Summary

Flere studerende med en funktionsnedsættelse trives ikke på deres uddannelse og ender med at droppe ud, fordi de ikke føler, at de studerer på lige fod med deres medstuderende. Mange ved slet ikke, at de kan få hjælp eller hvilken slags hjælp de kan få. Dette speciale er en udforskning, af hvordan en applikation kan hjælpe denne gruppe igennem deres studie. På trods af at de studerende med en funktionsnedsættelse er forskellige, har de stadig problemer på samme områder relateret til studiet. DCUM har lavet en vejledning til vejledere og administrativt personale på uddannelsesinstitutionerne med fokus på studerende med fysisk eller kognitiv handicap. I den forbindelse har vi udviklet en applikation, der skal være støtteværktøj til både studerende og ansatte på institutionerne. Applikationen samler alt relevant information, således at den studerende ikke selv skal opsøge viden flere steder.

Forskning viser, at der endnu ikke er fastsat designprincipper for udvikling af applikationer til gruppen af brugere, der har en funktionsnedsættelse. I denne artikel har vi, gennem interviews og participatory design, udformet designregler, som er blevet anvendt under udvikling af prototypen af applikationen. To studerende med ADHD blev interviewet med formålet om at diskutere 8 udvalgte studierelevante hjælpe-applikationer og deres design. Derudover blev den ene deltager involveret i designfasen, hvor han bidrog med ideer og forslag til applikationens udformning. Ydermere blev prototypen testet af 4 studerende via interviews, hvor applikationens design og funktionalitet blev diskuteret. Resultatet af testen viser, at de studerende med en kognitiv funktionsnedsættelse har en interesse i at sådan en applikation blev udviklet.

Vores bidrag består af en række designregler specifikt rettet mod brugere med funktionsnedsættelser. Ydermere leverer vi en prototype af en applikation, der fungerer som information- og kommunikationskanal mellem underviser og elev. Vi bidrager desuden med kendsgerninger omkring, hvordan der netop er mangel på mere oplysning om muligheder for hjælp for den enkelte studerende, og foreslår specifikke ideer til at imødekomme dette.

AALBORG UNIVERSITY

Disability must not be an Obstacle
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Disability must not be an obstacle to pursuing one's dreams

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Abstract

Many students in higher education with a neurological disorder in Denmark tend to drop out of school. Most often not due to their scholastics but lack of mere planning, structure and understanding from teachers. In Denmark you can get help for free professionally but many do not know this is an option. This article explores how it is possible to design an application for students with cognitive disabilities in higher education in order to prevent them from dropping out. To inform the design, interviews of students with ADHD were performed, and a set of design rules and a prototype application was developed through participatory design. The prototype was subsequently evaluated. The key results show that designing for people with cognitive impaired people is difficult due to differences in the individuals, but the design rules show to be of great importance.

In conclusion the students with cognitive difficulties can see the relevance of the application and how it would benefit them in their academic life. The design of the application also plays a big part in if the students would use the application. Although further development and test is still needed.

Keywords: disabilities; cognitive difficulties; participatory design; smartphone application; SPS; design criteria

INTRODUCTION

Many students with cognitive difficulties do not thrive and do not complete their education. According to the Danish parliament, everyone has the right to an education. However, there are generally fewer young people with a disability, than without, who start or complete a higher education. The Danish parliament has focused on the need for help to provide extra support for young people who have a disability in relation to starting and completing an education. In relation to this, the Danish parliament clearly states that the entire education system must be able to accommodate that not all young people have the same prerequisites, as some struggle with both physical and cognitive difficulties (Børne- og Undervisningsministeriet, 2021).

Danish young people must have the best opportunities for education and this also applies to those with a disability who need extra help. *"It is important that everyone has the opportunity to take an education, improve their skills and be part of the community. This of course also applies if you have a disability."* - says education and youth education spokesperson Katrine Robsøe (RV) (Børne- og Undervisningsministeriet, 2021).

Education is important on both a personal and on a societal level. The education level helps to raise the possibilities for work for both handicapped and non-handicapped people, but it has been shown that education is especially essential for the handicapped. Even though it is possible in Denmark to get special educational support (SPS), research shows that adults who have a competent education are much less represented among people with handicaps. From 2012-2020 there has been a drop in the amount of 30-40 year olds with a bigger mental handicap who have a competent education. People with a disability have generally more often dropped out of an education than people without a disability. In particular, people with mental disabilities appear to have dropped out more often - not just once, but two or more times (Det Nationale Forsknings- og Analysecenter for Velfærd, 2021).

In this article, the definition of disability is used in the understanding of a disability being something that can occur when the individual encounters barriers in the environment.

Students With Disabilities

Being a student with a disability can make the transition to new surroundings too much for the individual. However, it is not always visible that the student has a disability and therefore it can be difficult to see what challenges they have during their education. According to Tænketanken Perspektiv 63.9 percent of the participants experience that their disability is an

obstacle to achieving the same academic benefit as their fellow students. Furthermore, 48 percent of the participants have dropped out of an education they have started on. They believe it is important that the educational institutions show openness and furthermore state it should be easy for the students to seek out information and guidance (Poulsen et al., 2019).

For these students, it can be difficult and completely unmanageable to orientate themselves in their options as well as the information that is necessary, as they are already challenged as a result of their disability. In the long run, this can cause concern, both in physical, academic and social context, if the student cannot find, seek and get the necessary support. Tænketanken Perspektiv therefore believes that it is important that the path to guidance and support for the student with a disability, is as easy and clear as possible, as this will make life easier for the student (Poulsen et al., 2019).

The report from Tænketanken Perspektiv finds two important reasons why students with a disability have dropped out. 21.8 percent of the students with cognitive difficulties have dropped out due to failed courses or exams, and 21.5 percent due to a lack of support or auxiliary tools. These reasons came from the fact that the students with a disability lacked help in seeking support and information, and ended up with stress, depression or similar to that (Poulsen et al., 2019).

In connection with The Danish Agency for Research and Education, there has been raised questions about whether the institutions comply with FBL (The Discrimination Act), as a decision from the Equal Treatment Board makes the institutions responsible for not complying with FBL in a case concerning a person with a disability.

The institutions' procedure for assigning special examination conditions contains rules that students with a disability must apply to each individual examination for special examination conditions, even if the student has a disability that is likely to affect other future examinations.

According to FBL § 3, section 2, the prohibition of discrimination covers anyone who conducts educational activities. The Ministry of Employment's Guidance on the Act on the Prohibition of Discrimination in the Labor Market, etc. states that this should be interpreted as meaning that the ban applies to universities and its students. This is also supposed to include the educational institutions in the field of vocational, maritime and artistic fields. According to the above, the institution is obliged to offer appropriate accommodations to the student from that moment, the institution is aware of the special needs the student may have as a result of a disability. The board has recommended that the institutions correct their procedure for special examination conditions. It is then the institution and not the student who is to take the initiative to assign special examination conditions for the student with a disability. Thus the students should only inform about their disability once (Uddannelse- og Forskningsministeriet, 2020). These special examination conditions apply to both written and oral examinations. They can be organized in the form of extra preparation time, extra examination time or permission to use aids (DCUM, 2022).

Possibilities for Support and Help

According to a survey from Tænketanken Perspektiv, 49.2 percent of the students with cognitive difficulties did not receive guidance on the various options for support. In addition, 23.4 percent had received support outside the study or before the start of the study.

Tænketanken Perspektiv asked the students with cognitive difficulties how they became aware of the support and help they received. It turns out that 30.6 percent had searched for the information themselves. In addition, 17.4 percent of the students spoke to an education / study advisor, and 17.1 percent spoke to an SPS. Only 3.2 percent were made aware of this before the start of their studies, and 2.6 percent were made aware by a teacher. The reason why they did not receive guidance on options for support was according to 58.7 percent because they did not know about the options for guidance (Poulsen et al., 2019).

The students with disabilities who e.g. need exemptions, special educational support or disability allowance for the State Educational Grant (SU), point out that in order to navigate rules and applications, they have to spend a lot of time and extra energy. Energy that they do not have or that they prioritize spending on improving their skills in their education. In addition, the students also spend a lot of time on medical appointments, treatment and meetings with the municipality or the like, which in itself requires a lot of energy from the student (VIVE, 2021).

It is stated that it may seem that the period up until receiving the support is a bit rough. But the answers point to the fact that when one reaches the support and help, it is also worthwhile. The support makes a huge difference for them in order to complete their education equally to their fellow students. 35,3 percent answered that SPS 'to a very high degree' had significance to their ability to complete an education equally to others, and 31,3 percent of the students answered 'to a high degree'.

60,4 percent answered that they had been missing options for support so they would be equal to non-handicapped people in terms of completing their education. Furthermore, 75,4 percent answered that it would make a difference if their teacher had a greater understanding and more knowledge about their situation (Poulsen et al., 2019).

Dispensation

Some of the help that already exists can make a difference for the student with a disability whether they pass exams or not. At Aalborg University(1), dispensations are offered, including:

- Special examination conditions (eg. extended exam time)
- Extra exam attempts
- Changed exam form
- Extraordinary exam
- Postponement of submission deadline
- The first-year test (Participation requirement and the 24-month rule)
- Postponement of exam attempt

At Aalborg University, you can get 25 percent extra time for written exams. For a 4-hour written exam, the fifth extra hour can make a difference to whether the student passes the test or not. The information regarding that you can apply for extended time for the exam will only be communicated through AAU's website under 'Rules and forms' and further into 'Exemptions'. Extra exam attempts are regularly communicated to the students, and we are tempted to say automatically, as there is more mention of extra exam attempts, due to frequent re-examinations. Re-examination is also planned together with the ordinary examination. In addition, the information about postponing the submission deadline as well as exam attempts is also not 'advertised', unless the student themselves curiously asks the staff; teacher and secretaries about the opportunity. This can also be a big challenge for the student with a disability if one has social anxiety.

