University of Twente

CARO - THE ONLINE PLATFORM FOR SOCIAL ROBOT APPLICATIONS

BSc Creative Technology

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Abstract

Social robots are being implemented more in the recent years in the medical care setting due to an aging society and the limited staff in the healthcare sector. The effectiveness of these robots is often evaluated by their interaction with the client and how effective or impactful they are. An aspect that often gets overlooked is that the care workers also need to interact with these social robots in order for patients to receive their most optimal care. Care workers often have trouble with this due to poor user interfaces of the robots and lack of knowledge learned in their curriculum and a place where they can seek help. To combat this, one potential solution has been chosen and developed further: the CARO platform. CARO is an online community platform for social robots where people can browse for inspiration about what their social robots can do, ask help about how to perform certain activities with their social robot, or help out others who are having trouble with working with their social robots. The platform aims to allow people to do what they already excel at and finding a way to combine the knowledge with each other by providing a place where care workers can easily find help for their social robots to perform their designed activities with patients and people with more technical knowledge can explain to them how. The initial prototype testing shows potential about the concept and design, however further research and development needs to be done for the implementation of all the functionalities of the platform as well as the inner workings of the platform as a concept that can be applied to other applications.

Acknowledgements

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1 Introduction

The first section of this report will introduce the context of the research and make the commonly used terminology clearer. After that, the current situation and problem statement of social care robots being used in the healthcare sector as well as the primary goal of this research will be described. Following this, the research questions that this project aims to answer will be listed. Finally, a description of the outline of the rest of this report will be given.

1.1 Context Analysis

The subject of this research project is to make social robots more accessible to care workers for activity design. What exactly is meant with social robots or activity design might not be clear to everyone. Therefore, these terminologies will be explained in this section to get a clearer view of the context.

1.1.1 Social robots

Robotics is wide term that includes disciplines from a wide range of fields like computer science, electrical engineering and mechanical engineering [1]. Robots have been used in situations that are dangerous for humans, such as bomb defusal and situations where a large amount of precision and persistence is required like manufacturing factories. More recently, robots have been designed to primarily interact with people in their social environment. They can vary in size and appearances, from the size of an actual human to the size of a flower pot and from a human-like robot to an animal-like robot. See figure 1. Their primary objective is to aid humans by interacting with them and providing either physical aid like moving heavy objects, or mental aid like helping them remember tasks.

Figure 1: Social robots from left to right: Pepper, Paro and Jibo

1.1.2 Activity design

When most people think of activity design, they think something along the lines of organizing a day out to a theme park. That is not necessarily the primary focus of of an activity in the context of this research. An activity can be anything that a patient needs to do that a care worker helps them with. For example, a care worker can help a patient with a physical activity like bathing, but another activity can be to just keep the patients company and talking with them so they do not feel so lonely. There is a distinction between the physical activity and the goal of that activity. An example could be showing the patient a photo book. The physical activity is to simply look at the pictures inside and turn pages. A social robot can be used for this task, but there can also be different goals in doing so. For example, the robot will ask the patient when looking at the pictures if they can remember who that person is, trying to improve or retain the patient's memory. That is then an activity that aims to improve the patient's memory. Alternatively, when the patient is looking at the same picture, the robot can ask the patient if they can find a certain object, which is an activity that tries to train the patient's eyes. So the term *activity design* in the context of this research can be defined as the process of creating an activity for a (group of) patient(s) with a specific goal in mind to make it meaningful.

1.2 Problem description

In the digital day and age we currently live in, technology is all around us. Whether it is the smartphones we always have on hand, the computers we use for our work and education, or the automatic booths where we buy our train tickets; technology is everywhere. Technology can solve otherwise impossible problems and often offers people a lot of convenience. That is why technology is being implemented in a vast range of area's where previously there was none. One such area is the healthcare sector. In the past, healthcare workers provided all the care in person. However, with an aging society and a limited staff in the healthcare sector, it became much harder to provide the proper amount of care to the patients who needed it, especially with the current ongoing Covid-19 pandemic.

To relieve some of the stress in the healthcare sector, social robotics have been introduced. These robots can have a great impact on the patients receiving care, but also on the care workers themselves. Robots can do things that care workers cannot and vice versa. A social robot can always be available for the patients where care workers need their rest. However, the artificial intelligence of social robots have not reached a level where they can act on themselves without human interference to provide care for patients. Therefore, the two have a complementary role and if they are working together well, they can increase the quality of the care for patients whilst also reducing the workload for care workers.

Whilst social robots are being progressively implemented in the healthcare sector, they are not always easy to understand and use. Many of these robots are state of the art technologies and have not yet been streamlined to the point where the masses can use them without any issues. This causes a problem with the people that are eventually going to use them; the care workers. They often do not have a very technical background that allows them to interact with the social robot in such a way that it allows them to make the robot perform

the exact activity they want. Meanwhile the social robots are often evaluated based on their performance with the patients themselves whilst the usability aspect for the care workers get overlooked. In order to get the maximum potential out of a social robot, the interaction between the social worker and the social worker also needs to work smoothly.

1.3 Goal

The primary goal of this research project is to make social robots more accessible to care workers, regardless if they have technical knowledge or not. The aim is to develop a solution that allows to bridge the gap between the technical side of social robots and the activity design side that care workers are more familiar with. The possible solutions will be based on the literature review, state-of-the-art research and the results from the interviews with actual care workers. Though the aim is to develop a full solution, given the time period of this research, only a prototype might be developed for testing as a full fledged application might not be feasible.

1.4 Research Questions

In order to find a possible solution to the previously mentioned problem, the research will be centered around one main research question:

How can activity design for social robots be made more accessible to care workers?

To get a clear and concise answer to this research question, first several sub research questions need to be answered. The sub research questions that help clarify the main research question can be formulated as:

- What are the main challenges that care workers face when working with social care robots?
  - What tasks are social robots mainly used for currently in the care sector?
  - To which extent do existing systems allow for activity design?
  - What understanding of activity design of social robots do care workers have currently?
  - What knowledge about social robots is already being taught in the education of care workers, if at all?
  - How do care workers evaluate the impact of an activity of a social robot on the clients?
- What are important usability aspects for care workers when it comes to developing activities for social robots?

- What characteristics does a platform need to have such that it allows for multiple activity design?

The first sub research question with the five subsequent sub questions will provide the context about the current situation with social robots and care workers. This will primarily be done through a literature review, state-of-the-art research and interviews with actual care workers and teachers. Sub-questions two and three will primarily address what, in the eyes of care workers, are important aspects for them when it comes to providing a solution to make social robots more accessible to them. This will be done partly through more interviews and partly through the ideation and implementation of a solution and evaluating the effects of the solution through the means of user testing and interviews with care workers and clients.

1.5 Report outline

This report starts with an Introduction section on the context and meanings of social robots and activity design as well as the problem statement, goal and research questions. The report then moves on to a Background research, where the existing literature and state-of-the-art technologies will be explored, researched and reviewed. Following this will be the Methodology section, which describes what methods and techniques will be implemented in the next sections of Ideation, Specification, Realization and Evaluation. In the Ideation phase, ideas about a possible solution will be generated, considered and one will be chosen to work out further. The Specification phase will then follow up on this by reviewing and specifying the details of the application, which will then be realized in the Realization phase. When the application is realized, it will be user tested in the Evaluation phase and the results will be analyzed. These results will be presented and finally, the report will end with a Conclusion and Discussion section which discusses the research project as a whole as well as gives conclusions to the research questions, any limitations of this research and potential future works.

2 Background research

In this section, the background information regarding this topic will be researched. Firstly, the existing literature about the concepts will be looked at and reviewed. Secondly a state-of-the-art research will be conducted to get a perspective about what has already been done in this area in terms of real world applications.

2.1 Literature review

2.1.1 Introduction

Social robots are being implemented more in the recent years in the medical care setting due to an aging society and the limited staff in the healthcare sector. The development of these social robots began more than two decades ago and it is continuing at a rapid pace [2]. Currently, there are many applications of social robots being implemented in care sectors like elderly homes or homes of children who need assistance [3; 4]. The effectiveness of these robots is often evaluated by their interaction with the client and how effective or impactful they are. Social robots without meaningful activities are not very effective and impactful. While current medical care robots do contain a range of different activities they can perform, they are very standardized to fit as broad a range as possible to suit the needs of as many patients as possible. This is cost and time effective, however it does not offer the best care for the patients. By personalizing the activities that social robots can perform to each patient, the robots can cater much more to the personal needs of the patients and leave a lasting impact[5].

Activity design is hard and there are many different activities that can help patients. The challenge lies in the ability to recognize the needs of each patient individually and design an activity to suit their needs[6]. Care workers must make the activities of the robots meaningful to the client by knowing when, where and for what purpose they need to be implemented. This requires a lot of work since each patient has different needs, even when treating the same condition[7]. To add to the problem, many care robots that are currently on the market do not offer a platform in which new activities can be designed easily[8]. It requires a deep understanding of the robot and programming skills to design new activities, which the care workers do not possess. Therefore, it is very difficult for care workers to design new activities for the social robots without assistance from external parties[9].

While some research has been conducted about care workers and the way they must interact with social robots, that aspect remains largely unexplored. Therefore, the goal of this literature review is to investigate further into the interaction between the care workers and the social robots that is needed for care workers to design new activities for different individual patients. First off, the current uses of social robots in the care sector will be explored. This will give an indication to what the social robots are mainly used for. After that, the topic that will be explored is how much knowledge about robots and programming do care workers have. This will be done by looking at their educational program. Lastly, a conclusion will be given about the state between the social robot activity design and care workers.

2.1.2 Current use of social robots in the care sector

There are already many applications of social robots being implemented in care sectors like elderly homes or homes for children who need assistance like children diagnosed with autism[4; 10; 11]. There are also examples of robots being implemented in rehabilitation of e.g. accidents, mental disorders, dementia, or other neurological problems as well as among neuro-cognitive patients, disabled and injured people in medical surgery[12]. The range of sectors where social robots are active is huge. Therefore, the activities that the different social robots can perform is also very large. In areas where previously, interaction with social robots might have been difficult, like elderly homes, are becoming more accessible. Studies have shown that the likelihood of older adults interacting with social robots is ever increasing[13]. Robots that function in an elderly home might have activities that help elderly remind themselves to take their medicine at a certain time or physically demanding tasks like lifting heavy objects[14]. In other instances, like in a home for children with autism, the social robots might primarily have a more educational role rather than a reminding or physical role. Currently, common tasks for social robots to assist humans is lifting and carrying heavy objects, but new generation robots are expected to also assist humans in more complex ways like social interaction and, for example, feeding and bathing physically impaired persons[15].

2.1.3 Care workers' knowledge about social robots

When looking at the educational program for the study nursery at the Amsterdam University of Applied Sciences, there not much is mentioned about teaching students about robotics or programming[16]. It is mentioned that students are taught the basics of using computers, enough to fill in basic medical data into systems. This is obviously not enough knowledge for care workers to design their own activities with the social robots, unless there is a specific platform made for care workers, or other people who do not have the required technical knowledge to design the activities from scratch, that makes activity design for social robots more accessible. These conceptual approaches for defining, designing and selecting robots from both healthcare patients' and professionals' points of view are missing though[12]. Some service platforms have been introduced over the years, but more applications, concepts and approaches are needed. Especially from the healthcare professionals' point of view.

Without the help of these platforms to design activities for social robots, many care workers will get lost and overwhelmed when trying to design new activities for the social robots. More guidelines and methodology for using robots by caregivers are needed. Healthcare professionals often do not know how to handle social robots exactly or how to use it to their advantage for the care of their clients[17]. Only a very limited number of healthcare workers have experience with robots and the number of real cases where robots have been used is small, and therefore, the number of social and service robots is limited in hospitals and care homes, even though these robots are considered to be effective[12]. A common denominator is that healthcare professionals might need an introduction to social robots and vocational courses.

There also seems to be an issue of potential generational differences, with trainees, younger doctors and younger patients being more familiar with the digital solutions compared to

older doctors and patients[18]. This can be explained through the everyday use of computers and embedded systems that the younger generation uses on a day to day basis, where the older generation might not be as familiar with them. The user interfaces of the different kinds of computers that can be interacted with on a daily basis is very wide and it might be an advantage if you are familiar with them since they can overlap with the user interfaces for social robots.

2.1.4 Evaluation of social robots in a care setting

Care activities often have a practice-oriented nature where fundamental care elements like attentiveness, responsibility, competence, and reciprocity are very important. These elements are nearly impossible to replicate on a social robot. These elements form the backbone of a good care practice[7]. Social robots, in turn, can deliver on other elements where humans are lacking like availability. Robots can always be turned on and be ready when the patients need them where human care workers need to rest. The current social robots cannot replicate human care, however that might change in the future. Affective and functional touch are central in care work and currently, social robots are nowhere near replicating real human touch. Regarding the future, two types of social robots might seem relevant. The first question is, how the affective touch of the social robot can meet the needs of care of patients. The second question is, how are activities that require functional touch, such as bathing feeding, lifting or dressing patients intended to be assisted by social robots[15]. Social robots are really considered valuable as an interpersonal intervention when it can develop a partnership and reciprocity in the nurse-client relationship, however that might be still far ahead in the future.

