UNIVERSITY OF TWENTE.

AssortiMens

Autism and Technology

Exploring how digitization can contribute to individual preferences of young autistic adults to express themselves for designing their own assistive technologies

Juliëtte ter Brugge
Master Thesis
Interaction Technology
September 2022

Juliëtte ter Brugge

s2295067

- **Faculty**: Electrical Engineering, Mathematics and Computer Science
- **Department**: I-Tech
- **Master Programme**: Interaction Technology

School Institution

University of Twente
Drienerlolaan
57522 NB Enschede

Graduation Committee

Dr. A.J. van Hessen (Chairman & Supervisor)
Dr. ir. W. Eggink (External member)
Drs. J.C. van Huizen (Mentor from company)

September 2022

Autism and Technology

Exploring how digitization can contribute to individual preferences of young autistic adults to express themselves for designing their own assistive technologies

Juliëtte ter Brugge

Master Thesis Interaction Technology

University of Twente

Abstract

The transition to adulthood is an exciting life phase for almost every young individual. It is a period in which changes take place in many areas, such as finding a job, being able to make your own decisions, and being less dependent on parents or caregivers, in short, a life phase with new challenges. This also applies to young autistic adults (YAA). However, it may be that they feel extra vulnerable since autistic individuals generally have more difficulty with change, which is often accompanied by ambiguities and uncertainties. From my own personal experience, I know that the transition to adulthood can be a real challenge because autism runs in my family.

Autistic people could benefit from technological support in their daily lives to help them cope with these challenges. More and more technologies are being developed for this purpose. However, these "one size fits all" technologies often do not fit the individual, as they do not take into account the rich and complex life-worlds of autistic people, as the nature and difficulty of the challenges differ from person to person, and therefore require personalized solutions [1].

Design your life (DYL) therefore initiates a project aimed at researching and realizing a hands-on creative toolkit that enables YAA to design their own technology. This project is an innovative way of working with YAA, as the technologies developed are more in line with their needs and wishes, from their perspective and experiences. However, this toolkit is not yet fully compatible as it does not match the desired way of working that some YAA would like to have. As a result, a demand arose from YAA for a digital version of this toolkit.

My experience with an autistic family member and knowledge in the field of Human-Computer Interaction, through my study background in Interaction Technology at the University of Twente, motivated me to investigate how digitization can contribute to this.

By testing multiple designed digital prototypes with six autistic individuals, I came to several insights based on which a digital toolkit prototype could be realized. This toolkit complements the physical toolkit, allowing more freedom to customize it to YAA's own preferences and personal goals. This gives YAA the ability to decide how they want to carry out their assignments and what tools they want to use to do so. In this way, YAA can personalize their design process, allowing them to better express themselves and design technologies that meet their needs. Moreover, by using the digital toolkit, a wider group within the target group can be reached.

Contents

1 Introduction **4**

2 Theoretical Framework **8**
2.1 Autism . . . 8
2.1.1 Concepts of Autism . . . 8
2.1.2 Terms describing Autism . . . 10
2.1.3 Autism and young adults . . . 12
2.1.4 Autism and Technology . . . 13
2.2 Design Methods . . . 16
2.2.1 Co-Design . . . 16
2.2.2 Creativity . . . 19
2.2.3 Personalization . . . 21
2.2.4 Satisfaction . . . 22
2.2.5 Autism and Co-Design . . . 22
2.3 Design Your Life . . . 26
2.3.1 Design Your Life Process . . . 26
2.3.2 Case Studies . . . 28
2.3.3 Toolkit . . . 30
2.3.4 Demand digitization . . . 37
2.3.5 Design Question . . . 38

3 Research Methodology **40**
3.1 Ideation . . . 42
3.1.1 Generative session . . . 42
3.2 Specification . . . 43
3.2.1 Generative session . . . 43
3.3 Participants and Ethical Considerations . . . 43
3.4 Data Analysis . . . 46
3.5 Realization . . . 46
3.6 Evaluation . . . 47
3.6.1 Focus Group . . . 47

4 Results Ideation & Specification Phase **50**
4.1 Creativity . . . 51
4.2 Personalization . . . 54
4.3 Satisfaction . . . 56
4.4 Design requirements . . . 59

5 Realization Phase **62**
5.1 The DYL assignments . . . 62
5.2 Other relevant elements of the digital toolkit prototype . . . 65

6 Evaluation Phase **68**
6.1 Feedback participants . . . 68
6.2 Final Prototype . . . 75

7 Discussion **79**
7.1 Reflection on results . . . 79
7.1.1 Creativity . . . 79
7.1.2 Personalization . . . 79
7.1.3 Satisfaction . . . 80
7.2 Implications . . . 80
7.3 Research limitations & Recommendations . . . 80

8 Conclusion **82**

Bibliography **84**

Appendix A Appendix **89**
A.1 Appendix A: Procedure Generative Sessions Ideation Phase . . . 90
A.2 Appendix B: Consent Form Generative Sessions . . . 91
A.3 Appendix C: Slides about Technologie . . . 92
A.4 Appendix D: Assignment based on a fictional case study . . . 95
A.5 Appendix E: Mural worksheet Generative Session Ideation Phase . . . 97
A.6 Appendix E: Overall Mural worksheet Generative Session Ideation Phase . . . 100
A.7 Appendix F: Procedure Generative sessions Specification phase . . . 102
A.8 Appendix G: Assignment Generative Session Specification Phase . . . 104
A.9 Appendix H: Mural Worksheet Generative Session Specification Phase . . . 107
A.10 Appendix I: Results Generative Session Ideation Phase . . . 109
A.11 Appendix J: Results Generative Session Specification Phase . . . 115
A.12 Appendix K: Procedure Focus Group Evaluation Phase . . . 121
A.13 Appendix L: Storyboard for Evaluation Phase . . . 122
A.14 Appendix M: Prototyping Results . . . 123
A.14.1 Assignment - Sketching . . . 123
A.14.2 Assignment - Build my dream solution . . . 125
A.14.3 Tutorial . . . 126
A.14.4 Privacy . . . 127
A.14.5 Mural App . . . 128
A.14.6 Outline . . . 129

Chapter 1

Introduction

Making your own decisions, living independently and obtaining a degree - these are all characteristics expected of young adults. In recent decades, the pressure on young adults to be more independent in their daily lives has increased [2]. It is not so obvious to every young adult that the transition to adulthood is flawless and certainly not in a world where society marginalizes anything different, which can be an issue for young people who, in society's eyes, "deviate" from "normal". One particular group that has experienced a similar perspective from society is that of Young Autistic Adults (YAA). Traditionally, autistic individuals have been described as having a lack of psychological awareness of "others" and the self [3]. Autistic individuals may experience challenges with their social communication and find it difficult to empathize with the thoughts and emotions of others. In addition, they may experience challenges adapting to changing circumstances and certain interests can be selective, limiting or, on the contrary, very intense. What autistic individuals also have in common is a different way of processing sensory stimuli [4]. Because of these challenges, YAA may have the experience of being tense and being stressed as they progress toward adulthood [5].

From the perspective of society, aspects that deviate from "normal," including the above challenges that YAA may encounter on a daily basis, are seen as an aberration and are given negative exposure. In this regard, there has been a significant focus on the negative aspects of autism. In recent years, there has been a movement, which is the neurodiversity movement, that highlights the positive aspects. The perspective from the neurodiversity movement attempts to reframe the view of autism by emphasizing the positive aspects rather than approaching autism from functional limitations [6]. For example, by viewing that an autistic individual may be the perfect candidate for a job that requires actions with sharp detail perception. Nevertheless, it should not be denied that people encounter problems, difficulties, challenges, issues, or obstacles because of their autism. A neuro-atypical individual cannot avoid encountering challenges in everyday life, as it seems that one cannot help but accept that society is largely determined by neurotypical standards. In this report autism is defined as a collective term for a neurodevelopmental condition that one maintains throughout the life span. This means that the brain is developed differently from the "neurotypical" brain, indicating vulnerability they face on a daily basis in social interaction, communication, flexibility in thinking, moving and acting, in sensory stimulus processing and in filtering and integrating information. Autism can be described, defined or conceptualized in different ways, but it is necessary to focus on what is needed so that each individual within the autism spectrum, whether with a language disorder and/or intellectual disability or without, can be heard and can receive help when they encounter challenges in everyday life. There are more and more technologies that could support YAA to improve their quality of life [7].

Many different assistive technologies have been designed to empower YAA in everyday life. Current technologies have been developed primarily from a deficit model of disability, which has primarily considered mitigating a functional limitation [1]. For example, 'The Transporters' [8] which is used for recognizing and understanding emotion. Moreover, technologies are often made for an entire target group, which means that they are usually not properly tailored to the individual. YAA may feel stigmatized when using these technologies, which could cause them to avoid using them [9]. Consequently, it is important for designers to think carefully about the design process of assistive technologies. A consideration and an important aspect for designers is to have a good understanding of the experiences of YAA. In contrast to the functional approach to design, the rich and complex life-worlds of autistic individuals should be included as an opportunity space for design [1]. This can be done by applying co-design, where the user becomes the "owner and expert" in the design process.

Design Your Life (DYL) is a research project that focuses on the individual and considers the experience in depth [10]. DYL consists of a research group of the University of Twente and HAN University of Applied Sciences collaborating on the development of a new method combined with a toolkit aimed at user-initiated design of technologies which support young autistic adults in living more independently. Instead of looking at a one size fits all technology, DYL provides tools that YAA can use to find out what their daily challenges are and to determine a suitable solution to overcome these challenges. In the design process, the YAA have ownership of the design of their own conceived assistive technology, with a focus on empowerment. Ten different case studies were conducted with different YAA, which involved working with stakeholders in real life such as healthcare professionals. The case studies involved the design and testing of concrete DYL toolkit prototypes.

Analyzing these ten case studies revealed specific requirements for digitization of the DYL toolkit in a coherent manner. For example, participants seemed interested in digital means of expression versus physical, such as using a pen for this purpose. It was also mentioned that some participants felt restricted by the limited form of filling in assignments (e.g. drawing, using stickers, etc.) and by the space of the physical fill-in boxes. It was further indicated that a participant wanted to work in a program that he was familiar with. As an example, one person used a free text editor program to work out assignments. So the preference for the way of expression differs among participants. Since there is only a physical DYL toolkit, a demand arose from the YAA for a digital version of the DYL toolkit in combination with digital support in working out the activities of the design process. Therefore, the purpose of this study is to gain new insights into how a digital toolkit can support individual preferences of expression. This leads to the following overarching research question:

How can digitization of the DYL toolkit support individual preferences of expressing oneself, contributing to a creative, personalized, and satisfactory design process?

In order to answer the main research question, four additional supporting questions are considered as part of the research.

The first sub question focuses on the requirements from the perspective of YAA for a digital version of the DYL toolkit and examines how YAA want to work and how they can use their creativity in carrying out the activities using digital tools. This results in the below question:

- What does a digital version of the DYL toolkit require from the perspective of YAA?

The last three sub-questions address three key aspects: creativity, personalization, and satisfaction. These sub-questions examines how the aspects manifests itself in YAA when using a digital toolkit, how they can be operationalized in the practical implications of a digital toolkit, and how a digital version of a toolkit can contribute to YAA's important aspects. This results in the below questions:

- How can digitization of the DYL toolkit support creativity?
- How can digitization of the DYL toolkit support personalization?
- How can digitization of the DYL toolkit support satisfaction?

The contribution of this thesis is a digital toolkit prototype that facilitates the design process of YAA's own assistive technologies by supporting YAA's expressive capabilities and individual preferences. In order to realize this contribution several design sessions were conducted together with YAA to determine which functionalities the digital toolkit should require. The design and realization of the final digital toolkit prototype was accomplished by following the phases of the Creative Technology Design Process (CTDP) [11] as illustrated in Figure 1.1. This thesis is structured in a chronological manner following these design phases.

- Part one, *Theoretical Framework*, aims to understand where the demand for a digital toolkit comes from by drawing upon related literature and practical insights from the previous case studies. It provides the theoretical basis for understanding what YAA face in everyday life and what technologies are already being used to support YAA. Co-design is further discussed, along with some of its key components. This is followed by an in-depth review of DYL's current tangible toolkit.
- Part two, *Results Ideation & Specification Phase*, narrows the scope to understanding the aspects important to YAA when working in a digital environment. It provides practical insight by conducting two generative session for which each session a designed digital prototype was tested with YAA. These insights inform the requirements for the design of a digital toolkit.
- Part three, *Realization phase*, addresses the design and realization of the digital toolkit prototype based on the requirements from part two. It discusses a number of components of the prototype explaining why these modifications are constructed in this way and what requirements are covered by them.
- Part four, *Evaluation phase*, describes the evaluation of the digital toolkit prototype. It generates insights to validate the proposed design considerations from part three. In addition, it provides suggestions for improvement and shows what final adjustments have been made to the final digital toolkit prototype.
- Part five, *Discussion & Conclusion*, further discusses the interpreted results, implications, and limitations of this thesis. This is followed by recommendations for future research and concludes with a general conclusion.

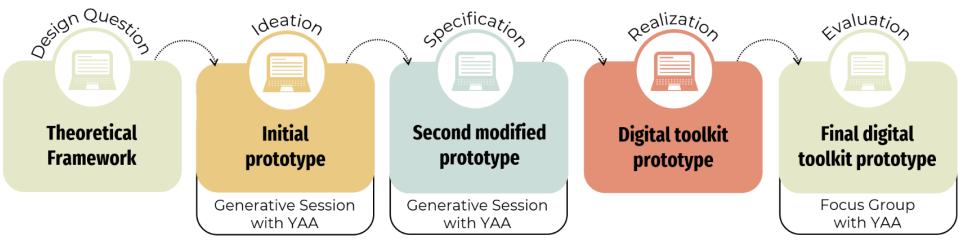


Figure 1.1: *An overview of the design phases used in this thesis. For each phase, the output of the design phase and the method used to evaluate the output are indicated.*

Part one

Theoretical Framework & Design Question

Chapter 2

Theoretical Framework

2.1 Autism

Autistic individuals have a different way of processing sensory stimuli compared to non-autistic individuals, making them a somewhat "neurological minority" in society. Society is structured based on the majority, leading to a society largely defined by neurotypical norms. As a result, autistic individuals encounter a variety of challenges in daily life. Challenges they might encounter include challenges in social communication, being able to empathize with the thoughts and emotions of others, and challenges in adapting to changing circumstances [4].

This section examines how the concepts surrounding autism have changed in recent years, which factors were involved, and how autism is viewed from different perspectives. This is followed by a further discussion of the language used to describe autism from different social and ideological beliefs of people. This chapter then provides a brief overview of the target group of Young Autistic Adults (YAA), focusing on what they encounter in their daily lives and how they perceive the different phases of adulthood, with the aim of gaining insights that could help in the design and development of better supports and services. Finally, it highlights different technologies that are already being used to support YAA. These technologies could make them less dependent on parents or carers.

2.1.1 Concepts of Autism

Autism was first termed by Leo Kanner in 1943, as a coherent disorder. His research provided a groundbreaking clinical description of eleven boys who had difficulty in making affective contact and also described forms of repetitive behavior [12]. Despite the fact that this was a study based on only eleven case studies of boys under the age of 12, his work has formed the basis for further development of the concept of autism [13]. Initially, autism was thought to be associated with an early form of schizophrenia, especially in children. In 1979, however, there was more evidence to suggest that other developmental disabilities are linked to autism. It rejected the belief that autism was an early form of schizophrenia [14]. Both the perspective from psychiatry and the developments around the concept of autism, have changed significantly to "disorders of cognition and behavior have an organic, brain-based etiology" [12]. Later, in the early 20th century, the term autism was introduced by Eugen Bleuler, who was referring to the disrupted emotional contact with others that he observed in patients with schizophrenia [15].

Autism is congenital, as it is all about the way information is processed in the brain. Autistic individuals process both relevant and irrelevant information as equally important. This over-

stimulation could cause chaos, requiring more time to properly process information. It could cause a delay in response and/or different interpretations [15]. Although it differs from person to person and environmental factors influence the manifestation of autism, there are a number of common traits that might constrain autistic individuals in certain situations. Autistic individuals may experience challenges with their social communication and find it difficult to empathize with the thoughts and emotions of others. In addition, autistic individuals may experience challenges adapting to changing circumstances and certain interests can be selective, limiting or, on the contrary, very intense. What people autistic individuals also have in common is a different way of processing sensory stimuli [4].

Nowadays, autism is often used as a synonym for Autism Spectrum Disorder (ASD), where "spectrum" refers to a high degree of heterogeneity among autistic individuals [15]. The term ASD is an umbrella term that includes Asperger's syndrome and PDD-NOS, in which only some of the features correspond to autism [12]. ASD is specifically referred to as the classification of a disorder according to the Diagnostic and Statistical Manual of Mental Disorders (DSM), which is an American classification system for mental disorders. This is established by the American Psychiatric Association to ensure that everyone uses the same definitions for certain psychiatric disorders. Due to its heterogeneity, it is a major challenge to classify someone under ASD, since diagnosis depends on the people observing the behavior and relies on cognitive phenotypes, without being able to do tests that can show whether or not a diagnosis can be established, as with laboratory tests, biochemical markers, or imaging results [12]. Thus, this cannot be tested and compared to a gold-standard postmortem neuropathology [12]. In addition, it is difficult to classify patients into diagnostic categories based on observations of behavior and cognition since observations of different persons may have different views of something that qualifies as a certain criteria and can be placed somewhere within a classification. The boundaries of these different classifications are blurred since for some criteria there may be overlap. For example, two children "traditionally" might have been diagnosed with autism, PDD-NOS, or Asperger's syndrome and yet differ in their symptoms. These different diagnoses no longer exist as distinct, but the boundaries are not ambiguous [12].

Apart from the classification, autism is also used in a much broader sense as a description of vulnerability, which manifests itself in all areas of life [15]. What this vulnerability is can vary greatly per individual and can vary throughout life. In addition, this vulnerability is influenced by predispositions and environmental factors. According to the literature review by Staal et al. [15], the concept surrounding autism is not directly viewed as a disorder. In fact, a disorder refers to a dichotomous concept, or in other words, it may or may not be present. There must be experienced and/or observed dysfunction in the socio-emotional, communicative, and cognitive areas for autism to be considered a disorder. This could bring challenges, as skills in these areas develop throughout life and can vary greatly from one individual to the next. Thus, one can speak of a partially normative decision when determining a disorder such as autism. When one becomes limited in daily functioning, which is discussed in severe forms of autism, speaking of a disorder is not likely to be a reason for discussion. On the other hand, there are also people whose characteristics related to autism play a role in daily life to a lesser extent and here the situation is more complicated, since it also depends on the environment whether characteristics of autism lead to functional limitations. For people with a milder manifestation of autism, it is perhaps better to speak of an autistic vulnerability that only leads to functional impairment in, for example, a stimulus-rich and unstructured environment [15].

How autism is perceived and what language is used to describe the condition is influenced by the differences in people's social and ideological beliefs [16]. This will be discussed further in section 2.1.2. As stated in the literature by Staal et al. [15] and Kenny et al. [16], these perceptions have changed in recent years. As movements for disability rights have emerged out of frustration with the fact that disability is considered a medical condition - one that must be "fixed," cured, or even prevented. Regardless of functional limitations, certain aspects of autism may also offer advantages in a right environment. For a job that requires actions with sharp detail perception, an autistic individual could be the perfect candidate. This example of emphasizing the positive aspects rather than approaching autism from functional limitations, is increasingly highlighted by movements such as Neurodiversity. Movements as such, attempting to change the view of autism by making a shift from seeing autism as a disability, to the perspective of a neurological difference: someone with a unique way of thinking and experiencing the world [17].

Nevertheless, it should not be denied that people could encounter problems, difficulties, challenges, issues, or obstacles because of their autism. A neuro-atypical individual cannot avoid encountering challenges in everyday life, as it seems that one cannot help but accept that society is largely determined by neurotypical standards. Interventions that are conceived on the basis of intellectual and language impairment would be welcomed and do not necessarily stigmatize autism, or threaten its characterization as a different, not deficient, way of being [18]. Autism can be described, defined or conceptualized in different ways, but it is necessary to focus on what is needed so that each individual within the autism spectrum, whether with a language disorder and/or intellectual disability or without, can be heard and can receive help when they encounter challenges in everyday life. Based on this, autism is defined in this report as a collective term for a neurodevelopmental condition that one maintains throughout the life span, which means that the brain is developed differently from the "neurotypical" brain, indicating vulnerability they face on a daily basis in social interaction, communication, flexibility in thinking, moving and acting, in sensory stimulus processing and in filtering and integrating information.

2.1.2 Terms describing Autism

The term autism can be described in several ways, with "autism" and "on the autism spectrum" being the most frequently used terms. In addition, the term "Autism Spectrum Disorder" is also used in a clinical context. However, this term is less common due to the use of the word 'disorder'. Consequently, a consensus has emerged within community groups [16]. Autistic individuals themselves endorse the term "autistic," but on the other hand, a large portion of professionals who work with autistic people (e.g. researchers, students, and volunteers) endorse the term "person with autism" [16]. According to the literature review by Kenny et al. [16], it depends on each person what the preferences are for the terms used to describe autism. Moreover, this also has an influence on how the relationship between language and the identity of autistic people should be understood. With the change to the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), there has been disagreement among autistic individuals, family members, researchers, and clinicians in different types of autism, for example Asperger's syndrome, are now no longer seen as a separate category, but is subsumed under a single diagnosis of ASD [16]. The examples given here make clear what is actually known and understood about autism is constantly evolving as a result of such changes. This has consequences for the way autism is perceived, understood and referred to from a wider perspective in society [16].

In the past, people were defined primarily by their disability from a medical perspective. Groups like disability right movement have tried to revise public perceptions of disability and are trying to promote "person-first" language [16]. By doing so, the focus is on the person as an individual and then followed by their disability. In this way, the emphasis is placed on what people can do, i.e. their capacities, and a subtle distinction is made between a person's disability and the person themselves [19], [20].

'The person should always come first e.g., a person with autism. Preferably using the person's name'., 'The person with autism is a person-first and their condition second'., 'I don't like phrases which describe a person as their condition, so would always go for "person" first, because that's what we all are regardless of what conditions we have. I would never describe myself as a thyroidy, for example'., and 'We need to describe the individual and ASD as separate entities with the emphasis on the individual not the disorder'.

— Participants (professionals) in the research by Kenny et al. [16]

However, several studies (e.g. [16], [6], [21], [3]) indicate that individuals who themselves fall within the autism spectrum do not see autism as something separate from the person. In addition, it has been shown that autistic participants rejected "person-first" language. They substantiated this by saying that people should not be required to remind people of their humanness, and to increase the salience of their autistic identity [3]. Therefore, "identity-first" language is preferred, since from their perspective they see autism as not negative; thus, it does not need to be separated from them [3]. They themselves refer to "autistic people," and "those who identify as on the autism spectrum," rather than "people with autism" [6]. But again, it depends on the person what their preference is for using the terminology. There are, of course, autistic individuals who use "people with autism".

'You know autism is innate. I'm not broken, I'm just human, I'm just a variation, you know, I'm neuro-diverse, I'm neuro-divergent rather. Neuro-diversity is all of us, neuro-divergent is people who differ from the majority. It's about me, it's the same as being a gay person. You know it's them, it's not something you can separate. I hate the term "a person with autism." I'm not with autism, I am autistic. You know I don't live with autism, I live with my wife and two cats.'

— Jon Adams [21]

'I understand the push for "I am a person with autism" but I would never say "I am a person with brown hair". I would say, "I'm a(n) aspie/autistic" or "I'm a brunette"' and 'separating the person from their autism is damaging, as it reinforces opinions about autism being a 'thing' that can be removed, something that may be unpleasant and unwanted, and something that is not just another aspect of a whole, complete and perfect individual human being. Describing oneself as autistic is an extremely important and positive assertion about oneself, it means that one feels complete and whole as one is.'

— Participants (autistic adults) in the research by Kenny et al. [16]

From a more socially inclusive perspective of disability, a person is distinguished on the basis of what is created by society, which reacts in a certain way and cannot, for example, respond to people's needs that are more specific or have different demands. Therefore, it is not necessarily from an individual's "condition" that a distinction is made as to whether or not someone is "disabled" [22], [23]. Research by Kenny et al. [16] has shown that the terms used to describe autism are influenced by multiple complex factors, such as the context in which

people find themselves and the way people perceive autism. In addition, the importance of the language used to describe people is mentioned. One should be aware that the language used to describe people can have an impact on the person in different situations [24]. A number of institutions, such as clinics, research laboratories, and schools, could contribute to how the concept is portrayed in society, so that there is better understanding and welfare for people on the autism spectrum [16]. In this report, the "identity-first" language is used, with no intention of disregarding different conceptions of the designation.

2.1.3 Autism and young adults

A large proportion of autistic individuals indicate that they "continue to experience vulnerabilities throughout their life course" [15]. In particular, the experience of being tense and stressed [5]. The systematic review and meta-analysis by Steinhausen et al. [25], suggests that approximately 30 percent of YAA function independently to some degree but have a need for support, while half of the target group remain highly dependent on care into adulthood. It is important to note that the situation is different for each YAA. Within the autism spectrum, there are different degrees of expression of vulnerabilities in daily life, which means that some YAA experience these vulnerabilities as functional limitations in daily functioning. This group is characterized by experienced and/or observed dysfunction in the socio-emotional, communicative, and cognitive areas [15]. There are also YAA that have a milder form of expression, which only manifests in highly stimulating and unstructured environments [15]. This report focuses on the YAA group who have milder manifestations of vulnerabilities.

There are a number of components that characterize adulthood. Living independently, being financially independent, finishing school, having a full-time job, and possibly becoming a parent [5]. For autistic individuals, achieving these milestones is not always a straightforward matter, and a large portion often need guidance and support during this process. Arnett [26] makes a distinction between the stages towards adulthood. His goal was to draw attention to the age period from the late teens through the mid-20s as a new period of the life course in industrialized societies, with distinctive developmental characteristics [26]. He argued that in this stage of life terms such as social relationships, a person's work or occupation and lifestyle situation differ from those of the stage of adulthood and adolescence [26]. In this phase, YAA may experience stress, given the difficulties in coping with change and adapting to changing environments [26]. Previous research has shown increased level of anxiety and depression, and an increased risk of suicidal behavior compared to non-autistic individuals [27].

In addition, a large proportion of YAA face a number of challenges at work, such as coordination problems or problems arising from an overly stimulating environment or tasks that are too challenging [15]. In terms of social cognition, YAA could be particularly at risk of becoming socially isolated, as communication and interaction with others does not always run smoothly. Approximately 1 out of 4 YAA experienced these feelings, meaning "they never saw or talked to friends and were never invited to social activities in the past year" [5]. There is often a strong desire to create social connections, though these are not easily established. This can lead to an increased risk of mood complaints, anxiety complaints and addiction problems [15]. Adult caregivers often assist in the transition to adulthood. A shortage of them can be seen as an obstacle to YAA. For example, psychiatrists and other caregivers should become more aware of these problems and should do their best to be helpful with referrals to the community [5]. About 26 percent of YAA have received little to no services that could help them with certain steps in life, such as finding work, completing education or being more independent in daily life [5]. Difficulties in executive functions, such as planning, goal-setting,

goal-directed planning, flexibility of thought, initiation of action, and monitoring performance can also provide challenges in the daily life of a YAA [5].

In contrast to the "objective" measure (e.g., having a career, making money, getting married, etc.) that YAA face in the process towards adulthood, the literature review by Kirby et al. [28] discusses the subjective experience (such as quality of life) from the perspective of YAA. They want to incorporate the voices of YAA in discussions about their own adulthoods. This experience emphasizes making decisions from one's own convictions and based on values, taking responsibility when certain actions have been taken, and making sure there is a similar relationship between parents and YAA [28]. Several studies (e.g., Cheak-Zamora et al. & Anderson et al.) indicate that when looking from the perspective of YAA themselves, there are findings that a large proportion had worries, fears, and anxieties about various aspects of the transition, and, as a result, were not taking active roles in preparing for their adulthood [28]. It is important to gain insight into the subjective experience of preparing for adulthood, in order to increase knowledge of supporting successful transitions [28]. In addition, these insights can help design and develop improved supports and services that could help young adults on their way to becoming adults and promote positive experiences of adulthood [28].

According to the literature review by Kirby et al. [28], it is suggested that adulthood from the perspective of YAA can be distinguished as "a progressive sequence of events that can vary by individual preference" [28]. It might help to refer to successive events in a timeline instead of referring to isolated goals, so that YAA can better visualize how goals at short notice may be related to goals for the long term. For example, talking about graduating from high school first, then going to university, then finding a job [28]. Other factors they consider, when thinking about and preparing their future, are transition roles, chronological age, individual criteria (e.g., living independently or being financially independent), character qualities (e.g., the sense of responsibility and maturity), productive activities, self-care and care for others, and how to deal with challenging situations after adult actions, and what they have achieved and the age [28].

2.1.4 Autism and Technology

Considering the challenges YAA face in their daily lives over the years, more and more technologies are being developed that can support YAA in providing a specific service to improve their quality of life [7]. There are various forms and types of emerging technologies, particularly the emerging developments around Information and Communication Technology (ICT), which are leading to rapid advances in technologies used to support autistic people [7]. For example, through Assistive Robots used during therapy [29] for autistic children to support them in learning social skills [30], Interactive Multimedia for recognizing complex emotions [31], Virtual Reality (VR) simulations [32], [33] and a Cooperative Tabletop Computer game for learning social skills [34]. Considerable attention is dedicated to the development of software for use on various platforms, such as personal computers, assistive technology devices and Personal Digital Assistants [35]. Another example is smartphone technology, which in combination with containing functionalities/elements (e.g., camera, GPS, microphone, and touch screen) is a relatively affordable, adaptable, and compatible solution due to the off the shelf available software applications [7]. Moreover, a smartphone can often be used in public by individuals and is already part of daily routines [7].

Despite the fact that technology is growing rapidly, direct services involving a human caregiver remain irreplaceable. Therefore, technology can have an important complementary role to

support autistic people [7], which would allow autistic individuals to live more independently and could reduce dependence on caregivers [36]. Putnam & Chong [35] indicate that technology is often referred to as an important strength and effective for a large portion of YAA, partly because they are often interested in technology and because technology is predictable and familiar to use. Additionally, given that autistic people may experience challenges filtering sensory information that is irrelevant to their daily interactions, technology can contribute to the filtering process by abstracting or limiting information so that only relevant information is displayed [37]. In addition, technology can often be used consistently, making it easy to repeat specific tasks with few changes, as software does not become impatient with repetition. By using computer-related software, the complexity of social interaction is reduced and the autistic user can perform tasks at their own pace [37]. Furthermore, software can often be customized to an individual's needs, one-on-one structured, which can be particularly effective for autistic users. These tools are usually accessible in a home environment, as they are easily available and affordable.

Although there can be many benefits to using technology to support YAA, it is questionable whether the success of technology solutions for one person will project to a larger group, given the small sample sizes used in current studies and the use of single subject designs [35]. There is reason for concern that the range of technology-based solutions for YAA is increasing, which is not necessarily successful for the entire target group. It depends on the design whether it is actually usable. A designer who is not autistic may design technologies with certain product features that are not important to them (e.g. the brightness of a color or a particular sound) that do matter to an autistic individual. One difference between a technology designed specifically for autistic individuals versus a general design could be that a general design does not take sensory preferences into account. Autistic individuals may be hypo (under) or hyper (over) sensitive to a wide range of stimuli. As a result, autistic individuals have sensory (sound, smell, light) preferences. An example of this is a brightly colored and shiny fidget spinner designed for a large group of people, without regard to individual preferences, demonstrating a general lack of inclusive design. When a designer focuses on inclusion, a set of solutions and strategies to eliminate the underlying mechanisms of social and digital exclusion so that individuals can participate fully in society [38]. An ineffective solution may cause lack of motivation and frustrate YAA rather than providing users with the right support [35]. A designer can have a significant role in this and could make a difference. In addition, there are also disadvantages in using technology. For example, it might lead to more isolation and could lead to the development of obsessive behavior [35]. It is possible that technology can only provide support within the YAA's home environment and cannot provide support in off-line situations or other environments [35].

Based on the before mentioned limitations and challenges, a couple of design options should be considered for developing effective technologies. For example, that the designer has a good idea of how technology can support YAA, and for which purpose. Putman & Chong [35] suggests that autistic people would primarily prefer technology for developing social skills, developing organization skills, and developing academic skills. In addition, they suggest that designers should consider sensory integration issues in the design, by allowing the user to choose colors and sounds and have the ability to customize them. Autistic individuals may respond differently to the sound they perceive around them, as YAA processes it in a different way compared to neurotypicals [39]. They also suggest that technologies should be designed to be portable and that objects requiring control should be designed to be easy to use, including several suggestions regarding control by voice. Their research also found that autistic people prefer

technology being designed with "fun in mind" e.g. design technology for learning experiences like games. It is important to include the young adults in the design process, as it can be challenging to understand what they truly need in technology design.

Consequently, it is important for designers to think carefully about the design process of assistive technologies. Current technologies have been developed primarily from a deficit model of disability, which has primarily considered mitigating a functional limitation [1]. However, this misses opportunities for design space, as it does not take the rich and complex life-worlds of YAA into account. The requirements that have emerged from the medical model and social model of impairments are useful for the design of technologies, however, the holistic capture of the situations that YAA encounter in their daily lives is missing. Therefore, it is important to have a good understanding of the experiences of YAA and to include this knowledge in the design process, as designers might face the risk of developing technologies that do not fit the YAA's situation or might even be stigmatizing [9], [1]. Hence, it is of importance to resort to co-creative methods which leverage the end-user's experiential knowledge in the design process [7]. User input for designing effective assistive technology goes beyond functionality and design preferences, as it must also fit the person in terms of age, aesthetically pleasing, whether it is on-trend, and it must be culturally and socially acceptable. If a technology looks "handicapped", YAA may not want to use it [40].

2.2 Design Methods

There are several methods that can be applied to designing technological interventions for and with YAA [41]. Mainly in the technology industry, companies are increasingly open to other ways that define the product based on what people need [42]. Previously, design was conducted mainly from the "expert perspective", where trained researchers instructed users to perform tasks or asked for their opinion on a product concept created by someone else. Then they went on to observe and/or interview the participants in a more passive manner [42]. Later, around the 1970s users had gained more and more influence and space in the design process, especially in the early design phases of informing, ideating and conceptualizing [42]. The active involvement of users in the design process is called a user-centered design approach. Later, Northern European researchers introduced the participatory approach, where users were seen as partners throughout the design process, rather than subjects. This method of involvement is called co-design. The advantage of co-design is that users and designers design together rather than just having a say, which makes the design even more compatible with the user.

The remainder of this section will examine co-design in detail in order to gain a better understanding of the process and method. It will then look at autism and co-design to provide an understanding of what needs to be considered when designing together with YAA. This is done mainly from the designer's perspective, what designers can do in order to give YAA the space and feeling to participate in the design process, where it is important that the YAA is not the person who should adapt to be part of the process.

2.2.1 Co-Design

In the field of participatory design research, as shown in Figure 2.1, the concept of co-design is growing. Co-design refers to a design method in which a collaboration of people and designers engage in creative activities in a design process, where the people do not necessarily have to be knowledgeable or trained in design [42]. The person who is included in the design process is given the position of "experience expert" and is involved in knowledge development, idea generation and concept development, where they play a major role [42].

