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Smart Solutions for Wellbeing Service Development and Management
– Winternational 6.0

Moisanen Kirsi, Huhtala Saija (ed.)

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Content

Foreword

Smart solutions and innovation are part of today's society. In social and health services too, smart solutions are being used to produce and develop services that meet the needs of patients and customers. The pace of technological progress and its application continues to offer new opportunities for the social and health sector that can significantly contribute to the efficiency, quality and accessibility of services.

Smart solutions such as artificial intelligence, machine learning and robotics can be used to improve social and health processes, patient care and customer service. AI-based solutions can help in areas such as diagnostics, treatment planning and prognostics, which contribute to the accuracy and speed of clinical decisions (Saria, Butte & Sheikh, 2018). Various technological applications can analyze large amounts of patient data, identify potential associations and provide personalized, patient-centered treatment recommendations (Esteva et al., 2019). Advanced technologies are advancing the design and implementation of services by analyzing large amounts of data. This enables individual needs to be identified and targeted services to be delivered, improving customer experience and service efficiency. (Esteva et al., 2019.) In turn, robotics can improve the efficiency of surgical procedures and patient rehabilitation, while offering the potential to reduce the physical burden on caregivers (Soriano, Yasuhara, Ito, Matsumoto, Osaka, Kai, Locsin, Schoenhofer & Tanioka, 2022).

Developing innovation is at the heart of social and health sector reform. Innovative solutions using smart solutions can make a significant contribution to cost-effectiveness and accessibility of services (Topol, 2019). Telehealth and telemedicine are examples of innovations that enable patients or clients to be monitored and treated regardless of geographical distance (Haleem, Javaid, Singh, & Suman, 2021), while digital platforms can connect different providers and clients, facilitating coordination and monitoring of services (WHO, 2016).

The social and health sector is vulnerable to change due to an ageing population, increasing chronic diseases and rising cost pressures (World Bank, 2016). The integration of intelligent systems and innovative solutions into daily operations is essential to meet these challenges and to promote the quality of social and healthcare services and the well-being of patients (European Commission, 2020). Collaboration between different stakeholders, including researchers, technologists, health and social care professionals and policy makers, is essential to develop effective

and sustainable solutions to improve the quality and efficiency of social and health care and improve the quality of life.

The Smart Solutions for Wellbeing Service Development and Management (5 credits) course was implemented for the seventh time in the academic year 2023-2024 in cooperation with teachers from Kajaani University of Applied Sciences and Neu-Ulm University of Applied Sciences. The publication describes five different innovations in the field of social and health services and their development in a joint article. This publication provides valuable insights and perspectives on different innovations that support the evolution of the social and health sector towards increasingly intelligent and efficient solutions. We hope that this publication will contribute to the understanding of the potential of smart solutions and inspire the development of new innovations in the social and health sector.

Kajaani, 26 August, 2024

Kirsi Moisanen, Saija Huhtala, Aleksander Würfel and Peter Kuhn

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1 MINTYMISSION – Toothbrushing Games for Kids

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Abstract

The prevalence of oral diseases, especially dental caries, is a major global health problem affecting a lot of people worldwide. Inadequate oral hygiene in childhood in particular contributes to this problem at an early stage. Thereby, mobile applications in the healthcare sector can be beneficial.

The following article describes a way to improve children's dental health. An app with a 12-week prevention program called "MINTYMISSION" was developed, whereby children's toothbrushing habits and dental health are promoted with gamification through competitive missions between family members. Dental staff is involved and manages the distribution of app IDs for access and the physical components required for technical implementation, a toothbrush attachment and a pair of glasses. In addition, the data protection-compliant recording of data and the monitoring of progress by the dentist creates a professional framework. An analysis of the app market, literature research and interviews led to the development of this innovation. The aim of this article is to develop and promote children's oral health well-being. Further, the purpose of the article is to describe how to promote children's dental care practice through the use of game-based activities.

Keywords: Oral Health, Dental Care, Health Apps, Gamification, Brushing Games for Kids

1.1   Introduction

In a world where every smile tells a story, unlocking the potential of a confident and vibrant life begins with the foundation of good oral health. So, one could assume that people are interested in their oral health. However, the reality looks quite different.

The World Health Organization published in the "Global oral health status report of 2023" that almost 3.5 billion people worldwide are affected by oral diseases. Of them, an estimated 2 billion people have caries in their permanent teeth and 514 million children have caries in their primary teeth. (World Health Organization [WHO], 2022, 6.) This means that oral disease is a major public health problem for countries and populations worldwide (WHO, 2022, 6). Oral diseases, especially cavities, could most often be prevented by routines such as brushing your teeth twice a day, using fluoride toothpaste, and reducing the use of sugary products. (WHO, 2023; Karies, 2023). In Finland, the problem with cavities results from the lack of teeth brushing. Studies indicate that school children brush their teeth much worse than recommended. (Karies, 2023; Koulukysely, 2023; Stein et al., 2017.) Therefore, new methods for addressing the poor oral hygiene among children and adolescents are urgent. Especially the digitalization of oral routines has the potential to make a key contribution to prevention efforts.

The growing use and global spread of mobile technology have increased the development and availability of health and wellness applications. Mobile applications (apps) are primarily designed for direct consumer use, but some are also used by healthcare professionals. (Holopainen, 2015, 1285.) Most oral health-related apps are geared towards health promotion (Väyrynen et al., 2023, 1). Health apps can be used to improve people's awareness of their own health. They play a crucial role in the empowerment process of individuals and in changing health behaviours. In the case of children and adolescents, playing games through those apps makes it possible to achieve long-term changes. (Mano, 2021, 1; Chen, 2021, 1,6–7,12.)

The aim of this article is to develop and promote children's oral health well-being. Further, the purpose of the article is to describe how to promote children's dental care practice through the use of game-based activities. The innovation, called MINTYMISSION, is an app to promote family dental health through interactive missions and competition. The name of the app refers to the concept of minty freshness combined with completing missions, making dental care fun. Families take part in a 12-week prevention program to improve their toothbrushing routines, while simultaneously offering missions and competition and involvement of the dentist. Thus, it combines interaction, coaching and tracking with the dentist guidance, which does not yet exist.

1.2   Background

Burden of Oral Diseases

According to (WHO, 2022, 6) about 3.5 billion people worldwide suffer from oral diseases, with approximately 2 billion people having caries in their permanent teeth, including children with caries in their primary teeth. The global average prevalence of oral diseases stands at a high rate of 45% (WHO, 2022, 9). In addition, the combined estimated number of cases of oral diseases globally is about 1 billion cases higher than the combined number of all five main noncommunicable diseases (mental disorders, cardiovascular disease, diabetes mellitus, chronic respiratory diseases, and cancers) (WHO, 2022, 7). This underscores the public health challenge posed by oral diseases globally.

Some of the most common reasons for poor oral health in children are geographical and socioeconomic barriers and therefore, limited access to dental services (Estai et al., 2020, 2). Oral diseases are caused by a range of modifiable risk factors including sugar consumption, tobacco, alcohol as well as poor hygiene, and their underlying social and economic determinants (WHO, 2022, 17). Figure 1 shows the prevalence rates of major oral diseases over the life course. Because teeth are susceptible to caries as soon as they break through, the peak prevalence is at the age of 6. Similarly, the prevalence of caries in permanent teeth typically shows steep increases after the eruption and reaches the highest levels in late adolescence and early adulthood before remaining stable for the rest of an adult's lifetime. (WHO, 2022, 19.)
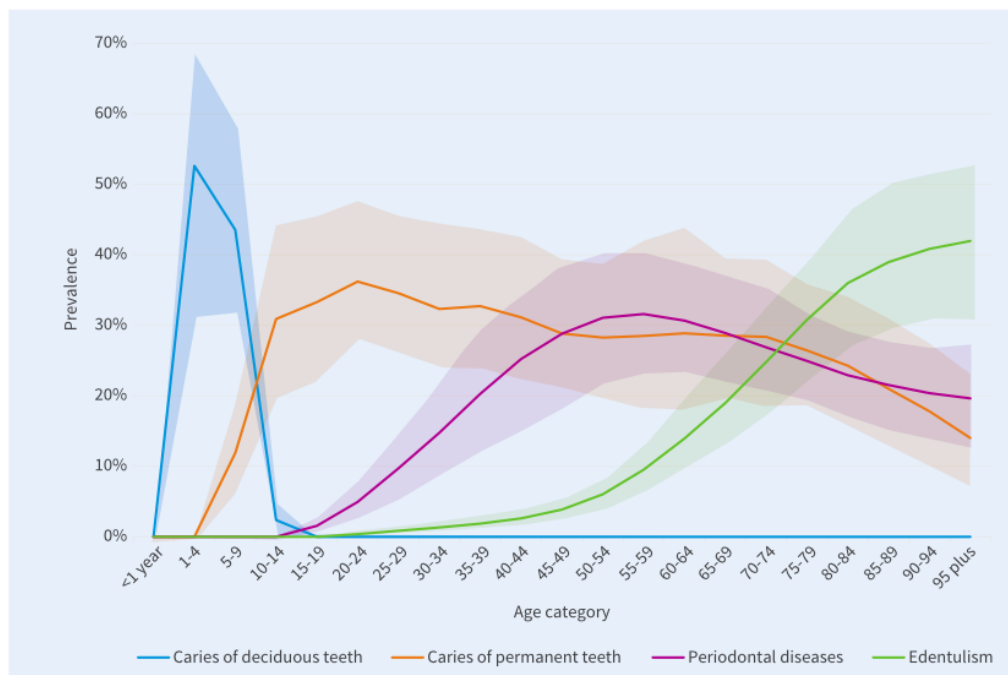
Figure 1. Prevalence rates of four major oral diseases over the life course (WHO, 2022, 19)

Left untreated, caries can have severe effects, leading to costly treatments and physical and psychosocial consequences such as pain, sepsis and disturbed eating, drinking and sleeping habits. A child's development may be affected by poor oral health, leading to below-average height, weight, head circumference, and increased absenteeism from school. (Estai et al., 2020, 2.) The good news is, that oral diseases are largely preventable or require only simple interventions, if they are diagnosed and addressed at an early stage (WHO, 2022, 60). This includes the promotion of oral health in the family, at school and work, as well as timely, comprehensive, and integrative care within the primary healthcare system. According to the WHO (2023, 67) these prevention approaches should be promoted. A balanced diet low in free sugars and high in fruit and vegetables, with water as the main beverage, quitting the use of all types of tobacco, including chewing areca nuts, reducing alcohol consumption, and brushing twice a day with fluoride toothpaste should be encouraged.

The School Health survey conducted in Finland in 2023 investigated the situation regarding brushing schoolchildren's teeth. The results show that 34.8 % of boys and 25% of girls in 4th and 5th grade brush their teeth less than twice a day. In older age groups, 8th and 9th graders, 42.9 % of boys and 28% of girls brushed their teeth less than twice a day. (Kouluterveyskysely, n.d.; Karies, 2023.) Furthermore, a statistical extract (Figure 2) of a 2018 study of 13-year-old children claims that 79% of girls and 53% of boys brush their teeth more than once a day. Consequently, Finland ranks worse in terms of tooth brushing than other countries.