2.1.5 Conclusion

In this section, literature from various sources has been used to answer the first sub research question along with the five subsequent sub-questions. It has become clear that the use of social robots are currently increasing at a rapid pace as technology continues to advance. Current social robots have limited functionalities and are mainly used to do simple or physically demanding tasks, whereas social robots in the future might be used for more complex and intimate tasks. Current social robots are also not the most user-friendly, especially for people who do not have a technical background, making it hard to implement different and dynamic functionalities for the social robot to do. It has also become clear that most care workers do not have any ICT or robotics related courses in their curriculum to gain the knowledge needed to work with some of the social robots.

2.2 State of the art

After having looked at the existing literature, the already existing technologies regarding social robots need to be explored. This is important to get a view of what has already been done by others, what parts can be re-used and more importantly, which parts can be improved upon. Currently, there are a lot of social robots implemented in the healthcare sector with all of them being different and having different ways to interact with them and use them for activity design. Therefore, in this phase of the research, the different existing social robots will be explored and how they they handle activity design. In addition to that, different methods that allows people to look for help when it comes to handling (social) robots will be explored as well.

2.2.1 Method

With the increasing use of social robots in the healthcare it is impossible to include all of them in this phase of the research. Therefore, only a few of the social care robots will be chosen to discuss in more detail. In order to narrow down the selection of the social care robots, a few criteria will be created to be more specific with the robots:

- The robot has some sort of built-in interface that allows users (re-)program the robot.
- The robot is available for purchase for consumers and/or businesses.

After these criteria, there are still many robots left. Since this research focuses on the ability for activity design of social robots, it will be more interesting to include robots that have a unique or well implemented way of interacting with the robots. Some robots will be chosen because they have an excellent user interface which allows users to design different activities with, but others are chosen because of the fact that said functionality is missing or is implemented poorly. This is chosen this way to highlight the contrast of the potential different user experiences a user can experience. Not all social robots have a very polished programmable user interface and not all user interfaces of social robots are poorly designed.

2.2.2 Cozmo Robot

This specific robot has been chosen because it was physically available for testing since the University of Twente have it ready for experimentation. The Cozmo Robot, first developed by Digital Dream Labs in 2016 [19], is a very small social robot that was initially intended as a playful educational robot that aims to teach children how to program. See figure 2. Users can use the corresponding Android and iOS app to program different functions for the robot like moving around, saying things, facial recognition and picking up blocks that come with the robot. Since Cozmo is an educational robot that aims to help children learn programming, it has an built in user interface that allows users to perform all kinds of different activities with the robot (figure 3). The developers are also still supporting the robot and mobile application after release, which means that the robot will get new features in the future with the sensors it already has inside the robot.

Figure 2: Cozmo Robot

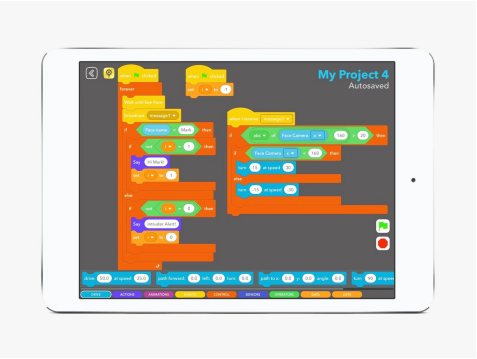

Figure 3: Programming interface of the Cozmo app

With this social robot, there is great potential for care workers to use this robot for different types of activity design. The robot is made with children in mind and teaching them how to code. Using the mobile application, users can very specifically program what they want the robot to do and when they want to do it. It should not be hard for adults to figure out how to use it. Still, there is still a learning curve and if the care worker has never had relevant experience in programming, they might still have difficulties designing activities with the social robot. However, there is an open source Software Development Kit (SDK)[1] available for the Cozmo robot, which allows for even more programmable potential with its expanded third-party libraries. It comes with a comprehensive set of low- and high- level functions and it uses the Python language which is a very beginner friendly programming language. Overall, it is a very powerful, yet flexible and customizable robot with great potential to be used for activity design by care workers, provided they have at least some knowledge about programming or are willing to invest some time to figure out how it works.

2.2.3 Pepper Robot

The Pepper robot, developed by SoftBank Robotics, is advertised as *"The world's first social humanoid robot able to recognize faces and basic human emotions."* See figure 4. The robot stands 120cm tall and can perceive its surroundings and engage in conversations with humans. The robot also has a touch screen that allows it to display graphical content to people. Pepper is a widely popular social robot that has been implemented in schools and businesses. Over 2,000 companies around the world have integrated Pepper as an assistant. With its 20 degrees of freedom for movement, the automatic speech recognition in 15 different languages, perception modules that can recognize and interact with the person talking to him, touch sensors, LED's and microphones, it primarily focuses on its interaction with users [20].

The Pepper robot also comes with an open source and fully programmable platform. See figure 5. The interface shown in figure 5 is called the Choregraphe software that allows

[1] https://developer.anki.com/

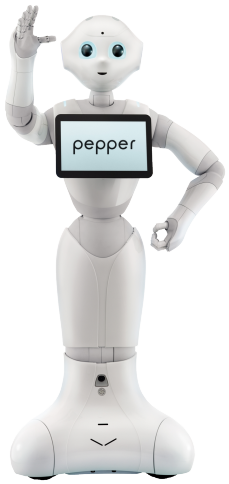

Figure 4: Pepper Robot

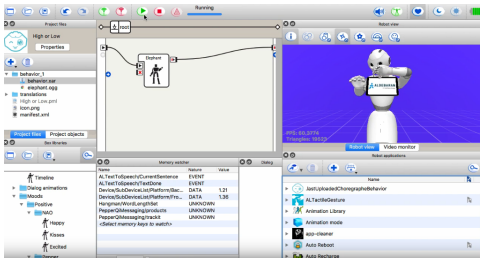

Figure 5: Programming interface of the Pepper app

users to implement new animations, behaviors and dialogues for the robot. THis software, however, is more complex and difficult to use than the mobile application that can be used with the Cozmo Robot. This software has to be run with on a laptop of PC and the robot needs to be connected to it, instead of wireless like the Cozmo. While the interface also uses Python, it is less intuitive to use for someone with not much programming experience. There is also another way to program the Pepper robot, called the Pepper QiSDK for Android Studio. This SDK plugin allows users to program the robot in Android Studio using the languages Java or Kotlin, which are not that beginner friendly languages. While this level of customization and programability is quite powerful, inexperienced users are going to struggle to work with it without investing a significant amount of time in learning it.

2.2.4 Honda ASIMO Robot

The last social robot that will be covered here does not fit either of the criteria held above. This is to show what a social robot would be capable of at the very top end of the range of social robot capabilities. The Honda Motor Company developed a robot named ASIMO (Advanced Step in Innovative MObility) [21] and it is currently one of the omost advanced humanoid robot in the world. This robot is currently what it is through more than thirty years of development. In 1986, Honda started development on a robot with as primary goal being able to walk like a human. Since then, it has come a long way and it's primary purpose has been altered from a simple robot that walks like a human, to a social robot that interacts with humans and assists people around the house with various household tasks. It now can walk and climb stairs independently as well as understand some gestures and spoken commands. It has hands with five fingers like a human which allows it to perform helpful tasks like opening doors, turning light switches and picking up objects. The robot is 1.3 meters high, which is the height that an average seated person. With the current development of the robot, ASIMO can even play sports like kick a football.

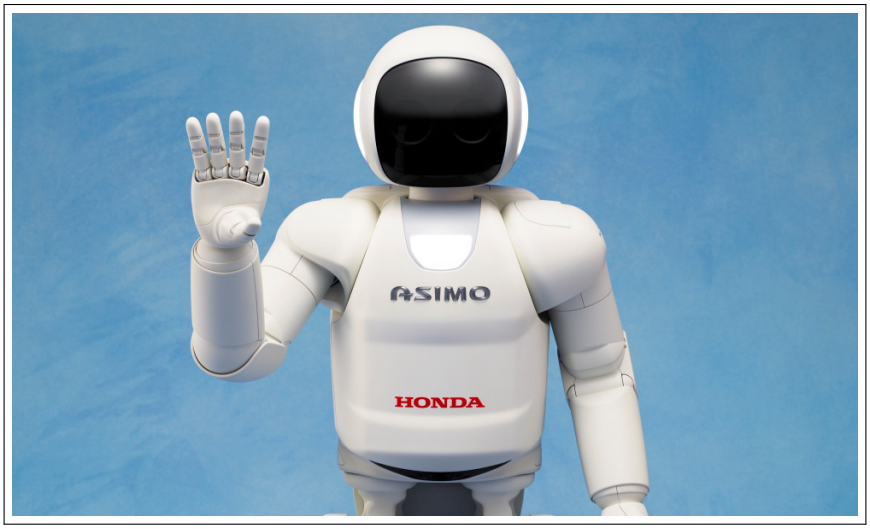

Figure 6: The Honda ASIMO Robot

While on paper, the Honda ASIMO robot sounds amazing, and in many ways it is, this robot is still state-of-the-art technology and is still a prototype. It is not in active development for the mass market yet so not many people will actually be able to receive help from the robot. While new features do get added regularly by the Honda Motor Company, they are done so by advanced program updates and new components altogether by the developers. It is not something an average care worker would be able to do. The programs and functionalities that the robot does have are not very personalized either. They are mostly still tech demos and are not tailored with a specific patient in mind. The Honda ASIMO robot is not designed with reprogrammability and activity design in mind, however maybe one day it will be able to do so and improve the lives of a lot of people.

2.2.5 Help on social robots

When it comes to already existing web services that help people specifically with social robots, as far as I could find, there were only the developer websites of the companies that have designed the robots. For example, the Anki Cozmo robot developer website containing the SDK[2], it does contain a fairly detailed and user friendly website that explains to you how to set up and use SDK, however, if it is still not clear to the users or if someone has a specific question about the social robot or they have a specific activity in mind for the robot, they don't have a place to ask that question, except for contacting the company through mail which could take a long time to receive an answer. For the Pepper Robot being developed by SoftBank Robotics, it seems that they used to have a community website where users could go to in order to ask questions, however this has been shut down. The alternative now is a Developer Center[3]. This Developer Center is much more comprehensive than that of the Cozmo Robot with clear explanations also, however, it does still have the same problem

[2]https://developer.anki.com/blog/learn/tutorial/getting-started-with-the-cozmo-sdk/index.html
[3]https://developer.softbankrobotics.com/pepper-qisdk

as the Cozmo Robot, when people still don't understand or have a specific question they would like to ask, they can't ask it anywhere. They will have to do with what is on the website currently, and hope that they add it some time down the road or try their luck contacting the company.

When it comes to platforms where people can ask questions about programming related topics, the most popular platform currently is by far StackOverflow. This is an online community platform where people can ask their programming related questions and other people can provide answers to the problems. This is a huge web platform with a very wide range of topics that people are asking questions about. While it is hugely popular among programmers, since the platform mainly focuses on coding, many people who do know anything about coding don't know that this web platform exists. There are many alternatives to StackOverflow like Bloomfire, AnswerHub, Obie or even Quora which all offer some sort of community Q&A platform, however all of them are not very specifically targeted towards any one area. None exist for social robots yet. And the same applies to all the other platforms, most of them are targeted towards programmers and are unknown to people who are not specialized in that area. Also, most of these online Q&A platforms function on one-way direction of question-answer relations. When a question is asked, people can provide an answer, but if the same answer can be applied to another question, all someone can do is to post a link to the other question as answer. This will lead to duplicates and can become cluttered.

2.2.6 Conclusion

In this state-of-the-art research, different social robots have been looked at and a few have been selected to look at in depth. As can be seen, the range of usability of a social robot varies wildly. There are social robots that have very easy to use software and development kits that allows people to easily reprogram the functionalities of the robot, whereas there are also robots that are very hard to do so and even robots that it would not be possible at all unless you have a degree in engineering. This is not surprising since social robots are still a relatively new concept for people and there is not a huge market for them yet. Therefore, the research and development of them are not on the same scale as for example smartphones and personal computers. This can only improve if the trend of social robots keeps rising and become more mainstream.

As far as platforms for social robots is concerned, most of the social robots have a support page where additional information can be found for that specific robot, however a place to ask for more help or more specific functionalities is lacking. In order to ask people online for help, they will need to visit a community Q&A platform. There are currently many of these Q&A platforms, however most of them have a very broad topic range about what people can ask there and there are none (that I could find) that are focused on social robots. Since they are mainly targeted towards people who are programmers, they are not very well known to people who are not programmers. Also, most of these online platforms focus on asking a question then providing an answer, not the other way around. It does not allow for people to search by answers to for example, browse for inspiration. Duplications will also become a problem if there is a lack of good moderation, since the questions or answers cannot be referred to from different topics.

3 Method

In this chapter, the used methodologies and techniques will be discussed. The methods and techniques are described in short with what research question it aims to answer and how it aims to achieve it. In section 3.1, the design process will be explained and after that, the different section will be described on what methods they will use and how to evaluate them.

3.1 Creative Technology Design Process

The Creative Technology design process is applied during this research, with an iterative process in mind. This process has been introduced by Mader and Eggink [22]. The aim of the iterative design process is to constantly get feedback from the stakeholders and adjust the project accordingly to the ever changing variables. This design process consists of four phases: Ideation, Specification, Realization and Evaluation. It is not a linear process, but rather an iterative process where you can go back to any step after you have completed another step in order to make improvements with keeping the stakeholders in mind as a high priority. Figure 7 shows a visual representation of the design process.