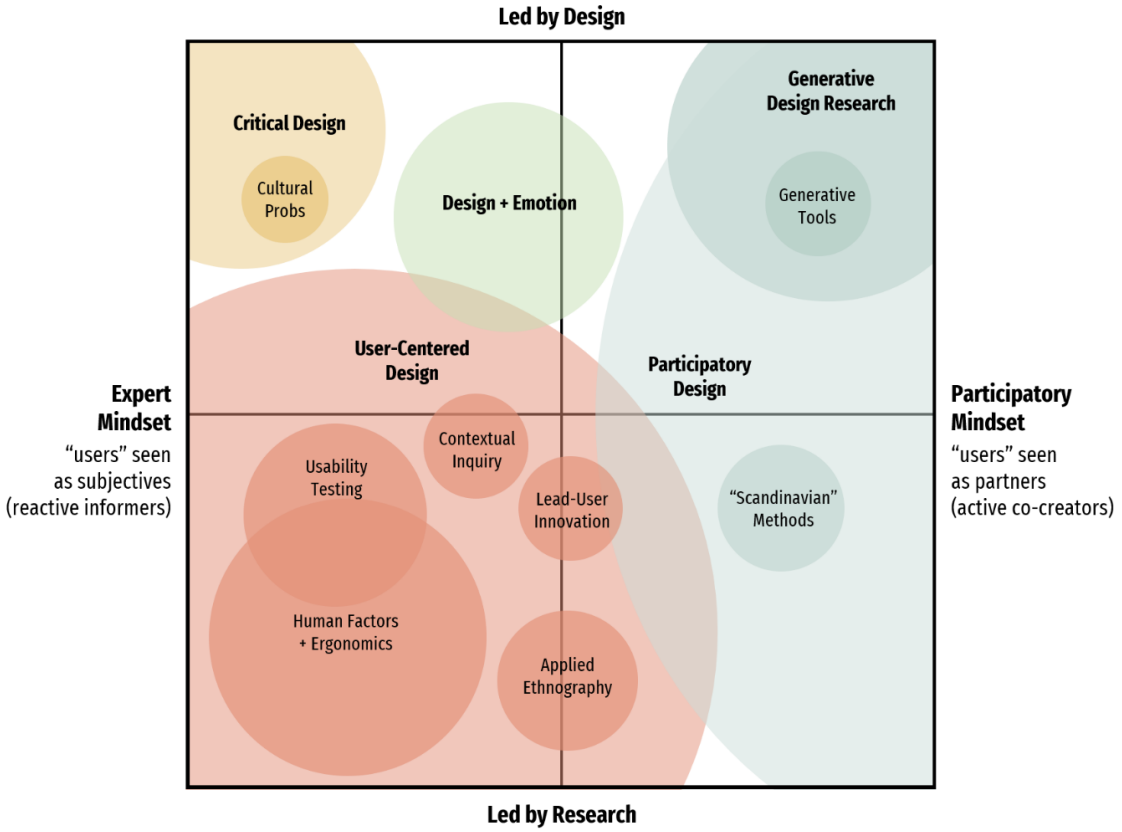


Figure 2.1: *The current landscape of human-centered design research as practiced in the design and development of products and services. The landscape is arranged in such a way that on the left side, design research is more focused on the user as subject, and on the right side of the landscape the user is seen more as a partner. In addition, the landscape is also divided horizontally with the upper horizontal axis that research design is more guided by design and the lower horizontal axis it is more guided by research. Adapted from [42, p. 6].*

There are several ways users can be included in the design process. In the literature review by Kientz et al. [41], for example, a framework is outlined on how children, as well as marginalized and potentially vulnerable populations, can be included. They stated that this framework, see Table 2.1, can also be used for autistic individuals for whom or with whom technology can be developed. The framework consists of different roles, where the role 'users' is a very passive way of involvement and the role 'partners' tend more towards an active role which is more appropriate for co-design.

Type	Description
Users	Autistic individuals are primarily using technology which has not been designed with their involvement. They may have participated in studies where they are observed using the technology and the results of their use may be published, but the technology was not knowingly used to affect the design of the system.
Testers	Autistic individuals were involved as testers of the system, and the results of the testing of the system were used to modify and/or improve the system's design. This either takes place early in the process by using low-fidelity prototypes, and/or later in the process with fully functional systems.
Informants	Autistic individuals were involved early in the design process and may have contributed some of the initial ideas through participatory design workshops where they help ideate or protype new ideas.
Design Partners	Autistic individuals were involved through the entire process and were made to be as equal of partners as possible, with special consideration taken to build relationships between the individuals and the design team.

Table 2.1: *A framework of different roles that an autistic individual can have for inclusion within a design process. These roles are: Users, Testers, Informants, and Design Partners. These roles are listed in an order that the autistic individual's involvement becomes greater and greater. Where the "Users" role has the least involvement in the design process and the "Design Partners" role has the most involvement. Adapted from [41, p. 24].*

The shift from user-centered design to co-design changes the roles of the "users" in the design process [42]. Within co-design, there is a mix of roles that a person can have. For example, the position of the person who ultimately goes through the design process is "expert of his/her experience". To support this process and to gain insight, the designer provides tools for ideation and expression [42]. The designer and the user then work together in the ideation phase, as skills are an important aspect of the development of the tools. An important point is that the user is the main person who gives the input for the final ideas and that work is done from their perspective.

According to Burkett [43], the way people can be involved in the design process depends on the stage of the design process and the context of the service users with whom one is working. According to Burkett, there are four stages in the design process, namely 'discover', 'define', 'develop', and 'deliver'. In Figure 2.2 a modified version of Burkett's stage overview is shown. It contains a view of all the activities related to each stage of the co-design process. In addition, Burkett [43] has distinguished between the 'generative research' part and the 'developmental design' part of the design process, where the stages 'discover' and 'define' fall under 'generative research' and 'develop' and 'deliver' fall under 'developmental design'. The 'generative research' part addresses more on getting to know the users and learning from each other, and creating a challenge. The focus is on identifying user needs to gather key insights for each stakeholder. The 'developmental design' part is more focused on actually designing innovations, making prototypes, checking the validity by testing and evaluating the resulting prototype with end users and other stakeholders, and then implementing them. Both are an iterative process, which implies that it is revised and repeated as long as the desired result is achieved. The strength of co-design is that the user has an active role in the development process and then all the people who will be affected by a service or product are included [42]. In this particular case: the YAA and their caregiver.

However, designers often do not belong to the target group for whom they are designing solutions [44]. In addition, it seems outdated and implausible that a designer can play the role of a passive, objective observer, given that this would require them to put aside their own background knowledge, experiences, and theoretical inclinations when entering the research field [45]. Designers often bring their own expertise and may interpret collected data from the target audience in a way from their perspective, causing designed products or services that do not work for a specific user [45]. Therefore, it is important to apply co-design for designing with YAA given the benefit that designers try to get closer to the lives and experiences of (perceived, potential or future) users by taking into account contextual and affective factors when designing to increase the likelihood that the designed product or service will meet the user's needs [44].

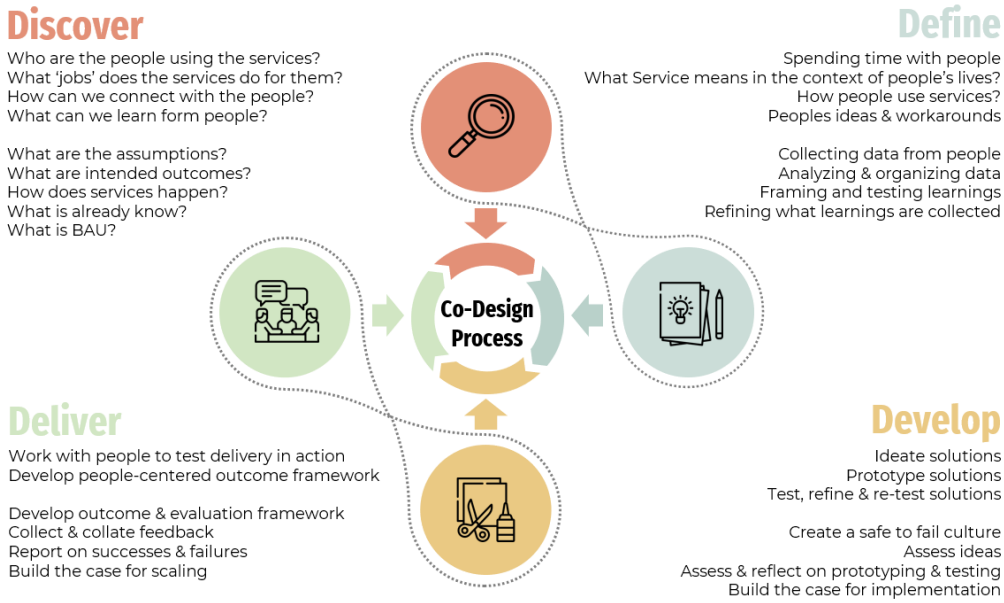


Figure 2.2: *A Co-Design process, consisting of the following steps: discover, define, develop, and deliver. Discover & Define fall under the Generative Research Phase, and Develop & Deliver fall under the Developmental Design Phase. Adapted from [43, p. 21-22].*

2.2.2 Creativity

Creativity plays an important role in co-design. It can be a beneficial factor in the conception of ideas and the way a person can express themselves. It can also help clarify thoughts and feelings. For example, by keeping a journal or charting thoughts. In addition, creativity can also bring people together by sharing a common passion. When creativity cannot be generalized within a co-design session, the co-designer may doubt themselves as being incapable of participating in the design process, it may create a barrier to collaboration, and the co-designer may be limited in their ability to express themselves [42]. The result may be that the co-designer is ultimately unable to contribute to the design of their own service or product.

Everyone has its own interpretation of the definition for creativity, meaning each definition is subjective [46]. Studies use a variety of terms to define creativity, e.g., novelty ([47], [46], [48]), imaginative ([46]), valuable ([47], [49]), effectiveness ([50]), original ([49], [50]), flair ([49]). In addition to using different terms to define creativity, a distinction can also be made between a product that is creative and the process of being creative. Akin's [47] literature review, for

example, also distinguishes between creativity as a product and as a process. When it comes to the product, creativity is defined as "the process that leads to the creation of products that are *novel* and *valuable*". The term novelty within this definition compares the product to pre-existing products developed for the same purposes. Creativity is referred to when at least one component differs from existing products. However, context must be considered in evaluating novelty, since the designer is not always aware of already existing similar products, so the evaluation of a product can sometimes be seen as creative which otherwise would not be the case. The term value refers to the relevance of a product for human purposes. Akin states that "Just because these are new, it does not necessarily mean that they are valuable pieces of art, architecture, music, or synthetic compounds. The value of the creative product is measured by the society that receives the product." [47]. The creative process on the other hand has many similarities with "ordinary" cognitive processes, such as heuristic search, recognition, and problem solving. However, there is a difference between the two, in that the process of being creative also requires skills not only in problem solving, but also in defining new problem spaces [47].

Gaut [49] adds an additional dimension to the definition of creativity, namely "creativity is the capacity to produce *original* and *valuable* items by *flair*" [51]. This definition emphasizes the essence of how something is made in determining whether the act of making it is creative. By flair, it is meant that things that have come about by chance or mechanically, for example, may not be considered creative. One would say that this seems contradictory, if something comes about consciously then an individual may be working out a number of steps to create something, one may wonder if an individual is working mechanically unconsciously. In addition, it could be questioned whether this definition excludes autistic individuals as being creative, since autistic individuals often work in a planned and incremental manner. This way of working could fall under a mechanical way of working. Autistic individuals are often forced to be creative given the challenges they face on a daily basis and still participate in society.

Every person is creative in their own way, but becoming a designer depends on the level of expertise, passion, and creativity [42]. Based on expertise and interest, four levels of creativity can be distinguished, with level 4 being most creative [42]. These four levels are: doing, adapting, making and creating, as can be seen in Table 2.2. People are at different levels in their daily lives at the same time. For example, someone can be very creative with devising recipes for cooking, but on the other hand can be less creative in adapting to the use of technological products. A user can grow in creativity, by gaining expertise, interest/passion, and effort. Creativity can be taught and learned [48].

Level	Type	Motivated by	Purpose	Example
4	Creating	Inspiration	'express my creativity'	Dreaming up a new dish
3	Making	Asserting my ability or skill	'make with my own hands'	Cooking with a recipe
2	Adapting	Appropriation	'make things my own'	Embellishing a ready-made meal
1	Doing	Productivity	'getting something done'	Organising my herbs and spices

Table 2.2: *Four levels of creativity of which level 4 is the most creative. It varies from person to person which level they fall into. For example, a person may fall into a higher level for music than for cooking. In addition, it is also possible to grow in the levels by gaining expertise, interest/passion, and effort. Adapted from [42, p. 12].*

Designers can anticipate when it is acknowledged that these different levels of creativity exists, by making it approachable for participants to facilitate the expression of creativity at all levels. The role a designer can take in this regard is to lead participants who are in the 'doing' level of creativity, guide those who are at the 'adapting' level, and provide scaffolding that support and serve peoples' need for creative expression at the 'making' level, as well as offer a clean slate for those at the 'creating' level [42].

The brain works differently for each individual and therefore everyone is creative in his or her own way. Putting this together, creativity is defined in this report as the process by which an individual can work out their own ideas from their experience with freedom of expressing oneself whereby insights can be generated that can be meaningful. Crucially, here, the output needs to be valuable to the person itself. A product does not necessarily have to be new as long as the product is designed in a creative way and is valuable to the individual. However, the value of the output can only be determined by the person who designs and develops it.

2.2.3 Personalization

As previously mentioned in Subsection 2.1.4 is personalization an important aspect in design because it addresses people's uniqueness [52]. Each individual has different needs that a product or service should meet, which are relevant and personal to the user [52], to meet the specific situation of an individual to achieve personalization [53]. When personalization cannot be realized in the design process, designers run the risk of developing technologies that do not fit the situation of the YAA or that may even be stigmatizing [9], [1]. What is meant by personalization in design, among other things, is adding user names, emphasizing their characteristics and virtues, promoting activities that are meaningful, using familiar references, promoting meaningful activities, and functions and features that meet a user's capabilities and preferences [54].

To translate this into the design of a product or service, designers must interact with users which includes considering the physical and mental characteristics and the surrounding situation that comprise products, services and related people [53]. See Figure 2.3 for a conceptual diagram of personalization in design with these characteristics of a user. The role of the personalization provider can vary from a designer who designs products together with the user to a product that can be personalized by the user itself, for example a digital program where a name and colors can be adjusted [53].

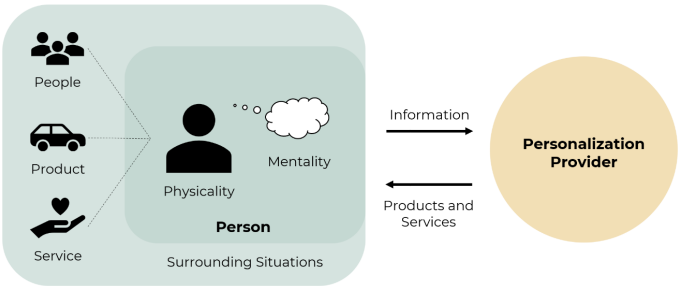


Figure 2.3: *An overview of the conceptual scheme of personalization design. Here in, it is shown that person-specific external characteristics (people, product, service, surrounding situations) and internal characteristics (physicality, mentality), are important to individual preferences when it comes to the design and role with the personalization provider. Adapted from [53, p. 741].*

Despite numerous studies that have been conducted around personalization, there is no general definition for personalization [53]. This report recognizes personalization as the way in which an individual has the freedom to go through the design process in their own way and can apply/expressing their individual creativity based on their experiences which can be reflected in the final product and is relevant and personal to the participant.

2.2.4 Satisfaction

Satisfaction is also an important aspect in co-design. When a co-designer is unsatisfied, there may be a lack of motivation and reduced enjoyment of participation. Full engagement is essential to capture the unique perspectives of users [40]. Moreover, dissatisfaction could also affect collaboration in terms of engagement and interaction between the designer and the co-designer. "The concept of satisfaction is probably universal. Human ability to reflect on himself and his situation invites to appraisals of like and dislike" [55].

Satisfaction is a broad concept, often appearing in different contexts. For example, in the context of buying and using products. Within this context, the essence is often emphasized on subjective evaluation - "individual's subjective evaluation of something experienced or used" [56], [57], and on an emotional responds to an experience - "an emotional response to the experiences provided by and associated with particular products or services purchased, retail outlets, or even molar patterns of behavior such as shopping and buyer behavior, as well as the overall marketplace" [58].

In the context of design, the definition of satisfaction tends to emphasize the essence on user experience - "a feeling developed from an evaluation of the use experience" [59], "how content a participant is with his or her work in the design process" [60], usability - "how pleasant it is to use the system" [61], "should be pleasant to use so that users are subjectively satisfied when using it; they like it" [61], and entertainment - "their entertainment value is more important than the speed with which things get done, because one might want to spend a long time having fun" [61].

Although the definition has different meanings/purposes in different contexts, such as satisfaction with purchasing a product or using an interface, there are similarities that could apply in the context of co-design. Based on these insights satisfaction is defined in this report as the favorability of the individual's subjective evaluation of, and emotional response to the experiences gained during the co-design process, which includes how content a participant is with their work in the design process.

2.2.5 Autism and Co-Design

The collaboration between autistic individuals and neurotypical individuals might be difficult as the two make sense of the world in different ways. For example, there may be a lack of social understanding which is biologically and socially determined in the expression of autistic individuals [6]. Within social interactions of many varieties between social "actors," differing experiences of lack of awareness or lack of understanding is often a common phenomenon, leading to the "Double Empathy Problem". Milton [6] has discovered this problem, which implies that the lack of understanding about perceptions comes from two sides, both from the autistic perspective, and that of neurotypical individuals. The problem works both ways. So it is true that autistic individuals lack insight into the perceptions and culture of neurotypical individuals, but it is also true that neurotypical individuals lack insight into the minds and

culture of autistic individuals [6]. Or that neurotypical individuals even lack social insight in social situations, because they can easily reset themselves to a natural attitude, and tuning tendencies of their peers [6]. In this theory the problem is not seen as that an autistic individual "deviates" from how it is portrayed in society as "normal", but that a difference in perception from different perspectives of "actors" is causing the problem.

Nevertheless, there are challenges that designers may encounter while working together in a design process. For example, when a person is limited in speech, oral communication will be a challenge. Another challenge designers may encounter is that YAA could be heterogeneous, with each individual having a different demand for support needs, from very personal and sometimes very specific interests and abilities [10]. Also, the intellectual capacities of each individual vary, which can range from intellectual disability to normal or high IQ ranges [10]. The challenge of working with and specifically for people with cognitive differences is circular: the user characteristics for which supporting technology needs to be designed could also create barriers for co-design [40].

In the literature review by Francis et al. [40], an overview is presented, as can be seen in Table 2.3, contrasting the characteristics that autistic people might have, with the presumed characteristics of a participatory design participant. Here it can be clearly seen that a number of characteristics can cause challenges during the involvement of the design process, especially when some characteristics are combined. For example, the designer's attempt to get the participant to participate may be hindered by an interrogative form of fear of failure combined with lack of motivation [40]. Most importantly, the individual should not be harmed by design activities that are not well structured or managed. Therefore, it is important for the designer to take these characteristics into account and to organize design activities in such a way that each individual can participate in the design process, i.e. customized co-design techniques [40].

No.	Characteristics of autistic individuals	Assumed traits of a Participatory Design participant
1.	Communication problems	Being able to understand instruction provided and interacting with other participants
2.	Difficulties in reading emotions	
3.	Difficulties with disruption of routine	Being able to engage and interact with people you may never have met before
4.	Motor skills difficulties	Will often involve participants to draw, write storyboards or place ideas on post-it notes to then arrange them in some ways
5.	Lack of motivation	Full engagement is essential
6.	Cognition problems	Being able to play a role, imagine hypothetical situations
7.	Over-sensitivity to failure	Some activities may be risky, such as the use of games to support a session
8.	Social anxiety	Dealing with unknown situations, often in an artificial environment (a design room), and being asked to perform tasks that you may never have encountered before
9.	Lack of psychological well-being	
10.	Stress	

Table 2.3: *Contrasting Characteristics that autistic individuals might have with assumed traits of a Participatory Design participant, adapted from [40, p. 127].*

Despite some of the challenges that YAA might encounter in daily life, designers need to anticipate and provide enough time, space, and a safe environment for YAA to participate in the design process. It is important to note that YAA should not have to adapt to be part of the co-design process. It is the designer who should anticipate and create the opportunity for YAA to have full ownership so that they can be experts in their own experiences. There are existing guidelines that designers can consider for successfully including YAA in the co-design process, namely, the use of careful sequencing and simple sentence structures. Avoiding abstract concepts should be taken into account when formulating interview questions [40]. Designers should not, for example, ask autistic individuals where they see themselves in 5 years. This is an abstract question, so YAA's cognitive "challenges" might get in the way of imagining themselves in hypothetical situations. In addition, motivating YAA in the first step towards the design process is an important aspect, given the vulnerability and fear often experienced by the target group.

As mentioned before, the experience of YAA is crucial for the design of effective technological interventions. There are a number of techniques that can be used to capture the experience, for example the technique "self photography" [40]. In this technique, the user takes a camera and records their daily activities, having full ownership and an additional memory tool [40]. In addition, the technique "video photography" can be used, in which the designer and photographer follow the user throughout the day and record all the experiences of activities performed during the day [40]. By doing so, the user's activities can later be viewed, discussed and reviewed. Furthermore, the technique "thinking aloud" can be used to identify the experiences during activities [40]. With this technique, the user can talk loudly while performing activities in order to process thoughts/feelings that they experience during activities. One must consider to which users this technique is applied, as it requires a level of verbal skills. Finally, the "role play" technique can be applied, in which the user, together with the designer, assumes different roles in different play contexts [40]. Here, the user must be able to play a specific role which the user finds relevant [40].

Furthermore, there are also contextual aspects in which the co-design activities take place that can play an important role in designing successful technological interventions, namely the location, communication styles, designer attributes, respect for the user as an individual, and the management of the user's special ability [40]. See Table 2.4 for an elaboration on each contextual aspect for which designers should consider guidelines when designing with YAA.

Contextual aspect	Guidelines for designers
Location	By choosing a specific location, it is often easier for the user to relate the design activities to the object of the design. However, quiet times need to be taken into account, as locations outside of familiar surroundings can provide less control and distraction. To this end, a designer can focus on one single task at a time, hold short on-site evaluation sessions as a reminder, and try to avoid overloading by doing extraneous activities at that specific location.
Communication	In terms of communication, it is important to ensure that the user fully understands the purpose of the activities and that they have the opportunity to discuss, inform and participate. Tools and language cues that are familiar to the user will facilitate the interaction, allowing sufficient time to do so, avoiding frustration, aggression and discomfort. It is of utmost importance that the designer is aware of the underlying conditions, such as the degree of acceptance of complexity and the tendency to confusion.
Self-image and control	The designer must ensure that the user's self-image and control are maintained. To this end, the designer can put the user at ease when they carry out a certain design activity, especially in public spaces. The designer should keep a close eye on signs of discomfort or overload, as YAA are sensitive to so-called "success or failure" tasks. The designer should ensure the user that the activities are not linked to success or failure. Nevertheless, the need for familiarity and the extra investment of time and empathy from the designer outweigh all of the above guidelines.
Designer	The designer must be able to deal with certain behaviour of the user (e.g. outburst reactions due to social anxiety or stress). For this it is important that the designer gives enough time to the user, gives short and helpful explanations, gives practical rehearsals, and when there are visual or motor barriers that weight of equipment and dimensions are taken in consideration.
Ability	The designer must be aware of the underlying conditions and familiarity with the user. For example, the characteristic of the individual, such as level of tolerance when something becomes complex, patterns in thinking, patterns in inappropriate behavior, and the designer must know when a user is doing the designer a favor instead of working with him constructively. For this, the designer can provide clear explanations, offer sufficient time, do practical rehearsals, and ask for suggestions from the user.

Table 2.4: *Overview of different contextual aspects a designer should take into account when designing with autistic individuals. Per contextual aspect there are a number of guidelines a designer can take into consideration. Summarized from [40, p. 132-133].*

2.3 Design Your Life

Design Your Life (DYL) is a project designed to provide YAA with tools to design their own supportive technology. The goal of these self-designed technologies is that they could support YAA, fit into their daily lives and could promote their independence [10]. The DYL project consists of a method (design process) and a physical toolkit (activities and prototype tools). This method could provide empowerment by not only allowing YAA to participate in the design process but also giving them tools to design and implement their own personal products. The YAA are central in this design process and the design is based on their own perspective. Therefore, they are not only participants in the design process but actually become the "owner" of the design process, what is also known as user-initiated design [10].

Four core principles are used within the DYL project. The first core principle is the importance of understanding the experiences of YAA, which stands central as an input to the design process [10]. This is to prevent technology from being ineffective. The second core principle is to encourage 'action-oriented tinkering'. This implies that an experience has to be lived through, which for design means that instead of looking at logical analysis during design, prototypes have to be developed in different scenarios in which YAA can find themselves in daily life. According to this core principle the design should not be seen as a separate activity but as a whole that fits different scenarios. The third core principle that DYL supports is user-initiated design, where YAA "own" and are an active part of the design process. The fourth core principle is that DYL makes use of Of-The-Shelf Technologies. Given that YAA might find it difficult to design a concept "from scratch", existing technologies are used to design new concepts. These Of-The-Shelf Technologies can range from non-digital low-tech to digital high-tech. An advantage of this is that it is easier to determine what possibilities there are for developing technologies and they are relatively cheaper as no customization is required.

The remainder of this section will examine the DYL process, the different case studies that have been carried out looking at different aspects (e.g. communication, creativity, etc.) with different forms of the toolkit (e.g. card set, board game, physical or hybrid form, etc.), with an evaluation. Then the current physical toolkit will be discussed and an evaluation will be made based on the points that emerged from the case studies which will be compared to the current physical toolkit.

2.3.1 Design Your Life Process

The DYL method consists of an iterative process that uses phases where stakeholders are effectively engaged during the design process [10]. The process consists of the following phases [62]: introduction, my situation, my focus, my idea, my solution, my test, my insight, and finally round-up.

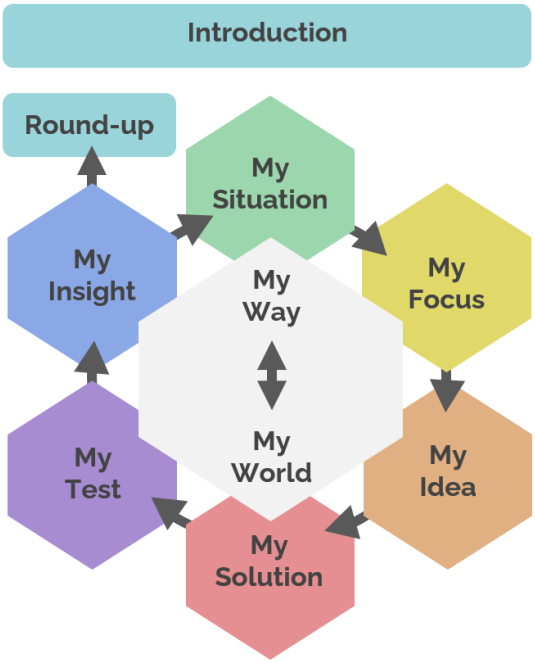


Figure 2.4: *An overview of the design phases of the DYL process. The process starts with an introduction, after which one of the six main steps can be chosen: my situation, my focus, my idea, my solution, my test, my insight. The process ends with the round-up phase, adapted from six phases designed by the DYL research team. Adapted from [62, p. 6].*

The process begins with the introduction phase, in which activities are given to prepare for the design process. Alternatively, a flow can be determined how to proceed through the design phases. For this, menus are offered that serve to get YAA started and support them in choosing activities, as can be seen in Figure 2.5. It is not necessary to define all activities for all phases, only those of the phase where the YAA starts. Based on the results of previous activities, follow-up activities can be chosen in the different phases. After the introduction, the following phases can be completed. Below is a brief explanation of the goals of these different phases of the DYL process:

- My Situation: YAA investigate what they encounter in daily life and what activities they engage in the physical and social environment. They also investigate what they already use to be more independent and work towards an initial understanding of their design context.
- My Focus: YAA are going to identify a focus they are going to focus on for the design process. Why do they focus on this? What can be done better? Where can technology be used as a support tool?
- My Ideas: YAA start thinking about ideas for an "ideal" thing. What should it look like? What functionalities should it provide? In this phase, conceptual and creative thinking is encouraged, through brainstorming and tinkering tools.
- My Solution: YAA put the focus on one idea, which is then developed. Finally, a prototype is created, which ideally is as close as possible to the technology they envisioned in the previous design phase.
- My Test: YAA are going to be testing the prototype in their daily lives. In doing so,

they are going to see if the prototype really meets their expectations and does what they envisioned.

- My Insight: YAA explicitly evaluate what worked well with the prototype and what should be explored in follow-up design iterations.

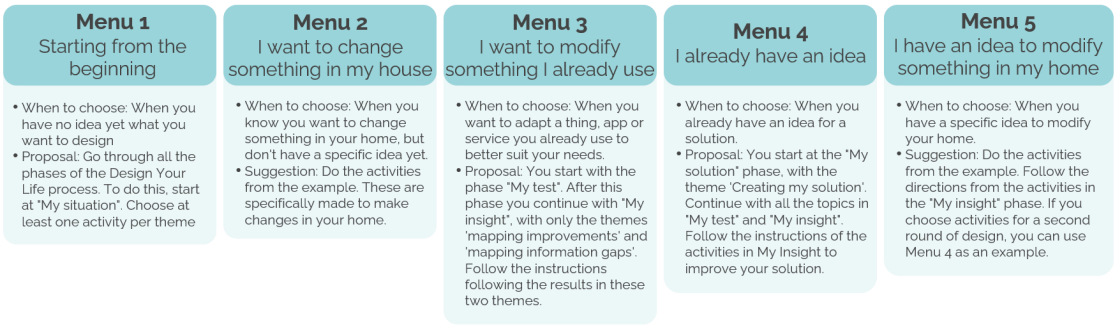


Figure 2.5: *An overview of the five menus that can be chosen in the introduction phase. A menu can be chosen to get the YAA started in choosing the activities to start the DYL process. Adapted from the introduction booklet made by the DYL research team.*

The "Round-up" phase allows YAA to inspire other designers and get started by documenting their solution. Finally, this phase reflects on what the YAA has learned about designing, about themselves, and about the co-designer. Going through the entire DYL process ultimately leads to a personalized designed technology that could support YAA in their daily lives.

2.3.2 Case Studies

Ten different case studies were conducted with different YAA, which involved working with stakeholders in real life such as healthcare professionals. Going through a case study involved designing a concrete DYL toolkit prototype and testing it. The toolkit represents the process of DYL (see Figure 2.4) and provides support, also referred to as tools (such as cards with instructions and assignments, visual materials, progress status, etc.), during the design process of the YAA and the caregiver. The design process can be run through several times until the YAA is satisfied with the final result.

These ten case studies were set up by different designers, including researchers and students. Per case study different aspects (e.g. communication between participant and caregiver, promote creativity, etc.) and different versions of the toolkit with different characteristics (e.g. physical, digital, hybrid, card set, board game, etc.) were examined. The entire process of conducting a case study ensured that, on the one hand, various promising tools and techniques are selected and adapted from co-design, as well as the social aspect between the YAA and caregiver whereby they get to know each other better by going through their lived experiences through which they become informed and inspired [62]. Subsequently, the theory and practice are brought together in concrete design choices for the method and toolkit [62]. These case studies were conducted through a 'Research-through-Design' method, where the focus is mainly on the insights that come out of the design process rather than the outcomes [62].

YAA's name	Participant profile	Research Question	Toolkit
Tim	14 years old; Living at home; DYL partner: parent.	How can a toolkit enable caregivers to support YAAs in creating a personalised, technological home environment that contributes to their independence?	Digital, interactive guide
Paul	33 years old; Living at mental healthcare organization; DYL	How can a toolkit facilitate a co-design space for people with autism and their caregivers to improve their independence through problem-finding and solving, without the need for a design expert?	Physical, card set
Vincent	23 years old; Living at mental healthcare organization; DYL partner: professional caregiver.	How can a co-design toolkit promote creativity to enable YAAs and their caregivers to find or create a technology to promote the YAA's independence without the need for a design researcher?	Physical, board game
Multiple YAA	25-32 years old; Living with parents and mental healthcare organization; DYL partner: parents and professional caregiver.	What set of aids can support the client and caregiver in online collaboration, for the development of the DYL toolkit?	Physical-digital hybrid, step-by-step guide
Willem	18 years old; Living with his parents; DYL partner: design researcher.	How can a toolkit incorporate the YAA's physical, social and emotional environment into the DYL process?	Physical, mini-workshops
Sky	17 years old; Living with his parents; DYL partner: parents and professional caregiver.	How can design thinking help to empower a YAA during their daily life?	Physical, mini-workshops
Simon	26 years old; Living at mental healthcare organization; DYL partner: professional caregiver.	How do you support communication between an autistic and neurotypical participant during a co-design process, without the design researcher being present?	Physical, box set
Anton	39 years old (outlier); Living on his own; DYL partner: design researcher.	How can design tools support reflection in and on action as part of the embodied practices of YAAs throughout the DYL process?	Physical, box set
Renée	18 years old; Partly living at a mental healthcare organization, partly living at home; DYL partners: two professional caregivers.	How can the concept of everyday design help YAAs and their caregivers in selecting/adapting/creating personalised technologies that empower YAAs in their daily life?	Physical, card set
Herman	32 years old; Living on his own; DYL partner girlfriend.	What are the essential steps of the DYL process that cannot be executed by YAAs and the design partner without the need for guidance from a designer?	Physical, card set

Table 2.5: *An overview with DYL case studies, including profiles, research questions and characteristics of the developed toolkits. To safeguard the identity of the participants, the names used in this Tableare pseudonyms, adapted from [62, p. 4-5].*

From the analysis of Van Huizen et al. [62], ten categories were identified under which the findings could be divided, as can be seen in Figure 2.6. Figure 2.6 is a summary of the findings categorized under the ten categories; Flexibility & Personalization, Digital versus Physical, Autism Specificness, Heterogeneity, Envisioning, Reflecting, Goal Setting/Validation, Inner versus Outer Focus, Top-Down versus Bottom-up, and Social Network.

This report will focus on one of the categories of the findings from the analysis, namely Digital versus Physical. Since a number of YAAs have a strong affinity for digital platforms, a digital supplement will be valuable in addition to the physical toolkit. The design activities included in the toolkit must be specifically designed so that autistic users can work with them. The next section will further explore the demand for digitization.

Flexibility and Personalization	Digital versus Physical	Autism Specificness	Heterogeneity
YAAs should be able to select their own design activities; go through the process linearly or iteratively; choose in which design phase they would like to start. Design instructions should be given through different sense modalities, either in a textual, visual or auditory way - if not a combination of all three.	The toolkit should come in both physical and digital shape; some YAAs had a great affinity with digital platforms, whereas others preferred to work in a physical setting.	Stereotypisation should not be avoided at all costs: the toolkit must accommodate autistic users, thereby also taking into account autistic information processing needs.	The participant pool in general has been limited, working with YAAs that were motivated to and had the ability to engage in design research. In future case studies, the participant pool must be expanded to consider different manifestations of autism as well as different care contexts.

Envisioning	Reflecting	Goal Setting / Validation	Inner versus Outer Focus
Due to their abstract and open-ended nature, design activities asking the user to envision future situations might be particularly challenging for YAAs. These activities should come with instructions in small steps and accompanied by relatable examples.	Similar to envisioning, reflecting calls on the ability to make inferences. This is difficult in general, but may be particularly challenging for YAAs. Clear instructions and examples can help to systemize the reflection-process.	The toolkit lacks a uniform method to validate the psychological effects of the toolkit. Evaluation so far has focused on functionality and usability of the end product, not so much on the empowering experiences that the process towards it may have produced.	A distinction exists between those design activities that aim to bring about a practical change in one's environment, and those that also try to establish a behavioural or emotional change.