11-year-olds who brush their teeth more than once a day

DIRECTION OF SIGNIFICANT CHANGE, 2014–2018 — GIRLS (%) / BOYS (%)

Country	Girls 2014	Girls 2018	Boys 2014	Boys 2018
Switzerland	89	91	85	84
Sweden	89	88	82	82
Germany	80	86	78	79
Denmark	78	82	77	80
Netherlands	84	82	77	80
Austria	83	84	78	72
England	82	84	74	71
Norway	78	81	77	74
Czechia	77	81	67	72
Serbia	–	81	–	69
Luxembourg	76	78	73	71
France	82	80	72	68
Scotland	81	79	73	68
Slovenia	77	80	68	64
Wales	79	77	67	66
Canada	74	74	64	67
Iceland	74	77	63	64
Italy	78	75	65	66
Portugal	73	77	62	60
Spain	75	73	65	64
Estonia	72	73	57	61
Ireland	73	74	63	60
Croatia	71	72	59	61
Poland	70	74	54	58
Finland	66	72	53	59
Bulgaria	75	73	61	56

13-year-olds who brush their teeth more than once a day

DIRECTION OF SIGNIFICANT CHANGE, 2014–2018 — GIRLS (%) / BOYS (%)

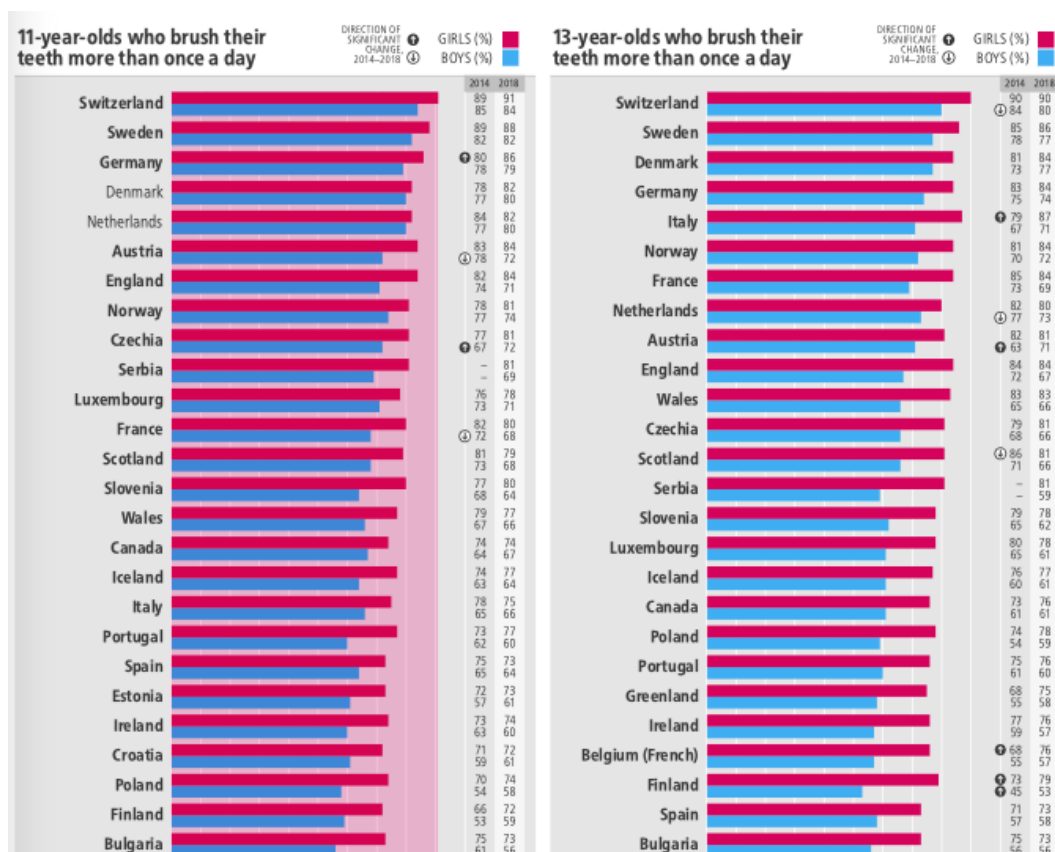| Country	Girls 2014	Girls 2018	Boys 2014	Boys 2018
Switzerland	90	90	84	80
Sweden	85	86	78	77
Denmark	81	84	73	77
Germany	83	84	75	74
Italy	79	87	67	71
Norway	81	84	70	72
France	85	84	73	69
Netherlands	82	80	77	73
Austria	82	81	63	71
England	84	84	72	67
Wales	83	83	65	66
Czechia	79	81	68	66
Scotland	86	81	71	66
Serbia	–	81	–	59
Slovenia	79	78	65	62
Luxembourg	80	78	65	61
Iceland	76	77	60	61
Canada	73	76	61	61
Poland	74	78	54	59
Portugal	75	76	61	60
Greenland	68	75	55	58
Ireland	77	76	59	57
Belgium (French)	68	76	55	57
Finland	73	79	45	53
Spain	71	73	57	58
Bulgaria	75	73	56	56

Figure 2. Spotlight on Adolescent Health and Well-being (WHO, 2020, 22-23)

The lack of access to dental care services is a common reason for poor oral health among childrens (Estai et al., 2020, 2). This is because access is not evenly distributed across the population and certain groups, such as low-income families or ethnic minorities, may have a higher risk of poor oral health due to structural inequalities (Benzian & Loistl, 2022, 150). Through a longitudinal study of health and behaviour in a full birth cohort, there arise complex relationships between socioeconomic status in early childhood, beliefs about oral health, and oral health behaviour (Broadbent et al., 2016, 809). Therefore, it is important to include the area of prevention. Digitalization plays an important role in prevention because the use of apps has increased in recent years, especially in the healthcare sector (Parker et al., 2019, 600).

Context of Health Apps

The ubiquity of mobile technology has led to the development and availability of various health and wellness apps, known as mHealth (mobile health). Mobile apps are primarily designed for direct consumer use, such as fitness and sports, but some are used by healthcare staff. These include remote consultation, patient monitoring, and health information apps. (Holopainen,

2015, 1285.) The use of patient-oriented apps in oral health has increased, especially among children and young people. Most of these apps are focused on promoting health. (Väyrynen et al., 2023, 1.)

The study considered next, examined apps aimed at preventing tooth decay available in Australia and found that over half of the apps were targeted at adults and young adults. In contrast, no apps specifically designed for young children focused on prevention were found in the study. Half of the apps focused on providing health information, while the other half aimed at behaviour change by offering goal-setting functions. The majority of the examined apps were available for free download. Of the apps, 93 % addressed oral hygiene, 43% the usage of fluoride, and 21% covered diet. Popular features included time spent on brushing, social media support, tips for better oral hygiene, goal setting and gamification. The most popular individual app was the Brush DJ app. The study suggests that in the future, to ensure the quality of these apps, professional perspectives and evidence-based information should be incorporated in the design phase. (Chen, 2021, 1,6–7,12.)

The benefits of health apps have been investigated in a literature review. It revealed that the use has positive effects on individuals' health and increases people's awareness of their health. Additionally, apps were found to provide health education, and improve the diagnosis of patients and complement the treatment they receive. In the case of children and adolescents, playing games through those apps made it possible to achieve long-term behaviour changes. (Heidel et al., 2020, 3–5). Further, health apps play a crucial role in the empowerment process of individuals and in changing health behaviour (Mano, 2021, 1).

Concerns about data privacy, data theft, and the selling of data to third parties were highlighted in the next study examined in relation to health apps. It investigated 79 apps, revealing that 90 % of them were connected to third parties. The majority of current apps are not certified as medical devices. This means, that the protection of data may not be monitored by a government agency. The absence of certification is often attributed to the slow and costly certification process. According to the research, a potential solution to data protection issues could be transparency in data handling as it could increase users' willingness to share their information. The European General Data Protection Regulation governs the processing of personal data, considering data as each individual's personal property. (Heidel et al., 2020, 5–6.) The study by Dawson, (2020, 7) expressed concerns about the sharing of health app data with third parties.

In the EU, various standards and specifications have been developed to increase the reliability of health apps. Health apps that are used for diagnosis, treatment or disease detection should be registered as medical devices. Different regulations have been developed for medical devices to ensure the quality and reliability of the devices. Various standards have been drawn up as a follow-up to the regulations. Products that meet the requirements for medical devices can be identified by the CE marking. (Suomen standardit, n.d.) Some health apps are not classified as medical devices, although they may contain personal information. To ensure reliability and quality, the technical specification CEN ISO/TS 82304-2 has been published. This assesses the medical validity, privacy protection, technical quality and usability of apps. Compared to the standards of medical devices, this procedure is less demanding. After the evaluation, the device is assigned a quality label. The specification procedure is still not carried out in Finland, but in the UK there is an assessment body ORCHA. (Suomen standardit, n.d.)

1.3   Innovation Methods and Development

First, a market analysis was carried out, using Google Play Store and the App Store, to find out which dental care apps already exist. For this objective, 17 selectively researched apps were examined in terms of their functions and target groups. There are already interactive tooth brushing apps for children and adults on the market, mostly connected to Bluetooth toothbrushes, as well as apps for monitoring and providing information on dental health. Combining these existing functions with an app that focuses on children's dental health with the involvement of professionals in a framed program is not available, which is the new idea of MINTYMISSION.

Second, a literature review was conducted to examine the background to oral health and mobile apps in the healthcare context, which was the basis for the innovation development. The main keywords "Oral Health, Dental Care, Gamified Brushing Apps, and Toothbrushing Games Kids" were used for this research. It was found that mobile apps increase people's awareness of their own health, and gamification can be used for long-term behavioural changes in children and adolescents (Heidel et al., 2020, 3–5). In addition, the need to promote oral health with the help of a mobile app was investigated. This showed that oral diseases are still a problem in today's world and could be affected by changing lifestyles, especially by brushing teeth. (WHO, 2022, 6; WHO, 2023; Estai M. et al., 2020, 2-5.) One way to influence lifestyles and habits nowadays is through health apps (Holopainen, 2015, 1285). Further, it became clear that the applications used in oral health care are mainly aimed at adults and young adults (Chen, 2021, 1,6–7,12). This research

confirmed the need to develop a gamified app aimed at promoting oral health long term targeted at children as it revealed that their brushing rate has not yet reached the recommended level.

Third, to understand the needs of potential users, interviews were conducted. Further, the" HOW MIGHT WE"- method was used to create new approaches to problems. (Siemon et al. 2018, 97.) The questions were asked from the perspective of the dentist, the child and the parents and the answers clarified the problem the app has to address. In addition, a work plan with Gantt and a work breakdown structure was created. Thereby, the project schedule was defined, and the necessary tasks and milestones were outlined.

