Dansk Resume

Dette speciale omhandler inkluderingen og assistancen af neurodiversitet i folkeskolen, ved at undersøge folkeskolelærers holdninger og ekspertise på undervisningen og inddragelse af deres klasser. Der er fortsat problemer med inddragelsen af autistiske og ADHD elever i formen af at forskellige aspekter af lektionerne og deres nuværende systemer stadigvæk er bygget til at primært fungere for neurotypiske elever. Denne artikel dækker udviklingen af et design eksempel på hvordan et system for folkeskoleelever bedre kan inddrage autistiske og ADHD elever ved at bruge metoder og design tilgange der har belæg for at hjælpe personer inde for neurodiversitets rammerne. Dette førte til syv design implikationer, der viser bestemte design muligheder og områder som kan anvendes til at støtte elever med autisme og/eller ADHD diagnoser.

Studie og workshop af lærernes tilgange til autisme og ADHD

Artiklen har formålet at undersøge folkeskolens tilgang til undervisning for autisme og ADHD, og udrede de designmæssige overvejelser der kan findes for de personers problemer. Denne undersøgelse blev udført ved at gennemføre en Inspiration Card Workshop med en gruppe folkeskolelærer, og derefter designe en løsning der blev brugt som et forskningsredskab til at bemærke design overvejelser og implikationer som burde fokuseres på når man designer med neurodiverse børn. Disse implikationer blev udviklet ved brugen af en Figma prototype og blev evalueret af en gruppe folkeskolelærer i et semi-struktureret interview. Lærerne blev spurgt om deres holdninger til designet og om applikationen af de specifikke metoder og hvordan de kunne se dem fungere i deres egen undervisning. Prototypen består af en lærer- og elev version, med større fokus på lærersiden og hvordan de skal facilitere deres undervisning.

Evaluering af prototype

Vi evaluerede vores prototype med folkeskolelærer for at åbne op en mulighed for bedre input og kritisk feedback til hvordan designet fungerer, og mulige problematikker som de potentielt kunne have. Denne evaluering havde fokus på designets funktionalitet og metodernes applikation, eftersom metoderne var nye for de fleste af folkeskolelærerne. Deres input blev brugt til at identificere de betydningsfulde aspekter af systemet, og hvordan de kunne blive brugt på en positiv og produktiv måde. Evalueringen bestod af to grupper af folkeskolelærer, den første gruppe var med en uformel ramme hvor lærerne kom gående gennem lærerværelset med samlet set 9 deltagere. Den anden gruppe var en formel ramme med en lærer og skoleleder, hvor vi holdt et forberedt interview og gennemgang af systemet. Begge grupper blev interviewet på lignende præmisser med samme interviewguide, og havde begge mulighed for at se systemet. De syv implikationer der kom ud af evalueringen består af: (1) Lærerens og elevens sider bør se så ens ud som muligt. (2) Nemt forstået og transparent pause-tagning, så eleverne ved hvornår der er pauser i undervisningen. (3) Brugen af pædagogikkens 10 H'er for at give eleverne klarhed for undervisningens indhold. (4) Inkludering af refleksionsmodeller indbygget i systemet for at streamline lærerens facilitering af lektioner evaluering. (5) Farvevalg til at hjælpe autistiske- og ADHD'er ved at bruge hjælpsomme farver for dem. (6) Lærer har behov for redskaber til at støtte inklusion. (7) Lav et redskab der kan bruges af hele klassen, samtidigt med at støtte neurodiverse elever.

NemSkema: A Teacher-based Facilitation Tool for Inclusive Lesson Arrangements Based on ADHD and Autistic Pupils

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ABSTRACT

With an increased focus on inclusion in Danish public schools, it has become more important to acknowledge and define the particular characteristics of each type of inclusion. Autism and ADHD have seen an improvement in academic and social treatment by the wider majority, with tools becoming more widespread. However, there is still a considerable amount of problems on a much more basic level that neurodiverse pupils are treated socially, even with the improvements that have happened. This article focuses on a Co-design study in a school setting to develop design implications that can assist teachers to support inclusion in their classes. By combining teachers' insight with autism and ADHD-specific methods, such as the 10 guidance questions and the 3-2-1 evaluation method, we focus on approaches that are helpful to them, without interfering with the other pupils. The study contributes a set of design implications that designers can use in their studies when designing inclusive tools that can help teachers facilitate their lessons. It also provides an example of how such a system would look and function.

INTRODUCTION

The well-being of Danish public school pupils is decreasing as fewer pupils can find the support they need when attending school [11]. In 2012 the Danish government passed the inclusion law, as a way to save resources in the public school system, as 96 percent of Danish children attend a public school regardless of if they have any special needs. Many special needs classes and schools were closed and incorporated with regular public schools [28]. The Danish government revised the curriculum for the teachers' education in 2013, removing special pedagogy as a subject [6] leaving future teachers without the proper tools to care for pupils with special needs. Evaluation of the inclusion reform reports an increase in children receiving a psychiatric diagnosis as grounds to implement the reform. It gave the schools more leeway to refer pupils to a psychiatrist rather than going through the municipal system first [20, 27]. A new report from the Danish Ministry of Children and Education [19] details that in the 2021/2022 school year, every fourth pupil had more than 10 percent absence from their classes, which is a 2 percent increase from the previous school year [1].

The documentary 'Smertensbørn' [27] shows how a school in Høng has trouble accommodating all its students as disruptions fill the classroom because their learning environment does not support the pupils adequately. The teachers in the documentary describe how they lack the resources to create the learning environment as their special pedagogies were laid off to save money. They had to resort to informal knowledge-sharing to help their pupils use their experiences and work practices as the expert information was lacking. This knowledge-sharing practice is also described by Badawi et al. [4], where the interviewees also experienced frustration with having to knowledge-share their methods as some of the schools do not have the resources to have an inclusion supervisor available.

During our research of related work, we noticed that It-based inclusion is not a well-researched area, as Anders et al. [3], recognised. Even though the Ministry of Children and Education [21] sees great potential in IT-based inclusion as tools to support the pupils practically. Their study acknowledges that pupils with learning disabilities are challenged when they receive demanding academic requirements, leading to the pupils not feeling academic success at school, which teachers believe might be a reason for the pupils to act out [27]. One of the inclusion guidelines from the Ministry of Children and Education is that the pedagogical personnel should not stigmatise the pupils who need support by placing them in "boxes" [21]. Badawi et al. [4], describe how their interviewees experienced children that would act out because they felt that their supportive tools made them stand out. To ensure neurodiverse pupils do not feel demeaned in the classroom, it has become increasingly important to implement inclusive practices and methods in classrooms so neurodiverse pupils do not feel left out. The results of our prior paper, *"A Study of how Teachers Prepare Teaching and Assign Tools for Neurodiverse Children"* [4], resulted in three design opportunities: *tools of concentration or sensory tools, structural tools, and stigmatisation and understanding of neurodiversity.* In this study it was decided to focus on structural tools, as we found that teachers lack tools to structure their lessons which was one of the main problem areas with public schools' inclusion today. Opening up the problem area of neurodiverse children in public schools, leading to the research question:

We want to examine which design implications a designer would need to acknowledge when working with a digitally inclusive platform that can help teachers facilitate their lessons, and help pupils prepare for their classes.

