health and well being of people with dementia [64]. The title translates to 'life network' and refers to the opportunities to organize and share past life experiences in the game. The concept can be described as a game that tries to reduce forgetfulness and to increase remembrance. Players are challenged to execute reasonable physical activity. Furthermore, social interactions are encouraged by the game. The goal is to provide a means for dementia prevention as well as dementia therapy in the early stages of the disease through physical, mental and social activity. The game is a tool for reminiscence (please refer to section 2.2) as players are able to input their own photographs and other documents, organize them and share them with family members, friends and supporting carers.

A first prototype for the game was developed for tablet computers. In this version, players could input their photographs. After they had chosen their profile picture, they were presented with an empty 'canvas' with their picture in the middle, which would represent the only static image on the canvas. On this canvas, they could organize their past experiences around their own picture, pulling them onto the canvas and slowly building their 'life network' out of photographs, people, places and notes. These could be moved around freely on the canvas and connections could be made between the different elements. Small minigames such as a memory game with pictures that have been pulled on the canvas were also implemented. Additionally, the game features a timeline view of all the elements on the canvas in chronological order, to provide an overview. Figure 3.13 shows screenshots from the game.

3.6 Chatbots in Serious Games

During the last couple of years, the main focus of video game developers has been set on producing better graphics. Moving through these immensely beautiful, realistic worlds can create and incredible sense of immersion but talking to any virtual character in these worlds can quickly destroy the illusion. With more and more capable computers and video game consoles, the technology is there to develop complex AIs so that conversations in video games become a lot more realistic.

Reading text in video games is generally perceived as boring and uninteresting [15]. Since players are motivated to complete the targets and challenges that the game has provided them with, reading is often avoided when it is not necessary to progress in the game and it breaks the *flow* [31] and the pace of gameplay. Time constraint can also be a factor. The situation is different for dialogue: because dialogue is interactive it may be integral or useful to advance in the game or to extract additional information about the plot.

Virtual characters or so-called Non Player Characters (NPCs) have seen little use in serious gaming environments and required inputs per transaction are usually based on selections or simple (alpha)numeric input [82]. Virtual characters controlled by the computer and able to dialogue with the player in a natural language are called Conversational Agents (CAs) [15] or Chatbots. There are great opportunities for interactive characters to be used effectively in various learning environments and serious games. Serious games can be used to practice communication skills through conversations in the game [33]. These conversations can have various objectives such as: get the player to know different types of conversational partners, these could range from cooperative to intractable, empathic to reserved or extrovert to introvert; get the player to learn and effectively use different conversational strategies, these could range from fact-driven to emotion-driven; and let the player experience how the partner and the course of the conversation can be affected by different communication styles, these could range from a more asking to more telling styles, or more fact oriented to more opinion oriented styles.

Bellotti et al. have developed specifications for NPCs favouring knowledge discovery in serious games, which include: every NPCs embodies certain well defined units of knowledge; NPCs are aimed at specific knowledge acquisition and at answering players' questions; and the context is very important for NPCs in serious games, as it can facilitate the dialogue. Examples for context are the appearance of the NPC, "its position, role and game level in which it appears."

The quality of the virtual characters in games reflects on the quality of the learning experience of players [33]. Therefore it is important for the characters to "behave in accordance with the assigned properties and strategies" and that they are used to react to player actions in a consistent fashion. If virtual characters don't behave as expected and don't act consistently and in a believable manner, the learning experience is disrupted and severely limited in consequence. It can even lead to the player adopting "inappropriate conversational strategies" and results "negative transfer of training". The fact that conversational systems are very "complex to author, manage



Figure 3.14: Project Milo allowed players to engage in a conversation with a ten year old boy [52].

and maintain” [15] creates great challenges for serious game designers to develop elaborate virtual characters, which may explain why they are not widely used.

There are a number of examples for games that provide the tools for meaningful conversations with CAs. The following games are examples that use various types of chatbots for different objectives.

Game Example: Project Milo

One example that showcases the possibilities of meaningful interactions with virtual characters is Project Milo [52], a now cancelled game prototype that was going to enable players to build up an emotional relationship with a virtual character. In the game, the player would engage in a conversation with a ten year old boy named Milo. Milo would respond much like a real boy and this allowed for a natural conversation with the character. This was made possible by making full use of the Kinect Sensor [60] and relying on its depth sensing and pattern recognition technologies in order to showcase the capabilities of the sensor. This way, the AI could react to human interactions such as the spoken word and gestures and even detect the nuanced levels of emotion in the player’s voice. As Project Milo was mainly developed for entertainment purposes, it could have equally been used as a platform for serious games. Figure 3.14 shows the interface of the game.

Game Example: Façade

Façade [56] is a 3D ‘interactive drama’ where the player is placed in the role of a person visiting a couple, Grace and Trip, two long time friends to whom he has not spoken in a while. The



Figure 3.15: Screenshots from the game *Façade* [56], images from [1]. Left: Trip and the Player greeting each other at the front door; Right: Grace and the Player greet each other.

game does not have a clear goal, instead the player can interact with the couple. This can be done through text input as well as performing touch actions through mouse clicks. The authors' goal was to create an artificial intelligence-based art/research experiment in electronic narrative and a novel architecture for supporting emotional, interactive character behaviour and drama-managed plot. For this purpose they built a real-time 3D virtual world inhabited by NPCs, where the player would experience a story from a first-person perspective.

The narrative is set to evolve over time based on the player's interactions with the world and the characters. For example, if the player asks Grace and Trip how they are doing and they reply in a hesitant way saying that everything is fine and then the player decides to ask more questions, he or she will discover that they are having marital problems. The player can then choose if he wants to comfort them or take sides in the conversation that follows these events. Everything in the game evolves continuously as there are no specific points in time where the player has to choose a specific option over another and the player can also choose to interrupt the virtual characters when they are talking. AI controls the virtual characters' personality and behaviour as well as emotive facial expressions, spoken voice and full body animations. By the end of the game, the player will have changed the lives of Grace and Trip. In theory, this should motivate players to replay the game and find out how the interactions could change the course of the game in different playthroughs.

Three main research efforts [56] were identified by Mateas and Stern: finding ways to deconstruct a dramatic narrative into a hierarchy of story and behaviour pieces; designing an AI-system that incorporates the player's interactions to create a real-time dramatic performance with the pieces; and writing an engaging and compelling story within this framework. Figure 3.15 shows screenshots from the game where the player greets the virtual characters.

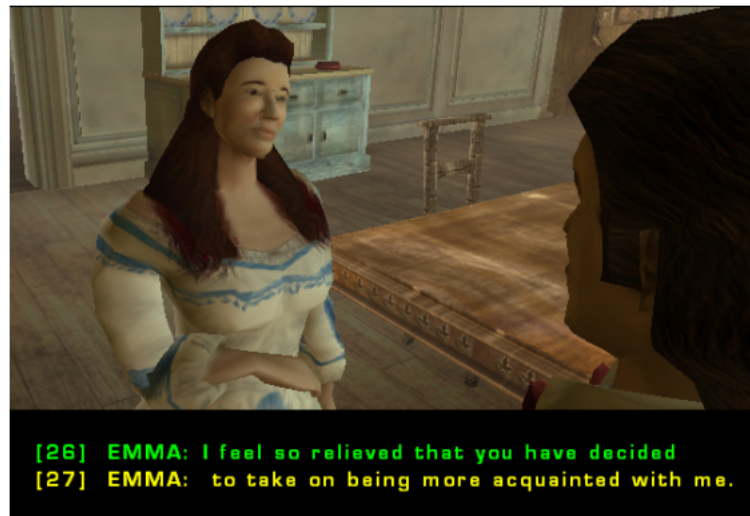


Figure 3.16: *EmoEmma*: Emma and Rodolphe, impersonated by the user, in the 3D virtual stage [27].

Game Example: EmoEmma

EmoEmma [27] [66] is an interactive storytelling system that focuses on immersion and features virtual agents in a 3D world. The system was designed to be a virtual reality demonstrator for multi-modal interaction in a 19th century setting and uses emotional speech recognition allowing unconstrained and natural speech interaction. The underlying narrative is based on Gustave Flaubert’s novel *Madame Bovary* in which a few chapters describe Emma Bovary’s decision to have an affair with Rodolphe. The player acts as Rodolphe in the game and can interact with an agent representing Emma. This agent doesn’t have a clear goal, but a set of feelings that it wants to reach: “The interactive narrative is driven by the emotional state of characters and their relationships” [27]. The player responds to Emma’s complaints and love declaration. The affective parameters of Rodolphe’s utterances are analysed in real-time and influence his relationship with Emma as well as the evolution of the scene. Figure 3.16 shows screenshots from *EmoEmma*.

Game Example: Scenejo

Scenejo [83] is a storytelling platform that provides a means for conversations between multiple artificial characters in combination with free textual input from multiple users. It allows for playful simulations between CAs and users and employs animated virtual characters and chatbot technology for text-based interactions in form of dialogue. Virtual characters are able to engage in a conversation or even a dispute and can seek advice from users, ask them for opinions or tell them to direct their interest. Scenarios are created by users through definition of actors and their properties such as gender, voice, visual representation and dialogue base. The converse of a story is described by a story graph which uses scenes as building blocks. They provide the

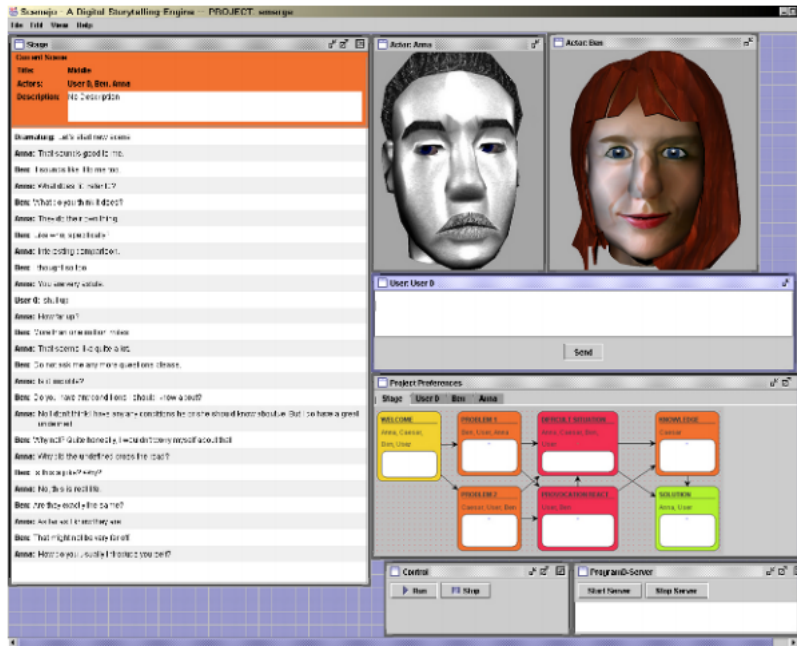


Figure 3.17: The interface of *Scenejo* [83]

context and environment for parts of the interactive story.

Scenejo can be used to provide a platform for dialogue in various subjects specifically those topics with uncertain facts or elements that are subject to interpretation such as philosophy. Furthermore language or conversational skills can be taught as well as mastering of difficult situations such as negotiations. It is also possible to teach terminologies within specific knowledge domains. Through interaction with multiple chatbots, the element of fun is created by the interactive and unpredictable nature of the conversation. Figure 3.17 presents the interface of *Scenejo*. Dialogue is simulated by animated talking heads and synthesized voice.

Game Development

4.1 Inspiration and Idea

“Home is where the mind is, for someone with dementia.” [35]

The main concept for the game was developed by Lorraine Hopping Egan, an author writer and game designer for Hopping Fun Creations [36]. As her relative Jane was diagnosed with dementia, she quickly realized what a great impact Jane’s condition would have on the people surrounding her and that Jane could no longer live an autonomous life as every day task would become almost impossible for her to complete. The more the disease progressed, the more difficulties Jane had expressing herself and the more she escaped what was going on around her and went back to the past. Jane has led an incredibly rich life with numerous different jobs, countries visited and many more things to tell and it was emotional to see how her mind was slowly getting more and more clouded in a fog of dementia. These difficulties in communication with her are where the idea for the serious game *Do I Know You?* came from, a game where players would talk to a person with dementia, in this case it would be Jane, and learn how to communicate effectively with her. The goal of the game would be to find out where she lives and to find out what home means for her in order to take her home. Since Jane had such a love for cats, she would feel ‘home’ when being around them.

The initial concept was for the game to be a point-and-click mystery game, where one would meet an elderly women in a wheelchair who asks the player to take her home [35]. Hence, the main goal would be to find out where home is for this woman. To achieve this goal, the player would engage in a conversation with her and quickly find out that her mind was lost in a fog of dementia. Gameplay was set to consist of the chat feature as well as a point-and-click mechanic which would serve to click on objects, uncover clues of the present as well as of the woman’s true past. Old photographs, letters and non-fiction biographical material would serve as the basis for this “treasure hunt”. A homing pigeon was going to serve as a guide throughout the game and was going to monitor the players progress during several levels of play. A score would be



Figure 4.1: Screenshot from the game *Passage* [70].

given to the player: the better he or she would be able to communicate with character and help her, the higher the score.