1.4   MINTYMISSION

Innovation Description

The innovation "MINTYMISSION" is an app to promote children's dental health through interactive missions, consisting of seven brushing and five bonus ones, and points-based competition in a 12-week dental care program, involving the dentist for professional guidance. With completing missions' users can earn points. This gamified approach serves as a motivation to enhance dental care. Well-planned gamification can increase learning motivation. (Sailer, 2016, 378.) The point's purpose is to describe the user's achievements as the game progresses. Leaderboards illustrate the achievements of different users. (Wu et. al., 2021, 4.)

On the one hand, there are brushing missions which are played daily two times. The toothbrush movement is used to play games by erasing a picture (e.g. an animal image) or by picking up things (e.g. apples of the tree). For completing one brushing mission, users earn 20 points. Figure 3 shows examples for brushing missions.
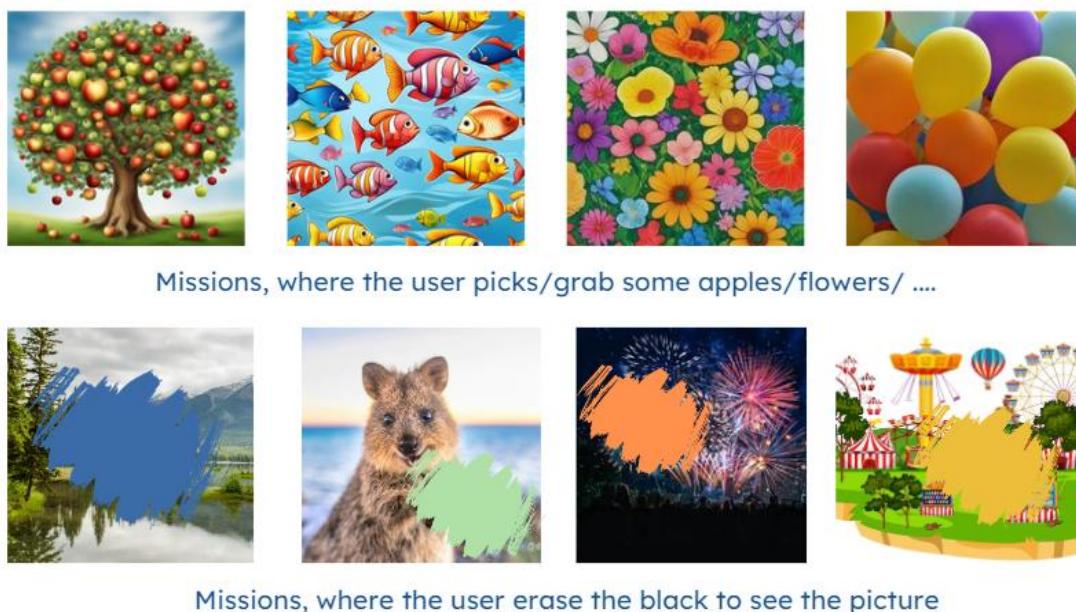
Figure 3. Brushing Missions Overview

On the other hand, there are weekly bonus missions where users can collect bonus points to increase competitiveness. These occur each twice after the introductory weeks. Described as follows: 1st sweets diary mission: don't eat sweets, 2nd drinks diary mission: don't drink soft and energy drinks, 3rd xylitol mission: use chewing gum or pastilles, 4th floss mission: use dental floss and 5th mouthwash mission: use mouthwashes. Each bonus mission lasts for one week, with participants earning 10 points per day upon completion. At the end of the week, a summary of the collected points is transferred to the points counter. Additionally, information regarding the importance of the bonus missions is provided every Wednesday through pop-up messages. An example can be seen in Figure 4. The first pop-up appears after the first brushing mission, the second and third after the second one. The last message in the middle of the week.
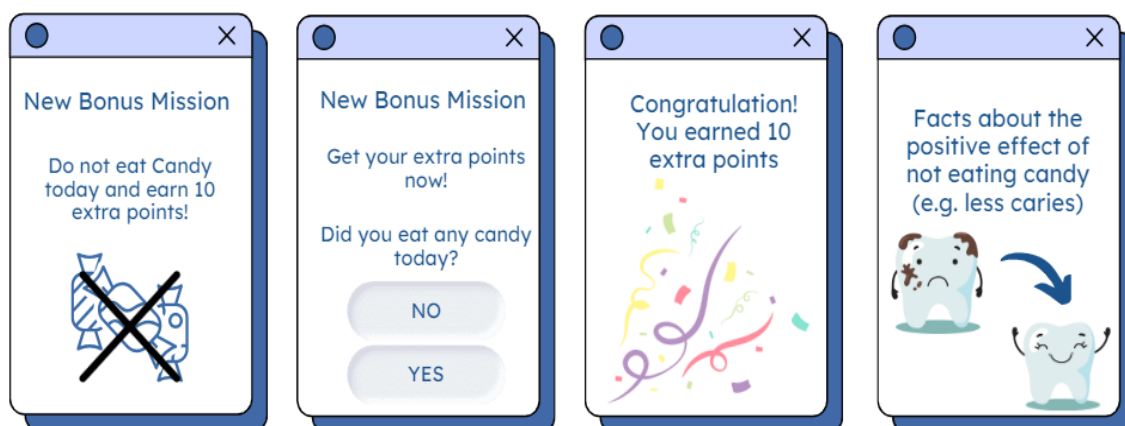

Figure 4. Bonus Mission Pop-up Messages

The family engages in a competition, employing a scoring system wherein brushing twice a day accrues 40 points, while bonus missions yield 70 points per week. Throughout the 12 weeks, the cumulative points amount to 4060. Engaging the whole family in the program is decisive. A 2019 study found that the family environment plays a big role in influencing children's toothbrushing, as teaching brushing teeth and increasing brushing skills are not enough to achieve long-term changes. No broader interventions have been developed in dental care aimed at parenting, family organisation and routines and thus achieving an impact on children's tooth brushing. (De Jong-Lenters et. al., 2019, 2.) Involving parents in children's tooth brushing establishes a routine and fosters family-wide behaviour change, enhancing children's health commitment.

To determine the program length, a study was used to investigate how long it takes to form new habits. The average time to habit formation was about 66 days, with a range of 18 to 254 days due to individual circumstances between the adults. (Lally, P. et al., 2010, 1002.) As there is no comparable study on children, this serves as reference. If the introductory weeks are excluded, then MINTYMISSION hits the length of approximately 66 days (~9.4 weeks). Table 1 shows the sequence of the 12-week program and the missions.

Table 1. Prevention Program 12-Week Progression

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Introduction weeks: Only brushing missions for acclimation		Brushing & sweets diary mission	Brushing & drinks diary mission	Brushing & xylitol mission	Brushing & floss mission

Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Brushing & mouthwash mission	Brushing & sweets diary mission	Brushing & drinks diary mission	Brushing & xylitol mission	Brushing & floss mission	Brushing & mouthwash mission

At the beginning of the program, each family receives app codes from the dentist to get access. Moreover, an appointment is set for users afterwards to discuss the outcomes at the end of the

program. This way a professional frame is created involving the dental staff. Finally, in Figure 5 a mockup of the app can be seen.
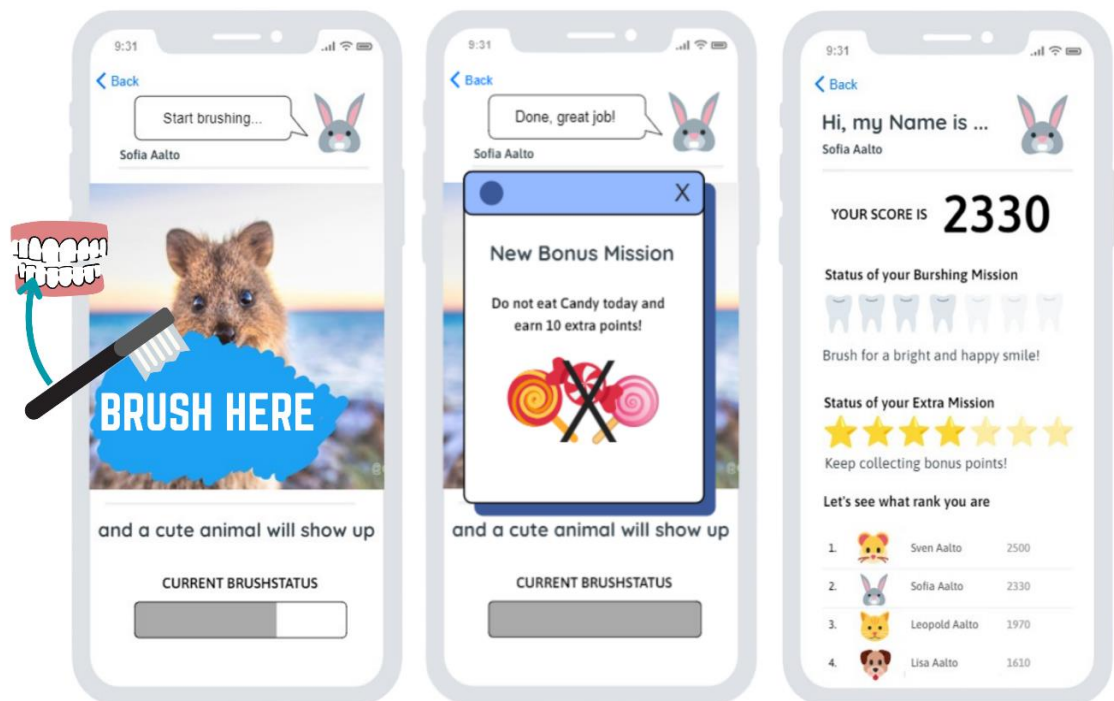

Figure 5. MINTYMISSION App Mockup

In Figure 5, the left screen displays a brushing mission, where the brush movement clears the animal image. A bunny icon initiates the mission with "Start brushing," while a bar shows the current brushing status. In the middle screen, a message pops up to introduce the bonus mission upon completion of the brushing mission. The right screen displays the profile overview: the current score, mission status, and family ranking.

Technical Implementation

For the implementation of the MINTYMISSION innovation, the technical setup is explained below: First of all, there is the professional staff, which is to be involved in this app. They have their own practice information system and therefore, an app connector is required to enable a widespread simple implementation without dependence on a specific practice system.