This study focuses on ADHD and autism as they are the most prominent diagnoses [18] and because the findings of our prior study [4] showed greater importance on them. To address the lack of support that some neurodiverse pupils experience, we conducted an Inspiration Card Workshop with a group of teachers, to generate design concepts where the participants assembled eight design concepts by combining the cards. Three concepts were selected based on specific requirements, and a knowledge-sharing forum and a school class structuring app were sketched out based on their inputs. These were further developed on where one was chosen for further iterations, as they met the requirements and aligned with the workshop participant's interests. With the results from the workshop, we used the Research-Through-Design [30] approach to create a design solution called NemSkema, for how a class scheduling system can be facilitated by the teachers. The NemSkema application is a clickable interactive prototype created in Figma and is designed to consider and include neurodiverse pupils. The prototype was evaluated with a different group of participants than the participants from the workshop. The evaluation process involved two semi-structured interviews, at two different schools. The findings from the evaluation derived seven different design implications that can be used to design systems for the teacher to support inclusion. These seven implications are: *Keep a consistent teacher-pupil design, Break structuring for pupils' daily workload, Use the 10 guidance questions to give pupils predictability, Include reflection models to remind the teacher to evaluate, Use colour coding to help children organise their work, Teachers need tools to help them support inclusion, Create a tool for everyone instead of the individual.*

As the paper concerns Autism and ADHD in particular it is essential to distinguish what language is used when referring to the neurodiverse community and what is considered acceptable terminology and vocabulary. The paper will try to adhere to these terms as best as possible, but because it is based on community consensus it will mean not everyone concurs on the same conclusions. We also acknowledge that there are older papers which use outdated terms such as Aspergers and will be recognised when applicable. Some of the terms this paper uses are:

1. Neurodiversity: Is the concept that people have fundamentally different ways their brains work which process information and social interactions differently than what is usually typical. It is also the umbrella term when referring to the neurodiverse community as a whole. It includes terms but is not limited to: Autism, OCD (Obsessive Compulsive Disorder), Dyslexia, ADHD (Attention Deficit Hyperactivity Disorder), and Tourette's syndrome.
2. Neurotypical: Is the designation of a person who has been deemed to have a typical way of thinking which fits into the way our society currently works.
3. Identity-first language: Is a manner of referring to people by using their identity, making it an integral part of who they are. Identity-first language refers to calling someone an "Autistic person" rather than a "Person with Autism", the reason for doing it this way is to emphasise the personality and life-shaping aspect that autism has on a person. Thus, being Autistic is not simply a diagnosis that can be discarded or examined when necessary, but an integral part of who they are as a person [25].
4. Allistic: Refers to a non-autistic person. It means both neurotypical people and neurodiverse people can be allistic as it simply refers to the absence of autism.
5. Special Needs: Is a term mostly used by the Danish school system and government, but is considered a taboo term by the wider neurodiverse community.

RELATED WORK

The related work in this study focuses on inclusive education, inclusive digital education, teaching tools for inclusion in the classroom, and teaching tools in HCI. The articles provide valuable insights into different approaches, strategies, methods and tools that support inclusive education.

Inclusive Education

D'Alessio et al. [10], analysed the inherent difficulties that come from comparing different countries' inclusive education where they note two things: (i) the terminology may be the same but mean different things from country to country and (ii) the methodological approach is not the same between countries, making it difficult to research and make comparisons. It specifies the importance of describing inclusive education as a process rather than a state and something that is both educational and social. In the publication from the Danish Ministry of Children and Education, inclusion is defined as the Manchester Inclusion Standard [21] which Rasmus Alenkær defines as: *"A dynamic and ongoing process in which the school increases the opportunities for presence, the experience of community, active participation and high learning outcomes from all pupils" [2].*

McLaughlin et al. [16], is an article that describes educational experiments conducted with medical students at university level, where it focuses on how to better include them during the course lessons. They look at both experiential and didactic coursework where the article asserts that while medical educators are experts in their fields they lack behind in pedagogical skills. The article conceptualised different goals that the teachers should focus on in their teaching, which included keeping an eye on: biases, stereotypes, microaggressions, and how a lack of inclusive learning can negatively affect the students. It also notes that strategies should be tailored to the specific subject being taught.

Kivirand et al. [14], examined a way of creating a training course for teachers and school leaders to help them develop skills when it comes to inclusive education. They studied what the participants wanted from such an in-service training course and if they had suggestions. They found that not every theoretical inclusive aspect could cleanly be translated into how the school practically worked. Including parents and guardians in the process is a similarly good idea, while emphasising the difficulty that lies in evaluating inclusion.

Digital inclusive education

The European Agency for Special Needs and Inclusive Education [29] established a need for inclusion and found that there is a need for increased digital education as technology and tools keep developing. They found that the learning environment for inclusive digital education needs to make the pupils feel supported intellectually and academically by using digital solutions such as social media, smartphones etc. in a school environment. The Danish Ministry of Children and Education [21] defines inclusive digital education to consist of five different categories: *Structure and Overview, Shielding and Focus, Differentiation and Understanding, Production and Communication, and Dialogue and Cooperation.* Structure and Overview consist of tools that help pupils visualise their schedule and structurize their school work such as online calendars, timers, and digital learning platforms. When exploring the Shielding and Focus category the Ministry mentions tools such as headsets, screen dividers etc. to help pupils shield the amount of sensory input they receive. Differentiation and Understanding technologies are used to present the pupils with the academic content they need, such technologies are learning games, video teaching etc. Production and Communication is a category that consists of tools to help the pupil communicate and help them convey their knowledge to others, such tools can be writing templates, presentation tools and so on. Dialogue and Cooperation are technologies which are used to help the pupil create a space for their academic conversations and cooperate with their peers with the use of learning platforms and virtual learning environments. The ministry focuses on how these supportive tools from the five categories can help pupils feel empowered and assist them in mastering their weaknesses. The usage of common digital solutions can help pupils who suffer from social vulnerabilities to feel included in the social school environment [29]. Though digital technologies in these five categories can help support inclusion, it is important that pupils and teachers also support them to use the full potential of the digital solutions [3].

Teaching Tools for Inclusion in Classroom

In response to the inclusion of autistic children in the conventional public school system, Cohen et al., created the Nest program [9, 4]. The primary goal of the Nest program is to support inclusion by ensuring that the teaching methods are tailored to fulfil each individual pupil's needs, to match a wide variety of pupils. This involves implementing a co-teaching approach, with two or more teachers and assistant pedagogues to assist with any potential challenges that may arise. Every pupil enrolled in the 'program' receives a personalised learning plan to assist them in academic and social goals for the school year. This method is beneficial for autistic pupils as it provides them with a sense of predictability and comfort during their time in school. Teachers participating in the Nest program are required to provide their pupils with a daily class agenda including the assignments and objectives for the day. The language used must be direct and easily understood by each pupil.

Through our prior study where we explored the learning environment in Denmark we found that the learning environment affects the neurodiverse pupils' learning abilities [4]. The study found that schools can use the 10 guidance questions by Bohr [7] to prepare and guide their pupils for activities whereas they could use the Nest principles to adapt their learning environment to include neurodiverse pupils. The study found that Aalborg municipality in Denmark created The Delta Class method which is their take on the Nest program. The Delta Class Method also promotes teamwork and collaboration, with pupils working in groups to perform tasks and solve challenges. During an interview with a school in Aalborg municipality, teachers said the method is used for structuring the day by presenting a subject agenda at the start of the class. This helps the pupils focus more effectively because they know exactly what is coming up and the duration they have for each task, before getting a break [4]. Furthermore, the school's physical environment needs multiple quiet work areas, and the classroom and school areas need to be decorated properly. Still, it should not be too overstimulating as it can be disruptive to neurodiverse pupils [26].