The game was conceived to have cartoon illustrations, simple animations, sound effects, music and a dialogue bubble, which would serve to communicate with the subject. Comparable to a chat bar, the player would enter text into the bubble and he or she would earn additional points if the correct key words discovered throughout the game are entered. Multiple levels were conceptualized, consisting of: a first level taking place on a promenade, where the player would meet Jane and slowly gain her trust; a second level, which the player would reach after having discovered Jane's address only to find out that it is the wrong address; a third level, representing the right home, but Jane would still be unhappy and want to go out; a fourth level, again on the promenade, consisting of a obstacle course and Jane leads the player in the right direction; and a fifth and final level, taking place in a pet store with all the cats that Jane has rescued over the years. Finding the right cat that makes her happy would complete the game. We contacted Lorraine Hopping Egan and asked her if we could develop a prototype for the game she had in mind and with her permission her initial idea was developed further to adopt new gameplay ideas.

Another source of inspiration came from the *Lebensnetz* project [64], which was presented in section 3.5. This project was designed specifically for the elderly and the goal was to give them a platform which enables them to collect, organize and share memories effectively with a simple and intuitive user interface. One essential aspect that relates to the *Do I Know You?* game was reviewing a persons past experiences and portraying it in digital form. One of the key findings during the project was that it is quite challenging to portray the sheer richness of things that people have experienced in a digital environment. Nevertheless, it is possible to get a meaningful glimpse of peoples lives through the game and people where able to successfully share their experiences with others. It was motivating to find out that elderly users were very exited to use the program and where enthusiastic about the game.

Passage [70] is a short art game created by Jason Rohrer about life, death, the passage of time and even about marriage. Life's challenges are represented as a maze and because of the resolution of the game, you can only see a tiny portion of that maze at any given time: you can see far out into the distance and what lies ahead (and also what lies behind at a later stage), but you



Figure 4.2: User interface of the indie game Papers Please [67].

cannot see what lies above or below. You may be able to see rewards close to you but there is no clear path to get them, and they might even be unreachable. The game lasts exactly five minutes and every playthrough is different, depending what path you take and every time you learn something new. The game can be described as a short, meaningful experience and this is something that we wanted to carry over to our game.

4.2 Game Conception

The idea for a game with an AI that simulates a person with dementia was compelling. The first questions that appeared during the very early stages of conception were: what type of game was it going to be? What was the user interface going to be like? What kind of gameplay was the game going to have? What would be the goal of the game? What is the target audience for the game?

Since the game was going to be based around the chatbot functionality, it had to be the main feature in the final game. Therefore the interface had to have a component that enables the interaction with the chatbot. It was clear early on that the game would not feature a very graphic intensive interface because the goal was to keep it as simple as possible so that people who have never played a video game before would be able to play the game. Last year's very successful indie game *Papers Please* [67] would serve as inspiration (receiving documents, analysing them, retrieving information from NPCs and progressing in the game by collecting clues and hints) for the overall type of experience that we wanted to create. The game also proved that despite the graphics being fairly simple and it even involving a lot of reading, people could still

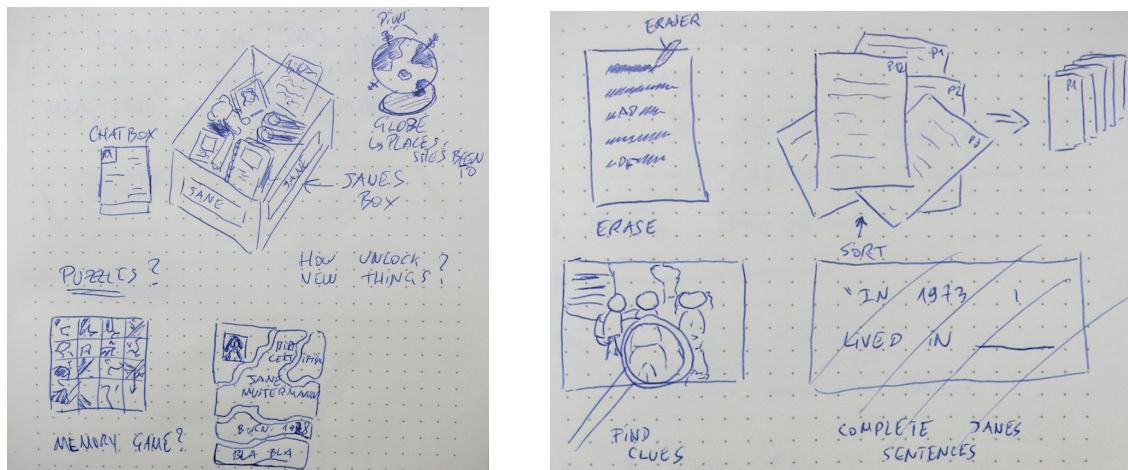


Figure 4.3: Game ideas in the early stages of game conception.

be immersed in gameplay and would still enjoy the game. Figure 4.2 present the user interface for *Papers Please*.

From the start, the concept that people suffering from dementia often relive past experiences was going to be an essential aspect of the game, but it remained unclear how this would influence gameplay. Furthermore, the question remained how serious the game should be, i.e. how important fun was during the experience. As we have seen in section 3.2, fun is in fact an important element of serious games and is essential for the learning process. The idea that several minigames or puzzles featuring biographical material from Jane was formed early on. These minigames were meant to diversify gameplay and provide variations of play in order to provide some short, fun and different forms of interaction than the main game.

Figure 4.3 shows a few examples of game ideas that were created in the early stages of game conception. The first ideas included several minigames based on biographical material, such as: a box containing all of Jane's documents and the player would have to find the documents he needed in order to progress; a globe where players would have to guess which countries Jane has visited during her lifetime according to the information collected up to this point and receive points for each correct pick; puzzle minigames, where documents have been torn into several pieces and it is up to the player to rearrange the pieces in order to make use of the document; a minigame where parts of the document have been crossed out and the player has to erase these markings in order to uncover clues and information contained in the document, a reference to erasing Jane's memory gaps; a game where the player has to organize documents in the right order to proceed; a minigame where the player has to find clues in pictures and documents using a magnifying glass; and a game where the player has to complete Jane's sentences by guessing the right words. These are just a few examples of minigame ideas that were developed.

Several meetings took place during the conception phase. These meeting were essential for the

formation of new ideas and developing the core concept of the game. In the following subsections we will present the key findings in each of these meetings and discuss what they meant for the game development process.

Meeting with Lorraine Hopping Egan

This meeting was held between Lorraine Hopping Egan, Daniela Ramsauer and Sebastian Czekierski-Werner on Google Hangouts and was intended for the participants to meet each other and discuss the concept for the *Do I Know You?* game and in what direction the development for the game should go. The most important aspect of this meeting was an introduction to Jane's person: We learnt that Jane has suffered from dementia for 5 years, that she lives in New York and has led an incredibly rich life, starting as a diplomat in Trieste, Italy, and then working as a reporter and a cultural critic (mainly for the opera) for The New Yorker magazine. We heard about all kind of little anecdotes about Jane, for example that she always carries a large purse with her or that she loves cats and has rescued many cats from the street over the years. These little details about Jane's life would prove invaluable for the game's success, as it makes the virtual character more believable, especially so when grounded in real personal experiences. We discussed ideas for minigames that we had, what each of us could contribute to game development and concluded that we needed to invest more time in research on dementia and serious games and that we would meet again soon after.

Brainstorming Session with the HCI Group

This meeting was held at the Human-Computer Interaction (HCI) group, which is part of the Institute for Design and Assessment of Technology of the Vienna University of Technology. Participants consisted of: Sebastian Czekierski-Werner, Daniela Ramsauer, Ao.Univ.Prof. Dipl.-Ing. Dr.techn. Peter Purgathofer, Projektass. Dipl.-Ing. Dr.techn. Fares Kayali, Projektass. Mag.art. Dr.phil. Özge Subasi, Projektass. Dipl.-Ing. Oliver Hödl, Univ.Ass. Dipl.-Ing. Naemi Luckner and Francisco Nunes. The goal was to brainstorm with experts in the field of HCI and game design and to discuss the game concept and gather ideas that could be implemented.

The first topic of discussion from the brainstorming was that there should be a kind of inventory in the game to store all the documents that one has received from Jane. This creates the possibility for the player to review documents at a later point in time to uncover more clues from them or to use them in some other form to progress. We then discussed the time shifts that would occur during the game, meaning that Jane would relive a moment of her past. We then thought of the possibility of there being not just shifts in time, but also in other "spheres" such as her personality traits. For instance, Jane has been described at being a very confident, demanding and career-oriented woman, but at the same time she expresses a deep emotional connection to cats. In the game, she could switch between these two personalities and this would create an extra challenge for players trying to converse with her. Next, we talked about what inspiration we could take from the movie *Memento* [63]: in the movie, the main character suffers from memory loss and has to slowly piece together the story with different artefacts he left for himself and in the process he develops a kind of "language" to handle them. Similarly, the player has to piece

together Jane's life story with the documents he receives. We discussed the importance of the artefacts (documents). If interactions with Jane in the game are based on predefined questions, then the artefacts could give additional options to the player. Artefacts could also serve as triggers to bring Jane into different time periods.

Next, the point was made that a general means of success needs to be provided by the game. This would prove difficult, because how do you measure success when talking to someone with dementia? We discussed the futility of contradicting someone with dementia. This relates to the *validation therapy* presented in section 2.2. In order for the player to be successful, he or she has to "go with the flow" and accompany Jane on her "time travels" and extract as much information as possible while doing so. It was argued that maybe the main goal of the game was not to take Jane home, but to take her fear away and to learn how to act to make her feel comfortable.

We discussed how interactions with the chatbot could be based on predefined nouns and verbs, instead of letting the player type full sentences. Choosing topics could also be a form of interaction as well as options such as "reaffirm Jane" or "contradict Jane". There must also be a means of getting additional information on topics, for example if the current topic is about the opera, the player might wonder what operas there are in New York. He or she could then ask more detailed questions and get feedback if the right questions have been asked. We discussed how we could provide this information: there must be some kind of device that helps the player in these situations, e.g. it could be simulated that you wear Google Glass [42] in the game. It was also argued, that instead of using the helper pigeon as a guide, the device could take care of this task.

Furthermore, it was the general consensus that the nature of the game would be very unpredictable or even random. Progress in the game could then be seen as successfully bringing Jane back to the present. The goal of the game was then discussed as well as the ending of the game, which could result in the realisation of the player that he or she is unable to help Jane or that he or she is not in control of the scene. In this case, the ending would be irrelevant, but it was still argued that the game would need a strong closure: e.g. Jane's housekeeper could appear after a while with a cat and this would make Jane feel happy. In the end, getting her home could be interpreted as getting her comfortable. We asked ourselves the question of why people would want to play this game. We concluded that the game doesn't have to be very educational and that replay value would not be that important. The most important finding is that it is all about the experience.

Meeting with Lorraine Hopping Egan and Jane

This meeting with Lorraine Hopping Egan, Sebastian Czekierski-Werner and Daniela Ramsauer was intended to discuss the results from the brainstorming session at the HCI group. The meeting was held as a Skype session, with Lorraine reaching us from Jane's apartment in New York. This was also going to be a chance for us to meet Jane and to talk to her and get to know her.

We first discussed that there needed to be some kind of inventory in the game for the player

to store all documents he or she had found. Then we conversed about the possibility of having some kind of device in the game that would provide additional information about the topic of discussion and about the documents. We then moved on to think about how the /acAI could work, how predefined answers would come into play and how documents would provide additional options to the players. We then turned our attention to the ending of the game and concluded that we would end the game with Jane having a cat in her arm and her feeling at home. We decided that for the prototype, we would concentrate on building just one scene/level, where the player meets Jane on the street, as a proof of concept. Also interactions would be limited to predefined options.

Furthermore, we took this opportunity for us to meet Jane in real person. Since Jane had trouble understanding us acoustically, we would tell Lorraine what we wanted to ask Jane, and Lorraine who was sitting right next to her past on our questions. This conversation proved to be really interesting, because we could see with our own eyes what it was like to talk to Jane. We were able to ask her simple questions like: “how is the weather?” or “what kind of music do you like?” as well as more personal questions about her past such as “where did you grow up?” or “what did your parents do?”. Sometimes, Jane would simply say “I don’t know.” and other times, we were unable to understand what she was saying as some of the words did not make sense. It was important for us to experience this first hand so that the game would simulate her natural behaviour.