Top-Down versus Bottom-Up	Social Network
The bottom-up approach of the design process puts the 'client' and their experience centre stage. The YAA should be in charge of their design process; the caregiver has a supporting role.	Instead of integrating the toolkit only in formal therapy or training, there is a demand for a social network of some sort in which users can brainstorm with each other on their design process.

Figure 2.6: *A summary of ten categories (Flexibility & Personalization, Digital versus Physical, Autism Specificness, Heterogeneity, Envisioning, Reflecting, Goal Setting/Validation, Inner versus Outer Focus, Top-Down versus Bottom-up, and Social Network) that were obtained through intermediate coding. For each category, there is a description of findings from the ten case studies that were conducted [62, p. 16].*

2.3.3 Toolkit

Based on various elements and findings of the previous ten case studies, a physical toolkit was designed. The toolkit is in a large cardboard box, which contains all the components needed to go through the DYL process (see Figure 2.4). Figure 2.7 shows an overview of the toolkit elements, consisting of activities, prototyping tools, photo & video tools, and a visual central overview of the process. In this overview, the prototype is also a component. The prototype serves as an example of what a final product could be after going through the DYL process.

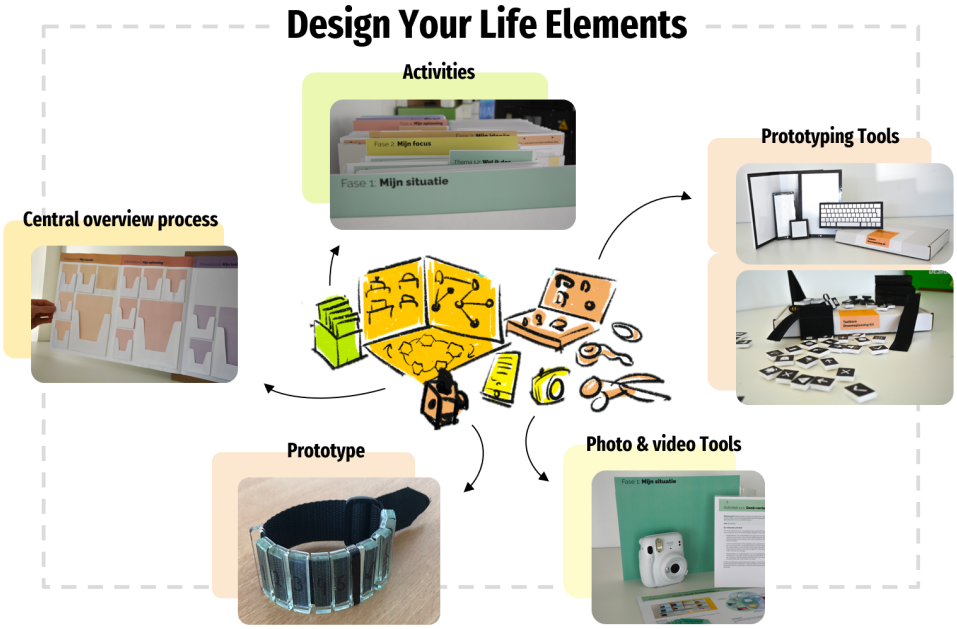


Figure 2.7: *An overview of the elements of the DYL process, consisting of activities performed by the designer and co-designer, various tools that can be used to develop an idea into a product, a central overview that visualizes the design progress, and a prototype as an example of what the final product could be after going through the DYL process. Visualization: Jelle van Dijk, Photo prototype: Omar Martínez Gasca, Photos DYL toolkit: DYL research team.*

Activities

Within each phase of the DYL process (see Figure 2.4) are themes and activities. Figure 2.8 provides an overview of all the phases with their themes and activities. An example is the phase "My Situation" which includes the themes "What I use" and "What I do". Within these themes, there are several activities. Figures 2.9, 2.10, and 2.11 show examples of activities. The activities serve as tools for YAA to go through the design process step-by-step, ultimately designing a personalized prototype of their own assistive technology. It is important to note that the YAA can decide in which phase they start and when a phase is completed, based on the results of another phase, YAA can always go back to the previous phase.

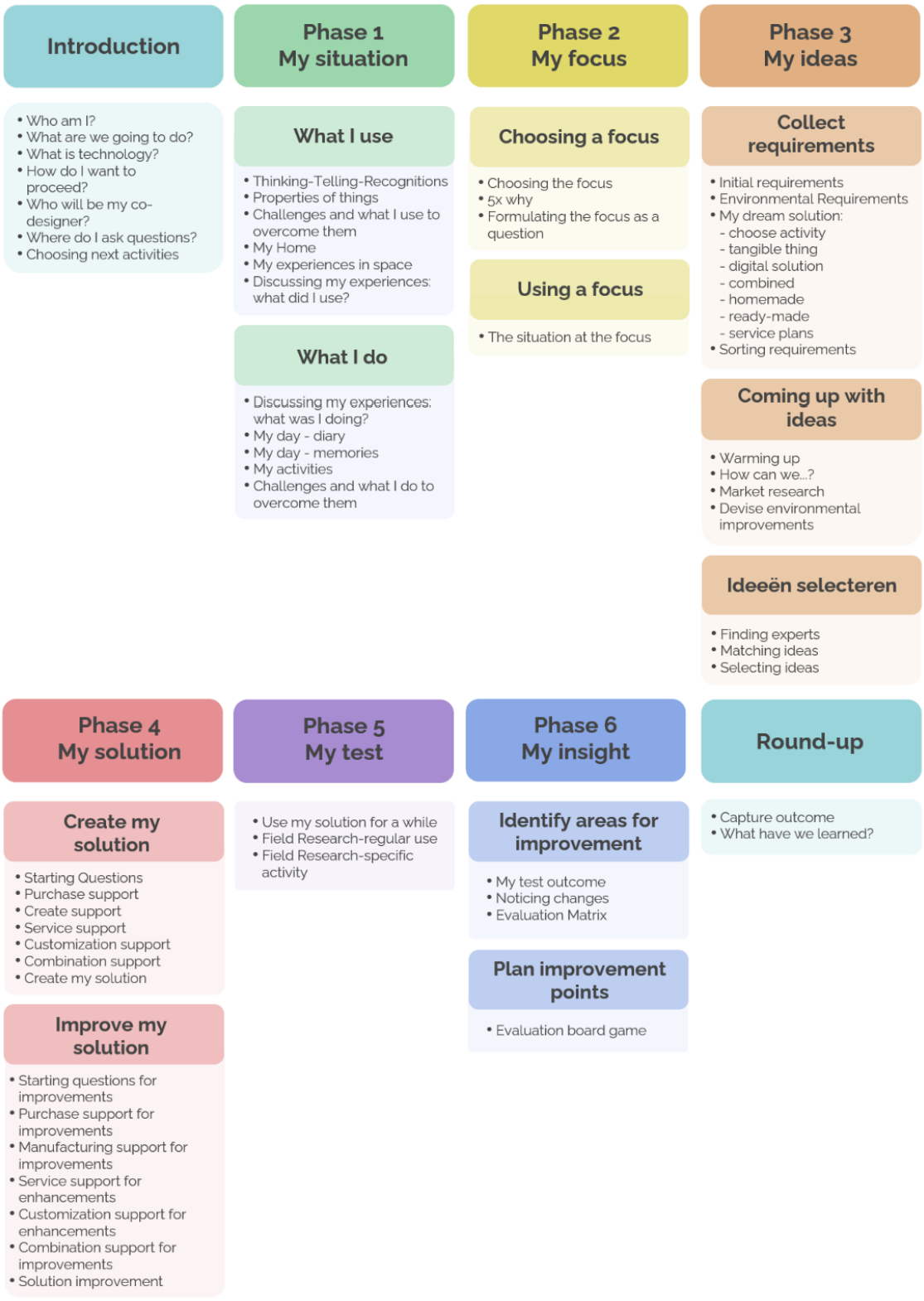


Figure 2.8: *An overview of all the phases (introduction, my situation, my focus, my idea, my solution, my test, my insight, and round-up) of the DYL design process, with their corresponding themes and activities. Adapted from the booklet of activity cards created by the DYL research team.*

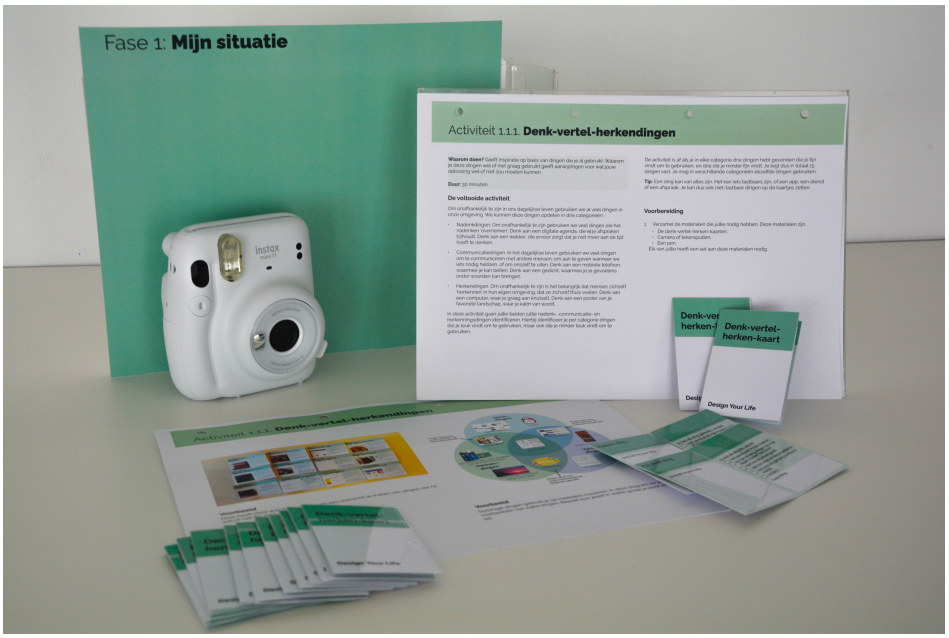


Figure 2.9: *An overview of the activity 1.1.1. "Denk-vertel-herkendingen". This is an example of an activity that falls within phase 1: my situation. In this task, the YAA seeks inspiration for what the solution should be able to do by writing down what things they like or dislike, based on things already used by the YAA. This photo was taken by the DYL research team.*

Figure 2.10: *An overview of the activity 1.1.2. "Eigenschappen van dingen". This is an example of an activity that falls within Stage 1: My Situation. In this task, the YAA is going to look at what characteristics they like about a particular thing. This photo was captured by the DYL research team.*

Figure 2.11: *An overview of the activity 1.2.2. "Mijn dag - dagboek". This is an example of an activity that falls within Phase 1: My Situation. This is a follow-up activity to "Mijn ervaringen in de ruimte" activity 1.1.5. In this activity, the YAA is going to discuss what activities are performed in a particular space while they are in the area of a beacon. And map out in what ways these activities affected herself. This will give the YAA an idea of activities that the YAA can change. This photo was captured by the DYL research team.*

Central overview process

The activities that YAA goes through are kept in an activity map. This is also an overview of the completed process. See Figure 2.12 for an example of the activity map.

Figure 2.12: *An overview of the DYL activity map. In this map all cards are stored that belong to the activities carried out. This map also shows the process that has been gone through by the YAA. This photo was captured by the DYL research team.*

Prototyping Tools

Within the toolkit, there are several prototyping tools offered that YAA can use to design their own assistive technology. These tools are offered to help YAA get started with the design process. The Velcro mock-up kit consists of several recognizable multitude of interactive elements, such as buttons that can be used to control volume, sliders and buttons with icons on them. See Figure 2.13 for an overview of the toolkit. The goal of this toolkit is to use the elements of the toolkit to link functionalities to it, so that eventually an electronic product can be designed. This could be existing products, to which functionalities are linked based on the needs of YAA. This toolkit allows for quick design of a mock-up interface.

In addition, there is a paper prototype kit to support software mock-ups. See Figure 2.14 for an overview of the toolkit. This tool can be used to quickly create low-fi prototypes for software prototypes [63]. The advantage of this tool is that it does not require any programming knowledge to still be able to design a low-fi prototype. The paper prototype kit consists of familiar interfaces of different devices, such as computer screens, tablets and smartphones.

Figure 2.13: *An overview of the DYL Velcrow toolkit which consists of several recognizable multitude of interactive elements, such as buttons that can be used to control volume, sliders and buttons with icons on them. This toolkit allows for quick design of a mock-up interface. This photo was captured by the DYL research team.*

Figure 2.14: *A representation of the digital dream solution-kit, which is part of the activity for designing a dream solution. In this digital dream solution-kit there is a keyboard and there are different sizes of screens that YAA can draw on to design their own interface.*

Prototypes

The output of the DYL process can be several things, such as something YAA can buy (an existing solution), something YAA makes itself (prototype), a service, something YAA already use with a modification, or a combination of these (for example, 2 apps that can communicate with each other or a product and an app). An example of a prototype created by a participant named Anton is a task bracelet that helps Anton remember whether he has completed his tasks. Anton's prototype is depicted in Figure 2.15. In addition to the practical outcomes, the DYL process could also contribute to the empowerment of YAA. For example, it could contribute to self-knowledge and self-confidence [64].

Figure 2.15: *Anton's conceptualized and created prototype. On the left is the mock-up, which is a scale or full-size model of a design or product made during the design phase. The photos on the right are the final prototype which is a task bracelet that helps Anton remember whether he has completed his tasks on the day. Photos prototype: Omar Martínez Gasca [65, p. 67].*

2.3.4 Demand digitization

Based on the findings of the analysis by Van Huizen et al. [62] the aspect of digitization is not yet included in the current physical toolbox. The shape of the toolkit should be offered in both physical and digital form. The current toolkit already suggests that a distinction can be made between a digital and tangible way of working, as can be seen in Figure 2.16. In activity 0.4., the user is asked "How do I want to work?". However, until now, this activity was merely included to map if users were truly interested in such a digital way of working, with the actual digital toolkit still to be made.

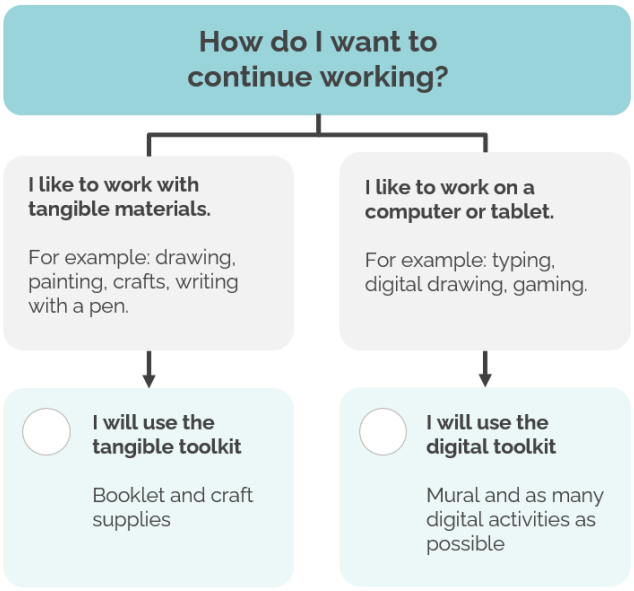


Figure 2.16: *Activity 0.4 "How do I want to work?" of the introduction phase of the DYL process. In this phase YAA have to indicate in which way they want to work. They can choose between a physical version or a digital version of the toolkit, adapted from the introduction booklet made by the DYL research team.*

It is important to have an understanding of where the demand for a digital shape comes from. In addition to the general benefits of technological tools as reported in section 2.1.4, there are further aspects from a theoretical perspective that show that there is a need and also a demand for digitization. For example, the literature by Francis et al. [40] mentions that autistic individuals may experience difficulties in fine motor skills. Because of this, assignments where writing is a component could create frustration. A digital form can make it possible to support the writing part by typing.

Furthermore, the literature review by Kientz et al. [41] mentions the difficulty of filtering sensory information. Autistic individuals may become overstimulated because they filter information in a different way, making it difficult to distinguish irrelevant information. Digitization can contribute to the filtering process by abstracting or limiting information so that only relevant information is displayed. Additionally, autistic individuals are often visual thinkers and tend to use mental representations rather than verbal [66]. This can make it difficult to put ideas or solutions that are in their heads into words. A digital environment can offer multiple avenues of expression, thus allowing visual thinkers to personalize their way of working.

Moreover, it was observed that the case studies revealed specific requirements for digitization of the DYL toolkit in a coherent manner. For example, the participant Tim [67] indicated that he does not want to write with a pen, given that he does not like to work that way and his handwriting is unreadable due to his motor skills. In the ideation phase of the case study, the answer for each question had to be written or drawn on a post-it and taped to a wall. Since this method requires writing or drawing on paper, this exact method did not work for Tim. So, Tim preferred digital support over tangible supports, which also showed that he managed the task better digitally. The same applies to the case study that was conducted with several participants [62] at the same time. A number of participants within the group have also indicated a preference for typing rather than writing with a pen due to their motor skills, resulting in illegible handwriting. In addition, they indicated that they are sometimes restricted by the limited form of fill-in (e.g. writing with a pen, drawing stickers, etc.) and by the space of the physical fill-in boxes. Digital would then be preferred by some of the participant group as there are more options for choice of expression. For example, participant Sky chose the tool MarkDown [1] to work out results, which is a free text-editor tool [68]. He works in this tool frequently and therefore preferred to work with it.

Other benefits of a digital toolkit have been suggested as well, participant Sky [68] mentioned that when he sits at his computer, he knows exactly what is expected of him and he feels confident because he can handle his computer well. In addition, Sky feels confident in his environment, in which the stimuli shown on his computer screen is the only thing that is unpredictable. Furthermore, participant Renée [69] expressed a preference for a hybrid solution, a combination of both physical and digital. A digital version would enable her to access her work at all times. She is also able to make changes on the activity board whenever and wherever an idea occurs to her. However, when it comes to collaborating with others, her preference is to work physically, as she feels more comfortable sharing personal issues in person rather than over a screen.

In short, the demand for a digital toolkit and digital support tools during the elaboration of the activities has not yet been fulfilled. In the context of co-design together with the YAA for designing a personalized assistive technology, the way of expression should also be in line with the desired way of working of the YAA. This not only personalizes the designed technology, but also the way the technology is designed.

2.3.5 Design Question

Given the request from YAA in previous case studies and based on the analysis of the physical toolkit, a demand arose for a digital form and digital support during the execution of the activities in the DYL design process. Therefore, the purpose of this study is to gain new insights into how a digital toolkit can support individual preferences of expression. This leads to the following overarching research question:

How can digitization of the DYL toolkit support individual preferences of expressing oneself, contributing to a creative, personalized, and satisfactory design process?

Both the theory (mentioned in Subsection 2.2.2, 2.2.3, and 2.2.4) and the ten case studies showed that the important aspects of creativity, personalization, and satisfaction need to be taken into consideration in order for YAA to participate in the co-design process. The ten case study also revealed that the form of the toolkit affects those aspects. In order to answer

[1] `www.markdownguide.org`

the main research question, four additional supporting questions are considered as part of the research.

The first sub question focuses on the requirements from the perspective of YAA for a digital version of the DYL toolkit and examines how YAA want to work and how they can use their creativity in carrying out the activities using digital tools. This results in the below question:

- What does a digital version of the DYL toolkit require from the perspective of YAA?

The last three sub-questions will focus on the three important aspects: creativity, personalization, and satisfaction. These sub-questions examines how the aspects manifests itself in YAA when using a digital toolkit, how they can be operationalized in the practical implications of a digital toolkit, and how a digital version of a toolkit can contribute to YAA's important aspects. This results in the below questions:

- How can digitization of the DYL toolkit support creativity?
- How can digitization of the DYL toolkit support personalization?
- How can digitization of the DYL toolkit support satisfaction?

Considering that the DYL toolkit is comprehensive and consists of several phases and activities, the emphasis on the prototype design is placed on phase 3: "My ideas," since it is primarily about idea generation - a core component of co-design. Given that the current study aims to examine the role of creativity, personalization, and satisfaction in co-design, the activities in phase 3 of the DYL process is therefore deemed most adequate for this purpose.

Chapter 3

Research Methodology

This chapter explains the approach to this research. In chapter 2, a literature review was conducted from which a design question emerged, namely *"How can digitization of the DYL toolkit support individual preferences of expressing oneself, contributing to a creative, personalized, and satisfactory design process?"*. As previously mentioned in Chapter 1, the CTDP (see Figure 3.2) was used as the process for designing the digital toolkit prototype. The phases of this design process will serve as a guideline for the structure of this chapter. Figure 3.1 shows an overview of how this design process was applied for this research.

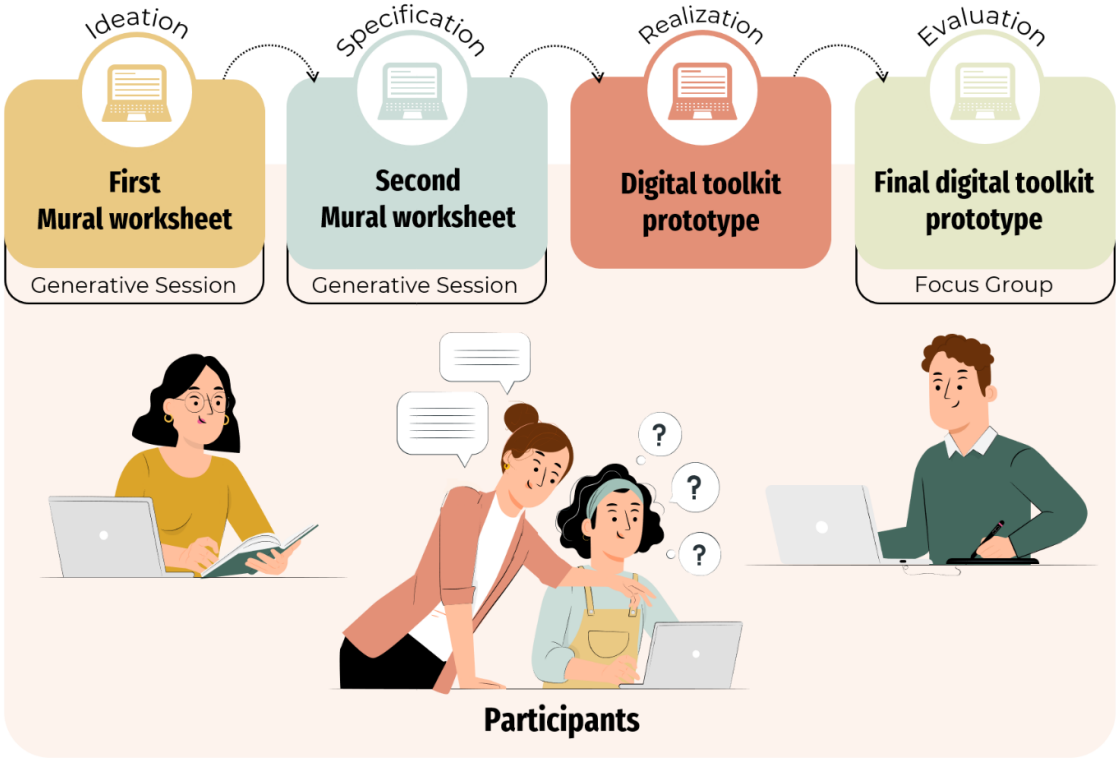


Figure 3.1: *Overview of the design phases that have been applied: Ideation, Specification, Realization, and Evaluation. This overview shows which digital prototype was used in which phase and which method was used to evaluate with the participants. Adapted from [11].*

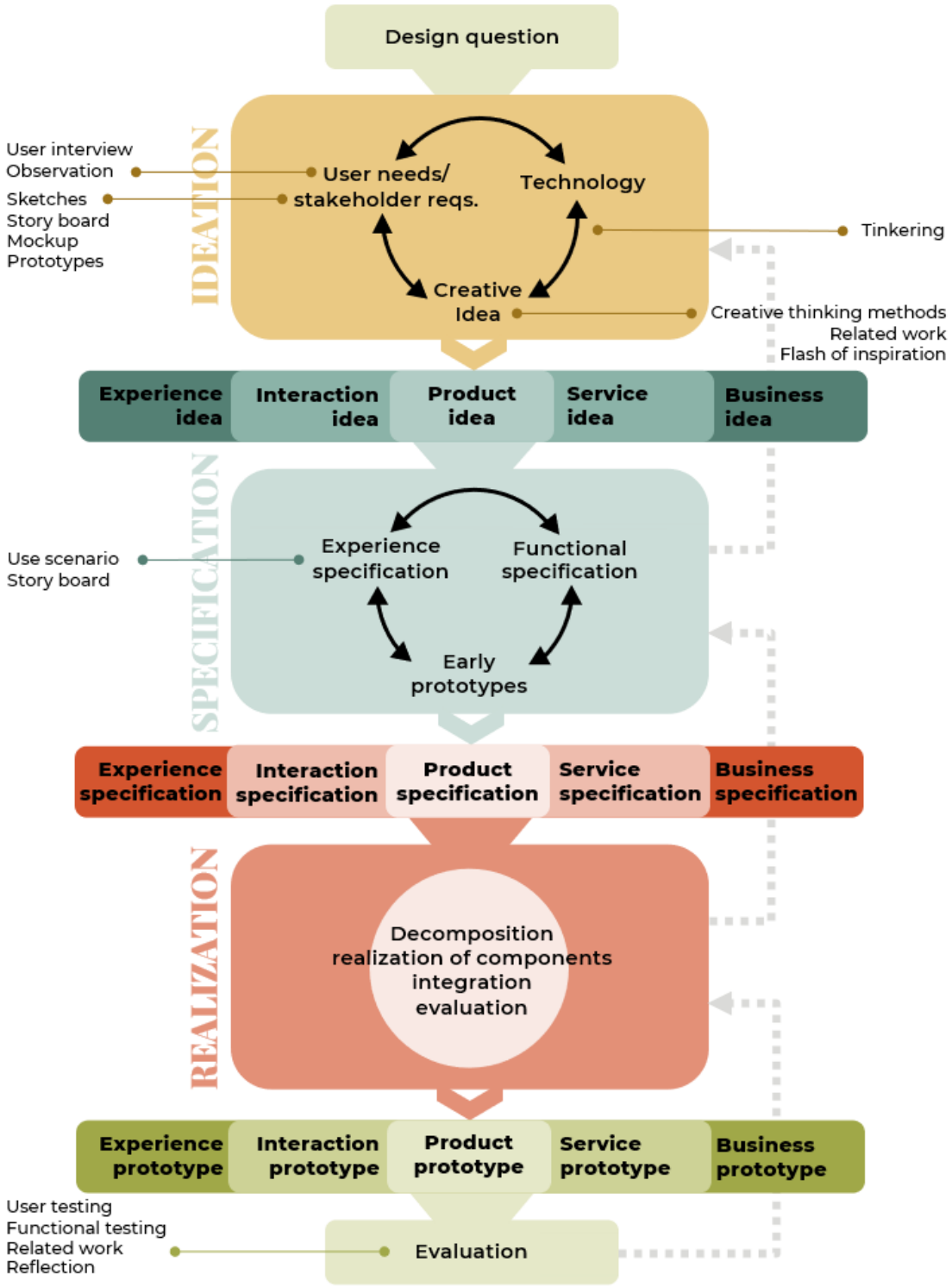


Figure 3.2: *An overview of a Creative Technology Design Process. The process includes the following phases: ideation, specification, realization, and evaluation. Adapted from [11, p. 3].*

3.1 Ideation

In order to explore how digitization could be an outcome for DYL's physical toolkit and the activities that comprise the DYL process, YAA will need to be involved. In the ideation phase, initial ideas for a digital tool were considered together with YAA. The purpose of the ideation phase was to gain a better understanding of how participants perceive and make sense of their experiences, and to gain insight into how YAA want to work, how this should look like, and what activities could be digitized.

A generative session was conducted to accomplish the aforementioned objectives. Participants created artifacts in a digital environment expressing their thoughts, feelings, and ideas. Then participants presented their artifact and explained what and how they had made it. Instead of using the conventional user study techniques (including interviews, observations, and focus groups), generative sessions also put the focus on potential future experiences, considering participants' dreams, fears, aspirations, and ideas [70]. Generative sessions allow participants to express deeper levels of knowledge about their experiences by going through small steps that the researcher sets up. The major benefit of this approach is that it creates insights and understanding about user experience, which could subsequently be used for design purposes [70]. The generative session conducted for the ideation phase will be discussed further in subsection 3.1.1.

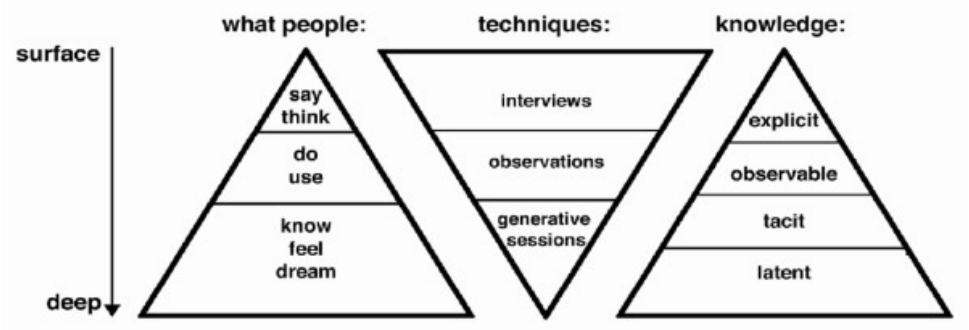


Figure 3.3: *An overview of a diagram that shows the relationships between the various forms of data gathering and their ability to access different types of understanding of the user experience [70, p. 123].*

3.1.1 Generative session

The generative session used a tripartite approach, including:

1. *Brainstorm session* of what is understood by the term technology from the perspective of DYL. It was important that both the participants and the researcher are roughly aligned when it comes to the term technology. An important part of DYL is to design a supporting technology to help address challenges in everyday life, and before a technology can be thought of, the term must first be clear. Otherwise, participants might be limited in their creativity if, for example, they think that technology can only be something digital or technical. For this purpose, a brainstorming session was chosen. During the session, examples (see Appendix A.3) were provided to discuss what participants and the researcher understood by the term technology based on their experiences.
2. *An assignment based on a fictional case study* to gain insight into YAA's working methods and preferences when using a digital environment. A fictional case study was chosen for

the pragmatic reason that it was not feasible to go through the entire DYL process and become familiar with working in a new digital program during the time of a generative session. Appendix A.4 further details the steps completed during the assignment. A Mural (see Appendix A.5) worksheet was designed in which the assignment could be performed. Mural is a digital workspace for visual collaboration and idea generation. Based on the objectives stated in section 3.1, Mural was deemed suitable as a digital environment for completing the assignment.

3. *Presentations with interview questions* where each participant exhibited their created artifacts. This provided insights and understanding about the user experience of the workflow in the digital environment. Additionally, it provided insight into which user needs should be further supported. These insights formed the input for a modified version of the Mural worksheet, which was tested again in the specification phase.

The generative session was split into two days because otherwise the duration of the assignments would be too long and this could be overwhelming for the participants. The session took place on April 22 and May 6 from 10:00 am to 12:00 pm. In Appendix A.1, the procedure can be found. Subsection 3.3 will further elaborate on the participants and the location. How the data were analyzed is discussed further in subsection 3.4.

3.2 Specification

To explore the design space for the digital toolbox prototype, a second iteration was performed on the design of the Mural worksheet based on the insights generated in the idea phase. In the specification phase, this Mural worksheet was tested with the participants to see if any functionalities needed to be changed or added based on YAA's experiences. For this purpose, a generative session was conducted.

3.2.1 Generative session

During the generative session, a two-part approach was followed, including:

1. *An assignment* to gain insight into the aforementioned objectives in the specification section. This assignment was based on their own situation instead of a fictional case study. This was due to the likelihood that participants may consider it easier to empathize with and create from their own experiences. Appendix A.8 further details the steps completed during the assignment. Participants used the customized Mural worksheet for the assignment (see Appendix A.9).
2. *Presentation with interview questions* where each participant exhibited their created artifacts just like in the ideation phase. These insights inform the requirements for the design of a digital toolkit prototype.

The generative session was for the same reasons as mentioned in the ideation phase split up into two days and took place on May 20 and June 3 from 10:00 am to 12:00 pm. Similarly to the ideation phase, subsection 3.3 will further discuss the participants and location, and subsection 3.4 will further discuss the data analysis.

3.3 Participants and Ethical Considerations

A total of 5 to 8 participants were invited to participate in the generative session. This included participants between the ages of 16 and 35, who have been diagnosed with autism and without

cognitive or speech impairments. The participants that were approached are active participants in the daytime activities of AssortiMens foundation [1], which is an innovative healthcare organization that offers daytime activities for autistic individuals with average or above average intelligence. Creativity in the broadest sense is the driving force within AssortiMens. Therefore, it was decided to approach participants of AssortiMens to provide input from their perspective on the design of a digital tool. See Figure 3.4 for an impression of the projects worked on at AssortiMens.

Eventually, six participants took part in the generative sessions - Annebel, Donny, James, Louis, Floris, and Elenore. During the focus group, five participants participated (James was not in attendance). For privacy reasons, pseudonym names are used. The age of the participants ranges from 24 to 52 years. Two participants fall outside the age group which was initially initiated as a characteristic in the search for participants. It was decided to make an exception for these two participants so that more user feedback could be given from multiple individuals. In addition, the two participants are suitable participants considering the DYL project. They would also benefit from designing their own assistive technology.

Since there are human participants who come up with an assistive technology based on their experience and personal situations, permission is requested to use their created designs and recorded discussed topics for this research. All participants were asked to sign a consent form prior to the start of the generative session (see Appendix A.2). After conducting this research, the audio fragments and transcribed documents will be deleted. The outcomes made by the participants will be anonymized.

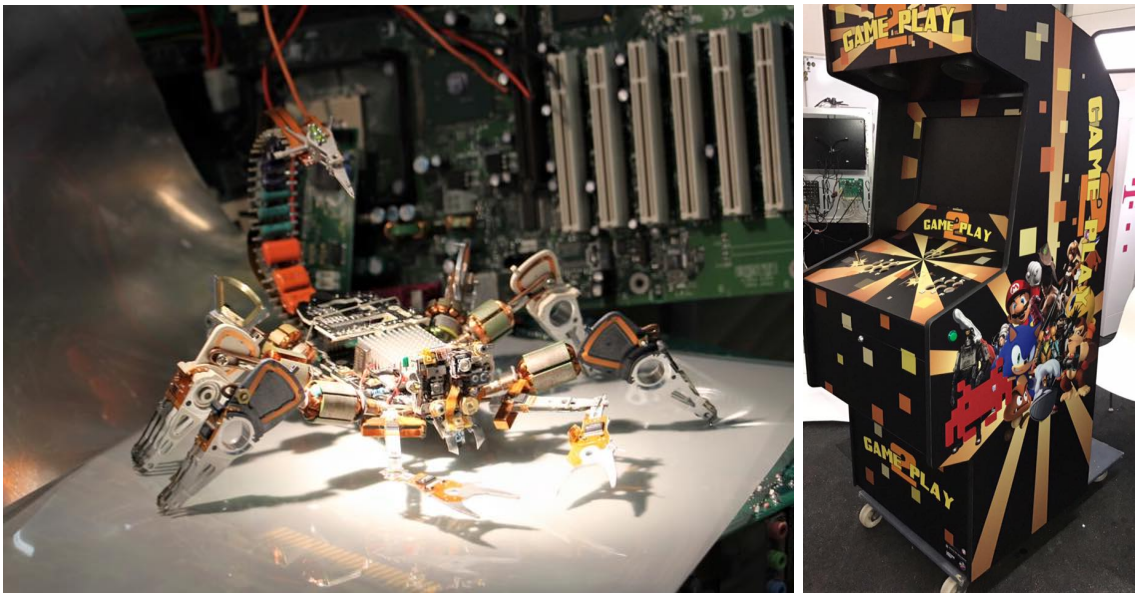


Figure 3.4: *Examples of projects created at AssortiMens. On the left is the result of an Upcycle project (a dab peg made from recycled products) and on the right is a self-made and designed Arcade cabinet. These images were captured by AssortiMens.*

[1] (www.assortimens.nl)

The Participants

ANNEBEL

24 years old

Active Participant
AssortiMens Foundation

DONNY

33 years old

Active Participant
AssortiMens Foundation

JAMES

50 years old

Active Participant
AssortiMens Foundation

LOUIS

52 years old

Active Participant
AssortiMens Foundation

FLORIS

25 years old

Active Participant
AssortiMens Foundation

ELENORE

28 years old

Active Participant
AssortiMens Foundation

3.4 Data Analysis

The data that came out of the generative sessions were analyzed. As mentioned, the goal was to synthesize all the insights gained along the way into a digital toolkit prototype. This means that the data should lead to requirements that served as the foundation for the digital toolkit. To systematically condense the qualitative data into meaningful units, a thematic analysis was conducted to process the data further. The thematic analysis was carried out using an iterative and recurring step-by-step plan by Braun & Clarke [71].