Rules and applications

If the student wants dispensation or other forms of support such as special educational support (SPS), auxiliary tools such as Nota or SU Disability Supplement, there are many laws and rules the student must comply with. At all universities there are SU offices (Uddannelses- og Forskningsstyrelsen), but it can be difficult to know where to find information or who to ask for advice. In addition, it can be a great challenge for students with a disability to read very heavy information, as the dissemination of this information is not designed for students with disabilities. Furthermore, the lack of structure as well as overview, and low energy have an impact. Furthermore social anxiety can be problematic in terms of asking for help. We allow ourselves to compare it to insurance: You only need insurance when the damage has occurred and then it is too late. The student only becomes aware of these things when the student is in the situation, and then at this point may already be extra challenged and stressed (refer to the section on disabilities). This means it is more difficult and puts more strain on the student to navigate these rules and applications.

Break down the barrier

In May 2021, the Ministry of Children and Education had DKK 29.2 million earmarked with the purpose of strengthening the efforts for pupils and students with physical and cognitive disabilities (Børne- og Undervisningsministeriet). They want to clear the obstacles that students with disabilities face, as they are aware that many students do not thrive and complete an education. They focus on the need for more initiatives to ensure students with a disability so they have as good opportunities as those without. It must happen through e.g. better counseling and more flexibility. They also want to strengthen holistic study plans and set up work groups to work with dispensation.

The Danish Center for the Teaching Environment (DCUM) is an independent, state knowledge center that focuses on ensuring a good teaching environment at all educational institutions. The center produces, processes, and disseminates research and research results, so that relevant knowledge leads to action and development for students' well-being and learning (DCUM).

DCUM has prepared a guide for employees in higher education to help students who have a physical or mental disability (DCUM). One of its purposes is to give institutions better conditions for making decisions in relation to the needs of the individual student and at the same time, the purpose is to break down barriers between students and teachers (Børne- og Undervisningsministeriet). This is one of the reasons - among many, why we have designed an application

Problem Statement

How do we prevent students with cognitive difficulties from dropping out of the education system?

BACKGROUND KNOWLEDGE

We have examined several related research papers on the brain and how the brain is affected when suffering from a disability. Furthermore, we examined different cognitive impairments and compared them with a focus on finding a target group. Moreover, we found an article that investigated how people with ADHD perceive presentation methods in relation to people without cognitive disabilities, which will later form the basis of our solution.

The Autonomic Nervous System

In order for us to help young students with cognitive difficulties, it is important to understand how the brain works (Brandstrup, 2020). Psychologist Susan Hart has developed a theory of the evolution of human emotional life: neuroaffective developmental psychology, by putting together theories of nervous system structure and maturation, evolutionary psychology, developmental psychology, attachment theory, and trauma understanding. *"The basic thing is that we humans are shaped through our relationships based on innate preconditions. To understand adults' mental vulnerability and malformations, one must know about the brain's emotionally normal development,"* says Susan Hart (Larsen, 2022).

Inspired by the model "The Triune Brain" from the American neurologist Paul MacLeans, Hart believes there is too much focus on cognitive maturation (Larsen, 2022). The 'three-part brain' is divided hierarchically

into autonomous, limbic and prefrontal levels, where they play together and are important for sensorimotor, emotional and cognitive development.

"At the bottom is "the sensing brain" - from here is controlled among other things: our breathing, heartbeat, digestion and our senses. Here, the brain decodes quickly whether there is danger ahead and responds automatically by attacking, fleeing or freezing. For example, it decodes whether to shout and strike or run away. At the center is 'the feeling brain', where our emotions are registered: anger, sadness, frustration, joy, etc. At the top is "the thinking brain" and from here, among other things, are controlled such as impulse control, attention, and the ability to plan and organize." Susan Hart (Larsen, 2014).

Through research of the brain, it turns out that if the emotional part of the brain is exposed to severe stress early in life, it will reduce the ability to handle stress and strain. This will lead to the nervous system being constantly on alert, which happens in the lower part of the brain. In practice, you are constantly on the lookout for any dangers, and you will overreact strongly to small things. At the same time, the upper thinking part of the brain, where the overview and impulse control is located, is put out of play (Larsen, 2014).

In order to help students, we must try to "hit" all three levels of the brain, and not just address through language to the "thinking brain" part. The senses must be affected to make the thinking part work (Larsen, 2014).

The Various Cognitive Disabilities

DCUM has created a guide for employees in higher education: Students with Physical or Mental Disabilities (DCUM). It is this guide that we have taken as our starting point as our overall target group. Furthermore, we have selected various cognitive impairments that we believe have something in common, and at the same time affect as broadly as possible.

Attention Deficit Disorder

Attention Deficit Disorder (ADD) is a neuropsychiatric disorder that affects the brain's ability to regulate attention and activity levels. One will have difficulty with attention and concentration, as well as maintaining an appropriate pace and energy level in daily life. With ADD, one is often perceived as quiet, shy, lazy, less gifted or introverted. One with ADD will have a negative self-feeling and a low self-esteem. In addition, they will be affected by mental turmoil, excessive and chaotic thoughts. In addition, a person with ADD will also have difficulty putting the knowledge they have acquired into practice or other situations.

Attention Deficit Hyperactivity Disorder

Attention Deficit Hyperactivity Disorder (ADHD) is a neuropsychiatric disorder that to varying degrees affects the brain's ability to regulate attention, activity level, and impulse control. They are easily distracted by external stimuli and have motoric or internal turmoil, and restlessness. Moreover, they tend to act quickly or recklessly. Symptoms of ADHD are often seen in situations that are unknown and do not have a clear structure. A person with ADHD will appear restless, forgetful and may interrupt or be loud. They can be easily distracted or seem unconcentrated. Another study shows how kids with ADHD treat information differently than other kids, for instance being more visual students than verbal (Baghaei et al., 2016).

Autism

Autism is a collective term for a variety of developmental disorders. The symptoms are within 3 core areas 1. Deviant social interaction, 2. communication, and 3. limited flexibility and imagination. They may have difficulty interpreting verbal and nonverbal language such as gestures, facial expressions, tone of voice, and may perceive things very literally. They are often sensory challenged, and may experience being overwhelmed when they are out as they take all impressions in. These can be felt by varying intensity. Persistent congestion can result in stress or anxiety.

Bipolar

Bipolar is a mental illness in which there are periods of significant fluctuations in mood and activity level. One will oscillate between having a lot of energy and being overexcited (mania) and on the other hand being energy depleted and constantly sad (depression). There are 2 types of bipolar disorder and the type is determined by the degree of mania. In type 1, large manias occur, often with psychotic traits. In type 2 lighter manias occur - also called hypomania. You may also experience a mixed state where you quickly switch between manic and depressive symptoms or have the symptoms at the same time. Between episodes, there are neutral periods of varying length, but some also experience depressive or manic symptoms outside of the episodes.

Borderline

Borderline is an emotionally unstable personality disorder that divides into two subtypes: impulsive and borderline. One is typically impulsive, the mood can change quickly and many have violent reactions and emotional outbursts. Borderline is also characterized by a feeling of emptiness, which can mean that you experience a lack of sense of who you are. You may have difficulty giving yourself care and you may not, for example, be aware that you are tired and feel the need to take a break, or you may not feel that you are about to get angry. With borderline, you may have a great need for contact and be afraid of being let down. This group may have difficulty entering into close and stable relationships, as these are associated with a degree of insecurity and lack of trust in others. Some people with borderline may have self-harming behaviors.

Depression

Depression is a mental illness that goes from mild depression to moderate and severe depression. The most common symptoms are feeling depressed, lack of energy, decreased desire and interest, difficulty concentrating, sleep disturbances, change in appetite, hopelessness, meaninglessness, negative thoughts about oneself and self-blame. Severe depression can lead to suicidal thoughts, delusions and hallucinations. Depression can be experienced once, periodically, repeatedly or chronically. Many people find it difficult to acknowledge that they have depression (or one on the way) and therefore do not get the right help, which can aggravate and prolong the depression.

Stress

Stress occurs over a period of time when there is no balance between a person's individual resources and the strain one experiences. It is a reaction to a prolonged load that exceeds what we can handle. Prolonged stress can in some cases lead to other diseases. The most common comorbidities are depression and anxiety. The symptoms of stress can be many. These include headaches, palpitations, dizziness, fatigue and sleep problems, lethargy, bad mood, irritation and anxiety. In addition, one may experience cognitive symptoms that may manifest such as difficulty remembering, concentrating, and keeping an overview.

Common traits

Common to ADD, ADHD and autism is that it is the brain's ability to regulate attention that is primarily affected. For ADHD and ADD, this is primarily shown by inner turmoil, which manifests itself through a lack of impulse control and thereby causes problems in keeping an appropriate pace. Autistic people are primarily affected in their understanding of their surroundings and may have difficulty interpreting language and communication. In addition, they may feel overstimulated by the many impressions when they are out.

Common to bipolar, borderline, and depression is that their emotional world is affected. This means that these groups experience greater fluctuations in their mood which go from a lot of energy to being depressed or a feeling of emptiness.

Stress can often be the cause of depression and anxiety, and depression and stress show some of the same symptoms such as lethargy, fatigue and bad mood. There is also a tendency for memory problems, difficulty concentrating and difficulties with comprehension, which are also seen in ADHD.