As we ended our conversation with Jane, we continued to talk to Lorraine. She told us that Jane would always carry a huge purse with her, containing several items such as: gloves, which she always had with her; wallet, where she always had some money; Pan-Cake make-up, which was very popular in the 1950s and 60s; a comb; several different lotions; cards; lipsticks; and tissues. We also learned more about Jane’s parents: her father, Bill, was a publishing executive and her mother, with whom she had fought over the years, worked for the National Geographic. Jane has been to Iran, Libya and Syria. We learned that Jane is a “cat lady”, that her favourite cat’s name was Daisy, a Bengal Tiger cat, and that Jane had rescued hundred of cats over the years, which she kept in her apartment until she found a new home for them. We were then able to get a tour of the apartment and found out that she had a large number of cat paintings on the walls, as well as several covers of the New Yorker. Lorraine continued by explaining that when Jane travels in her mind, she would not travel to the time of her childhood, but she would often believe that her parents were still alive and she would tend to travel to different places instead of time periods. We decided that for the game we would have her travel to different time periods.

Mockup Creation and Rapid Prototyping

Following the game conception phase, methods such as mockup creation and rapid prototyping were used to test out various ideas and concepts. This allowed us to find out which ones worked and which ones we had to reject.

Figure 4.4 shows two examples of user interface mockups that were created. The example on the left features a window space dedicated to showing the current scene (e.g. the promenade), an area for the documents where the player could move them around with drag and drop move-

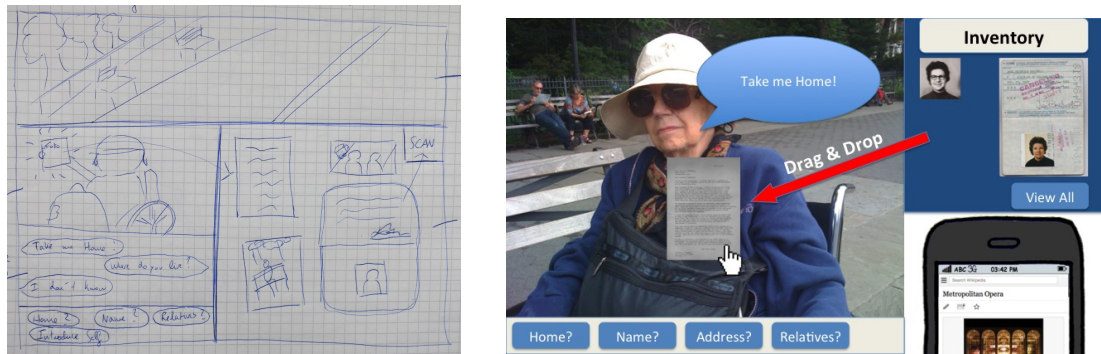


Figure 4.4: User interface mockups

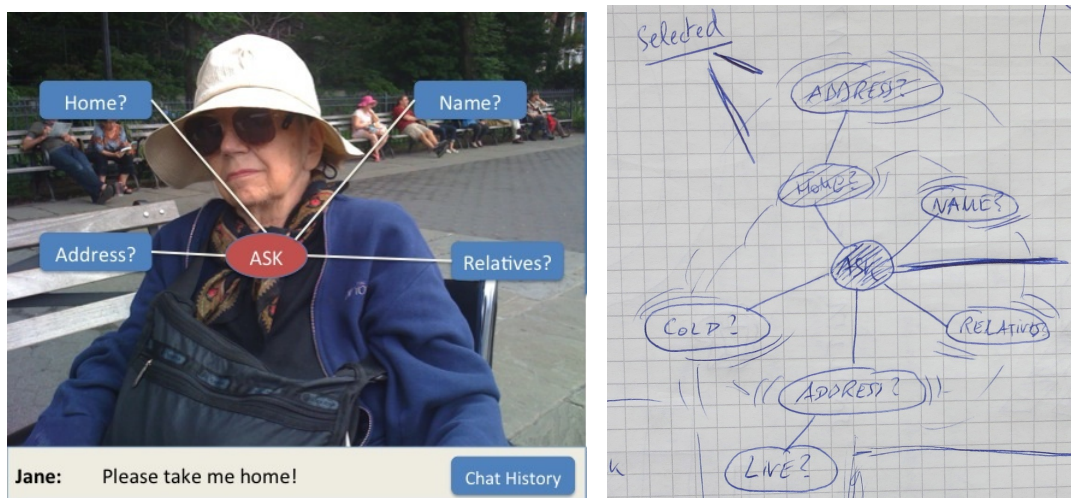


Figure 4.5: Different ideas for chatbot interaction

ments and a chat area, dedicated to the interactions with the chatbot. The example on the right dedicated more window space to the chatbot and featured a separate area for a device, in this case a phone, that would display additional information to the player. Documents could be shown to Jane simply by dragging and dropping them onto the character. This design was very close to the one used in the prototype, where we already decided on just creating only one scene/level.

The question remained of how the player would interact with the chatbot. Figure 4.5 presents two ideas for chatbot interactions: on the left hand side, small bubbles would float around the virtual character representing the different options; and on the right hand side, this idea was further developed as selecting one option would reveal additional bubbles that would branch out of the initial bubble and there would be the possibility to combine different bubbles to form a question for the chatbot. This idea was too complex and ambitious for the prototype and we opted for a simpler solution with buttons representing the different questions.

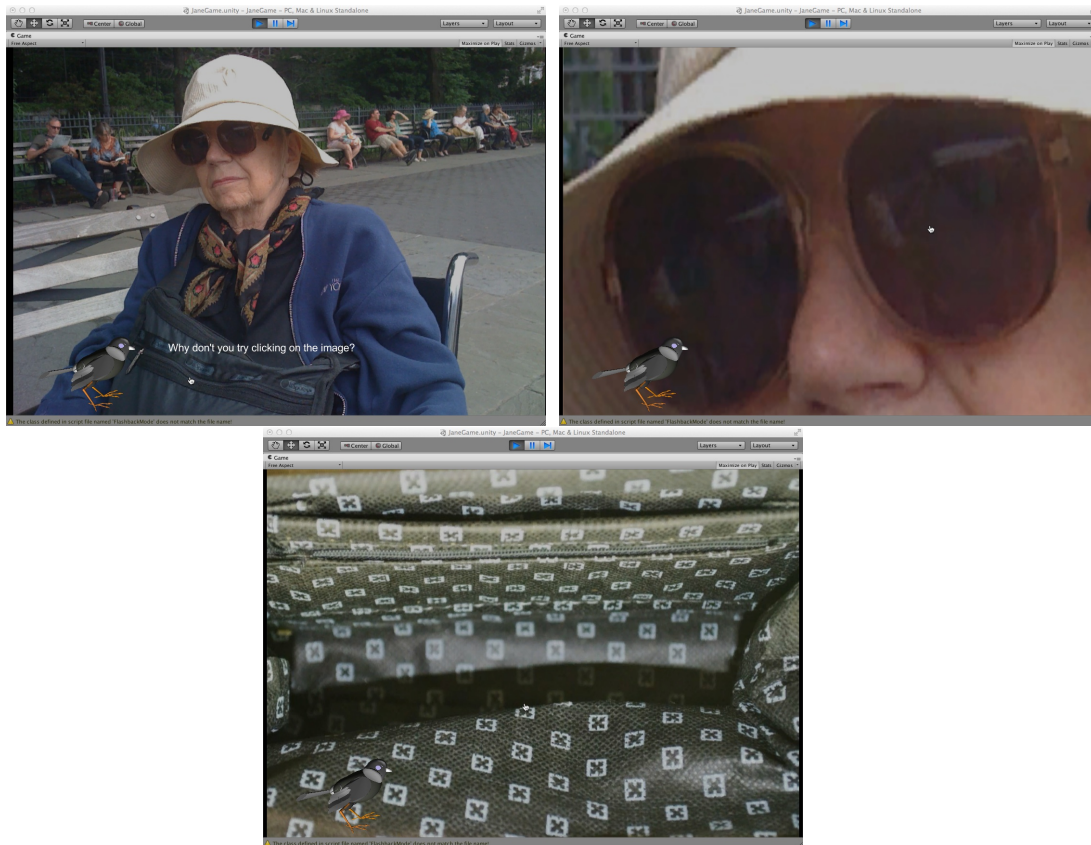


Figure 4.6: Rapid Prototyping using the Unity [81] game engine

Rapid prototyping allows for quick and effortless testing of ideas. Figure 4.6 depicts an example of a small test for a point-and-click mechanic that was created using rapid prototyping in the Unity [81] game engine. In this example, the player could click around on the image and discover clues. For instance, by pressing on the sunglasses, the camera would zoom onto the sunglasses and the idea was that one could discover hints in the reflection of the environment. This example was also used to test the idea of looking into Jane's purse in order to gather even more clues. A helper pigeon was introduced that gives hints to the player, for example that one can click on the image.

4.3 Content Creation and Data Collection

In order to proceed with game development, a significant amount of information about Jane's person had to be collected and organized. This information would be used to create a coherent experience and would serve as basis for the answers that Jane would give in the game.

Documents received included photographs, letters, passport copies and copies of identification cards. The Documents were organized into 5 different topics: *Now* (symbolizing the present time), *March of Time* (the time period where Jane worked for March of Time), *CBS* (the period of time where Jane worked for the Columbia Broadcasting System), *Diplomat* (the time period where Jane worked as a diplomat in Trieste) and *New York* (everything related to her time at the New Yorker magazine). This categorization was used to define which documents Jane associated with which time period. Showing her a document in the game would change her behaviour which could be observed in her answers. Certain documents, which supposedly had a special meaning to her, would cause her to undergo a “time shift”, where she would mentally travel back in time and relive those moments. We also had to define which documents are associated with which answers: for some specific answers, the player would receive a document from Jane and in some cases this would launch a minigame as well.

The chatbot would represent the main part of the game and it was decided that the chatbot interactions would last 6 minutes (total playtime should approximately be 10 minutes). Therefore, additional information on various topics had to be collected in order to provide a sufficient amount of possible answers so that the chatbot wouldn’t “run out” of content. Furthermore, fictional and non-fictional content had to be consistent and fictional content had to be based on the non-fictional elements we had gathered as to create a realistic representation of a real person. Some facts, such as Jane telling Lorraine that she had worked for the CIA, could not be verified but were also included in the game since we decided to create a believable representation of her character.

4.4 *Do I Know You?* Prototype Showcase

The prototype for the *Do I Know You?* game was developed by Sebastian Czekierski-Werner and Daniela Ramsauer: the AI for the chatbot was developed by Daniela Ramsauer and Sebastian Czekierski-Werner was responsible for the game design. We used the Unity [81] game engine and the “Free Edition” of the NGUI: Next-Gen UI kit [79]. We decided to use Unity since we were already familiar with the engine having worked with it on various occasions and we knew how flexible and powerful the engine was. We felt that, if we wanted to further develop the game in future work and add more levels to it, such as an obstacle course level (please refer to section 4.1), this could be done easily in Unity.

For this prototype, we decided not to reward any points to players or to give them any kind of score. We reasoned that the goal of the game was to raise awareness on dementia and that it was our main priority to get the core components to work.

The Story

When starting the game, players are presented with the following introduction:

“You are walking along a promenade in Brooklyn... When you encounter an older woman in a wheelchair... She seems lost so you ask her if you can help her... She

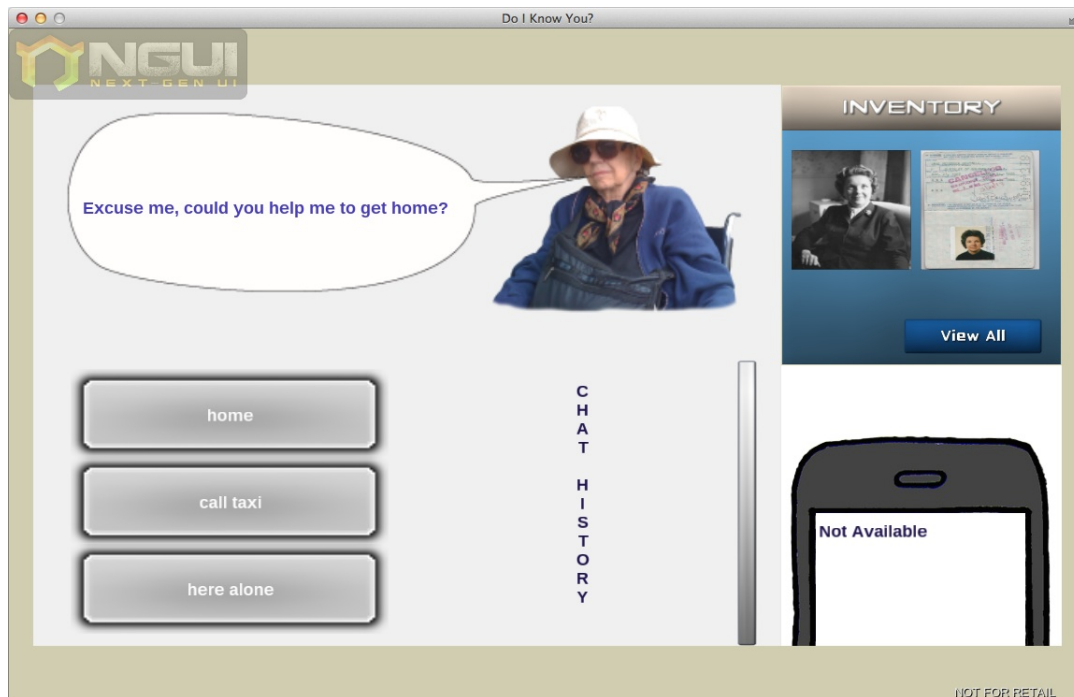


Figure 4.7: The main screen of the game.

asks you to take her home and gives you some documents, which you carefully save in your inventory... Maybe you can show them to her later..."