The dentist distributes a starter package to the families. This first part of the package are the required IDs to use the app. The second part contains the physical components such as, an attachment for the toothbrush as well as a pair of glasses, that must be used for each brushing action. To record the movement of the brush, a coloured attachment is provided, which is placed

at the brush end. For that purpose, a study was consulted, where a 3D ball-shaped attachment on a toothbrush successfully performed the tracking of toothbrushing behaviour in terms of propensity and accuracy via a tablet camera on seven children over 20 days. This attachment is coloured with a specific colour sequence and is divided into two hemispheres, whose connecting circle is orthogonal to the main axis of the brush. Each hemisphere is split into six slices and thus, different colours. In order to avoid inequalities, the two hemispheres were painted according to two different colour sequences, making it possible to estimate the spatial orientation of the toothbrush. (Marcon et al., 2016, 35-37.) As this study has a small test frame, the technical setup also includes a pair of glasses with bright round stickers on both sides, allowing the phone camera to better capture the face position for evaluating the brush movement. Hence, the camera recognizes various fixed points using the movement of the attachment and the face recognition through the glasses stickers and saves these as brushing data. Facial localization technology based on Active Shape Model technique is used to recognize the fixed points (Marcon et al., 2016, 38). The use of this technique to find the landmarks is a promising approach with robust object identification and location (Cootes et al., 1995, 57). Figure 6 shows the components of the starter package and the app ID distribution.
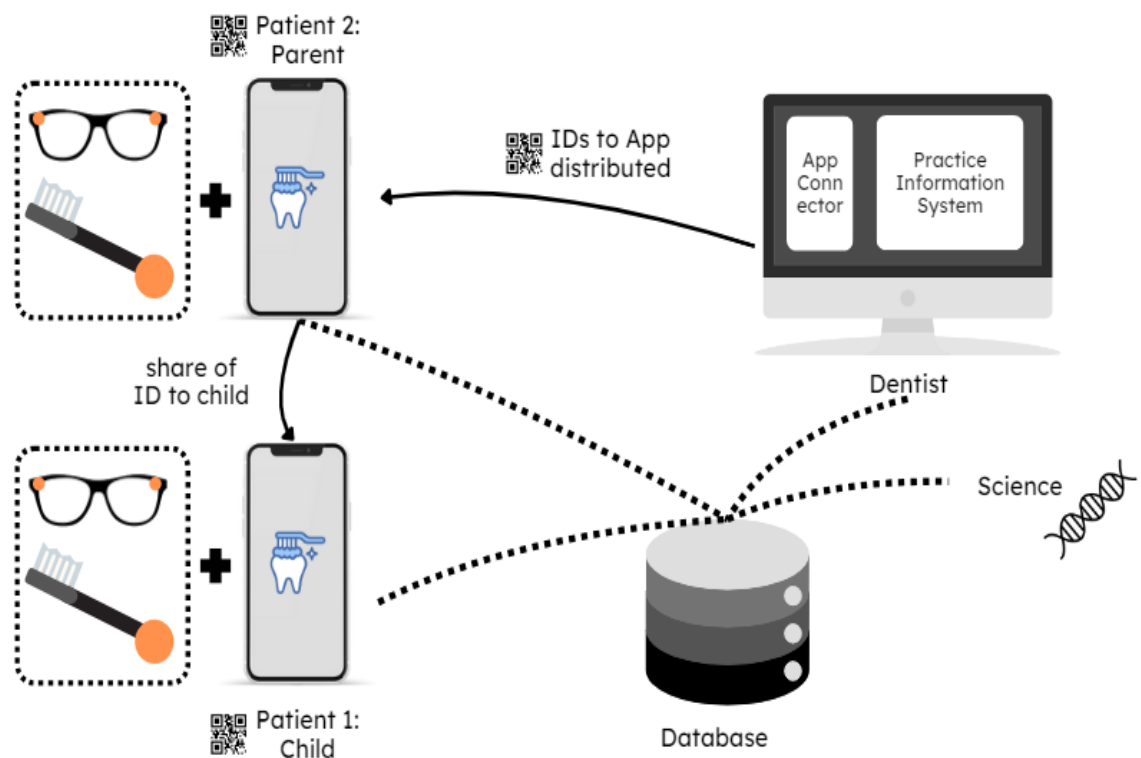

Figure 6. MINTYMISSION Technical Setup

Moreover, Figure 6 displays the data transfer between the actors. Data is generated for the Patients 1 and 2, which is stored in a database hosted by Amazon. When brushing, information about the brusher's glasses and brushing is sent to an app on the mobile phone. Brushing transmits information to the app about the time spent brushing and brush movements. Then the app identifies the mission as completed. In addition, the app will contain information about bonus missions acknowledged by the user himself through the pop-up messages in Figure 4. The data collected is transferred to the database. Competition between family members requires that the information from the database is transmitted between them. The information conveyed is the points earned by each member through missions. The information in the database is available to users in real time, and the information on the points earned by users is updated immediately. This keeps the competition up-to-date and encourages the family member to grab available missions to earn points. The database transmits information to the dentist, who is then informed about the progress with the number of brushing and bonus missions performed through weekly ready-made reports. This data is discussed with the dentist at the program end at the previously scheduled appointment. Additionally, the data on brushing behaviour can be used for scientific purposes.

Data Privacy

As described above, this construct in Fig. 6 processes a lot of personal data about toothbrushing behaviour. For this reason, care is taken to ensure the identity of the users, when it comes to data privacy. The health app is used under the supervision of a clinic professional. Users log in to it with an ID received from the dentist. Family members are registered as users of the program using pseudonyms, not real personal information. In connection with the pseudonym, the professional has an ID number provided by the patient information system. The ID number allows the professional to find the right user in the system. However, the app and patient information system are not connected to each other, so the ID number entered in the professional's app does not compromise the user's privacy. Keeping users "anonymous" can reduce the risk of data theft, as it is not possible to link app data to the right person. Data theft has been suggested in literature as one of the major concerns in the data privacy of health apps. (Heidel et al., 2020, 5–6.)

Data privacy must also be taken into account when users log in to the app. For authentication the user has to create a password in the first log in process, with which only the right user can log in to. This prevents unauthorised access. (Scott et al., 2015, 7.) Authentic competition within the family drives app usage. Hence, ensuring the right user is crucial. To prevent misuse and maintain

fairness, each family member receives individual IDs. Additionally, safeguarding personal information with unique PIN codes or fingerprints on phones is essential. Moreover, attention should be paid to the privacy policy. Before the app is downloaded, the required permissions have to be known. These apps include, but are not limited to, camera access, location data, call data usage, and contact usage. (Scott et al., 2015, 3.) It is crucial to inform the user what data is collected for what purpose for transparency. Compliance with the GDPR is essential to ensure data protection, as medical data is processed that falls under the European Union regulation as personal data.

1.5   Discussion and Conclusion

This article highlights a huge oral health problem and the importance of developing innovative oral health interventions as oral diseases affect millions of people worldwide. In countries such as Finland, where oral health is a challenge, the development of innovative approaches to improve oral hygiene is needed. Recent studies show that children and adolescents often do not brush their teeth sufficiently. (Karies, 2023; Stein et al., 2017, 7.) Current studies, e.g. the school health study in Finland, show that children and young people often do not brush their teeth sufficiently (Tarnanen, 2023). This underlines the need for a targeted intervention to improve oral hygiene and promote oral health in general, especially among children and families. To convey the importance of oral hygiene, especially to children and adolescents, it is important to focus on developing routines and habits in childhood, which may translate into lifelong behaviour. (Tarnanen, 2023; Mano, 2021, 1.) It should be recognized that there is a need to increase the focus on preventative measures in children in particular (Chen et al., 2021, 1,6–7,12). Preventative measures in connection with digital interventions (Parker et al., 2019, 600) offer new opportunities for prevention and thus, they are highly promising.

In this context the approach of "MINTYMISSION" represents an innovative approach to develop and promote children's oral hygiene through game-based activities. This includes the integration of gamification elements such as interactive brushing missions and weekly bonus tasks to make oral hygiene engaging. Therefore, the app not only promotes proper dental care through gamified missions and competitions, but also incorporates professional guidance from dentists, ensuring a comprehensive approach to oral health well-being. By engaging families in a 12-week prevention program, the app aims to instil this through the development of long-term habits. Encouraging family involvement for establishing a routine is vital, as research highlights the importance of parental engagement in children's tooth brushing habits.

The increasing prevalence of digital health apps like MINTYMISSION presents a promising opportunity to enhance access to healthcare services and promote preventive measures (Parker et al., 2019, 603). By harnessing mobile technology and gamified approaches, health apps such as this innovation can reach a broad spectrum of users and assist them in learning and maintaining healthier behaviours. Furthermore, the integration of professional guidance and support from dentists enables personalised and high-quality care. The implementation and utilisation of such apps has the potential to improve oral health on a wide scale and consequently, has long-term positive effects on population health and well-being. (Heidel et al., 2020, 3-5.)

Another advantage of establishing MINTYMISSION is that dental professionals are informed about the number of toothbrushing, and bonus missions carried out. The data collected is forwarded to the dentist weekly in reports, broken down by family and its members, allowing the dentist to track progress simply and easily. As the study shows, the joint discussion of the data with the professional at the end of the program is highly relevant, as this allows problems to be identified and refined. (Heidel et al., 2020, 1.) Ultimately, the data on toothbrushing behaviour can be used for scientific purposes to promote the improvement of long-term oral health.

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2 VeriSeal - the smart wound dressing with integrated healing indicator - combined with VeriSeal Plus

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Abstract

This article addresses the pressing issue of skilled labor shortages in healthcare, which strains both patients and professionals. With dwindling nursing staff, there's increased stress, longer patient waits times, and shortcomings in elderly care. The study seeks to boost nursing staff efficiency by exploring innovative digital methods. Specifically, it examines the use of smart wound dressings like VeriSeal and VeriSeal Plus to streamline wound care. These dressings integrate advanced monitoring, allowing realtime assessment of wound healing and dressing change requirements. The purpose is to embrace these smart solutions, so nurses can trim unnecessary workload and time consumption, thus enhancing care quality and easing staff burden. According to the studies the potential of digital innovations to transform healthcare delivery and improve work efficiency, offering promising avenues for future advancements in the field. The aim of the article is to develop work efficiency from the point of view of the direct working time of home care workers. The purpose of the article is to describe how digital methods can be used to improve the efficiency of nurses' direct working time.

Keywords: wound care, home care, direct working time, smart solution, innovation

2.1   Introduction

The shortage of skilled labour has not stopped in the healthcare sector. According to a study by management consultants PricewaterhouseCoopers (later PwC), almost 1.8 million jobs in the healthcare sector in Germany will no longer be filled in 2035 due to a lack of qualified labour. In contrast to the 7% shortage today, this will be 35% in 2035. (Burkhart, 2022, 5.) There are two main reasons for the shortage of skilled labour. On the one hand, the reasons for the staff shortage are demographic change and, on the other, the tough working conditions that nursing staff have to cope with. (Roche Deutschland Holding GmbH, 2024.) Demographic change is having an impact on both nursing side and patients (Rothgang et al., 2012, 102).

The shortage of nurses and practical nurses in Finland has dramatically increased in just two years. Finland is lacking over 16 600 nurses, whereas the corresponding figure was 8000 two years ago. The healthcare sector would need around 200 000 new workers by 2035 or 2040 to replace retiring workers and meet growing demand for services. (Sohlman, 2020; Tehy, 2023a.) The shortage of practical nurses has also grown immensely, with a shortfall of 8800 qualified personnel across the country according to a new study. With fewer nurses available, the workload and stress on those working increases, leading to even more strain (Työterveyslaitos, 2023, 13-15). The shortage of nurse's manifests practically for citizens through long waiting times for care, crowded emergency departments, ward closures, canceled surgeries, serious deficiencies in elderly care, and so forth (Lehtonen et al., 2023, 43; Tehy, 2023b).