In most cases, regardless of the type of cognitive difficulties, there is a need for knowledge about various options for dispensation, close contact with the supervisor, teacher, mentor or other person with whom the student can consult. In addition, there is a great need for planning days and time, and to structure ones' tasks. Moreover many people benefit from a form of recognisability with regard to the people they have to interact with, as well as visiting the institution in advance to make the place recognizable.

For many, it can be beneficial for the studygroup and teachers to know the student's problem so that they can support and understand them if something is difficult or they need something special from them. Several also benefit from membership of Nota (Danish Library and Expertise Center for people with print disabilities) due to their difficulty concentrating (DCUM, 2022).

Many traits and difficulties are similar for the various groups even though they are different. They also tend to need the same kind of help as to why we treat these groups as one entity in this article.

Effect of Visual Information Processing

A group of students at Towson University, USA, investigated how ADHD affects visual information processing with three information presentation methods (textual, chart, and tabular). Their study showed that the neurotypical group and the group with ADHD showed different patterns of interaction experience with the three information presentation methods. Their results showed that the chart method was the one the neurotypical participants preferred the most and the textual method was the one they preferred the least. Whereas the group with ADHD preferred the table method the most and the chart method the least. Furthermore, the results also showed that the neurotypical performance measures were consistent with their preference ranking, while the ranking of the group with ADHD did not. Suggesting that the ADHD group is more likely to be affected by additional factors.

Based on our research, this indicates that there is a difference in how neurotypicals and people with a cognitive impairment perceive information. This emphasizes that information must be presented in a different way than if one were designing for neurotypicals.

DESIGN OF APPLICATION

There is a lot of information that does not reach the students, which may be relevant to them. Through interviews and previous studies, it shows a clear picture that the students are not aware of dispensations, special test conditions, rules and applications for SPS, auxiliary tools, support and more. Most often it is on the students own initiative that they find this information. Many have not thought of it as an option, because of the notion that the university focuses on the student being independent and that it is an independent study.

The Choice of an Application

From the literature and the background knowledge we have gathered, we can conclude several things. Firstly, we want to gather all the information in one place. Next, we were aiming for a support tool that would help both the students but also the teacher's communication to the students. At the same time, it must be something

that is always available to the students without the need to buy a new product. Applications are faster than a website and it is possible to make it more user-friendly. In addition, an application will also have the ability to work with other products such as the Apple watch.

No Design Principles for Cognitive Disabilities

Many frameworks and guidelines exist for general interaction design. Normann & Nielsen among others have developed a number of design principles that should guide the process for the designer, who designs interfaces and is used to evaluate prototype designs. These design principles clarify the design so that systems are teachable, efficient and accommodating and also takes accessibility into account (Benyon, 2016, p 86).

However, according to Manta et al., 2020, there are no set rules for designing for users with cognitive disabilities. It is pointed out that if designers, developers and project managers only see accessibility as a checklist of accessibility standards, the focus is only technical and the human interaction aspect tends to get lost (Manta et al., 2020).

Lorna McKnight has written the article "Designing for ADHD", where she explains design principles. However, these design principles are generally for the design of materials to support people with ADHD, but nonetheless, more of these principles go back to Normann & Nielsen's design principles. However, there are some additions that are worth taking into account when talking about design for users with cognitive difficulties:

- Provide a 'calm' environment with soothing colors. No decorations or distractions.
- Ensure a high-reinforcement environment - reward good behavior and performance of all tasks assigned to the user by using positive language.
- Distinguish important information by putting it in bold or color. Divide sections and group related information in panels.
- Help the user to follow the text by writing / highlighting alternate lines in different colors.

In 'use positive language', Lorna McKnight refers to the usability guidelines, in 'write affirmative instructions'. She emphasizes that the reward structure is seen much less in software tools, and suggests that designers could consider incorporating these features. However, she stresses at the same time that one should be careful about overusing these features for the regular users, as it can become condescending for users who do not have cognitive difficulties.

The last point is often recommended by designers where information in list form is used, for instance if using databases. However, Lorna McKnight stresses that one should be careful about coming into conflict with the design principle of simple screens without too much color and distractions. She suggests that where possible, these lists should be avoided (McKnight, 2011). This also helps the purpose of avoiding using large amounts of text. In her earlier research she also suggests separating the information into different screens, if necessary.

As it is not with certainty that these design principles from Normann & Nielsen are suitable for all people, we are examining if they are different for people with cognitive disabilities.

Elaboration of Design Rules

To elaborate design rules, a semi-structured interview was conducted with two participants with ADHD. Participant 1 is a 24 year old male who has ADHD and studies social science in his 4th semester at Aalborg University. Participant 2 is a female student who has ADHD and studies psychology in 4th semester at Aalborg University.

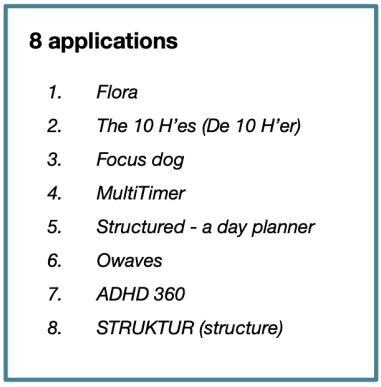

Figure 1: 8 applications from Socialstyrelsen, hjælpemiddelbasen (Socialstyrelsen)

8 different assistive applications (AT: products, equipment, and systems that enhance learning, working, and daily living for persons with disabilities) were used during interviews as inspiration for participants and to give them something concrete and tangible to relate to (Figure 1) (Assistive Technology Industry Association (ATIA)). The applications were selected from a total of 50 applications, with the main goal of covering as much ground in terms of availability, features, visual expression, and overall design. I.e., free applications were favored, and the selection was narrowed down to cover applications with a wide variety of assistive features, as well as differences in the approach to the same features. For instance a planner can be visualized both as a circle or in a classic calendar format. The purpose of the eight applications is exclusively to be seen as a tool for the interview to examine the design, and therefore not an analysis of the functions in the applications.

Furthermore, we designed a list of 16 topics that we would talk about for the interview (Figure 2). The topics were collected with inspiration from Normann and Nielsen's Design Principles, as well as Lorna Knight's article: "Designing for ADHD". There were no criteria for the selection of topics, as we wanted to include as much as possible, to be covered as broad as

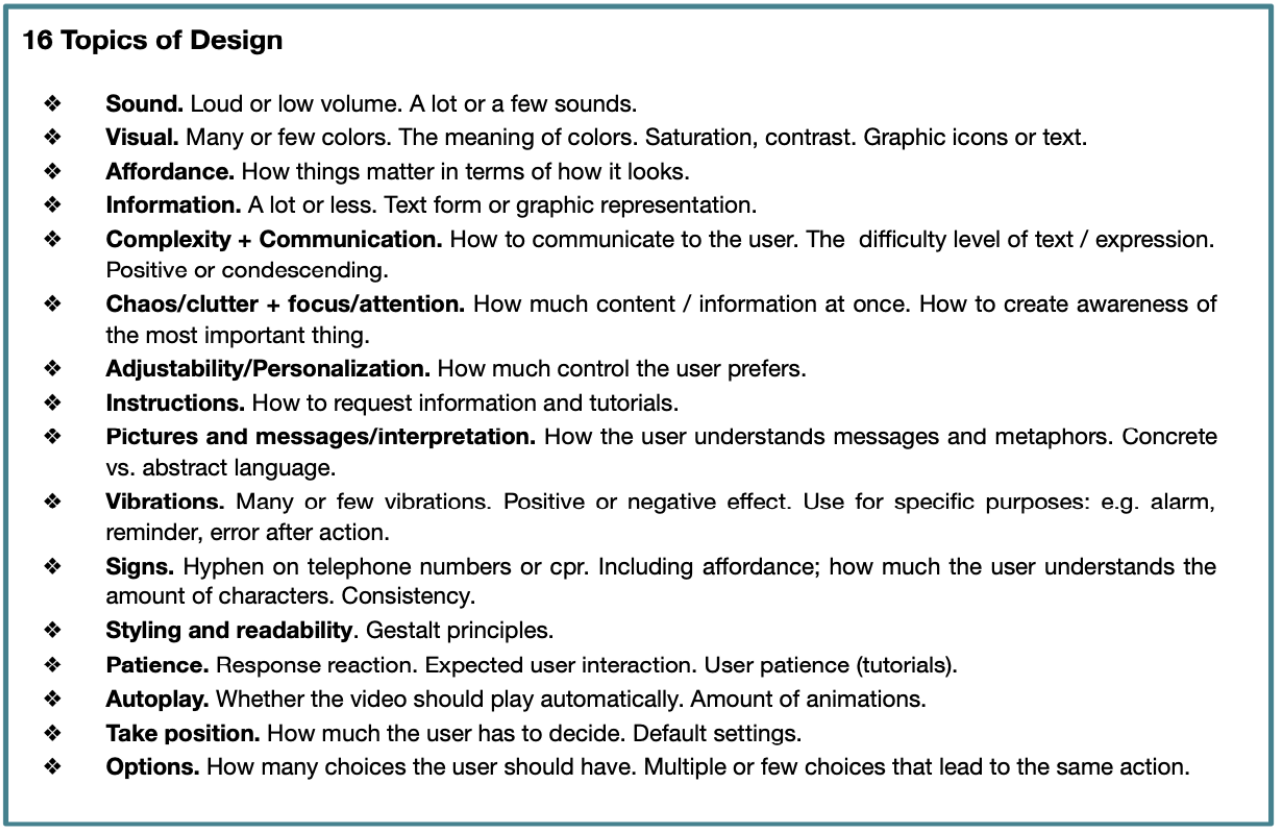

Figure 2: 16 Topics of Design

possible in all areas during our interview. That is, we used the list as a guide to follow-up questions related to input from participants on the topics.