This short introduction reveals that the scene takes place in Brooklyn, that the woman you meet is sitting in a wheelchair and that she seems lost. There is no mention of her dementia as we intentionally left out any further information as we wanted to make it up to players to discover this fact for themselves and find out what they have to do. They therefore need to find out how to progress, what the documents might be used for and hopefully they will feel compelled to engage in a conversation with the elderly woman to find out more about her and find answers to questions they might ask themselves, such as: “Why is she here all alone?”, “Where does she live?” or “Where is home for her?”.

Chatbot

As stated earlier, the chatbot represents the main part of the game. Figure 4.7 shows the main screen of the game. The player can interact with the chatbot via the three input buttons. We decided to limit the interactions to just three, predefined options for the sake of this prototype and to facilitate communication. We didn’t want player to feel overwhelmed by the game, yet bored because they have to repeatedly execute the action of typing in their questions. A chat history is located to the right of the buttons and shows the previous questions and answers for later review. The speech bubble contains Jane’s latest answer. The first thing Jane says is: “Excuse me, could

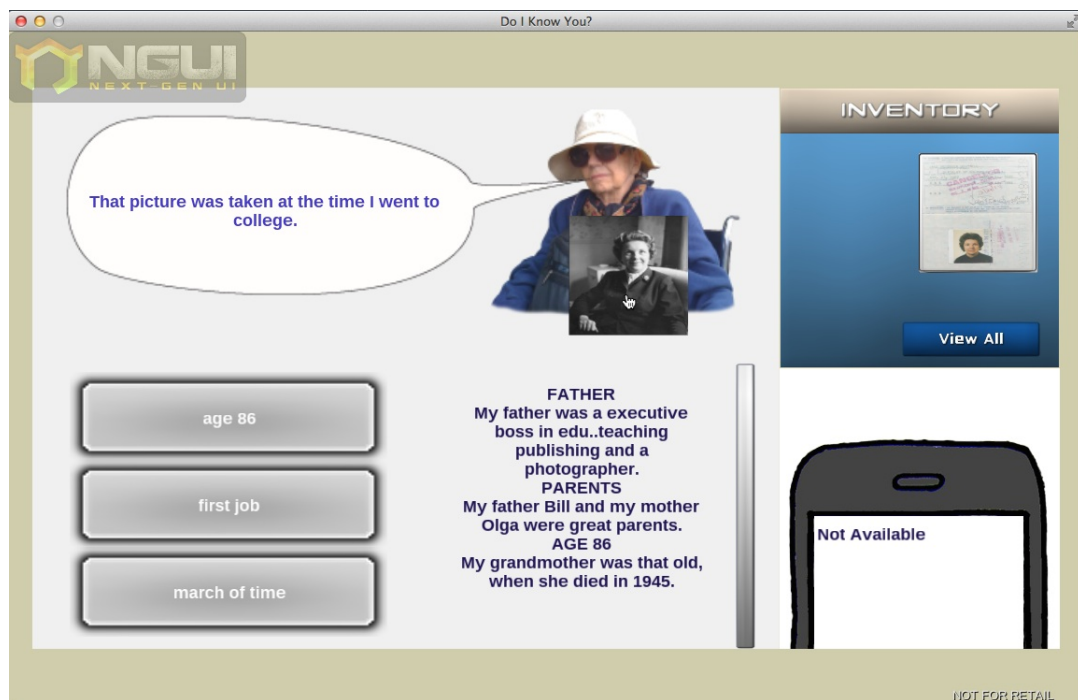


Figure 4.8: Show images to Jane using drag & drop.

you help me to get home?” The goal of this sentence is to intrigue the player and to challenge him to find out more.

The player can interact with the chatbot using the documents. When asking the right questions, players will gain Jane’s trust and she will give them more and more documents. An inventory with the latest two documents received is located on the right of the screen. Dragging and dropping one of these documents onto the virtual character translates to showing a picture to Jane. As discussed in section 2.2, *reminiscence therapy* is described as reviewing things from the past, such as photos, familiar objects or music and can be used to improve mood, wellbeing and some mental abilities such as memory. Showing Jane a picture can cause her to remember the events depicted on that specific image and she will travel back to that moment in her mind. They can also be used to bring her back to the present. In figure 4.8, the player drags a picture onto Jane, which results her remembering the time when the picture was taken. In this case, she remembers the time period when she used to work as a diplomat in Trieste, as shown in figure 4.9. The says: “That’s me. Why is it so cold, usually it’s wamer here in Trieste”, which shows that she thinks that she is in Trieste not in New York. Time shifts are represented by a visual effect in the game: Jane “fades out”, symbolizing that her mind is drifting away to another time period. In consequence, the options for the questions change.

Documents can be used to bring Jane to different time periods as different documents have a

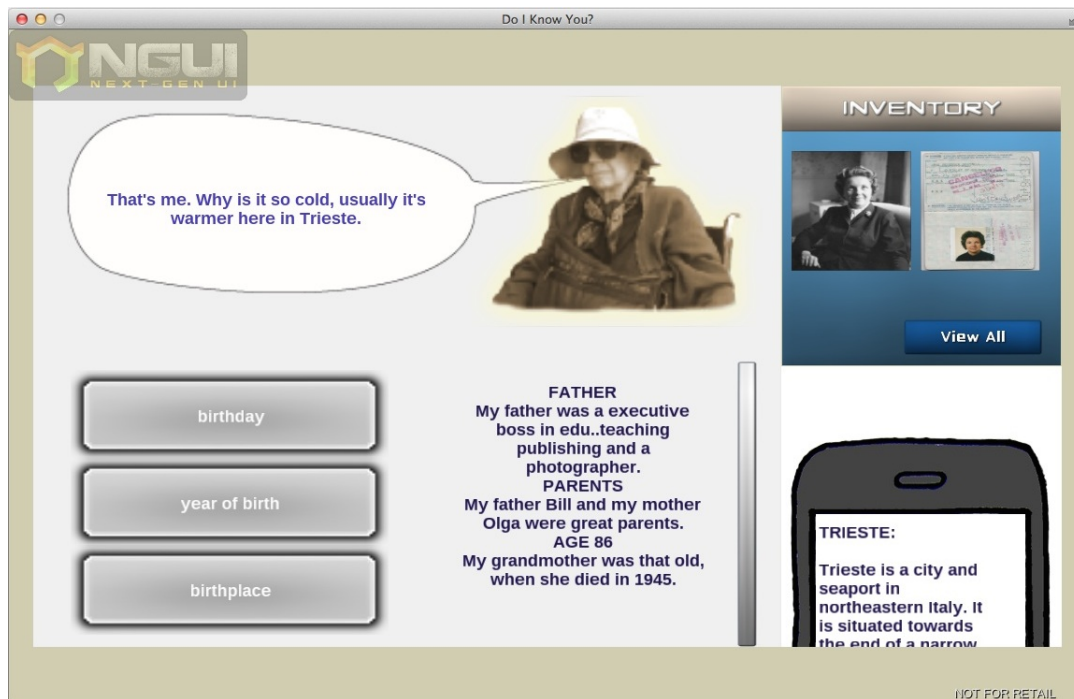


Figure 4.9: An example of a time shift. Jane “fades out” indicating that her mind is drifting away.

special meaning to her. If the player wants to find out more about one specific time of her life, he can use them to make her remember more easily. As people with dementia often tend to live in the past as discussed in section 2, we implemented a 30 second timer, after which Jane randomly switches to another time period. These 30 seconds are only counted if the player is currently not playing any of the minigames, which will be presented in section 4.4. These constant switches are aimed at complicate the communication process and add an extra challenge for players. During the 10 minutes or so that the game takes to complete, players are able to converse with Jane and get to know her on a personal level. We hope that players will learn that in order to communicate with people with dementia, one has to understand that their cognitive functions are impaired and that they suffer from memory loss. For instance, Jane’s answers don’t always make sense and she will often invent new words such as: “birthhour” when she actually meant “birthday”. It is up to the player to find out what she wanted to say.

Inventory

The inventory, depicted in figure 4.10, shows all the documents that have been collected so far by the player. From the inventory, the player can choose to show the documents to Jane or he or she can choose to view the documents in a preview window.

At one point we discussed the idea of using Jane’s handbag as an inventory, but quickly de-

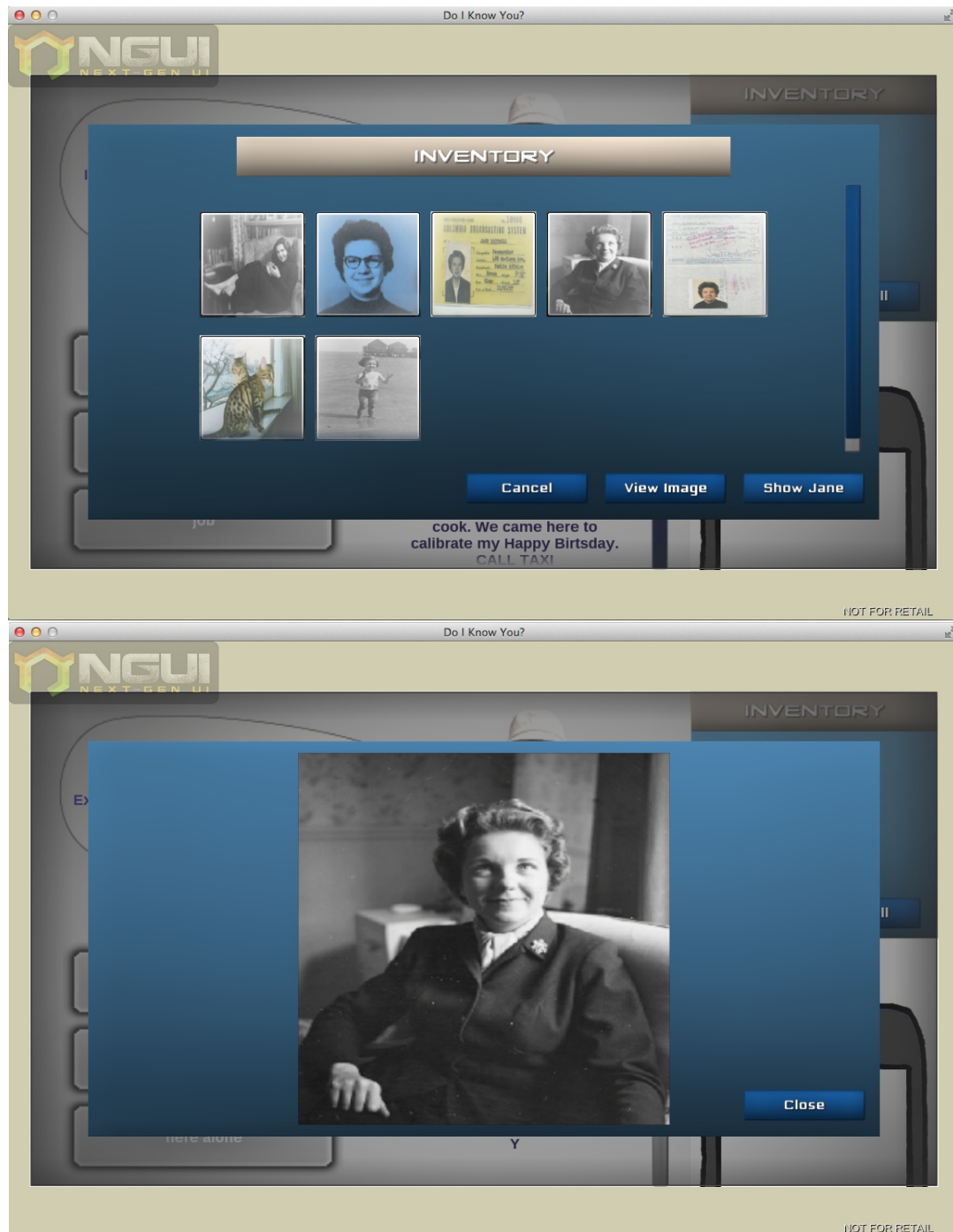


Figure 4.10: The inventory in the game. Top: a view of all the documents collected so far. Bottom: a more detailed view of the selected document.



