Using Virtual Agents to Bridge the Dutch Digital illiteracy Gap

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ABSTRACT

The rapid pace of digitization is causing digital exclusion of several groups in society. Whereas the Dutch government is increasingly digitizing its current services, many citizens experience difficulties with online tasks. This holds especially for low literate people, digital illiterates, non-native Dutch speakers and elderly people. The focus of this study is on the simplification of online forms by using a virtual agent. By means of an iterative, user-centered design approach, a virtual agent was designed, built and tested among three different user groups who experience difficulties with online tasks. The study revealed new user-requirements to improve the accessibility of online forms. Furthermore, it shows how a user-centered, collaborative, iterative, adaptive design approach can lead to better digital service, and increasing digital inclusion of citizens who are not able to cope with the digitization.

KEYWORDS

Digital Divide, virtual agents, online government forms, digital illiteracy, low literacy, ICT4D, iterative-adaptive design, user-requirements, digital inclusion.

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1. Introduction

The Dutch government is increasingly digitizing government services as part of a specifically designed strategy 'Nederland Digitaal' (Dutch digitalization strategy) that is used to lead the nation's digitalization process. The Dutch government website even explicitly mentions to be the number one on the digital forefront in Europe[1]. Despite the ambitious strategy, various groups of people lag behind in becoming digitally engaged. Common terminology for this actuality is digital exclusion, which was already being researched in the beginning of the internet era in 2002 by Servon[2]. In recent years the digital exclusion, or also referred to as the digital divide, gained more attention among researchers and governments. In 2016, the Dutch government asked the 'Sociaal Cultureel Planbureau', a scientific governmental institute, to conduct a large scale research regarding the future of the Dutch citizens. This research highlighted the transformation to a digital society and showed the importance of digital skills for social inclusion[3]. As follow-up, the municipality of Amsterdam conducted a research 'De bouwstenen voor digitale inclusie' (Building blocks for digital inclusion), in which the digital divide of Amsterdam was investigated. The research outlined various digitally excluded groups with the help of interviews and real life examples, and provided specific recommendations based on those use cases[4]. The municipality transformed these recommendations into projects like 'the DigiChallenge' and 'Digimaatjes' (DigiBuddy's) in order to tackle the digital exclusion, and to create a complete digitally engaged Amsterdam among all citizens.

One of the most excluded groups that are having difficulties with digitized forms are low literate people. Research shows that 1.3 million Dutch citizens are classified as low literate, of which 300.000 with very poor reading-, writing- or digital skills. Respectively that is 11,9 and 2,6 percent of the entire Dutch population[5]. A high percentage of this group also experiences difficulties in other functional areas such as calculus, problem solving skills and internet usage. Since most information on the Internet is textual information, other than operational skills like handling a computer, one also requires informational skills to be able to judge various types of information on their relevance and reliability[6].

Due to the digitization of society, low literate people frequently experience difficulties with digitized forms, online banking, or finding an online route description. LostLemon, a research organization in the social domain that develops IT-tools for municipalities, conducted a research among low literate people regarding their perception towards digital forms. The research outlined several barriers that are experienced by low literates when operating in a digital environment; (i) anxiety in making errors that result in judicial or financial consequences, (ii) forms are experienced as not personal, (iii) webpages contain too much textual information on a dense area, (iv) user interfaces are complex and crowded with unclear symbols[7]. In collaboration with TNO, The Netherlands Organisation for applied scientific research, LostLemon developed 'Toegankelijke Formulieren' (accessible forms), in which a digitized form was improved to the needs of low literate citizens by using co-design and design guidelines created by TNO. Although the research and the guidelines are supportive in improving the lay-out of digitized forms, research in this domain is yet scarce. Furthermore, there is

a knowledge-gap of other methods or best practices in improving digital forms that considers the needs of low literates.
Therefore, this research focuses on bridging the gap in the Dutch digital divide. This was done by investigating the implementation of virtual agents in digitized forms.

2. Literature review

Digital exclusion has been a research topic as early as the rise of the Internet. Many factors have been investigated to explain the occurrence of digital exclusion in various geographical areas or under specific demographic circumstances. There is an overall consensus among researchers of the social problematics that are accompanied with the digital divide and the ongoing increase of internet diffusion. The main challenge is that access to information technologies (IT) is not evenly spread throughout civilizations. This generates a division between the group of people who are benefiting from the considerable benefits of IT, and the group of people being excluded, leaving them in a more disadvantaged position in society[8].
The early stages of the digital divide, 1990 to 2005, were mostly defined by access-divide. Having access to a computer directly influences the ability of using the internet and being able to use its benefits. Looking at mostly socio-economic demographics such as gender, age, income and education, Colby classified the digital exclusion in terms of accessibility[9]. As addressed by Rogers, the access-divide evolved into a learning- or content-divide when internet diffusion reached a high level of maturity in many countries by the late 2000's. Especially in developed countries such as The Netherlands, digital exclusion is nowadays mainly caused by the lack of reading-, writing- or digital skills.

Literacy is one of the core skills defined by the 'Programme for the international Assessment of Adult Competencies' (PIAAC). This programme, initiated by the Organization for Economic Co-operation and Development (OECD), defines literacy as 'understanding and analyzing written language, and being able to use that information to act'. This definition is generally accepted in the Dutch public debate, and is used as benchmark in multiple reports from 'Stichting lezen en schrijven', a social organization that focusses on improving language proficiency in the Netherlands. Based on this definition, a language level of 1F or below, is classified as being low literate in the Netherlands. In other words, people who are capable in reading or writing, but do not possess 'eindniveau vmbo' or 'mbo-2/3' are considered low literate[10][11].

Much research of digital exclusion in relation to low literacy is mainly focused around health issues. Low literate patients frequently encounter difficulties when handling online dossiers or health surveys. EHealth literacy is increasingly attractive in the research domain due to its threatening character on citizens' health. "eHealth literacy is defined as the ability of people to use emerging information and communications technologies to improve or enable health and health care". A study showed that less literate eHealth patients did significantly worse in self-managing their health care. [12]. To tackle the low health literacy challenge, Bickmore et al. built a virtual agent to explain health questionnaires. They were able to do statistical analysis by testing the questionnaires with random participants. Although the results were not significant, participants indicated a slight preference for the assistance with the virtual agent in comparison to human explanation[13].

Research with a different perspective conducted by TNO, focused on the accessibility of forms by investigating the lay-out of webpages. In collaboration with the municipality of Haarlemmermeer, they developed a new design for an existing webpage on the municipality's website, 'Melding Openbare Ruimte'. The design is based on four general design principles that aims to improve user experience on usefulness, usability, desirability and persuasiveness. Furthermore, they incorporated cognitive abilities of users and specifically implemented guidelines for people with a low cognitive ability. Feedback by a test group consisting of low literate people resulted in adjustments of the municipality's webpage regarding; the order of webpages, usage of understandable language, use of visuals, avoidance of open questions and being transparent about privacy sensitive information[14].