1. *Familiarize with the data*: All generative sessions were transcribed verbatim and valuable transcribed texts were transferred into an Excel document for each participant.
2. *Generating initial codes*: Next, the transcribed texts were reviewed in a repetitive manner to indicate initial codes. These codes described an idea or feeling expressed in a particular part of the text, with the topics of creativity, personalization, and satisfaction in mind. Ultimately, 29 initial codes were identified, which overlapped with various statements made by YAA or about their user experience with the digital tool that was salient and interesting as insights for designing a digital tool.
3. *Searching for themes*: Once concepts were established, patterns were identified and themes were formulated. A theme is an overarching term for a combination of multiple codes. This analysis synthesized three themes from the data (1) creativity, (2) personalization, and (3) satisfaction.
4. *Reviewing themes*: Then, all of the participants' quotes were reviewed again to see if the meaning matched and made sense with the sub-themes and overarching themes.
5. *Defining and naming themes*: Once the themes were identified, definitions were formulated and connections were established so that the data can be interpreted that resulted in requirements for the prototype design.

3.5 Realization

In this phase, a digital toolkit prototype was developed based on the requirements identified during the specification phase. Considering the requirements, the choice was made to use Mural as the digital environment for the design of the digital toolkit. Mural supports many of the functionalities that the participants needed to express their ideas in a digital environment during the generative sessions. In addition, it is a flexible program that makes it possible to work with multiple programs. The prototype was designed based on the following steps:

1. The components of the physical toolkit were converted to the digital environment in Mural. This included all activities, canvases, cards, and the design board. Although this thesis focused on phase 3 "My Ideas", as appointed in Section 2.3.5, the choice was also made to add the introduction phase, phase 1 "My Situation", and phase 2 "My Focus" to the prototype due to the requirements that affected the introduction and the other two phases.
2. For each requirement, possible means to safeguard the requirements in the digital toolkit prototype had been considered. The requirements were related to (1) the assignments of the digital toolkit, and (2) some functional requirements of a digital environment itself.
3. The requirements that were related to the assignments were first incorporated into the prototype. Here the main focus was on how digitization can support YAA in executing the

assignments. Then the other requirements related to the digital environment itself were incorporated into the prototype. The focus was mainly on what a digital environment must require from the perspective of YAA.

3.6 Evaluation

To examine whether the prototype met the requirements that were established from the analysis of the ideation and specification phase, an evaluation was conducted. It was important to validate with YAA whether the design decisions and solutions in the prototype worked for them since a solution could work for participant A, but might not work for participant B. Most studies apply user testing as the most effective method to accomplish this [72]. However, it was logistically infeasible to apply user testing in this study. Therefore, a storytelling session centered on design-oriented scenarios was chosen for this purpose. This method could be used for usability testing, needs-validation, and other forms of evaluation [73]. A focus group was chosen in order to conduct this evaluation procedure [74].

3.6.1 Focus Group

The focus group for the evaluation phase uses a tripartite approach, including:

1. *Going through a storyboard* to help participants remember the points they encountered the last time they worked with the Mural worksheet. For the participatory process, it was important that the participants were first aware of the problems they encountered while working in the Mural worksheet. This caused the participants to warm up allowing them to productively think along with the solutions designed for these points. The storyboard included a scenario that addressed the issues (points of attention) so that everyone could participate and provided feedback on the solution included in the prototype digital toolkit (see Appendix A.13).
2. *A cognitive walkthrough of the digital toolkit prototype* to identify suggestions for improvement, focusing on how convenient it was for the participants to perform tasks with the toolkit. For each point of attention, participants were first asked what they needed so that they could better perform the assignment in the program and what they expected from the solution. Then the actual solution which was incorporated into the design of the digital toolkit prototype was shown.
3. *Feedback session* on the solutions designed and included in the prototype. For this purpose, a number of questions were prepared in advance that could be used during the focus group in order to gather as much feedback as possible:

    - What do you think of this solution?
    - Are there any aspects (such as information) missing?
    - Asking Why the solution is perceived as pleasant or unpleasant.
    - Are there more who think this way? How do you experience this?

Subsequently, the feedback from the participants was analyzed and incorporated into a feedback matrix (see Figure 3.5) whereby feedback was classified based on good aspects, points of attention, and suggestions for improvement. Based on this feedback, final adjustments were made to the final digital toolkit.

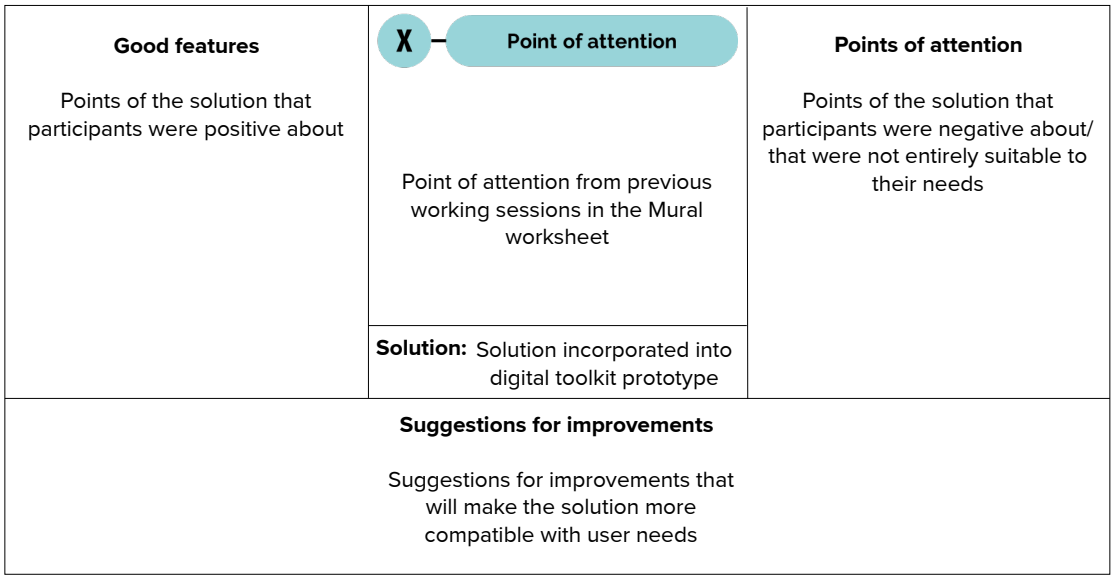


Figure 3.5: *An example of a blank feedback matrix used to analyze the points of attention discussed based on: good aspects, points of attention, and suggestions for improvement.*

The focus group took place on August 19 from 12:00 am to 13:00 pm. In Appendix A.12, the procedure of the focus group can be found. In Appendix A.1, the procedure can be found. Subsection 3.3 addresses the participants and the location.

Part two

Results Ideation &
Specification Phase

Chapter 4

Results Ideation & Specification Phase

This chapter focuses on three overarching, and often overlapping, themes found in the generative sessions regarding aspects important to YAA when working in a digital environment: 'creativity', 'personalization', and 'satisfaction'. These insights inform the requirements for the design of a digital toolkit. The digital toolkit aims to (1) support YAA in designing their own assistive technology, (2) foster their ability to express themselves, and (3) foster their individual preferences. The final thematic map of the important aspects that YAA has indicated during the generative sessions is shown in Figure 4.1.

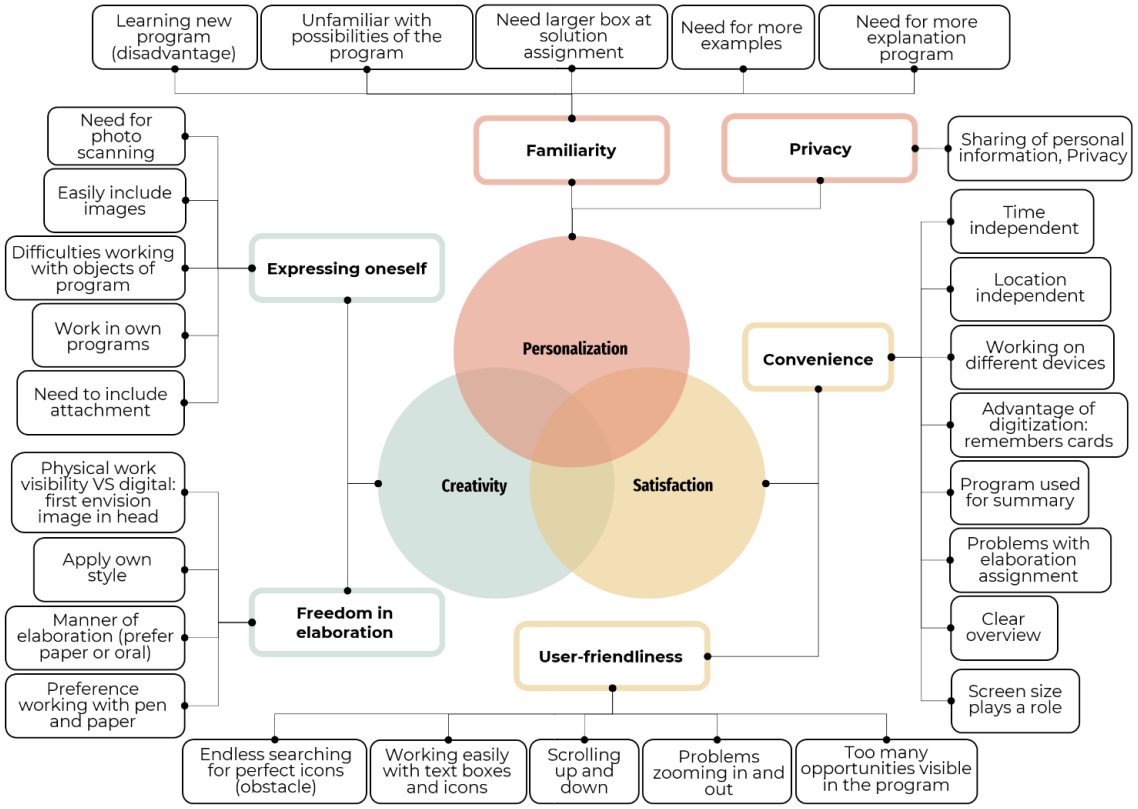


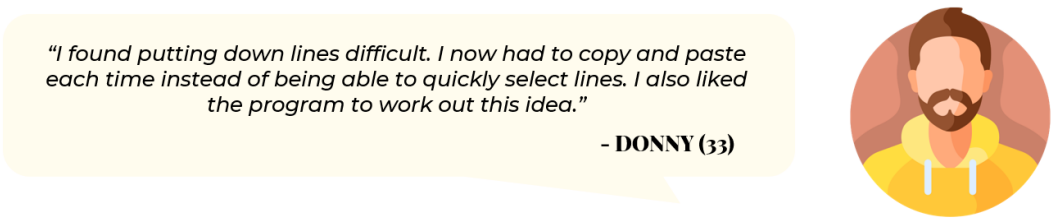
Figure 4.1: *Thematic map, which represents an overview of the themes (Creativity, Personalization, and Satisfaction) that were established based on analyzing the Generative Session data.*

4.1 Creativity

The term creativity itself was not discussed during the generative sessions, as discussing the definition would become probably too abstract for the participants. Moreover, the interest of this research during the generative session was primarily in the preferences and practices of the participants in the Mural worksheet. However, based on the results and observations during the generative sessions, creativity can be referred to as an important aspect, considering the definition as earlier described in Subsection 2.2.2 *"creativity is the process by which an individual can work out their own ideas from their experience with freedom of expressing oneself whereby insights can be generated that can be meaningful. Crucially, here, the output needs to be valuable to the person itself. A product does not necessarily have to be new as long as the product is designed in a creative way and is valuable to the individual. However, the value of the output can only be determined by the person who designs and develops it"*. Two ways in which the construction of creativity manifested itself emerged from the analysis - in conversations, results, and observations about (a) Expressing oneself, and (b) Freedom in elaboration.

(a) Expressing oneself

In practice, the concept of "expressing oneself" was related to creativity, which could be conceptualized as the act of being able to express who you are in any way - with colors, music, art, or anything else. In this case, the way participants can convert the idea they have in their heads into a digital environment, which is the Mural worksheet. Some participants had difficulty finding and or using certain functionalities in the digital environment to elaborate their ideas. For example, Donny indicated that he found it difficult to draw lines quickly to work out his idea. Nevertheless, Donny eventually did manage to work out his idea in the Mural worksheet (see Appendix A.11, Figure A.19 for Donny's elaboration).



Floris also had difficulty expressing his idea due to the limitations of the program's functionalities. He, therefore, used his own program to work out his idea. Floris more often uses programs such as Illustrator [1] and InDesign [2]. It was interesting to see that during the second generative session he felt free to use his own programs to develop his idea. He then placed his design in the Mural worksheet to keep an overview (see Appendix A.11, Figure A.20).

[1] www.adobe.com/nl/products/illustrator.html
[2] www.adobe.com/nl/products/indesign.html

"I found it less enjoyable to align buttons and objects in this program, prefer an easier way to manipulate the shape of an object."

"I usually use Illustrator/InDesign myself to work things out."

"I like the program, the basics are good. Only for drawing ideas I missed the rotation of lines and merging of objects. I then prefer to use another program that I use to work it out."

- FLORIS (25)

In addition, for the brainstorming assignment, Annebel used sticky notes and a pen to work out her ideas. She indicated that this way she could express the ideas that she had in her head more quickly. She also used the program Word to further elaborate on her idea, she gave a reason that she had more space for her elaboration and that she was familiar with the program. She also indicated that she could not find the right image as an example for her elaboration. She would have preferred an example that she already used at home, but for her, the threshold was too high and it seemed too complicated to load an image of her own example into the Mural worksheet. She also indicated that she could not fully communicate her idea in the Mural worksheet in the way that she had already done in her Word program. Annebel did not know that it was possible to add an export of her Word document as an attachment.

"I do think more was possible with the program. But I haven't done a whole study with what's possible with this program. Maybe you could give examples of others who have already worked it out, so you know how to lay out the layout a little bit for yourself."

"I first just wrote on an A4 sheet because you can just put a little more text in there. And I also had, for example, a different temperature gauge in mind than the picture I could find. Afterwards I could probably scan that in with a picture. But this doesn't seem easy so I left that. And I also have an example with a personal plan. Of what I could do. I came up with a color system and to my mind I couldn't have explained this quite right with text. And I could have made this clearer if I could have just explained it to the papers that I had already worked out. So I don't know if it's possible to add attachments? Maybe I can add my word documents as attachments?"

- ANNEBEL (24)

Based on these findings, it can be concluded that participants have their own way of expressing themselves and that their preferences in this differ. As a result, participants tend to use their own programs to work out their ideas and they should not be limited by the functionalities of a digital program to be able to express their ideas. The digital tool should be flexible to account for individuals' preferences for different modes of creative expression. It is important that this is clear in the assignment that YAA has that freedom, that this is a low threshold, and that the elaborations eventually come into the digital tool.

(b) Freedom in elaboration

The results of the generative sessions also indicated that the concept of "freedom in elaboration" appeared to be related to creativity. This could be conceptualized as the act of being free in how the assignment is carried out. In this case, it refers to the participants' way of working

in which they decide how to elaborate on the assignment. During the generative sessions, participants expressed a preference for working out the assignment in different ways. For example, Annebel used a different approach to working out the assignment. She was not present during the second generative session and conducted the assignment in her own time. Annebel did the brainstorming part with pen and paper since she can do this spontaneously in her own time and in an environment when an idea comes to her. Then she made a step-by-step plan and a diagram in her own created Mural environment based on her elaborated brainstorming session. See Figure 4.2 for an overview of Annabel's way of working out the assignment. After she had worked out her ideas globally, Annebel used the Mural worksheet to work out a summary of her idea, as can be seen in Appendix A.10, Figure A.12.

"I want to be able to think freely first, and I would also like to describe some things in more detail. But it's nice to be able to add images immediately in an easy way."

"So I prefer to do brainstorming with pen and paper. If you have an idea, you can quickly add it without having to open the whole program."

"Brainstorming I prefer to do on paper, because I always come up with new ideas at different times of the day ... then I go do something else and then I think oh yes this is also a good idea and then I can write it down so spontaneously. That was unstructured and loose phrases and then I worked all this out in a word document."

- ANNEBEL (24)

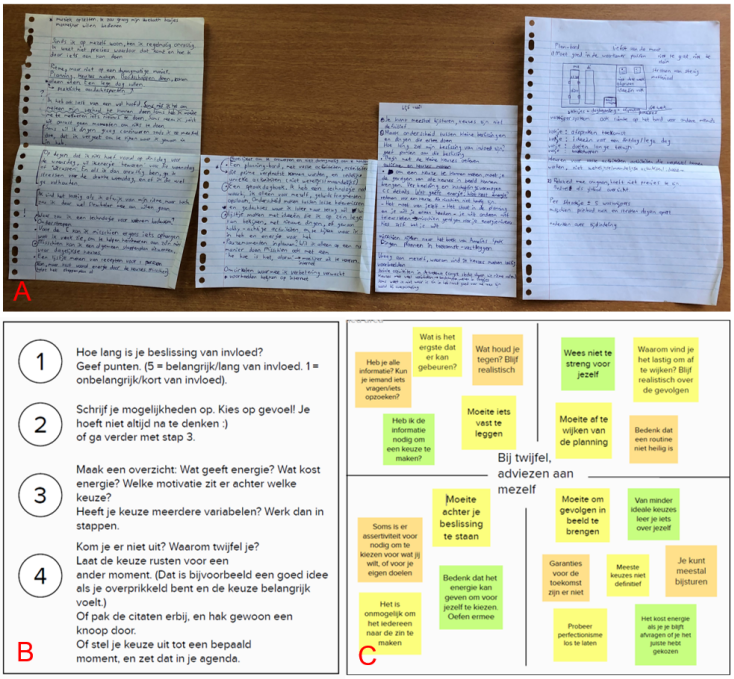


Figure 4.2: *Overview of Annebel's working method. First, Annebel worked out her ideas on paper, as shown in image A. Then she made a step-by-step plan in her own Mural environment that she can apply in situations when she has doubts, see B. In image C, a diagram was made in her own Mural environment with advice that she gives to herself when she gets into certain situations.*

Floris has also indicated a preference to work out his initial ideas on paper. For this purpose, he indicated that this works faster for him.

"Drawing the first design/idea is easier to get your design on paper faster."

- FLORIS (25)

Donny also indicated that he finds it important to work in his own way and that this gives him the freedom to apply his own style in order to express himself creatively. He does indicate that in some situations he prefers to work physically because in digital environments he first has to sketch an image in his head before he can work something out.

"For me it is clear and straightforward and I could apply my own style a little bit to show how the app should look like in my opinion."

"I've been working things out digitally quite often but in some situations I prefer to work it out by doing so. Actually I usually work something out as I go along. For example, I cut a tree and in the meantime an unexpected problem arises, such as the tree getting stuck in another tree. That's what I like about just doing things instead of working them out digitally: I can see the problem and I can create an appropriate solution on the basis of what I see. And with digital working out I first have to form a picture in my head of the problem before I work it out."

- DONNY (33)

Based on these findings, it is important for a digital environment to encourage and provide freedom for participants to complete an assignment in their own way. This allows YAA to express their creativity in the assignment based on their experiences.

4.2 Personalization

The term personalization was not discussed during the generative sessions, as discussing the definition would become probably too abstract for the participants. Moreover, the interest of this research during the generative session was primarily in the preferences and practices of the participants in the Mural worksheet. However, based on the results and observations during the generative sessions, personalization can be referred to as an important aspect, considering the definition as earlier described in Subsection 2.2.3 *"personalization is the way in which an individual has the freedom to go through the design process in their own way and can apply/expressing their individual creativity based on their experiences which can be reflected in the final product and is relevant and personal to the participant"*. Two ways in which the construction of personalization manifested itself emerged from the analysis - in conversations, results, and observations about (a) Familiarity, and (b) Privacy.

(a) Familiarity

In practice, the concept of familiarity was associated with personalization, which could be conceptualized as the act of choosing one's own programs, materials, or environment to elaborate on an assignment that a person is well-known and comfortable with. Some skepticism about working with the digital tool was expressed due to the lack of familiarity with the Mural worksheet. Which caused them trouble expressing their ideas, frustrations with learning a new program, limitations in developing their ideas, and sometimes they were even lost in the program due to unfamiliarity with its functionalities.

"I always hate having to learn a new program. You have to go through a whole learning process first. And then once you get there, I think it would be fun to work with it. It would be a big threshold for me to work with a new program."

- JAMES (50)

"It takes some time to figure out how it works, but in itself I find it a helpful program. Zooming in and out could be a bit easier."

- LOUIS (52)

"I don't know what is possible in the program."

"At first I didn't know whether I found the post-its useful. Because the more you wrote in them, the smaller the text, but I realized afterwards that it is handy. Considering the space."

- ELENORE (28)

"I would like examples of what is possible with this program. I think I have used very little of what is possible."

"I didn't know exactly what all the possibilities were with this program. I just started dragging and dropping. In retrospect, maybe I could have structured it better, so I hope it's clear enough for someone else to understand. My plan was to use those yellow memos and then I had tried to work out all the other things I wanted to explain better with the text boxes."

- ANNEBEL (24)

As the participants used the program more often, it could be observed that they found it easier to find their way around the program and enjoyed the assignments more.

"You can, however, once you know the program get an overview of what approximately your idea is and then you can work from there."

- DONNY (33)

Using these findings, participants explain how familiarity with a program affects their personal way of working out and influences their creativity. Therefore, for the design of a digital tool, some important aspects must be taken into consideration. For example, explaining the program, reassuring the participants about using a new program, and making the possibilities known through examples.

(b) Privacy

One participant associated privacy with personalization, which could be conceptualized as the freedom a participant has to work things out, without anyone from the outside knowing or influencing it. Despite the fact that the concerns about privacy were only reported by one participant, it was deemed important to consider it in the design of the digital toolkit, because the participant felt restricted in communicating her idea. The design of the Mural worksheet in the ideation phase was a global workspace for all participants, allowing everyone to see each other's elaborations. Sharing her own plan for over-stimulation in the global workspace, she felt, was too personal to be seen by others. Annebel does not feel restricted from communicating her idea when she can control who can see her ideas.

"In my solution I talk about a personal plan per color. I could explain this better using my own plan for overstimulation and I would show it, but found it too personal to add here."

- ANNEBEL (24)

4.3 Satisfaction

The term satisfaction was also not explicitly discussed during the generative sessions, for the same reasons as appointed for creativity and personalization. However, based on the results and observations during the generative sessions, satisfaction can be referred to as an important aspect, considering the definition as earlier described in Subsection 2.2.4 *"satisfaction is the favorability of the individual's subjective evaluation of, and emotional response to the experiences gained during the co-design process, which includes how content a participant is with their work in the design process"*. Two ways in which the construction of satisfaction manifested itself emerged from the analysis - in conversations, results, and observations about (a) Convenience, and (b) User-friendliness.

(a) Convenience

Primarily based on observations, the construct of convenience was associated with satisfaction, which could be conceptualized as a person's perceived ease of use of the digital toolkit. Participants repeatedly mentioned the benefits of easily using the digital tool. For example,

Elenore mentioned the convenience of using items, such as cards, that do not need to be put away when work resumes. All used items are collected and stored in one place.

"What I find useful about a digital program is when you have assignments with cards for example, you have to sort them again that same day or the day after or put them right or something, with a digital program this can recover by itself."

"I found using the program an easier way to get to the core of the problem."

- ELENORE (28)

Participants also indicated that the tool worked in an easy way because it allowed them to get to the heart of the problem in a simple way. It further enabled them to create a clear overview of their solution. Annebel also indicated that she liked the fact that the digital tool allowed her to work out the assignment independently in her own time and place. This allowed her to spontaneously work out her assignment when an idea came to her.

"I'm not so sure what they mean by the categories (the assignment itself)."

"I like that I could really just try to make it clear in a summary way. That I could make a clear overview at a glance."

"The program provided support in the thought process and overview."

"I liked the fact that I can also use this board in my own time. So that when I want to work with it and come up with ideas I can also work with it. Then I am not dependent on the location."

- ANNEBEL (24)

However, the analysis showed that there are aspects that can be improved with regard to ease of use. For example, James indicated that the size of the screen affects working in the digital tool. A larger screen is easier for him to work with than a small screen. The reason for this was the overview became a bit smaller, which made it difficult for him to work out the assignment.

"The size of the screen does play a role. A larger screen is easier. With a small laptop, it is a little more difficult to complete the assignment."

- JAMES (50)

Additionally, Working on different devices also affected convenience. Annebel, for example, indicated that she tried to work in the Mural Worksheet on her tablet device, partly to see if her work had been saved. This did not work for her, as the screen was too small, and zooming in and out did not work easily.

"I had checked on my iPad whether my work was being saved. This was not entirely clear. But on the tablet, zooming in and out didn't quite work. On the tablet it didn't work as nicely as on the computer."

- ANNEBEL (24)

Based on these findings, participants identified how the ease of use of the digital tool affects the evaluation of experiences during the co-design process and the level of contentment with the final product. This is partly because of the benefits of the digital tool, such as the ability to use the digital tool location and time independent, create a solution in a clear and summary way, memorize items with everything in one place, and the digital tool helps as a support for the thinking process. To increase the convenience of use, the digital tool should also be responsive to different screen sizes and devices.

(b) User-friendliness

The construct of user-friendliness was associated with satisfaction, which could be conceptualized as an effective, efficient, and fulfilling way in which participants can use the digital tool. Participants expressed dissatisfaction with some functionalities of the digital tool, claiming they were not user-friendly. For example, Louis indicated that he does not think it is necessary to see more things on his screen than is required to carry out the assignment. Elenore also indicated that because of the number of icons she can spend too long searching for the perfect icon. Annebel wondered if it is really necessary to have so many options in terms of the colors of sticky notes. These aspects affect the over-stimulation in YAA.

Additionally, some frustration was noted among participants while zooming in and out within the Mural worksheet. Scrolling also did not go the way participants wanted it to. This frustration arose mainly during the initial design of the Mural worksheet in the ideation phase when the design of the Mural was aligned widthwise and there were multiple worksheets next to each other, as can be seen in Appendix A.6. Participants are more used to scrolling up and down, as for example in a standing A4 size Word document. Participant 6, Louis, also had difficulty working in the program. For example, with adding texts to the brainstorming part and with zooming in and out. Differences in digital literacy were observed between age groups. While younger participants seemed to navigate through the program intuitively, older participants required additional support and explanations to complete the tasks in the digital environment. This can also be seen in the results of the assignment, for example, it can be seen that James (see Appendix A.10, Figure A.11) and Louis (see Appendix A.10, Figure A.15) have a rather empty Mural worksheet and did not quite manage to work out their dream solution for Bob.

"I really didn't like zooming in and out. Things I don't need to see for working out the assignment in the program, I don't need to see either."

- LOUIS (52)

"I thought it worked fine zooming in and out. I've also been working with the program more often now (after the previous generative session), so I thought it was fine. But I don't find the search function with the icons very useful, because then I'm looking for the perfect icon and then I'm an hour further."

- ELENORE (28)

"There are many options, I wonder if it is functional. Are 8 color sticky notes needed? I prefer to just work on 1 page where I scroll down. The mural page you could scroll left to right as well as top and bottom. I prefer to just work on 1 page where I can scroll up and down."

- ANNEBEL (24)

Participants also expressed positive thoughts considering the effectiveness and efficiency of the digital tool. For example, Annebel indicated that the easy use of icons and text boxes allowed her to develop her idea in the digital program in a quick efficient manner.

"It was easy to work with text fields and icons, which allowed me to quickly develop my idea in the program."

- ANNEBEL (24)

Based on these findings, participants identified how the user-friendliness of the digital tool affects the effective, efficient, and fulfilling way in which they can use the digital tool. This is partly because of the easy way of adding icons and working with text fields. However, for another participant, this can be an obstacle. To increase user-friendliness, the design of the digital tool should consider the distinction between visible important elements (such as text, icons, number of sticky notes actually needed) and less relevant elements to avoid over-stimulation. Zoom in and out and scrolling in the digital tool should also be taken into regard.

4.4 Design requirements

This analysis focused on three overarching themes in addressing important considerations from the YAA's perspective regarding the development of a digital tool - important considerations such as (1) creativity, evidenced by practice results in expressing oneself and freedom in elaboration, (2) personalization, evidenced by practice results on familiarity and privacy, and (3) satisfaction, evidenced by practice results on ease of use and overview. While the data have now been categorized into three overarching themes, it should be noted that they are not completely mutually exclusive. The analysis revealed that the themes are partially interdependent. For example, how satisfied a participant is affects creativity and vice versa. When a participant is unable to express themselves it affects both satisfaction and creativity. The same applies, for example, to a lack of familiarity which can affect trouble expressing themselves, limitations

in developing ideas, which affects their creativity. A lack of familiarity could also create irritations during the design process which could affect satisfaction, and so on. Therefore, it remains challenging to prioritize the requirements.

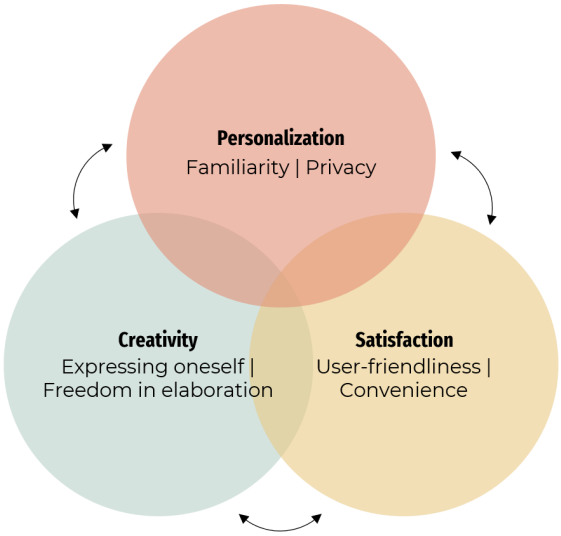


Figure 4.3: *Overview of the relationship between the themes - Creativity, Personalization, and Satisfaction, which are not completely mutually exclusive and the themes are partially interdependent.*

It is therefore important to focus on all aspects of the design of a digital environment. There is a chance that if the focus is placed on one aspect, the other aspects will be underdeveloped. Below is an overview of the requirements per theme:

1 **Flexible *in* individual preferences**

The tool should be **flexible** to account for individuals' **preferences** for different modes of creative expression, which must be **clear** in the assignment and have **a low-entry level** to safeguard **accessibility**

2 **Freedom *in* elaboration**

The tool should **encourage** and provide **freedom** for participants to complete an assignment in **their own way**.

3 **Explanation *and* guidance *for* using tools**

The tool should **explain** the functionalities of the tool, **reassuring** the participants about using a new tool and ability using **own tools**, and making the possibilities known through **examples**.

4 **Assuring *and* reassuring privacy**

The tool should **ensure privacy**, allowing a participant the **freedom** to work things out without anyone on the outside **knowing or influencing it**.

5 **Responsive *and* adaptive design**

The tool should **automatically adapt** to different screen sizes and viewports, making it **easy to work** with on any device

6 **User-friendliness *and* simple design**

The design of the tool should only use elements that are necessary for YAA (according to the **less is more** principle). And should also have a **user-friendly way** for **scrolling** and **zooming in and out**.

Part three

Realization Phase

Chapter 5

Realization Phase

This chapter elaborates on the design and realization of the digital toolkit prototype based on the requirements identified in the previous chapter. Although the entire components of the physical toolkit have been incorporated into the digital toolkit prototype, this chapter will focus on (1) two activities from the "my ideas" phase. As mentioned in Section 2.3.5, this is consistent with it being most appropriate for idea generation, a crucial aspect of co-design, given that the current study seeks to evaluate the role of creativity, personalization, and satisfaction in co-design. In what follows, (2) other relevant elements of the digital toolkit prototype which are worthy of mentioning.

5.1 The DYL assignments

The two assignments that will be highlighted in this section are: (1) sketching, and (2) build my dream solution.

Sketching

This assignment focuses on explaining ideas of possible solutions through sketches. In the physical toolkit, drawing utensils and a paper canvas are used to elaborate on this assignment. With the prototype digital toolkit, YAA is free to choose how they want to communicate their ideas. For instance, by using drawing programs, using a tablet and a drawing pen, or even printing the canvas and completing the canvas by hand. Hence, there are several ways in which YAA can elaborate on the assignment and the way in which they could express their ideas. In Figure 5.1, different parts of the assignment are highlighted using red dotted lines with the letters A, B, C, and D. These parts are adjustments that had to be made to make the assignments compatible with the digital environment. A more detailed discussion of these adjustments will be provided below in Table 5.1, explaining why these adjustments are constructed in this way and what requirements are covered by them.