Figure 4.11: Different examples of additional information displayed by the smartphone.

cided against it because it would not seem realistic that a person would let a stranger look into their handbag shortly after meeting them, whereas showing someone pictures would not seem as that improbable. So we argued that we needed a separate space to store items. What might seem possible is that after a while, having gained her trust, she would let you look into her handbag which would reveal additional hints and clues about her person.

Another idea that we would like to implement in future work, is a kind of a scanning device to “scan documents” to reveal little details that one might not see at first glance. This scan feature could be integrated into the smartphone (please refer to section 4.11). This could be similar to the scan visor in the game *Metroid Prime* [62], where players could scan the environment and the visor displays background information that provides a more immersive experience.

Smartphone

The smartphone, located on the right hand side of the window, is intended to display background information on the current topic of discussion. The need for such a device has been discussed previously in section 4.2. We decided to use a smartphone and not a augmented reality device such as Google Glass [42] because these samrtphones are being used by more and more people and it is quite probable that players of our game own one. Furthermore, simulating a functioning augmented reality device in-game would have required a lot more resources than we had at our disposal.

As we can see in figure 4.9, when Jane undergoes a time shift and starts remembering her time in Trieste as a diplomat, the phone displays a description about Trieste. By clicking on the phone, the phone’s display appears in its entirety, so that the player can read the information. Another click on the phone “hides” it again. Figure 4.11 shows the different types of information that the phone will display during the game: *March of Time*, *Trieste*, *The New Yorker* and *CBS*. When

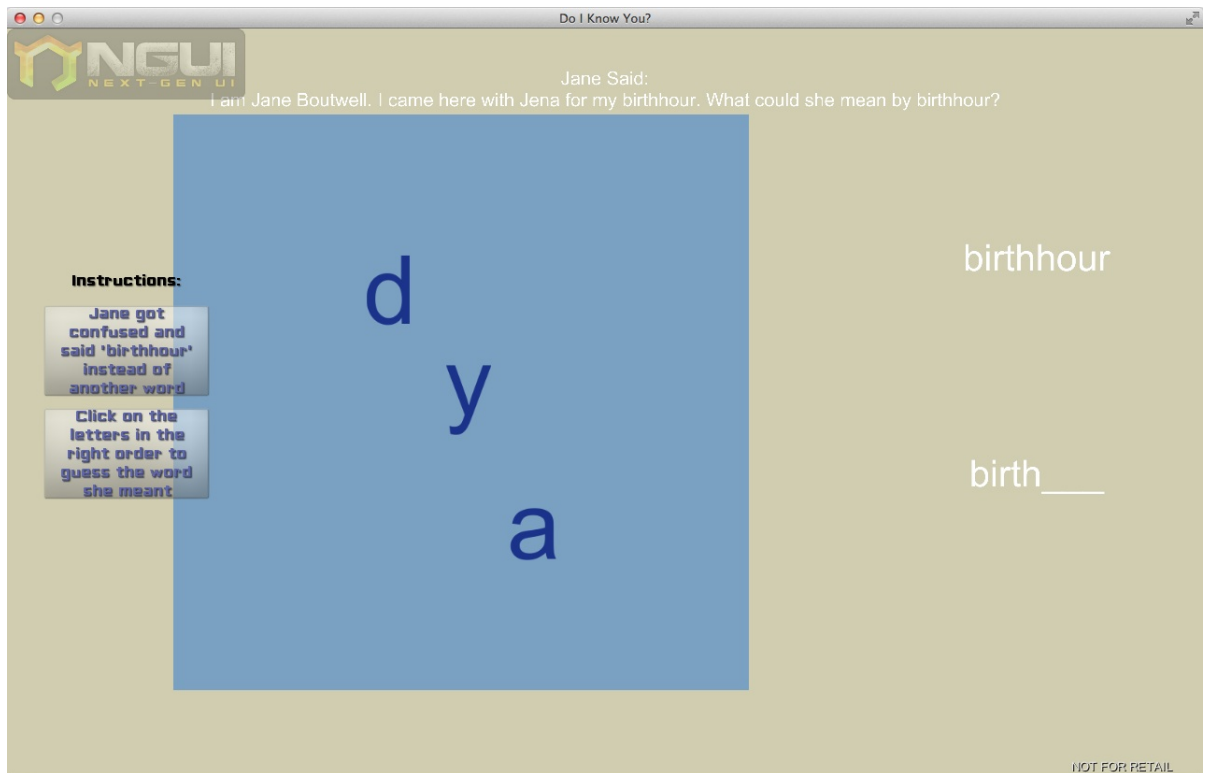


Figure 4.12: The “guess the word” minigame

Jane is currently not trapped in the past, the phone will not display anything.

Minigames

Several minigames were developed for the *Do I Know You?* prototype. These minigames were intended to add some variety to gameplay and create a more fun and entertaining experience.

The main motivation behind the minigames was to use the documents in a fun and exiting way. The idea was that the documents have been torn into pieces and that is was up to the player to rearrange the pieces in order to use them further. We also had an idea for a minigame, where the player had to identify Jane in a picture of a scene with about twenty different people. The idea was tested in Unity using rapid prototyping but proved to be less fun and rewarding than expected.

The minigames are launched under the following conditions: Jane uses a faulty word in one of her answers or the player receives a document which has been linked to one of the minigames. After completing the minigames, the game returns to the main screen (see figure 4.7).

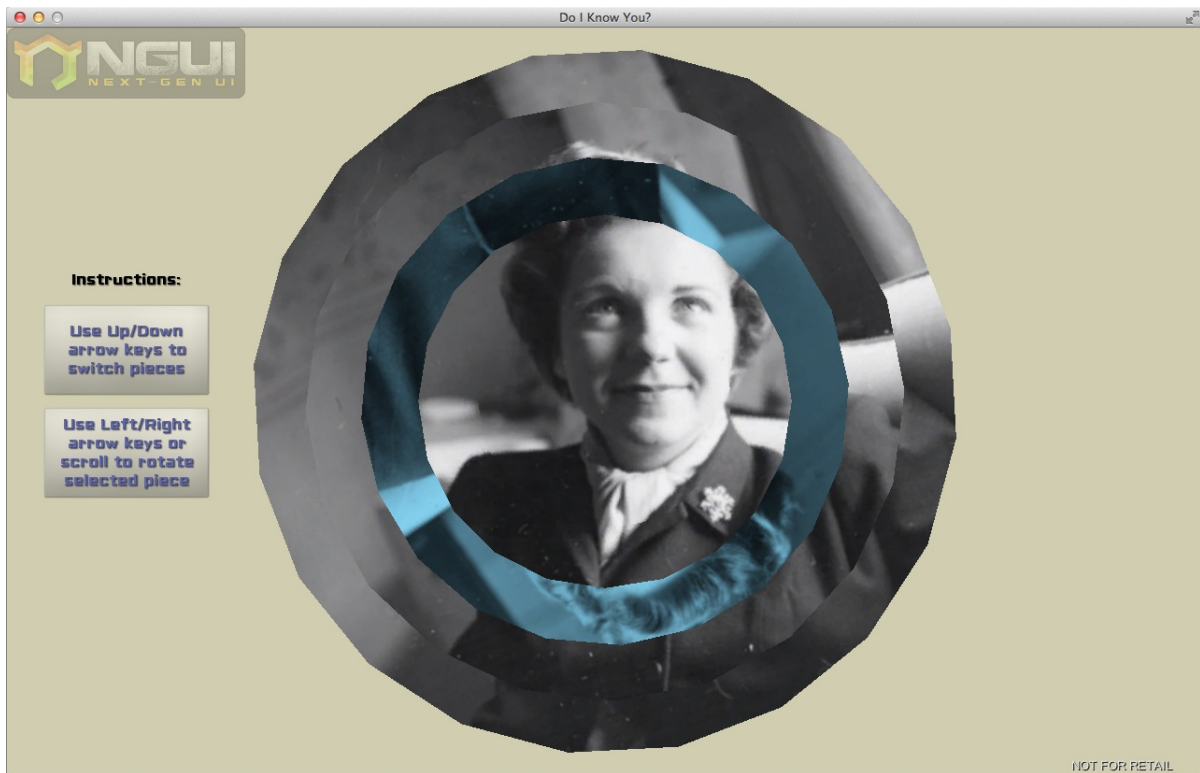


Figure 4.13: The “turn the pieces” minigame

Guess the Word Minigame

In this minigame the player has to guess which word Jane meant instead of the one she invented. For example, she might say: “I am Jane Boutwell. I came here with Jena for my *birthhour*”. The player has to guess which word Jane was referring to. When playing the game, letters of the correct word float around and the player has to click on them in the right order. Figure 4.12 shows an example of this minigame. The game is launched each time when a faulty word has been used in one of Jane’s answers, under the condition that she hasn’t used it before. Launching the game requires three arguments: *janeMessage*, the message to be displayed representing Jane’s last answer; *correctWord*, the correct word; and *faultyWord*, the faulty word that Jane used.

Turn the Pieces Minigame

This minigame was inspired by a puzzle found in Assassin’s Creed II [80]. Images are divided into different circular pieces which have been turned around randomly and in order to complete the game one has to turn the pieces into the right position to reconstruct the picture. Using the up and down arrow keys switches between pieces and the left and right arrow keys, as well as the scroll wheel, rotate the pieces. In the first version of the game, the center piece was treated as any other piece and was randomly turned around at initialization, but we decided to leave this

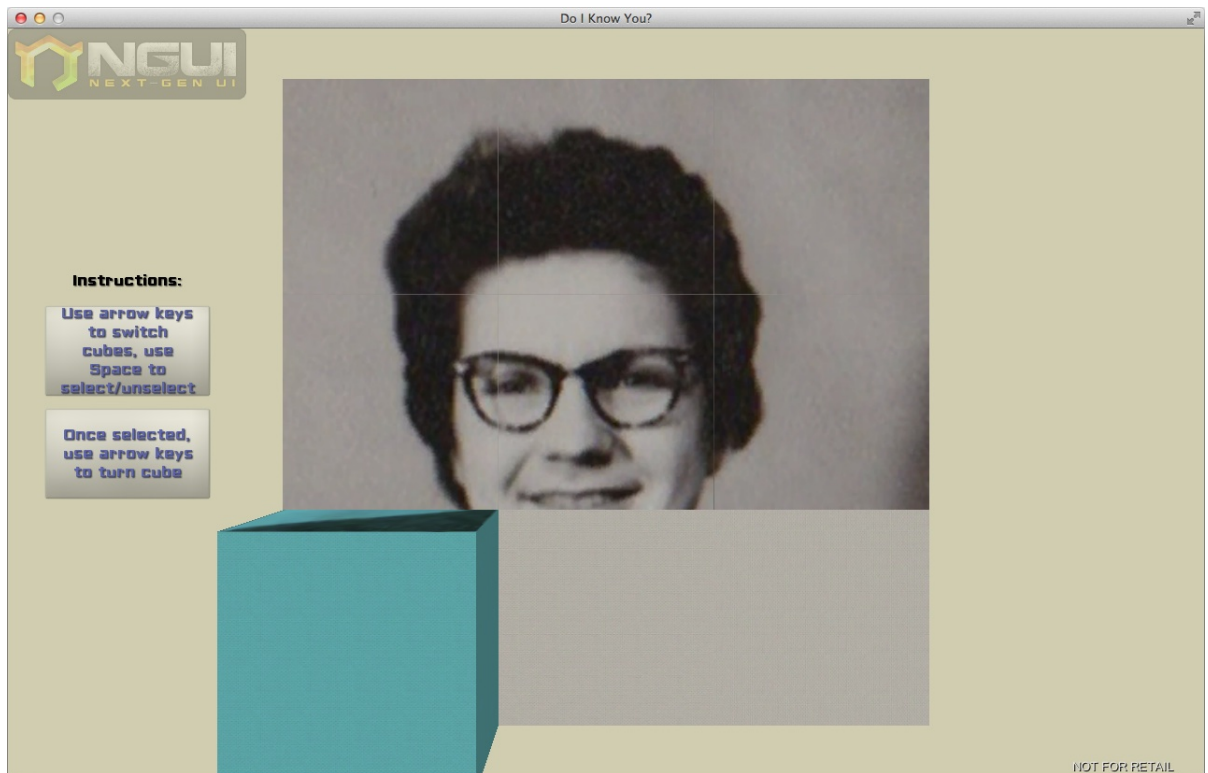


Figure 4.14: The “rotate the cubes” minigame

piece in its original position. Using one specific image for this game, it was difficult to find the correct rotation of the entire image, even if all the pieces were perfectly aligned, because all the pieces were either rotated too far to the right or too far to the left. Figure 4.13 shows an example of the “turn the pieces” minigame. Two alterations of the game have been developed using two different pictures.