Teaching tools in HCI

In the field of Human-Computer Interaction (HCI), Hirano et al. [13], developed and evaluated vSked, a digital scheduling system that provides a visual representation of daily schedules. The system is designed to support classroom activities for autistic children, by helping them understand and navigate their daily routines. A field study was conducted to evaluate vSkeds' effectiveness in two classrooms for autistic children. The study lasted over a period of several weeks and involved observing the use of vSked as well as collecting feedback from the teachers, parents, and children. The study found that vSkeds' visual representation was an effective technique for supporting classroom activities for autistic children. They also discovered an improvement in communication between the teachers, parents, and children.

Bhattacharya et al. [5], investigated the use of motion-based activities to engage autistic pupils in a classroom setting. The researchers developed a series of activities involving movement, sound, and visual stimuli to later evaluate their effectiveness. In the first activity game, the pupils were required to catch objects to earn points, in the second, they had to move blocks to match patterns in a puzzle game, and in the last, they had to follow a character on a screen in a dance game. In all the activities the researchers used an electronic whiteboard and a Kinect sensor. In a classroom setting, the motion-based activities engaged autistic pupils more effectively, where they demonstrated increased social interaction with other pupils and increased engagement in learning.

The article discusses different aspects of inclusive education and inclusive digital education. With the understanding of inclusion and how to support digital inclusion, we choose to focus on the inclusive digital education category: *Structure and overview*, as we want to build a class schedule system for the teacher to facilitate their classes. The theories mentioned in the "Teaching Tools for Inclusion in Classroom" section, including the Nest program, the Delta Class Method, the 10 guidance questions, the vSked system, and motion-based activities, can be used to create teaching tools for pupils with learning difficulties. The theories' insights can help us develop

Participant	Age	Ba. In teaching	Teaching subjects	Grade	Length of teaching
WP1	38	YES	Danish/Music	Preschool	9 Years
WP2	58	YES	Danish	7-9th grade	30 Years
WP3	28	YES	Danish/Cultural studies	7-9th grade	1,5 Years
WP4	34	NO	M.A. Danish/History	7-9th grade	4,5 Years

Table 1. Workshop Participants (WP) from the Inspiration Card Workshop.

a more inclusive learning environment by using learning plans, team teaching, computerised scheduling, and motion-based activities as tools.

INSPIRATION CARD WORKSHOP

This section provides an overview of the data collection phase and the methods used. It describes how an Inspiration Card Workshop was conducted with four participants and will cover the workshop's objectives, participants, materials, procedure, and data analysis.

Workshop Preparations

Based on our prior study, we found that teachers currently have an increased workload when teaching neurodiverse pupils as they were not provided with adequate support when inclusion reform was implemented. We, therefore, defined three distinct design opportunities [4]. These opportunities consisted of: *tools of concentration or sensory tools, structural tools, and stigmatisation and understanding of neurodiversity.* In this study we chose to focus on structural tools and therefore conducted an Inspiration Card Workshop developed by Halskov et al. [12], to involve participants early in the design process. The workshop aimed to engage the participants' creativity and help them generate design concepts based on technology and domain cards provided to widen the design space. Technology cards represent a specific technology or application, as seen in Figure 1, while domain cards represent information on the domain we intend to design for, as seen in Figure 2, all of the cards used in the workshop can be seen in Appendix 1. These cards were defined as within and outside of the domain during the preparation phase, where they described different concepts and processes that are present in them respectively. In our variant of the Inspiration Card Workshop, we call the domain cards: Within the domain, and technology cards: outside of the domain.

A total of 40 inspiration cards were made with unique images and words describing the chosen technology or domain, including three blanks, allowing the participants the opportunity to make their own cards. The cards inside the domain were based on methods, techniques and tools, that were acquired from Badawi et al. interviews [4], as well as further studies from related work: Teaching Tools for Inclusion in Classroom, which included the Nest program, the Delta Class Method, the 10 guidance questions, the vSked system, and motion-based activities. The cards outside the domain are methods, techniques and artefacts that could conceivably be used by the school or children in their everyday life, as well as containing objects whose only purpose is to arouse creativity.

Figure 1. Example of a card inside of the domain.

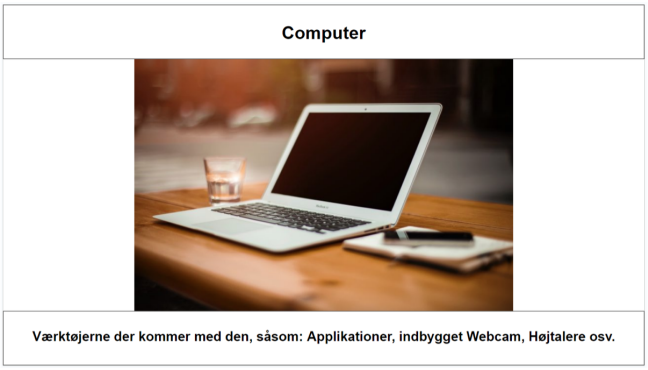

Figure 2. Example of a card outside of the domain.

The Inspiration Card Workshop was conducted with one preschool and three 7-9th grade teachers, as seen in Table 1. The teachers had varying levels of teaching experience and backgrounds in subjects such as Music, History, Cultural Studies, and Danish which they all had in common.

During the workshop, the participants worked together as a team, giving tools such as markers and tape to combine the chosen inspiration cards into a cohesive solution, as they conveyed on a piece of A3 paper. To ensure that they did not use too much time on each concept during the one-hour session, we used timers to keep track of the time spent. As a result, the workshop participants created eight overall design concepts. Figures 3 and 4 show two of the created concept posters the rest of the posters can be seen in Appendix 2. The concepts were then analysed to determine which were relevant to our study.

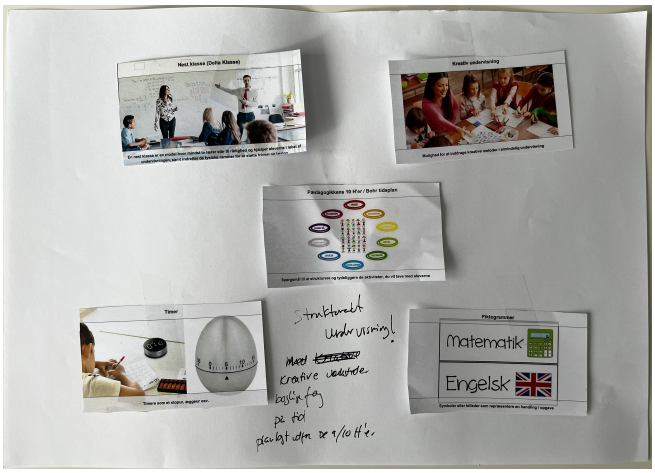

Figure 3. Structured teaching with a creative workshop based on literary subjects and scheduled according to the 10 guidance questions.