On the one hand, many nurses from the baby boomer generation are currently working and will soon be retiring, while on the other hand, demographic change means that more people in need of care can be expected in the near future. This will lead to an even greater shortage of skilled nursing staff. (Brockfeld, 2024; Tehy, 2023a.) To counteract this problem, intelligent technologies have become established that can relieve the burden on staff. In the above-mentioned study by PwC, 62% of the professionals surveyed confirmed that they see such technologies as an opportunity to relieve staff. In addition, 59% confirm that intelligent technologies are noticeable in their day-to-day work by saving time for patients. (Burkhart, 2022, 22.) One part of these new technologies is sensor technology. This technology helps to relieve the burden on nursing staff, increase efficiency in nursing care and improve patients' quality of life. This enables medical complications to be detected at an early stage and thus avoided. (Wahl et al., 2024, 307.) This is precisely the approach taken in this article, particularly in the care of wounds in the outpatient sector. The project described in this article by students at the University of Applied Sciences in Neu-Ulm and

students at the University of Applied Science in Kajaani aims to utilize both human resources and dressing materials efficiently to avoid waste. This is to be achieved by optimizing the intervals at which wound dressings are changed. The change intervals can be optimized through early detection of an infection. This is important, among other things, because wound dressings are very expensive. They account for 2 % to 5.5 % of the total healthcare budget (Kallio et al., 2020). VeriSeal and VeriSeal Plus were developed for this purpose. VeriSeal is a wound dressing with an integrated indicator that recognizes when the dressing needs to be changed. VeriSeal Plus enables realtime digital monitoring by recognizing the information provided by the intelligent indicator.

The combination of the two smart technologies extends to wound monitoring and may represent a paradigm shift in healthcare. The application can collect and record comprehensive information that influences the care of the patient's wound today and in the future. This data serves as a valuable basis for personalized care plans as well as efficient and day-specific route planning for outpatient nursing staff (Eskelinen, 2022, 231; Pesonen et al., 2022, 8).

The aim of the article is to develop work efficiency from the point of view of the direct working time of care workers. The purpose of the article is to describe how digital methods can be used to improve the efficiency of nurses' direct working time. This article describes how the combination of VeriSeal and VeriSeal Plus can be used to improve the precision, efficiency, and quality of wound care. Through this smart solution, the digital application becomes a cornerstone in the development of healthcare and promises a future in which the well-being of patients is enhanced by intelligent and responsive solutions.

2.2   Background

A comprehensive literature review was conducted from November 2023 to May 2024 to investigate the background and basis of wounds. Both current and older literature was used. Relevant research was also taken into account. The search was conducted in databases such as Google Scholar, WISO and PubMed at Neu-Ulm University of Applied Sciences. Finnish databases such as Cinahl, PubMed, Researchqate and Finna.fi were also used. The following search terms were used using Boolean operators: Wund*, Infektion* AND Wund*, Homecare, Wund* AND Temp*, Wunde AND Exsudat*, as well as Woundcare, Direct working time, Kotihoito, Haavanhoito, välitön työaika. In addition, a structured expert interview was conducted to gain insights and

feedback from professionals in the field of innovative wound care. Here, the selection was based on expertise and experience in the development of medical devices. The experts were informed and agreed that the interview would be recorded and used anonymously. The research included books, review articles, journals and studies on wounds that provided relevant information for the development of an innovative wound dressing. Based on the results of the literature research and the expert interviews, an innovative wound dressing with a corresponding cuff was designed and developed. The technological approaches were determined on the basis of the knowledge gained.

The working time of home care workers can be divided into direct and indirect. In Finland, the national goal is to increase the direct working time of home care workers (Pesonen et al., 2022, 9). Based on research data and monitoring by municipalities, it is known that in home care, direct client time for nurses is about 20-40% of total working time and for community nurses about 40-70% of total working time. It is important to ensure sufficient time for direct client care because the demands for home care services are increasing. To identify areas eligible for direct working time improvement, information on how time is spent on various home care activities becomes essential. (Helgheim et al, 2018; Sosiaali- ja terveysministeriö [STM], 2013, 44.)

Home care managers need to create new innovations and ideas how to develop home care. Performance effectiveness is related to the training, effectiveness of scheduling, quality of individual nurses and the way care is organized. So, the nurses would realize how this would help them in their daily work, and they can balance their workload across shifts. (Groop et al., 2017, 17; Vaartio-Rajalin et al., 2020, 1051.) One way to develop the direct working time of nurses is to improve wound care. This is the reason why nurses need to know about wounds and wound care. A wound is a disruption of intact skin or the underlying tissues. Wounds occur because of external factors, such as injury or illness. Wounds can be categorized into acute and chronic wounds. An acute wound is formed due to the influence of some external physical force. A chronic wound is defined as a wound that has remained open for at least a month. (Terveyskylä, 2021a.) A chronic wound patient is typically elderly and multimorbid, and often the same patient has multiple factors underlying the wound. No cause of a wound excludes another cause. (Vaalasti et al, 2011, 133.)

The prompt initiation of treatment promotes the healing of wounds. An open wound often significantly impairs the patient's quality of life. Wounds are associated with pain, functional impairment, aesthetic damage, depression, and financial problems. Swift initiation of treatment and addressing the root cause of the wound ensure an improvement in the patient's quality of life and, from a societal perspective, the most cost-effective care. At its worst, a wound can also pose a threat to the patient's life or the preservation of a limb. Therefore, a wound always requires a

prompt professional assessment, and in chronic wounds, a multidisciplinary team that addresses the overall wellbeing of the patient is often needed to achieve the best possible treatment outcome. (Terveyskylä, 2021b.)

The number of wound patients is increasing due to the changing age structure of our population. Comprehensive expertise in wound care consists of the ability to plan, implement, and evaluate treatment. Approximately one percent of individuals over the age of 50 have long term, poorly healing wounds. The direct costs associated with wounds account for approximately 2-5 percent of total healthcare costs in Finland, comparable to the costs of treating obesity or cancer (HUS, 2023). Posnett, Drew, and Rusling (2007) have studied the costs of wound care in the UK, which they argue can be generalized to other parts of Europe. The estimated cost of wound care for the years 2005-2006 was approximately €3,3-4 million per 100 000 people. According to these research findings, wounds represent a significant source of healthcare costs (Posnett et al., 2007).

Due to the general shortage of resources in healthcare, as well as the high costs and patient harm associated with wound care, we set out to develop an innovation that could partially address these factors. With VeriSeal and VeriSeal Plus, the patient's wound care time can be reduced, wound care sessions are only performed as needed, saving staff time, allowing for better allocation of resources, and reducing costs by avoiding unnecessary changes of wound care products.

2.3   Innovation and it's evaluation

Continuous monitoring of the wound with the innovative VeriSeal product in conjunction with the digital VeriSeal Plus product should enable outpatient nursing staff to plan dressing changes for patients at home in a more efficient and patient-centered way. Figure 1 shows both products. First, the wound is closed with VeriSeal. This is a wound dressing that contains indicators in different fibers. These are, on the one hand, the pH value (1) and, on the other, proteins (2) in the wound. Other indicators for wound healing include exudation (3) and temperature (4) (Karl, 2023, 77). VeriSeal Plus, a cuff with a Velcro fastener, is then applied to the innovative wound dressing. As can be seen in Figure 2, both products are applied to the wound. The application thus collects wound specific information to determine the condition of the wound and therefore the need for a dressing change.
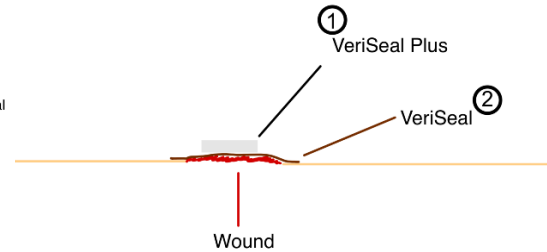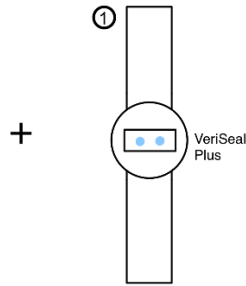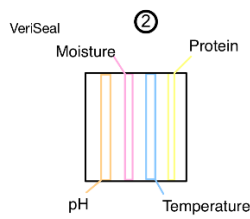
Figure 1. Indicator and cuff

Figure 2. VeriSeal and VeriSeal Plus

1) The indicator for the pH value is located at the edge of the wound dressing. A non-infected wound has a pH value of around 5.5. If an infection occurs, the wound becomes increasingly alkaline and can reach a pH value of over 8. The bacteria in the wound change their environment in order to grow optimally. The pH is an important indicator as it can be detected earlier than pus or redness (IDW, 2023). Figure 3 shows an infected and a non-infected wound. A pH indicator was applied to both wounds. The indicator on the infected wound turns blue and the indicator on the non-infected wound remains colorless. The VeriSeal wound dressing therefore changes color at the site with the pH indicator as the infection increases.
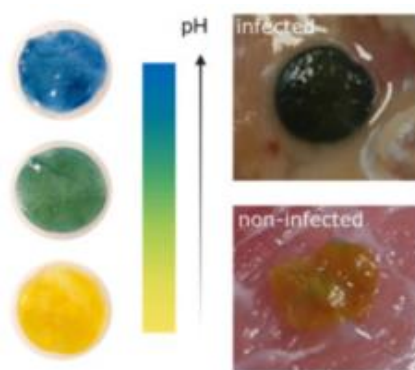

Figure 3. pH of the wound (Eskilson et al, 2023)

2) The next indicator measures the loss of proteins in the wound. The amino acids arginine and glutamine are particularly important for the wound healing process. The formation of new blood vessels as well as cell division and cell growth are stimulated by arginine. Glutamine is an important energy supplier for immune cells, but also for fibroblasts and epithelial cells. Depending on the exudation, up to 50 g of protein per day is lost through a wound. As a rule, patients with chronic wounds are therefore supplied with 1 to 1.5 g of protein per kg of body weight per day. Inflammatory cells that enter the wound from the bloodstream destroy microbes and produce oxygen radicals and proteinases to fight pathogens. (Hietanen & Juutilainen, 2018, 44; Karppinen

et al., 2020.) If this reference value is exceeded, the indicator changes color. For this purpose, the Coomassie Brilliant Blue dye is integrated into the wound dressing. This dye binds the proteins and causes a visible color change (Georgiou et al., 2008, 391-403).

3) Another indicator shows the moisture in the wound. A certain level of moisture is good as it accelerates wound healing. In order for the wound to heal, new cells must be formed. This is the best place for the skin to renew itself. It also prevents the formation of scabs, which is an advantage as scabs are irritating and hinder wound healing. Moisture also keeps the wound soft and supple. This ensures less scarring. However, it becomes problematic if the wound secretion is so thick that the wound dressing can no longer absorb it. Then the protection of the dressing is no longer guaranteed. If the moisture content in the indicator changes, it changes color. This is due to hydrochromic fibers, which become colored if the moisture content is too high. The amount of exudate indicates the stage of wound healing. It also indicates whether the wound is in the infection or inflammation phase. The amount of exudate indicates the stage of wound healing. It also indicates whether the wound is in the infection or inflammation phase. (Solte & Martin, 2023, 292.)