3.1.1 Ideation

In this section, ideas for solving the main problem of the graduation project will be explored. Different methods will be used to come up with a wide variety of potential ideas. First off, interviews will be constructed with stakeholders, the care workers. They include (ex-)nurse students, currently working nurses and teachers of care related programs. These interviews will be held entirely online in order to minimize the risks of spreading the Covid-19 virus. The participants will be approached online and the interviews will also be held online through an online video chat service like Skype, Zoom, Jitsi or Microsoft Teams. This section will primarily focus on the first sub research question and the respective following five sub-questions. In this section, care workers will be asked what they already know about activity design for clients, general knowledge about ICT and robotics, knowledge about social robots, study curriculum and more. This will provide a clear understanding of the needs care workers and what aspects are currently lacking. This is important later on in the research to design a solution to the main problem.

Next will be a brainstorm session in order to come up with a wide array of ideas that covers many aspects and possible solutions to the problem. All possible solutions will be carefully weighed and considered against the results of the interviews. Afterwards, the best concept solution will be chosen and worked out further. This section will carefully consider the second research question when trying to find a solution.

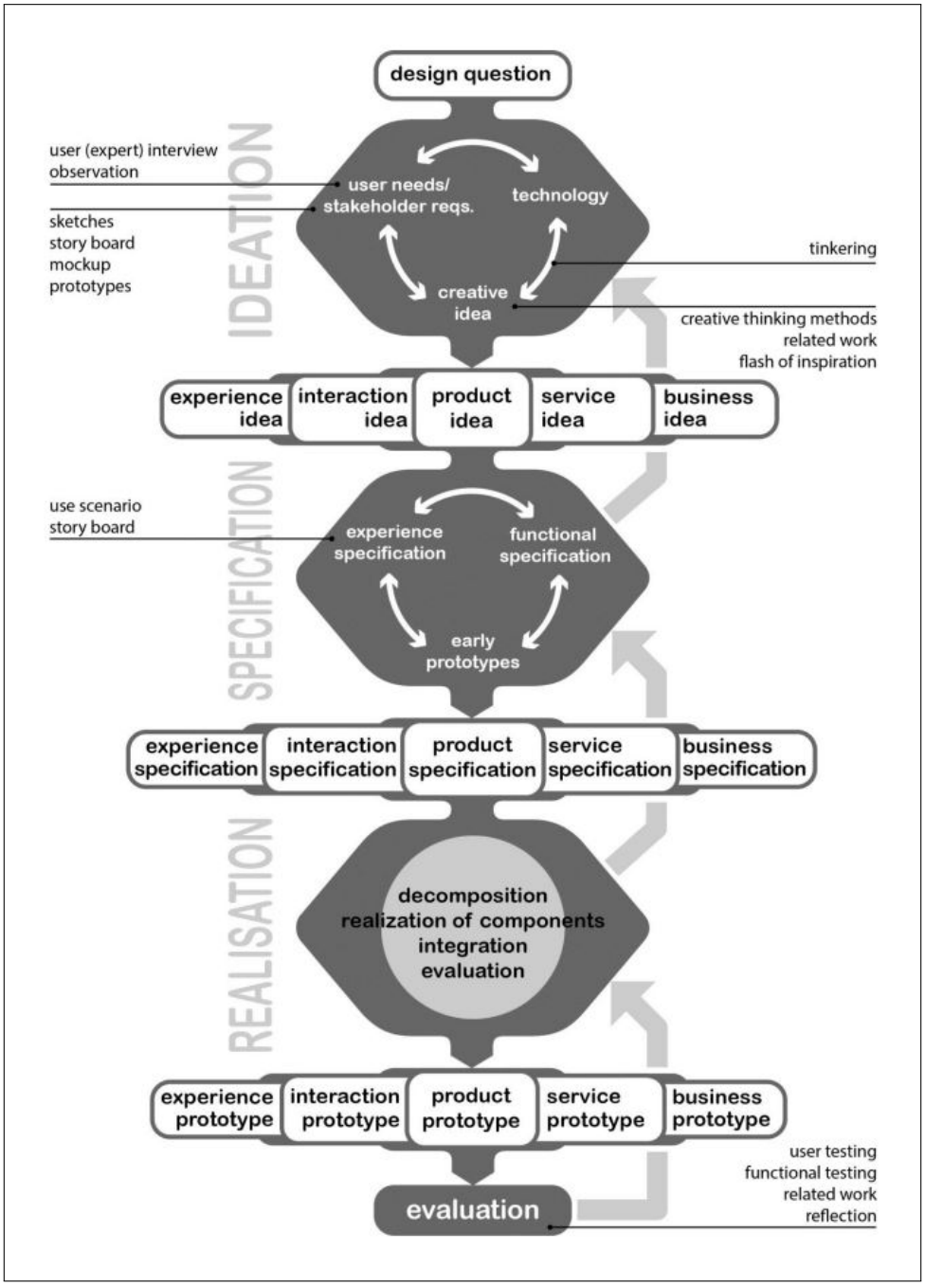

Figure 7: The Creative Technology Design Process

3.1.2 Specification

In this phase, the chosen application will be worked out further in more detail. A detailed description of the vision of the application will be given and the methods used to make design decisions will be described in depth. The specifications phase will also give an idea of the implementation plans as well as the design aspects like the functionalities, use case scenarios and the functional and non-functional requirements. Finally, the specification phase will end with an early draft of the applications and an architecture of the application to make the relation between the elements clearer.

3.1.3 Realization

When the specifications have been worked out in detail, the Realization phase can begin. This section will focus on the realization of the actual project in detail. This section will focus on both the second and third research question. The information needed to make the design of the project meaningful and impactful will be carefully considered. This will be done through literature and interviews. When the necessary information has been collected, the design of the application can begin. This phase can be done in several iterations of the application, each iteration improving upon the previous one. This will be done until it is either fully satisfactory or until the time-frame of this research project allows it. The final iteration of the application will then be user tested for the final evaluation in the next phase.

3.1.4 Evaluation

In this phase, the final user testings will be held. The final versions, however far they are in the development process given the time-frame, will be presented to the stakeholders and can be tested. Their feedback will be considered for possible improvements. This can include additional features, unnecessary aspects or aspects with room for improvements. This can be taken into account for further development or future works. The goal of the evaluation phase is to check if the goal of the research project has been accomplished.

3.2 Conclusion

The planned workflow of this research project has been described in this chapter. It must be noted that, while this chapter has a linear structure, the actual graduation project will be done through a continuous feedback loop. In each section, new information or feedback will be collected and will be implemented to improve the project, whether it comes from literature, user feedback or feedback from the project supervisor or critical observer.

4 Ideation

4.1 Students and working care workers interviews

After getting an idea of the current situation in activity design and social robot usage in a medical care setting through the literature, it is needed to verify the information in a real-life setting. This will be done by conducting interviews with people from the Netherlands who are in the following group:

- *Students who are currently following, or are finished with, an educational program in the care sector or are alternatively working in the sector field.*

The results from the interviews will provide more information about social care workers and their understanding of technology and activity design. After analysing the data, the following research questions can be answered:

- What understanding of activity design and social robots do care workers have currently?
- What knowledge about social robots is already being taught in the education of care workers, if at all?
- How do care workers evaluate the impact of an activity of a social robot on the clients?

4.1.1 Method

Due to the current Covid-19 pandemic, extra safety measurements have to be taken. Therefore, all participants were approached through online means like WhatsApp or e-mail. They have been informed shortly about the research and asked if they wanted to participate in an interview. If they agreed, a consent form (see Appendix A) was sent to them. The consent form contains a more detailed description of the research as well as the procedures and risks of the interview. The conducted interviews have a semi-structured form, with a standard list of questions prepared beforehand, but leaving room for spontaneous questions during the interview. The interviews were all held online through Discord, Microsoft Teams and video call. The interviews took between 20 – 40 minutes each. The full list of interview questions can be found in Appendix B.

4.1.2 Participants

In the scope of the research, six students or working care workers were interviewed. The age between the participants ranged from 22 – 31 years old. All students and working care takers were female and five out of six participants had followed the study nursery at a Dutch college level. The fourth participant had followed the study 'SPW 4' which stands for in

Participant	Age	Gender	Study	Working
1	23	Female	Verpleegkunde	Yes
2	22	Female	Verpleegkunde	Yes
3	23	Female	Verpleegkunde	Yes
4	31	Female	SPW 4	Yes
5	30	Female	Verpleegkunde	Yes
6	22	Female	Verpleegkunde	Yes

Table 1: Overview of (ex)student participants

Dutch 'social pedagogical employee' at a Dutch MBO 4 level. See Table 1 for the overview of the interviewed participants.

4.1.3 Results

4.1.4 Understanding of activity design

The participants were all asked about their main focuses of their study program. They described their study and what they were taught. Examples were nursing skills, medical knowledge, communicative skills, ethics and law. Participants 1, 2 and 6 also said that they were taught technical skills whilst participants 3 and 5 said that they did not have an explicit course about technical skills, but it was sparsely taught in some of the other courses in a very basic form. Participants 1, 2, 5 and 6 graduated their study in Saxion Enschede whilst participant 3 graduated her study in Hanzehogeschool Groningen. Participant 4 indicated that there was no focus on technical skills at all in her study program.

When asked about their experience with activity design, all of the participants stated that they have had some experience with it in one form or another during their study and internships. Initially, without any explanation, all of the participants thought that activity design meant physical activities like a day out. After clarification, participants 1, 4, 5 and 6 indicated that they had a daily routine which they needed to take care of, however they did have time during the day to do various activities. Participant 4 indicated that in addition to that, her supervisor mainly designed new activities for new technologies like a touch pressure sensitive vest. Participant 3 works as an assistant and indicated that she does very little activity design of her own. Three participants did indicate that they have some difficulties with activity design for their clients in that they sometimes misunderstand the needs of the client.

4.1.5 Understanding of technology

When asked about their understanding of technology in general, all of them said that they did not have in-depth knowledge about technology, but they do know some of it in a basic form and can interact with the most commonly used devices like smartphones and computers without issues. Participants 1, 2 and 6 did indicate that the technical skills that they were

taught in their study was limited to working with equipment in their field and commonly used computer programs for administration. Their curriculum did not contain any really technical stuff like programming. Participants 1, 3, 4, 5 and 6 were already aware of the concept of a social robot and what they can do for their clients. They might have heard it in the news or heard it from other colleagues and have a general picture. Participant 2 had an idea but did not know if it was right.

4.1.6 Opinions on social robots

Whilst all of the participants are currently working in the field, none of them are currently working with any form of social robot. They do use technical equipment to get measurements for example and administer data into a computer system, but they do not interact with a social robot in their day-to-day work.

All 6 participants unanimously agreed that social robots can be beneficial to social care workers if they are implemented well, especially for the more mundane and tasks. Their expectations of what a social robot can do is very low, since robots do not provide personal care as well as a human nurse. The human touch element in providing care is not replaceable by a robot. Only participant 3 thought that maybe if the social robots were designed really well, it could also do more complex tasks a human care worker would do.

Participants 1, 3 and 6 said that, if there were a social robot being introduced in their day-to-day work, they would evaluate the effectiveness of the robot mainly on the satisfaction to the clients. Participant 2 thought that it was very important that the communication and interaction between conversations would flow naturally.

As for the impact of introducing social robots that are able to be designed by the care workers, participants thought it would be very beneficiary. Robotics can be the future in providing care, if they are implemented well. If there is a system that makes it easy for care workers to design different activities, robots can give better more personalized care to each client. This would also take workload off of care workers, but not too much since these activities do need to be designed and the essential care that only human care workers can provide is not going to be replaced.

4.1.7 Conclusion

The findings from the interviews are in line with the findings of the literature review. While participant 1, 2 and 6 were taught some form of technical skills, they were very limited and basic and did not go very in-depth in the topics. Only for the equipment and programs they might need. Participant 3 and 5 did have some technical skills as part of different courses and participant 4 did not have any technical skills. This might also be because she graduated 12 years ago, and back then technology was not as widespread as now. Participants also already had some experience designing activities during their studies and internships, so they are familiar with the concepts. The expectations of social robots were, however, very low. This can hopefully be changed with a platform that allows care workers to design their own activities with social robots.

4.2 Brainstorm

A brainstorm session has been held to get general ideas on how to make activity design for social robots more accessible to care workers. See Figure 8 for the brainstorm. The brainstorm resulted in four general categories of ideas with each category having its own colour.