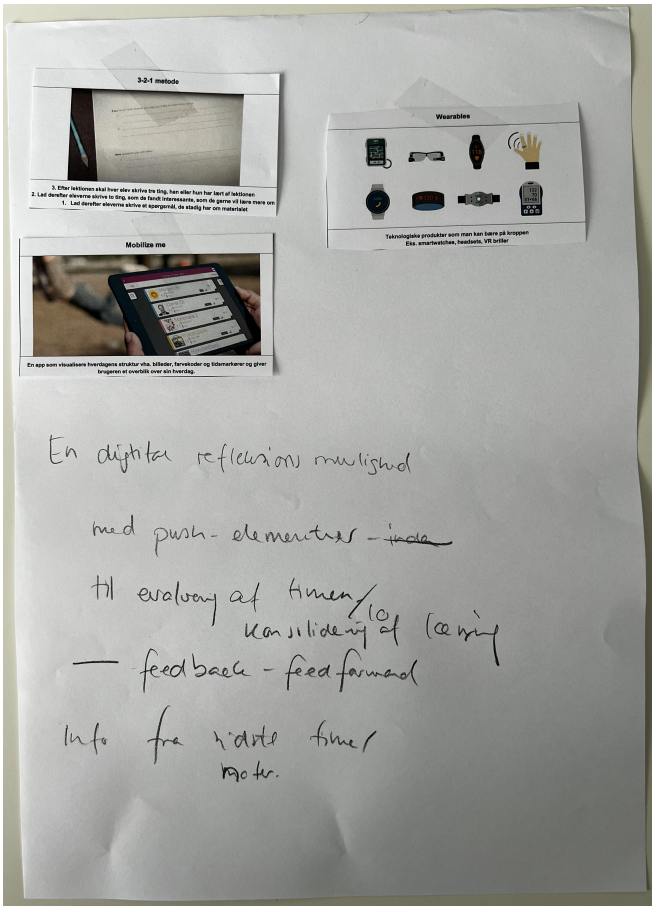

Figure 4. A digital reflection opportunity using the 3-2-1 method, with notifications using wearables reminding students to complete it before leaving class.

Data Analysis

We reviewed each concept and selected three of them that had the most potential for solving the given problem of providing a tool for teachers to adapt their teaching methods to neurodiverse pupils. Additionally, we considered the concepts based on specific requirements from Badawi et al. [4], which included: *being cost-effective, easy for teachers to facilitate, easy to integrate into teaching, and not being an overly broad solution*. Each of the chosen three concepts was sketched individually to develop further. We then discussed and restructured the ideas collectively, to arrive at two distinct concepts, a knowledge-sharing forum and a framework for a school lesson structuring app. The knowledge-sharing forum is an app or system for teachers to share teaching methods, receive feedback, and use them as a model for their classes, while the school app is an app or system for teachers to provide students with a daily schedule, and note-taking capabilities, to help them keep track of their notes with relevant compendiums. At the time of the workshop, the participants used at least three different systems for their teaching. (i) Aula is a communication application between teachers/parents/pupils which is where pupils see their schedule and homework. (ii) MinUddanelse where pupils collect the assignments for each of their subjects. (iii) Each teacher uses different collaboration platforms for the students to work on, the workshop participants used either Google Drive or Microsoft Office Online. The participants noted that their pupils had problems remembering which system to use and when they should use it. Each of the concepts was assessed through the lens of our requirements and related work to observe each concept's benefits. The school lesson structuring app was chosen to iterate on further because it met our requirements as well as giving pupils a clear picture of their daily schedule, and note-taking capabilities, which was something that aligned with the participants' interests during the workshop.

NEMSKEMA

Based on the data and concepts of the workshop, a concept regarding a school lesson structuring app was iteratively refined before reaching a design, called NemSkema. As a teacher-centric design solution, NemSkema is designed to primarily meet and focus on a teacher's needs and specifications, with a minor focus on the pupil version to exemplify the teacher version's functionality and how it reflects it. In this section, the proposed solution's key features and functionalities will be described in detail.

Design Requirements

The analysis conducted after the workshop resulted in a set of requirements and insight, guiding the next phase of the design process, to further iterate on the chosen concept of the school class structuring app. The main motivating factor behind designing a prototype for structuring class lessons was based on the workshop participants' desire to have a platform that combined multiple of their existing systems into a single platform. This was because the participants wished for a solution that could incorporate exam notes, as well as streamlined processes, eliminating the need for pupils to navigate between multiple platforms.

The established requirements defined specific goals to guide the design of the application. They consisted of:

- Weekly/module divided calendar
- Implementation of the 10 guidance questions as a teaching tool for each lesson
- Implementation of the 3-2-1 reflection and evaluation tool for each lesson
- An understandable and transparent way of setting and seeing breaks during the lesson
- Make it transparent when homework is due
- Make each class specifically colour coded so that they stand out from each other, and adhere to ADHD-approved colours
- Can take notes in the lesson to help to a communal class compendium

After establishing the requirements we held sketching sessions where different design approaches were sketched out to explore the possibilities inside the design requirements. The structuring school tool is meant to fulfil the existing system requirements of Aulas' schedule and homework functions while making it more pertinent to autistic and ADHD children. This led us to our design.

The design is set up in two facets with a teacher and a pupil version. The teacher version contains the planning and structuring of lessons, and the pupil version contains what the teacher has planned. Each version is designed to mirror each other so both parties see a similar setup, making the process of progressing through them easier to understand. The design consists of multiple methods that are constructive in supporting neurodiverse pupils. The design incorporates a method of consistent break timers to structure in detail how long and when a break will take place [4], this is a helpful method for ADHD and autism to give them predictability. Likewise, the 10 guidance questions is a method designed by Bohr that is meant to give clarity to the pupils in question about the learning plan and substance for the specific lesson [7]. The 3-2-1 reflection tool is meant to give the student in question a way of reflecting on what they have learned, and what was interesting, along with a question they have about the lesson [24]. Colour-coding is a guideline by Mobilize Me where it is used as a contrasting tool that helps children with autism and ADHD, to get an overview of their schedule [17]. Shen et al., reported that contrasting a warm-coloured background and cold text could help children with ADHD attention span [22]. The purpose of using these methods is to increase the experience for pupils who need the added support while keeping the essential functionality as is, so it does not interfere with the pupils who do not need it. The purpose of note-taking is meant to support the teacher in making a compendium of notes made by the pupils themselves.

The NemSkema prototype

To illustrate how you could create a class structuring application to support inclusion we have created NemSkema, a research-through-design application [30] for the teacher to structure, and we have made a student version to illustrate how it could be designed. The teacher and student version is designed to be as similar as possible so the teacher knows what the student sees when using the system.

Teacher version of NemSkema

The Application is designed to be a desktop application for teachers in the 7-9th grade in the Danish public school system. The teacher can access their schedule and the subject (s) they teach from the front page. The schedule is segmented into a weekly format to keep it simple and not too overwhelming, see Figure 5, the teacher can browse through the weeks on top of the page.