Interviews about design in applications

In the following section, we have analyzed the data from the two interviews and divided the results into several categories. These categories were further used to develop design rules for assistant application for students with cognitive difficulties.

Focus, relevance and positive reinforcement

In relation to focus, participant 1 says he may have a hard time knowing where to look if he gets all the information at once. The rule of direction of reading is not enough for him as he does not know where to look or start. He refers to the phrase 'glaze over eyes'. He feels he gets a filter over his eyes, they zoom out and see everything at once, and thus he is actually not looking at anything at all.

Since he is very strongly against using punishment, positive reinforcement is the most important thing. It should be easy to have a successful experience. He comes back to an application because success experiences makes him excited. He mentions the chronic dopamine situation. Those who have ADHD generally have low dopamine. Everything will have to have a reward formulation as those with ADHD cannot figure out how to do it themselves.

The participant suggests the ongoing reward as a strategy. People with ADHD have a hard time getting things done. Therefore one can say that people with ADHD are punished more often because they more often do not finish things. Instead of doing a less stimulating thing before getting a reward, the good thing should be built into the task. This should be understood in the sense that instead of for instance rewarding with a glass of soda afterwards, one can have a glass whilst performing the task. Postponing one's cravings is wildly difficult with ADHD.

Time and tasks

It is also difficult for people with ADHD to decide how long things take. Some applications offer to help with this particular problem in different ways. To that end, participant 1 believes that there is, in fact, a vacuum for ADHD aids. People with ADHD have a different profit system to which the focus on time is misleading as he rarely works how these applications want him to work. For him it is incorrect to use time as a reward.

For people with ADHD, time does not really exist. They do not measure the time or length of the task, but focus more on that it is in fact a task and how many sub-tasks it consists of. A two-hour workday can be just as demanding, but also as rewarding as 6 hours. For people with ADHD, time makes no sense. Whether you have spent 5 hours or 1 hour on a task is not important, but what is important is what you have done and how hard

it was to do.

He mentions an analogy, which is very true for autism, but can also apply to ADHD: A task is not always one task, but contains several tasks that must be completed before the task itself. For example, if the task is having a lecture - that also consists of packing a bag, going out to the car or down to the bus, plan the route, take the bus, sit close with other people and find the room to be in. All those things can be hugely demanding and more demanding than just sitting in the actual lecture listening.

High sentimental value

Participant 1, when asked about the app 'Focus Dog', expresses that he would quickly delete it again because as he states "it does something completely illegal for helping applications - it punishes me". Within the application you can set a timer that either counts up to a specific amount of time or down. When stopping the timer, Focus, the dog, reacts either positively or negatively by smiling or crying. The participant feels that he is potentially making his dog sad. *"Punishments are we all - both with and without ADHD - trained super much in"*, he says, and he does not believe in it as a method. He especially sees it as a method that should be avoided for people with ADHD who have been punished throughout their lives for not being good enough to do work. It does nothing but manipulate morbidly, and he will even go so far as to say traumatize. He already spends much of his day deliberately avoiding situations where there is potential for failure. He designs his plan so that he CANNOT fail because failing is so traumatic. He does not believe that punishment helps and that it does indeed harm.

People with ADHD can be very empathetic, give things a high sentimental value, and tend to personalize things.

Focus, however, is a fictional dog, but participant 1 feels that he is abusing something that feels alive to him. He can imagine how miserable he would be if the dog stopped smiling. He thinks it probably does not apply to everyone, but he feels that when he looks the dog in the eye, he should be on guard as it actually takes him hostage. It is a tool of manipulation against him.

He can imagine it having an impact on children and young people, and he is self-conscious enough to spot that it is manipulation for him, but if one is not, then one hurts a dog before it dawns on one.

He believes that if there is to be a dog in a design, then the relationship should only be a potential one and it should be positive. The relationship must have only one character, otherwise it begins to be a weapon.

Colors and icons must be realistic

Participant 2, perceives colors as something that creates organization. She sees color saturation as an indicator of importance; a higher saturation equals something more important. In addition, she also experiences saturation as a hierarchy of reward; the more saturation the more appreciative it is.

Colors must be meaningful and realistic. There should be only a few color changes and they should be kept in the chosen theme. Contrasts allow her to filter the different elements apart and focus on the important, as they stand out. However, too much contrast can feel harsh to the eyes. She prefers pastel colors that are not too dusty and finds neon colors distracting. She likes rounded corners best as it is more calm and manageable.

In the same way that colors must be realistic, it is also important that icons are recognizable and realistic. It must be concrete and not abstract. If the application is, for example, a garden app, this must be illustrated clearly and logically. This also applies in terms of not deviating from well-known elements; it does not make sense for her to replace the letter 't' with 'u' in a calendar to signal that it is Tuesday and not Thursday. This can be read from the context. Icons should make sense right away, and not be something you have to think about as a user.

For participant 2, it is preferred that things be broken down into small details. If something can be made into icons e.g. time illustrated as a clock, then it is preferred. It is nice if you can click on an icon and show a text so that it allows an explanation of an icon. She also likes when numbers can be illustrated graphically, for instance with a progress bar so you can see how much is left, as it is more manageable than with numbers. She also prefers large text that is short and precise.

Overview: all items on the same page but kept short

She thinks it is best if you can avoid scrolling and that you can see everything you have to see on one screen. It gives her an overview and she does not have to remember all the previous things. She also thinks that it is good if you can see the important elements from the outside, so that you do not have to press into all the elements. If a lot of things happen on a page, she has to spend a long time decoding and understanding what something means - especially if the elements are similar to each other. It is therefore important that elements that are different are illustrated differently to ensure that they are not mixed together. If you have elements you can do something with, this must also be made clear. For example, if you hold an element down, it can be illustrated that it can be moved by making the edge thicker.

Graphic tutorials and own choices

According to participant 2, one should be able to either skip tutorials and find them again at any time. Otherwise there should be tutorials for several individual functions. Moreover, it is nice if you are shown what to do at the same time and you are not just told. If you have to choose things yourself, such as icons for something, or colors, it is nice if there is a wide selection. However, it should not be too wide, as it then becomes unmanageable.

Stressful elements: More critical but not more important

Participant 2 tells how with ADHD one is more likely to feel inadequate because of their ADHD. This means that if something has a negative effect, it is far greater than a potential positive effect. She argues that it is therefore more important to go in the opposite direction and point out what is less critical rather than what is important. For example, an exclamation point for her is a stressful element that makes the individual thing more critical, but not more important. On the contrary, the other elements should be made less important.

The negative thoughts occur again when it comes to comparing oneself with one's friends. Participant 2 does not like applications that expect her to show something to her friends, as she does not want them to see how difficult it is for her to focus. Conversely, she is also not interested in seeing the progress of her friends because she does not want to be compared. She says that it will therefore be frustrating that a progress bar for friends never will be filled in her example.

Motivation: Ongoing positive feedback

With the application 'Flora' you plant trees by focusing for x number of minutes. If you stop ahead of time, you will receive a message that you have 'killed a tree'. The tree can be revived and put into the real world if you pay for it. Participant 2 says that for people with ADHD, this is not wise as one can easily get a bad conscience. Thus, she will do a lot of impulse purchases to revive all the trees. She asks instead for a more positive reinforcement such as 'well done', focusing on the positive. Moreover, the idea of an oak tree is not a motivator for her to stay focused. She sees the dead tree as a harsher punishment than there is a reward for it, and reads it as a negative voice saying *"see how little you are able to stick to it"*. She imagines that a face, or an avatar who gives ongoing comments or feedback on her work, would be good. She explains that she is less likely to get started next time if she focuses on what she has not gotten done. Something visual that illustrates that she has actually had something done would therefore be nice.

In general

Many elements overlap between the two participants' opinions. Both participants have ADHD and feel strongly about how one should steer away from punishments and focus on positive reinforcement. Using anything that can be emotionally manipulative is frowned upon as well as using friends as a measuring tool. Moreover, as everything is taken literally, elements should be realistic and not abstract and it is stated how colors have a big impact. Moreover, there is a need for information to be given in a short and concise way to keep their focus and not overwhelm them. It is furthermore important to show how you can interact with the system and it should naturally follow what one is used to. One should not try to control or suggest how the application should be used as the user does not like to be controlled.

Participatory design

It is concluded in a study from 2020 that designing for disabilities is a very complex and difficult task. They realize the importance of using real people and how everyone involved should know how people with cognitive disabilities use the internet. It is concluded that the key aspect for success in this process is to involve and communicate directly with this group of people throughout all phases of implementation from design to implementation and testing (Manta et al., 2020). Developing this prototype therefore involved the first interview participant from early on, who have ADHD. The prototype was developed in Figma, a tool in which one can collaborate in designing high fidelity prototypes.

Design Rules

These design rules are developed and designed based on interviews as well as participatory design.

1. Tutorial

- Possibility to skip (control)
- Less text, more interaction

The design of the application should be transparent enough to make tutorials less important. The user must not be forced, and there must always be choices, as the user may have difficulty maintaining focus and possibly have difficulty concentrating. Therefore it is important to allow the user the possibility to skip a tutorial, in case they do not have the concentration for it. Allow them instead to be able to find the tutorial again at any point should they need it.

2. Colors

- Bright colors with high saturation.
- Realistic colors
- Many colors can be good, just not in the same place.

Colors should help divide elements, but should not "make noise". It can be disruptive and take focus away from the important parts. Avoid too dusty colors and neon colors. Too much contrast can be harsh on the eyes. Colors should be kept in the same theme; colors in different themes should have the same saturation and contrast.