4) Temperature can be an indicator of a disturbed wound relationship. It is measured without contact by an infrared camera. This means that there is no physical contact between the object being measured and the temperature sensor. The temperature of the wound can therefore be monitored regularly, allowing wound healing to be checked at any time. If the temperature persists for several days, this may be a sign of a wound infection. This requires special observation of the wound in order to avoid complications later on. (Rostock, 1950, 97.)

VeriSealPlus is designed to generate alerts, which are then sent to the nursing staff, if critical values are exceeded or if there are changes in the wound that indicate an infection. This should enable early consultation with a doctor and thus prevent further complications. By using the product, unnecessary product changes should be avoided, time and material saved, and preventive action can be taken in the event of a change in the wound condition.

The connection to the nursing staff is established via VeriSealPlus, which forwards the information to a connector via Bluetooth. The connector is installed at the patient's home in such a way that the information from VeriSealPlus can be received at any time. It is important that the connection is always maintained, otherwise information may be lost. The connector then transmits the data to the server in real time via API. The server stores the data in a database with SQL. A message is sent to the caregiver's mobile device via the API path. The caregiver can then query

the type of message via the database. The software must be installed on the caregiver's mobile device. It is advantageous that the software works on both smartphones and tablets, for example. This ensures a certain degree of flexibility for users. This is shown in simplified form in Figure 4.
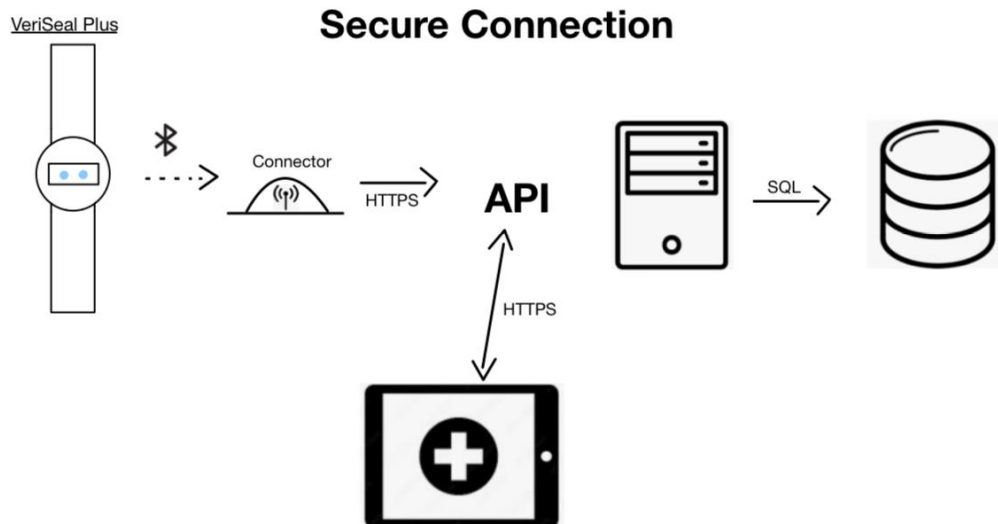

Figure 4. Own illustration

VeriSealPlus is also able to generate alerts for nursing staff, for example in the event of unexpected hypersecretion of a wound. This means that the nursing staff can react quickly to inspect the wound. It also provides alerts for secretions that indicate infection. This makes it possible to consult a doctor at an early stage and prevents further complications. By using this product, unnecessary product changes are made, time and material can be saved, and preventive action can be taken in the event of a change in the wound status.

2.4   Conclusion and reflection

The demographic development with an ageing society and the increasing changing framework conditions in the healthcare sector due to the shortage of skilled labour and high costs changing framework conditions in the healthcare system make it necessary to adapt the care structures for people with chronic wounds that are difficult to heal wounds. (Karl & Storck, 2023, 298.) According to the study by Vaartio-Rajalin et al., 17% of nurses direct working time in home care in Finland is spent on wound care (Vaartio-Rajalin et al., 2020, 1050). As the majority of chronic wounds are associated with age-related diseases, it can be assumed that the number of wound patients will increase significantly over the next 30 years (Karl & Storck, 2023, 298). An innovative approach to

wound care, particularly the use of smart technologies, offers an opportunity to alleviate staff burden and improve work efficiency. Technology - applications, digital services, devices and systems - can support living at home and ageing, maintaining personal capacity and home-based services. Technology is not yet fully used for this purpose. (Lähteenmäki et al., 2020, 52.) Among the technologies, sensor technology can prove to be very useful. Not only can it assist in care documentation, but it can also make predictions and related recommendations. (Mania, 2022.) This is the approach taken by the innovations presented here.

The aim of the research was to enhance the efficiency of direct working time for nursing staff. The introduction of intelligent wound dressings such as VeriSeal and VeriSeal Plus could improve the precision, efficiency and quality of wound care. VeriSeal and VeriSeal Plus integrate intelligent technologies for wound monitoring, representing a paradigm shift in healthcare. These applications collect and store comprehensive data valuable for individualized care plans and efficient route planning. The impact of innovation on the immediate working time of nursing staff and its optimization should change significantly. Innovative wound dressings can reduce unnecessary workload and loss of time by optimizing the intervals for dressing changes through early detection of infections. This saves resources and improves the quality of care. (Springer Vienna, 2016.)

Overall, the innovative approach to wound care offers a promising perspective for healthcare development. Through smart and responsive solutions, patient well-being can be enhanced, and the burden on healthcare staff can be alleviated, which is particularly crucial in the current challenging workforce situation. According to Rytkönen's study, nursing staff feel that the use of technology can facilitate their work and support the elderly in living at home (Rytkönen, 2018, 169). This study focused on enhancing the direct working time of home care nurses through an innovative solution. The current shortage of skilled labor in the healthcare sector is a growing problem that significantly impacts the workload of healthcare personnel and, consequently, patient care. Particularly, the workload of home care nurses has dramatically increased, leading to challenges in resource allocation and heightened stress levels. This, in turn, affects the care received by patients and its quality. (Bettig et al., 2012, 7-8, Työterveyslaitos, 2023, 15.)

The VeriSeal and VeriSeal Plus innovations offer a solution to this problem by directly targeting the time spent by home care staff on wound care. Intelligent technologies are designed to reduce the time spent on wound care for patients and ensure that wound care is only carried out when necessary. This can save costs and avoid unnecessary visits to the doctor. (Sarji, 2023, 6.) VeriSeal in particular is designed to save staff time, enable better resource allocation and reduce costs by avoiding unnecessary changes of wound care products. The two products are designed to enable

nursing staff to continuously monitor wounds and record data from home. This should ensure more efficient and patient-centered wound care planning for home care staff. Intelligent indicators in wound care, such as pH, moisture, temperature and proteins, help to recognize the stage of wound healing and the need to change wound care products. In addition, VeriSeal Plus is able to generate alerts when negative changes in wound status are detected. This should enable the nursing staff to react immediately and call in a doctor, for example. In this way, complications can be avoided, and the effectiveness and quality of patient care ensured. The starting point must be the requirements set by the involved stakeholders (doctors and therapists, patients, payers) for such systems. A telemedicine assistance system must have functions for therapy support, therapy monitoring, communication between those involved in the treatment process, and secure data storage. (John & Einhaus, 2017, 289.)

The shortage of skilled labor in the healthcare sector is a concerning trend that impacts both patients and healthcare professionals. Research indicates that the shortage of nurses and practical nurses has dramatically increased, leading to stress and increased workload for healthcare staff. Working conditions and work practices in home care are considered stressful. For instance, staff members suffer from time pressure. This, in turn, results in long waiting times for patients and serious deficiencies in elderly care. (Bettig et al., 2012, 7-8; Ruotsalainen et al., 2020, 11.)

This work demonstrates how intelligent technologies can play a crucial role in addressing the challenges of healthcare workforce and improving work efficiency. By investing in such innovative solutions, we can ensure that the needs of patients are effectively and efficiently met while alleviating the working conditions and workload of healthcare personnel. Thus, it can be said that the integration of smart technologies in healthcare can not only improve patient outcomes but can also create a sustainable and supportive working environment for caregivers. This can strengthen the entire healthcare system.

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3   SIM Physio "stay independent by moving" – a home exercise app

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Abstract

People are living longer, with one in five people expected to be over 60 by 2050. This demographic trend is leading to increased demand for healthcare services, as older people are increasingly multimorbid. In particular, sarcopenia and dementia are common conditions that affect a person's independence. Exercise is a key component in combating these conditions. Studies show that regular physical activity can improve the health, well-being and quality of life of older people. The popularity of using a mobile health application for this purpose is growing. Digital solutions such as mobile health apps offer the opportunity to support older people in exercising independently, thereby reducing the burden on healthcare professionals.

The aim of this article is to increase the physical activity of older people so that they can live independently at home. This article will describe how an innovative digital application can be used to support the physical activity of older people.

The app has been designed with the needs of older people in mind. This includes ease of use, multi-sensory technology and adaptability, taking into account contraindications. Healthcare professionals can create individual training programmes and monitor progress. No additional equipment is needed to make the app accessible to everyone, so costs can be kept low. The future long-term benefits of such an app must be discussed. In particular, the measurability of independence in order to achieve the long-term goal. In addition, the potential risks of independent therapy need to be discussed, e.g. whether social contact will be reduced if the physiotherapist no longer visits the patient at home.

3.1   Introduction

The population is ageing all over the world. In 30 years, one in five people will be 60 years old or older (World Health Organisation [WHO], 2017, 6). Ageing has a variety of effects on a person's ability to be independent. It brings with it a wide range of health challenges, including physical inactivity, nutritional problems such as obesity, underweight, malnutrition, substance abuse, mental health problems, and loneliness (Sosiaali- ja terveysministeriö [STM], 2020, 17). Older people need more care and attention than younger people due to multimorbidity and associated limitations such as general mobility and the ability to conduct daily activities (Neubart, 2018, 10). It is expected that healthcare expenditure will increase due to the increase in the number of older people and the associated increased need for healthcare services; the extent is unknown, but it is necessary to discuss future ways to mitigate this problem (Reiners, 2021, 235). An important goal is therefore to enable healthy ageing (Solis-Narrow et al., 2022, 2).

In principle, the topic of exercise and activity must be considered, as it can be seen as a key factor in the prevention of illness and functional limitations (Solis-Navarro et al., 2022, 2). Several studies have demonstrated the comprehensive, positive benefits of physical activity for the health, well-being and quality of life of older people (Jyväkorpi et al., 2014, 6). An exercise program for older people must include daily activities such as climbing stairs or getting up from a chair, as well as strength and balance sessions adapted to the individual (Berger & Graeb, 2022, 17). This requires professional support. One way to meet the growing demand for services is through the use of technology. (Radic & Radic, 2020, 297.) Digital solutions such as mobile health apps can support the currently strained care situation for doctors and therapists. Patients benefit from the combination of traditional analogue consultations and accompanying digital therapy. (Pförringer et al., 2023, 6-8.)