Other research conducted by TNO, in collaboration with Cremers and the Applied University of Utrecht, was concentrated on health questionnaires in order to improve health surveys specifically to the needs of low literate people. By using co-design they developed 'Ontwerpen voor laaggeletterden' (designs for low literates), a guideline that aims to improves the user experience of low literates when using online forms. Using big font sizes, minimal usage of buttons, illustration with pictures and visuals were among the most important recommendations. Figure 1 in the Appendix provides an overview of most applicable guidelines resulted from the research[15]. Several of these guidelines will be discussed in more detail and provided guidance in the development of the prototype.

Most previous research strongly focused on the lay-out components to improve webpages for low literate people. However, new technologies, ironically as it may sound, could be helpful in developing more accessible digital forms. Virtual agents are mainly used in assisting people in completing digital tasks. They are used in a wide range of industries, from improving E-commerce to treatment for depression. Most well-known virtual agents nowadays are Siri and Google. Supported by voice-based technology they are able to guide people through basic digital tasks. These tools mainly use natural language processing, social abilities and learning techniques to offer support in information gathering or other user experiences[16]. Although voice-based technologies are supportive for low literates, research has shown that the visual presence of an agent is critical when looking at motivational and affective outcomes in particular. Hence, a voice alone containing a message delivers less significant results when that same message is communicated by using a virtually present

agent[17]. Moreover, a visually present agent in combination with human led voice, provides greater learner perceptions and increases the agent's credibility in the context of a learning environment[18].

An initiative by the municipality of Utrecht resulted in a virtual agent to support digitally unskilled citizens with difficult online forms, social service applications or their online banking. By using an interactive and approachable website, Steffie.nl, citizens are guided through application forms by a virtual assistant named Steffie. The website provides extra explanation for difficult language, and provides audio assistance to deliver extensive support to their citizens[19].

Although Steffie.nl made an important first step in supporting low literates in the digital domain, it only provides support through their webpage. Therefore, users are forced to switch between two different webpages. From Steffie.nl to obtain helpful tips, to the webpage containing the digital form. This may cause stressful situations among low literate or digitally unskilled users. Furthermore, there is a lack of documentation and design requirements that assist development of online forms to the specific needs of low literate people. Especially when these forms are augmented with virtual assistance and audio, there is little literature available that discusses guidelines or requirements.
Therefore, this study investigates the usage of a virtual agent to improve digital forms. Important to note, the content of digital forms are implemented in the virtual environment to prevent switching between webpages. Moreover, detailed process description and careful documentation of design requirements were key principles along which this study was conducted. This translates to the following design question of this Master thesis.

Design question: "How can we design a practical solution (i.e. virtual agent) to facilitate information provisioning to low literate and digital illiterate users?"

To specify the leading research question, it is important to elicit the requirements for the design of virtual agents for these focus groups. Therefore, this research investigates the following sub-question.

Sub-question: "What are the requirements of developing a virtual agent to the specific needs of low literate and digital illiterate users?"

3. Methodology

This research investigates the ability of virtual agents in guiding low literate people to complete digital forms. Based on the interviews during the context analysis and the literature review, I found it valuable to investigate the design question by developing and testing an actual prototype of a virtual agent. Consequently, I decided to perform a design science technical action research as discussed by Wieringa. The purpose of this study is to improve a societal context through the use of an artifact (i.e. the prototype). Main focus points were on understanding the context and close collaboration with key stakeholders in order to deliver the most effective result. Since the solution in design science is the design itself, it is evaluated by its utility[20]. As this study is centered around low literate people, their user feedback was important to measure the prototype's utility. I developed the prototype by using an agile methodology, which was tested among different groups of low literate people.
The practical approach of this research is augmented by a qualitative part in order to extract results. Strauss and Corbin defined qualitative research as "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification"[21]. Given that this research involved a target group that is difficult to reach, any kind of quantification of the data was not possible due to the limited amount of participants. Furthermore, qualitative research is more centered on a naturalistic approach and aims to incorporate context from real life settings[22]. Due to the practical approach used in this thesis, obtaining more in-depth information regarding the prototype provided better results than doing statistical analysis. Since user-experience feedback is invaluable in improving prototypes that use user-centered design, I was convinced that a qualitative approach would benefit the results of this research the most.
Furthermore, I structured the research by using (an adapted version of) the ICT4D 3.0 approach and framework[23]. ICT4D 3.0 is a collaborative, iterative, adaptive approach and framework for designing and building information systems targeted at marginalized groups. It consists of five stages, of which I used the following four as a guideline along which I constructed my thesis: (i) context analysis, (ii) needs assessment, (iii) use case and requirements analysis, (iv) engineering and testing. The next paragraphs specifies each individual phase and provides detailed insights in how this research was conducted.

3.1 Context analysis & needs assessment

As part of answering the research question, I found it valuable to gain a more general understanding of the digital divide in the Netherlands from various viewpoints. These different viewpoints were provided by meeting with:

- Digi Challenge Amsterdam 2018 hosted by PACT. They are striving for an inclusive digital world. They organize events to foster collaboration between municipalities, social organizations and citizens to tackle the digital divide in Amsterdam.
- Different research consultants from LostLemon, a research organization in the social domain that develops IT-tools for municipalities.
- An employee from the municipality of Amsterdam who is overseeing various projects involving low literates. Furthermore, he was an initiator of the research 'De bouwstenen voor digitale inclusie' (Building blocks for digital inclusion).

- A social worker from the organization ‘Stichting lezen en schrijven’. She is specialized in product development in the social domain with a focus on low literates.
- The creator and current administrator of Steffie.nl. A website that uses a virtual assistant that guides people in doing common digital tasks.
- Program coordinator urban practice at Hogeschool van Amsterdam. Project BOOT is a core project that specifies in language development in focus areas. Co-creation and Living Labs are key principles in their projects.

Figure 2 in the Appendix provides a detailed overview of the conducted interviews during the course of this research.