Rotate the Cubes Minigame

In this minigame, players have to reconstruct an image by rotating up to 9 different cubes into the right position. Using the arrows keys, the player can select the cube to be rotated. Pressing the space bar will select the cube. The cube will then move backwards along the z-axis, nearer to the camera. The cube can now be rotated using the arrows keys and once the correct position has been found, the cube will automatically move back to its original position and the cube will be unselected. Figure 4.14 depicts an example of the “rotate the cubes” minigame. Again, two alterations of the game have been developed using two different pictures.

Ending

The ending of the game is reached after spending 6 minutes in the main screen. Combined with the minigames, the overall playtime lasts about 10 minutes. At the end of the game, the following message is displayed:

*“Suddenly, Jena, Jane’s housekeeper, returned. She had been searching for Jane’s cat. As soon as Jane saw the cat she was at happy.
Because where ever there are cats Jane feels ‘home’. The End.
Thanks for playing.”*

The ending was mainly influenced by the discussion we had at the meeting with the HCI-group (in section 4.2). We had come to the conclusion, that the ending was not that important and that what truly mattered was the act of getting there: it is all about the experience. We had also discussed that we shouldn’t care much about replay value and that the game didn’t need to be that educational. All that we wanted to achieve is to present the difficulties in communication that are caused by dementia. Therefore, we decided to implement an ending that was always going to be reached after a certain amount of time. We want players to consider the experience of getting to know Jane and discovering details about her rich past as enough of a reward. Also, every playthrough should feel a little different, and each time players should learn something new. Indeed, the core idea was that one would find out that Jane has dementia and therefore to raise awareness on the issue.

State Diagram

To provide an overview, we developed a state diagram presented in figure 4.15. It shows how the different elements of the game are linked to each other when transitions occur according to which player action.

The *Idle* state represents the time when players are in the main screen of the game. They could be occupied with reading Jane’s latest reply, deciding which option to choose next, reading information on the smartphone or looking at documents in the inventory. If 30 seconds elapse in this state, a time shift is triggered, the 3 input options change and the state changes to *Time shift Occurs*, after which the state immediately changes back to *Idle*.

If the player chooses to ask a question, it is determined whether or not this questions triggers anything or not. If the question does not trigger anything, the answer is delivered immediately and the state changes to *Answer Received*. If the answer results in Jane giving a document to the player, the state changes to *Receive Document*. Next, the document is checked, and if it is assigned to a “turn the pieces” or “rotate the cubes” minigame, the game is launched and the state changes to *Cube or Pieces Minigame*. If the minigame is completed or the document doesn’t trigger anything, the state changes to *Receive Answer*.

Now that an answer has been received, the answer is evaluated. If the answer is associated with the “guess the word” minigame, i.e. the answer contains a faulty word, the minigame is

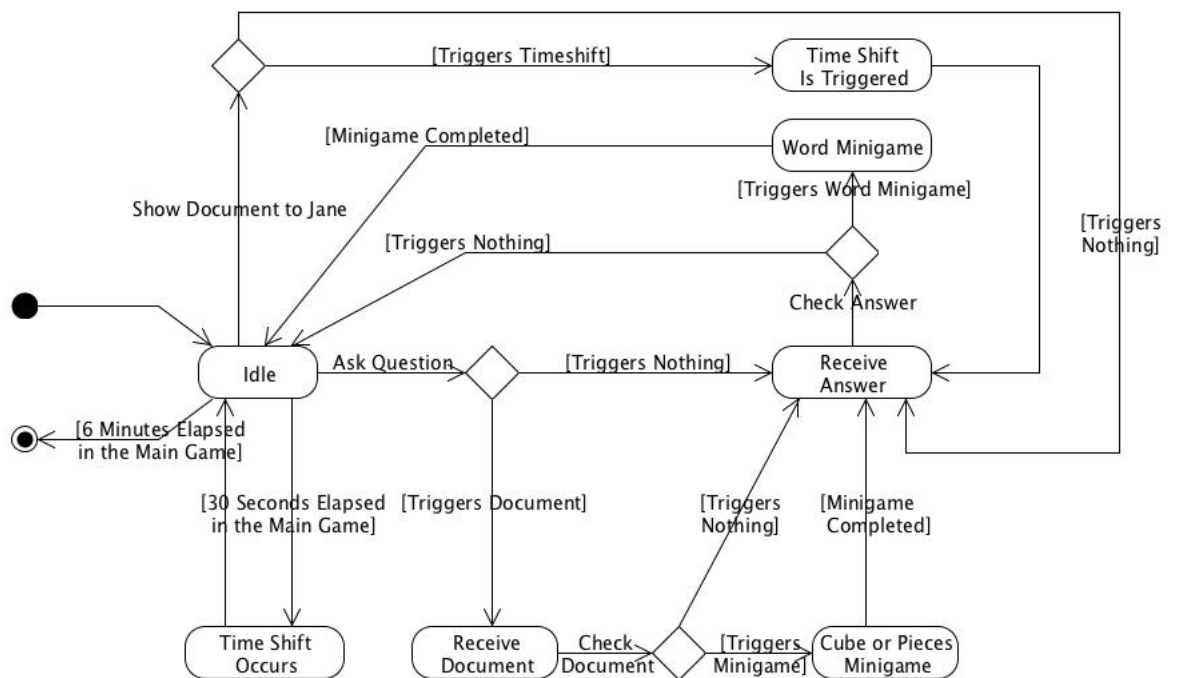


Figure 4.15: State diagram for the game.

launched and the state changes to *Word Minigame*. Otherwise, the state changes back to *Idle*. This is also the case after the minigame has been completed.

If the player chooses to show a document to Jane, it must be evaluated if the document triggers a time shift or not. If the document triggers a time shift, the state changes to *Time Shift Is Triggered*. The difference between this state and the state *Time Shift Occurs* is that this time shift has been triggered by the player whereas the other time shift is being triggered by the game itself. The state then changes to *Receive Answer*. If the document does not trigger a time shift, e.g. the document would result in Jane to return to the present but she already was in this time period, the state changes to *Receive Answer* and the player simply receives an answer.

The game ends after 6 minutes have elapsed in the *Idle* state. Since the game was meant to take about 10 minutes to complete, these 6 minutes are only counted when the player is not currently playing any of the minigames.

Evaluation and Discussion

This chapter provides an analysis of expert reviews that were provided by computer science students attending the “Explorative Design” course. The students were asked to play the game and fill out a questionnaire. 20 participants took part in the evaluation of the game. The questionnaires consisted of 12 questions and a space for additional remarks or comments. For the most part, the questionnaire had open questions with the intention of receiving extensive and useful feedback. Evaluation of the game was aimed at finding out if players had understood the core concepts of the game, what they had learnt through the game, if players enjoyed the game, what they would change about the game and any other relevant comments that they had about the game. The questionnaire can be found in appendix A.

A brief presentation was given to students before the evaluation process in order to give them some background information. We explained the origins of the idea and presented a short description of the concepts of the game. We provided participants with a link to OS X and Windows versions of the prototype. In the following two sections, we will present the results from the review (section 5.1) and proceed by discussing the results and what they mean for the prototype (section 5.2).

5.1 Results

Results indicate that 55% (11 participants) of participants either know or have someone in their family suffering from dementia and 45% (9 participants) have never know anyone with dementia. Participants that answered this question positively said that they have grandparents or close family members with dementia. One participant indicated that he or she had worked as a medic for their civil service and he or she had talked to many people suffering from dementia.

When asked how well participants know about Jane, the most of them responded that they know only a few basic facts about her and were not able to find out more in the short period of time

that it took them to complete the game. Three respondents said that they know Jane very well. One participant added: “She revealed many details of her life but there’s still some distance”. We asked participants how they would describe Jane’s ability to speak. Most of them said that she stuttered a lot, that she forgot words or misspelled them, that she jumped around between topics and that she gets confused quite often.

Most participants did not correctly interpret the blurring of Jane as her shifting away to the past. However, some did connect her changing representation to the new input options and this was often interpreted as her losing track of the topic of conversation, which is in fact true. Some people didn’t even realize that something had changed in Jane’s representation and were confused as to the changing input options. We then asked participants how they liked the interactions with the chatbot. About half of participants said that they did not like the interactions as they were confused about the changing options and Jane’s inappropriate responses. Furthermore, some participants said that the experience improved when playing the game more than once: “It occurred to me, that that’s when she loses track of the conversation we had, because at the same time when she blurred, the conversation options went back to earlier ‘story-branches’.” Participants expressed the experience as too static and would have preferred more options: “I would rather have real question or answer possibilities, and not only few words.” 3 participants said that they liked the interactions. The next question we asked was about the images in the inventory and what they were for. Almost all participants responded correctly and said that they helped her remember her past.

Furthermore, we asked participants how interesting and enjoyable the game was for them. Participants found the game more interesting than enjoyable and said that they felt that they didn’t understand the goal of the game. Regarding the minigames, some people said that they found them quite entertaining and that they offered a good variation of gameplay compared to the chatbot, while others said that they were not challenging enough. The word game in particular didn’t resonate well with players. We could not find any correlation between interest in the game and players who know someone with dementia as most players expressed an interest in the idea of the game.

Overall, participants expressed a general interest for the topic and for the game, but felt that there needed to be quite a few changes in order for them to find it compelling.

5.2 Discussion

Most of the participants expressed a general interest for the game and were motivated to play our prototype. “Very interesting topic!” and “Nice to play and interesting, since it is not a typical game” were some of the responses gathered. However, evaluation revealed that there are quite a few problems that need to be addressed for the game to provide a meaningful and enjoyable experience.

First, there was a general feeling that there was a lack of a goal. Players didn’t know what to

do or what their main challenge was. Furthermore, people expressed the desire to be rewarded with a score and an indication of how well they were doing in the game. The phone could be used as a means of presenting progress and score. Additionally, further uses for the phone could be implemented as some players didn't understand its purpose. This could include help prompts that show hints and clues to players that don't know what to do.

It was interesting to find out that a bit more than half of the total number respondents (55%) said that they know someone with dementia. Some people decided to share more details on the subject as one participant wrote: "My grandma suffers from a severe case of dementia where she doesn't even recognize her own children any more." This confirms that the growing prevalence of dementia is a serious topic and that more and more people are affected directly and indirectly by the disease. Almost all participants correctly described some of the symptoms of dementia when asked to characterise Jane's ability to speak. Respondents stated that she stuttered a lot, that she forgot words or misspelled them, that she jumped around between topics and that she gets confused quite often.

One of the key aspects of the game is discovering the rich history and depth of a person's life through interactive play. As players stated that they don't know Jane that well, they often expressed the need for more playtime in order to find out more about her. This indicates that the playtime of 10 minutes was not enough time for them to get to know her properly. Some players indicated that they had played the game multiple times and it helped in this regard. They also had a lot of trouble communicating with Jane, which they mainly associated with her having trouble to keep track of the conversation. Indeed, communication with people with dementia can be frustrating, a sensation that we tried to reproduce in the game. As a result, the interactions with Jane were not perceived as fun or entertaining. As one participant stated: "I liked the 'adventurous' touch of raising questions and digging into more details. However, it was difficult to uncover the supposed interaction." Also, some players started to doubt that everything Jane told them was correct. For instance, one respondent said: "She also told me about a job at the CIA, but I don't believe her."

Another participant stated: "You grow a certain empathy mainly because of the pictures in the inventory. But it's really hard to grow a relationship to her because of the displayed image of her." A more elaborate representation of the virtual character as well as a more streamlined user interface might improve the atmosphere in the game. Inspiration can be taken from games presented in section 3.6, although it should be noted that a lot of resources need to be allocated for the presentation of virtual characters in games. Indeed, graphical fidelity was not a priority during game development, but this area will be addressed in future work.

The element of fun was not perceived by all participants. Indeed, this represented one of the main challenges during development. The "guess the word" had no great entertainment value, whereas the "rotate the cubes" and "turn the pieces" games mainly resulted in positive responses. Players expressed that they would have liked more minigames of the same kind, and more challenging minigames. This could be achieved by placing a time limitation on minigames. One

participant presented an idea for a minigame, where one has to find out if Jane was lying or not. Another said that he would have liked a game where the goal is to rearrange words in a sentence so that they make sense. Furthermore, the possibility to skip minigames was also requested.

In conclusion, participants liked the idea for the game, but pointed out the importance of the entertainment aspect in serious games. Overall, respondents said that if the necessary changes would be made, they could see the potential in the game: "Through some polishing I think the game could look nice and have a definitive informational impact.". As almost all respondents correctly described the symptoms of dementia observed on Jane, the main objective of the game, raising awareness on dementia, ultimately prevailed. The main challenge lied in providing an enjoyable experience while trying to convey how frustrating it can be to speak to a person with dementia. This evaluation suggests that the element of fun is essential for a serious game to be successful.