Dementia can also be a risk for elderly people with low physical activity (Liu et al., 2020). Cognitice function can be improved by moderate exercise. Even with the short-term lasting moderate physical activity had been shown to improved cognition. (Carta et al. 2021.) Physical activity with training can reverse physiological decline in age-related conditions. Maintaining a physical condition lowers the risk of cardiovascular mortality, sarcopenia and plays a role against neurodegeneration. A training program for elderly people would improve their physiological function. (Mendonca et al., 2016.)

Also, the independence of elderly people can be supported by digital services (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2020, 6). There is a separate international research

initiative "Active and Assisted Living" for this purpose, which deals with assistance technologies and systems that are used in particular to maintain skills relevant to everyday life (Venek & Rieser, 2022, 133-134). A Swiss study concluded that more and more people over the age of 65 are using digital applications, but that specific health apps are still rarely used (Seifert et al., 2020, 41, 56). One possible reason for this is low usability from the target group's perspective. This article therefore examines the requirements necessary for use by older people and presents the prototype of a digital training app. Specifically, it is about the development of the SIMPhysio app, which is to be used in Finland with the slogan "Stay independent by moving".

The authors present the development process, the requirements management, the legal situation, the specific functionality and its technical background of data storage. Finally, the conclusion discusses the overarching goal and why the app presented represents an improvement for the healthcare system. As it can be assumed that healthier seniors require fewer visits to the doctor, nursing treatments or therapeutic interventions, this is an important way of maintaining healthy old people in order to reduce care bottlenecks due to demographic change.

The aim of this article is to increase the physical activity of older people so that they can live independently at home. This article will describe how an innovative digital application can be used to support the physical activity of older people.

3.2   Theoretical background

The increase in the over-65s can also be seen in Finland (Sosiaali- ja terveysministeriö [STM], 2020, 15). There are different definitions of when a person is considered a geriatric patient, but it can be assumed that the risk of multimorbidity increases from the age of 65 (Neubart, 2018, 10). People with at least 3 relevant diseases are classified as multimorbid. Geriatric patients often have even more diagnoses at the same time, which restrict their autonomy and independence. (Neubart, 2018, 11.) Functional capacity is often treated as a broad concept from the perspectives of physical, mental, social and cognitive functioning, which interact with each other and with the environment. Functional capacity provides the basis for a client's own life, in which the client can cope with everyday activities that are meaningful and necessary for him or her. Good functional capacity in different areas of functional capacity and a supportive environment helps people to feel well, to find their place in society and to cope independently in everyday life (Terveyden- ja hyvinvoinninlaitos [THL], 2023). Living at home is known to have many well-being benefits for

older people, such as the ability to influence their own lives and make independent decisions and better connection to their social network (Kristinsdottir et al., 2021,2).

Sarcopenia in particular is a problem with far-reaching consequences. The disease describes the decline in muscle strength and mass. This poses a risk to independence, as the risk of falling increases. A German study found a 5.7% prevalence of sarcopenia in people over the age of 65. The main cause is an altered protein metabolism and reduced activity. Special diet and exercise are therefore the first line of defence against the limitations of sarcopenia in daily life. (Schaupp et al., 2021, 718-721.) In addition, gerasthenia, which only describes the onset of frailty but not the associated disabilities, increases with age. Together, sarcopenia and gerasthenia are the main factors that lead to reduced activity levels in older people and therefore pose a risk to independence. (Jyväkorpi et al, 2020, 339.) This is because being able to live independently requires being able to cope with the activities of daily living. The Finnish elderly people institute UKK recommends physical activity for muscle strength and balance exercise to maintain physical ability at least twice a week. On top of that, performing moderate activities for 2h 30min per week is advised. Figure 1 shows these recommendations and how they can be integrated into everyday life. (UKK Institute, 2023.)

Figure 1. UKK Institute weekly physical activity recommendation for elderly people (UKK Institute, 2023)

Physical inactivity can also represent as a risk factor for memory disorder (Liu et al., 2020). Studies have shown that moderate exercise improves individual's cognitive function. Even the short-term moderate physical activity had improved cognition in healthy elderly people in the study made in 2021. (Carta et al. 2021.) In general, older people favors activities in their daily routine. Active physical exercise is less common. However, strength training increases lean body mass, improves physical activity and has a positive impact on an active daily life. Regular physical activity can help maintain quality of life, health and physical function and prevent falls. (Langhammer, Bergland, & Rydwik, 2018.) Overall, the use of digital health applications is increasing (Meskendahl & Bachmann, 2020, 15). These represent a possible solution for motivating older people to exercise. The use of technology to promote the well-being and health of older people is becoming increasingly important (STM, 2020, 34). They are also increasingly able to use technical solutions. In recent years, there has been an increase, especially among the over 75s. (Tilastokeskus, 2023.) Over the past 10 years, ownership of touchscreen phones among Finns aged 65-74 has increased from 15% to 82% (Tilastokeskuskus, 2024a), while ownership of touchscreen phones among those aged 75-89 has increased from 15% to 49% (Tilastokeskus, 2024b). Some of them are already confident in using the internet and other technologies (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2020, 35).

Physical activity and training can reverse the age-related physiological decline. Maintaining a minimum quantity and quality of physical exercise lowers the risk of cardiovascular mortality, sarcopenia and even neural degeneration. A structured training program would improve the physiological function on elderly people. The benefits vary but the results have been shown to be positive. (Mendonca et al., 2016.) This can also create added value for society and relieve the burden on the healthcare system as a whole, as longer-lasting independence has a positive impact on healthcare and social systems (Neubart, 2018, 12). The German Ageing Report estimates the savings from digitalisation in 2018 at 34 million euros (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2020, 91).

3.3   Innovation and its evaluation

Methodic procedure

The basis for the project was the idea of developing an app for home training to replace or supplement regular physiotherapy. The app was to be aimed specifically at older people. The first

step was a market and literature search. The research was specified with the keyword's "physio-therapy", "home-based", "seniors", "digital", "training" and "geriatric patients". The search was conducted in English, German and Finnish. The databases searched were Google scholar, SpringerLink, PubMed and national ministries. In addition, the authors' university libraries were also searched. The results of the market research are listed below.

In Germany, the market is divided into an unregulated, freely accessible market and a regulated market for digital health applications, which is scrutinized by the competent authorities. In the latter case, the costs can be covered by health insurance companies after they are used by patients on a doctor's prescription. (Schlieter et al., 2023, 108.) The applications are usually designed for specific clinical pictures. In the area of the musculoskeletal system, there are mainly apps for knee and back problems. All officially registered apps can be found on the website https://diga.bfarm.de/de/verzeichnis/00387. You can also find "Nola - your digital physiothera-pist" in the mobile app stores. As soon as symptoms are specified, the app creates a therapy plan and guides the exercises. (Health-nola, 2022.) In AIMO, the training app with artificial intelligence, people can complete personalized workouts after a movement scan of a squat in front of their smartphone camera (AIMO, 2024).

In Finland, the market is still much emptier than in Germany. There is only one application which is developed for elderly people in Finland. There is no official register where you can see applications that have been assessed by the health system or national authorities (Valvira, 2024). For this reason, the project is focused on developing an application for the Finnish market. Such an app can relieve the burden on therapists and improve care for the elderly.

In the second step, the requirements were identified with the help of brainstorming and interviews with older people, because it is very important to know what kind of application they want to use. In this way we can create products that provide meaningful and relevant experiences to users (Interaction Design Foundation, n.d). A large part of the project consisted of creative work, the creation of mind maps and mock-ups. The result of the requirements analysis can be found in the following chapter. The legal situation for the development of such a health app in Finland is then considered. Finally, the App and its functions are shown by description and mockups and its technical background, before the Conclusion takes the main information into account and discuss the Aim and Purpose result of this article.

Application requirements

A search on the internet and in the usual application stores did not reveal any apps for older people that specialize in providing qualitative support for physiotherapy. The relevance of developing an exercise app for senior citizens is therefore given. A distinction between apps for everyone and apps for older people is necessary for various reasons. The most important requirement is the simple and intuitive operation of the application (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2020, 26; Göbel et al., 2022, 45). The reason for this is the currently low affinity for technology among the over 50s. Göbel et al (2022,44). also found that they rate their own competence in dealing with technology as low. This leads to the conclusion that good instruction is necessary at the beginning of the application in order to motivate patients and make them confident in using a movement app.

The special requirements of an application used by older people should be taken into account. Due to age-related illnesses and limitations in the sense of sight, hearing and touch, a multisensory output should be created. A few large buttons on the user interface provide a good overview, can be recognised by the visually impaired and are easy to use even with limited fine motor skills. There are 55,000 visually impaired people in Finland. Of these, 32% are between 65 and 84 years old and 39% are over 85 years old. This means that the majority of visually impaired people are over 65 years old. (Näkövammaistenliitto, n.d.) The option of voice output is also a useful addition for people who have difficulty reading instructions. A slow speaking pace and simple, clear instructions are important to compensate for age-related hearing loss. For example, the loss of treble, which can lead to difficulties in understanding, especially when there is background noise. (Huhn, 2020, 31-32.)

Furthermore, the data must be treated confidentially, and the patient's autonomy must not be restricted. Participation in a health app and the tracking of relevant data must be completely voluntary (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2020, 21). When introducing digital health applications, it can be helpful to adhere to the ethical principles of Childress and Beauchaup. They include autonomy, harm avoidance, care and justice (Waibel, 2024, 408). Swoboda et al. point out that fairness must also be taken into account, as many applications require the purchase of suitable equipment and this is not possible for everyone (Swoboda et al., 2022, 19). SIMPhysio should therefore be designed in such a way that no other hardware is required in addition to the end device used, such as a tablet or smartphone. The selection and prescription of physical exercises for a patient must be carefully monitored by qualified healthcare

professionals, as contraindications may arise that pose a risk to the individual's health. SIMPhysio should therefore only be used after consultation with a doctor.

Statutory and legal requirements

A wellbeing application requirement in Finland are described by the National Supervisory Authority for Welfare and Health, Valvira. Within the meaning of the act on the electronic processing of client data in healthcare and social welfare, the application needs to be linked to the MyKanta database in Kanta Services. The Kanta database includes private wellbeing data of the individual citizens. Valvira maintains the database of wellbeing applications which need to meet the essential requirements and have been registered with Valvira. The essential requirements as well as certification process for wellbeing applications are set forth in regulation 6/2021 of the National Institute for Health and Welfare (THL). The request for registration can be sent on Valvira website. (Valvira, 2024.)

The EU has drafted a directive that requires barrier-free access to websites and mobile applications (Directive 2016/2102). Following the creation of a first prototype, SIMPhysio will be tested and revised to meet these requirements.The product also needs CE marking. The CE marking signifies that the product sold in the European Economic Area has been assessed to meet high safety, health, and environmental protection requirements. The assessment confirms that the product is safe, and the manufacturers are responsible for setting up the technical file, issuing the EU declaration of conformity and affixing the CE marking to the product. By this mark, the consumers know that the product is safe. The CE marking for Restriction of Hazardous Substances is managed by the Directorate-General for Environment. (European Commission, 2021.)