The various interviews provided interesting insights on several aspects. The challenge of dealing with digitized (government) forms is not limited to low literates, but is felt among a growing group of people such as elderly, digital illiterates or immigrants. Given the overlapping characteristics of the challenges among these various groups, I strongly believe that the findings of this study could, to a decent extent, be generalized and used in a broader context.
Other recurring insights included the novelty and growing urge of this subject. Despite intensified attention by governments and researchers, I found a lack of generally accepted best practices and reusable methods in this domain. This causes the absence of a unified nationwide approach by the Dutch government to effectively tackle the problem. Although extra budget is given to various municipalities and organizations, new projects and initiatives are often decentralized and executed on a local level.
Another recurring theme I observed, was the experienced difficulty in reaching low literate people for researching purposes or product testing. Both LostLemon and the municipality of Amsterdam expressed certain barriers that keep the target group from being easily approached. Feelings of shame and the inability to find the right support are addressed as the main causes that low literate citizens are being distant and hard to contact. Although the group of low literate people in the Netherlands is significant, the ‘Toegankelijke Formulieren’ test session conducted by LostLemon was only attended by four participants. Test sessions conducted by other social organizations have on average five to six participants. Their argument centers around the difficulty in motivating participants. Furthermore, test sessions are labor intensive due to the dependency on both participants and volunteers.
The obtained information from the interviews in combination with the literature review, provided me with enough perspective to identify the key stakeholders in this challenge. First, the government, and in particular municipalities, are a major stakeholder due to their involvement on financial level, acting as sponsors to certain organizations, as well as being directly involved with the target group through various projects. Second, organizations such as LostLemon and ‘Stichting lezen en schrijven’, who are operating and doing research in this domain, are a major stakeholder due to their direct involvement and comprehensive knowledge about low literates through practical experience. Notably, their established trust with a small group of low literates gives them a central role in, for example, testing prototypes or practice with newly developed methods. At last, low literate, digital illiterate and non-native Dutch citizens are an important stakeholder due to their involvement as end-users of prototypes, methods or projects initiated by the first two stakeholders. Furthermore, they are at the heart of the digital exclusion giving them an strong influence due to their needs.
LostLemon developed a stakeholder map with a central role for the low literates (Appendix figure 3). The map outlines all identified stakeholders and distinguishes between direct and indirect stakeholders, as indicated with a star symbol.

3.3 Third iterations requirements analysis

Requirements analysis took a central role in the design and evaluation of the prototype. Given the unknown requirements, I decided for a user-centered agile approach for the system's development, which was defined by iterative testing phases that were used to improve the prototype. This reduced the risk of spending time on development before testing against the demanded requirements[24]. The research consisted of the following iterating phases; (i) I constructed version 1.0 of the prototype by using the obtained information during the context analysis as fundament. Use cases from LostLemon and the ‘Ontwerpen voor Laaggeletterden’ were used as guidelines in constructing the prototype’s lay-out. I tested Version 1.0 among a test group consisting of non-native Dutch speaking participants. Results were obtained by observing the participants in completing the prototype, and by conducting a group interview for user-feedback. (ii) Re-engineering of version 1.0 based on the obtained user-feedback from the first test session. I converted the feedback into an initial requirements document, which was used to build version 2.0 of the prototype. Version 2.0 was tested, using a similar approach as the first test session, on a group of low literate people. I conducted a group interview to obtain user feedback on the second version of the prototype. This feedback was used to supplement the requirements document. (iii) The obtained feedback on version 2.0 formed the basis in constructing prototype version 3.0. I used Version 3.0 to validate the findings of the first two test sessions. Additionally, it was used to verify the constructed requirements in order to finalize the requirements document. At last, I compared the feedback of the different test sessions regarding the different focus groups and converted it into findings.

4. Prototype Design & engineering

Given the practical approach of this research, a central role was taken by designing and constructing the virtual agent. Having sound design criteria is necessary to give structure in a path that has many unknowns. Furthermore, being able to argue why certain choices were made is imperative to explain specific features of the system. Moreover, it is helpful to refute

uncertainties at a later stage, both for yourself as a researcher as well as to the public. When applying an iterative approach, it is important to carefully document the steps that were taken that led to the final result. Therefore, this paragraph discusses the argumentation that was used in making the design choices for the first prototype.

The specific needs of the target group directly influenced the design choices that were made when designing version 1.0 of the prototype. Since version 1.0 was used as the fundament for prototypes version 2.0 and version 3.0, its design takes a central role in this research.
The context analysis provided me with several important requirements that were used as vital elements of version 1.0. During the interviews with experts in this domain, two terms were repeatedly mentioned; (i) simplicity (ii) ease-of-use. This was also stressed by the co-inventor and current administrator of steffie.nl, "Any extra button or visual on the screen can be perceived as a distraction, keep it simple.". Accordingly, to give structure to the construction phase of the system, I divided simplicity and ease-of-use in terms of two aspects; (i) focus on appropriate lay-out for the target group, which is outlined in this paragraph (ii) focus on technical components in order to provide the right functionalities, as is discussed in paragraph '5. Engineering'.

As for the lay-out, I used several guidelines of 'Ontwerpen voor laaggeletterden', developed by TNO and Utrecht University of Applied Sciences, as design criteria. Their focus group was identical as the focus group in this study. Additionally, their research was conducted in a similar context. Consequently, many of the guidelines, in terms of lay-out, could be directly applied in version 1.0. The following guidelines were used that formed the basis for the design criteria of version 1.0:

- Simple language; use plain language and short sentences
- Minimize number of functions
- Consistent screen layout
- Show only relevant items
- Limited number of items to choose from
- One question per screen
- No progress indication
- No ''back''-function
- Relaxed atmosphere [25]

4.2 Avatar

The primary goal of the system is to guide low literate people in completing digitized forms. An important aspect to create empowerment among the user group is to develop an environment that generates comfort and trust. As addressed by Bandura "Once the visual and social presence of an anthropomorphic interface agent is established, one of the most important factors in its design as a social model, is appearance. As supported by research with humans, a social model's appearance is key to influencing another's motivation, attitude and future behaviors through directly impacting message acceptance and self-efficacy beliefs"[26]. In short, the avatar takes a central role due to its active engagement within the system, in which appearance is crucial. Its main function is to simulate human tendencies to create trust among its users and stimulate motivation. Since many low literate people experience stress when handling online forms, building a safe and comfortable environment is crucial in empowering them and boosting their confidence. The following measures were taken to create an empowering environment.
At first, I decided on a female avatar. This was mostly intuitively motivated due to the more open and relatable appearance of females in comparison to men.
Secondly, I found it important to simulate human movement to create a more natural appearance. The natural tendencies were simulated by letting the avatar blink, and by folding its left arm towards its middle. These movements were assumed to give the agent sufficient natural appearance while limiting possible distraction among users. The three different avatar appearances are displayed in figures 1, 2 and 3.
A critical aspect in a human's appearance is clothing. The program coordinator 'Urban Practice' at 'Hogeschool van Amsterdam' strongly suggested to use neutral colors, and clothing that is all-covering to make the avatar as 'general' as possible. This to include users from many different backgrounds and beliefs. As a result, I designed the avatar with a light brown turtleneck on top of a pair of blue jeans. Furthermore, the agent was given a yellow fillet as accessory to create a slight color contrast with the avatar's brown hair.
The positioning of the avatar on the screen was chosen by imitating 'Steffie.nl' in combination with intuition. Placing the avatar on the far right of the screen gives a more natural appearance. Furthermore, I perceived it as less distracting in comparison to having the avatar in the middle or on the left side of the screen. At last, it gives room to implement in-screen answering options that appear above the text window in the middle of the screen.