3. Design Elements

- As few items as possible
- Divide elements and focus on each one
- Avoid lattice division
- Arrange according to relevance and focus on prioritization
- Rounded corners and soft edges
- Icons must be recognizable and realistic
- Several ways to achieve the same things.

Important messages must be distinguishable from surrounding information. Unrelated messages should

be easy to distinguish so that the degree of their relationship is clear. Do not expect the user to remember. Avoid scrolling and divide the tasks.

Too many elements can be loud for the user and can have the opposite effect of giving an overview. This is similar to 'glaze over eyes', where it is difficult to decode too many elements at once.

The user experiences all elements as the same value if they have the same shape, sizes or color. It is therefore important to show what the reading direction is. But even if the elements have the same value, the reading direction still needs to be clear. Focus on showing what the reading direction is. What is most important must come first, and most likely also be biggest. Avoid illogical formats, sizes and text; the user may have difficulty filtering emotions and therefore illogical elements may be disruptive.

4. Sounds

- Sounds as well as vibrations give a rewarding feeling
- Find a balance

Some users may be very sensitive to sounds and vibrations. Find a balance and keep it minimal and only where necessary. Possibly replace it with something graphic.

5. Focus Area

- Interaction of the application's various functions must be concentrated from the surrounding elements.
- Apply gradient as reading direction

Fade or remove redundant and unnecessary items. For instance change the background behind pop-up windows. Use design effects to show the reading direction.

6. Sentimental Value

- Constant reward (positive reinforcement)
- Avoid that the user can fail as it has a big psychological impact on them
- Avoid manipulative elements
- Avoid alerts and call to action
- The app must not break the operating system's rules
- Avoid comparison with other users

Focus on the positive and remove the negative. Show what the user has achieved, rather than what they are missing.

The user acts before they think; warnings are therefore not always read. Avoid that the user can fail. The user learns by interacting with the application and not through information. Do not expect the user to have energy and patience to try to see through the application; if it is not obvious to the user, they will stop using the application.

No items or features may alter or break the operating system rules. The user may have a negative experience with the application if habits, rules and patterns are suddenly broken. This also applies to patterns and rules such as letters for days of the week. The user may have low self-esteem and/or feel it is difficult to achieve the same as others.

In General

We believe that these new elicited design principles are in fact rules one should adapt when designing for users with cognitive disabilities. But however, design is not a vacuum: what the application aims for and how well the app accomplishes it has just as much influence.

THE APPLICATION

In the following sections, we will present the purpose of the application and the requirements for the application. These requirements are elicited through interviews and participatory design, and are requirements for the application. This will show that they are very much in line with the design rules that we have worked out previously. The following sections include the finished content of the application followed by how we have solved the requirements for the application.

The Purpose of the Application

The application is made for all students and teachers across the country who attend a higher education where SPS is attached. The purpose of the application is to gather all the information in one place. Much of the information that the student benefits from does not reach the student. Through the research that has been conducted from related work, as well as the interviews we have made, it shows that the students are not aware of most of the information that we believe is important.

A channel between teacher and student

The application should serve as a support tool not only for the student but also for the staff of the educational institutions. It should act as a communication channel between teacher and students to make the distance shorter. Through previous studies, the student wants educators to be more aware of the students who have a disability, and believe that it will make a huge difference. It can be difficult for the individual to raise their hand or take the initiative to contact the teacher about the needs that arise, if one suffers from social anxiety. It can for instance be that students who have a disability are affected by road work and feel a need to be in another room for teaching. We want to make the communication between teachers and students easier, shorter and more informal via the application.

Application requirements

1. Use rounded corners.
2. Avoid too many different elements on the page.
3. Apply positive reinforcement and focus on feedback.
4. Time may be misleading for some users with disabilities, such as ADHD and autism. Time can be hard to relate to.
5. One task is not just one task - it consists of many small tasks.
6. Avoid punishment.
7. Avoid animations in the form of avatars or animals.
8. Control color saturation in relation to the importance of elements.
9. Colors must be realistic and resemble reality. Avoid blue mountains and purple trees. Avoid too dusty or neon colors.
10. Avoid too much contrast as it is hard on the eyes.
11. Too many colors create confusion.
12. Colors should be kept in theme.
13. Icons must be recognizable and realistic, concrete and not abstract. Avoid deviating from familiar elements/systems.
14. Avoid long scrolls. As far as possible, make sure you can see everything you need to see on one screen. Do not expect the user to remember.
15. Create an overview of the important things. Make the content visible so that you do not have to go into more elements.
16. Elements that are different from each other are illustrated differently from each other.
17. The function of elements must be clearly illustrated.
18. Show graphically what to do rather than in text.
19. Point out what is less critical than what is most important. It can be difficult to distinguish as elements may seem equally important or have the same value.
20. Avoid call to action.
21. Focus on what has been achieved rather than what is lacking.
22. Several ways to achieve the same. Always have an opportunity to return.
23. Avoid metaphors. Everything is taken literally as it can be difficult to understand allusions or sarcasm.
24. Apply colors, effects and animations as it provides dopamine to the brain. Keep it controlled and do not overdo it.
25. Suggestions for how the user can use the application should be avoided.
26. No comparison with friends.
27. Avoid deciding on the user's time.

Content of the application

1. Login Page:

The application requires a user login, which is the same login the student uses to log in to the study portal. When you log in, you choose which university you go to, and then log in with your student email. This makes it easy to pull the required information of the individual student into the application, as the application will retrieve information about the student such as; courses, syllabus, deadlines, calendar, teachers, email contacts, etc.

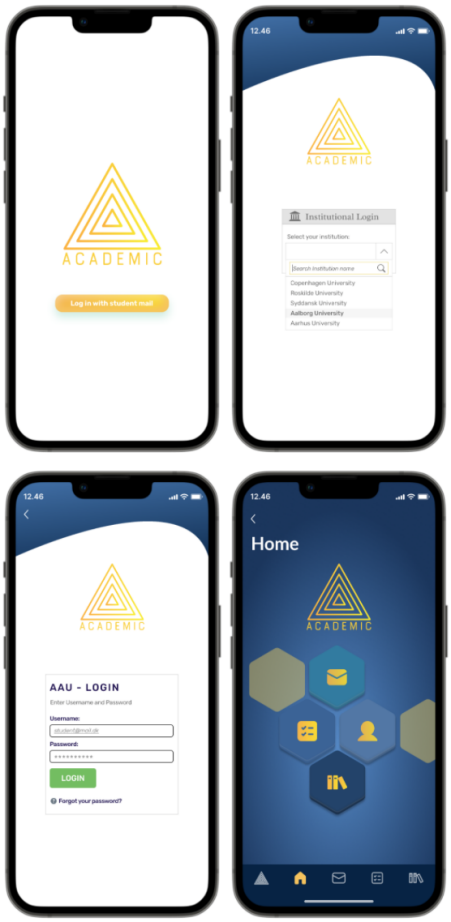

Figure 3: Prototype page 1-4

2. Message Page:

Many students with a disability tend not to read emails, or may overlook opening the mail inbox due to the university sending out a lot of general information several times a day. It can be difficult for the student to see which emails they should respond to and whether the email is relevant for them. For some students, there are also other reasons why they do not want to open the software program they use for all their emails.

Figure 4: Prototype page 5-8

Via the application's Messages page, the student can receive and view the most important emails that are personal and directly for them. At the same time, it also acts as a communication channel between essential contacts and the student. The design is selected to be more informal and recognizable like other platforms where the student is used to send messages from, rather than a design reminiscent of emails.

3. Checklist Page:

When you start university, you have to remember many things. For people with cognitive difficulties, this can be even more challenging and overwhelming. In the application, the user can find checklists for what must be ready before the start of studies, the next ordinary semester and the examination period. The checklists are accompanied by a progress bar to help them get started and get through the list. The list consists of a drop down box, which gives a short description with further explanation of the task. The designed checklists shown in the figure below are 'Checklist for study start', 'Checklist for next semester' and 'Exam checklist'; including 'Two weeks before exam', 'The day before exam' and 'Exam day'.

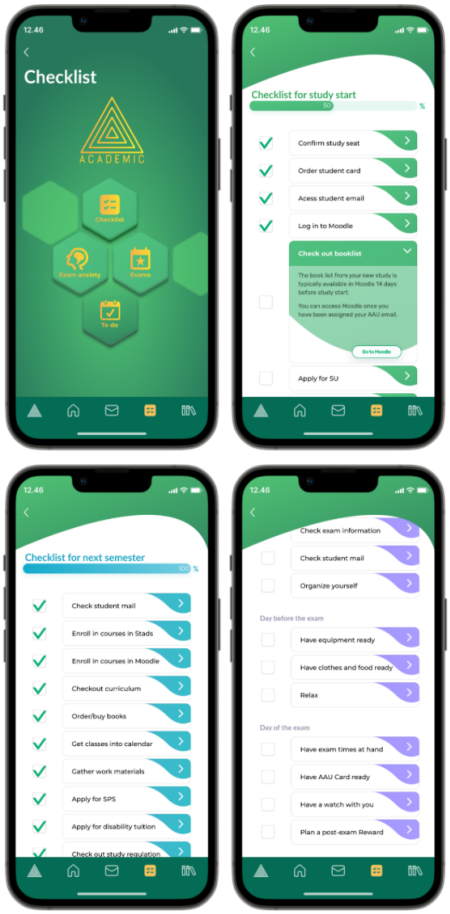

Figure 5: Prototype page 9-12

Furthermore, there is a tab with exam anxiety. This page comes with 13 tips on how to deal with exam anxiety. The language is informal, fun and supportive, and it is important for us to tell the student that it is perfectly normal to be nervous about exams with or without a disability.