4.2.1 Coding aid

One possible solution to make social robots more accessible to care workers is providing coding aid to care workers. This can be done in many different ways like online training courses, video tutorials or including it in their study curriculum. By training care workers to write code on a basic level, the barrier that prevents care workers from designing their own activities with social robots will become lower or disappear altogether. This can be very beneficial, not only to program social robots, but for understanding and working with other technologies in their daily work. However, this is very hard to accomplish and there are many problems with this solution. For one, it will take a lot of time and focus for care workers to learn how to program properly. Many care workers could find it very hard or have no motivation for it. They have deliberately chosen a study program that would not require it. There are also a lot of different kinds of social robots and learning to program

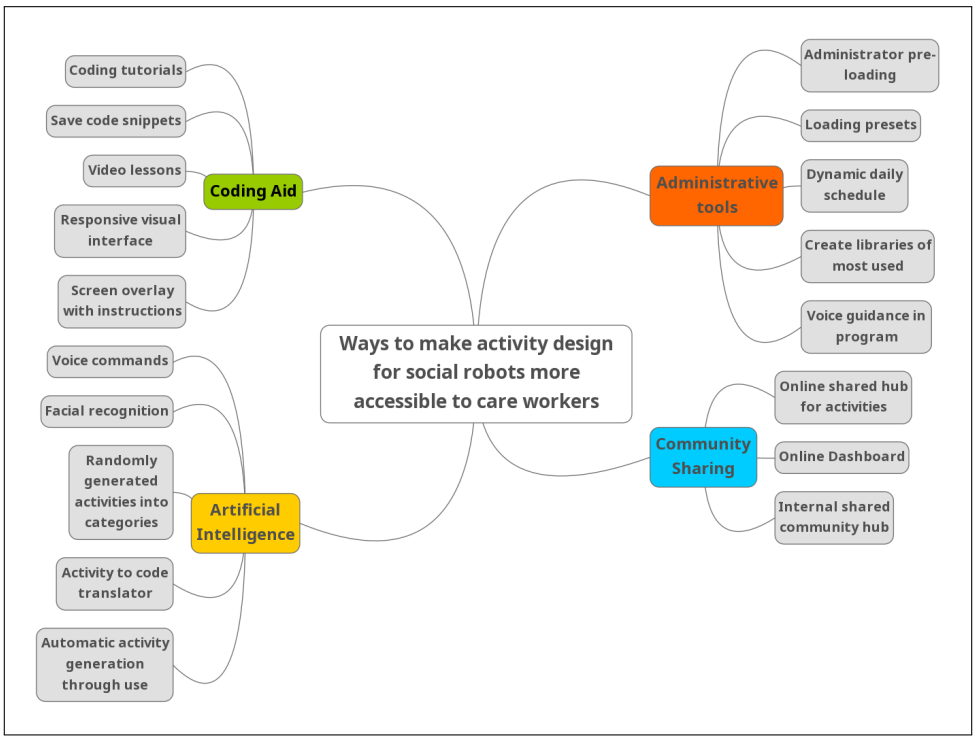

Figure 8: Brainstorm

them all will be impossible. It would be even very difficult for professional programmers, let alone care workers who do this in addition to their own craft. Therefore, this solution was not further explored, and a different approach needs to be considered.

4.2.2 Artificial intelligence

Using artificial intelligence can be another solution so that care workers will get aid from computers and make designing activities easier. For example, social robots can use AI to detect which activities they have performed during which day and what time and try to detect if it was successful. If it was, then they can repeat that activity at an appropriate time and learn when exactly it will be most useful to perform that activity. Or implement an algorithm that implements facial recognition per client and have specific schedules for each different client during the day. Maybe even switch between different clients during the day or have voice recognition to perform activities on voice commands. There are many applications to making activity design easier using artificial intelligence.

The advantages of this solution are that over time it will become easier and easier to use the robot since, in an ideal world, the social robot will learn use patterns and daily routines of clients to predict when and what activity is needed from the social robot. The disadvantages of this solution are that it is very hard and time consuming to implement artificial intelligence well. Clients and care workers are human beings and do not adhere to a strict schedule every day or have the same needs over a period of time. There are also a lot of different kinds of social robots on the market and in use and they all have different functionalities and capabilities. Writing one good working artificial intelligence algorithm for one social robot is already very difficult not to mention time consuming, but they will most likely not work on other social robots and will have to be re-written to optimize them. Therefore, this solution was not chosen.

4.2.3 Administrative tools

The third explored solution was to use administrative help to aid care workers in designing activities for social robots. This category primarily focuses on providing tools for one (or several) specialized person(s) in a care taking facility like elderly homes who will do the activity design for the actual care workers. For example, a platform where someone can create activities with a robot and make it easily deployable in their own care taking facility. This will prevent that care workers need to learn how to program a social robot, but it does mean that either for every care taking facility or for every social robot, there needs to be someone who specializes in creating activities with the robot. The problem would then be, that the specialized person could be very good in programming the social robot, they would probably still not fully understand the complete needs and wishes from the clients. Only the care workers will know what they need exactly. This will result in a disparity that requires a lot of communication and transparency to get right. It would also be expensive to hire an additional specialist who can program the social robots for every care taking facility or train an existing employee. Not all facilities could afford it. Therefore, this category would also not fully solve the issues.

4.2.4 Community sharing

The fourth solution that was thought of revolves around creating tools for people of different backgrounds so that they are going to be able to work together and share their ideas. For example, an online shared community hub where people can combine ideas for activity design with robot functionalities. This has as advantage that people can focus on what they already excel at and combine it with new information that they do not yet possess. Such a platform would not be too difficult to set up and once it is up and running, everybody can start using it and continue using it with new updates, provided the community uploads that new information. The only condition for such a community platform to function is that people will use it so that there is enough information to share with everybody.

4.3 Chosen application

Current care workers have experience with designing activities for clients, but they might not have the necessary knowledge of computer science to start programming advanced social robots to do exactly what they intend to. From the conducted interviews with actual care workers, most of them do have some basic understanding of technology. With the digital age we live in right now, most people including the social care workers have experience using devices such as smartphones and computers. They can navigate through menu's and browse the web effortlessly since they are so used to it in their day to day lives.

From the fourth brainstorm category, community sharing, the idea of creating a shared community hub for people to upload their ideas from different backgrounds seems very promising. As mentioned, such platform would not be too difficult to create and maintain, but it does seem very promising and opens a lot of opportunities for care workers to gain more accessibility to creating activities for social robots that other, more technical, people have more knowledge about. Such an application would also be accessible to people who only have a basic understanding of technology and for example, only use their smartphones every day and do not know anything else in terms of technical operations and would also fit in a project of this difficulty and time scope. Therefore, this application was chosen to be worked out in more detail, implemented in a working form, and tested and evaluated by actual care workers

4.4 Teacher interviews

After a concept application was chosen, two more interviews were carried out with two participants who are currently teaching in the Dutch study programme *'Verpleegkunde'* and *'Healthcare and Social Work'*. These interviews were focused on different subjects than the first round since they were, firstly, teachers of the study programme instead of students, and secondly, the application has already been chosen. These participants became available later than the first round of interviews, but given the already limited time frame of the research, the project had to carry on. These interviews primarily focused on asking the teachers how an activity is designed in practice, what is already being taught in the curriculum in terms of activity design, how important technical aspects are for care workers and what they thought of the concept of CARO. For a full list of the interview questions, see Appendix C.

4.4.1 Participants

The participants consisted of one female and one male person and were 43 and 33 years old, respectively. Participant 1 has studied *'Pedagogiek'*, which is pedagogy, and currently teaches in the Healthcare and Social Work programme. Participant 2 has studied Biomedical Engineering and is currently teaching Health and Technology in the Nursing programme.

4.4.2 Results

The additional interviews have brought up a lot of new insights. In the study progamme for Nursing, it is actually possible to choose physics as a course as well as a course called Product Technology, which somewhat comes somewhat close to working with robots, however very simple ones. This is a specialization branch of the study and is not chosen much. Like the previous interviews, both teachers have also indicated that the main program of the nursing study does not include any explicit lessons on activity design. In bigger projects called *'Producttoetsen'*, or product tests, students might encounter the concept of activity design and learn the concept in practice. Both teachers also agreed that while students have chosen for a 'non-technical study', they should still learn about technology since it will be impossible to avoid technology in the future of healthcare. Therefore, it would be wise to start teaching the students more about for example robotics or programming. At the same time, both teachers also indicated that they thought that a gap between the accessibility of social robots and care workers does exist currently, and that they would like to bridge it. When asked about what where they would search to get help on social robots, both indicated that they would have no idea. Participant 2 gave an explicit example about a care robot named Zora, which is a quite complex robot. The department had extra budget and decided to invest in the Zora social robot. They got a course when they first got the robot, but after that they didn't get any more support. They still didn't know what the robot could do or how it worked. They even went back to the company one time to ask for extra guidance, however they only got the same course again without new insights and still struggle to work with the robot.

After explaining the CARO platform to the participants, both were very enthusiastic. They indicated that the biggest problem was that they did not know where to find help if they got stuck when working with a social robot. CARO could provide a solution. Participant 1 was particularly enthusiastic about the fact that there would be a centralized place for social robots, while participant 2 was particularly enthusiastic about the ability to link together activities with robot functionalities, which allows you to browse through both problems and solutions for inspiration. Important aspects that the CARO platform should have were according to the participants:

- Usability clarity of the interface.
- The ability to provide visual guidance since care workers do not like to read a lot of text and might be more credible or believable if people saw the solution working instead of only reading about it.
- The ability to communicate with another user further if one requires more information or further explanations.
- The linking between activities and robot functionalities working efficiently.

Whilst the application has already been chosen at the time of the interviews, the insights received on through these interviews can still be used in the following sections.

5 Specification

5.1 CARO - The online community hub for social care robots

The concept of CARO is that people from different backgrounds can all contribute together to improve the ability for activity design for social robots. Care workers can design activities that they would like to do with their clients, the manufacturers of the care robots can explain how their robot works and how you can develop more activities for the robot and programmers can design additional functionalities for those robots. CARO brings these people together and try to make it easy for the people to combine their crafts into a joint application.

There is a distinct difference between the functionalities that a robot does, their interaction and the activity that a care worker wants to perform with the client. Given an example, a photo album can physically only be opened, closed, and looked at by a client. Functionalities for a social robot could be that it will assist the client in opening and closing the photo album or turn the pages. A social robot can maybe also use facial recognition to recognize the client and ask questions. Next to that, there is also the question of what the care worker is trying to achieve with the client. For the photo album example, the care worker could use it to try and trigger some memories of an elderly person by asking if they can remember who was in the given picture or when it was taken. However, when the care worker asks a different question to the client whilst looking at the same photo, like if they can find a specific object in the photo, then what the care worker is trying to achieve with the client might be totally different, for example, trying to train the brain or eyesight of the elderly client.

These are different activities that a care worker might try to perform with the client, but with the same physical object and actions. These actions can also increasingly be performed using social care robots. The care worker might know exactly what they want to do with the client since they are experts in their respective field, but they might not how they can achieve that with a social robot. With the example from above, a care worker might not know how to program a social robot to ask different questions or how to point at something on a photo. An engineer might know how to program it, but it might be hard to get in contact with someone with knowledge about your specific social robot or planned activity. This is where the CARO platform comes in. CARO will aid the care worker to get in contact with people who have the knowledge about the programming of their specific social robots and help them perform certain activities.

5.2 Observation and activity plan

In order for care workers to design activities with their clients to achieve a certain goal, certain specific steps need to be carried out. Primarily, observations need to be performed and then the activities need to be designed around that with a guidance plan. Observations are performed using an observation plan. When the necessary information has been gathered using the observations, the activity will be designed using an activity and guidance plan.

5.2.1 Observation plan

Observing can be a good way to solve problems for clients of care workers and provide useful information to help design activities around them and make the right decisions. Observing a client is not just done aimlessly, care workers have to do it with permission of their supervisor and possibly also the client him/herself or their caretakers. Only when all parties involved have agreed, then an observation can be carried out.

There are different kinds of observation plans that care workers can use to get the information needed to design their activities. A common way of performing an observation plan is to fill out a work plan that consists of 8 steps, ranging from the preparation starting state to the final way of reporting the findings, paying attention to detail to each step. An example can be found in the Social Work study book[23]. These steps include:

1. Determine the starting situation.
   Before starting the observation, a short and concise description of what is going to be observed and what situation or problem is being assumed is created

2. Collect background information.
   To get the full context, as much background information as possible is gathered. Background information can include for example, name, age, family situation and their situation within their group.

3. Determine the goal and target audience.
   In this step, a very detailed description of the goal is formulated. The goals should only have one possible way to formulate the goal, without any other possible interpretations. In addition, the target audience is described. Most of the times it is a single person or a specific group of people.

4. Create observation questions.
   Observation questions help to bring structure to your observations and help organize approach and help achieve the goal that was set out.

5. Choose a way of registering.
   There are two primary ways of registering the observations: descriptive observation or observation scheme. A descriptive observation is written loosely and can contain anything of importance. This is often more time consuming but more thorough. An observation scheme is basically a checklist where you can check off certain pre-determined tasks and maybe can provide some context like timestamps. An observation scheme is usually much easier and less time consuming but is less thorough and it is possible to miss out on certain details.

6. Determine the observation situations.
   This step, in combination with step 7, is needed to eliminate variables and makes sure that the observations are reliable. An example could be that the care worker will observe a client on the same time intervals, but in different situations and perceive their behaviour/interactions and see if they differ from each other comparatively.

7. Establish the observation data and time stamps.
   This step will establish the observation data and time stamps. To get rid of the

variable changes, observations often need to be performed in multiple time frames to see if the results are still the same. The duration of the observation should also be mentioned.

8. Choose a way to report the findings.
   The data that was gathered in the observations need to be interpreted first before being able to be used. The results, significance and conclusions need to be reported in this step. The target audience for the report also need to be considered before writing the report.

5.2.2 Activity plan

Designing the actual activity for the client can vary a lot and depends often on the client itself, their conditions, and the context of the current situation of the goal. Despite the vast variety of possible activities with clients, care takers still need to create an activity plan to make their activity concrete and explicit. An example would be the internship document of a social pedagogical assistance student who has to design an activity for a client[24].

First off, the physical activity that the care worker wishes to perform with the client needs to be described in detail in such a way that it is only able to be interpreted in the intended way. This avoids confusion or other complications regarding the activity. A reasoning should also be included. Why does a care worker want to perform that activity with the client? The reasons can vary from medical necessity to simply entertaining the client. After that, the goal of the activity should be described. It is already established in section 6.1 that a physical activity and what goal a care worker wishes to accomplish with that activity are two separate things.