Figure 1. Eva_default


Figure 2. Eva_blinking


Figure 3. Eva_armfold

4.3 Name

To further enhance the agent's natural appearance, I decided to give the agent a name, Eva. It was assumed that this would enhance the approachability of the agent and that it would improve user experience. Furthermore, my intention was to add a personal tendency to the agent to generate more trust among users. Given the focus on Dutch governments forms, a typical Dutch name like Eva was found suitable. Moreover, the commonality of the name 'Eva' in the Netherlands, was used as

an advantage to address a wide range of users, both Dutch and non-Dutch people.

4.4 Background

The background has a central role in providing the appropriate environment for users. In this, comfort and trust were taken as key components in deciding for the appropriate background. Therefore, I chose an image of a grass-pitch covering the entire screen for various reasons. Research by Lee shows that the color green has a stimulating effect on humans' span of attention. Furthermore, the study showed a decrease in omission errors when participants were confronted with a green color[27]. I considered both effects helpful in creating a comfortable and stimulating environment for users. Moreover, the color green is associated with calmness and it promotes restfulness since its light consist of low wavelengths[28]. I considered these attributes as powerful factors to create a "relaxed atmosphere" as suggested in 'Ontwerpen voor laaggeletterden'. The color blue has many similar attributes as the color green and was also taken into consideration to use as format for the background. However, the grass-pitch image better accentuates the text window as well as the avatar. This creates more restfulness while also making the environment more user-friendly.

At last, to cover the 'Ontwerpen voor laaggeletterden' guideline "consistent screen lay-out", I chose to make this image the default background throughout the entire form. Figure 4 displays the full screen lay-out to visualize the aforementioned design choices.

Figure 4. Full initial screen lay-out

4.5 Form content

Since the focus of this study is on testing a virtual agent, the form content that was used in the prototype was merely seen as a means to create a functioning system. However, given the focus on Dutch governments forms and the desire to simulate a real-life online application, I chose to implement the content of a 'DigiD' application. A 'DigiD' is a Dutch digital identity. It allows citizens to safely login on Dutch government- and healthcare websites. Furthermore, a DigiD allows citizens to apply for various kinds of government services such as healthcare- or child allowance[29].

5. Technical framework

Converting the design criteria into actual system output is an important phase in which both limitations and opportunities were encountered. Especially for further research purposes or applications of this system, it is interesting to understand these limitations and opportunities. Therefore, this paragraph discusses the technical aspects of the different tools that were used in constructing the prototype.

5.1 RenPy

RenPy is a visual novel engine that allows for digitized storytelling. RenPy runs on the programming language Python, allowing it for advanced animations. The tool comes with an extensive package of default settings that is automatically provided when starting a new RenPy project. These settings are easily adjustable since it allows users to make changes in the three different default scripts; gui.rpy, options.rpy and screens.rpy. These options offer a wide variety of customization possibilities ranging from font size to placement of the in-screen text window. In addition to these default scripts, users are provided with an 'open' script, script.rpy, that is specifically used for writing code. This script allows for implementation of conversation, images or icons, sound and animations through its built-in functions like 'show' or 'play sound'.

RenPy's extensive and easy adjustable default package was a decisive factor in choosing this tool for building the prototype. Furthermore, it's accessible built-in functions delivered great benefits during the construction of all versions of the prototype. Section 2 in the appendix provides an explanation on the technicalities I used to create the natural movement. Furthermore, there is a link to the source code that is publicly available on github.

5.2 Avachara

The avatar was created by using an online character maker, Avachara. This tool allows for a wide range of animated avatar illustrations by providing numerous customization options. Furthermore, it offers a large set of default features to choose from when building an avatar. To give an impression about the amount of possibilities the tool provides; it includes 8 options for different head types, 64 options for different types of eyes, 48 options for different types of mouths, 60 options for eyebrows, 48 options for different types of nose's, and 120 options for different hair styles. On top of this, it provides numerous options for both clothing and accessories.

Although Avachara does not allow users to self-construct or customize any of the features it contains, the design criteria did not require for that level of detail. Therefore, the extensive package of default options convinced me in choosing Avachara as the avatar creator tool.

5.3 Paint 3D

After downloading the avatar from Avachara, it needed several finalizations in order to qualify for in-screen usage. I used Paint 3D to delete the avatar's background canvas. Moreover, it was used to minimize the differences between the three versions of Eva on a pixel level. Due to the self-construction limitations of Avachara, Paint 3D was used to generate the arm-fold position of Eva. Its 'magic select' function allowed for specifically selecting and shifting Eva's forearm. Afterwards, I smoothed out any inaccuracies on pixel level.

5.4 Voice Record Pro

RenPy supports three different audio formats among which mp3. Therefore, a free recording application, Voice Record Pro, was downloaded to record audio files in mp3 format. A set of earplugs was used to minimize background noise and to ensure consistent decibel levels. At last, a female voice was used to align with Eva's gender.

6. Iteratively testing & re-designing

6.1 First cycle testing & re-designing

6.1.1 Test set-up

SEZO, a social organization that offers citizens of Amsterdam Nieuw-West language- and computer courses, helped in organizing the test session. They offered to conduct the test session on a group they actively support on various aspects, including language- and computer skills.

The test session consisted of three parts; (i) a group assignment, in which participants were asked to solve language exercises (ii) individually testing the application on a computer or laptop (iii) feedback session in group context.

The participants started the application, simultaneously, in a classroom environment. Me and two volunteers were present to guide participants in case of uncertainties. During testing, the participants were observed in their progress. I made notes regarding participants' behavior, and regarding their questions. Once finished, participants held a coffee break. This time was taken to obtain feedback by informally talking to the participants. After the break, I initiated a semi-structured group interview which lasted approximately twenty minutes. The feedback in group context was chosen due to a strong group cohesion in which certain members felt more encouraged to speak up. The following questions were aimed to obtain information about the different components of the system;

- How did you experience the application?
- Was the language understandable?
- What is your opinion on Eva?
- Did Eva give you confidence in completing the application?
- Would you change anything about Eva?
- What is your opinion on the green background?
- What is your opinion about the font size?
- What would you improve about the application?
- Would you use this system rather than current online forms?

6.1.2 Test group

The group consisted of nine male participants. All participants were part of a program named 'Gouden mannen'. This program focusses on reintegrating socially isolated middle-aged men in Amsterdam Nieuw-West[30]. All of the participants have a migration background and are non-native Dutch speakers. The language exercise exposed a significant difference between the language levels among participants. Although every participant was able to understand the Dutch language, four participants possessed limited speaking- and vocabulary skills. Three participants possessed a decent understanding of the Dutch language. Most of the participants applied for a DigiD before. However, there was confusion about the functions of DigiD among the group.