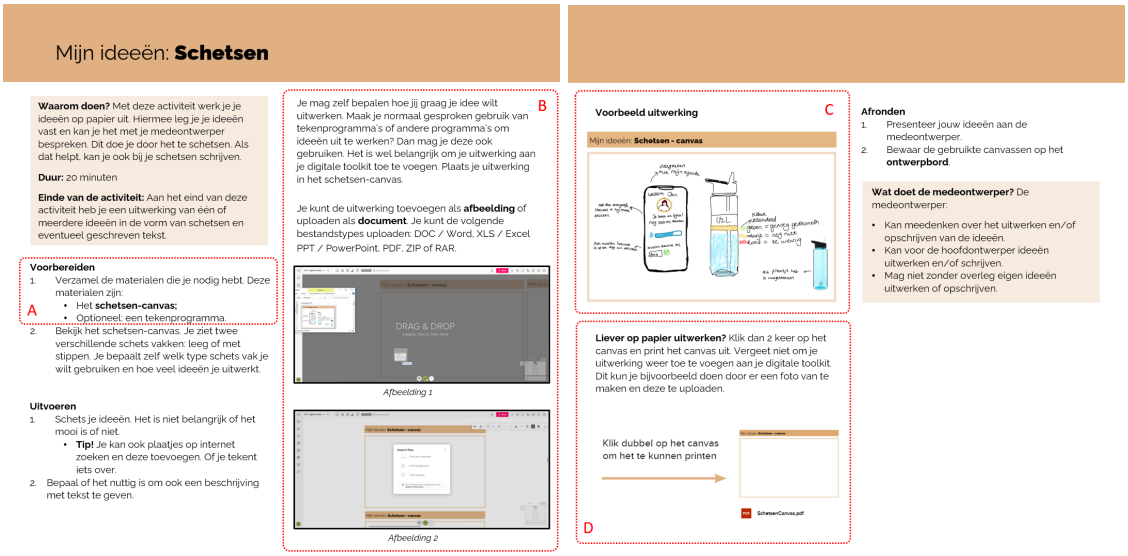


Figure 5.1: *An overview of the activity "sketches" from phase 3 "My Ideas". In the overview, you can see by means of the red dotted lines and the red letters A, B, C, and D which adjustments have been made to make the assignment compatible within the digital environment. See Appendix A.14.1 for a more readable version.*

#	Component in the prototype	Substantiation	Requirement
A.	Instructions in the preparation phase of an assignment	To make it clear to YAA that they have the freedom to choose resources (e.g., their own programs) that they would like to use to complete the assignments, it was chosen to indicate this in the instructions of an assignment. An assignment consists of three phases: preparation, execution, and completion. It was chosen to place these instructions in the preparation phase, in order for YAA to be aware of the opportunity before they start working on the execution.	1. Flexible in individual preferences
B.	Instructions in the executive phase of an assignment	Instructions have also been chosen to be included for the execution phase. Given the freedom YAA have outside of the digital toolkit, it is important to collect the elaborations of the assignments back in one central place for an overview - in the digital toolkit. Step-by-step instructions supported by visual images have been added that together explain how YAA can add their elaborations back to the digital toolkit.	1. Flexible in individual preferences
C.	Examples of elaborations	Participants expressed the need for examples of an elaboration of an assignment. In the prototype a number of examples have been added by means of visual representations. This supports YAA in seeing which programs can be used and in which ways they could work out an assignment. To prevent YAA from literally copying the example or being limited by a single example, it was decided to add multiple examples.	1. Flexible in individual preferences & 2. Freedom in elaboration
D.	Instruction freedom in elaboration	In order to give YAA the opportunity to be free in the way they want to work out an assignment, the choice was made to offer the option of printing the canvases. This allows YAA to choose whether they want to work physically or digitally. Through instructions, this option is communicated to YAA.	2. Freedom in elaboration

Table 5.1: *Overview of parts that had to be added/adapted from DYL assignments to make the assignments compatible for the digital environment, which includes: A: instructions in the preparation phase, B: instructions in the executive phase, C: Examples of elaborations, and D: Instructions for freedom in elaboration.*

Build my dream solution

This is another example of an assignment that had to be modified to make the assignment compatible with the digital environment. In this assignment, the focus is on building a dream solution. A dream solution is a "fake" thing that is conceived: it doesn't work yet, but can be used by YAA to indicate what a solution should do and be able to do. The assignment indicates that building can be performed in several ways: digital, physical, or a combination

of these. For each possibility, examples have been added and the instructions explain how YAA can perform this assignment. Similar to the "sketching" assignment, red dotted lines and letters indicated which parts needed to be modified to make the assignment compatible with the digital environment. Table 5.1 describes the rationale for the construction of these changes and the requirements they fulfill.

Figure 5.2: *An overview of the activity "build my dream solution" from phase 3 "My Ideas". In the overview, you can see by means of the red dotted lines and the red letters A, B, and C which adjustments have been made to make the assignment compatible with the digital environment. See Appendix A.14.2 for a more readable version.*

5.2 Other relevant elements of the digital toolkit prototype

This section further discusses other components designed for the prototype that is worth mentioning. These components relate to the following requirements: 3. Explanation and guidance for using tools, 4. Assuring and reassuring privacy, 5. Responsive and adaptive design, and 6. User-friendliness and simple design. For each requirement, Table 5.2 lists the solutions applied in the prototype and why they were chosen.

#	Component in the prototype	Substantiation	Requirement
1.	Tutorial (Appendix A.14.3)	The choice was made to create a tutorial to explain the functionalities of the digital toolkit, to reassure the participants about using a new digital program, to make it clear to them that they are capable of using their own tools, and to familiarize YAA with the possibilities and the functionalities using examples. The motivation is that a tutorial is an appropriate way to both inform and give an user skills to be able to perform certain tasks based on examples. The content of a tutorial can be supported with visual examples so that YAA can recognize the functionalities when they actually use the digital toolkit.	3. Explanation and guidance for using tools
2.	Privacy (Appendix A.14.4)	The functionalities of Mural allow sharing the elaborations of the assignments with others. YAA can assign roles to the people they share it with: rights to make edits, the right to read-only, or even no rights at all. In addition, YAA can also enter a password as additional security for their digital toolkit. It was chosen to provide this information to YAA through the tutorial.	4. Assuring and reassuring privacy
3.	Mural app (Appendix A.14.5)	YAA can use the Mural app to access their digital toolkit on different devices. The app makes it easier to use the digital toolkit on different devices. This information is also given through the tutorial. In the introduction, YAA can scan the QR code and install the free app on their phone or tablet.	5. Responsive and adaptive design
4.	Outline (Appendix A.14.6)	The choice was made to design an outline that helps YAA navigate through the digital toolkit. When an item of the toolkit is clicked on in the outline, that item is immediately zoomed in. This allows YAA to see only the tasks they want to complete, so they are not confronted with more information than necessary which could cause over-stimulation otherwise.	6. User-friendliness and simple design

Table 5.2: *An overview of components of the digital toolkit prototype that were created based on the requirements. For each part, it is indicated what exactly has been made, why, and which requirements are attached to it.*

Part four

Evaluation Phase

Chapter 6

Evaluation Phase

In this final phase, the digital toolkit prototype was evaluated based on the evaluation method introduced in section 3.6. This chapter will first discuss the results and findings of the evaluation of the digital toolkit prototype. This will be followed by a further discussion of the latest modifications to the digital toolkit prototype.

6.1 Feedback participants

During the focus group, a storyboard (see Appendix A.13) was first run through with the participants. The storyboard incorporated points of attention based on the requirements (see Figure 6.1), identified in the results of the ideation and specification phase. Since not all points of attention could be addressed during the focus group, a selection of six was chosen. This enables the discussion of as many of the solutions incorporated into the prototype digital toolbox. Each point of attention was shown what the solution was by means of a cognitive walk-through and subsequently, questions were asked about what the participants thought of these solutions. The following points of attention were incorporated into the storyboard:

#	Point of attention	Description
1.	Using a new program	Participants do not know what they can do with the program or how it works.
2.	Too much in one overview	The participants do not need to see more than is necessary for the task at hand. Zooming in and out does not work properly.
3.	Freedom in elaboration	The participants sometimes prefer to work things out on paper first, it works faster for them.
4.	Privacy	Some participants used personal information to design their solutions. They prefer to keep it to themselves.
5.	Responsive and adaptive design	Participants want to do activities on their tablets because it means they do not necessarily have to sit behind their computers.
6.	Flexible in individual preferences	Participants want to use other programs to elaborate their ideas. The digital toolkit does not have the desired functionality.

Table 6.1: *Overview of points of attention that participants ran into last time when working in the Mural worksheets. For each point of attention, a description was provided.*

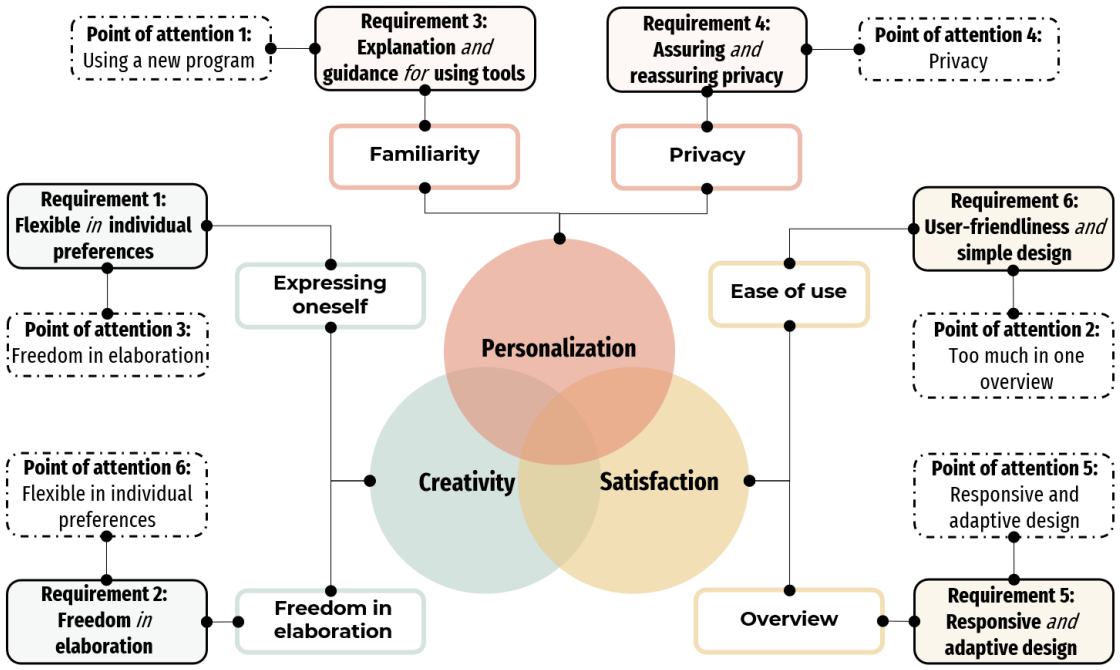


Figure 6.1: *Overview showing the relationship between the six points of attention and the requirements, sub-themes (expressing yourself, freedom to elaborate, familiarity, privacy, ease of use, and overview), and themes (creativity, personalization, and satisfaction).*

Eventually, five participants participated in the focus group on August 19 from 12:00 am to 13:00 pm. These were the same participants who participated in the generative sessions in the ideation and specification phase. All participants actively participated and gave their feedback on the prototype. Below the results will be presented per point of attention.

Figure 6.2: *Overview of participants who participated in the focus group.*

Point of attention 1: Using a new program

Participants indicated in advance what they needed and expected from a tutorial that could have helped them perform the activities in the generative sessions. The participants indicated that they expected short and concise explanations of the functionalities needed to perform the assignments: *"I expect that you explain functions that you need to be able to do the assignments. I don't think more is necessary." - P1.* They also expressed a preference for being shown through visual displays how they could have used the program Mural and that the purpose of using the program should be clear before being shown how to work with it: *"I think you need visual examples so that you know where each thing is in the digital tool.*

Also that you know what the purpose of the program is. Over the vacations, someone tried to explain a game, forgetting what the purpose of the game was. This made it very difficult to understand what we were working towards then." - P2.

After watching the tutorial, participants were very appreciative: *"I think such an information tutorial is very useful!" - P1*, *"Yes, the tutorial is clear and straightforward." - P4*, *"I think such an information tutorial is very useful!" - P1*, *"I think the tutorial is very clear. It's straight to the point. Not a whole story around it: this is it, this is what you should do and this is how you can do it. - P5.* Despite the positive feedback from most participants, there was also one participant who came up with a suggestion for improvement: *"Would it perhaps be helpful if you first explained what all needs to be done and then explained what you need to do? Then this information will also stick the longest." - P2.* By this, the participant meant that it might be better to first explain the phases of DYL and what is seen through DYL with technology, and then explain how to work with the digital toolkit. Here she also referred again to the example that the purpose of the game must first be clear before explaining how the game works. The other participants agreed with this suggestion for improvement.

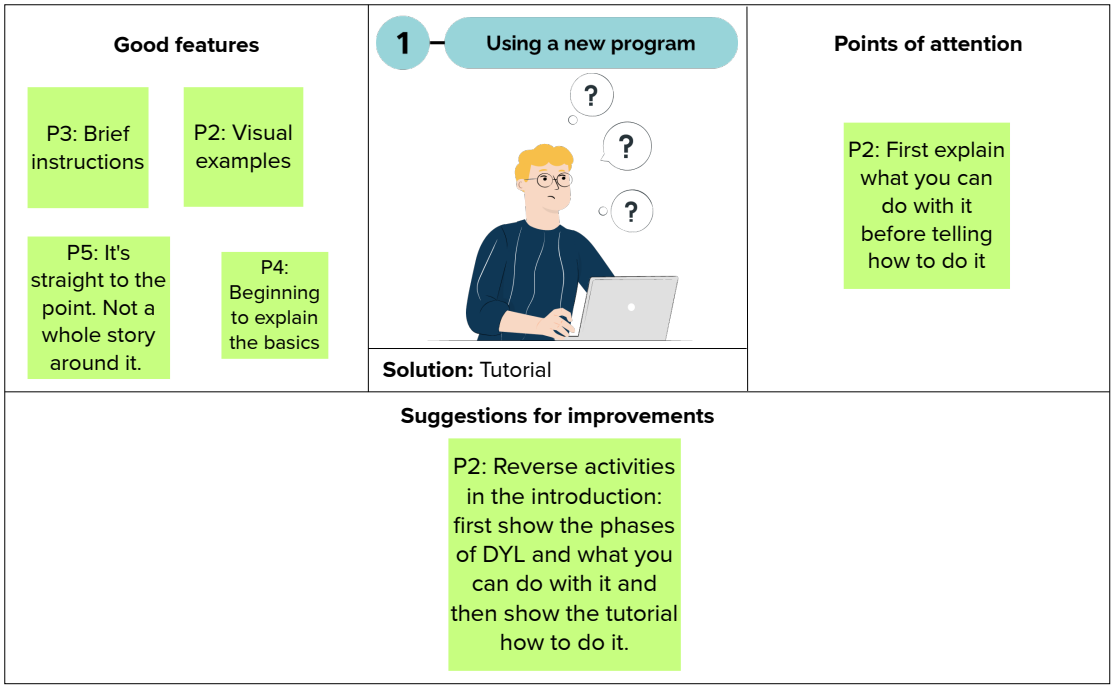


Figure 6.3: *Overview of the participant's feedback points for point of attention 1: Using a new program. These feedback points are divided into good features, points of attention, and suggestions for improvement.*

Point of attention 2: Too much in one overview

Overall, a number of participants found the outline a convenient solution for navigating the digital toolkit: *"It's kind of convenient that you can click between different activities, so you can easily switch by clicking on the outline." - P2*, *"I do think this is a clear way how you can navigate through the toolkit. You can always not use the outline and navigate through the toolkit yourself." - P5.* Nevertheless, one participant did not know that this functionality was in the toolkit. Because she saw too much information, the outline had not been noticed: *"Even though I do find the outline very convenient and logical, at first I didn't know it was possible.*

I was busy reading everything." - P2. As a suggestion for improvement, one of the participants came up with a solution that one can consult at the time they need help for getting the right information at the right time and helps navigate, i.e. where to find the information they need: *"You actually need some kind of Clippy* [1] *that can help you at certain times. For example, when you need information and where that information is.".*

The outline alone does not solve the problem of seeing too much information in one overview. For example, one participant indicated that there is still too much visible in the entire digital toolkit and that this can be perceived as overwhelming: *"I do think it is very comprehensive, I see so many tasks when I see you scrolling through the toolkit. I would imagine that this can be overwhelming for some." - P1.* This was also supported by the other participants: *"Such very long assignments can also sometimes be discouraging when you see what you have to do next. Then I would like it if you could fold modules in and out." - P2.* The participants came up with the suggestion for improvement by folding the phases they are not working in and therefore do not need. This leaves only the assignments and phase in which they are working visible: *"You now see all the chapters but that you can expand (open and close) modules for example, when you open them you immediately see where you left off. So basically you only see what you are working on and the rest is folded. Then you are not confronted with what still needs to be done." - P2, I would like it if I could fold the rest so that I only see the assignment that I am working on at that moment. If you have a very long list, for example, it would be nice to be able to fold the rest and open it later. - P4.*

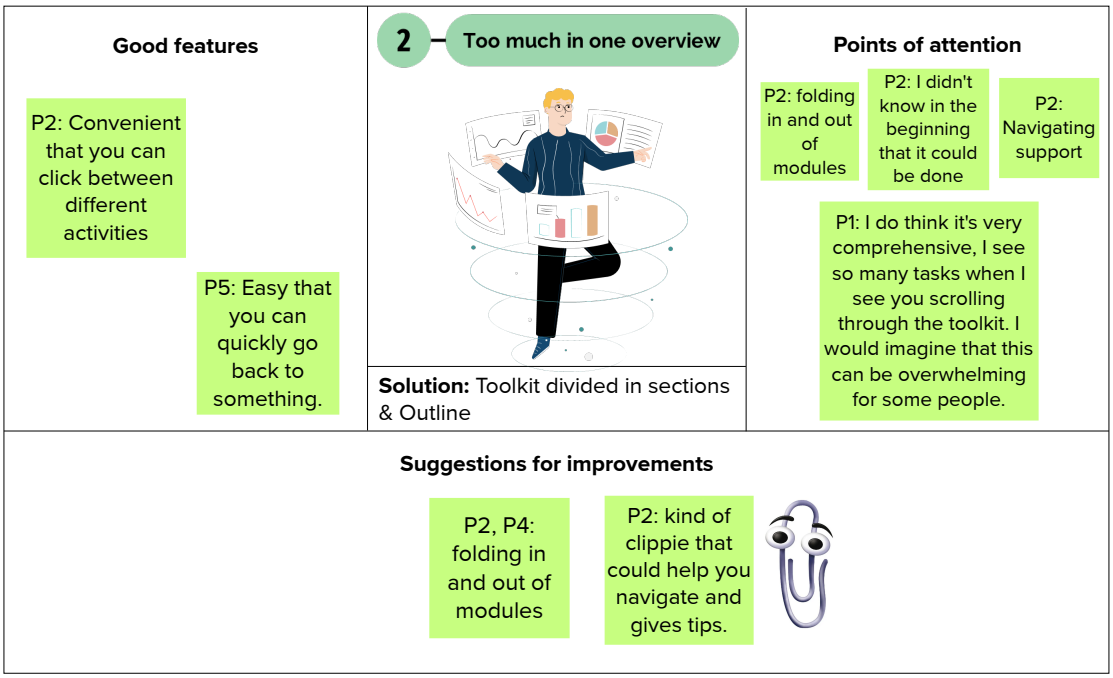


Figure 6.4: *Overview of the participant's feedback points for point of attention 2: Too much in one overview. These feedback points are divided into good features, points of attention, and suggestions for improvement.*

[1] In 1997, Microsoft introduced an "office assistant" called "Clippit," better known as "Clippy," an animated character designed to help users with common tasks.

Point of attention 3: Freedom in elaboration

When the point was brought up that participants prefer to do the assignment in their own way, this was reconfirmed. Some participants indicated that they prefer to develop ideas on paper first, rather than using the digital toolkit immediately: *"I like to work on paper first because it works faster. Then I can work out ideas quickly." - P4*, *"For me, sometimes at certain moments ideas come into my head and then I want to write them down. If I'm just sitting in front of a computer then those ideas don't come into my head that quickly. So I like to just work out ideas with pen and paper." - P1*. In contrast to these participants, another participant indicated a preference for working directly in the digital toolkit: *"Well I experience that differently. Sometimes I'm in the kitchen and then I walk to the living room and then I've forgotten what to do. I once read that the moment you go into another space you get a kind of reset and you start a new moment. If it's not already ready, like a laptop that I can work on, I may be easily distracted and then I'm out of the moment. So sitting at a computer works better for me, then I can focus on ideas. - P2*.

After the solution of giving everyone freedom in how someone elaborates an assignment was shown in the prototype, there was a positive response from the participants: *"Oh that's convenient! Then you can just choose how you want to work." - P2*, *"I also find this useful indeed." - P5*, *"I think it's good that that option is there! If uploading is very easy, it's kind of convenient." - P1*. After these responses, another demonstration was given on how to upload something and the question was asked if this is an easy way and if the threshold is low enough for uploading the elaborations. All participants indicated that this is a solution that could work for them. There were no further suggestions for improvements.

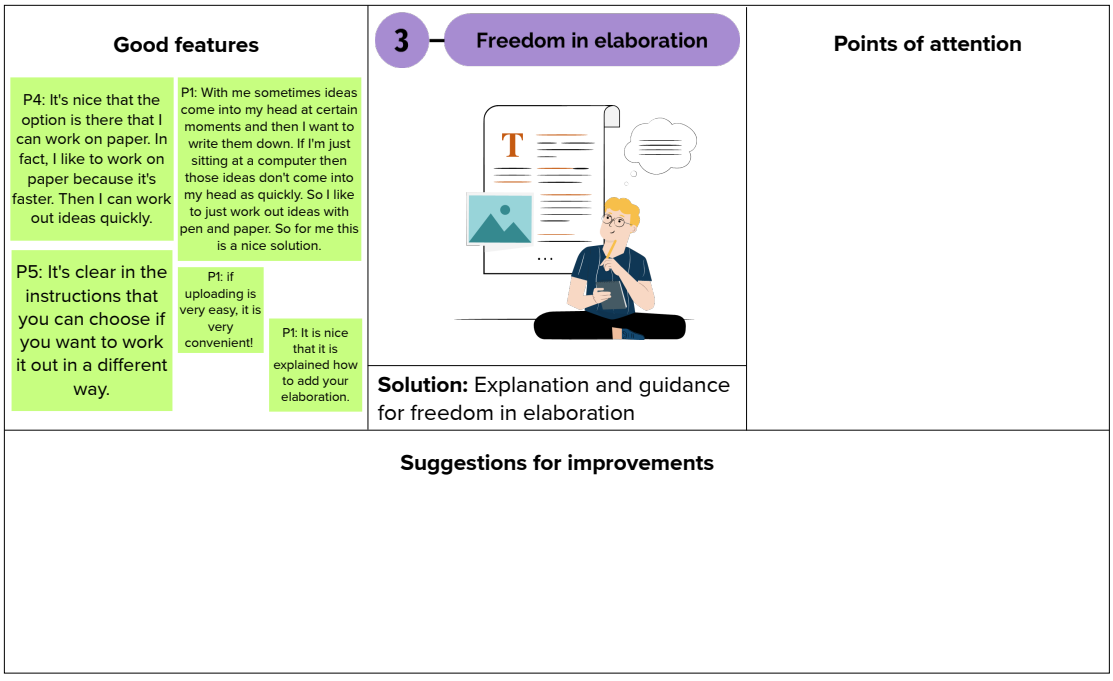


Figure 6.5: *Overview of the participant's feedback points for point of attention 3: Freedom in elaboration. These feedback points are divided into good features, points of attention, and suggestions for improvement.*

Point of attention 4: Privacy

After the issue of privacy was addressed, participants were asked which of them considered privacy to be an important aspect. The participants indicated that they do not feel the need to share all the information they want to use to elaborate on their assignment. When others can see the elaborations, this can be perceived as additional pressure: *"I think privacy is also important for my work. I don't want everyone to see my results. This also feels like it should be worked out extra well." - P2*. After demonstrating how privacy can be ensured with the digital prototype, one of the participants came up with the question of whether specific components could also be shielded instead of the entire digital toolkit: *"Can you also specify which parts someone else can or cannot see? For example, that they can know the ideas, but I can keep the sketches to myself for a while?" - P2*. Several participants indicated a desire for this feature. Which resulted in the suggestion for improvement: the ability to shield specific sections from other people.

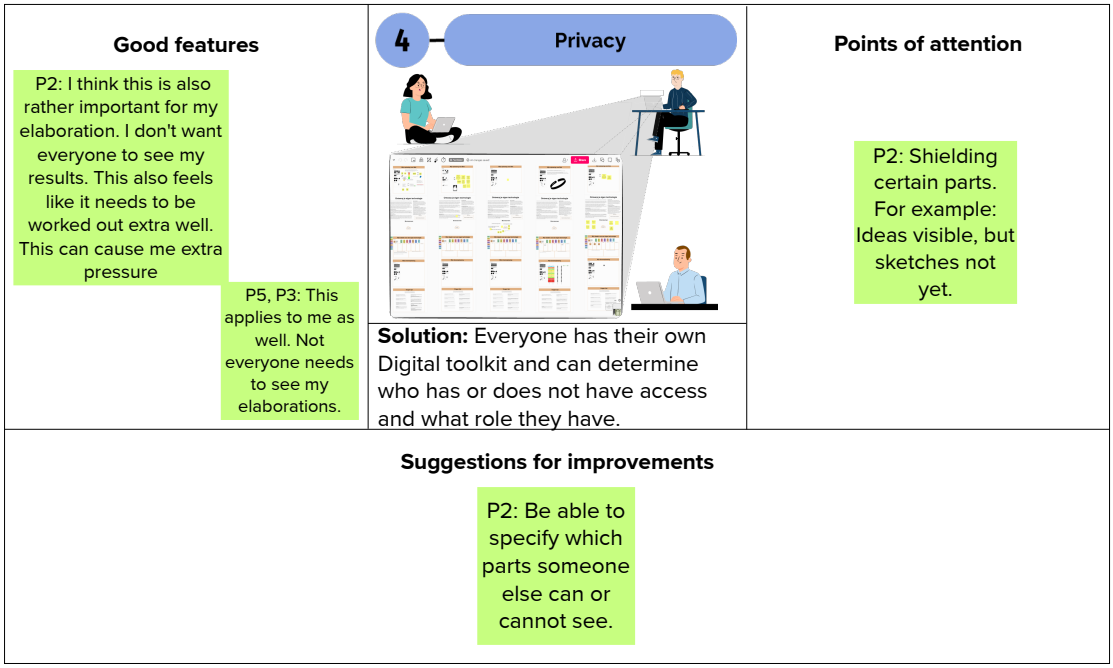


Figure 6.6: *Overview of the participant's feedback points for point of attention 4: Privacy. These feedback points are divided into good features, points of attention, and suggestions for improvement.*

Point of attention 5: Responsive and adaptive design

A number of participants have indicated that they like the possibility of being able to use the Mural app. This allows them to use the digital toolkit on different devices and they are not dependent on the location: *"If I used the app last time, I think it would have been easier to work with the toolkit. Last time, the program didn't work fine on my tablet." - P1*, *"I would like to have the possibility to use the app. Because sometimes I'm on the train and then it' s nice to be able to write ideas down in the toolkit." - P5*, *"Writing down notes would work well for me through the app."*. One of the participants remained skeptical and said that it would have to be demonstrated in practice whether it would actually work fine. He indicated that it does not work fine for him when larger texts had to be written: *"I can't say if the mobile app is a solution for me. This would have to be proven in practice, at least for me it does not*

work if I have to type a lot." - P3.

After seeing how the app can be downloaded by scanning the QR code, one of the participants indicated that it might be a better option to add the link to the Google Play Store or the Apple Store in addition to the QR code: *"What if you are on your phone? Then how can I scan the QR code? Maybe it would be a useful idea to have the ability to click on a link as well. That the apple store or google play store opens immediately?" - P2.* Other participants also indicated afterward that a link would be a good addition to be able to scan the QR code: *"A QR code and link would work for me though. Preferably a link that you can download immediately." - P3.* Which resulted in the suggestion for improvement: A link to the Mural app that goes directly to the Google Play Store or the App store.

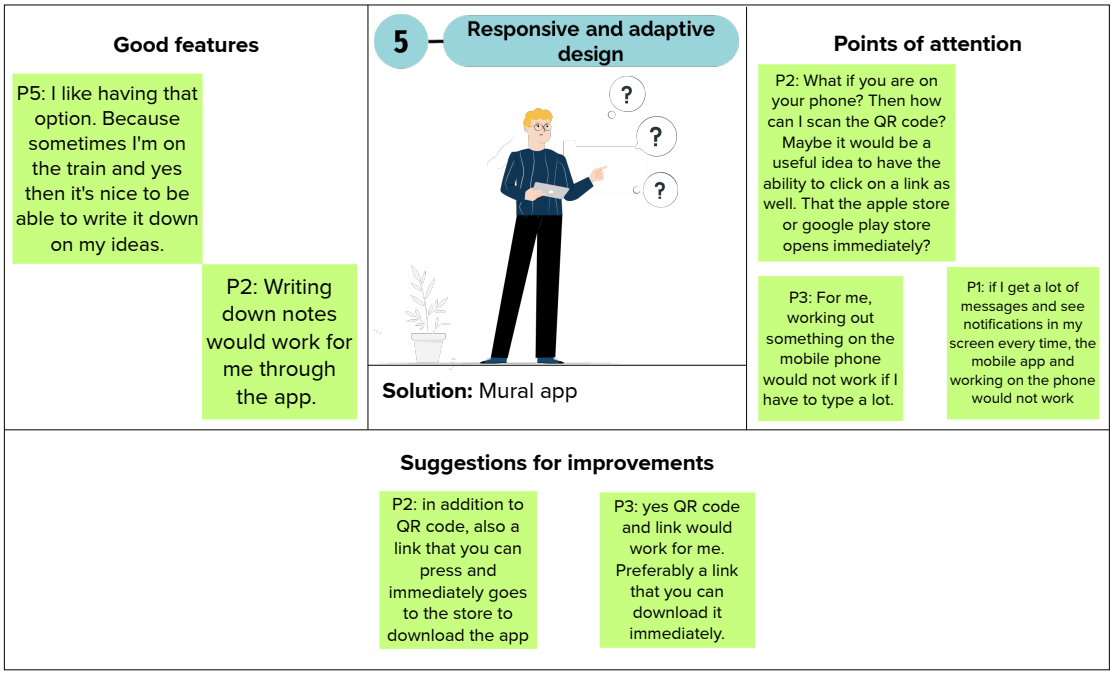


Figure 6.7: *Overview of the participant's feedback points for point of attention 5: Responsive and adaptive design. These feedback points are divided into good features, points of attention, and suggestions for improvement.*

Point of attention 6: Flexible in individual preferences

Before the solution incorporated into the prototype was shown to the participants, participants were asked what they needed to feel the freedom of being able to use their own programs in which they could elaborate on the assignments: *"Maybe it would be helpful to let people know at the beginning what they can use for this and what programs. Maybe a Clippy tip? Also that you know how much knowledge you need to have to be able to work with certain programs." - P2.* Participants were then asked where they expect to find this information: *"At the beginning of the assignment what the possibilities are and how you can make it easy for yourself. That you see at the beginning what the assignments are and what you need for them." - P2, "The information must be provided at the right time. Not that you're already working in Mural and later find out that you could have worked it out in another program." - P1.*

Subsequently, the prototype was shown and participants were asked what they thought of the solution and whether the instructions were adequate. All participants indicated that this is a solution that could work for them: *"Yes exactly this is what I meant! First, the instructions what is needed with examples before you can already start working out the assignment." - P2*, *"Yes this is very nice then I know in advance that I can use other programs to carry out the activity before I even start the activity. The example of how you could work out the assignment is also nice to have. You don't want to copy something, you want to be free in your thinking, but it's nice that you can make a start with an example. Otherwise, you see such a blank sheet and then I feel like I don't know where to start. That you get inspiration how you could work it out." - P1*. There were no further suggestions for improvements.

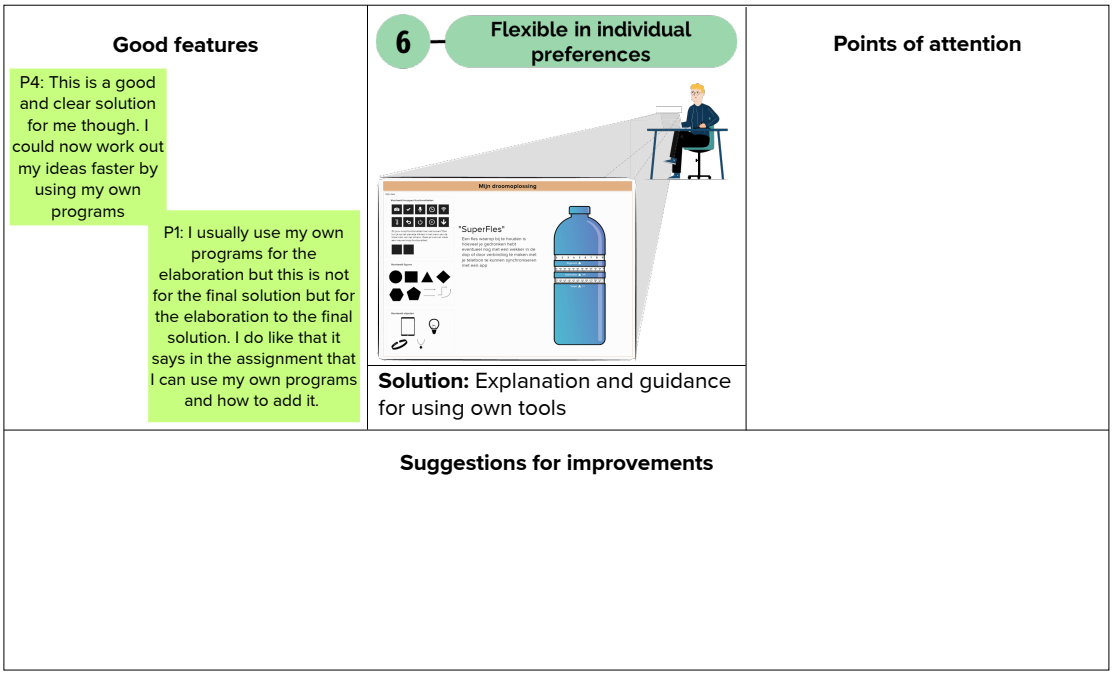


Figure 6.8: *Overview of the participant's feedback points for point of attention 6: Flexible in individual preferences. These feedback points are divided into good features, points of attention, and suggestions for improvement.*

6.2 Final Prototype

This section discusses the final adjustments to the digital toolkit prototype. These adjustments are based on the feedback points that resulted from the focus group. For each point of attention, for which a suggestion was indicated, it has been considered whether the suggestion for improvements can be applied in the final digital toolkit prototype or not.

Point of attention 1: Using a new program

Based on the feedback from the participants, the activities in the introduction were modified. The activities were incorporated into the toolkit as follows: (1) Digital Toolkit & Mural, (2) What is Design Your Life?, and (3) Warm-up - What is Technology? For the final digital toolkit prototype, the order of activities in the introduction has been changed to (1) What is Design Your Life?, (2) Warm-up - What is Technology?, and (3) Digital Toolkit & Mural. This first clarifies the purpose of what YAA can do with the DYL digital toolkit and what is

meant by the term "technology" from the DYL perspective and then explains how YAA can work with the digital toolkit.

Point of attention 2: Too much in one overview

Some participants suggested an improvement to have the possibility to fold in and out the phases and activities. This functionality is unfortunately not supported in Mural and therefore cannot be applied in the final digital toolkit prototype for this study. For the further development of a DYL digital toolkit, it is recommended to include this suggestion for improvement in the requirements.

Point of attention 4: Privacy

As a suggestion for improvement, participants indicated a need to shield specific sections in which they work: *"For example, that they can know the ideas, but I can keep the sketches to myself for a while?" - P2*. Within Mural, it is possible to shield specific content by using the 'Hide this content in the mural' functionality, which can be seen in Figures 6.9 and 6.10. However, this information about this feature has yet to be incorporated into the digital toolkit.