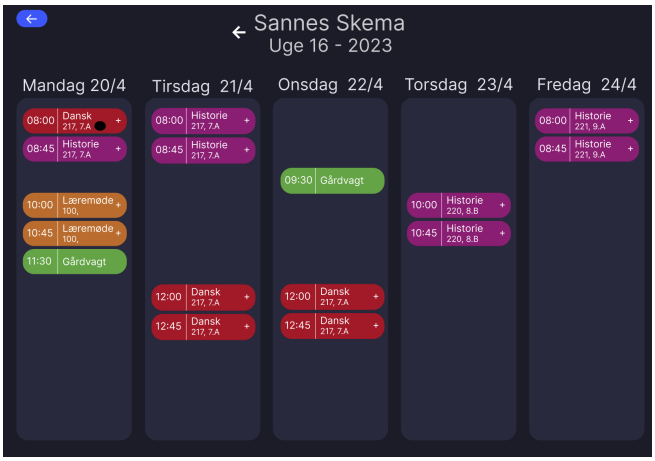

Figure 5. The teachers weekly schedule page.

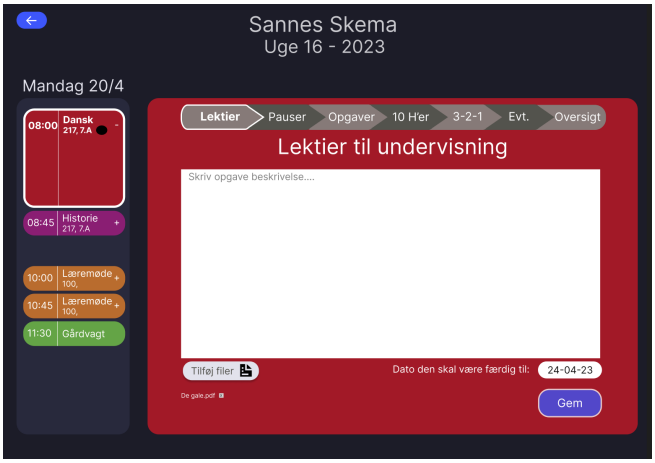

Figure 6. Page where the teacher can structure homework for the lesson.

Each class is scheduled for 45 minutes as it is how our participant's school structure their classes. The black dot will indicate if the teacher has not scheduled the upcoming class. When the class is clicked on, the weekly schedule disappears and the page transforms into a class structuring page with the daily schedule on the left side of the page, see Figure 6. The teacher can freely click through the different class structuring steps or they can choose to do the class structuring step by step.

The first page is the "Homework Page" where the teacher can structure the homework for the class by writing descriptive text and uploading files if necessary. The next page is the "Pause page" where the teacher determines the schedule for the following 45 minutes. The page includes examples of which types of breaks a teacher can structure for their pupils. The break page concept is from Badawi et al. [4], who found that structured breaks can help pupils concentrate. The chosen schedule can be seen on the left side of the page under the class in the daily schedule, see Figure 7.

Figure 7. Page where the teacher can structure the time schedule for the lesson.

The following page is the "Homeroom assignment page" which is designed the same way as the "Homework page". After structuring the schedule and the tasks of the class, the teacher can choose to incorporate the 10 guidance questions by Bohr [7], see Figure 8, the fields that the teacher chooses to write in will show up on the student page of the application, see Figure 13, as every question might not be relevant for each lesson, so the teacher can choose which are relevant for the class.

Figure 8. Page where the teacher can add the 10 guidance questions to the lesson.

Next, is where the teacher chooses if they want to incorporate the 3-2-1 reflection method, see Figure 9, we have designed it to be optional for the teacher. If they choose to incorporate it into their schedule they can set the date for the student to turn in their reflection task. If the teacher does not want to use the standard 3-2-1 questions they can change them in the fields on the page.

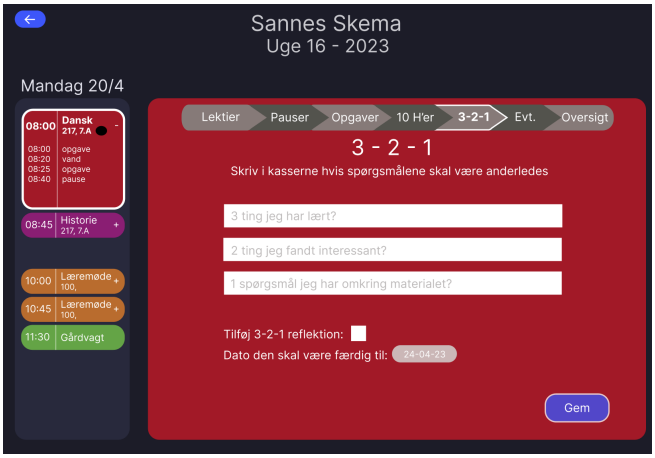

Figure 9. Page where the teacher can add the 3-2-1 evaluation to the lesson.

The last steps the teacher goes through are an "Eventually Page" where the teacher can write extra notes that are unique for that specific day, this could be "remember indoor shoes for P.E.". And the "Overview Page" where the teacher gets a short overview of the things they have input to the class and they can choose to edit them if necessary, see Figure 10. A user journey of the Danish teacher Sanne planning a lesson for 7.A can be seen in Appendix 3.

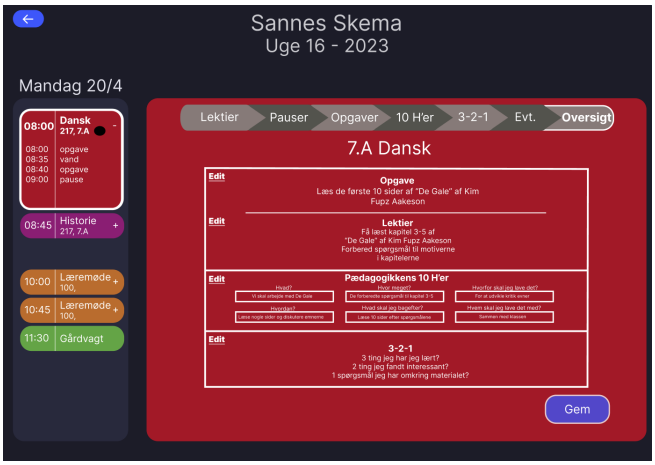

Figure 10. Page where the teacher can see an overview of the lesson.

If the teacher chooses to tap the arrow button in Figure 5, to go back in their weekly schedule a white dot will indicate that there is a student who has written notes and/or submitted 3-2-1 reflections for the class. If the teacher clicks on it, they will get an overview of all the students where they can choose between

notes or 3-2-1 reflection, a dot will indicate which student has written notes or 3-2-1. If the teacher clicks on a pupil with a star, they can see their notes from the class and the teacher can choose to incorporate the notes into a compendium for the class to use, see Figure 11. The teacher can click on the 3-2-1 reflection and learn about what the pupil found interesting and what questions they might have about the subject.

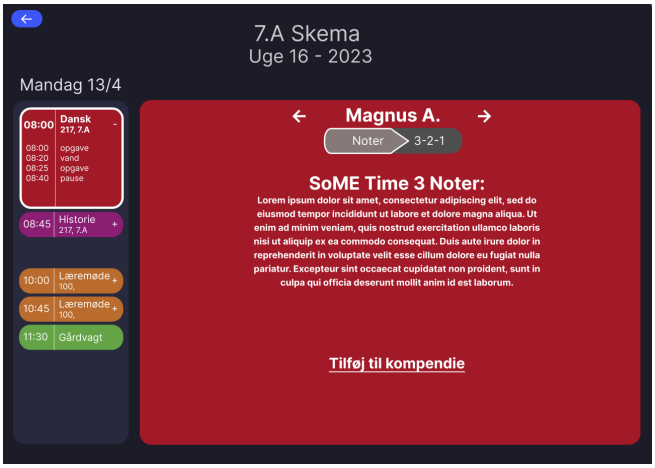

Figure 11. Page where the teacher can see the specific pupil's notes and 3-2-1 evaluation.