6.1.3 Observations & user feedback

The start of the application exposed a large difference in computer skills among the participants. While five participants autonomously found their way through the application, four participants were confused about the assignment and needed guidance in starting the application. Two of them ended up in other screens or webpages. They were redirected to the 'start'-screen of the application by guidance of the volunteers.

Four participants finished the application within five minutes. The other five participants finished between six and nine minutes. The participants who finished earlier, were the same participants who showed significant better language skills during the language exercise.

The reactions from the feedback session were generally very positive. Each participant enthusiastically reacted to the included audio. It supported them in concentrating on the content of the application. Furthermore, they felt more confident in finishing the application. However, participants noticed the lack of a replay-button in the system. Some participants expressed a need to rehear certain questions.

Each participant gave enthusiastic reactions about the presence of Eva. While Eva provided some participants with a sense of restfulness and empowerment, it provided other participants a game-like experience "Het leek wel op een spelletje". Interestingly, none of the participants commented on Eva's appearance and were unable to remember distinctive characteristics. This gave reason to believe that Eva's appearance was perceived neutrally, and did not distract participants in focusing on the questions.

Participants positively reacted to the 'one question per screen'. It felt less intimidating than a screen filled with questions. Furthermore, the font size was perceived pleasantly and easy to read according to all participants.

The background color was enjoyed by most participants. For some it created a calming effect, others found it comforting since they like green as a color "Ik vind groen een mooie kleur".

Although participants completed the application faster than anticipated, many participants were confused about the lack of a continue-button. Only certain screens mention to press 'enter' to

continue. Participants indicated it would be helpful if every screen explicitly indicates how to continue.
All participants indicated a preference of this system towards current online forms. Moreover, they found the system accessible and easy to use. They indicated it would be an improvement if this would be offered on a broader scale in the digital environment.

6.1.4 Prototype version 2.0

Although the overall received feedback was positive, participants provided two improvements towards the initial prototype. The first improvement involved the implementation of a replay-button that enables users to rehear questions. Unfortunately, Renpy's technical capabilities does not allow for such a functionality. Therefore, this was only included into the requirements document. Second, a clear 'enter to continue' indication should be present on every screen. This was augmented to version 1.0 by both text and audio to every screen. With the absence of other improvements, this was the only extension that was implemented to construct version 2.0 of the prototype.

6.2 Second cycle testing & re-designing

6.2.1 Test set-up

This test session was supported by 'Stichting Lezen en Schrijven', a social organization that focusses on improving language proficiency in the Netherlands. A group of language ambassadors, who are frequently involved in similar test sessions, volunteered to test the prototype.
The test session consisted of three parts; (i) an interview to obtain information about participants' internet behavior (ii) individually testing the application on a computer or laptop (iii) feedback session in group context.
To obtain background information about the participants' internet behavior, I started the session with a small group interview. Participants were asked about their frequency of internet usage, their DigiD application and their experienced difficulties when using the Internet. Afterwards, participants were asked to test the application using version 2.0 of the prototype. Similar to the first test session, this was done individually in a classroom environment. I observed participants during testing, and made notes regarding their behavior and their questions. After each participant finished the application, a feedback session was initiated. The group context was chosen due to time constraints, but also due to the positive experience of the group interview from the first test session. Participants feel more encouraged to speak up when providing feedback in group context.
The questions to obtain information about the different components of the system were similar to the previous session (see end of paragraph 6.1).

6.2.2 Test group

The test group consisted of four participants. Many of the participants had previous experience in similar test sessions or researches. This was noticeable during the feedback session, in which the participants provided constructive feedback in a structured manner.
The group was a mixture of both native Dutch and non-Dutch participants. All participants possessed an advanced, or fluent, spoken level of the Dutch language. However, two participants indicated a certain lack of Dutch reading and writing skills. Although all participants regularly use the Web, three participants did not apply for a DigiD personally. Two participants were supported by their family to apply for a DigiD, and one participant does not have a Digid-account. All participants had decent to advanced computer skills. However, two participants frequently encountered difficulties by logging in on certain websites such as the 'APB', a pension insurance company, or DigiD.

6.2.3 Observations & user feedback

All participants were able to start the application without difficulties. During testing, there were few questions regarding the use of the prototype and participants completed the application at their own pace. One participant finished the application within four minutes, two participants finished the application in approximately five minutes, and the last participant took eight minutes to finish. The fastest participant was also the participant who applied for her own DigiD previously. The participant that took eight minutes to finish was the participant that has the most difficulty with reading and writing the Dutch language.
Since the participants were eager to provide feedback, the feedback session started directly after the last participant finished the application. The overall feedback was very positive and participants indicated that the prototype was "Geweldig" (Great) and "Echt een makkelijk systeem" (System is really easy to use). Participants were enthusiastic about the pace by which they were able to go through the questions "Het ging zo snel" (It went really quick). The combination of audio and text was perceived as pleasantly, while also providing the participants with more trust. One participant mainly focused on audio, and indicated it would be helpful to implement a replay-button. It would comfort him to be able to rehear certain questions.
Eva's appearance was hardly noticed by the participants and they indicated that it was not disturbing. Participants were not able to recall specific details of Eva since they were more focused on the questions. Eva was perceived as "Cool, niet vervelend" (Cool, not disturbing) and "Rustig en duidelijk" (calm and clear). This also applied to the background. Participants found it restful and it provided them with a sense of calmness. It helped them in focusing on the questions.
Participants positively reacted to the 'one question per screen'. It supported them from getting distracted from other questions or in-screen appearances. However, they indicated a help-function at certain questions would be helpful. Especially for the username and password questions, one participant said it would have supported him if an example was present.
At last, one participant mentioned the lack of a back-function. It would comfort him to go back through the application to overlook previous answers.
There was consensus on the preference of the prototype towards current online forms. Participants were enthusiastic about its ease of use, and indicated that such a system should be the standard for online forms.

6.2.4 Prototype version 3.0

The feedback session provided three improvements for version 2.0 of the prototype. First, similarly to feedback from the first test session, participants asked for a replay-button. Second, participants desired a help-function that offers explanation or examples at questions such as the username or password. As technical limitations of Renpy do not allow for such in-screen functionalities, this was only documented into the requirements document. At last, one participant asked for a back-function. However, I specifically excluded a back-function due to the 'Ontwerpen voor laaggeletterden' guideline. Since only one participant stated a preference for this function, it was decided to not implement it in version 3.0. Due to the limitations of Renpy and since it was specifically chosen to not implement a back-function, version 2.0 of the prototype remained unchanged.

6.3 Third cycle testing & re-designing

6.3.1 Test set-up

The test session was organized with support of 'Academie van de Stad', an organization that tackles challenges in the social domain by connecting students to social projects. They have students who act as digicoaches to support elderly and digital illiterates in improving their digital skills.