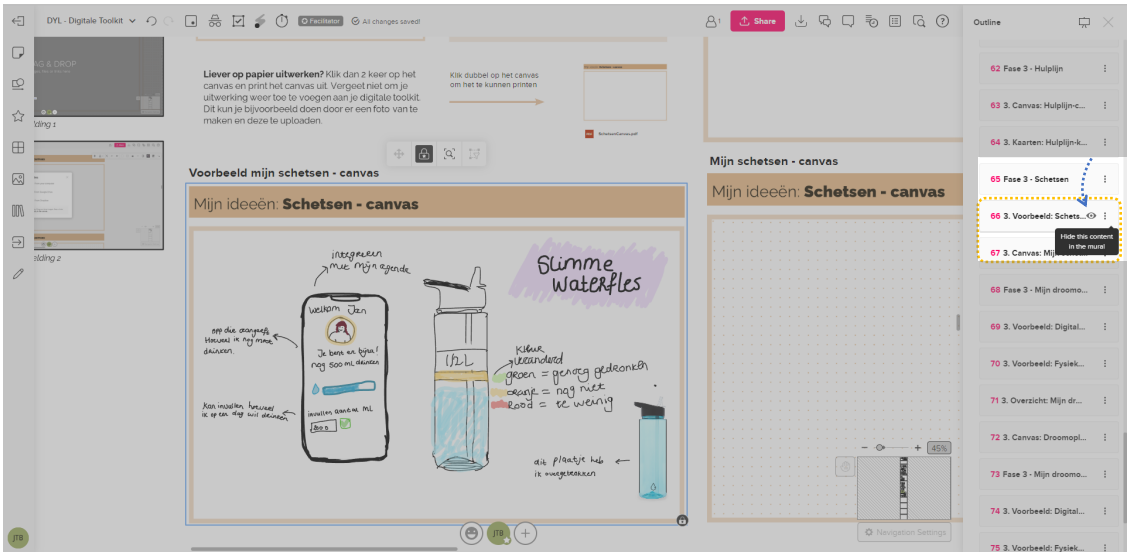


Figure 6.9: *Overview of the 'Hide this content in the mural' functionality.*

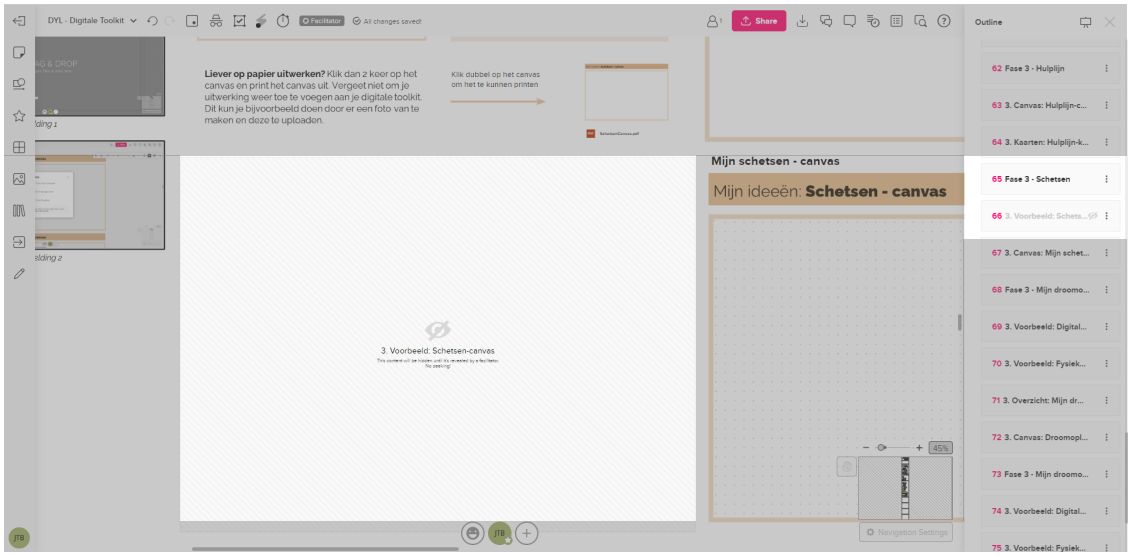


Figure 6.10: *Overview of the 'Hide this content in the mural' functionality applied in the DYL digital toolkit prototype.*

Point of attention 5: Responsive and adaptive design

In addition to the QR code that refers to the app store where the Mural app can be installed, the participants indicated that they would like to be able to click on a link. To this end, the QR code in the digital toolkit prototype has been made clickable so that YAA can also access the Mural app through a link.

Part five

Discussion & Conclusion

Chapter 7

Discussion

7.1 Reflection on results

The aim of this study was to gain new insights into how a digital toolkit can support individual preferences of expression. This led to the following overarching research question: *"How can digitization of the DYL toolkit support individual preferences of expressing oneself, contributing to a creative, personalized, and satisfactory design process?"*

The design of the digital toolkit prototype, as well as the results from the generative session and the focus group, already provide a partial answer to this question. To further elaborate on these results, the primary research question will be answered by means of four supporting questions. This will be done using the important aspects: creativity, personalization, and satisfaction

7.1.1 Creativity

Creativity manifests itself in YAA mainly when they are able to express themselves flexibly and when they have freedom in the way they can work out an assignment. In accordance with what was stated in the case study [67], it was found that there is indeed a strong need for flexibility and the use of its own programs by YAA to be more creative. It was found that YAA had difficulty in finding the functionalities and also in working with new programs, which limited their creativity. Subsequently, it was consistent with case studies [62], [67], that there is a strong need for freedom in the way YAA can complete assignments by, for example, working something out on paper first and then in a digital program, whereby they should not be restricted. For example, due to lack of space and because some YAA prefer to brainstorm on paper, they were restricted by only using the digital option.

7.1.2 Personalization

The construction of personalization manifested itself in practice when YAA have the opportunity to use programs with which they are familiar. This has overlap with the important aspect of creativity. As indicated in Chapter 4, the important aspects are not completely mutually exclusive and are partially interdependent. The importance of privacy was also mentioned. This is consistent with the findings from the case study [69]. In this thesis, it is mainly due to the fact that some participants could not fully express themselves in the digital program because others could then also see the personal elaborations.

7.1.3 Satisfaction

Practice has shown that the satisfaction of YAA is enhanced when the digital tool is user-friendly and they can use it with ease. By using the digital prototype, participants were able to use the toolkit location and time independently. This allowed them to spontaneously work out their assignment when an idea came to them. In addition, the results of this study indicated differences in digital literacy between age groups. While younger participants seemed to navigate the program intuitively, older participants needed additional support and explanation to complete tasks in the digital environment. As a result, the older participants had less motivation to complete the task, which affected their satisfaction.

7.2 Implications

The results gained in this research build on existing evidence that one size fits all technologies often do not fully match the needs of the individual [35]. What works well for one person leads to frustration for another. For example, it was observed the preferences in the elaboration of assignments differ among the participants. These results are in line with the practical insights that emerged from the ten case studies. This indicated, for example, that some participants prefer to work with their own program rather than use a paper version, see Section 2.3.2. Also when YAA are not able to express themselves through the current physical toolkit, lack of motivation, frustration, and dissatisfaction could result during the design process. The digital toolkit complements the physical toolkit, allowing more freedom to customize it to YAA's own preferences and personal goals. This gives YAA the ability to decide how they want to carry out their assignments and what tools they want to use to do so. In this manner, YAA can make their design process more personal, allowing them to better express themselves and design technologies that meet their needs. In addition, the use of the digital toolkit allows a broader group to be reached within the target group.

7.3 Research limitations & Recommendations

One of the limitations of this thesis is the fact that it was conducted on a small scale. Only six participants were involved, so the results are not representative of all persons within the target group. Additional research with more persons within the target group is therefore necessary.

Furthermore, it is important to note that the participants in this study consist of YAA who, in particular, often work with creative thinking processes. As a result, a non-representative sample may have been used. Therefore, it is recommended that this be validated in a more diverse and representative sample. It could be that there is a need within the target group for more support during the design process. For this, additional research is needed to find out if digitization can provide additional support in the area of stimulating creativity.

A number of design choices were made for the design of the digital toolkit. These choices were made based on input from the participants. However, no research has been done into the different solution possibilities per requirement, as this is beyond the scope of this research because it is too extensive. In view of the above, additional research is therefore recommended.

For this study, Mural was chosen by the researcher as the digital program to develop a prototype of a digital toolkit, based on insights from the participants about the necessary functionalities

to properly express their ideas. However, the evaluation revealed that there are still some components in the prototype that do not fully meet the participants' requirements. For example, the overview shows more information than is necessary, which can cause over-stimulation. It is therefore recommended to investigate how this can be better integrated into the digital toolkit or whether another program might be more appropriate for the digital toolkit.

Another aspect to keep in mind regarding the evaluation method used in this thesis is that the toolkit has not been evaluated based on user testing. In this study, the prototype digital toolkit was evaluated based on a cognitive walkthrough by the researcher clicking through the toolkit. By allowing users to test themselves, the evaluation is based more on the experiences of YAA, creating a better understanding of the areas of improvement and strengths. Therefore, it is strongly recommended to test the digital toolkit prototype with YAA and the latest changes made after the evaluation phase.

Chapter 8

Conclusion

This thesis provided additional knowledge on how digitization can play a supporting role in better meeting the individual preferences of YAA. Digitization of the DYL toolkit leads to more freedom and flexibility in the way YAA can go through their design process, which results in more customization. This allows YAA to make better use of their own creativity, which improves their satisfaction. An important additional benefit is that by using the digital toolkit, a broader group within the target group can be reached. This thesis has also made clear that additional research is needed in several areas to achieve greater validity and reliability of the research results. These include expanding the group of participants, developing a prototype that fully meets the requirements of the participants, testing the toolkit by YAA in their own environment, and finding the most appropriate instrument to design the digital toolkit in.

Acknowledgment

First and foremost, I would like to thank my supervisor, Arjan van Hessen. I am very grateful for the support and valuable insights I received while writing this thesis.

I would also like to thank my supervisor from the Design Your Life project, Niels van Huizen, for always being there for ALL my questions and for the valuable guidance during this research.

In addition, I would like to thank all the staff and especially the participants of AssortiMens for their valuable input during my research. Without you, I could not have conducted this research.

I would also like to thank the entire Design Your Life team for their wonderful advice and collaboration.

Furthermore, I would like to thank my parents, family, and friends for their love, support, and encouragement during the period of this study. Especially my fellow student, Michael, and my uncle, Frank.

Finally, I could not have completed this thesis without the support and love of my partner, Bob.

Bibliography

[1] C. Frauenberger, J. Good, and N. Pares, "Autism and technology: beyond assistance & intervention," in *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, pp. 3373–3378, 2016.

[2] C. Schoemaker, M. Kleinjan, W. Van der Borg, M. Busch, M. Muntinga, J. Nuijen, and C. Dedding, "Mentale gezondheid van jongeren: enkele cijfers en ervaringen," 2019.

[3] M. Botha, B. Dibb, and D. M. Frost, "" autism is me": an investigation of how autistic individuals make sense of autism and stigma," *Disability & Society*, pp. 1–27, 2020.

[4] I. Servatius-Oosterling, M. d. Jonge, and A. d. Bildt, "Inleiding deel i–autisme: een plaatsbepaling," in *Autisme bij kinderen*, pp. 3–6, Springer, 2021.

[5] R. Wisner-Carlson, S. Uram, and T. Flis, "The transition to adulthood for young people with autism spectrum disorder," *Child and Adolescent Psychiatric Clinics*, vol. 29, no. 2, pp. 345–358, 2020.

[6] D. E. Milton, "On the ontological status of autism: the 'double empathy problem'," *Disability & Society*, vol. 27, no. 6, pp. 883–887, 2012.

[7] S. J. O'Neill, S. Smyth, A. Smeaton, and N. E. O'Connor, "Assistive technology: Understanding the needs and experiences of individuals with autism spectrum disorder and/or intellectual disability in ireland and the uk," *Assistive Technology*, vol. 32, no. 5, pp. 251–259, 2020.

[8] O. Golan, E. Ashwin, Y. Granader, S. McClintock, K. Day, V. Leggett, and S. Baron-Cohen, "Enhancing emotion recognition in children with autism spectrum conditions: An intervention using animated vehicles with real emotional faces," *Journal of autism and developmental disorders*, vol. 40, no. 3, pp. 269–279, 2010.

[9] S. Fletcher-Watson and F. Happé, *Autism: A new introduction to psychological theory and current debate*. Routledge, 2019.

[10] T. Waardenburg, N. van Huizen, J. van Dijk, M. Magnée, W. Staal, J.-P. Teunisse, and M. van der Voort, "Design your life: User-initiated design of technology to support independent living of young autistic adults," *arXiv preprint arXiv:2105.12370*, 2021.

[11] A. Mader and W. Eggink, "A design process for creative technology," in *DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations, University of Twente, The Netherlands, 04-05.09. 2014*, 2014.

[12] D. H. Geschwind, "Advances in autism," *Annual review of medicine*, vol. 60, pp. 367–380, 2009.

[13] F. R. Volkmar and J. C. McPartland, "From kanner to dsm-5: autism as an evolving diagnostic concept," *Annual review of clinical psychology*, vol. 10, pp. 193–212, 2014.

[14] S. Wolff, "The history of autism," *European child & adolescent psychiatry*, vol. 13, no. 4, pp. 201–208, 2004.

[15] W. Staal, M. Buruma, and I. Servatius-Oosterling, "Autisme: een concept in beweging," in *Autisme bij kinderen*, pp. 7–20, Springer, 2021.

[16] L. Kenny, C. Hattersley, B. Molins, C. Buckley, C. Povey, and E. Pellicano, "Which terms should be used to describe autism? perspectives from the uk autism community," *Autism*, vol. 20, no. 4, pp. 442–462, 2016.

[17] D. E. Milton, "Autistic expertise: A critical reflection on the production of knowledge in autism studies," *Autism*, vol. 18, no. 7, pp. 794–802, 2014.

[18] F. Happé and U. Frith, "Annual research review: Looking back to look forward–changes in the concept of autism and implications for future research," *Journal of Child Psychology and Psychiatry*, vol. 61, no. 3, pp. 218–232, 2020.

[19] J. Blaska, "The power of language: Speak and write using "person first."," *Perspectives on disability*, pp. 25–32, 1993.

[20] D. Feldman, P. A. Gordon, M. J. White, and C. Weber, "The effects of people-first language and demographic variables on beliefs, attitudes and behavioral intentions toward people with disabilities," *Journal of Applied Rehabilitation Counseling*, vol. 33, no. 3, pp. 18–25, 2002.

[21] D. Oliver, "On neurodiversity - a study room guide on neurodiversity." 2019.

[22] D. L. Baker, *The politics of neurodiversity: Why public policy matters*. Lynne Rienner Publishers Boulder, CO, 2011.

[23] M. Oliver, *Politics of disablement*. Macmillan International Higher Education, 1990.

[24] P. Lee, "Language in thinking and learning: Pedagogy and the new whorfian framework," *Harvard Educational Review*, vol. 67, no. 3, pp. 430–472, 1997.

[25] H.-C. Steinhausen, C. Mohr Jensen, and M. Lauritsen, "A systematic review and meta-analysis of the long-term overall outcome of autism spectrum disorders in adolescence and adulthood," *Acta Psychiatrica Scandinavica*, vol. 133, no. 6, pp. 445–452, 2016.

[26] J. J. Arnett, "Emerging adulthood: What is it, and what is it good for?," *Child development perspectives*, vol. 1, no. 2, pp. 68–73, 2007.

[27] L. Mattys, I. Noens, K. Evers, and D. Baeyens, ""hold me tight so i can go it alone": Developmental themes for young adults with autism spectrum disorder," *Qualitative health research*, vol. 28, no. 2, pp. 321–333, 2018.

[28] A. V. Kirby, M. Schneider, M. Diener, and J. Henderson, ""who is going to pay for the wi-fi?" exploring adulthood from the perspectives of autistic youth," *Autism in Adulthood*, vol. 1, no. 1, pp. 37–43, 2019.

[29] B. Robins, K. Dautenhahn, R. Te Boekhorst, and A. Billard, "Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills?," *Universal access in the information society*, vol. 4, no. 2, pp. 105–120, 2005.

[30] B. G. B. Taga, "Sociale vaardigheidstraining met de ono-robot voor jongeren met ass,"

[31] O. Golan and S. Baron-Cohen, "Systemizing empathy: Teaching adults with asperger syndrome or high-functioning autism to recognize complex emotions using interactive multimedia," *Development and psychopathology*, vol. 18, no. 2, pp. 591–617, 2006.

[32] S. Parsons and P. Mitchell, "The potential of virtual reality in social skills training for people with autistic spectrum disorders," *Journal of intellectual disability research*, vol. 46, no. 5, pp. 430–443, 2002.

[33] N. Newbutt, M. M. Schmidt, G. Riva, and C. Schmidt, "The possibility and importance of immersive technologies during covid-19 for autistic people," *Journal of Enabling Technologies*, 2020.

[34] A. M. Piper, E. O'Brien, M. R. Morris, and T. Winograd, "Sides: a cooperative tabletop computer game for social skills development," in *Proceedings of the 2006 20th anniversary conference on Computer supported cooperative work*, pp. 1–10, 2006.

[35] C. Putnam and L. Chong, "Software and technologies designed for people with autism: what do users want?," in *Proceedings of the 10th international ACM SIGACCESS conference on Computers and accessibility*, pp. 3–10, 2008.

[36] L. C. Mechling, "Assistive technology as a self-management tool for prompting students with intellectual disabilities to initiate and complete daily tasks: A literature review," *Education and Training in Developmental Disabilities*, pp. 252–269, 2007.

[37] J. A. Kientz, M. S. Goodwin, G. R. Hayes, and G. D. Abowd, "Interactive technologies for autism," *Synthesis lectures on assistive, rehabilitative, and health-preserving technologies*, vol. 2, no. 2, pp. 1–177, 2013.

[38] I. Mariën and D. Baelden, *8 Profielen van Digitale Ongelijkheden*. idealic. be, 2015.

[39] N. Carmona-Serrano, J. López-Belmonte, J.-L. Cuesta-Gómez, and A.-J. Moreno-Guerrero, "Documentary analysis of the scientific literature on autism and technology in web of science," *Brain Sciences*, vol. 10, no. 12, p. 985, 2020.

[40] P. Francis, S. Balbo, and L. Firth, "Towards co-design with users who have autism spectrum disorders," *Universal Access in the Information Society*, vol. 8, no. 3, pp. 123–135, 2009.

[41] J. A. Kientz, G. R. Hayes, M. S. Goodwin, M. Gelsomini, and G. D. Abowd, "Interactive technologies and autism, second edition," *Synthesis Lectures on Assistive, Rehabilitative, and Health-Preserving Technologies*, vol. 9, no. 1, pp. i–229, 2020.

[42] E. B.-N. Sanders and P. J. Stappers, "Co-creation and the new landscapes of design," *Co-design*, vol. 4, no. 1, pp. 5–18, 2008.

[43] I. Burkett, "An introduction to co-design," *Sydney: Knode*, 2012.

[44] M. Kouprie and F. S. Visser, "A framework for empathy in design: stepping into and out of the user's life," *Journal of Engineering Design*, vol. 20, no. 5, pp. 437–448, 2009.

[45] L. Varpio, R. Ajjawi, L. V. Monrouxe, B. C. O'Brien, and C. E. Rees, "Shedding the cobra effect: problematising thematic emergence, triangulation, saturation and member checking," *Medical education*, vol. 51, no. 1, pp. 40–50, 2017.

[46] "Creative problem solving tools & techniques resource guide," 2016.

[47] Ö. Akin and C. Akin, "On the process of creativity in puzzles, inventions, and designs," *Automation in Construction*, vol. 7, no. 2-3, pp. 123–138, 1998.

[48] M. Rhodes, "An analysis of creativity," *The Phi delta kappan*, vol. 42, no. 7, pp. 305–310, 1961.

[49] B. Gaut, "The philosophy of creativity," *Philosophy Compass*, vol. 5, no. 12, pp. 1034–1046, 2010.

[50] M. A. Runco and G. J. Jaeger, "The standard definition of creativity," *Creativity research journal*, vol. 24, no. 1, pp. 92–96, 2012.

[51] B. Gaut, "Creativity and imagination," *The creation of art*, pp. 148–173, 2003.

[52] M. C. Den Haan, R. Brankaert, Y. Lu, *et al.*, "Design for one: personalisation and experiences of design researchers and participants," in *Proceedings of the Sixth International Conference on Design Creativity (ICDC 2020)*, pp. 279–286, 2020.

[53] K. Kaneko, Y. Kishita, and Y. Umeda, "Toward developing a design method of personalization: Proposal of a personalization procedure," *Procedia CIRP*, vol. 69, pp. 740–745, 2018.

[54] C. Treadaway, "Personalization and compassionate design," in *HCI and Design in the Context of Dementia*, pp. 49–61, Springer, 2020.

[55] R. Veenhoven, "Developments in satisfaction-research," *Social indicators research*, vol. 37, no. 1, pp. 1–46, 1996.

[56] J. L. Giese and J. A. Cote, "Defining consumer satisfaction," *Academy of marketing science review*, vol. 1, no. 1, pp. 1–22, 2000.

[57] R. A. Westbrook, "Intrapersonal affective influences on consumer satisfaction with products," *Journal of consumer research*, vol. 7, no. 1, pp. 49–54, 1980.

[58] R. A. Westbrook and M. D. Reilly, "Value-percept disparity: an alternative to the disconfirmation of expectations theory of consumer satisfaction," *ACR North American Advances*, 1983.

[59] E. R. Cadotte, R. B. Woodruff, and R. L. Jenkins, "Expectations and norms in models of consumer satisfaction," *Journal of marketing Research*, vol. 24, no. 3, pp. 305–314, 1987.

[60] L. Pu, "Co-design approach: a collective design method for improving working efficiency and satisfaction in user support design processes: an empirical study based on three comparison groups simulating a real-world quick start guide design process," Master's thesis, University of Twente, 2019.

[61] J. Nielsen, "Chapter 1 - what is usability?," in *User Experience Re-Mastered* (C. Wilson, ed.), pp. 3–22, Boston: Morgan Kaufmann, 2010.

[62] N. van Huizen, T. Waardenburg, N. Overdevest, J. van Dijk, W. Staal, and M. van der Voort, "Developing a toolkit to empower young autistic adults: Using grounded theory to analyse ten design case studies." 2022.

[63] N. Overdevest, "Designing a toolkit to empower young autistic adults to create personal products that promote independence," master thesis, University of Twente, 2021.

[64] W. Boevink, H. Kroon, P. Delespaul, and J. Van Os, "Empowerment according to persons with severe mental illness: development of the netherlands empowerment list and its psychometric properties," *Open Journal of Psychiatry*, vol. 7, no. 1, pp. 18–30, 2016.

[65] O. Martínez Gasca, "Inside my head - exploring how design tools for reflection become part of the lived experience of an autistic adult," master thesis, University of Twente, 2021.

[66] M. Kunda and A. K. Goel, "Thinking in pictures as a cognitive account of autism," *Journal of autism and developmental disorders*, vol. 41, no. 9, pp. 1157–1177, 2011.

[67] L. van den Berg, "Designing a toolkit that supports autistic young adults in creating a personalized contribution to their independence," bachelor thesis, University of Twente, 2020.

[68] B. Wetselaar, "Empowering a young autistic adult by using goal-based design thinking," bachelor thesis, University of Twente, 2021.

[69] F. Wonink, "To be and to become an everyday designer," master thesis, University of Twente, 2021.

[70] F. S. Visser, P. J. Stappers, R. Van der Lugt, and E. B. Sanders, "Contextmapping: experiences from practice," *CoDesign*, vol. 1, no. 2, pp. 119–149, 2005.

[71] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative research in psychology*, vol. 3, no. 2, pp. 77–101, 2006.

[72] L. Fu, G. Salvendy, and L. Turley, "Effectiveness of user testing and heuristic evaluation as a function of performance classification," *Behaviour & information technology*, vol. 21, no. 2, pp. 137–143, 2002.

[73] E. Spaulding and H. Faste, "Design-driven narrative: using stories to prototype and build immersive design worlds," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 2843–2852, 2013.

[74] J. Lazar, J. H. Feng, and H. Hochheiser, "Chapter 8-interviews and focus groups," *Research Methods in Human Computer Interaction (second edition ed.), Jonathan Lazar, Jinjuan Heidi Feng, and Harry Hochheiser (Eds.). Morgan Kaufmann, Boston*, pp. 187–228, 2017.

Appendix A

Appendix

A.1 Appendix A: Procedure Generative Sessions Ideation Phase

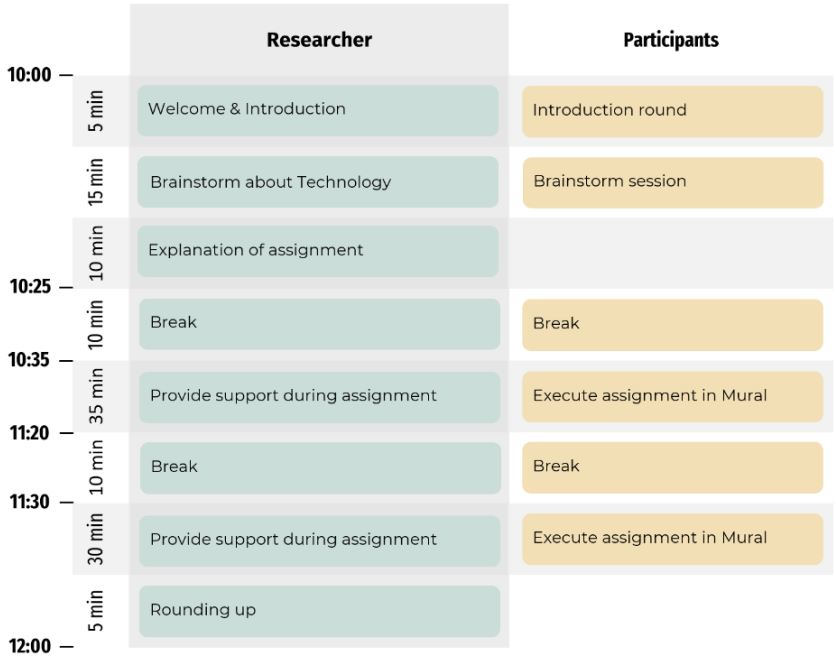


Figure A.1: *An overview of the procedure of the first part of the generative session for the ideation phase.*

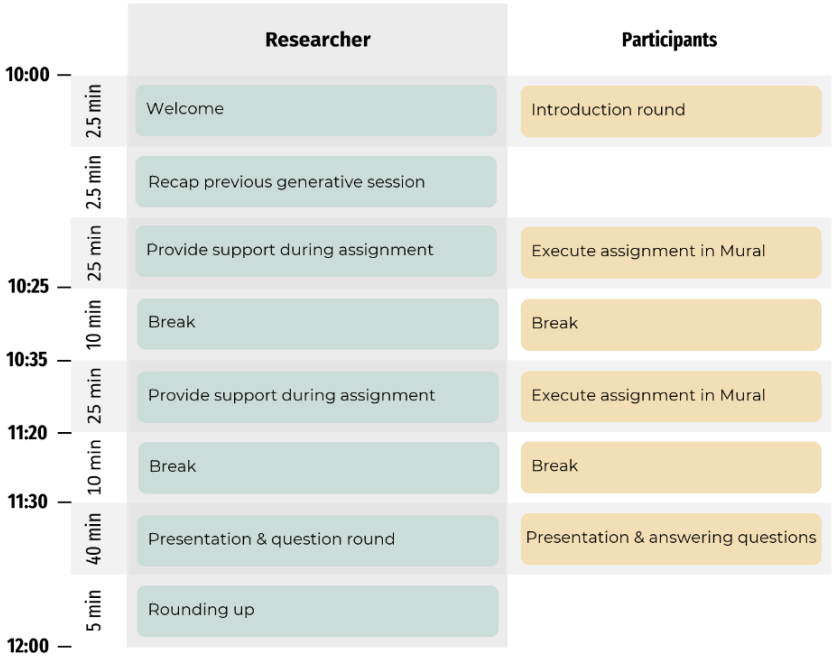


Figure A.2: *An overview of the procedure of the second part of the generative session for the ideation phase.*

A.2 Appendix B: Consent Form Generative Sessions

Geïnformeerde toestemming voor standaardonderzoek
Hierbij verklaar ik dat ik op een voor mij duidelijke wijze ben geïnformeerd over de aard en de werkwijze van het onderzoek zoals beschreven in de informatiebrochure. Mijn vragen zijn tot mijn tevredenheid beantwoord. Ik stem uit vrije wil in met deelname aan dit onderzoek. Ik behoud mij het recht voor deze toestemming in te trekken zonder opgaaf van redenen en ik ben mij ervan bewust dat ik mij op elk moment uit het experiment kan terugtrekken. Ik ben me ervan bewust dat de resultaten van mijn Focus Groep activiteiten en de communicatie over mijn Focus Groep activiteiten (offline of online) gebruikt zullen worden als onderzoeksgegevens. Als mijn onderzoeksresultaten gebruikt zullen worden in wetenschappelijke publicaties of op een andere manier openbaar gemaakt zullen worden, dan zullen ze volledig geanonimiseerd worden. Mijn persoonlijke gegevens zullen niet aan derden worden doorgegeven zonder mijn uitdrukkelijke toestemming. Indien ik nu of in de toekomst nadere informatie over het onderzoek wil, kan ik contact opnemen met de hoofdonderzoekers:

- Jelle van Dijk — jelle.vandijk@utwente.nl
- Niels van Huizen — j.c.vanhuizen@utwente.nl
- Thijs Waardenburg — thijs.waardenburg@han.nl

Mocht u klachten hebben over dit onderzoek, dan kunt u deze richten aan de secretaris van de Commissie Ethiek Natuur- en Ingenieurswetenschappen van de Universiteit Twente, Postbus 217, 7500 AE Enschede (NL), telefoon: +31 (0)53 489 2547; e-mail: m.c.kamp@utwente.nl.

[ ] Ik geef hierbij toestemming om de onderzoeker audio- en video-opnamen te laten maken van de sessies en bijeenkomsten online en op locatie.
[ ] Ik geef hierbij toestemming om de onderzoeksgroep de geanonimiseerde transcripties van deze opnames te laten gebruiken in (wetenschappelijke) publicaties.

Ondertekend in tweevoud op:

Verklaring deelnemer

....

Naam deelnemer Handtekening

Verklaring onderzoeker

Ik heb een toelichting gegeven op het onderzoek. Ik verklaar mij bereid eventuele vragen die nog over het onderzoek rijzen naar beste vermogen te beantwoorden

....

Naam onderzoeker Handtekening

A.3 Appendix C: Slides about Technologie

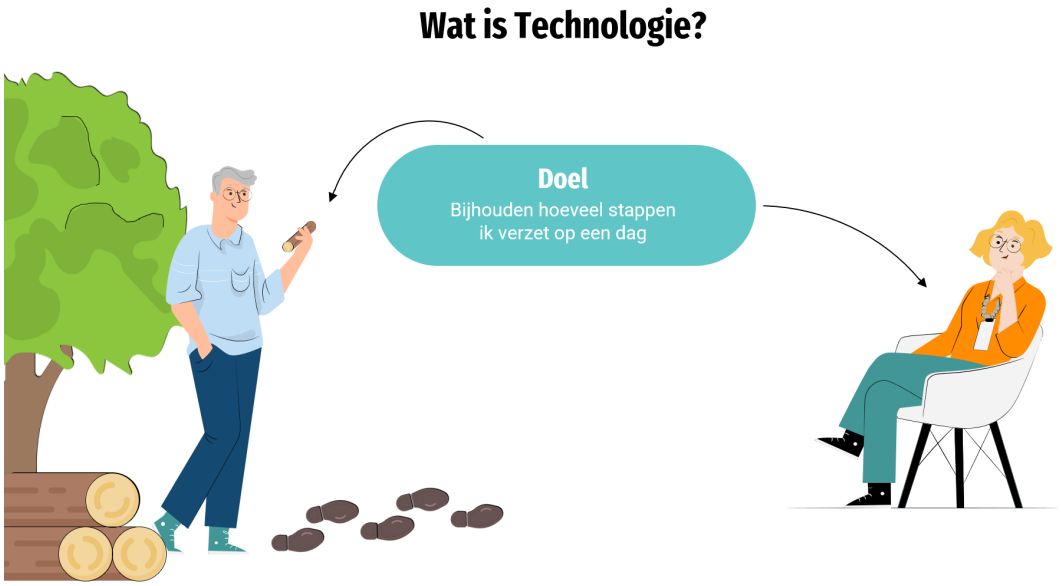


Figure A.3: *The slide which is used for the brainstorm session about the term technology during the generative session in the ideation phase.*

Figure A.4: *The slide which is used as an example of a supportive technology made by a participant during the DYL process for the brainstorm session about the term technology during the generative session in the ideation phase.*

Figure A.5: *The slide which is used as an example of another supportive technology made by a participant during the DYL process for the brainstorm session about the term technology during the generative session in the ideation phase.*

A.4 Appendix D: Assignment based on a fictional case study

Assignment based on a fictional case study

Bob has a **hard time saying no** and takes on all tasks. He does this at work but also in his social life. As a result, Bob has **no energy left** at the end or even during the day.

Technology for Bob

Could you think of a technology that could help Bob properly distribute his energy throughout a day?

- Step 1: Brainstorming
- Step 2: My ideas for Bob
- Step 3: My dream solution for Bob

Step 1: Brainstorming

In this step we are going to **brainstorm**. Try in this step to look at Bob's **challenge**. Could he use something to address his challenge? If you have ever run into something like this yourself, what advice would you give to Bob?

My Ideas
for Bob's challenge

Challenge
Hard time saying no.

Bob has **no energy left** at the end or even during the day.

Step 2: My ideas for Bob

This step helps to quickly map out what your solution for Bob should or should not be able to do or have. Choose at least 5 requirements.

As an aid, there are categories that your requirements can fall under: hear, see, feel, move, smell, do or cooperate.

Assignment: Look at the examples and write down your requirements or wishes that your solution for Bob should meet.