Conclusion and Future Work

The goal of this thesis was to design a serious game for dementia awareness. This work describes all the steps that were involved in creating a concept for the game as well as how *Do I Know You?* prototype was developed. This thesis is divided into 5 main chapters.

Chapter 1 gave a short introduction into the motivations behind this work and formulated the problem statement. We gave a brief overview of the expected results of this work and described the relationship with Media Informatics.

In chapter 2, we presented all relevant information on dementia. We explained that dementia is a syndrome which affected 35.6 million people in 2011 and that it is becoming one of the main challenges that our society has to face due to people having longer life expectancies. The symptoms of dementia include impairments of judgement, reasoning, problem solving skills, learning capacity, comprehension, calculation and in impairments in language, communication and social skills, which often result in changes in personality. We have seen, that there is an early, middle and late stage of dementia and the effects of the condition increase from one stage to the next. People with dementia tend to “live in the past” as they relive moments of their past as if they were truly there and this has great consequences on their behaviour. The most common type of dementia is Alzheimer’s Disease (AD) and other types include Vascular Dementia (VaD), Frontotemporal Dementia (FTD), Dementia with Lewy Bodies (DLB) and Dementia in Parkinson’s Disease. There is currently no cure and no treatment that prevents or slows down the progression of the disease. Therefore, people with dementia are even more dependent on the people surrounding them. We presented the *Common Core Principles for Supporting People with Dementia*, discussed communication therapies such as *validation therapy* and *reminiscence therapy* and offered an insight into a new approach for care in the dementia village. Next, we discussed the impact of dementia and its effects on the family carers, which are often described as “hidden patients”. Dementia is also referred to as a “family disease” and relationships are bound to change. We continued by reviewing the public understanding of dementia. The general public often associates the symptoms of dementia with the natural part of ageing, people

do not recognize the symptoms associated to dementia and they also don't understand the risks factors that often lead to dementia.

In chapter 3, we discussed the global rise of games, and in consequence of serious games, and discussed the wide variety of applications that games can be used for. We presented various different definitions for serious games and stated that a clear distinction from other game types can not always be made. We concluded that the definition used depends on different perspectives and interests. Next, we discussed the impact of serious games and explained their effectiveness. Therefore, we presented the relationships between play and learning and concluded that all types of play are learning and all types of learning are play. Fun is an important element in serious games as the entertainment aspect is essential for effective learning. The Input-Process-Outcome Model takes into consideration extrinsic and intrinsic motivations for learning and argues that the *game cycle* is the most important aspect of learning in games, closely related to the concept of *flow*. Positive outcomes of games can be cognitive skills, motor skills, affective learning outcomes and communicative learning outcomes. Player types for serious games for dementia can be categorized into: potential patients, patients, public and professionals. Serious games for dementia awareness are rare, and research in this area is non existent, but we presented a few examples: *Alz*, the *Virtual Dementia Experience*, *Into D'mentia* and the *Virtual Dementia Tour*. Serious games for dementia care have the goal to improve the quality of care and train caring professionals to give them the tools they need to provide better support for people with dementia. The game *Hazel Court* was presented as an example. There are a large number of serious games for dementia prevention and rehabilitation, such as *Lebensnetz*, aimed at maintaining and increasing the mental, physical and social health and well being of people with dementia. Finally, we discussed chatbots in serious games. Serious games can be used to practice communication skills through conversations in the game. These conversations can have various objectives such as: get the player to know different types of conversational partners, get the player to learn and effectively use different conversational strategies, and let the player experience how the partner and the course of the conversation is affected by different communication styles. Examples that use various types of CAs for different objectives are: *Project Milo*, *Façade*, *EmoEmma* and *Scenejo*.

In chapter 4, we described the game development process for the prototype of the *Do I Know You?* game. Inspiration for the game came from various sources. The original concept was developed by a writer and game designer who's relative was diagnosed with dementia a few years ago. Further inspiration came from the game *Lebensnetz*, a platform which enables elderly users to collect, organize and share memories, as well as from the game *Passage*, a 5 minute art game about life, death, the passage of time in which every playthrough is a little different. Game conception took place in various meetings, where to core concept of the game was developed. Mockups and rapid prototyping were used to create and test different ideas. We discussed the importance of content creation for the game and what challenges we faced. The main part of this chapter consisted of the prototype showcase. The prototype features a chatbot that represents a person with dementia. The player can interact with the chatbot using three different input buttons, as well as images collected throughout the game. Three different minigames were de-

veloped in order to provide some variation to the game and to create a fun experience.

In chapter 5, the game prototype was evaluated by students of computer science. 20 participants played the game and completed a questionnaire in form of expert reviews. Evaluation showed, that overall, motivation of players was present, but the game still has a series of problems that need to be addressed. Participants liked the idea for the game, but pointed out the importance of the entertainment aspect in serious games. As almost all respondents correctly described the symptoms of dementia observed on Jane, the main objective of the game, raising awareness on dementia, ultimately prevailed.

Future work

During development of the *Do I Know You?* prototype we encountered various challenges and problems that we would like to mention briefly. As talking to someone with dementia can be quite frustrating, creating a fun experience based on the idea of communicating with someone suffering from the condition while trying to maintain a realistic representation of the symptoms can be quite challenging. Content creation emerged one of the main areas that we struggled with. Feeding the AI database with enough content for a 10 minute prototype proved quite difficult. Furthermore, providing a fun experience when the main part of the game is text based requires a lot of effort.

Based on feedback from evaluation, it is clear that there are quite a few areas of the game that need to be improved. The following list represents features of the game that need improvement or that need to be added in future work:

Content Additional database content needs to be added to the game in order to provide a longer gaming experience. Furthermore, existing content needs to be improved in order to provide better and more understandable input options and remove unintentional spelling mistakes.

Minigames Additional, more diverse minigames need to be added to the game in order to improve the element of fun in the game. Furthermore, minigames need to have certain time limit to be completed and an option to skip minigames should be made available. The “guess the word” minigame should be improved or removed. The following list of minigames ideas could be implemented in future versions of the game:

Is Jane Lying? A minigame where the player has to guess if Jane is telling the truth or not. By guessing correctly, players are rewarded with points and loose points otherwise.

This doesn’t make any sense! A minigame where the player has to rearrange words in a sentence so that they make sense.

Complete the sentence A minigame where players have to complete Jane’s sentences.

Memory A minigame based on memory with the pictures that have already been collected.

Where is Jane? This idea has already been implemented but was not included in the prototype. Players could be challenged to find Jane on a picture with many different people on it and they would only have a very short time period to succeed.

The globe This idea was presented in section 4.2. The minigame consists of a globe where players would have to guess which countries Jane has visited during her lifetime according to the information collected up to this point and receive points for each correct pick.

Score/Points Award points in the game. The faster a player completes a minigame, the more points are awarded to him. Points can also be distributed for every document that has been collected, motivating players to find as many pictures as possible.

Levels Add different levels to the game. These could be represented by different location settings. Progression would be indicated by advancing to the next level. One could only advance to the next level if a specific key fact has been revealed.

User Interface Polish the overall user interface for a better experience. This includes making more options available for players to choose from, such as options to contradict or to reaffirm Jane or allowing players to type full sentences, and providing a more realistic representation of Jane in the game. A character model could replace the current version and animations could make her more lifelike. Visualization of time shifts needs to be improved. Time shifts should not occur while players are spending time in the inventory. Furthermore, a specific screen area should be dedicated at depicting the current location or level. This area can also serve to better indicate Jane's time shifts. For instance, the view of the current location could be overlayed with a depiction of the time and location where her mind has wandered of to.

Phone Add more functionality to the phone. The phone could be used to show instructions or help prompts, display player progress and points. It could also include a scanning device to scan documents in order to reveal additional clues.

Sound Effects and Music Although they are not an integral part of the gameplay experience, sound effects are a feature that we would like to implement in future versions of the game as they do play an important role when interacting with specific elements. For instance, Jane's emotional state can be represented with different sound effects such as laughing, humming, groaning, screaming or sighing. Music can play an important role and add a sense of immersion. For example, a relaxing song could be played during the main part of the game when players are talking to Jane and analysing documents, whereas a fast pace, more entertaining song could be played during minigames.

List of Acronyms

AD Alzheimer's Disease

AI Artificial Intelligence

CA Conversational Agent

DLB Dementia With Lewy Bodies

DGBL Digital Game Based Learning

FTD Frontotemporal Dementia

HCI Human-Computer Interaction

NPC Non Player Character

PD Parkinson's Disease

VaD Vascular Dementia

VR Virtual Reality

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Questionnaire

Do I Know You? Game

The “Do I know You?” game prototype was developed by Sebastian Czekierski-Werner and Daniela Ramsauer as part of their master thesis on raising awareness of dementia with serious games. The purpose of the game is for players to develop empathy and an understanding for people with memory loss. In order to see if we achieved our goal, we would be very interested in hearing what you think of our prototype and we hope to gain valuable feedback on things we need to work on or change and how we can provide a better experience. After playing the game, please answer following questions:

- What characterizes Jane’s speech?
- What do you know about Jane’s life?
- How well do you know Jane?
- What happens to Jane, if she blurs out?
- How did you like the interaction with the Jane chatbot?
- What are the images in the inventory for?
- How interesting was the game for you?
- How enjoyable was the game for you?
- How did you like the mini games?
- What would you change about the game?
- Did you learn anything new about dementia you didn’t know before?

- Have you ever known anyone with dementia?
- Additional Remarks, Comments:

Bibliography

- [1] Façade. <http://www.interactivestory.net/>. Last visited: April, 15th 2014.
- [2] Hogeweyk care village. <http://dementiavillage.com/en/kenniscentrum/>. Last visited: March, 25th 2014.
- [3] Into D'mentia. <http://intodmentia.com/>. Last visited: December, 7th 2013.
- [4] Stencyl jam 2014. <http://www.newgrounds.com/collection/stencyljam2014>.
- [5] Norman Alm, Richard Dye, Gary Gowans, Jim Campbell, Arlene Astell, and Maggie Ellis. A communication support system for older people with dementia. *Computer*, 40(5):35–41, 2007.
- [6] Alzheimer's Association. Frontotemporal dementia (ftd). <http://www.alz.org/dementia/fronto-temporal-dementia-ftd-symptoms.asp>. Last visited: March, 28th 2014.
- [7] Alzheimer's Association. What is dementia. <https://www.alz.org/what-is-dementia.asp>. Last visited: March, 30th 2014.
- [8] Alzheimer's Australia. Therapies & communication approaches. <http://www.fightdementia.org.au/services/therapies--communication-approaches.aspx>. Last visited: April, 11th 2014.
- [9] Alzheimer's Australia Vic. <http://www.fightdementia.org.au/victoria.aspx>. Last visited: December, 7th 2013.
- [10] Alzheimer's Disease International. Dementia statistics. <http://www.alz.co.uk/research/statistics>. Last visited: April, 2nd 2014.
- [11] Alzheimer's Society. The dementia guide: Treatments. http://www.alzheimers.org.uk/site/scripts/documents_info.php?documentID=2231&pageNumber=2. Last visited: April, 11th 2014.

- [12] Alzheimer's Society. The later stages of dementia. http://www.alzheimers.org.uk/site/scripts/documents_info.php?documentID=101, 2012. Last visited: March, 31th 2014.
- [13] Sander Bakkes, Ellis Bartholomeus, Thomas Geijtenbeek, Jacco van Uden, and Sabine Wildevuur. *PLAY ON - Serious Gaming for Future Seniors*. STT Netherlands, Study Centre for Technology Trends, 2012.
- [14] Jose Luis Bayo-Montón, Carlos Fernández-Llatas, Juan-Miguel García-Gómez, and Vicente Traver. Serious games for dementia illness detection and motivation: The emotiva experience. In *III Workshop on Technology for Healthcare and Healthy Lifestyle, 2011*, 2011.
- [15] Francesco Bellotti, Riccardo Berta, Alessandro De Gloria, and Elisa Lavagnino. Towards a conversational agent architecture to favor knowledge discovery in serious games. In *ACE '11 Proceedings of the 8th International Conference on Advances in Computer Entertainment Technology*, 2011.
- [16] Francesco Bellotti, Bill Kapralos, Kiju Lee, Pablo Moreno-Ger, and Riccardo Berta1. Assessment in and of serious games: An overview. *Advances in Human-Computer Interaction - Special issue on User Assessment in Serious Games and Technology-Enhanced Learning*, 2013, 2013.
- [17] Richard Blunt. Do serious games work? results from three studies. *eLearn*, 2009(12), 2009.
- [18] Ernst Bohlmeijer, Marte Roemer, Pim Cuijpers Phd, and Filip Smit. The effects of reminiscence on psychological well-being in older adults: a meta-analysis. *Aging & Mental Health*, 11(3):291–300, 2007.
- [19] Bruno Bouchard, Frédérick Imbeault, Abdenour Bouzouane, and Bob-Antoine J. Menelas. Developing serious games specifically adapted to people suffering from alzheimer. In *SGDA'12 Proceedings of the Third international conference on Serious Games Development and Applications*, pages 243–254, 2012.
- [20] Michelle S. Bourgeois and Ellen Hickey. *Dementia: From Diagnosis to Management - A Functional Approach*, pages 20–30. Psychology Press, 2009.
- [21] Johannes Breuer and Gary Bente. Why so serious? on the relation of serious games and learning. *Eludamos, Journal for Computer Game Culture*, 4(1):7–24, 2010.
- [22] Bundesministerium für Gesundheit (Germany). Leben mit demenz. <http://www.bmg.bund.de/pflege/demenz/leben-mit-demenz.html>. Last visited: March, 26th 2014.
- [23] Bupa Care Services. Caring for someone living with dementia. Last visited: March, 26th 2014.