This session's set-up was similar as the previous test session; (i) an interview to obtain information about participants' internet behavior (ii) individually testing the application on a computer or laptop (iii) feedback session in group context.

The questions to obtain information about the different components of the system were similar to the previous sessions (see end of paragraph 6.1).

6.3.2 Test group

The test group consisted of four female participants, of which three were aged 65+. All participants were native Dutch speakers and were fluent in all aspects of the Dutch language. All participants regularly join the computer lessons to practice their digital skills. Three participants had not applied for a DigiD before and indicated that they never use it. One participant applied for a DigiD herself, but rarely uses it. All participants occasionally use the Internet, but frequently encounter difficulties with online forms or registering for an account such as Facebook.

6.3.3 Observations & user feedback

Although all participants possessed limited computer skills, one participant in particular struggled in completing the application. While the other three participants completed the application in approximately seven minutes, it took her eleven minutes to finish the questions. In particular, the participant misunderstood the '6-32 characters' requirement of the username-question. This led her to insert a username of 32 characters. After explanation from a volunteer, the participant misinterpreted the password requirement of '8-32 characters' as well. With support from a digicoach, she was able to complete the remainder of the application. The participant indicated it would be helpful to have a help-function that shows examples of possible usernames and passwords.

Other observations were regarding participants' computer handling. Some participants were not confident with typing on the keyboard. They were afraid to press 'wrong' keys and cautiously handled the computer.

Three participants provided positive reactions about the prototype and said "Dat ging goed" (It went well). It was clear and the lay-out was pleasantly. Participants experienced it as less serious as if it were a game. One participant found it really difficult "Heel moeilijk" and indicated she just started with computer lessons and had never experienced an online application before.

All participants were enthusiastic about the font size "Echt van die bejaardenletters" (Font size for elderly people), and found it easier to read than normal websites.

Participants were not disturbed by the presence of Eva, and it felt if she guided the participants through the questions "Alsof ik aan de hand werd genomen". Two participants did not noticed Eva and focused on the questions. They did understand Eva's function and could imagine that people would appreciate its presence. No participant was able to recall any details of Eva's appearance. They liked the agent as it was presented.

Although most participants focused on the text, the audio was not perceived as disturbing. One participant indicated that the audio made the questions more accessible, it "Vergemakkelijkt het antwoorden" (Made it easier to answer).

The green background was preferred over a white background. It was calming on the participants' eyes. One participant experienced it as a soccer game due to the grass pitch background.

Although most participants rarely fill in online forms, they were enthusiastic about the prototype. Having online forms as the prototype would empower them to try online applications more often individually.

6.3.4 Prototype adjustments

The participants in this test session provided similar feedback as participants from the second test session. They provided two improvements to the prototype; a back-function and a help-function. While 'Ontwerpen voor laaggeletterden' specifically mentioned to exclude a back-function, multiple participants found it comforting in having the option to go back to previous answers. Therefore, it was decided to include the back-function into the requirements document. The help-function was already incorporated in the requirements document due to the last session. No other adjustments were made regarding version 2.0 of the prototype.

7. Findings

7.1 General findings

The three test sessions provided an extensive and varied overview on the prototype through the perspective of the focus groups. While the initial focus of this study was on low literate people, the context analysis exposed more focus groups that encounter similar difficulties when handling online forms. I found it important to include their perspective in the research. For this reason, one test session was conducted with digital illiterate people. When

comparing feedback between low literate and digital illiterate participants, many similarities were observed. Both groups indicated a desire for a help-function that supports users by providing examples or extra explanation. Additionally, participants from both groups expressed a demand for a back-function. While I intentionally excluded it due to the 'Ontwerpen voor laaggeletterden' guideline, the various requests in different test sessions were found convincing to incorporate the back-function into the requirements document. Moreover, the overlap in feedback was perceived as a strong indication that the challenges in handling online forms is a problem that is present among different groups in the Dutch society, such as low literates, digital illiterates and non-native Dutch speakers. While the challenge of low literates and digital illiterates are different in nature, they both benefit by the same solution; a more accessible, user-friendly system that guides them in overcoming the challenge in a structured and step-by-step approach.

Next to overlapping feedback, low literate and non-native Dutch participants expressed a higher demand for a replay-button. The implemented audio was a vital functionality that supported them in concentrating on the content of the form. It improved their understanding of the form by reading along with the audio.

The feedback from all three different test sessions was generally very positive. Most participants found the prototype intuitive and straightforward to use. Furthermore, participants felt empowered by the presence of the virtual agent. It provided them with a sense of calmness that enabled them in focusing on the content of the form. Additionally, the agent produced a game-like experience that contributed to a less formal digital experience. Interestingly, no participant, from all test session, was able to recall any specific features of the agent's appearance. This corresponds with their feedback of not being distracted by the agent's presence. Therefore, I concluded that the 'neutral' design of the agent was sufficient. While it is important to include basic features in order to resemble human presence, I advise to limit the amount of time spent on the agent's level of detail.

Participants were positive on the prototype's accessible lay-out. They perceived it as relaxing while limiting the risk of distractions. Low literate and elderly participants were especially positive about the big font size. It enabled them to carefully read the sentences. All participants indicated a preference toward this type of lay-out over current online forms. Some participants were surprised by the pace in which they were able to complete the form. The enthusiasm I observed from that felt like empowerment, as if it provided them trust to take on other digital challenges as well.

While the most important results were obtained during the test sessions, there are other outcomes of this study that were found worth sharing. The engagements with the experts and volunteers revealed interesting insights. While I expected to encounter difficulties in finding participants, all organizations were very open in cooperating, and even supporting, in hosting the test sessions. They were enthusiastic by the idea that this challenge is being researched and were hopeful that it could make an impact. This indicated the level of urgency of the problem. While digital education for the focus groups is an important component, this challenge requires not active, but a proactive mindset of the government. The Dutch digitalization strategy is ambitious and inspiring. However, creating a digital society that excludes a large portion of people, is not sustainable. Therefore, they should be more actively involved and develop a strategy specifically designed to bridge the Dutch digital divide. Currently, experts in this domain that are collaborating with the government on projects, indicate that bureaucracy is the biggest challenge that restricts effective change within the Dutch government and municipalities.

7.2 Requirements document

The user feedback and findings of this study were converted into a requirements document by using the MoSCow method. This is a technique that is commonly used to prioritize functionalities in software development projects[31]. When developing online forms that are to be used by low literates, digital illiterates or people who are non-native Dutch speakers, I strongly advise to use table 1 as a guideline. These requirements support in creating increased engagement from these focus groups. Moreover, it helps in distressing a large group of people in handling online forms. Additionally, it empower them in tackling other digital challenges.