Difficulties that can occur when performing the activity should also be considered and written down beforehand. When preparing for an activity with a care client, it is always good to consider what might give a problem when trying to achieve a goal and alter the activity accordingly. For example, children with ADHD might have difficulties keeping concentration if the activity is over a long period of time or autistic people might not understand the activity if it is even slightly complicated. The preparations beforehand also need to be described in the activity plan. That way, it will become less likely that something goes wrong during the activity or that something is forgotten. This applies for both mental requirements as well as physical requirements like the physical objects needed as well as conditions like the date, time frame, and place.

It is also important to consider in the activity plan who you should plan this activity with. Examples could be the supervisor, colleagues, or the guardian of the client. Naturally, the client you are going to perform the activity with should also be described in the activity plan. This can be one individual or a group of clients.

Evaluation of the activity plan consists of a few criteria. One criteria is how a care worker can justify what he/she has done and what the minimum requirements are for the activity in order to be satisfied with the activity. Care workers should also consider how the activity will join the possibilities of the target group to perhaps apply it in the future to other people of that same group. Lastly a reflection about the execution of the activity should be

included in the activity plan to evaluate what went well and what could be improved in the future.

5.2.3 Guidance plan

Through the help of a guidance plan, it becomes possible for a care worker to work methodically to provide good care and support to a client. Working methodically is important since it enables care workers to get a structured view of the needs and wishes of clients and create clear possibilities to not only meet those needs and wishes but also adjust them to each client personally. This way, the client will receive the maximum amount of personal attention and care. Additionally, a guidance plan is being evaluated continuously throughout the process so that the care keeps being adjusted to the altered needs and wishes of the client.

In order to make a guidance plan concrete and measurable, it needs to be done through S.M.A.R.T. formulation. S.M.A.R.T. is an abbreviation for a method to work methodically and concrete. It stands for Specific, Measurable, Acceptable, Realistic, Timebound method. Each component has specific questions that need to be answered or requirements that need to be kept in mind.

Specific means that the plan needs to be specific to the point of not being able to interpret it in a different way. It should be clear who, what, when, where or why something happens. Measurable puts the emphasis on having explicit values that can be measured to get concrete answers. Acceptable focuses on identifiable and action-oriented approach, so is it repeatable? Is there enough support to reach the end-goal? Realistic underscores if the goals set out are reachable or have enough challenge. The goal should not be too easy or too hard. Finally, Timebound makes sure that the plan will stay within a certain time frame and does not exceed the provided data.

The contents of a guidance plan can vary and there is no one way to set up a guidance plan. It depends many factors like the client's specific problem, their needs and wishes, possibilities for a solution and many more. Whilst there is no one specific way of creating a guidance plan, most ways to create a guidance plan follow a certain number of steps. First, a description of the current situation is given with the background information of the client and the problem statement. After that, the guidance needs are described. So, what the client needs and what the care workers can provide for him/her. After that, the goal of the guidance is described. This is the end goal of the guidance and is what will be worked towards. Then the actions and activities that need to be performed in order to reach the goal are described to give a clear picture of what needs to be done. Finally, the guidance plan needs to be evaluated to see what went well and what could be improved in the future.

This way of setting up a guidance plan to create activities for clients provides a systematic approach for care workers to follow. When followed correctly, care workers will always work in a fixed method and perform the same steps to create new guidance plans for new activities. And through the continuous evaluation of each guidance plan, the activities and guidance plans will always be improving.

5.2.4 Implementing the plans into CARO

In order to make it easier for care workers to find what they are searching for in an activity plan, the previously described plans can be taken into consideration when designing the CARO platform. Common themes between all three plans are that they always have to describe the situation clearly, define the target audience, define a specific end-goal that needs to be worked towards and the physical actions that need to be taken in order to realize the goal.

Taking this in mind, it would make sense that a care worker can specify these details when adding an activity to the platform. When creating a new activity on the platform, there will be several forms that the care worker can fill in. These are: Title, Problem description, Target audience, Goal, Activity solution. When these fields are filled in, it can then be paired to different possible functionalities to provide solutions. When not all fields are filled in, so for example, the Activity solution field has been left blank because the creator did not know how to solve the problem or achieve the goal, other users can not only link functionalities but also put in suggestions to the activity solution field. That way, it will become more accessible to care workers who do not know their specific goals yet and the community can help. Other users can not only suggest items to empty fields, but also already filled in ones, but also filled in ones. So for example, other users can also suggest an additional target audience than the one already filled in by the creator if the activity is also applicable to other target audiences. This will provide the maximum amount of compatibility's and prevents additional topics with almost the same information but with a different target audience. It will just be grouped together.

5.3 Functionalities

The main interface and interaction take place on a web interface. The platform will be entirely web based to increase accessibility since, unlike mobile apps, you do not need to download and install anything. Following will be a list of the most important functionality aspects of the CARO platform with a short explanation of the functions.

- The CARO platform will support multiple social robots.
  It will be very limiting if the platform will only support one social robot type like the Anki Cozmo robot since there are so many different types of social robots on the market. The activities and functionalities for each robot will be sorted by each different type of robot.
- Users can search for specific robots.
  There needs to be a search function in order to quickly find the robot that care workers need in order to save time and cause less frustration. The list of social robots will initially be sorted by the most popular robots so that most people visiting the platform will not even have to search for their specific robot.
- Users can browse the platform as a guest, or they can create an account and login.
  Users do not have to create an account to browse or quickly find a solution to their

problems or provide a functionality. Any contributions made to the platform will then be displayed as anonymous and finding their contributions back might be a bit harder. Users can also choose to create an account and quickly see all their posts and reactions and have their contributions credited to that account.

- Users can create an 'activity' or 'functionality' .
  Depending on what the users want to contribute to the website, they can create either an 'activity', which is what a care worker would like to do with a client, or a 'functionality', which is what the social robot will be able to do. Users can add a description of the activity or functionality as well as optional photos. They will be listed in separate tabs for organization and easier browsing.

- Creators can specify different fields when creating an 'activity'or 'functionality'.
  When creating a new topic, fields like Title, Problem description, Target audience, Goal and Activity solution can be filled in. This will make the problem more specific and users can find a topic that meets their specific needs better.

- Users can link together activities and functionalities.
  Users can suggest which functionalities can solve which activities and vice versa. When they click on a created contribution, they can suggest from already created activities or functionalities or create new ones. The suggested contributions will then be linked with each other and show up on the page and when clicked, will take you to their respective pages and show how many up votes the link has to indicate how successful the link is. Users can also leave reactions to the suggested links to ask additional questions or thank other contributors.

- Users can send other users private messages.
  If a posted activity or functionality is unclear to a user, they can send the other user a private message asking for additional help. Provided, of course, that they have created an account.

5.3.1 Use case scenario

Lisa is a care worker currently functioning in an elderly home. Her daily tasks consist of taking care of elderly by regularly taking their heart rate and giving them their medicine on time amongst other things. One day, the elderly home facility where she works has introduced a social robot to take workload off the staff. The social robot that has been introduced is initially only capable of walking around and picking up objects. The provided manual that came with the social robot has instructions on how to use a computer program to add in additional features like talking to clients. The computer program is supposed to be very user friendly, however after spending several hours trying to figure out the computer program, Lisa is still very confused. She would like some help but nobody at the elderly home facility where she works knows how to do it either.

Then she remembered that a colleague of her once told her about a website where care workers can get help from other people on the internet about care robots. She picks up her phone and browses to the website. Once there, she sees a list of robots, but hers is still very new so it was not listed on top. She searched for it in the search bar above and clicked on

her model. There were a few activities listed that you could do with the robot, however she wanted to make the robot talk to her elderly clients to keep them company and that one was not listed. She created a new activity with a detailed description of her intended activity with the client. After the post was created, she put her phone away and went on with her daily tasks.

An employer of the company that manufactured Lisa's robot is assigned to help their customers with designing activities in order to get a good customer service rating. He has searched online on forums but has only found a few results for his specific robot. Then his boss told him to look on a website where care workers could upload specific activities they wanted to do with which specific robot. He went to the website and looks up his specific robot and sees a few entries of care workers having trouble with programming activities. As an expert, he designed a program for the specific activities and uploads them to the website. He then links each specific program to each intended activity. Since he then still had some time left, he thought of an additional few functionalities that his robot could do that care workers can take benefit of and uploads them to the website for future care workers seeking help.

Lisa returns to work the next day and realizes she still did not solve the issue with her social robot. She looks on her phone again for the online platform and sees that there is a functionality linked to her activity with a few up votes. She clicked on the linked functionality and reads the described instructions and attached pictures. She follows these instructions carefully and soon enough she gets the robot to talk to her clients.

5.3.2 Requirements

Functional requirements:

- The web layout shall scale accordingly to which screen it is viewed on.
- The web layout shall be familiar to users, even to those who are not technically wired.
- The web layout shall be intuitive and responsive to user input.
- Visitors shall be able to create an account which stores their posts, reactions, preferences and notification settings.
- Visitors shall be able to create as many posts with activities or functionalities as they would like, provided they are not duplicates.
- Visitors shall be able to assign different activities and functionality posts together with one voter per account.
- Visitors shall be able to sort robots, posts and reactions by different metrics like name, most popular or most recent.
- Visitors shall be able to send other users private messages if a post is unclear or they want more assistance.
- Visitors shall be able to post reactions to the suggested linked items.

Non-functional requirements:

- The web pages shall load within 3 seconds
- Created user accounts shall meet required security measurements.
- The web layout shall allow users to reach their profile data from any page within 3 clicks.
- The database shall be scaleable if in the, the amount of users, robots, posts or reactions become too large.
- The servers shall be accessible 24 hours a day.

5.4 Interface mock-ups

In order to make the process of implementing the actual web platform easier, a few mock ups were created. The mock ups can bee seen in Figure 9.

5.4.1 Method

These mock ups have been first sketched on paper to get an initial idea of the layout and then created digitally using the software Adobe XD CC. This program allows you to create visual representations for user interfaces very fast, which is ideal for this use case.

Figure 9: The initial web mock ups for the CARO platform

5.4.2 Contents

The created mock ups are very basic in their designs. They still lack the detailed graphics, color schemes and images. However the main idea of the elements that should be included and where they should be on the page as well as the basic navigational structure has been drafted. This will provide an initial base to build on when actually implementing the web platform. These designs are a baseline foundation that the implementation can build on and are subject to change when actually implementing the web platform. That is why a more detailed description of all the elements will be discussed in the next chapter of this research.

5.5 Conclusion

In this chapter, the concept of the CARO platform has been explored and researched. A detailed description of what the platform is, how it works and what is should do has been described. The elements that need to be included have been researched and adapted into the design. Also the functionalities of the web platform has been described with a use case scenario and both the functional and non-functional requirements. Lastly the initial designs have been sketched using a few mock ups. These elements will be fully worked out in the next chapter of this research where the actual web platform will be implemented.

6 Realization

In this chapter of the research, the concepts of the previous chapter will be worked out in detail and the design decisions as well as the full implementation will be argued and discussed. The web platform is online and can be accessed through the following link: http://caro.byethost7.com/.

6.1 Method

The initial idea for implementing the CARO platform was to use plain HTML, CSS and Javascript in some sort of text editor like Visual Studio Code to develop the front-end of the website since that is the industry standard and most flexible way to create a front-end web interface. To create the back-end of the website, the initial idea was to use either Django or Flask since they are based on Python, which has been covered in the Creative Technology Bachelor curriculum and should be familiar to work with. However, due to the time constraint of this research, creating a back-end for the CARO platform is not feasible. This means that users cannot actually create their own activities or functionalities to upload on the website. A few examples will be created on the front-end to test the usability. A few other important functionalities will also not be working as a result of this time constraint and not having a back-end. Examples are the search function, sorting the listings, linking activities and functionalities, upvoting system and creating personal accounts.

Due to the unfamiliarity and inexperience of using plain HTML, CSS and Javascript and the time constraint of the research, the web platform has been developed using a software called Adobe Muse CC. This software allows users to create websites with a more graphical user interface. This should work well since in the scope of this research, there will be no back-end to integrate. The initial design of the mock ups created in the previous chapter will be taken and used as a baseline foundation to create the web platform in Adobe Muse CC. Adjustments will be made where necessary and a more aesthetically pleasing design will be used.

6.2 Elements

6.2.1 General

It is important for the web platform to feel familiar to already existing web pages out there in order to avoid a learning curve when people are visiting the web page and can immediately use the website when first visiting. That way, the most amount of people will be able to use the website. That is why for the basic navigational structure of the web platform, the CARO logo has been placed on the top left of the page, with in the middle of the page a horizontal navigation bar and to the right a place for people to access their personal account. See figure 10. This is a very common layout for a lot of websites and should feel familiar to the users, even if they are not very technical. As long as they can use a computer to navigate most used web pages.