Hear	See	Feel
•My solution uses sound •The solution talks to me •I can adjust the volume •Sound turns on at a certain time •I get reminders in the form of sound	•I can see the time on my solution •I get reminders on a screen •All buttons are lit •My solution has a screen •My solution uses text	•I can use my solution without looking •When I use my solution my solution vibrates •My solution does not move at all

Move	Smell	Do
•I can move my solution easily •I can deform my solution •My solution is nice to fiddle with •My solution can move in such a way that...	•My solution contains an smell •My solution removes unpleasant scents •My solution can spread pleasant scents	•I can give orders by touching •I can have contests with others •Others can share things with me •My solution tracks my movement •My solution uses sliders

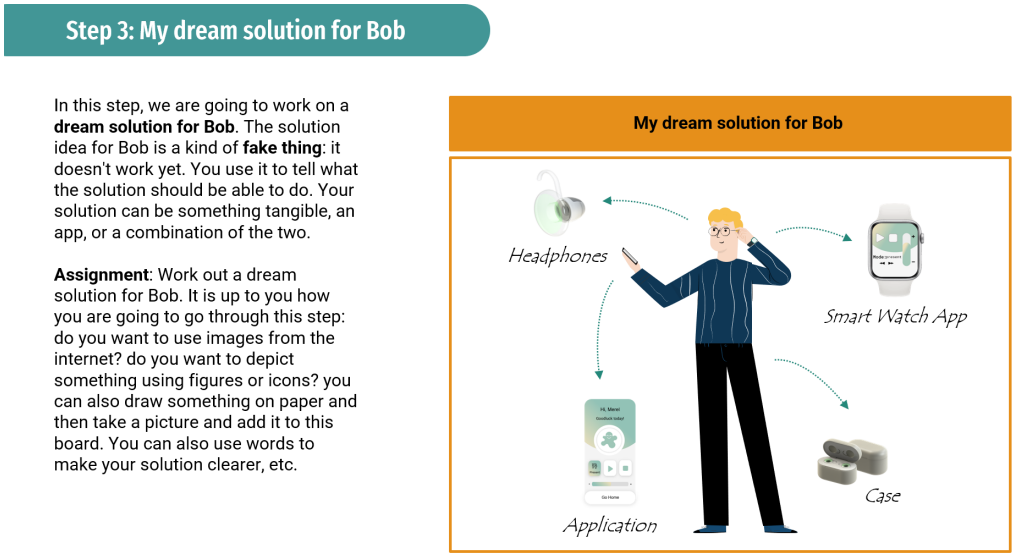
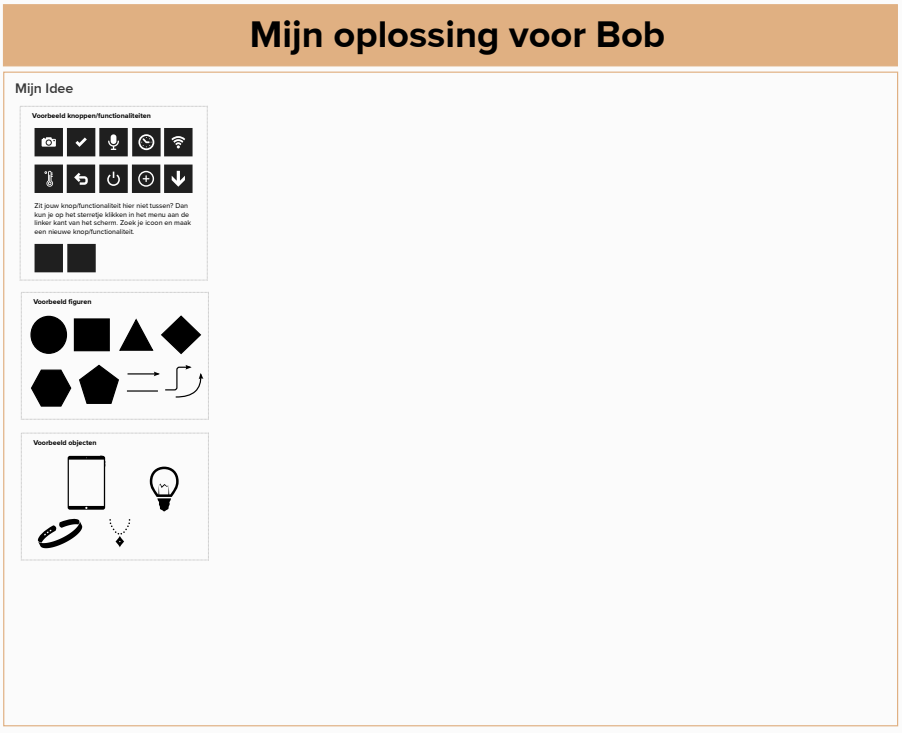


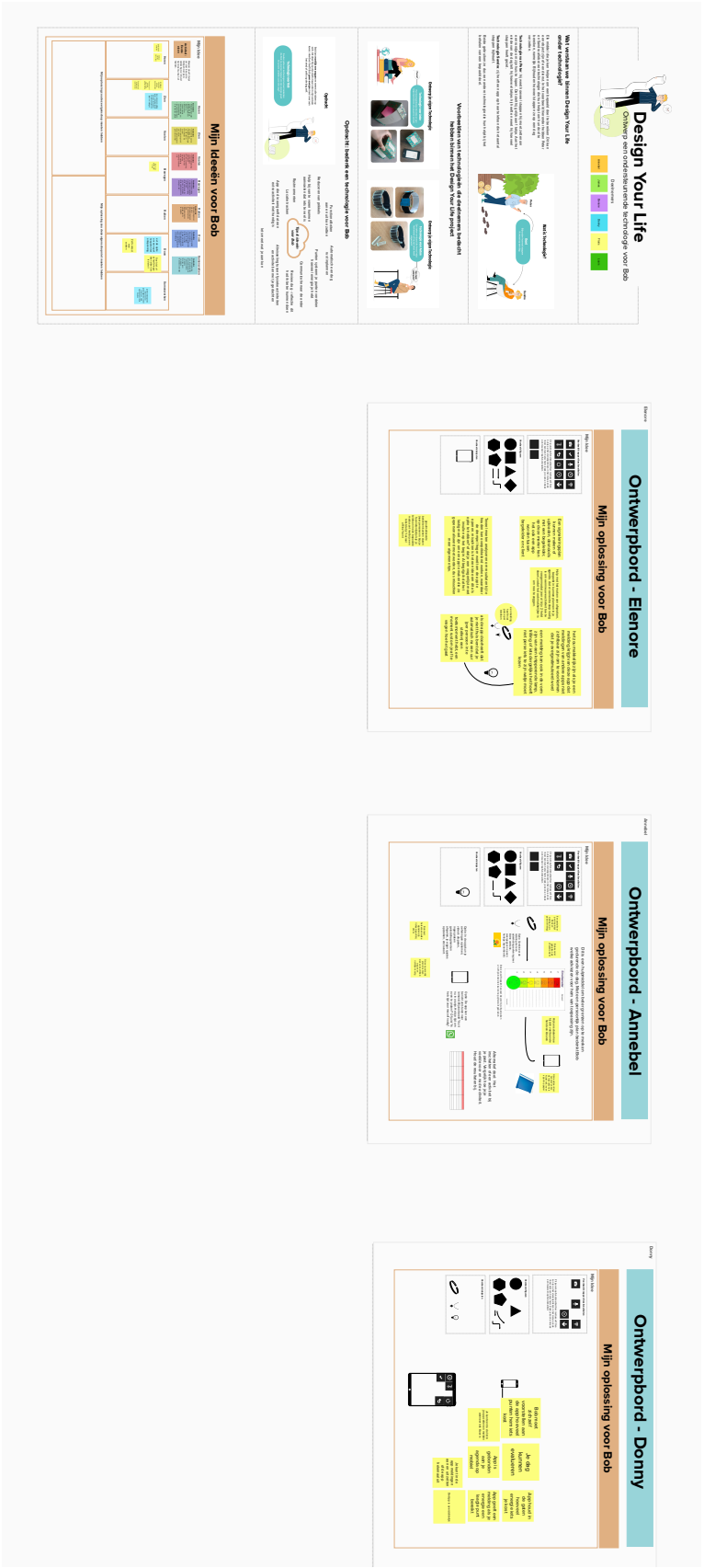
Figure A.6: *Overview of the 3 steps completed during the generative session in the ideation phase. In Step 1, participants brainstormed about possible ideas for Bob's challenge. In Step 2, ideas are thought about what the solution for Bob should or should not be able to do. In step 3 the opportunity is given to design a dream solution for Bob, which is a fake thing and a representation of what the solution should be able to do.*

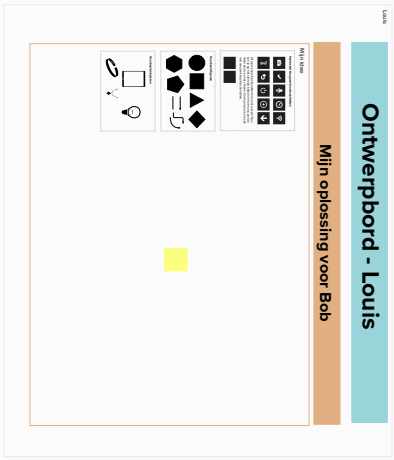
A.5 Appendix E: Mural worksheet Generative Session Ideation Phase

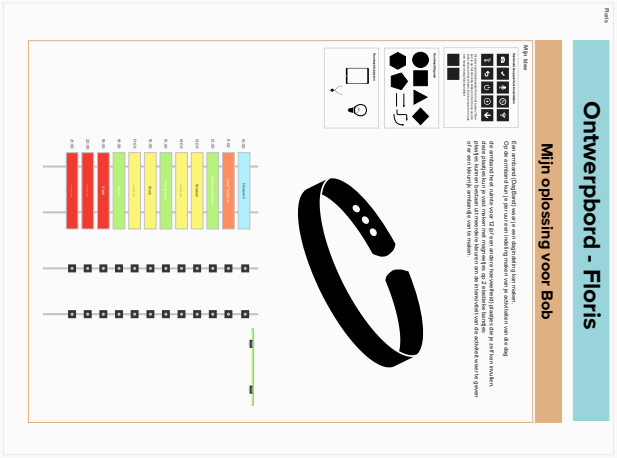

Horen: geluiden die de oplossing kan maken of opnemen
Zien: het uiterlijk van de oplossing en wat de oplossing kan "zien"
Voelen: de materialen in de oplossing en wat de oplossing moet kunnen "voelen"
Bewegen: bewegingen die de oplossing kan maken en bewegingen die je ermee moet kunnen doen
Ruiken: geuren die de oplossing kan hebben
Doen: acties die jij met de oplossing moet kunnen doen
Samenwerken: manieren waarop en dingen waarmee de oplossing samen moet kunnen werken;
Mijn ideeën voor Bob
Mijn Idee
Activiteit: Eerste eisen
Waarom doen? Helpt om snel in kaart te brengen wat jouw oplossing wel of juist niet moet kunnen of hebben.
Horen
Zien
Voelen
Bewegen
Ruiken
Doen
Samenwerken
Mijn oplossing zou deze eigenschap moeten hebben
Mijn oplossing zou deze eigenschap niet moeten hebben

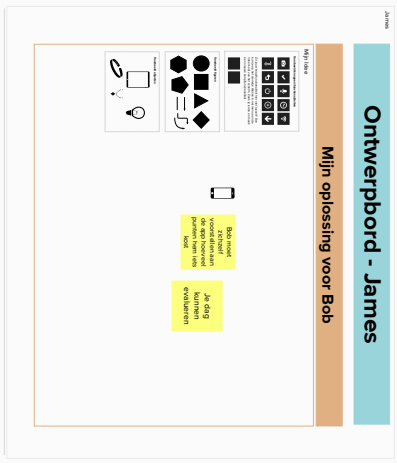

Mijn oplossing voor Bob
Mijn Idee
Voorbeeld knoppen/functionaliteiten
Zit jouw knop/functionaliteit hier niet tussen? Dan kun je op het sterretje klikken in het menu aan de linker kant van het scherm. Zoek je icoon en maak een nieuwe knop/functionaliteit.
Voorbeeld figuren
Voorbeeld objecten

A.6 Appendix E: Overall Mural worksheet Generative Session Ideation Phase




Louis
Ontwerpbord - Louis
Mijn oplossing voor Bob


Floris
Ontwerpbord - Floris
Mijn oplossing voor Bob


James
Ontwerpbord - James
Mijn oplossing voor Bob
Je dag kunnen evalueren

A.7 Appendix F: Procedure Generative sessions Specification phase

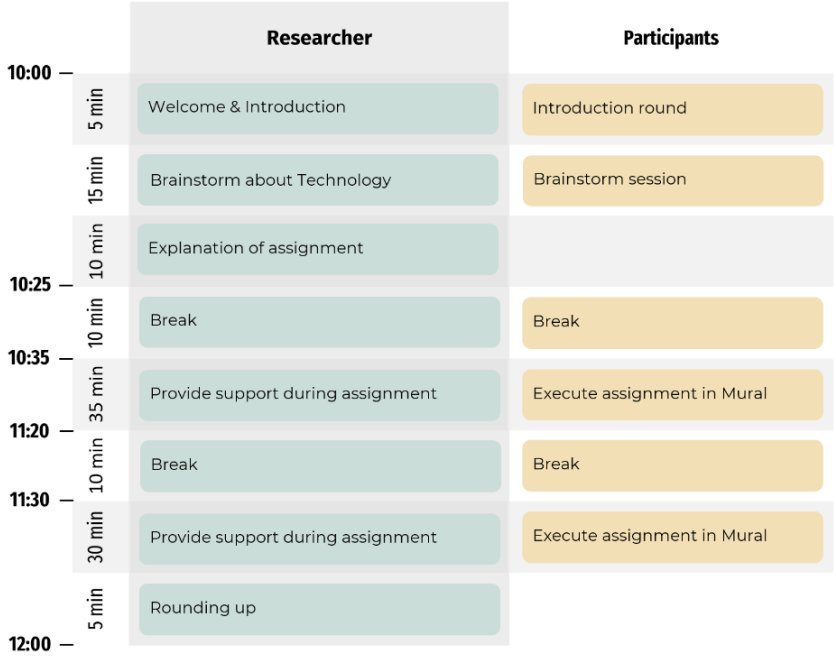


Figure A.7: *An overview of the procedure of the first part of the generative session for the ideation phase.*

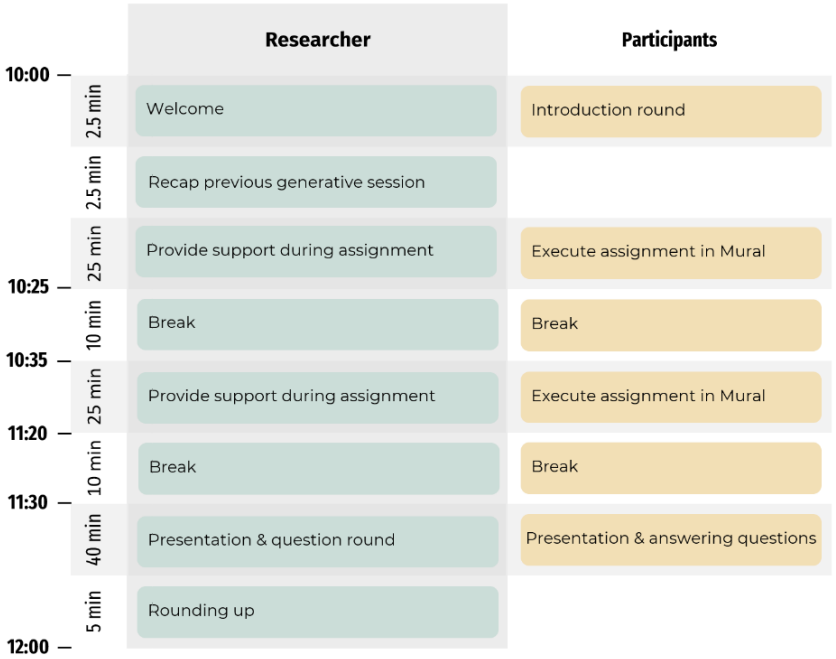


Figure A.8: *An overview of the procedure of the second part of the generative session for the ideation phase.*

A.8 Appendix G: Assignment Generative Session Specification Phase

Step 1: My situation

In this step we will look for a **challenge**. A challenge is a situation that you find annoying, but that you encounter in your life anyway.

You can ask yourself the question: What challenges do I run into in everyday life? To get you started you can start with assignment 1.

Challenge I find it difficult to concentrate.	**Strategy: what I do** I find a quiet place for a while.	**Strategy: what I use** I use something to reduce stimuli.
What distracts you?	In what ways do you seek peace?	Like earplugs or an eye mask. What do you use?

*** The cards are in Mural**

Assignment 1: Choose one challenge card that you feel most comfortable with or write your challenge on a blank card. Add an explanation if necessary.

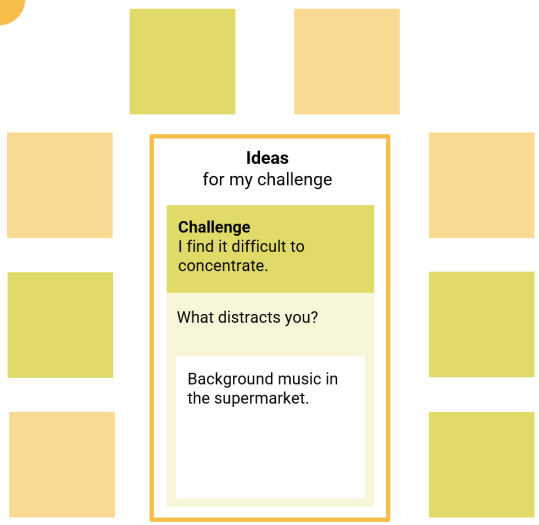
Assignment 2: What do you do to make the challenge you selected less annoying?

Use the **strategies cards**. By using your strategies you will make the challenge less annoying, maybe even fun!

Step 2: Brainstorming

In this step we are going to brainstorm. Try in this step to look at your strategies with your chosen challenge. What are you doing now, and what are you using?

Assignment 1: Ask yourself if your strategies are sufficient for your challenge. Does this solve your problems? What could you improve on? Try to brainstorm about this and write down your ideas around your challenge.



Step 3: My ideas

This step helps to quickly map out what your solution should or should not be able to do or have. Choose at least 5 requirements.

As an aid, there are categories that your requirements can fall under: hear, see, feel, move, smell, do or cooperate.

Assignment 1: Look at the examples and write down your requirements or wishes that your solution should meet.

Hear	**See**	**Feel**
•My solution uses sound •The solution talks to me •I can adjust the volume •Sound turns on at a certain time •I get reminders in the form of sound	•I can see the time on my solution •I get reminders on a screen •All buttons are lit •My solution has a screen •My solution uses text	•I can use my solution without looking •When I use my solution my solution vibrates •My solution does not move at all

Move	**Smell**	**Do**
•I can move my solution easily •I can deform my solution •My solution is nice to fiddle with •My solution can move in such a way that...	•My solution contains an smell •My solution removes unpleasant scents •My solution can spread pleasant scents	•I can give orders by touching •I can have contests with others •Others can share things with me •My solution tracks my movement •My solution uses sliders

Figure A.9: *Overview of the 4 steps completed during the generative session in the specification phase. In step 1 the situation with challenges of the participant is analysed. In Step 2 the challenges and strategies to deal with the challenges that came forward in Step 1 are brainstormed. In Step 3, ideas are thought about what the solution should or should not be able to do. In step 4 the opportunity is given to design their own dream solution, which is a fake thing and a representation of what a solution should be able to do.*

A.9 Appendix H: Mural Worksheet Generative Session Specification Phase

NAME

Design Your Life

Ontwerp je eigen ondersteunende technologie

Stap 1: Mijn situatie

Stap 1: Mijn situatie

In deze activiteit gaan we op zoek naar een **uitdaging**. Een uitdaging is een situatie die je vervelend vindt, maar die je sowieso tegenkomt in je leven.

Je kunt jezelf de vraagstellen: Tegen welke uitdagingen loop ik aan in het dagelijks leven? Om je een beetje op weg te helpen kun je beginnen bij stap 1.

Opdracht 1: Kies één uitdaging kaartje waarin jij je het beste kan vinden of schrijf jouw uitdaging op een leeg kaartje. Voeg eventueel een toelichting toe.

Opdracht 2: Wat doe je om de uitdaging die je hebt geselecteerd minder vervelend te maken?
Gebruik de strategieën kaartjes. Door je strategieën te gebruiken maak je de uitdaging minder vervelend, misschien zelfs leuk!

Opdracht 1: Mijn uitdaging

Opdracht 1: Kies één uitdaging kaartje waarin jij je het beste kan vinden of schrijf jouw uitdaging op een leeg kaartje. Voeg eventueel een toelichting toe.

Mijn uitdaging is:

Ik heb niet genoeg overzicht.
Van afspraken of taken, maar misschien ook van spullen of informatie. Wat is jouw uitdaging?

Ik vind het vervelend om anderen om hulp te vragen.
Waarom vind je om hulp vragen vervelend? Waar wil je graag hulp mee?

Ik raak makkelijk iets kwijt.
Wat raak je makkelijk kwijt? Waarom raak je dit makkelijk kwijt?

Ik wil graag iets op een andere manier doen.
Wat raak je makkelijk kwijt? Waarom raak je dit makkelijk kwijt?

Ik vind het moeilijk om mij te concentreren.
Wat leidt jou af?

Ik wil graag minder tijd besteden aan een bepaalde activiteit.
Zoals kluisjes of door social media scrollen. Waar wil jij minder tijd aan besteden?

Ik wil graag dat mensen mij beter snappen.
Wat snappen mensen vaak niet goed?

Ik vind een situatie of ding spannend.
Wat vind jij spannend? Waar zou je graag meer over willen weten?

Ik vergeet vaak afspraken of taken.
Misschien omdat je geen fijn overzicht hebt of je herinneringen mist. Wat is jouw uitdaging?

Zelf invullen..
Toelichting:

Opdracht 2: Mijn strategie

Opdracht 2: Wat doe je om de uitdaging die je hebt geselecteerd minder vervelend te maken? Gebruik de strategieën kaartjes. Door je strategieën te gebruiken maak je de uitdaging minder vervelend, misschien zelfs leuk!

Mijn strategie (wat ik doe) is:

Mijn strategie (wat ik gebruik) is:

Strategie: wat ik doe
Ik zoek meer informatie over de uitdaging op.
Zoals door vragen te stellen aan iemand met meer ervaring. Waar vind jij informatie?

Strategie: wat ik doe
Ik vraag iemand anders om de uitdaging op te lossen.
Zoals een kleermaker vragen om een broek in te korten. Wie neemt de uitdaging over? Hoe doen zij dit?

Strategie: wat ik doe
Ik zoek even een rustige plek op.
Op welke manier zoek jij rust op?

Strategie: wat ik doe
Ik combineer de uitdaging met iets leuks.
Bijvoorbeeld door strijken met tv kijken combineren. Waar combineer jij je uitdaging mee?

Strategie: wat ik doe
Ik vraag iemand om hulp bij de uitdaging.
Aan wie vraag je hulp? En op welke manier vraag je dit?

Strategie: wat ik doe
Ik beloon mezelf.
Waar beloon jij jezelf mee? Wanneer beloon jij jezelf?

Strategie: wat ik doe
Zelf invullen...
Toelichting:

Strategie: wat ik gebruik
Ik gebruik iets om prikkels te verminderen.
Zoals oordopjes of een oogmasker. Wat gebruik jij?

Strategie: wat ik gebruik
Ik gebruik iets om mij te helpen concentreren
Zoals een koptelefoon of app die bepaalde apps toegankelijk maakt als ik werk. Wat gebruik jij?

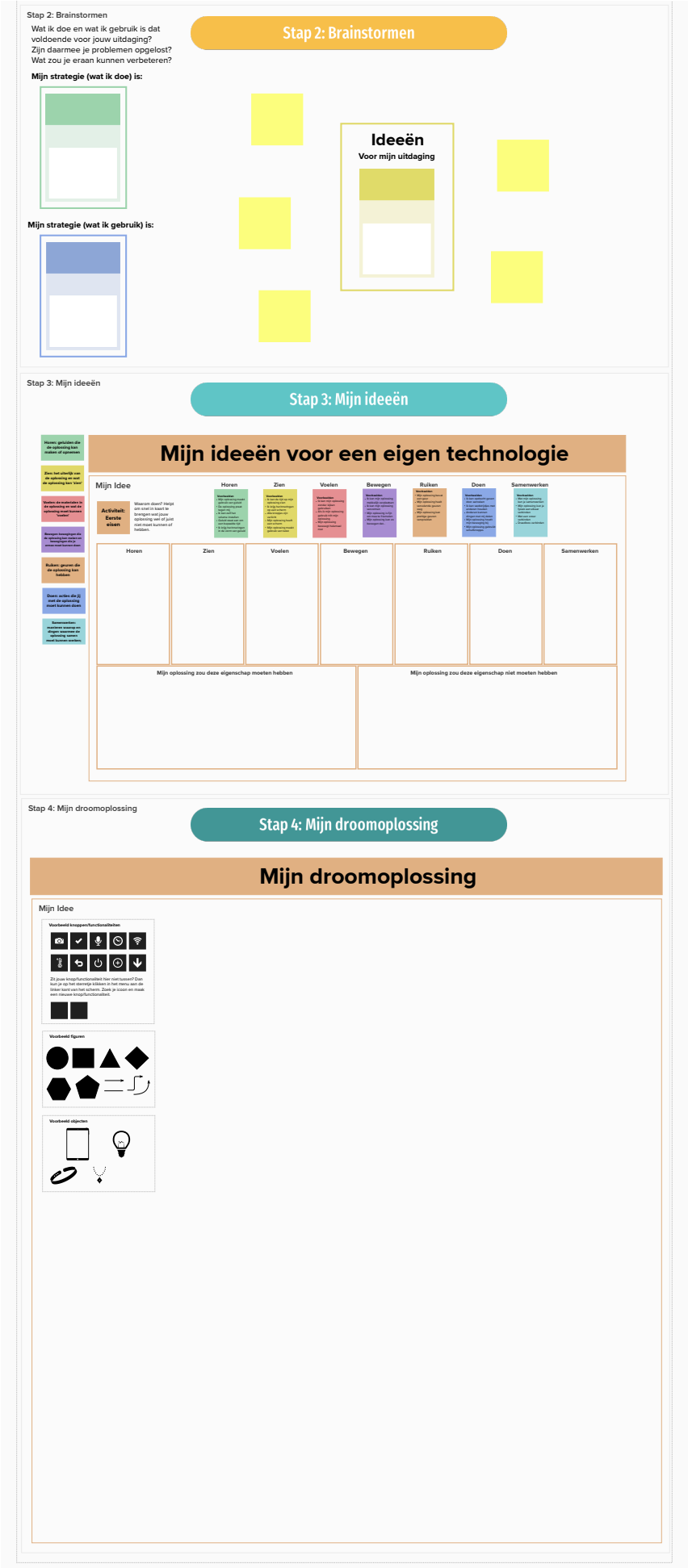
Strategie: wat ik gebruik
Ik gebruik iets om mij overzicht te geven.
Zoals een weekschema of een boodschappenlijst. Wat gebruik jij?

Strategie: wat ik gebruik
Ik gebruik herinneringen om taken niet te vergeten.
Zoals notificaties op je telefoon of memoblaadjes op je bureau. Wat gebruik jij?

Strategie: wat ik gebruik
Ik gebruik iets om mij in contact te blijven met mensen om mij heen.
Zoals kaarten die je op de post doet of een berichten-app. Wat gebruik jij?

Strategie: wat ik gebruik
Ik gebruik iets om de uitdaging voor mij op te lossen
Zoals een stofzuigerrobot om het stofzuigen over te nemen. Wat gebruik jij?

Strategie: wat ik gebruik
Zelf invullen...
Toelichting:


Stap 2: Brainstormen
Wat ik doe en wat ik gebruik is dat voldoende voor jouw uitdaging?
Zijn daarmee je problemen opgelost?
Wat zou je eraan kunnen verbeteren?
Stap 2: Brainstormen
Mijn strategie (wat ik doe) is:
Ideeën
Voor mijn uitdaging
Mijn strategie (wat ik gebruik) is:
Stap 3: Mijn ideeën
Stap 3: Mijn ideeën
Mijn ideeën voor een eigen technologie
Mijn Idee
Activiteit: Eerste eisen
Horen
Zien
Voelen
Bewegen
Ruiken
Doen
Samenwerken
Mijn oplossing zou deze eigenschap moeten hebben
Mijn oplossing zou deze eigenschap niet moeten hebben
Stap 4: Mijn droomoplossing
Stap 4: Mijn droomoplossing
Mijn droomoplossing
Mijn Idee
Voorbeeld knoppen/functionaliteiten
Voorbeeld figuren
Voorbeeld objecten