Category	List
Must have	- Audio assistance - Replay-button for audio assistance - Consistent, calm screen lay-out - Virtually present agent - Clear 'continue to next screen' indication
Should have	- Big font size - Back-function - Understandable sentences - Help-function that includes username and password examples - One question per screen
Could have	- Variety of avatars and lay-out options
Will not have	

Table 1. Requirements document in MoSCow-form

8. Discussion & Future work

This research contributes in understanding the requirements of designing online forms for low literates, digital illiterates and non-native Dutch speakers by using a virtual agent. It is the first time that an actual prototype of a virtual agent was tested on these specific focus groups. Additionally, it builds upon previous

studies that focused on developing accessible online lay-out designs for low literate people. Most of the 'Ontwerpen voor laaggeletterden' guidelines were validated by this research. However, the direct user feedback from participants provided new insights on the digital desires of these target groups by testing with a physically present agent in combination with audio support. Moreover, it was the first time that test sessions were conducted in this particular setting (see paragraph 6.2 and 7.2), with participants from three different focus groups. This enabled the opportunity to compare feedback between the different groups. Interestingly, it was observed that most of the feedback was similar in nature and that the different focus groups encountered similar challenges when handling online forms.
Furthermore, it is the first time that requirements for designing online forms using virtual agents are described by using a structured and methodological method. While there are organizations that focus on the practical aspect of supporting low literates and digital illiterates, like Steffie.nl, there is a lack in publicly available guidelines that are able to assist the government in creating accessible online forms. This study provides an elaborative description in design choices for the lay-out components as well as functional requirements that fills a gap in the knowledge domain of this particular challenge.

The technical limitations of RenPy constraint me in testing and validating functionalities that were desired by participants. Implementing these functionalities would provide the opportunity to test and refine the prototype by using participant's feedback. Now, it is only included in the requirements document. This leaves room for interpretation on the design of such a functionality. Available user feedback on the design of these functionalities would have increased the quality of the requirements document.
The variety of user feedback has been valuable in this study and its results. At the same time, I experienced it as the biggest challenges of this research. While the second test session included a test panel with participants who were able to provide constructive and structured feedback, the other two test session consisted of participants that were not used to provide feedback constructively. This made it challenging in equally evaluating the feedback of participants from the different groups. However, research in this domain will always be due to circumstances as experienced in this study. Closely observing participants' behavior during testing and during interviewing, allows for obtaining important pieces of information.

Over the course of this research many challenges surfaced that come along with the Dutch digital divide, both on organizational and technical aspect. The biggest organizational challenge is caused by the lack of a centralized approach by the government. The size of this challenge is too large to be solved by decentralized projects and without unity. Organizations would benefit from increased cooperation and a shared strategy that supports them in delivering more effective results. Furthermore, additional research on new methods or implementing new technologies could support these organizations in becoming more efficient. Supporting low literates and digital illiterates is a labor intensive process due to the many volunteers needed. New tools would be helpful in increasing their efficiency to enable them in bridging the current gap.
As participants indicated a preference of the prototype used in this research, having a specifically UI-toolkit or git-kit, including default designs and lay-outs, would be an interesting follow-up. This tool can be used to easily create accessible and customized online forms without needing technical expertise. Users are able to personalize forms by choosing from the variety of backgrounds, avatars, fonts and other functionalities the tool provides.
Looking even further into the future, these systems could incorporate intelligent agents that are solely voice based. Low literates and digital illiterates will become empowered due to the abundance of using a keyboard. These systems could be connected to known technologies such as Alexa and the Google Home that enables users to fill in online forms without seeing user interfaces and by only using voice based commands.

9. Validation

The digitization of Dutch government forms is putting pressure on low literates, digital illiterates and non-native Dutch speakers in the Netherlands. As more government forms shift to a digital format, these people increasingly encounter stressful situations when applying for social services, tax returns or using DigiD. They experience anxiety in making errors that result in judicial or financial consequences, forms are experienced as not personal, webpages contain too much textual information on a dense area, and user interfaces are complex and crowded with unclear symbols. Changing the design of these forms by taking into account the specific needs of these focus groups can lead to a positive impact on their digital engagement. This leads back to the leading design question; *How can we design a practical solution (i.e. virtual agent) to facilitate information provisioning to low literate users?*
Working in iterative phases and using user-centered design were found effective in developing the prototype. The different phases allowed to discover unknown requirements directly from an user perspective. These perspectives were used to develop a prototype of a virtual agent. The test sessions were important to gain user feedback. This feedback was converted to establish a requirements document that can be used as a guideline to make online forms more accessible. Testing the prototype over three sessions allowed the validation of user feedback and resulted in stronger findings of this research. Moreover, it allowed me to compare feedback between the different focus groups. Given the overlap in feedback, it was concluded that most findings can be generalized to other groups that encounter similar difficulties with online forms.
The second design question was specifically targeted at finding the requirements of the practical solution; *What are the requirements of developing a virtual agent to the specific needs of low literate users?*

The most important requirements are listed in table 1 under the headings 'must have' and 'should have'. As indicated by participants, following these requirements increases the sense of calmness, increases user's ability to focus on the content of the form, and it decreases their level of stress when handling online forms. Additionally, it not only relieves stress and anxiety among the focus group, it could empower them in becoming more digitally engaged. Encouraged by their ability to handle online forms, other digital tasks become less stressful.

10. Conclusion

This study investigated the use of a virtual agent to improve online government forms for low literate, digital illiterate and non-native Dutch citizens. It has shown new insights regarding the development of these online forms in terms of simplicity and ease of use. Their user perspective and feedback was valuable in designing a requirements document that is able to give guidance in creating online forms that are accessible for these groups of people. The user-centered design in combination with iterative phases (agile method) were key in obtaining the necessary requirements. Despite a thorough context analysis, testing the prototype gave valuable insights in the actual needs of the focus groups. It showed me that certain functionalities or lay-out decisions can easily be overlooked due to the different perspective you have as a designer. Furthermore, it convinced me that active engagement with the focus group or end users is an important phase of designing practical solutions. It not only provides you the opportunity to deliver a better solution, it also saves time since it is easier to incorporate changes at an earlier stage of the process. While an agile user-centered approach is more time consuming and labour intensive, it significantly improves the result of the outcome. Given that the Dutch government must be inclusive to all citizens, they are obliged to take into account the demands of these groups in their digitalization strategy. A solution such as the toolkit I suggested in the 'future work' paragraph, could significantly improve the digital engagement among these groups. Given that we all benefit as a society that is digitally inclusive, there is yet a great deal of work to be done in order to bridge the digital divide. The continuous efforts of the organizations and the volunteers are indispensable in this challenge. Together with a proactive government and a applicable strategy, we as society can make important steps towards an inclusive digital nation.