Figure 12. Page where the pupil can see their schedule.

Pupil version of NemSkema

The pupil front page is similar to the teacher, they can choose to see their schedule or each subject they have that year. If they click on their schedule they will also see the weekly schedule, each subject is colour coded to create an easy overview of the schedule, see Figure 12. The white dot indicates that the pupil has homework or 3-2-1 reflections to do that day, when they click on a page with a step-by-step bar and the daily and class schedule on the left side will show up, see Figure 13.

The pupil can always see the 10 guidance questions that the teacher has chosen for the class, as well as browse through the pages to see homework, tasks for the day, and the 3-2-1

Figure 13. Page where the pupil can see their homework for the lesson.

Figure 14. Page where the pupil writes their notes for the lesson.

reflection and the pupil has the option to write notes. If the pupil writes notes for the class in the text box the teacher will be able to see them help the pupils facilitate their notes, see Figure 14.

If the pupil clicks on the subjects on the front page, they will be taken to the subject page, where they can choose between the themes they are taught in the subject, under each theme there is a sub-theme where they can see the notes that the teacher has facilitated from the students. Appendix 4, shows the pupil Magnus from 7.A's user journey during the Danish lesson in the 7.A class. Figma files for the teacher and pupil versions can be found in Appendix 5 and 6.

EVALUATION OF NEMSKEMA

During our study, we conducted semi-structured interviews with teachers from two schools to evaluate the NemSkema application. These interviews resulted in results that provided insight, suggestions and perspectives that can help refine and improve the prototype.

Participant	Age	Ba. In teaching	Teaching subjects	Grade	Length of teaching
EP1	26	Yes	Danish/Social science	7-9th grade	1 Year
EP2	35	No - MSc.	Maths/Physics	7-9th grade	5 Years
EP3	54	No - M.A.	German	7-9th grade	15 Years
EP4	41	Yes	Danish/English	4-6th grade	17 Years
EP5	28	Yes	Music/Home Economics/Danish	4-6th grade	2 Years
EP6	30	Yes	Danish/English	1-3rd grade	3 Years
EP7	37	Yes	English/Maths/P.E.	7-9th grade	10 Years
EP8	43	Yes	Natural sciences /Biology/Geography/Home Economics	7-9th grade	18 Years
EP9	46	Yes	Danish/Maths	School leader	10 Years
ST1	22	Teacher in training	English/Social science	7-9th grade	1 Year - Substitute
ST2	21	Teacher in training	English/Physics/Chemistry	7-9th grade	6 Months - Substitute

Table 2. Table of the evaluation participants (EP) and Student teachers (ST) during the evaluation.

Evaluation Participants

To evaluate the NemSkema application, we interviewed the evaluation participants, through semi-structured interviews [15]. We presented the prototype step-by-step through each page of each version where the participants had the chance to interact with the prototypes and give feedback during the interview. The evaluation involved two groups of teachers and two teachers in training with diverse backgrounds and levels of teaching experience, seen in Table 2. The participants for the evaluation were comprised of teachers from two schools that were different from the one where the workshop was held.

Findings

During the evaluation, the semi-structured interviews primarily focused on the incorporation and utilisation of neurodiverse models and methods. As a result, five themes emerged from the evaluation. These are: General findings, Inclusion models, Colours and colour-coding, Indication dots, and Notes.

General Findings

The evaluation with the participants provided insight into how the designed system is supposed to work in practice, along with suggestions for improvements. When asked about the general impression of the NemSkema most participants were positive about the design and its functionalities. Both EP8 and ST2 liked its simplicity and how structured it was, yet customizable to taste, as ST2 mentioned: *"I like that it is structured, but there is still a lot of freedom to do it in a way that suits the teaching"*. The participants especially praised the organisational part, as they liked the convenience of having all the pupils' materials in one place. However EP5 stated: *"It was quite overwhelming to begin with, but it seems simple and straightforward once you take a closer look at it"*, to this ST1 added: *"The workflow seems fine, but I would be confused if I had to plan each step to plan a class"*. Most of the evaluation participants agreed on this point. The idea of creating a pupil version that resembled the teacher's version was well-received among the participants, as they gained a better understanding of how pupils view a lesson from a broader perspective as a result. The confusion of posting videos and photos as homework or assignments was mentioned multiple times by the participants, as EP2 mentioned: *"Is there an option to insert images? And view the image without having to download it?"*. And EP7 mentioned: *"Pictures, pictures, pictures. Often, I just upload a picture of the tasks they need to complete so they don't have to carry books, etc., around"*. EP6 did miss the addition of pictograms, as EP6 mentioned: *"Pictograms can help students with understanding"*. Similarly, EP8 and EP9 mentioned pictograms as a future which was missed in the application.

Inclusion models

When asked about the use of inclusion accommodating models, the 10 guidance questions and the 3-2-1 evaluation, they responded positively. They found that having an explanation of what the class was going to be about and a way of explaining it to the children consistently and concisely was a big plus. The evaluation method was likewise positively received, seeing the advantages of having a teacher be able to appraise the need for evaluation for each lesson. This is something EP9 emphasised on: *"I think, and now I'm just speaking on your(teachers) behalf, something that is difficult to find time for is evaluating [the lesson] ... so I think having a structure for evaluation that the teacher has ready access to is good"*. This is something the workshop participants also found difficult to find time and plan for, therefore giving them a structured chance to remember to include an evaluation when they plan their lessons is convenient.

Their reception to the break timer was one of moderate indifference because there was general confusion as to why it was important. However, after being given an explanation they were generally positive about the implementation. They also noted that it could be a good idea for the system to track when the break starts, freeing up the teachers needing to look at their watch, as EP9 mentioned: *"It could be nifty to be able to track the breaks and have a timer built in, so you didn't have to constantly look at your watch, at the same time making the children less restless"*.

Colours and colour-coding

When we asked the participants about the colours used in the system there was an agreement that colour-coding can help the pupils have an overview of the subject, EP1 said: *"I think it works well when you have adjusted to the design, our pupils colour-code their stuff [Books, Notebooks etc.] already, so I think it would help them"*. Though some of the participants

found the use of colours overwhelming EP8 noted: *"I think it is a bit too much and overwhelming with all those colours, maybe if there where an overlay or something that would mute the un-important subject, then it maybe could work"*. However as EP7 mentioned: *"I think we have some students who would get overwhelmed by all those colours, but we also have students who find it difficult to see things in Aula, so it will probably end up in a stalemate"*.

Indication dots

The white and black dots in the teacher version symbolise assignments and tasks that are yet to be done and when pupils have provided notes and evaluations. In the evaluation, participants mentioned that there might be confusion about the meaning behind the dots. TS2 said: *"I think I would prefer if you could press "Plan" instead of "+" and the black dot I think it would make it easier for us that might not be so technically skilled"*. Though the functionality of the dots seemed clear to all participants, EP4 said this about the dots: *"I think it makes sense with the white dot, as it is the same thing we see in Aula. However, it is bigger in this system and it makes it more noticeable"*. EP8 also had worries about the dots from the pupil's perspective of the system: *"I think it might be too much with the dots, there might be dots everywhere in the schedule then and that could become overwhelming for the pupils. Maybe the dot should disappear when they complete their homework"*.