Additionally, there are two tabs, with exam dates and a "to do" list. Exam dates is an overview of the exams the student must take in the current semester. It contains information on whether it is a written or an oral exam, the duration of the exam, the date of the exam, and the start and end time of the exam. The "to do" list is a classic "to do" list, but with the addition of 'Place to go' and 'People to speak to'. Through our interviews, we have recognized that it can be difficult to remember to call the doctor and order medicine or contact their family and friends, as time goes by when you are a student.

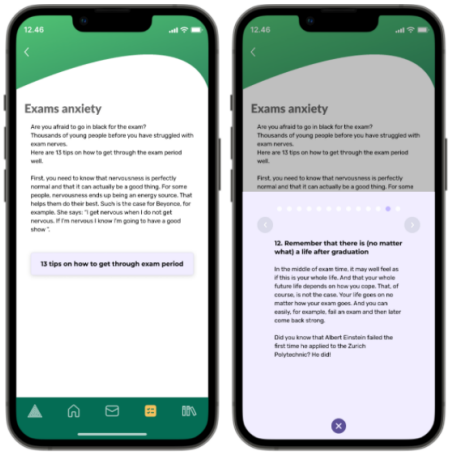

Figure 6: Prototype page 13-14

4. Studio Page:

The student can find a book list for the semester and syllabus, which gives an overview of their courses, what to read for the next lecture and when the lectures are.

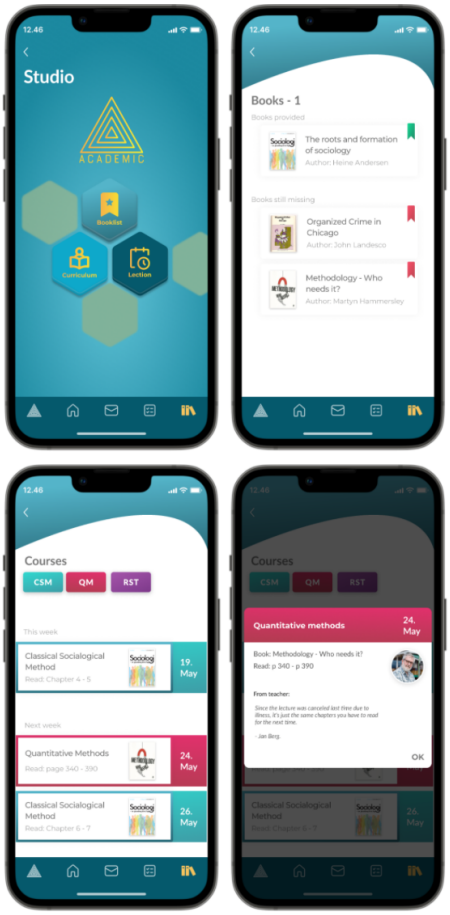

Figure 7: Prototype page 15-18

The teacher has the opportunity to write a comment on what is to be read. In addition, we have also made a tab that gives an overview of the teachers the student has for the current semester, what they teach and when they have the next lecture with that teacher. There is also an overview of the distribution of the various lectures. This is not as such a calendar, but should give an abstract visual picture of how the lectures are clustered in a month.

5. Special Education Support Page:

As stated in this article, it is evident that students lack knowledge on the fact that they can get help in the first place and how they are to do so. Within this application this information has been made easily accessible for the user. In keeping the design condensed, the information has been made on fold-out cards and limited to a few with only the information needed.

To help the student fill out the application and focus during it, when clicking to type, the active part becomes highlighted. To motivate the user to fill out the form, we have incorporated a progress bar which moves in percentages on every completed field alongside a motivational line of text.

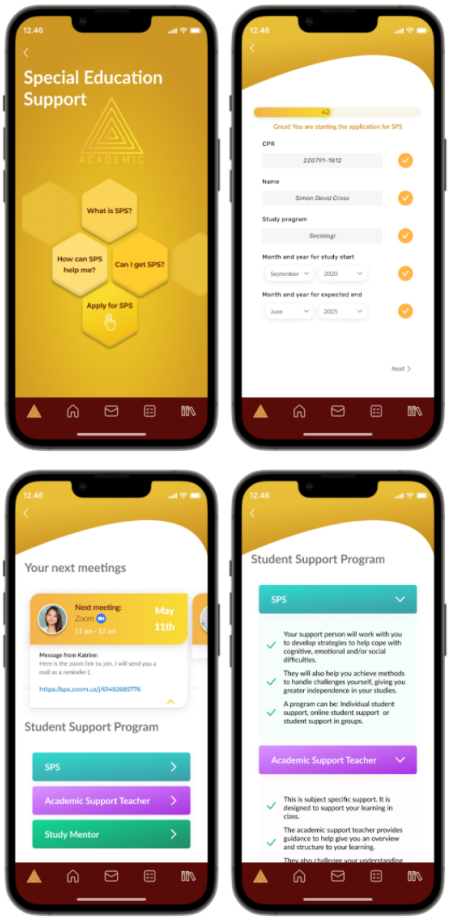

Figure 8: Prototype page 19-22

When one has SPS they can see options for the different types of help they can get. They are also able to see their next meeting with their SPS contact people, where it takes place and at what time. Moreover when clicking on the card they will find a note by eg. their mentor if there is anything the student should know or remember for their meeting.

6. Home Page:

Homepage is also one of the most important pages in the application. In addition to showing an overview of the most important information, such as new messages, next meeting, next course and what to read, it is also on this page where the student can enroll for the exam. The button for enrolment for the exam is visible in the middle of the page. The home page acts as a landing page when you open the app, and therefore 'enroll for exams' will be visible every time the user opens the application. When the button is inactive, it appears gray, and during that period you can not enroll in exams. When the exam registration is open, the button will turn green during that period. That way, every day when using the application, the student will be reminded to register for the exam, which was one of the main problems that also was the reason why students with a disability dropped out of university as they forgot the deadline.

Figure 9: Prototype page 23

Requirement Fulfillment

1. We have used rounded corners in all frames. Rounded corners make it seem calm and soft to the user. Edged corners can be hard on the user. See example below.

Figure 10: Non-rounded Corners v Rounded Corners

2. There are as few items on each page as possible. Too many elements remove focus from the main element and create a chaotic image. We have chosen that the most important thing comes first and is the biggest. It also means that the application gets more depth as we split the elements into groups.

3. We have designed an application that uses a language which is both positive and humorous. The SPS page frequently guides and supports the user to complete the application via motivational text and progressbar.

4. In our application we do not have any timers. The way we have defined the time is in different ways, for example, in the exam list we have shown both the duration of the exam but also shown the start and end point. We also do not use calendars in our app. We focus more on giving an overview and showing a visual picture of the distribution of courses in a month.

5. If we ask the user for several things at once, we have divided the tasks. We understand that filling out a form is not one task. Therefore, filling it out is divided into "invisible" categories such as; 'Personal information', 'description of challenges', 'consent statement' and 'digital signature'. This is not visible in the form of text, as more text on the page will only create clutter for the user. The effect of the division still works, even if it is not visible to the user in the form of text.

6. We do not have alarming elements in our application. The user can not fail either. On all our pages, the user can use the features in the application as they wish. In one place, on the SPS application, we have wanted to take control from the user. This is the consent statement where the user can not proceed / press 'next' before the user approves both ticks. In order for the user not to fail, we have removed the 'next' button completely, and it will only reappear when the user accepts the consent. This is the way we avoid the user may fail or press incorrectly, by simply removing the option.

7. We have not chosen to add avatars or animals to our application. The user may feel that they are being taken hostage if they are to encourage, 'take care' or satisfy an avatar figure.

8. On all pages, we have used color saturation to illustrate what is important and less important. Elements that are important have higher saturation or more contrast (polygons), whereas elements that are less important or indifferent are light colored or less saturated and have less opacity.

9. Some colors in the application are warm to create a calm and relaxed setting, others are cold to create a clean and simple look.

Figure 11: Theme Colors

The color choice is deliberate as they have a purpose:

- The green represents new beginnings and growth. It has a harmonious effect and signals stability.
- Blue represents calmness and responsibility. A light blue is refreshing and friendly, while the dark is strong and reliable.
- Magenta is associated with creativity and imagination.
- Warm yellow represents energy, joy, hope and enthusiasm.
- The orange color represents change and movement. In addition, it invokes attention, but is not nearly as serious as a red color.

10. All the colors are deliberately chosen according to their contrast. Here is an example of two purples where L1 has a lot of contrast and L2 is softer.

Figure 12: Contrast Variants L1-L2

11. The colors on each page have the same color but different contrasts (see figure 11).

12. The colors have the same saturation and contrast that is repeated on all pages, even if there is a color change.

13. In relation to affordance, we have chosen icons that are simple and recognizable. It is common to use an envelope as a symbol for emails, which we have also chosen. For other icons such as exam dates or syllabus, we have chosen icons we think make the most sense. For instance we have, under the syllabus an icon that shows a person reading. We have indicated a book list with an icon of a bookmark.

14. On most pages, all elements are on the page without scrolling. Places where there are scrolling have been used based on a design theory to show that there is more under this group, e.g. 'Next meeting' under the SPS page. Elsewhere, scrolling will automatically occur if a card element is expanded in shape or there is a drop down box element selected by month and year.

15. We have made the way short to the places to go to. For each topic (messages, checklist, bookmark, SPS), we have given them each a 'home' page to provide an overview for the user as well as show what each button contains. No more than two layers appear in the application. Several layers are shown with an overlay in the form of a pop-up, which means that you are not removed from the page. In addition, it is also shown in the various 'homepages' if something new has occurred, such as a new message.