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13. Appendix

1. Figures

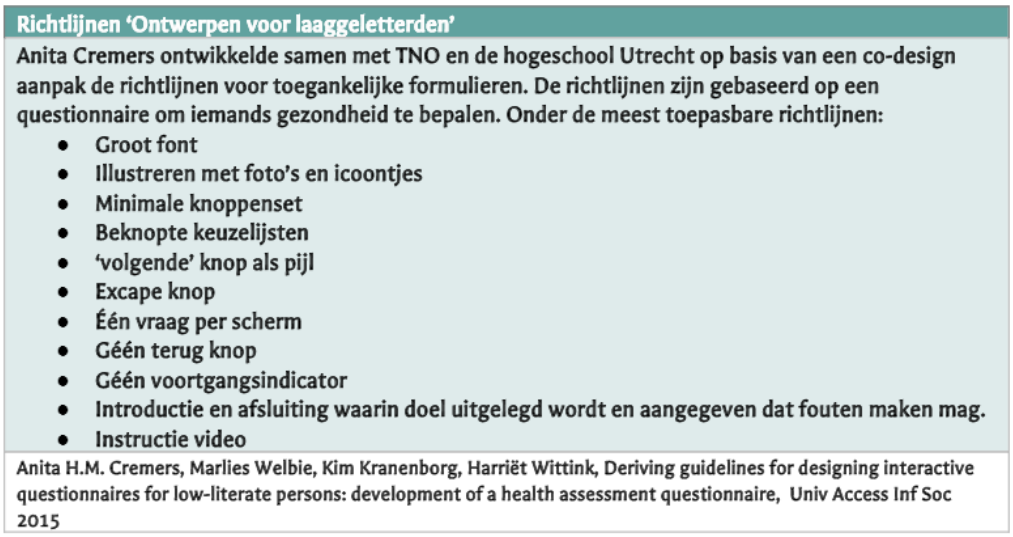

Figure 1: Ontwerpen voor laaggeletterden

Organisation	Duration	Type of Meeting	Content
LostLemon	70 Minutes	Face-to-face	Mutual introduction of LostLemon and our projects + research methods
Municipality of Amsterdam	48 Minutes	Face-to-face	Current municipalities projects + introduction of our projects and introduction to focus groups
LostLemon	53 Minutes	Face-to-face	Elaboration on LostLemon's research methods + introduction to focus groups
Stichting Lezen en Schrijven	25 Minutes	Phone	Challenges of product development for low literates + introduction to focus groups
Stichting Leerzelfonline (Steffie.nl)	29 Minutes	Phone	Design choices of Steffie.nl + challenges in the creating content for low literates
PhD candidate, Vrije Universitiet	45 minutes	Face-to-face	Technical questions about RenPy
Vrije Universiteit, Hva, Stichting Boot	70 Minutes	Face-to-face	How to create involvement from the usergroup. Focus on co-creation and make use of living labs
Taal en Computercoach, stichting SeZo	50 minutes	Face-to-face	Setting up a test-session with a group ze coaches during language- and computer lessons
Athena workshop	20 minutes	Presentation	Giving a presentation about my research to invites of the workshop. The workshop intended to foster collaboration to improve social inclusion.
SEZO	80 minutes	Face-to-face	Test session
SEZO, project coordinator	15 minutes	Face-to-face	Short evaluation of test session + networking for other test session opportunities
Stichting Lezen en Schrijven	70 minutes	Face-to-face	Test session
Academie van de stad	75 minutes	Face-to-face	Test session

Figure 2: Overview of meetings including short summary of discussed content

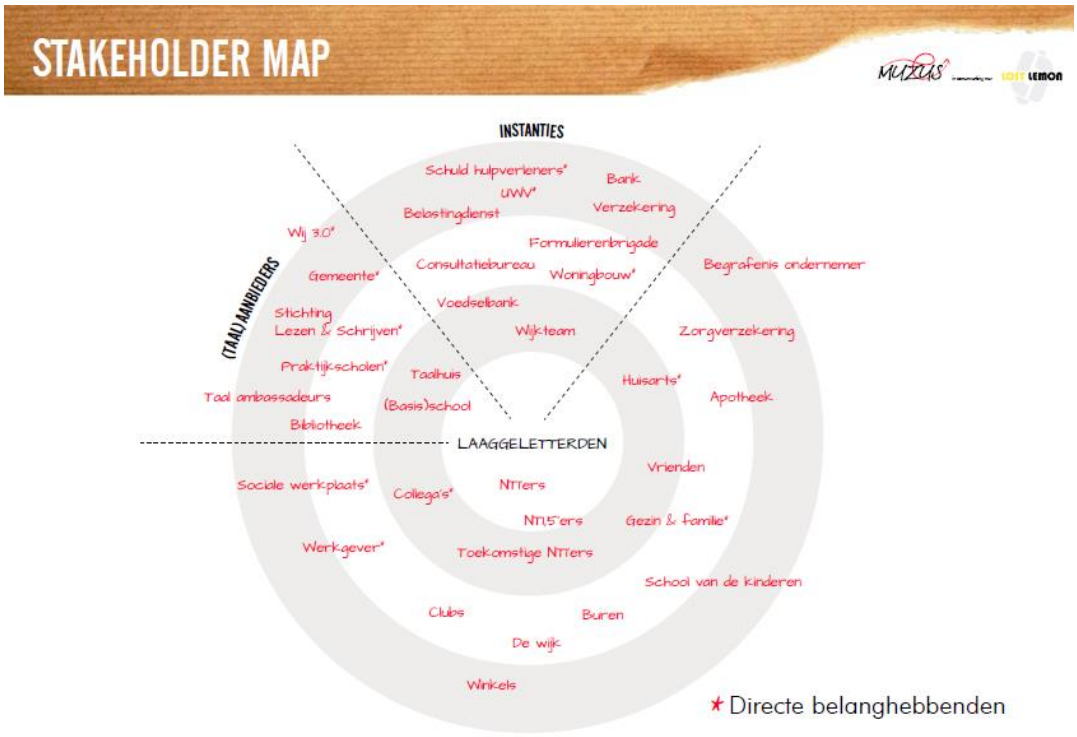

Figure 3: Stakeholder map developed by Lostlemon

2. Technicalities

Link to source code: Master thesis source code

To generate natural movement, three versions of the avatar were built, Eva_default, Eva_blinking and Eva_armfold (figure 1, 2 and 3), and defined inside the RenPy script. An animation function was created by interchanging the three different avatar images after a given number of seconds, as shown in figure 4. Trial and error in combination with intuition was used to imitate humanlike behavior regarding the agent's blinking and arm folding. After seventeen interchanges between default, blinking and arm-folding, the built-in repeat function was used to create an infinite loop of the animation.

```
image Eva_animation:
    "Eva_default"
    3.9
    "Eva_blinking"
    0.3
    "Eva_default"
    4.6
    "Eva_blinking"
    0.2
    "Eva_arm_fold"
    3.5
    "Eva_blinking"
    0.2
```

Figure 4. Animation function