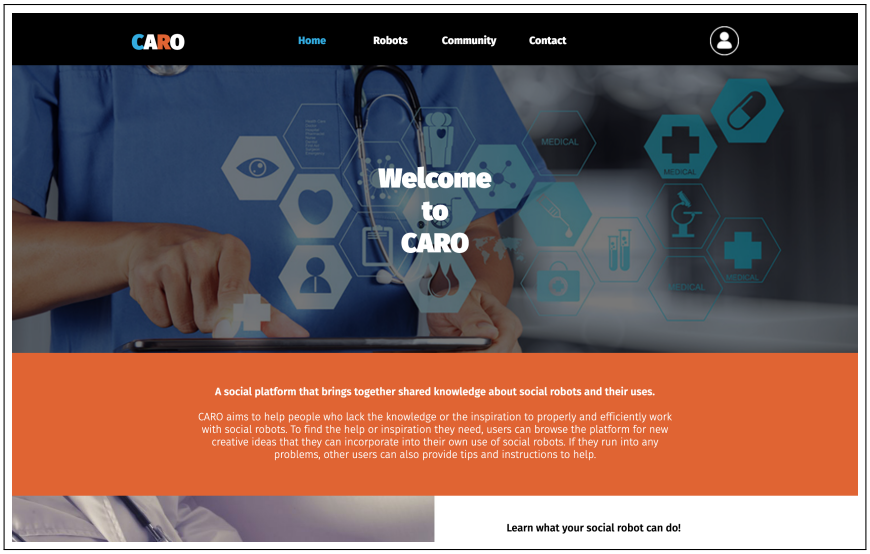

Figure 10: The home page of CARO

The chosen color scheme of the website consists primarily of two colors: a shade of light blue and a shade of rich orange. A shade of light blue is commonly used in robotics used in healthcare, which leads us back to familiarity to the user. The shade of orange is a complementary color of the shade of blue which means they work well together on the same page. The color scheme will be consistent throughout the whole website to give the web platform more coherent and have a more distinct identity. This can also be traced back to the logo of CARO, which actually is just a combined word of CAre RObots. The theme that the blue elements indicate the healthcare aspects and the orange elements the robotics aspects also remain consistent throughout the whole website as can be seen in the activities and functionalities pages later This makes it easier to distinguish the elements for the user.

6.2.2 Home page

The home page is very important for a first impression of the web platform. See Figure 10 for the landing page. In one glance, it should feel consistent and modern whilst also delivering the most important information about what the CARO platform is, who it is for and what it can offer. Figure 10 shows the landing page of the web platform. It first shows a welcome sign that is in front of a picture. Right below that, a short description about what CARO is supposed to be is described. People who are new to the platform should be able to read quickly what the platform is and should not have to go looking for it.

Below the initial description are two blocks of additional information for the users. It lists what the website has to offer to the two different groups of people who visit the web platform: people who visit the website looking for inspiration or help for their social robots and people who want to share their knowledge about a social robot and what you can do with it. The blocks of information also has a hyperlink, allowing users to quickly navigate to the relevant

sections of the web platform. In the first block, it allows users to quickly create a new topic and in the second one to browse the website by robots. At the bottom of the home page, there is a lengthier description of how the platform actually works. This will come in handy for the first time visitors who do not yet understand how the platform works.

6.2.3 Robots page

This is the main navigational page of the website. See Figure 11 All of the activities and functionalities are sorted per social robot. Visual representation is important according to interviewees in chapter 4. Most care workers or casual users in general do not want to look solely at text and much more prefer to look at visual elements like pictures or videos. Therefore, on the left hand side of each social robot listing, a picture of the robot is displayed. This way, users don't have to read the text to select the social robot they want. There is some text next to the picture, giving a short description of the intended use and functionalities of each social robot. This is listed because it might be useful for users who are looking for a social robot to perform a certain task and do not know which features each social robot has.

Users should, in addition to only browsing the social robots, also be able to search for a specific robot they want. This can be done using the search bar. The users can also sort the listing of social robots in different ways to make it easier to find the one they want. The sorting options that are available to the users can include: Alphabetical A / Z, Alphabetical Z / A, Most Popular, Least Popular and Latest new topic. The loading of all the robot should be limited to save data usage and speeding up loading times. If the user wants more than the listed amount of robots, they can click on see more to load more robots in.

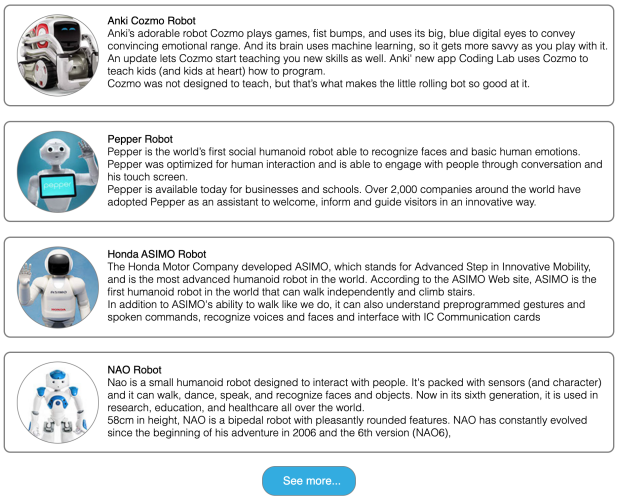

Figure 11: Listing of social robots

6.2.4 Activities and functionalities pages

When a robot is selected from the browse robots page, it will lead the user to the page of each specific robot. See Figure 12. Each specific robot page has two different tabs: one for activities and one for functionalities. The activities page shows a listing of all the different activities that users want to achieve with the robot, but they either don't know how or they have encountered some sort of problem when trying to realize the activity. They can list who they want to perform an activity for, what their goal for the activity is, what kind of activity they would like the robot to perform to achieve that goal and optionally what problems they have encountered. The functionalities page is much like the activities page but instead it shows the listings for the different possible functionalities that users have uploaded on what the robots can do. There it lists what the actual functionality is, a preview of the instructions of the functionalities and optionally who it intended for and for what goal. The title summarizes the activities and functionalities in a short sentence. Other information that is short such as the target Audience, Goal and Activity are shown in full and the Description and Instructions is only displayed as a preview because they are allowed to be very long and can contain images or videos.

Like the browse robots page, users can also search within the specific robot page for specific activities and functionalities or sort them by different metrics like Alphabetical, Recent, Latest update and amount of Replies. Users can also create new topics by clicking on the green button 'CREATE NEW'. This will lead them to a separate page that allows them to fill in a form for new topics. The form that needs to be filled in is based on the criteria researched in the conceptualization chapter and the listings in the mock up. When the database gets implemented, the new topics will then be added to the according page. Not all fields need to be filled in when creating a new topic, the user can decide how much they want to fill in. The more filled in, the more specific the topic. But they can also leave a

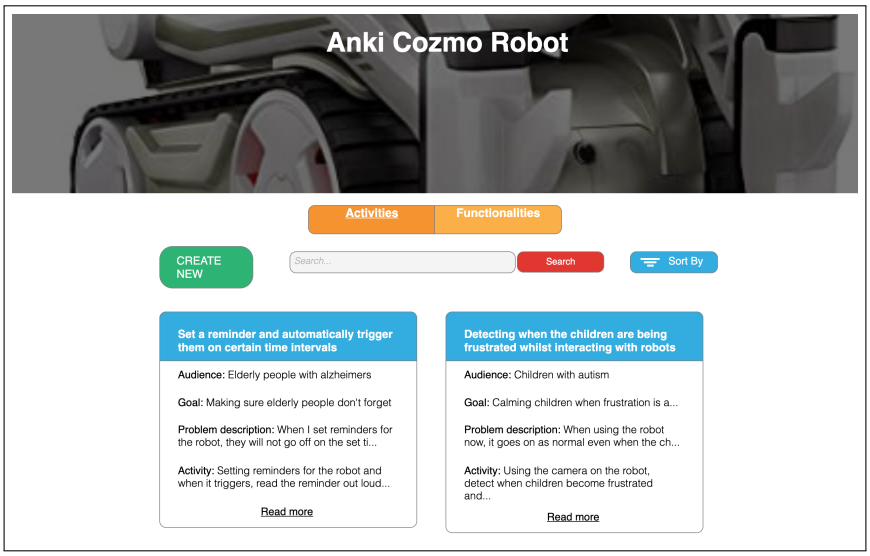

Figure 12: Activity listings for a the Anki Cozmo Robot

few fields open to leave room for suggestions. For example, they might fill in a form for an activity a goal of what they want to achieve with the patient with what robot and the other fields left empty. Other users can then suggest what the activity can be and what functionality can get linked to it to achieve the goal.

Each topic has its own separate page that the user can access for more information by clicking on 'Read more'. See Figure 13. Once there, the activities and functionalities are shown in full with the all of the information of the descriptions and instructions, including any images and videos. Here, users can link the activities and functionalities together to find the best solutions for every different scenario. Users can select if they want to link an already existing topic or if they want to create a new one and automatically link it. For example, a user clicks on an activity topic where the activity goal is to help elderly to remember their daily tasks. The actual activity is listed as robots asking elderly if they remember what they are supposed to do two minutes before they are supposed to do something. If the elderly replies yes, the robot gives a compliment and if the elderly says no, the robot tells them what they were supposed to do. To link this activity to a functionality the user clicks on the 'SUGGEST' button and gets taken to a list of functionalities for that robot. He searches for a solution, but only finds it in parts. One is to get the robot to remind users when they should perform a task and another part is to reply to the users based on their input. The user can then decide to link both of the functionalities to the topic or the user can choose to create a new topic specific for this activity, combining both functionalities, and then link it.

All linked items are listed below each detailed topic page and are sorted based on the amount of upvotes it has. The better solutions obviously have a better chance of being upvoted so this way it prioritizes the links in order to try and get the most effective results for the users. The best link will get highlighted and the others are listed below. The score is displayed on the left hand side.

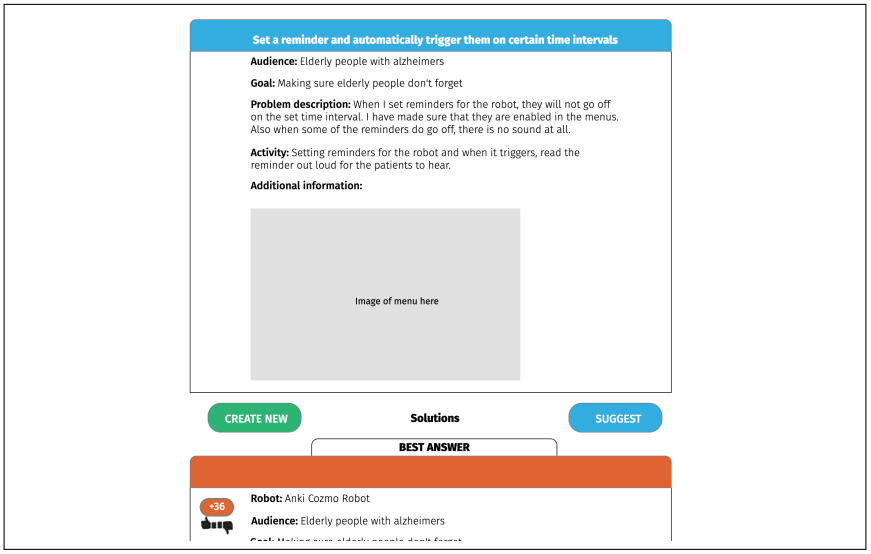

Figure 13: A detailed topic listing and it's best answer

6.3 Conclusion

This section has shown and described the different front-end elements that the current version of the platform has. It's functionalities are described and the reasoning behind the choices. There are a few pages not yet finished on the platform like the community page, contacts page and the account page. The community page is a page where you can search for different users, add them as friends and see all their contributions on the website. In the final version of the CARO platform, it should also allow users to send messages to each other in case they need further support. Unfortunately, due to the lack of a back-end server, that is currently not possible. The same goes for the account page. It should allow users to create their own account and manage it. The contacts page is also not yet finished, however that will not make a difference in the user testing and evaluation of the CARO platform for now. The implemented front-end website should suffice in the usability testing and get useful data for future works.

7 Evaluation

7.1 Introduction

When the front-end of the CARO platform is realized, it will be evaluated with user tests. The aim of the evaluation phase is to get to know which parts of the web platform work well and which parts still need improvements. The evaluation aims to answer the second and third research questions *'What are important usability aspects for care workers when it comes to developing activities for social robots?'* and *'What characteristics does a platform need to have such that it allows for multiple activity design?'*, respectively. The evaluation will provide useful feedback that can be used in the next versions of the CARO platform. This results of this chapter will be based on several user interviews with care workers and instructors.

7.2 Method

Due to the current ongoing Covid-19 situation, the front-end CARO platform will be tested through online means only. The usability tests consists of a series of tasks that the user must perform using the developed prototype of the CARO platform. The users are asked to share their screen and are observed by the researcher. The users do not use the platform beforehand to get familiar with the platform, they will use it as the first time they visit the site. The users are encouraged to use the 'thinking out loud' technique when performing these tasks. These tasks consisted of basic functionalities that the web platform offers like *'Create a new topic for the Anki Cozmo Robot'*, *'Search help for setting a reminder for the Anki Cozmo Robot'*, *'Suggest a use case for turning off silent mode on the Honda ASIMO Robot'* and *'Create a new functionality for the Anki Cozmo robot'*. Afterwards, an interview will be held with the user to evaluate the prototype and find out what aspects needs improvement and what content the user would upload tot the web platform. A list of the tasks and interview questions can be found in Appendix D.

The participants for the evaluation phase of the research consisted of participants from the earlier interview in the ideation phase. Only four of the previous participants were able to do a follow-up user test and interview within the given time constraints. The ages ranged from 22 to 30 and all of them have studied nursery at a Dutch "HBO" level and are currently working in a healthcare related field.