- [24] Alessia Cadamuro and Valentijn Visch. What remains ?: A persuasive story telling game. In *Proceedings of the 3rd european conference on gaming and playful interaction in health care*, pages 153–160, 2013.
- [25] Suzanne Cahill, Eamon O’Shea, and Maria Pierce. Future dementia care in ireland - sharing the evidence to mobilise action, 2012.
- [26] Dylan Carter. Alz. <http://www.newgrounds.com/portal/view/634905>. Last visited: April, 7th 2014.
- [27] Fred Charles, David Pizzi, Marc Cavazza, Thurid Vogt, and Elisabeth André. Emoemma: Emotional speech input for interactive storytelling. In *AAMAS ’09 Proceedings of The 8th International Conference on Autonomous Agents and Multiagent Systems*, volume 2, pages 1381–1382, 2009.
- [28] Richard Clark. Learning from serious games? arguments, evidence, and research suggestions. *Educational Technology*, 47:56–59, 2007.
- [29] Cathleen Connell, Mary Janevic, and Mary Gallant. The costs of caring: Impact of dementia on family caregivers, 2001.
- [30] Thomas M. Connolly, Elizabeth A. Boyle, Ewan MacArthur, Thomas Hailey, and James M. Boyle. A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education*, 59(2):661—686, 2012.
- [31] Mihaly Csikszentmihalyi. *Flow: The psychology of optimal performance*. Cambridge University Press, 1990.
- [32] Stuti Dang, Amit Badiye, and Geetanjali Kelkar. The dementia caregiver—a primary care approach. *Southern Medical Journal*, 101(12):1246–1251, 2008.
- [33] Karel Van den Bosch, Arjen Brandenburgh, Tijmen Joppe Muller, and Annerieke Heuvelink. Characters with personality! In *IVA’12 Proceedings of the 12th international conference on Intelligent Virtual Agents*, pages 426–439, 2012.
- [34] Department of Health (United Kingdom). Common core principles for supporting people with dementia - a guide to training the social care and health workforce. <https://www.gov.uk/government/publications/common-core-principles-for-supporting-people-with-dementia>, June 2011. Last visited: March, 31th 2014.
- [35] Lorraine Hopping Egan. Do i know you? (design doc). http://www.hoppingfun.com/files/Do_I_Know_You_game.doc. Last visited: April, 16th 2014.
- [36] Lorraine Hopping Egan. Hopping fun creations. <http://www.hoppingfun.com/>. Last visited: April, 16th 2014.

- [37] Natasha Egan. Virtual dementia experience for aged care workers. <http://www.australianageingagenda.com.au/2013/10/24/virtual-dementia-experience-for-aged-care-workers/>. Last visited: December, 7th 2013.
- [38] Luciano Gamberini, Francesco Martino, Bruno Seraglia, Anna Spagnolli, Malena Fabregat, Francisco Ibanez, Mariano Alcaniz, and Javier Montesa Andrés. Eldergames project: An innovative mixed reality table-top solution to preserve cognitive functions in elderly people. In *HSI'09 Proceedings of the 2nd conference on Human System Interactions*, pages 161–166, 2009.
- [39] Rosemary Garris, Robert Ahlers, and James E. Driskell. Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33(4), 2002.
- [40] James Paul Gee. *What Video Games Have to Teach Us About Learning and Literacy*. Palgrave Macmillan, 2003.
- [41] Andrew Goldfarb. Gta 5 has shipped 32.5 million copies. <http://www.ign.com/articles/2014/02/03/gta-5-has-shipped-325-million-copies>, February 2014. Last visited: April, 2nd 2014.
- [42] Google. Glass. <http://www.google.com/glass/start/>.
- [43] Victoria Guillén-Nieto and Marian Aleson-Carbonell. Serious games and learning effectiveness: The case of it's a deal! *Computers & Education*, 58(1), 2012.
- [44] Stefan Göbel, Sandro Hardy, Viktor Wendel, Florian Mehm, and Ralf Steinmetz. Serious games for health – personalized exergames. In *MM '10 Proceedings of the international conference on Multimedia*, 2010.
- [45] Home Instead Senior Care. Virtual dementia tour - your window into their world... <http://www.homeinstead.com/391/LEARNINGCENTER/Pages/VirtualDementiaTour.aspx>. Last visited: March, 25th 2014.
- [46] Johan Huizinga. *Homo Ludens: Study of the Play Element in Culture*. Routledge & Kegan Paul Ltd, 1949.
- [47] Dan Hurley. 'village of the demented' draws praise as new care model. *Neurology Today*, 12(10):12–13, 2012.
- [48] IJsfontein. Into d' mentia (english). <https://www.youtube.com/watch?v=ToCR8zZXxwC>, 2013. Last visited: April, 7th 2014.
- [49] Raph Koster. A theory of fun. <http://www.theoryoffun.com/theoryoffun.pdf>. Last visited: April, 5th 2014.

- [50] Stuart E. Lacy, Michael A. Lones, and Stephen L. Smith. Characterisation of movement disorder in parkinson's disease using evolutionary algorithms. In *GECCO '13 Companion Proceedings of the 15th annual conference companion on Genetic and evolutionary computation*, pages 1479–1486, 2013.
- [51] Shani A. Langdon, Andrew Eagle, and James Warner. Making sense of dementia in the social world: A qualitative study. *Social Science & Medicine*, 64(4):989—1000, 2007.
- [52] Lionhead Studios. Project milo. <http://www.ign.com/games/milo-138200/xbox-360-14354412>. Last visited: March, 4th 2014.
- [53] Minhua Ma, Andreas Oikonomou, and Lakhmi C. Jain. Innovations in serious games for future learning. In Minhua Ma, Andreas Oikonomou, and Lakhmi C. Jain, editors, *Serious Games and Edutainment Applications*. Springer, 2011.
- [54] Jaime Garcia Marin, Karla Felix Navarro, and Elaine Lawrence. Serious games to improve the physical health of the elderly: A categorization scheme. In *CENTRIC 2011, The Fourth International Conference on Advances in Human-oriented and Personalized Mechanisms, Technologies, and Services*, 2011.
- [55] Tiago Martins, Vitor Carvalho, Filomena Soares, and M. Fatima Moreira. Serious game as a tool to intellectual disabilities therapy: Total challenge. In *SEGAH '11 Proceedings of the 2011 IEEE 1st International Conference on Serious Games and Applications for Health*, pages 1–7, 2011.
- [56] Michael Mateas and Andrew Stern. Façade: An experiment in building a fully-realized interactive drama. Game Developers Conference GDC'03, 2003.
- [57] Simon McCallum and Costas Boletsis. A taxonomy of serious games for dementia. In *Proceedings of the 3rd european conference on gaming and playful interaction in health care*, pages 219–232, 2013.
- [58] Simon McCallum and Costas Boletsis Gjøvik. Dementia games: A literature review of dementia-related serious games. In *4th International Conference on Serious Games Development and Applications (SGDA)*, volume LNCS 8101, pages 15–27, 2013.
- [59] David Michael and Sandra Chen. *Serious Games: Games That Educate, Train, and Inform*. Thomson Course Technology, 2006.
- [60] Microsoft. Kinect. <http://www.xbox.com/en-US/Kinect>. Last visited: March, 4th 2014.
- [61] National Health Service (UK). How is dementia treated? <http://www.nhs.uk/Conditions/dementia-guide/Pages/dementia-treatment.aspx>. Last visited: April, 11th 2014.
- [62] Nintendo. Metroid prime trilogy. <http://www.nintendo.de/Spiele/Wii/Metroid-Prime-Trilogy-282035.html>. Last visited: March, 1st 2014.

- [63] Christopher Nolan. Memento (2000). <http://www.imdb.com/title/tt0209144/>. Last visited: March, 1st 2014.
- [64] Ovos Media GmbH. Lebensnetz. <http://lebensnetz.at/>. Last visited: March, 1st 2014.
- [65] Seymour Papert. Does easy do it? children, games, and learning. *Game Developers Magazine*, 5(6):88, 1998.
- [66] David Pizzi and Marc Cavazza. Affective storytelling based on characters' feelings. In *AAAI Fall Symposium on Intelligent Narrative Technologies*, pages 110–117, 2007.
- [67] Lucas Pope. Papers please. <http://papersplea.se/>. Last visited: March, 1st 2014.
- [68] Genaro Rebollendo-Mendez, Katerina Avramides, Sara De Freitas, and Kam Memarzia. Societal impact of a serious game on raising public awareness: the case of floodsim. In *Sandbox '09 Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games*, pages 15–22, 2009.
- [69] Ute Ritterfeld, Michael Cody, and Peter Vorderer, editors. *Serious Games: Mechanisms and Effects*. Routledge, 2009.
- [70] Jason Rohrer. Passage. <http://hcssoftware.sourceforge.net/passage/>. Last visited: March, 1st 2014.
- [71] Second Wind Dreams. Virtual dementia tour. <http://www.secondwind.org/virtual-dementia-tour/>. Last visited: December, 7th 2013.
- [72] Dave Singleton. Take the virtual dementia tour - a journey toward understanding and empathy for caregivers and family members. <http://www.nextavenue.org/article/2013-08/take-virtual-dementia-tour>. Last visited: March, 25th 2014.
- [73] Anja Sisarica, Neil Maiden, Dalia Morosini, Lucia Panesse, Kevin Pudney, and Malcolm Rose. Creativity support in a serious game for dementia care. In *C&C '13 Proceedings of the 9th ACM Conference on Creativity & Cognition*, 2013.
- [74] Alexander Sliwinski. Call of duty: Black ops 2 sales reach \$1 billion in 15 days. <http://www.joystiq.com/2012/12/05/call-of-duty-black-ops-2-1-billion/>. Last visited: April, 2nd 2014.
- [75] Andrew J. Stapleton. Serious games : Serious opportunities. In *Proceedings of the 2004 Australian Game Developers' Conference*, 2004.
- [76] Elisabeth Steinhagen-Thiessen and Bert Hanke. *Neurogeriatrie auf einen Blick*, pages 4–83. Georg Thieme Verlag, 2003.
- [77] Tarja Susi, Mikael Johannesson, and Per Backlund. Serious games – an overview. Technical report, School of Humanities and Informatics - University of Skövde, 2007.

- [78] Wai Jia Tan, Philip Yap, Song-lee Hong, Nan Luo, and Tong Jen Lo. The lay public's understanding and perception of dementia in a developed asian nation. *Dementia and Geriatric Cognitive Disorders Extra*, 2(1):433–444, 2012.
- [79] Tasharen Entertainment Inc. Ngui: Next-gen ui kit. http://www.tasharen.com/?page_id=140. Last visited: April, 16th 2014.
- [80] Ubisoft Entertainment. Assassin's creed ii. <http://assassinscreed.ubi.com/en-us/games/assassins-creed-2/index.aspx>. Last visited: March, 1st 2014.
- [81] Unity Technologies. Unity3d. <https://unity3d.com/unity>. Last visited: April, 16th 2014.
- [82] Peter van Rosmalen, Johan Eikelboom, Erik Bloemers, Kees van Winzum, and Pieter Spronck. Towards a game-chatbot: Extending the interaction in serious games peter. In *Proceedings of the European Conference on Games Based Learning*, 2012.
- [83] Sebastian Weiss, Wolfgang Müller, Ulrike Spierling, and Florian Steimle. Scenejo – an interactive storytelling platform. In *ICVS'05 Proceedings of the Third international conference on Virtual Storytelling: using virtual reality technologies for storytelling*, pages 77–80, 2005.
- [84] World Health Organization. Fact sheet about dementia. <http://www.who.int/mediacentre/factsheets/fs362/en/>. Last visited: December, 7th 2013.
- [85] World Health Organization and Alzheimer's Disease International. Dementia: a public health priority, 2012.
- [86] Pieter Wouters, Erik D. van der Spek, and Herre van Oostendorp. Current practices in serious game research: A review from a learning outcomes perspective. In Thomas Connolly, Mark Stansfield, and Liz Boyle, editors, *Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces: Techniques and Effective Practices*. Information Science Reference, 2009.