Note-taking

Most of the participants liked the idea of including notes in the application as a way to help the students facilitate their notes as it gives the pupils the same common ground academically. EP3 recognised the worries that the workshop participants talked about: *"I have a pupil in the 8th. grade who never can find their things, it would be nice if I could help them collect them without me controlling it completely"*. Whereas EP8 had some doubts about the function to which they said: *"I think you should be careful about the notes, I like the idea, but I can see its limitations. I fear that pupils might feel vulnerable if we use their notes, maybe it should be a task we do in class and create the notes together"*.

DISCUSSION

In this section, the findings will be discussed and deliberated against the literature and existing research from the related work section. The design process and reflection of the article's methodology will be discussed. Furthermore, will the study's limitations be examined, and design implications will be derived from the findings.

Evaluation participants' experience with NemSkema

The workshop participants confirmed what D'Alessio et al. [10], identified, the participants talked about how inclusion is both an educational and social aspect, where they need tools to support their situation and environment. They found it challenging to allocate time to use the tools they needed, as the tools might work in theory, but not in practice which Kivirand et al. [14], pointed out in their study. One of the problems that the interviewees from Badawi et al., experienced with inclusion is that each pupil has different needs, and might feel excluded from the class because of their assistive tools [4], which is in line with McLaughlin et al. [16]. When presented with our prototype the evaluation participants confirmed that they need a structuring tool like the NemSkema. EP9's school was currently working on a similar structural planner, which was a whiteboard with a timetable where the teacher could structure the class at the beginning of each lesson. It supports the visual presentation that pupils with learning disabilities might need, as pupils with ADHD and autism are dependent on predictability [4], It might not have the desired effect on the pupils. Having an application that the pupils can access at home could support the predictability needed as a part of digital inclusion [29].

The Nest program [9] focuses on the individual pupil's needs as they get included in the regular public school, where we choose to focus on using the concepts from the program in the whole class to match the wide variety of pupils. The evaluation participants agreed that the principles of seeing the class agenda and timetable beforehand would help the pupils organise their work for the class as well as give an overview of what they need to do. Multiple of the evaluation participants did not know or have not used the 10 guidance questions before they confirmed that the questions can help their pupils prepare and know exactly what they have to do [4]. This can be because many of the evaluation participants did not receive mandatory lessons in special pedagogy during their teachers' education as it was reduced to a few lessons of their general pedagogy course curriculum in 2013 [6]. Similarly with the 3-2-1 reflection model [24], multiple participants from the workshop and evaluation felt like they did not have the resources to have the children evaluate their lessons. Having a reflection form integrated into the system can help them make time for it, as it is an important asset for the teachers and pupils.

When asked about the overall design of the system the evaluation participants found that it could be overwhelming at first, but after some usage and explanation, they found that it was simple and useful. One of the factors that made the system overwhelming was the use of colours in the system, but the evaluation participants agreed that the use of colours and colour-coding [17, 22] does help the pupils have control over their school subjects. Tufvesson [26] defined that a learning environment should not be overstimulating but as the evaluation participants noted with ours, there might be too much sensory input in NemSkema at first. Though after a while, it seemed to the evaluation participants that they just needed to get used to the colours and layout. Colour-coding is an important method that enhances the experience for ADHD people, both children and adults, by making the colours pop and identifiable, as Mobilize-Me also confirms in their guideline [17]. Hirano et al. found that visual presentation can support the classroom for autistic pupils, the evaluation participants agreed that visual representation is important for their pupils as it can promote their independence [13]. When we asked about what functionalities the evaluation participants liked the most, they mainly answered the 10 guidance questions, the 3-2-1 evaluation and the possibility to have a timetable for the class. Many of the workshop and evaluation participants liked the ability to write

exactly what and when tasks are going to occur during the lesson, as it would give freedom to the pupils and would make it easier to include physical activities in teaching. The pupils are prepared for what they are going to do and have the chance to be independent when they are outside of the classroom, where Bhattacharya et al. [5], found that it can help with social interaction and learning engagement. When we asked about the break structure and the examples provided in the system, the evaluation participants agreed that it was necessary but they did not recognise the kind of break structure, such as 5 minutes hard breaks that remove the pupils from the activity after 20 minutes, which Badawi et al., explored in their study [4].

NemSkema compared to existing systems

Danish public schools use Aula and MinUddanelse for their scheduling, parental contact, lesson planning and general educational structure. The evaluation participants mentioned that existing systems do not support inclusion enough even though the Ministry of Children and Education sees potential in IT-based inclusion [21], therefore we created an IT-based solution to further inclusion in that direction. According to the workshop and evaluation participants, many teachers use different workspace platforms such as Google Drive or Microsoft Office Online. This gives the pupils a lot of systems to keep track of and it can make it hard for them to remember where all of their notes and general schoolwork are. There was an intention of collecting all the systems and functionality in one place because the workshop participants talked about the annoyance of having to move between systems and offer the pupils access to school-approved exam tools. There is still the consideration that some people find it helpful to have work divided up in neat specific places, as it could be overwhelming when shifting through one big system. One of the main points from our workshop participants was to have every school activity collected in one system, which made us design NemSkema as we did. When we asked about how the evaluation participants used the existing systems and compared them to the NemSkema prototype, the responses were generally in favour of having a system like ours because Aula does not support the structural requirements that the schools have [23]. It supports the possibility to have everything collected in one place and it reminds the teacher about evaluating their lessons.

Reflecting on the methodology of NemSkema

When choosing the direction for the application there was a prospect of going in a broader direction and focusing on neurodiversity in a more wide-ranging way. The spectrum of neurodiversity is very wide and includes many different groups and kinds of people we needed to restrict the scope of the study. We chose to limit ourselves to ADHD and autism, as they are the most common occurrence of neurodiversity in children in Denmark [18], as there is a greater chance of interviewing teachers who have experience in these fields. Going with a wider space of neurodiversity would have resulted in a hypothetical extensive solution that could have included more general problems that arise in the classroom as seen in the 'Smertensbørn' documentary [27], rather than focusing on two specific edge cases. We instead decided to focus on a solution that would more subtly benefit autistic and ADHD pupils while still allowing it to be helpful to neurotypical pupils. Both to accommodate the alien feeling that arises when giving specified tools to neurodiverse children and also to improve aspects of the current system that does not currently work appropriately. In other words, an important way of creating tools would be to focus on a general problem with constraints set in place, as if the solution becomes too broad it might not have a significantly positive effect on the recipients. As inclusion consists of five different categories [21], it was necessary to choose one to narrow our focus. Badawi et al., mention that individual tools might get destroyed if the children feel excluded socially from the class, therefore, we wanted a tool that could be used for the entire class which the teacher would facilitate [4]. The workshop and evaluation participants also noted the same, that they needed tools to support them in structuring their lessons. The *Structure and Overview* [21] category, would be the most fitting to fulfil these needs.