16. All topics; 'Messages', 'checklist', 'book list' and 'SPS' are divided and illustrated in different color themes. This is to show that they are different from each other. Furthermore, the polygons are also illustrated with color contrast, so each button does not have a connection with each other, but belongs to the same subject. Under the SPS page, we have illustrated different colors that Olivia Denmark (SPS which is affiliated with Aalborg University) offers, to show that there is a difference.

17. We have illustrated buttons with several types of shadows, both inner and outer shadow to give a 3D effect. All items like checklists, cards, messages, etc. have shadows to illustrate them as objects. Objects behind objects such as 'Next meeting' under SPS, we have illustrated with shadows to give a 3D effect to indicate that there are objects 'on top' of each other. Furthermore, we have illustrated the places where you can see more information with an arrow, e.g. at dropdown boxes.

18. The application does not have any tutorials, but in several places we show, with icons or effects such as shadows that graphically show, the various elements and its function. Eg. we have an arrow indicating dropdown boxes instead of a text that says 'show more...'.

19. Instead of making something more clear than the rest because it is important, we have made what is not important less clear. This is done in several places by using color saturation, gradients and opacity. On the various homepages, a gradient has been used to illuminate where it is important for the user to direct their attention. By pop up messages, we have made the background more indistinct.

20. We have no call to action such as 'Purchase'. We focus on the user not being able to fail. See point 3.

21. The checklists and the application for SPS are features that require something from the user. The user's input is measured in a progress bar that focuses on how far the user is.

22. On all pages, there are several ways to get back. This is illustrated by an arrow in the upper left corner, which is recognizable to iPhone users. Furthermore, you can press the navigation bar to go directly to another place. In addition, with all pop-ups, it is possible to either press the cross, to close it, or press outside the box to return to the page. Furthermore, all pop-ups can also be swiped away.

23. The language of the application is direct. There are no metaphors or ambiguity.

24. All checklists and other dropdown boxes have animations in the form of a soft bounced effect. This works for the user as it is more calm. There is a focus on sensitive users, which applies to both sides and you have to find a balance. Exaggeration of animations and effects can seem disruptive as well as too hard on the user. Instant and spontaneous objects can also affect the user negatively.

25. The application is divided into different topics, but how the user uses the app is up to the user himself. Several elements can be used in different ways for what works for the user (checklist, books, messages, exam). The user can decide for themselves how much they use the different pages or how the elements can help them.

26. We have not created a community in the application, comparison with friends or the outside world. We have no elements that measure the user's performance or track how well users perform in relation to the study. The application is a support tool and not a tool that judges or decides over the user.

27. We have not chosen to take care of when the user has to do homework. We have chosen to show homework in relation to the syllabus. When the user reads homework is up to the user himself. Whether it works best for them before or after lecture. We only provide information about which possibilities there are and the possibility for the teacher to provide additional information. Time is illustrated only as information and not as a choice.

The magic lies in the detail:

The overall design: aims to limit the use of unnecessary elements but still allows it to be aesthetically pleasing and modern. Small details can have a big impact on the user. By using a curved gradient design the user is guided in a certain reading direction throughout the application. This is also accomplished by placing buttons on the lower right bottom.

In order to keep the user entertained and motivated, a series of animations have been used when interacting with it. The functions follow the system of the phone's design, which makes it a recognisable feature and easy to learn. For instance to close certain elements on iPhones you are to swipe downwards which is a function incorporated into the application.

The application relies on automating the different tasks a student must remember to do when starting a higher education. Moreover to especially accommodate users with cognitive disabilities, the application is made to show only little text at a time and make the things which are not important at that moment indistinct.

The Theory of Colors: One of the areas of color theory is harmonies. Color harmonies consist in that there is balance and consistency between the colors, that the colors fit together and are put together in a conscious way. We have used analog color harmony to create the background colors in the application. They are created using colors that lie next to each other in the color circle. The green background is e.g. created by several shades of green. Analog color harmonies give a more vivid impression and are relaxing. Common to harmonies is that they create structure and are calm, as opposed to contrasting colors. Contrasting colors give life and excitement and also act as eye-catchers. However, one must be aware that not all color combinations are equally good (Meyhoff, 2017).

The application uses an overall color scheme which consists of few, but clean colors with different meanings. Each page in the application uses a different color to underline that something new is happening. Using whitespace in certain areas serves the purpose of not overwhelming the user, to keep them calm and focused.

Polygons and gradients: We have chosen to use polygons in a non-grid format. The grid helps to create visual elements, divide space in smaller units, align elements and help to arrange and and put them in order.

The grid adds a starting point on where to look from. In this case the four polygons give the center as a starting point for the eye of the user. Moreover, the grid also helps to create hierarchy among the elements or the lack hereof. By making a grid that is not linear or list form, we do not add any hierarchy as nothing on the page is more or less important (Bokil, 2009).

According to Bao Xiaoxiao and Liu Wenming gradients colors can be used to mark, distinguish and emphasize information, which enables users to navigate the interface more logically (Xiaoxiao and Wenming, 2018). The colors on the buttons are made gradient with a radial fill to create focus on the buttons in the center of the screen. Moreover the gradients give depth, and indicate buttons to be pushed. This follows the principles of affordance, by showing resemblance to the real world and tells the user to interact with it as a button. Gradients also add a visual interest and give a modern and sleek look. It also makes the element stand out as to why only the buttons which are actually clickable are gradiented. Gradients are also used to make the design stand out.

TEST RESULTS

To test the application we conducted a semi structured interview with four people who have different combinations of disabilities. What we were interested in was primarily how the design affected the user. We gave a quick introduction to the project and showed the different pages in the application. Thereafter the interview proceeded with questions about how the participant could see themselves use the application and what impact the different design choices had on them. As Figma does not allow incorporation of sound, these features have only been discussed with the testers on an hypothetical level.

Messages Page

The list of the various contacts was positive and gave a good overview. They felt that it could sometimes feel chaotic and unmanageable when mixed with other emails. Therefore, they saw this feature as incredibly useful and usable.

Checklist Page

Checklist: Overall, there was positive feedback on the checklist. On a daily basis, it can be a nightmare to get a handle on all the things they need to remember for their study. Furthermore, it is nice for them that the boxes you have crossed off do not disappear, so you can see what has actually been achieved. The checklist also provides an overview of what to do and avoid getting stressed.

Under the checklist page, participants wanted to be able to create their own checklists or add items under the current checklists. However, they pointed out that it can also be dangerous if the user can create too many checklists or to do lists. In addition, they lacked an overview of where to find various programs that they use in their study. For example, information about setting up the Internet, information and dispensation of equipment, information about programs such as teams and analysis programs.

Exam anxiety: The way the exam page was set up gave a good overview as it was very straightforward. They liked that the quantity was appropriate, that everything was gathered in a line and placed in order in time. On the list of 13 tips for exam anxiety they found it very useful as they are written in a language that is soothing. They also think it was nice that it was easily accessible.

On the other hand, this page is also full of text, which could be a bit confusing. Here it was suggested either to divide the text more into sections or greater line spacing so that it was not a dense block of text. Furthermore, funny quotes and fun facts could be put in boxes to separate them from the rest. This would provide a visual division that would be more manageable.

Exam list: As mentioned earlier, students with a disability may have difficulty relating to time. On the exam list, they suggested that it counted the number of days down to the exam as dates can be difficult to relate to.

To do: They were also very positive about the "To-do" list, as they think it is very important. Both the checklist and the to-do list are also things they work on through their SPS process, and it helps them to keep them in one place.

They suggested that you could add more lists that you could make yourself. At the same time, they suggested notes under messages automatically were added to the to-do list, so everything was gathered in one place.

Studio Page

Book list: Overall, there was positive feedback on the book list. Both from themselves and those they know, see a problem in that books and articles can be a difficult to navigate in. They do not think Moodle (a virtual learning environment for Aalborg University to provide course materials and activities for present students) makes it easy for them. Furthermore, they gave positive feedback on that there was a picture of the book. This also made it easier to navigate through the various books and articles.

Curriculum: They were also enthusiastic about the syllabus list as some of them even worked on making syllabus lists themselves. The syllabus gave them an overview of what to read and is very useful in the form of a support tool.

Courses: They think it's good to have an overview of which lessons are next and in which order. According to the participants, it is a nightmare to use Moodle and it is also not always easy to get the Moodle calendar into your own calendar. In addition, it was also very nice that it was shown which teacher has which lesson, as the visual in the form of profile picture was more recognizable to them. They also think that it is nice that there is direct contact with the teacher, who is thereby more at eye level.

In the page for courses where there is a monthly overview of the distribution of lessons, they suggested that if you click on them, that they show the date, start and end time as well as room number for the lectures. Some studies do not have their own classroom and have lectures in different auditoriums. Furthermore, they suggested that the days they do not have lectures to be lit up.

SPS Page

The application for SPS is much more manageable in the application as the current manual approach is cumbersome. They think it will make a huge difference that it is so easily accessible. They were very positive about the way it was designed and they

noticed the invisible categorization of the division. For the application, the progress bar was again very convenient, as it made the task of filling out the form more predictable and clear. The actual division of the application was equally convenient, as it can be difficult to relate to several things at once. In addition, they were happy that you can use NemID as a digital signature, as it makes it much easier.

Olivia Denmark which is a special educational support affiliated with Aalborg University offers various courses. Here it was suggested that there was a point under their personal SPS page, with an overview of these courses. Furthermore, it was suggested that one could sign up for the various courses directly in the application and then automatically added and displayed in ones own calendar. They usually receive information about courses by email, but this can be difficult to see.