A.10 Appendix I: Results Generative Session Ideation Phase

Participant 1 - Elenore

Figure A.10: *The result of Elenore's elaboration*

Participant 2 - James

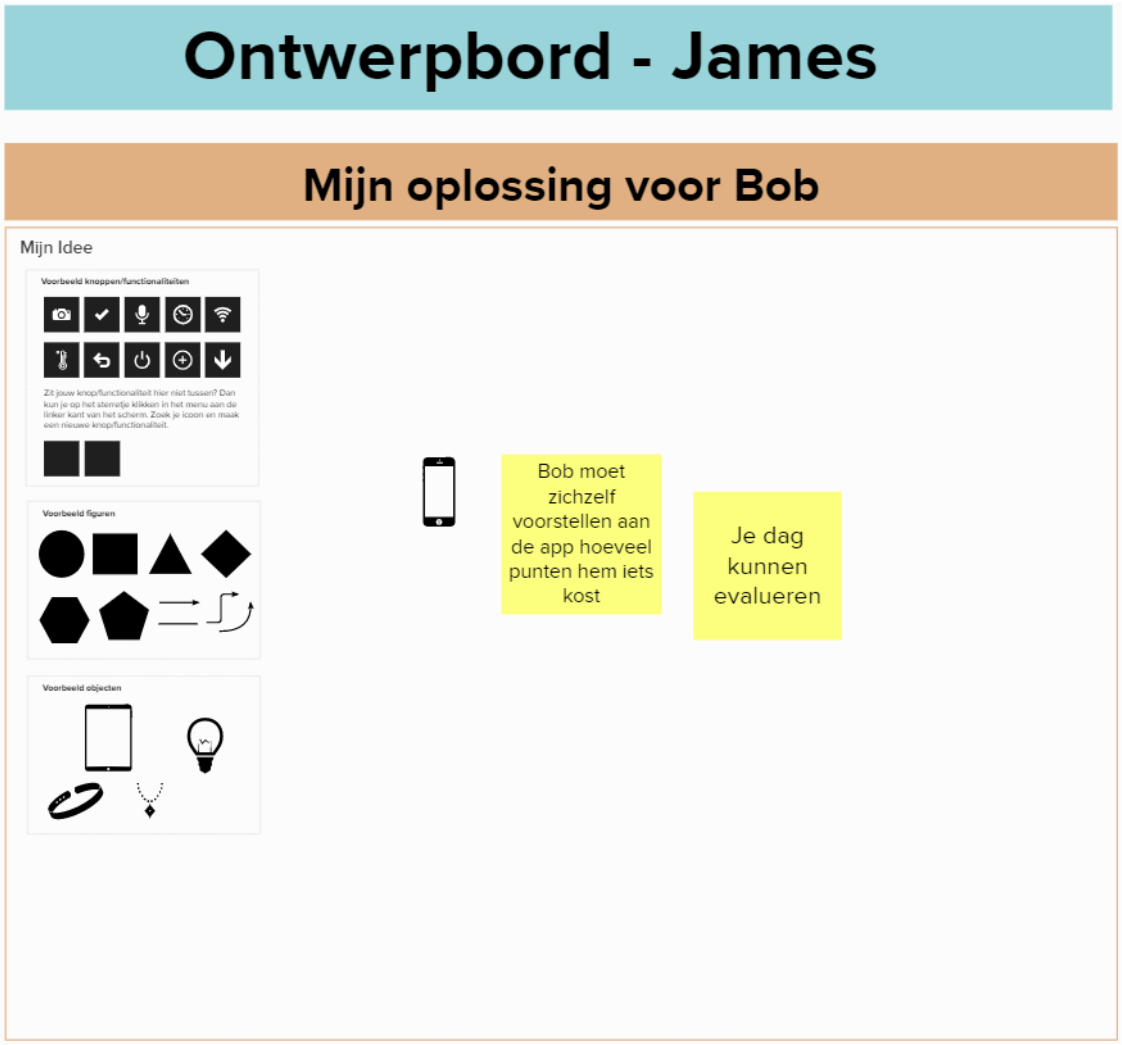


Figure A.11: *The result of James's elaboration*

Participant 3 - Annebel

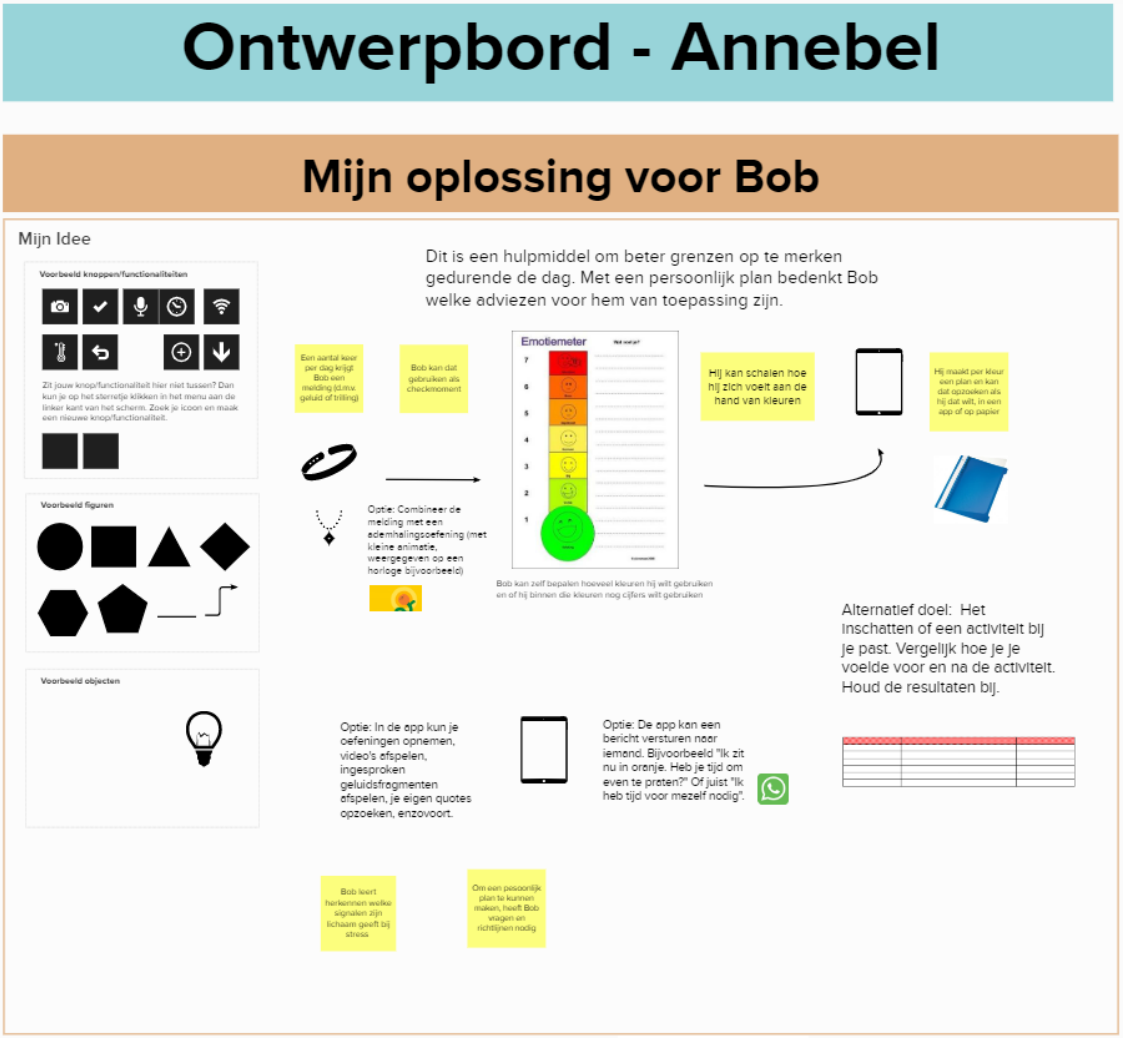


Figure A.12: *The result of Annebel's elaboration*

Participant 4 - Donny

Figure A.13: *The result of Donny's elaboration*

Participant 5 - Floris

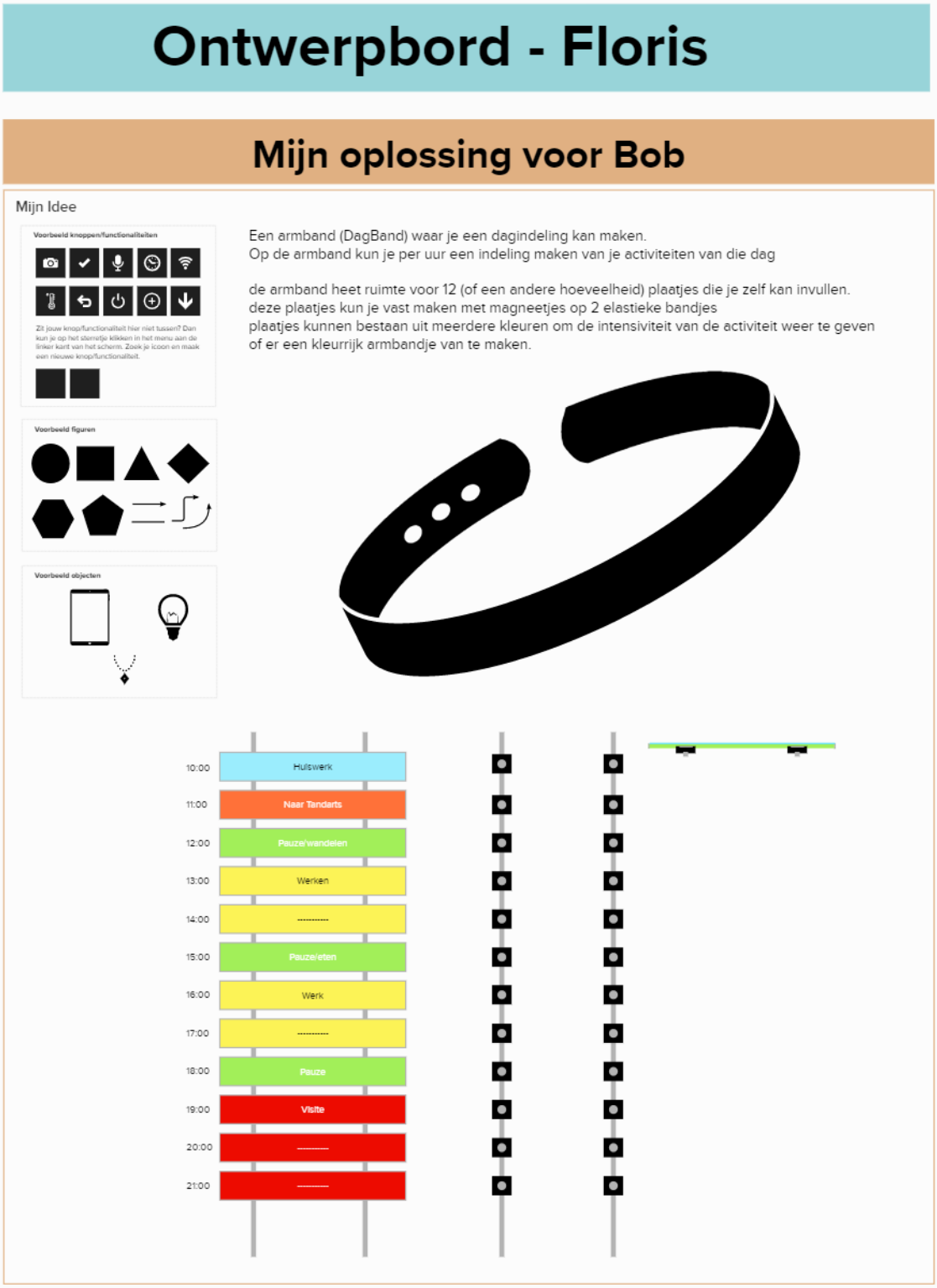


Figure A.14: *The result of Floris's elaboration*

Participant 6 - Louis

Figure A.15: *The result of Louis's elaboration*

A.11 Appendix J: Results Generative Session Specification Phase

Participant 1 - Elenore

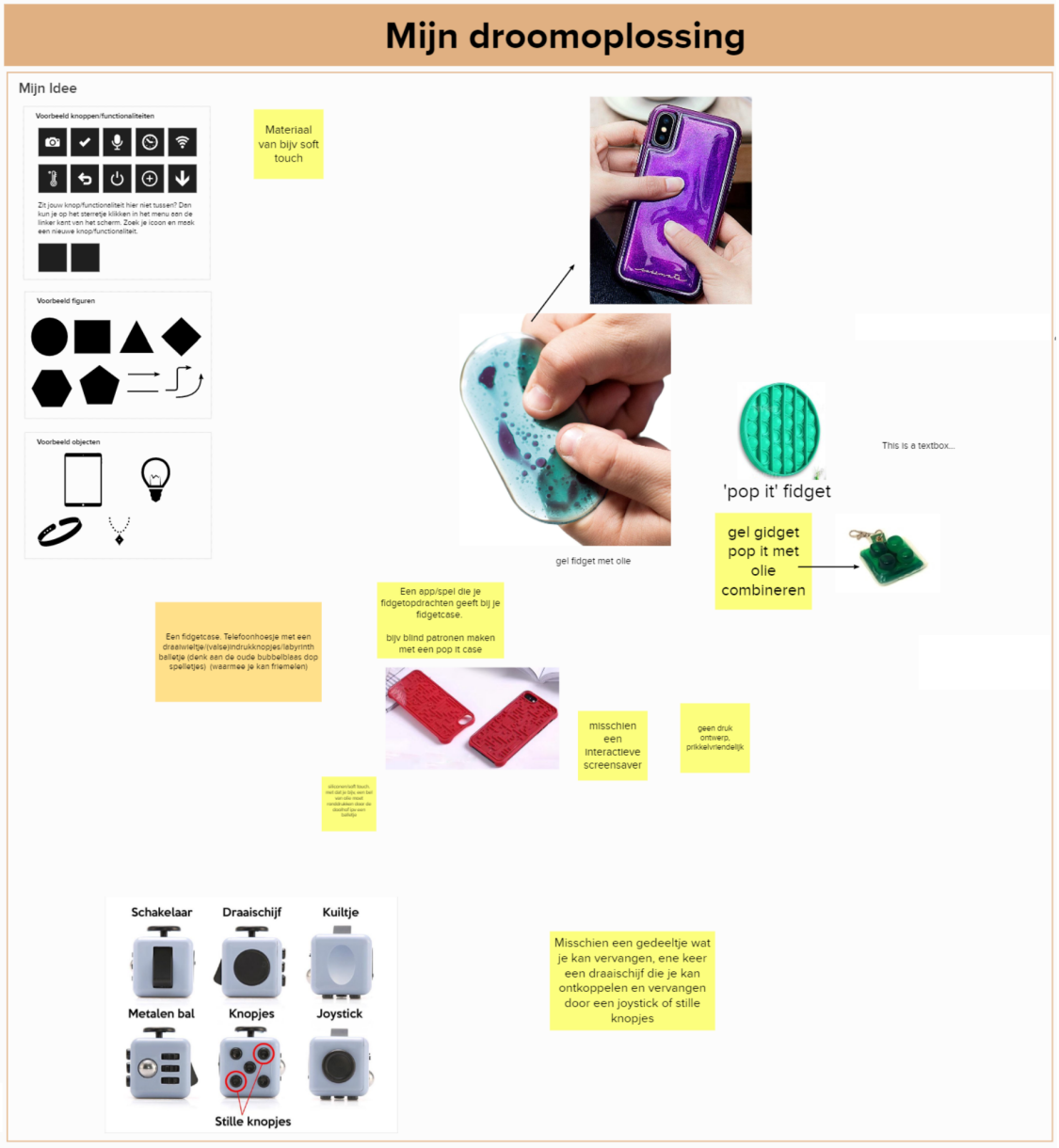


Figure A.16: *The result of Elenore's elaboration*

Participant 2 - James

Figure A.17: *The result of James's elaboration*

Participant 3 - Annebel

Figure A.18: *The result of Annebel's elaboration*

Participant 4 - Donny

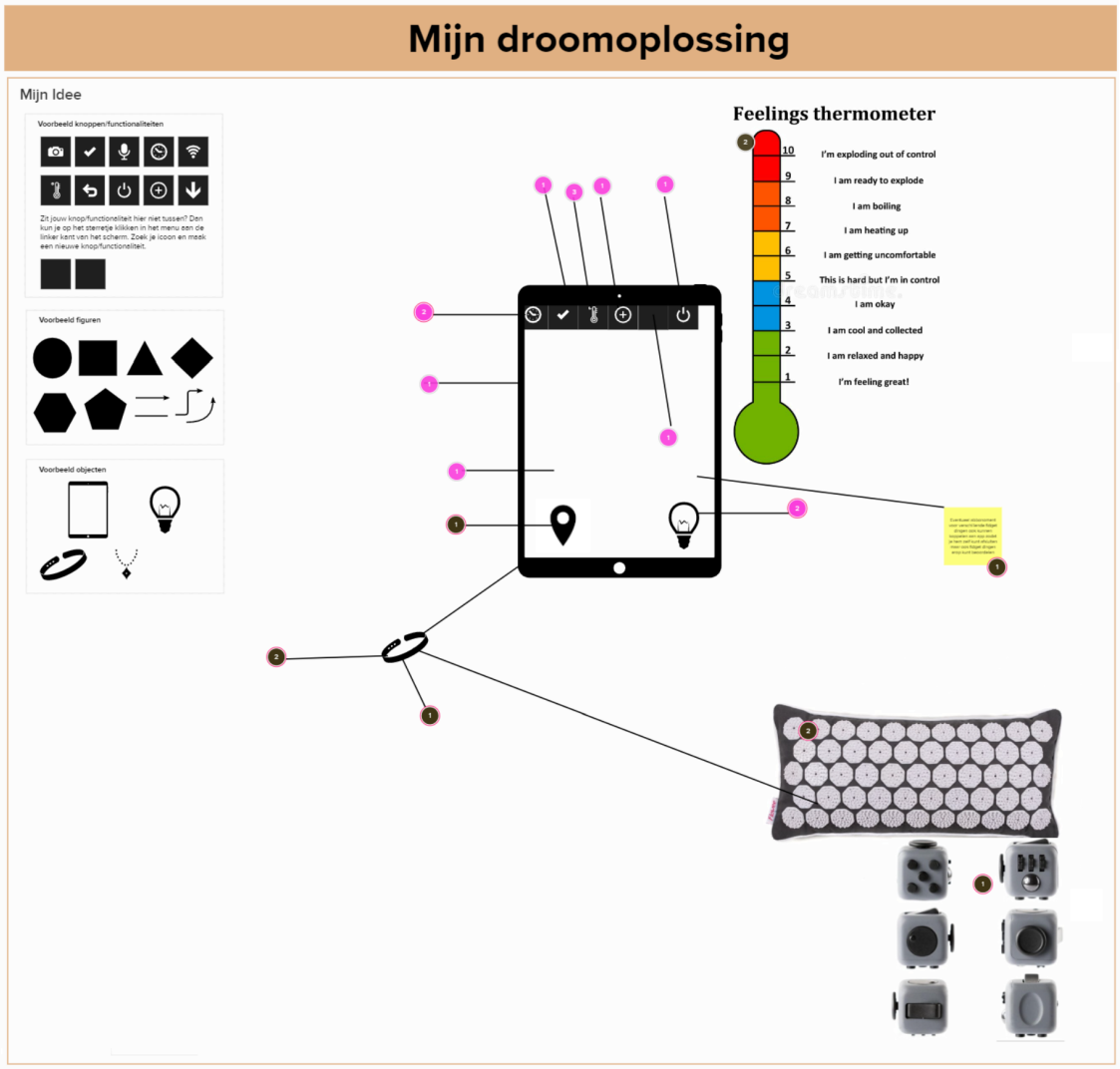


Figure A.19: *The result of Donny's elaboration*

Participant 5 - Floris

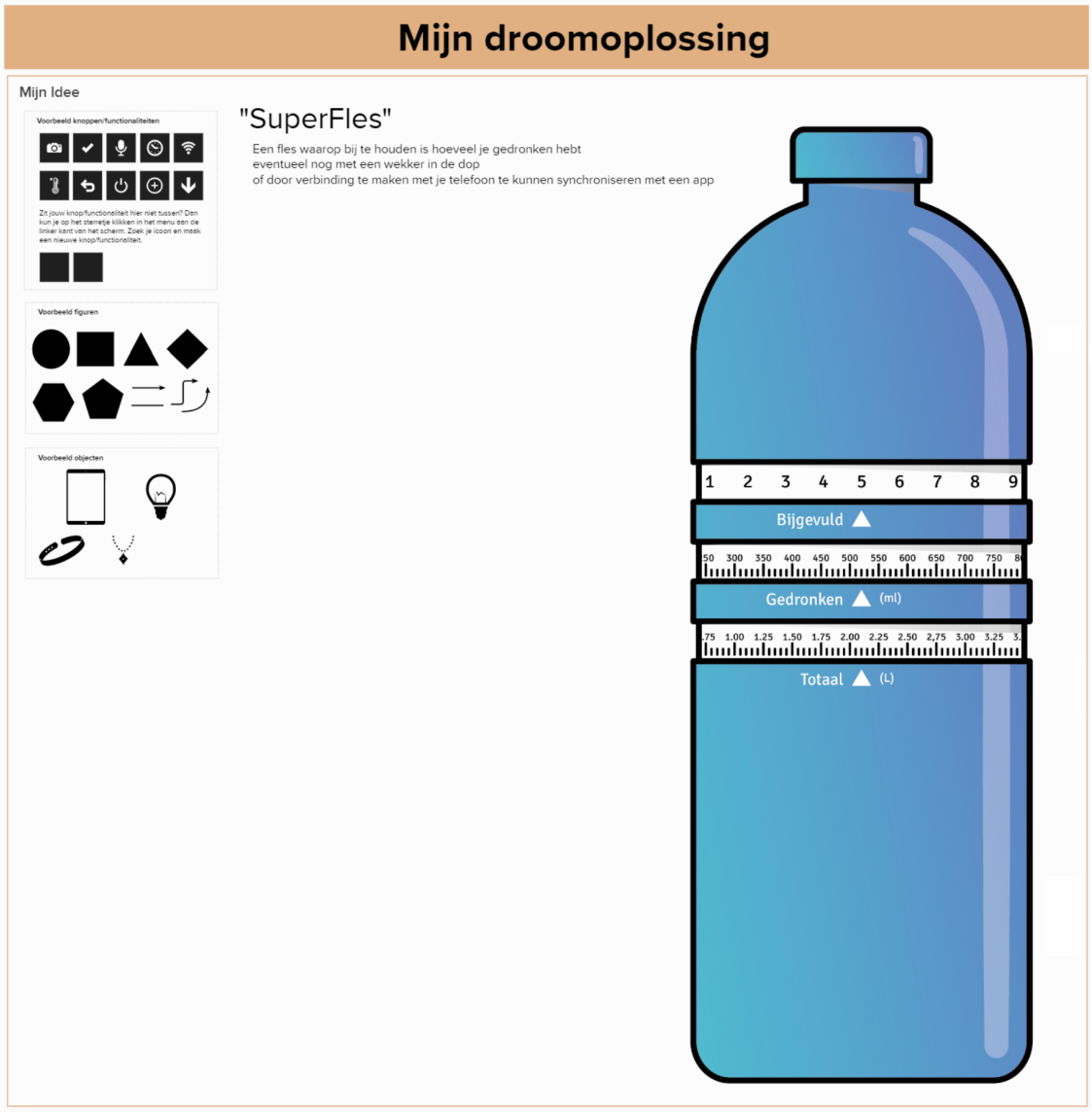


Figure A.20: *The result of Floris's elaboration*

Participant 6 - Louis

Figure A.21: *The result of Louis's elaboration*

A.12 Appendix K: Procedure Focus Group Evaluation Phase

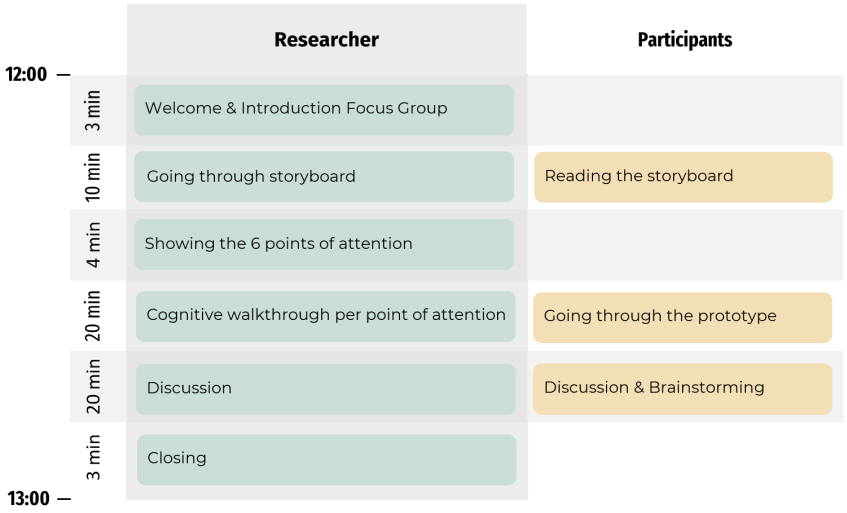


Figure A.22: *An overview of the procedure of the focus group for the evaluation phase.*

A.13 Appendix L: Storyboard for Evaluation Phase

Figure A.23: *Storyboard for the evaluation phase. This story is about a fictional person who wants to come up with a solution to his problem. In his path to the solution, he encounters problems while working with the first version of the digital toolkit.*

A.14 Appendix M: Prototyping Results

This Appendix includes visual representations of the requirements incorporated into the digital toolkit prototype.

A.14.1 Assignment - Sketching

Mijn ideeën: **Schetsen**

Waarom doen? Met deze activiteit werk je je ideeën op papier uit. Hiermee leg je je ideeën vast en kan je het met je medeontwerper bespreken. Dit doe je door het te schetsen. Als dat helpt, kan je ook bij je schetsen schrijven.

Duur: 20 minuten

Einde van de activiteit: Aan het eind van deze activiteit heb je een uitwerking van één of meerdere ideeën in de vorm van schetsen en eventueel geschreven tekst.

A

Voorbereiden

1. Verzamel de materialen die je nodig hebt. Deze materialen zijn:
   - Het **schetsen-canvas;**
   - Optioneel: een tekenprogramma.
2. Bekijk het schetsen-canvas. Je ziet twee verschillende schets vakken: leeg of met stippen. Je bepaalt zelf welk type schets vak je wilt gebruiken en hoe veel ideeën je uitwerkt.

Uitvoeren

1. Schets je ideeën. Het is niet belangrijk of het mooi is of niet.
   - **Tip!** Je kan ook plaatjes op internet zoeken en deze toevoegen. Of je tekent iets over.
2. Bepaal of het nuttig is om ook een beschrijving met tekst te geven.

B

Je mag zelf bepalen hoe jij graag je idee wilt uitwerken. Maak je normaal gesproken gebruik van tekenprogramma's of andere programma's om ideeën uit te werken? Dan mag je deze ook gebruiken. Het is wel belangrijk om je uitwerking aan je digitale toolkit toe te voegen. Plaats je uitwerking in het schetsen-canvas.

Je kunt de uitwerking toevoegen als **afbeelding** of uploaden als **document**. Je kunt de volgende bestandstypes uploaden: DOC / Word, XLS / Excel PPT / PowerPoint, PDF, ZIP of RAR.

Afbeelding 1

Afbeelding 2

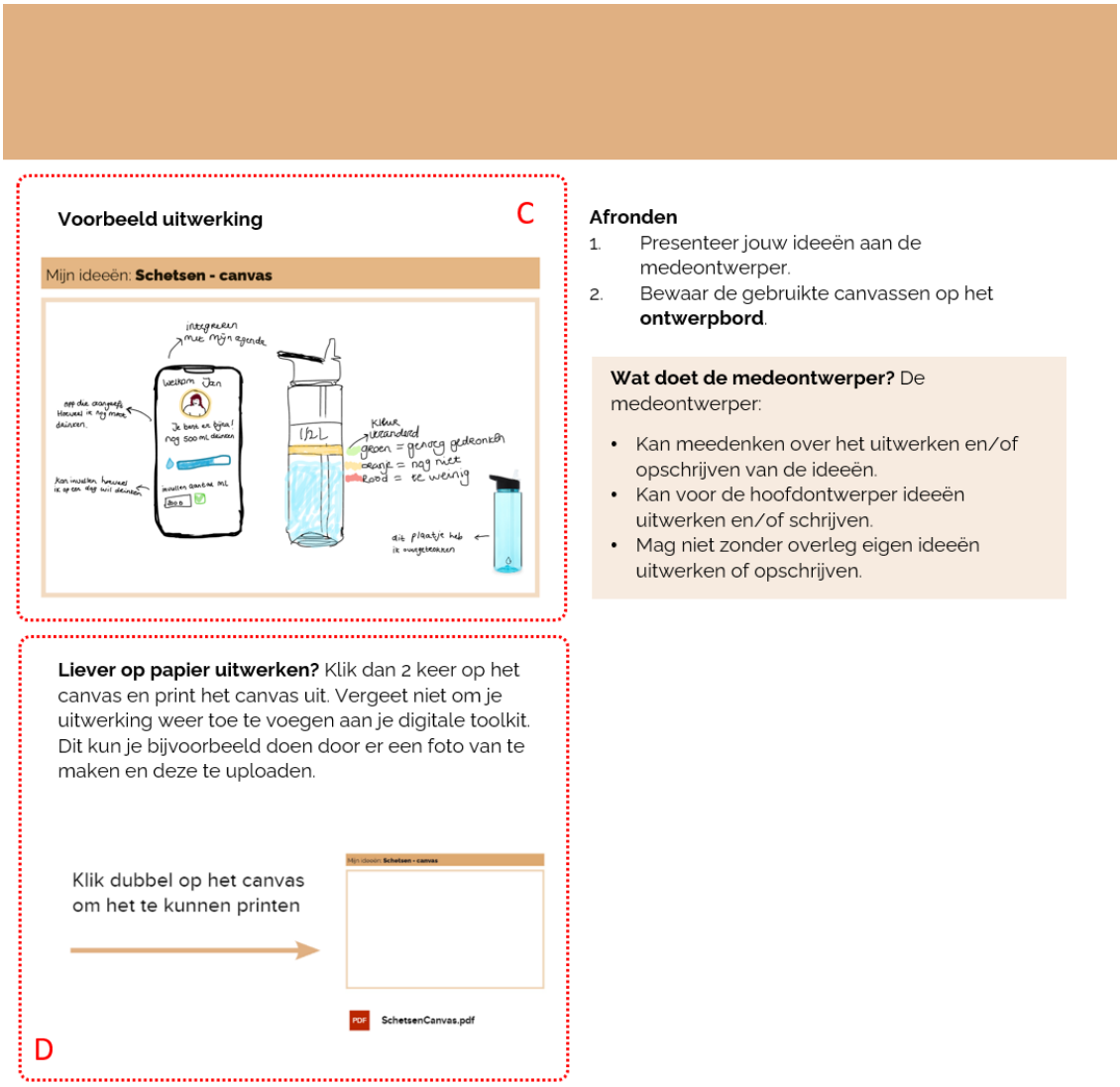


Figure A.24: *An overview of the activity "sketches" from phase 3 "My Ideas". In the overview, you can see by means of the red dotted lines and the red letters A, B, C, and D which adjustments have been made to make the assignment compatible within the digital environment.*

A.14.2 Assignment - Build my dream solution

Mijn ideeën: **Mijn droomoplossing bouwen**

Waarom doen? In deze activiteit bouw je een representatie van jouw ideale oplossing: de droomoplossing. Dit is nog geen werkende oplossing, maar het vertelt en visualiseert hoe jouw oplossing eruit kan gaan zien en wat het moet kunnen doen.

Duur: 40 minuten

Einde van de activiteit: Aan het einde van deze activiteit heb je door een eigen gekozen manier jouw ideale oplossing gebouwd. Aan de hand hiervan heb je minimaal drie eisen waaraan jouw oplossing moet voldoen opgeschreven.

Voorbereiden

1. Verzamel de materialen die je nodig hebt. Deze materialen zijn:
   - Het **droomoplossing-canvas**;
   - Eventueel een programma waarmee je jouw representatie van je droomoplossing in kan uitwerken;
   - Eventueel eigen bouw- en knutselmaterialen, zoals lego, klei, oude verpakkingen, keukenrolletjes, etc.;
   - Eventueel eigen toevoegingen die je wilt verwerken in jouw droomoplossing.
2. Bekijk het droomoplossing-canvas alvast. Hierop geef je aan het einde van deze activiteit de naam, omschrijving en een afbeelding van jouw droomoplossing.
3. Bepaal op welke manier jij jouw droomoplossing wilt bouwen. Je kunt dit namelijk op verschillende manieren uitvoeren. Bijvoorbeeld:

A

Digitaal C

Maak je droomoplossing digitaal, door bijvoorbeeld een programma te gebruiken waarmee jij denkt dat je een representatie kan bouwen van je droomoplossing. Zie afbeelding 1 als voorbeeld van een droomoplossing die digitaal is uitgewerkt. Klik in je outline op '3. voorbeeld droomoplossing: digitaal' als je het voorbeeld groter wil zien.

Afbeelding 1

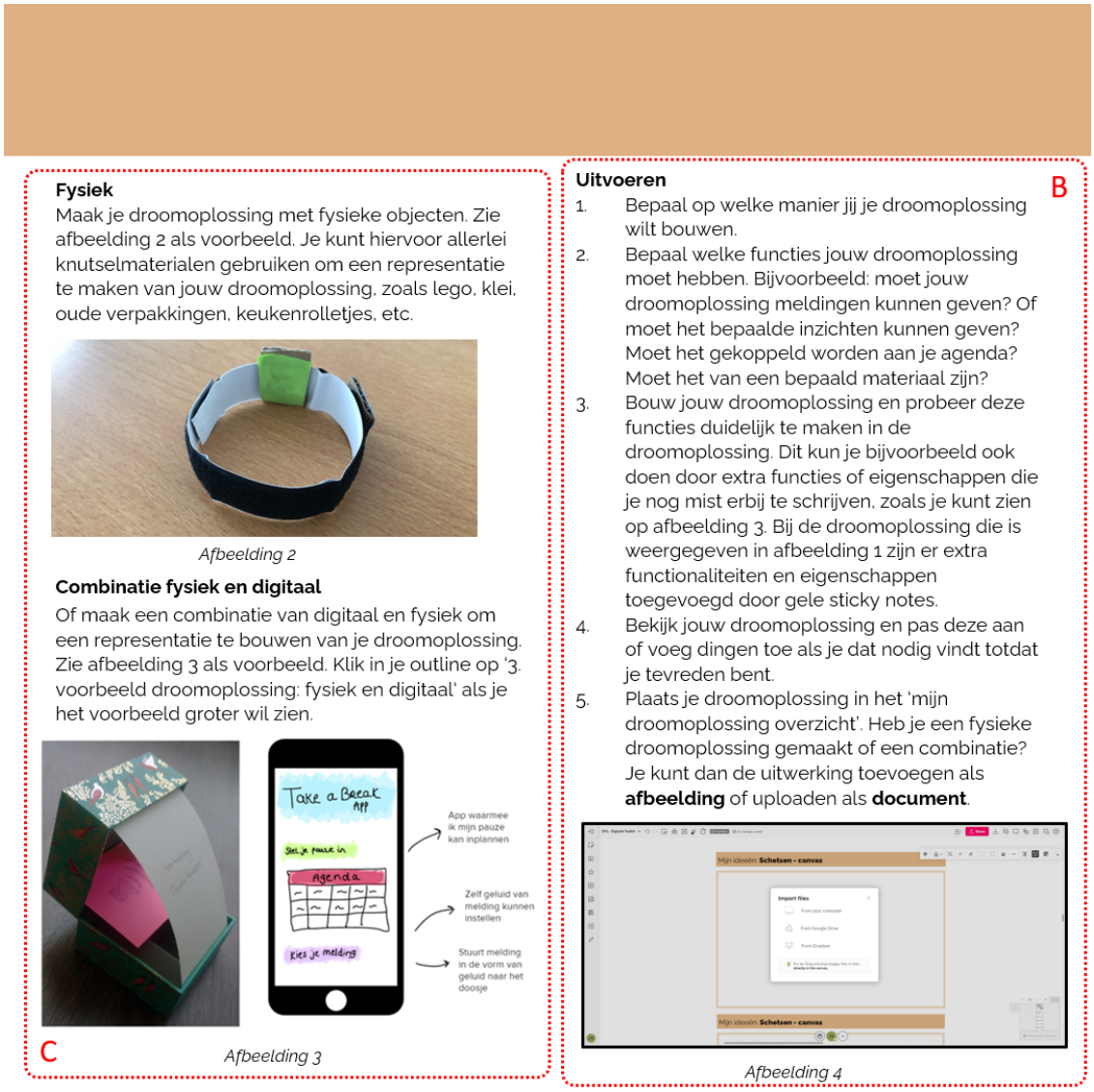


Figure A.25: *An overview of the activity "build my dream solution" from phase 3 "My Ideas". In the overview, you can see by means of the red dotted lines and the red letters A, B, and C which adjustments have been made to make the assignment compatible within the digital environment.*

A.14.3 Tutorial

The tutorial was created using a script. This script consists of the following parts: (1) what can YAA expect from the tutorial, (2) what can YAA do with the digital toolkit? (purpose), (3) how can YAA work with it, and (4) what are the possibilities? The details of exactly what these parts entail are as follows:

1. Small introduction to what YAA can learn from the tutorial. Using three structured steps.
2. The purpose of the digital toolkit with an example of someone running into a problem and using the digital toolkit to come up with a solution to it. In it, the DYL phases are shown with examples of what can come out of the "my ideas" and "my solution" phases.

3. The functionalities in Mural are explained which are necessary to perform the assignments. In addition, how the Mural can be shared and how a person can ensure their privacy from the content in the Mural is also explained. Finally, navigating the digital toolkit is explained (the outline).
4. The Mural app is discussed.

The tutorial has been added as a YouTube video to the digital toolkit and can only be seen by people who have the following link: `https://youtu.be/lgm1M6osGQA`.

Figure A.26: *Thumbnail of the tutorial for using the DYL digital toolkit prototype. The tutorial can be found through the following link:* `https://youtu.be/lgm1M6osGQA`.

A.14.4 Privacy

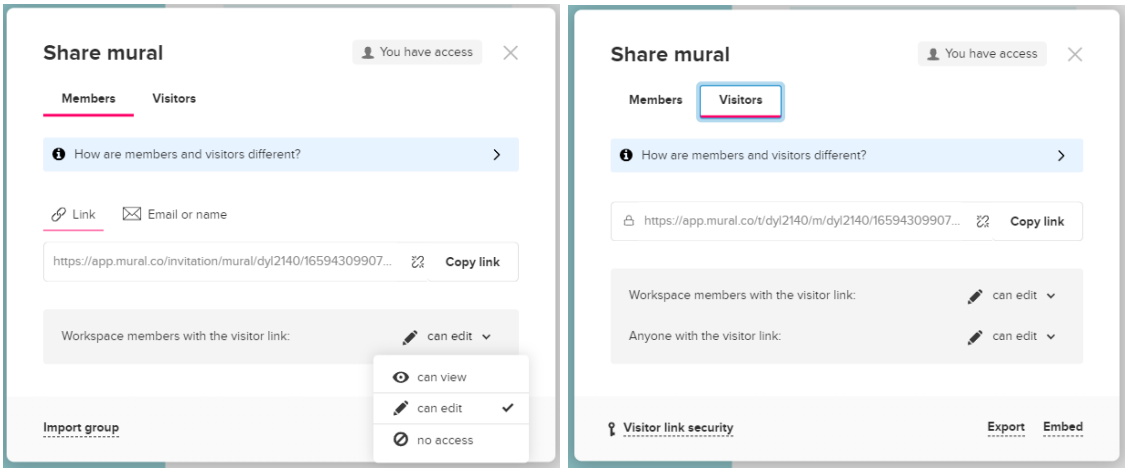


Figure A.27: *Overview of the privacy functionality of Mural. On the left is shown that different roles can be assigned. On the right is shown that the link can be copied with which the Mural can be shared.*

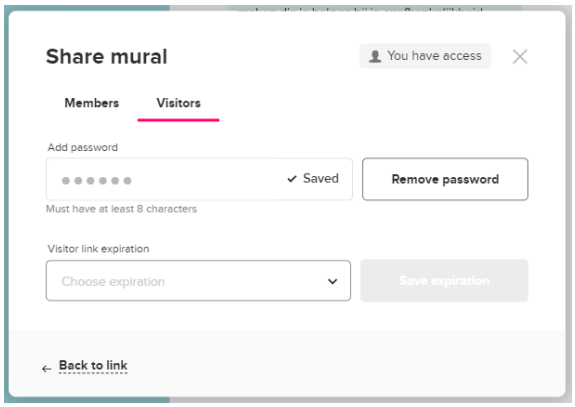


Figure A.28: *Overview of the privacy functionality of Mural - setting password.*

A.14.5 Mural App

Mobile:

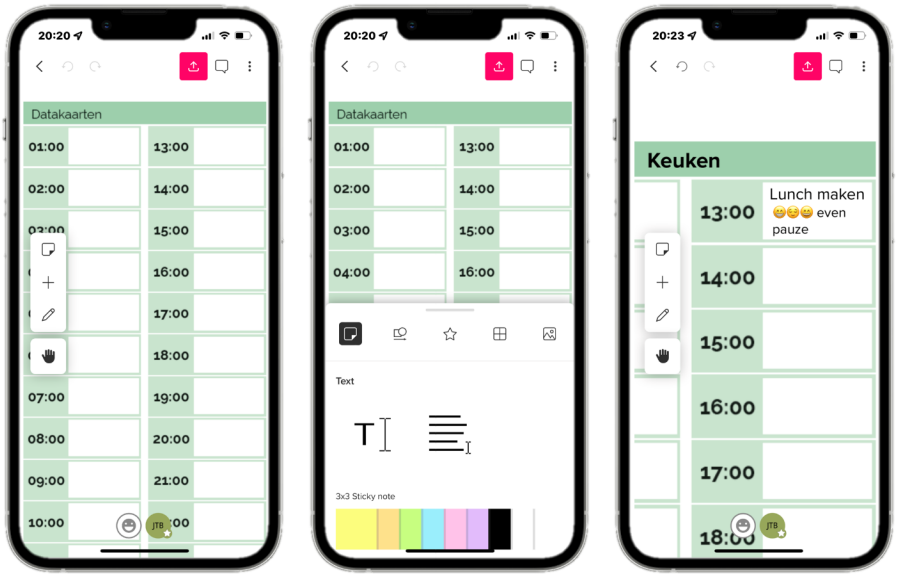


Figure A.29: *DYL activities can be performed on the mobile app.*

Tablet:

Figure A.30: *Tablet proof - DYL activities can be performed on a tablet using the Mural app.*

A.14.6 Outline

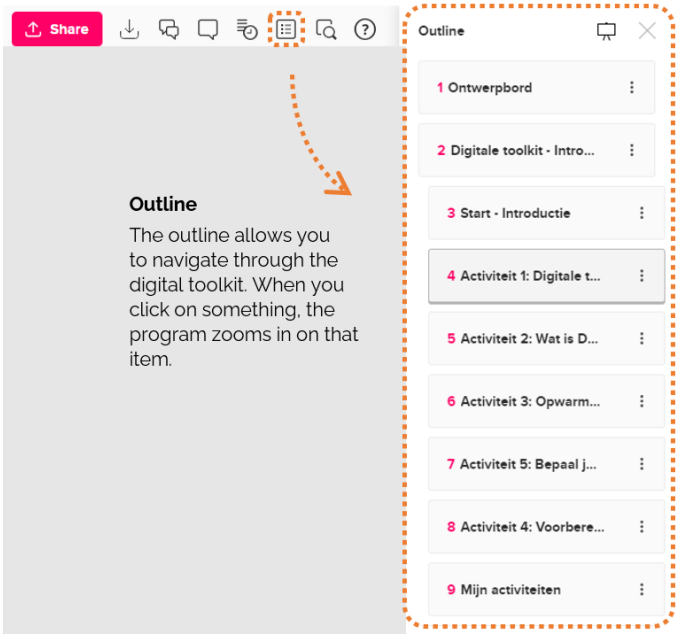


Figure A.31: *Overview of the solution - Outline.*