7.3 Results

The results are based on the observational reactions from the participants whilst they were performing the tasks given to them as well as the interview results afterwards. During the user tests, the screen was recorded in combination with their facial cameras to get an initial impression of what they thought of the web platform and the interview answers were also recorded to analyze the results further. The results were analyzed by looking back at the recordings and writing down everything that might be of interest in answering the

questions that were formulated. After everything has been written down, the results were then grouped per section. This was done for all the participants and in the end, all the answers and insights of the different participants were then added together to provide an overview. These results will be elaborated more on in the following sections.

7.3.1 Usability aspects

The participants were all informed that it was a front-end website only for now, meaning there would be a lot of functionalities missing. Regardless, all participants tried some functionalities like sorting the lists and searching anyways, out of curiosity mostly. During the interview, three of the participants indicated that the web platform felt very responsive and intuitive to use in terms of button placement, menu layout and the website structure in general. The fourth participant also indicated that the web platform was responsive, however less intuitive because the buttons were sometimes in strange misaligned places. This could be that this specific participant was using a very old laptop with a low resolution screen. The website was made on a screen supporting a Full-HD (1920x1080) resolution and was optimized for that resolution. Regardless, through observation when the participants were trying to perform the tasks given on the platform, it seemed that all four participants did not have trouble regarding navigation through the website. When asked about this later in the interviews, all participants stated that they would not need additional guidance to be able to navigate through the website because it felt familiar with other web platforms they frequently use on a daily basis.

7.3.2 Content aspects

The explanation on the web platform itself about what the platform exactly is, what its goals are and how it was supposed to be used was mixed among the participants. Two of the participants thought is was clear enough to get the idea and after using and exploring the web platform itself it became clear. The other two thought that the complete story was still a bit vague and that they did get the idea of the website, but were not able to figure out how it was supposed to work with linking the activities and functionalities together. The terms used like *'Activity design'* and *'activities'* and *'functionalities'* and *'linked solutions'* were not understood immediately. Even though there was an explanation on the home page of the web platform, they needed additional explanation to fully understand the context, goals and how the web platform worked.

When asked in the interview after the test session, the participants were unsure what real-life activities or functionalities they would add to the platform if they were to use a social robot. There were four examples of activities and functionalities on the web platform that were pre-programmed on the website and they said that they would probably upload something along the lines of what was already uploaded on the web platform; if they wanted to perform a task with the social robot but they were unsure how to do it, and gave examples like for a robot to pick up things and bring it to their patients or themselves, physical assistance for an elderly to put them on their bed or in bath and talking naturally to their patients and go into their responses.

When asked about the forms that a user has to fill in, in order to upload an activity or functionality, the reactions were also mixed. Two of the participants indicated that the forms were good and that it contained all the information and features like uploading pictures or videos in order to make their problems clear. One other participant said that the activities form was fine and would not know what to add, but in the functionalities form the fields *'Audience'* and *'Goals'* were not necessary since with functionalities they can be targeted towards any goal or audience, as long as the functionality worked. The fourth participant indicated that it was a bit confusing to distinguish between the fields like *'Title'*, *'Goal'* and *'Activity/Functionality'*. She didn't know what information should be filled in into which field and could use some more clarity about what information goes where. Especially if it is dependent on linking the activities and functionalities together.

Regarding the linking between the activities and functionalities, three of the participants thought that the linking method between the activities and functionalities would work when the web platform would have an actual database to record them in, maybe provided with some additional explanations. They indicated that it would take very little effort to find the easiest solution to your problem and it does not restrict people to only thinking of solutions to other people's problems, but also allows other people to create their own functionalities that they simply would like to upload and then see what other people can do with it. They thought that the two way implementation was refreshing, if the algorithm behind the linking and ranking is implemented well in the future. One participant was a bit sceptical if this would work, because people are allowed to leave fields blank which could cause for problems regarding duplication of topics and the fact that the activity submission form has more fields than the functionalities, that it would be difficult for them to find each other and get linked.

7.3.3 Aesthetic aspects

Regarding the aesthetic aspects, all four of the participants indicated that the initial impressions were good overall. The homepage looked pleasing and professional. The colors worked well in contrast with each other, the pictures were a bit standard but were nice to look at and set the tone well and fit the context and the text size and font were very readable. All participants also indicated that the *'Browse social robots'* page was aesthetically pleasing and the icons for each robot was very handy in combination with a name next to it in quickly recognizing the robot they wanted to if they worked with one in real life.

Where the participants were mixed about, was the landing page when having selected a social robot and being navigated to the activities and functionalities page for that robot. Two of the participants said that the page looked fine and displayed what it should to the user, whilst the other two indicated that it looked a little off. The colors of the buttons and the and the cards were overwhelming with so many different and bright colors. All of the boxes were also rounded off, which came off as being made for a child. They indicated that this was distracting to them and looked out of place coming from the home page.

7.3.4 Overall Remarks

Overall, the reactions from the participants seemed positive. After interacting with the web platform for a while, they did figure out how it worked and saw the potential in it. They indicated that it would be very handy if something like this would exist and is implemented well, they would use it in their daily lives, provided they would need to work with a social robot in the future. They all indicated that there are quite some improvements to be made, as well as implementing the back-end.

When asked about the primary improvement aspect for the CARO platform, (apart from adding the back-end database and implementing the algorithms for suggesting, linking and up-voting of the activities and functionalities) two of the participants indicated that some more clarity about some of the terms would be appreciated as well as how the platform works. Another participant indicated that the web platform could be improved more regarding responsiveness and consistency in shapes and colors. The last participant indicated that the linking together of the activities and functionalities could use some more thought and could be worked out in more detail as well as which fields would be necessary to fill in when trying to submit an activity or functionality.

When asked about a functionality that wasn't currently in the web platform or described in the final version, but they would like to see, three participants indicated that it would be very practical to have a way of getting into contact with the person who provided a solution to you, to ask further questions if you still don't understand or somehow it does not work for you or just to simply thank them. The last participant could not think of anything to add, once all functionalities had been added and work well and the front-end was smoothed out.

7.4 Conclusion

In conclusion, the participants were enthusiastic about the CARO platform and thought it has potential to become widely used in the future. The initial impression of the platform was good, the navigation through the platform felt intuitive and the idea of linking together activities and functionalities of social robots together in a two way fashion was refreshing. However, to get the platform running for real, there are many things that can be improved. The front-end website could be more responsive and consistent, more explanation on what the platform is and how it works could be added, the back-end database and functionalities are still to be added and the linking between activities and functionalities as well as the fields that users need to fill in need to be worked out in more detail. All-in-all, with only the front-end side of the CARO platform, the participants provided very useful information that can be taken into account when working further on the platform.

8 Discussion and Conclusion

In the final phase of the graduation project, the results will be discussed, a conclusion will be drawn and answers to the research questions will be provided as well as the limitations and potential future work will be described.

8.1 Discussion

8.1.1 Approach to evaluation

The results of the evaluation has provided a lot of useful information that can be used in future research, however looking back at it and comparing it to the scope of the entire project research, the evaluation has been really focused on the technical aspect of the CARO platform itself, rather than the overarching goal of the research project, which was to provide a way for social workers to access social robots more easily. The results of the evaluation was able to collect a lot of useful technical information that can be implemented in future versions and prototypes of the CARO platform like that care workers in general find it very important to have visual stimulation and information instead of only written text. A functionality where people can directly contact other people about their solutions seems to be also very wanted. Regardless, a big portion of the information that is collected during the evaluation phase of the research is only applicable to the current version of the platform that I am developing like the colors, navigation and responsiveness of the website, even without the core functionalities of the back-end of the website. If somebody else were to develop a similar platform to CARO, that information would not help them. The focus should have been on the concept of the platform, not a concept draft of one potential variation.

8.1.2 Reflection

The time spent on evaluating the front-end aspects of the platform would have been better spent focusing more on what actually would have mattered to the concept of such a platform as a whole. Examples could be to focus on the aspects of real world use case scenarios from care workers on what they would upload to the website and how they would do it. This would provide information about what information care workers would find really important to describe what they are struggling with and how they would put it to words and ask for help. That information can be used in more than this single CARO platform. It would have also been possible to work out more how the linking of activities and functionalities would actually fit together, what information is needed to link them together and how not to create duplicates of the topics by effectively and efficiently grouping them together. However, I lost the scope of the research project and tunneled too much on the front-end aspect of the CARO platform because that was what I have actually made in terms of technical implementation while the rest is all research based. This will be a useful lesson to remind myself to always take a step back sometimes and look at the bigger goal of the research and work towards that, rather than what you have just made and test that as in depth as possible.

In light of this, looking back at the research project and its process, CARO is one possible solution to tackle the presented problem. This might also be a case of tunnelling. While during the Ideation phase, interviews were held to get an idea of the current situation and needs of the care workers in addition to brainstorm sessions with the results carefully considered, realistically, one possible solution was worked out further. It might be a good idea to work out multiple ideas in more detail and ask the stakeholders also what they might think is the best idea instead of choosing an idea and afterwards asking for their opinions and feedback. This way, the problem is open to more possible solutions.

Another aspect that could have gone better was to make clear to the participants and user tests what the term *'activity design* as well as the difference between the *'activities'* and *'functionalities'* sections, really meant in the context of this research. I struggled a lot to make it explicitly clear what it would contain, both during the first interviews and during the user test on the web platform itself. Several user test feedback have suggested the same. This is important to get right, since it will cause users to understand the goal of the platform better and thus also a better understanding of how the web platform should work.

8.1.3 Potential of CARO

Looking at the CARO platform as a whole, with the initial prototype of the web platform, it shows promise. The results of the initial evaluations had positive elements, with feedback on how to build and improve on them. Yes, there is still a lot of work to do still, however care workers indicated that they currently have no idea where to look for help if they were stuck on designing new activities with an actual care robot other than a google search. With CARO, people of all technical levels can find help or contribute to the community of social robots, all in one place. Currently, there is no similar platform online (that I was able to find) that is specifically focused on social robots. There are general websites like stackoverflow that have a very broad range of topics that people ask help on, but even that is only a one-way information transfer. One person has a problem, asks a question on the platform and someone else provides the answer to it. With the CARO platform, people with technical functionalities and solutions can put them on the website regardless if currently someone needs it or not. Other users can simply link them to the newly created activities.

Currently, there are still relatively few social robots on the market right now. Whether it is in a healthcare facility or in someone's home. The literature shows that there is a growing trend for social robots, which means in the future they will increase in popularity. This gives CARO the perfect opportunity and time to develop further, continue testing with actual care workers, work out the bugs, increase the functionalities and overall give it time to mature into a fully developed platform with all the functionality that someone would need from working with a social care robot. This will also give CARO the time it needs in order to increase itself in terms of popularity and the brand name, which is also very important. CARO is a community platform, so it needs the users to upload their problems and solutions themselves. If the web platform is visited by not many people, the whole platform will not achieve its purpose. This is perfect time to start development for such a platform for the future is right now, before people get more familiar with social robots and try to use them more.

8.2 Conclusion

During the background research phase as well as some of the ideation phase with the interviews, the first research question, *'What are the main challenges that care workers face when working with social care robots?'* could be answered along with its sub research questions. Currently, social care robots are very limited in their functionalities, the places they are currently implemented in and the usability and reprogramability of them. This is to change however, since it is predicted that the use of social robots will increase. Currently, care workers are often not explicitly learning activity design and have to learn it implicitly during their other assignments or real world experience like internships. They are also often not learning much about working with technology beyond what is necessary for care taking like inputting tracked information into a program. This is crucial information that is missing from their curriculum.

The second and third sub research questions *'What are important usability aspects for care workers when it comes to developing activities for social robots?'* and *'What characteristics does a platform need to have such that it allows for multiple activity design?'*, respectively, were answered during the specification phase research and after the realization also the evaluation phase, but they were answered with keeping one of multiple ways to make activity design more accessible to care workers in mind; with the CARO platform. Important usability aspects for care workers when it comes to developing activities for social robots are that the robot has a more graphical user interface that the care worker can see more clear at a glance without reading paragraphs of text first and also that the interface is intuitive to use and familiar to already existing pieces of software to eliminate the learning curve. The use of a simplified programming language could also help a lot. Regarding the characteristics of a platform that allows for multiple activity design, the platform should be able to allow users to upload their activities that they have problems with realizing using a social robot, and other people should be able to provide help by either linking an existing functionality or creating a new one. Sadly, the definitive information on what actual information forms need to be filled in when creating a new activity and functionality needs more research. The gathered information during the specification phase is theoretical and in the evaluation phase, due to the small participant numbers and the lack of effective communication about important terms meant that no meaningful real world use case scenarios have been collected to be used. Some other characteristics that the platform does need to have consists of the ability to effectively link an activity to a functionality or vice versa without being restrictive in a way. Another characteristic would be being able to add more clear and visual information in the activities and functionalities topics like being able to upload photos and videos to elaborate more on the problems or solutions, as well as the ability to create accounts and being able to message other users if further communications are desired.

To sum this all up, through all the research and user tests, the main research question can be answered. ***'How can activity design for social robots be made more accessible to care workers?'*** Currently care workers do not learn much about working with robots in their care study curriculum, however the question does rise, that whether or not social workers actually should learn to work with more advanced technology like robots. They have chosen a non-technical study and are learning to provide care for patients. Why should they in addition to their current curriculum, also need to learn about technology, which is in a different field of speciality altogether. CARO - The online platform for social robot

applications can help bridge the knowledge gap that exists between care workers and social robots. CARO allows care workers to not worry about the technical aspect of social robots, and focus on what they are good at: designing activities for their patients and taking care of them. As long as the care worker has knowledge about basic web navigation, they can find help about their specific social robot. The platform also allows people with more technical knowledge access to the platform and do what they are best at: explaining and inspiring people what they can do with their social robots. That way, people are encouraged to do what they already excel at and the CARO platform provides a way to bring that together.