Home Page

The participants loved the homepage as a landing page, as it gave a good overview of what was happening in the application. They said they needed to know where to turn their focus on when they opened the application, as one can do several things. The home page works like a dashboard, where they felt they could see new updates such as if new messages had arrived or quickly see what they should read for the next lecture. At the same time, they also knew that there was information about their study and their student mail. It had a LinkedIn look that made them feel important, like having a title. They were also quite excited to be able to register for the exam through the application, as it is the only application available where you can do it. Although the homepage provided a good overview, the homepage also stood out from the rest of the application. It had a slightly different look, and did not follow the polygon design. This was noticed by the participants and it was clear that they were marked by the change. For us, it was interesting to see how much it affects the students who have a disability and there was also one who had a particularly extreme reaction.

The participants suggested that it should definitely be consistent throughout the entire app. In particular, there was a participant who "just could not deal with it". But they were happy with the very concept of the overview. In addition, they also did not need a picture of themselves, which makes sense, as it is not a profile others can see. Therefore it is just an unnecessary element that fills out space, draws the eye and is disturbing. There was also someone who suggested that instead of the button for enrollment for exams being green, it should be red. This was suggested to be more alarming and thus show that it was extremely important that one remembered to register for the exam. However, we investigated this, and found that "Viewing red in achievement situations prior to or during task engagement has been shown to evoke avoidance motivation and behavior in a number of studies using a variety of different indicators" (Elliot and Maier, 2014). This means that red can actually make the student avoid pressing the button. Changing the color from green to red is therefore not something we would do.

In General

Overall, the impression of the application was positive. It seems very useful and clear for the participants. They can see the application as a great help in everyday life. They feel it gives an overview of exactly what they need, so they do not get unnecessarily stressed about things far into the future. The information was straightforward and calm. It would be a great support tool for their study. They also think it's nice that it's all gathered in one place and the application would be a huge help if it were a reality.

Colors: In relation to the colors, they saw them as positive, and thought that the color theme contributed to a nice design. The colors are faded and not loud as well as manageable as opposed to chaotic. The soft colors are nice and help not to take focus from anything else. The gradients further make the expression soft and provide a greater contrast between the different points, without there being any contrast in the colors.

Icons: The icons are straightforward, make sense and are very natural. One participant commented that if the icons did not make sense then she would not use the application at all.

Animations: In general, the animations seemed to give a less harsh expression, and instead made it softer and friendlier to use. In addition, it provides something visual and keeps the brain activated. On the login page, there are two animations, one being preferred over the other as it had a softness that affected their senses. Animations at the progress bar had a positive overall effect on the design. They liked that there was a good balance as too much animation is a waste of time.

Sounds: The program we used to make the design prototype of the application has no sound or vibration functions. During the test, we discussed sound and vibration in the application. Here it was suggested that it would be nice with vibrations when you have completed the SPS application, as you can usually get paranoid about whether you have completed it and sent it, or if you have filled it out correctly. However, they also made us aware that we need to be careful with sound and vibrations as some of the participants were very sensitive to it. Sound and vibration must be limited and only used when extremely necessary. In some places, sound can be replaced with graphics instead, which they preferred. For example, a

timeline could be shown for how far one's application was, as the process for approving an application can take up to half to a full year.

Logo: On all pages there is a logo of the application. The logo was disturbing as it was the same size as the other elements and was very clear it had no purpose. It did not matter that the logo was there, but they suggested that it was significantly smaller and moved up in the corner.

Info page: It was suggested that there should be an information page that quickly provided an overview of the various pages. It was important it was simple with e.g. a picture of icons from each page and a text next to it, so you could quickly and easily look up where the different things were. This could be very useful in the beginning when you start using the application until you get to know it.

Motivational text under progress bar: On the SPS page, there was a motivational text below the progress bar. It did not receive positive feedback, but neither did it receive negative feedback. It was not remarkable but not disturbing either. Since it did not matter to them, they did not suggest that it should be added to the other progress bar in the application as it could risk being a disruptive element.

Design: In relation to design, there were positive comments. The navigation bar is recognizable from other applications, which is good as it makes it easy to use. Furthermore, they saw the use of polygons instead of a list, as a good thing. A list would be too boring for them and they would leave the application.

As we had expected, they commented on the superfluous polygons, however, it did not have a negative effect in terms of disruption. Some of the superfluous design elements had mixed opinions as to whether or not they should be removed as it would feel empty without them. Participants with ADHD can be very perfectionist, but the experience of the application was that it was neat and clean.

DISCUSSION

There is a massive lack of information given to the student about his or her rights to help related to their study. Many are forced to seek out knowledge themselves, and a larger percentage end up dropping out because they do not receive the necessary help in time. The Ministry of Children and Education wants to strengthen the efforts of students with physical and cognitive disabilities. Thus there is a need for a tool that can help this group. We have tried to address this issue with an application that makes use of some specially developed design rules. In the following it is discussed how the application and the design rules individually and together contribute to the solution of the problem. In addition, we look at our solution in a larger organizational context and also discuss the limitations and results of the study.

Dual Contribution

The result of the project involves both the application itself, as a solution to the problem, but also the design rules as a result. Since research shows that there are no set rules for designing for the cognitively impaired, we have been forced to develop a set of rules. This has been necessary in order to create a solution that contains both the functionality needed and design it in a way that suits the target group.

We have gained several experiences in relation to the design of the application. We have both designed with and without participatory design, and we have also tested the design. In terms of participatory design, it has proven to be incredibly effective as we have saved a lot of time in comparison to if we had to switch to and back from design and test. Participatory design has meant that we received quick and direct input from the participant. Furthermore, we also see it as important to get input early from participants when working with a target group with special needs.

The application's contribution is that information is gathered in one place, there is easy contact with the teacher and SPS. In addition, there is help to be found related to the start of studies, the start of the semester, as well as the exam, which are phases that are particularly difficult for the cognitively handicapped. In addition, there is a strength in that all information is retrieved automatically and the user does not have to enter info themselves. In addition, direct and fast communication with the essential people is important as it provides communication at eye level. It also helps to give the student a sense of recognizability and less formality. The application also has some limitations. As the target group is very broad, there will still be some who have needs that are not covered. People are different - even if they share diagnoses there will still be differences, which is hard to accommodate.

As we have developed the application and the design rules simultaneously, we have had direct experience of applying them in practice. Thus, evaluation of the application has not only given feedback based on the solution's specific features and design, but indirectly also for the design rules.

Organizational Culture

The purpose of this thesis has not been to create a complete solution that can be easily rolled out. Instead, it has been expanding the knowledge we have about what can prevent people with cognitive difficulties from completing their education.

By not focusing on the organizational constraints, it has allowed us to focus more on the needs of the user than being hindered by the system. Our way of designing these features is not necessarily where our solution lies. Our research says that some other designs

are needed for this group, and this group has some other needs in relation to the study. How we have made the features in the app are just possible suggestions for better communication. How it should be developed and implemented is beyond the scope of this study.

In order for the application to be implemented as it is intended, it requires a change in the organizational culture of the employees at the institutions. This could be, for example, extra workload on the secretaries or teachers who will have to set aside extra time for the specific communication. In addition, it is intended to add a sorting tool in the form of a database that can filter important emails to the students, which also requires some form of maintenance.

Limitations and Suggestions for Further Research

Validation of the design rules with more testers is still required. Furthermore, it is up to further research to examine the design rules in the context of becoming wiser about how general the rules are across diagnoses and symptoms. In addition, a field study of the application over a longer period of time is required. The effectiveness of the application is difficult to elicit during interviews and visual inspection. With this you can see both the details of interactions of specific features and what has the greatest effect in relation to the problem of why people are not completing their education.

During interviews, it was confirmed that students do not have the knowledge they should have regarding the help they can get. In addition, sound sensitivity was pointed out, in which one can investigate further how this affects the various diagnoses, as some greatly prefer sounds and vibrations, while others prefer to be without them. In addition, it may also be interesting to look at how you can change the state of the application automatically to accommodate users with OCD. Furthermore, it was illustrated how more people do not open their emails due to being overwhelmed by too many emails.

This study does not have enough data on the diagnoses to be able to generalize design rules, but through tests and interviews we have tried to cover it as broadly as possible. Despite a low number of participants, we have targeted broadly in relation to the number of diagnoses, as several participants have had a mix of diagnoses.

The rules that have been formulated are not exclusively relevant to this solution, but with more research they will be able to be developed, validated and generalized.

It is also difficult to say whether something is more specific to the individual diagnosis. This therefore calls for further research if the design rules are to be made for specific diagnoses.

CONCLUSION

There is a problem with students dropping out of the education system with cognitive difficulties. To solve the problem, we have developed a prototype of an application. The result of the study is both the application and the developed design rules. The application contributes to the solution of the problem by illustrating ways in which one can especially help the students with cognitive disabilities. This involves both gathering the information about help in one place, automating information retrieval, creating a more informal and easy communication, and helping the student to remember important study-relevant elements and create an overview. Simultaneously with the development of the prototype, we have developed a number of design rules, aimed specifically at this target group. People with cognitive difficulties prefer information presented differently than people without, and neuropsychology illustrates how one should hit all the senses and not just the thinking part. In addition to this, so far no design rules have been established for cognitively disabled users. Our research shows that design is important for this group, which is why the design principles become rules that must always be followed. In addition, there is still a challenge in designing for this group due to its wide coverage and the differences of the individual.

Future work will consist of testing the design rules on a larger group / several groups, and possibly further research into whether there is a difference in the individual's experience of design. In order for the application to work in practice, it also requires a change in the organizational culture of the institutions.

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