To determine a direction for this study we conducted a variant of the Inspiration Card Workshop based on the findings from our previous paper [4]. The participants from this workshop included some of the interviewees from the previous study including a few of their coworkers. Conducting an Inspiration Card Workshop made it possible to gather insight loosely and conceptually, utilising their different dispositions and creativity to explore possible design concepts early in the design process. We only had the resources to conduct one Inspiration Card Workshop which may limit the validity of our workshop findings. To provide a broader spectrum we ensured that the participating teachers had varying levels of teaching experience. The workshop was facilitated with cards inside and outside of the domain based on our findings from our previous study and on tools and methods that are used in school and by children, to ensure that the workshop participants had familiarity with some of the cards. We presented eight within-domain cards, that the participants may not be familiar with, at the beginning of the workshop. We facilitated the workshop in this way to ensure cooperation, as without cooperation, it can leave out individual participants' input that may be overlooked, hindering the overall outcome of the workshop. In the absence of proper facilitation, it can diverge into unrelated tangents and underline the workshop's intended agenda. However, unrelated tangents can lead the participants to be creative and lead them in unexpected directions, creating extreme concepts.

To arrive at a set of design implications, we created a Research-Through-Design solution [30] called NemSkema in Figma. This approach provided a method of more precisely studying our problem area, by giving form to what was being researched. Creating a prototype in Figma gave us the possibility to create a clickable prototype that the evaluation participants could navigate during the evaluation. Using Figma made it easy to demonstrate what a possible design could look like and how it could get used. During our design phase, we created many possible designs in Figma and evaluated them with the student teachers from the Findings section, before we created the design for the prototype. The student teachers noted that while our possible designs seemed understandable it would help to have a pupil version that the teachers could reflect on,

which made us create two versions of the system. The two versions were well received during the evaluations, and the teachers agreed that it gave them a broader perspective. While the visual advantages of Figma encourage design possibilities and flexible creativity it also limits how it can be evaluated, as it is only a clickable prototype without any functionalities that could be evaluated.

During the testing and evaluation phase of the prototype, it was not possible to continue working with the same participants from the workshop, leaving the need to find a new group of participants. It meant the Co-design [8], process could not be fully concluded, and instead, two additional groups of participants were recruited to provide feedback on the prototype. The first group was interviewed in an informal setting, where we had the opportunity to engage in unplanned conversations with them. On the other hand, the second group was interviewed in a formal setting that we had planned in advance. The informal setting allowed the teachers to discuss their experiences more naturally, while the formal setting followed a more standardised structured approach. Due to this, the results from the evaluation could differ as the circumstances of each interview's surroundings and environment could prompt different levels of comfortability and professionalism, even if they followed the same semi-structured interview questions.

Limitations

While collaborating with our workshop participants, we encountered some limitations that affected them during our study. The evaluation meeting was the only time they were unable to participate, which meant we could not evaluate the prototype with the same participants, as we had collaborated with during the initial interview during the pre-specialization phase and the Inspiration Card Workshop. Despite this, we were still able to get feedback from other participants within the target audience in the evaluation phase. Besides the mentioned limitation, other limitations restricted our study. The lack of time available for further development of the prototype and its implementation in a real-world setting. This prevented us from observing the teacher's and pupils' interactions in practical situations, thereby gathering valuable information about its practical application that could have made potential improvements to the system.

Design Implications

The design of the NemSkema application shows a variety of implications when it comes to designing systems for autism and ADHD, within the confines and limitations of the Co-design [8] process. Through our evaluation, we have identified a total of seven categories of design implications.

Keep a consistent teacher-pupil design

Our evaluation showed a general interest in streamlining the planning process and making both sides of the application identical to each other. The evaluation participants found that it could align with how they explain their lessons and could reduce confusion. It was similarly helpful to have a way of introducing inclusive methods that support autistic and ADHD pupils without taking them away from the rest of the class as well as keeping the workload for the teachers at a comparable level as before

Break structuring for pupils' daily workload

It is important to note the significance of the break timer and the implications it has. Most of the workshop and evaluation participants talked about how it could be helpful but simultaneously did not understand why it was necessary. It shines a light on a not-as-thoroughly understood aspect of autistic and ADHD timekeeping and how they are able to structure their time. A way of structuring their lessons came in the form of giving them more control and leeway when defining breaks. Giving the children a clear understanding of when breaks start so both they and their teachers could plan accordingly.

Use the 10 guidance questions to give pupils predictability

The evaluations revealed that the teachers were not familiar with the 10 guidance questions by Bohr [7], but multiple of them found the questions useful and plan to use them as part of their preparation. It is a method that gives context to the meaning behind a specific assignment or task, where it is meant to aid with conceptualising the themes in the said assignment. This is an important delineation as many neurotypicals tend to take the unspoken social rules and norms for granted and just expect everyone else to conform. By using this approach it gives a clear and definable backdrop for those who need it.

Include reflection models to remind the teacher to evaluate

The results from the evaluation show that including a reflection model such as the 3-2-1 [24] model in a structuring application can help remind the teacher to evaluate their lessons and make them structure their time schedule to do it. The implication of the method is that it gives the pupil a structured way of evaluating their work or lesson, while also prompting their creativity to think about in particular terms what they learned.

Use colour-coding to help children organise their work

Even though the teachers found that the colours could make the system overwhelming, colour-coding [17, 22] is an important tool to help children organise their work and help them focus during their lessons [22].

Teachers need tools to help them support inclusion

While many papers focus on creating tools to support inclusion with children, it is important to recognize that teachers are in need of tools as well. Our results identify that teachers need tools to help them support their pupils and that they are open to utilising structuring tools such as NemSkema.

Create a tool for everyone instead of the individual

Our findings indicate the necessity for a universally accessible tool to support inclusion. As Badawi et al. [4] confirms, inclusion is not only for the neurodiverse pupils, but it can be useful for the whole classroom. Inclusion is also a multifaceted field that includes a lot of different aspects and avenues that can take different shapes and solutions. While a broad solution should address the initial problem it seeks to solve, it should incorporate specific elements that have been proven to enhance and assist the particular group in question, namely autism and ADHD in this case.

CONCLUSION

Through the findings of our former study and the initial data from the workshop with the teachers, we identified a need for a design solution that helps teachers create an inclusive learning environment. We are asking the following research question:

We want to examine which design implications a designer would need to acknowledge when working with a digitally inclusive platform that can help teachers facilitate their lessons, and help students prepare for their classes.

We approached the research question by addressing related literature and inclusive methods that support the school experience of autistic and ADHD children. We developed and evaluated a Research-Through-Design solution named NemSkema, to arrive at a range of design implications. The process involved using an inspiration card workshop with 7-9th grade teachers to include them early in the design process, as well as conducting a semi-structured interview with another group of school teachers, to evaluate the solution and to get feedback. We found that while the participants were knowledgeable about the subjects they taught they were still lacking in some techniques that could help autistic and ADHD pupils. The evaluation cast light on how some of the design implications were methods they had no knowledge of. Since scheduling breaks and the 10 guidance questions were things some of the participants had not heard about. Based on this the evaluation resulted in seven design implications that designers can use in their studies when designing inclusive tools that can help teachers facilitate their lessons.

FUTURE WORK

To further improve NemSkema, future efforts will focus on three main areas: Testing with pupils, conducting workshops with pupils who have ADHD and/or autism, and deployment in a real-world setting. By involving pupils, we can get feedback to ensure that the features and functionalities meet their needs. Pupils with ADHD and/or autism can be included during a workshop, in order to gain valuable insights into their unique needs, allowing for a more inclusive solution. Lastly, the deployment of NemSkema in a real-world setting will give us the opportunity to observe how it actually performs during a regular school day, from both the pupils' and teachers' points of view.

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