8.3 Limitations

There are a few limitations given the scope of this graduation project. Firstly, the current worldwide Covid-19 pandemic has limited the possibility to perform user tests and interviews in a big way. Due to the pandemic it is much harder to reach out to potential participants, especially if those participants are working in the critical healthcare sector. Healthcare personnel are currently very busy and have much less time than regularly. It would also not be ethical to keep them from their care work or put any more additional strain on them than they already have. They can only be approached through online means like e-mail or a messaging application. Also all the user test and interviews needed to be held online to minimize the risk to spread the coronavirus. Due to this limitation, the number of participants that were interviewed and user tests performed were lower than I had hoped in order to get a more representative view of the current situation and feedback on the first CARO prototype.

A limitation that followed from the previously mentioned limitation is that, because the target group of my graduation project, care workers, are hard to recruit, the participants consisted of mostly people that I know personally and have a relation with outside of the research. This might not impact the results much from the first interviews in the ideation phase in Section 4.1, however during the user test it might have influenced the results of the user tests and the feedback the participants had for me. Especially with the already low number of participants.

Another limitation was the time-frame of the graduation project. I would have liked to have had more time in order to optimize the front-end aspects of the CARO platform as well as implement the back-end database of the website for the full functionalities to work like the actual submission of the topics and their linking. These are essential aspects of the CARO platform, however it is not possible to do so within the given time-frame. This is also partly due to my personal technical skill level on developing a web platform. While other people may be able to develop the full platform in the given twenty weeks, I did not have the required knowledge and skill to do so in addition to doing all the background research, ideation and specifications.

8.4 Future Work

The foundation of making social robots has been laid out with the research on the current situation and the idea of the CARO platform. However, as indicated in the results of the evaluation, there is still a lot of work to do before CARO is fully realized and can be used with actual data from actual care workers. Also, more research is needed in order to get a more definitive answer to the question on how to make activity design for social robots more accessible to care workers. This research has focused on only one solution, and with that one solution, the primary focus with the user tests has been put on the technical side. The front-end of the web platform can still be made more responsive to resizing and different resolutions as well as add a new mobile version. The back-end functionalities like actual storing, sorting, displaying and linking of the activities and functionalities can be implemented. On the web platform itself, the core of how the web platform works can be explained more clearly as well as some terms like *'activity design'* and *'activities/functionalities'*. As you can see there is a lot of improvements to be made to the current research, however there are also a lot of opportunities for new studies. A new study could focus more on what actual content would be uploaded to the platform by care workers and therefore, more accurate and in detail what fields are necessary to fill in when submitting a new topic for an activity or functionality. Another study could focus on the actual working out of how the linking process would work and how the sections like *'goals'* or *'activities'* can be grouped together efficiently. Another study might even be about a brand new way of helping care workers design new activities with social robots with for example new artificial intelligence technology.

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A Consent form Cozmo Robot - applicaties in sociale zorg

Contacinformatie voor vragen over uw rechten als een onderzoek deelnemer

Als u vragen heeft over uw rechten als een onderzoek deelnemer, of graag informatie zou willen krijgen, vragen stellen, of zorgen discussiëren over het onderzoek met iemand anders dan de onderzoeker(s), neem dan a.u.b. contact op met de secretaris van het Ethische Committee van de afdeling EWI.

Contact onderzoeker: Kaixin Chen – k.chen-2@student.utwente.nl
Contact begeleider: Dennis Reidsma – d.reidsma@utwente.nl
Contact ethische committee: EC Create and iTech – ethics-comm-eemcs@utwente.nl

Het onderzoek

Dit document betreft een toestemmingsverklaring voor deelname aan onderzoek. Het onderzoek wordt uitgevoerd door de onderzoeker, Kaixin Chen, in de context van een bachelor eindopdracht. Meedoen aan het onderzoek betekent dat je ongeveer 30 minuten zal worden geïnterviewd door de onderzoeker. Het onderzoek betreft de vraag in hoeverre de huidige zorg robots gebruiksvriendelijk zijn voor zorgmedewerkers. Vaak worden deze zorg robots geëvalueerd op de impact die ze maken op de patiënten. Wat vaak overkeken wordt is dat zorgmedewerkers ook goed met de zorg robots overweg moeten kunnen om ervoor te zorgen dat de interactie tussen de robot en patiënt effectief is. In deze fase van het onderzoek wordt informatie verzameld over in hoeverre de huidige zorgmedewerkers al overweg kunnen met sociale robots en andere ICT gerelateerde taken. Dit wordt voornamelijk gedaan door studenten en leraren van de opleiding verpleegkunde te interviewen over hun eigen ervaringen, capaciteiten en het huidige curriculum van de opleiding verpleegkunde.

Informatie over de onderzoeksprocedure

De informatie voor het onderzoek wordt verzameld door een interview af te leggen. De audio van het interview kan opgenomen worden voor verwerkingsdoeleinden. Deelname aan het onderzoek is geheel vrijwillig en kan op ieder moment, zonder opgaaf van reden, worden beëindigd. De verzamelde data in interview antwoorden en audio opnames zullen uitsluitend worden gebruikt voor wetenschappelijke doeleinden. De verzamelde data is enkel toegankelijk voor mensen die betrokken zijn bij het onderzoek en zal niet langer worden bewaard dan strikt nodig is voor het onderzoek. De geanalyseerde data zoals antwoorden op de onderzoeksvragen en citaten wordt anoniem gemaakt en kan worden gebruikt voor vervolgonderzoeken. De gegevens waar u op te herkennen bent wordt nooit publiekelijk vertoond. Als je tijdens of direct na een activiteit besluit dat je niet (meer) wilt meedoen, worden al je gegevens van die sessie verwijderd. Als de onderzoeksmaterialen eenmaal anoniem gemaakt zijn kunnen ze niet meer aan jou gekoppeld worden en kunnen ze dus ook niet meer verwijderd worden.

Toestemmingsverklaring:

- Ik verklaar hierbij dat ik volledig geïnformeerd ben over het onderzoek. Het doel van het onderzoek en de methodes zijn mij uitgelegd, waarbij ik de ruimte heb gehad om vragen te stellen.
- Ik begrijp dat ik mijn deelname op ieder moment, zonder opgaaf van reden, mag en kan beëindigen zonder dat hieraan enige consequenties aan verbonden zijn.
- Ik heef hierbij toestemming voor het verzamelen en gebruik van anonieme gegevens zoals beschreven in de informatie hierboven.
- Ik geef toestemming voor het maken van audio-opnames voor onderzoeksdoeleinden.
- Ik geef toestemming voor het publiek beschikbaar stellen van anonieme onderzoeksmaterialen die zijn vermeld tijdens mijn deelname aan het onderzoek.

B Interview Questions

Questions for students:

RQ 'What understanding of activity design of social robots do care workers have currently?'

1. What were the main focuses of the study program?
2. What experience do you have designing activities for patients?
3. How do you approach designing new activities for patients?
4. What are some difficulties that you face when designing new activities for patients?

RQ 'What knowledge about social robots is already being taught in the education?'

1. How familiar are you with computer programs or robotics?
2. Did the curriculum of the study contain any ICT or robotics related courses? If yes, which ones? If no, do you think they should be included?
3. What do you already know about 'social' robots?
4. What are your opinions on the use of these social robots in the medical care sector?

RQ 'How do care workers evaluate the impact of an activity of a social robot on the clients?'

1. How much do you work with social robots in your work/internship if at all?
2. If there would be a social robot being introduced into your current regular work environment, what do you expect this robot to be able to perform?
3. Do you think social robots could help you in providing care to your patients? If yes, how? If no, why not?
4. If there would be social robots being introduced, what would be important aspects for you to evaluate the robot's performance on?
5. How do you think the ability for activity design of a social robot will impact patients? And how do you think it will impact you as care givers?

Questions for teachers and instructors:

1. Naam, leeftijd, studie, functie
2. Hoe lang bent u al werkzaam in uw vakgebied?
3. Wat verstaat u onder de term 'activity design'?
4. (Uitleggen wat activity design inhoudt)

RQ 'Hoe wordt een activiteit in de praktijk ontworpen in de zorg?

1. Hoe wordt het aangepakt om een activiteit te ontwerpen in praktijk?
2. Hoe wordt een begeleidingsplan of observatieplan opgezet?
3. Hoe worden mensen geleerd om die plannen op te zetten?
4. Wat zijn voorbeelden van activiteiten ontwerpen die u al heeft moeten toepassen?
5. Hoe wordt onderscheid gemaakt tussen een goed ontworpen activiteit en een slechte?

RQ 'Wat voor kennis over activiteiten ontwerpen wordt er al in de opleiding les over gegeven?'

1. In hoeverre geeft u les in het omgaan met activiteiten ontwerpen?
2. Denkt u dat activiteiten ontwerp een belangrijk onderwerp is voor de opleiding als een expliciet vak? Waarom wel/niet?

RQ 'Hoe belangrijk is het technische aspect van sociale robots voor zorgprofessionals?'

1. Heeft u al ervaringen gehad met werken met sociale robots in de praktijk?
2. Zou u zelf een nieuwe activiteit kunnen laten programmeren op een sociale robot denkt u? (Met bijvoorbeeld een voorbeeld van Cozmo)
3. Wordt er lesgegeven in het curriculum van de opleiding over deze technische aspecten?
4. Vind u dat een zorgmedewerker tot genoeg technische kennis moet beschikken om zelf de sociale robots te kunnen programmeren?

RQ 'Wat zouden belangrijke functionaliteiten zijn om ervoor te zorgen dat zorgmedewerkers het CARO platform gaan gebruiken?'

1. Waar zou u op het moment hulp zoeken als u problemen zou hebben met een sociale robot?

2. Wat denkt u over een platform dat mensen van verschillende achtergronden samenbrengt?

3. Wat zouden belangrijke functionaliteiten zijn voor een platform als CARO om voor u het platform te gaan gebruiken?

C Instructor Questions

Vragen voor de instructeurs:

- Naam, leeftijd, studie, functie
- Hoe lang bent u al werkzaam in uw vakgebied?
- Wat verstaat u onder de term 'Activity design'?
- (Uitleggen wat activity design inhoud in de context van deze research)

RQ 'Hoe wordt een activiteit in de praktijk ontworpen in de zorg?'

- Hoe wordt het aangepakt om een activiteit te ontwerpen in de praktijk?
- Hoe wordt een begeleidingsplan of observatieplan opgezet?
- Hoe worden mensen geleerd om die plannen op te zetten?
- Wat zijn voorbeelden van activiteiten ontwerpen die u al heeft moeten toepassen?
- Hoe wordt onderscheid gemaakt tussen een goed ontworpen activiteit en een slechte?

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- Heeft u al ervaring gehad met werken met sociale robots in de praktijk?
- Zou u zelf een nieuwe activiteit kunnen laten programmeren op een sociale robot denkt u? (Bijv. d.m.v. Cozmo)
- Wordt er lesgegeven in het curriculum van de opleiding over deze technische aspecten?
- Vind u dat een zorgmedewerker tot genoeg technische kennis moet beschikken om zelf de sociale robots te kunnen programmeren?

RQ 'Wat zouden belangrijke functionaliteiten zijn om ervoor te zorgen dat zorgmedewerkers eht CARO platform gaan gebruiken?'

- Waar zou u op het moment hulp zoeken als u problemen zou hebben met een sociale robot?
- Wat denkt u over een platform dat mensen van verschillende achtergronden samenbrengt?
- Wat zouden belangrijke functionaliteiten zijn voor een platform als CARO om voor u het platform te gaan gebruiken?

D Evaluation Questions

Assignments for participants:

- Create a new topic for the Anki Cozmo Robot
- Search help for setting a reminder for the Anki Cozmo Robot
- Suggests a use case for turning off silent mode on the Honda ASIMO Robot
- Create a new functionality for the Anki Cozmo Robot

Interview Questions

1. What are your first impressions on the platform (aesthetics, functionality, fluidity, scalability, etc.)

RQ 'What are important usability aspects for care workers when it comes to working with the online platform?'

1. Did you think the navigation throughout the website was intuitive? Why?
2. Did you need guidance when first navigating through the website?
3. How did you experience the consistency of the online platform? Did some aspects feel out of place compared to others?
4. How did you experience the direct feedback of the website? Was the website responsive to use?
5. Did you feel that the website was familiar to existing web interfaces? Why?

RQ 'What are important content aspects for care workers when it comes to working with the online platform?'

1. Did you think that there can be enough information specified to succesfully match problems with solutions?
2. What information was missing for input when trying to create a new topic, if any?
3. What information was missing for specifying when trying to create a new functionality, if any?
4. Did you think that the structure of displaying information is clear and logical?

RQ 'What are important visual aspects for care workers when it comes to working with the online platform?'

1. Was the font type or size distracting on the website?
2. How did you perceive the color scheme of the website? Was it too distracting/colorful or on the contrary?
3. Did the pictures used on the website fit in or feel out of place? Why?

Concluding Questions

1. What do you think of the website overall? Do you think it might have some success in the future?
2. What do you think the most important aspects to improve are?
3. Would you use such a platform later when it is finished? Why?