Functionality and mockup of the application

SIMPhysio is an application used with a smartphone or tablet based on Android or iOS. There are two parts to the application, one for the healthcare professional and one for the patient, no other equipment than the smartphone is necessary. During the doctors or physiotherapists appointment the necessity of a home exercise program is determined. First the healthcare professional creates an account, considering the patient's medical conditions. He then chooses a training program and applies it to the newly created account. The training program does always fit the patients' needs. A QR-Code is provided for the patient to quickly download the app from the app store. After that, the Healthcare professional advises the patient on the usage of the app. Now

the app is ready to use, and the patient can perform the exercises at home and get the profit from the benefit. The journey of getting the app is shown in figure 2.
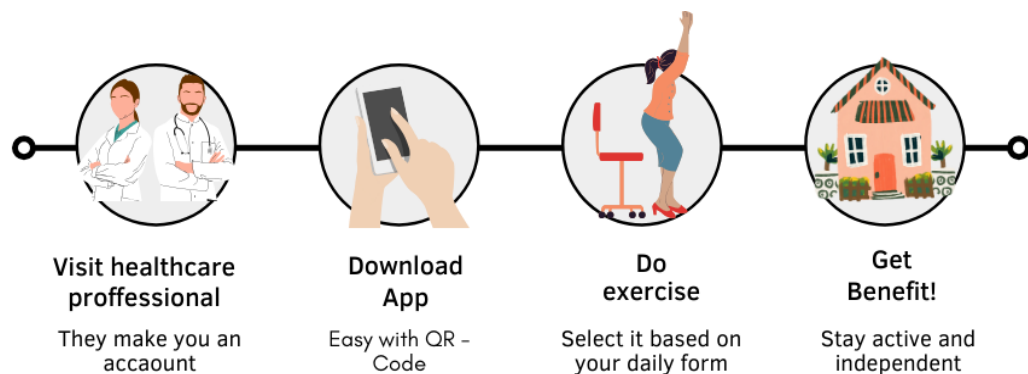

Figure 2. Patient Journey

The app has separate exercises for different muscle groups and joints. The exercise tells you how many times to do the movement and how many times to repeat the sequence of movements. SIMPhysio app is easy to use. Each page of the app has clear instructions on where to press on the screen to select the next step. There are also clear pictures and videos. For people with visual difficulties a big speaker symbol is at each page, where you can get an audio explanation of the exercise instructions. This makes it easy to use on the small smartphone screen, even with the special requirements of older people.

The following describes how to use the app. The app is opened by pressing the app icon on the smartphone screen. Next, the exercise can be selected. The selection is made by pressing on the body image. The circles on the body charts indicate the problem zones. The size of the circles indicates how necessary the exercise is. The bigger the circle the more important the exercise is. (Figure 3) If the exercises are performed frequently, the circle becomes smaller to draw attention to other areas of the body to be trained. The circles therefore vary depending on the frequency and importance of the individual exercises. This perfects the individual exercise program and avoids performing just one exercise. In addition, circles of the body regions are shown in different colors, which are used in the further course to generate a recognition value. Next, the type of exercise can be selected. Whether to do endurance, mobility, or muscle-strengthening exercise. The app then displays 5 exercises that correspond to the body region and the selected training type. For example, as shown in Figure 4, strengthening exercises for the knee joint.
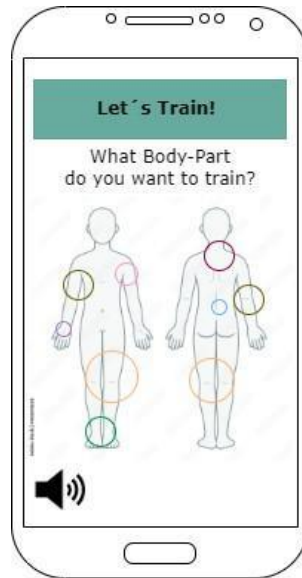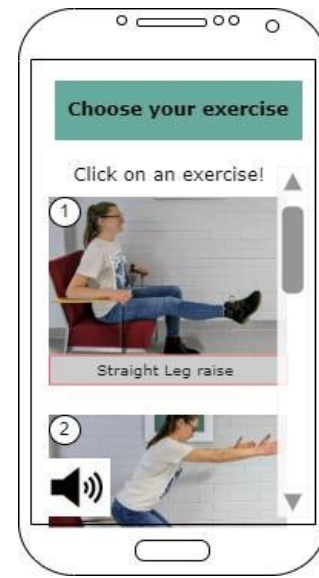
Figure 3. Mock up of the first page
Figure 4. Mock up of exercise list

All exercises are accompanied by an instructional video that shows you how to perform the exercises correctly. The instructions for the exercises are therefore audiovisual. As can be seen in Figures 3 and 4, the speaker button can be used to explain and read out the displayed page as often as desired, so that patients are constantly supported in its use. The app saves the user's exercise history. The doctor is notified when the patient has completed the exercise. The user can also view their own training history. This option is explained to patients depending on their user behavior so that they are not overwhelmed. In general, the training history and its effects can be analyzed at the next appointment. The users of the application thus receive feedback from medical professionals and the training can be adapted if necessary.

Technical background

The application consists of a back end and front ends for several platforms. There will be a front end for the mobile platform, specifically for the iOS and Android operating systems, for use by patients with smartphones and tablets. There will also be a front end for use in the bowser by medical staff. This will give them a different view of the program so that they can create users and make specific individual settings for their training program. The backend runs on a server and is connected to a database. Figure 5 provides a technical overview to show the connections of the required components.
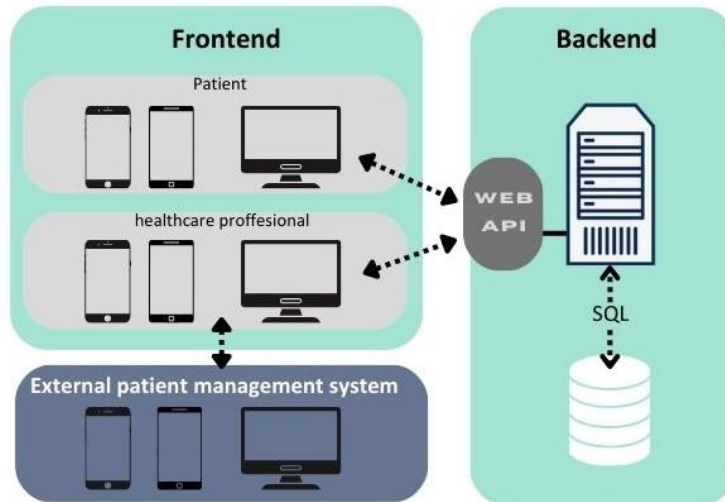
Figure 5. Overview of required technical components

In the database all exercises and its instructions are saved. The data should be stored centrally so that medical staff can access it. Also, users´ history of exercises will be recorded in the database. This is done on a user-specific basis. Also, the user information has to be stored in the database. The initial information for creating a user will be gathered using an API (Application programming interface) from an external patient-management-system. Additional information for creating a user can be entered by the healthcare professional. For example, the contraindications. A relational Database will be used. These enable a clear assignment through the use of primary keys. On the one hand, each exercise is assigned a primary key and, on the other, each patient data record. These can then be used as foreign keys to store the history. This ensures non-redundant storage of the data. (Mielebacher, 2024, 90-91.) In addition, the three most frequently used databases are relational, as a survey of developers in 2023 revealed (Stackoverflow, 2024). Relational Databases are queried using SQL (Structured query language). This query language allows the data to be queried, read and used in the application. (Mielebacher, 2024, 93.)

3.4   Conclusion

This article will describe how an innovative digital application can be used to support the physical activity of older people. This innovative digital application would be the easy way to support the physical activity of older people. Technological innovations are needed to complement healthcare services. The use of technology in healthcare must consider legal guidelines, for example on data protection (Valvira, 2024). The use of technological applications is also an opportunity for older

people, as an increasing number of older people are able to use technological applications (Seifert et al., 2020, 41, 56). More and more older people have a smartphone. They also know how to use their phones in a variety of ways. They know how to use different applications. (Tilastokeskus, 2024a; Tilastokeskus, 2024b.) Digital solutions such as mobile health apps can support the currently strained care situation for doctors and therapists. Patients benefit from the combination of traditional analogue consultations and accompanying digital therapy. (Pförringer, et al., 2023.)

The SIMPhysio app is one example of a way to increase mobility for older people. It is easy for a healthcare professional to teach a person how to use the app. Using the app is simple for the user. The usability of the app was a particular focus in the development of the innovation. The app's selection buttons, and exercise instruction videos are clear. Good physical condition can prevent from long hospitalization and helps recovering from possible traumas. Growing the muscle mass is possible throughout the whole life, also on elderly age (Borst, 2004). Muscle mass protects the bones and can be vital protection from serious fractures on bones (Sarvazyan, et al., 2014). Based on these known facts, it's very important to exercise even on older age.

Exercises are selected according to the patient's needs. The patient is also asked about their own interest in the different exercises. The doctor or physiotherapist also selects exercises according to the patient's health condition. Only exercises that are safe for the patient are selected for the app, taking into account medical conditions. The app collects information on how to do the exercises. The health professional can give feedback to the client on the exercise they are doing. To date, studies on the benefits of e-health applications have rarely taken age into account or analysed the effects on certain diseases (Bundesministerium für Familie, Senioren, Frauen und Jugend, 2020, 92). With the help of an application such as SIMPhysio, data can be collected in a structured way and later used to analyse the benefits.

However, questions arise about the disadvantages of using such an app. These and the following questions should be analysed promptly. Does using the app increase the experience of loneliness among older people? Does using the app reduce the social contacts of older people? Can the use of the app completely replace home visits by a physiotherapist? In the future, is it important to study the experiences of older people using the app. Is research also needed on the experience of inclusion of older people? Does increased physical activity increase the experience of inclusion? For example, does increasing physical activity increase the experience of inclusion? Research is also needed on the impact and effectiveness of the app in maintaining older people's functional capacity. Maintaining functional capacity of older people requires multidisciplinary cooperation.

The SIMPhysio app is an example of this innovative collaboration. Innovative collaboration is needed to enable older people to live in their own homes, able to function, for as long as possible.

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4   "Step into my World!" – helping parents to understand their child with autism better

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Abstract

Autism spectrum disorder presents a significant challenge for both children diagnosed with the condition and their parents. While many are aware of autism, few truly understand its im-pact on daily life. This article presents the experiences of parents with autistic children, giving extra attention on the difficulties they face in understanding and supporting their children. Parents are often overwhelmed and isolated and may struggle to manage their child's behavior and their own feelings of embarrassment and unawareness. This lack of understanding and support can slow down their child's development and integration into society as they grow older.

Recognizing the need to enhance the awareness and understanding of the parents, this article demonstrates the potential virtual reality must help parents understand how their child sees the world. By letting the parents dive in simulated environments that copy how autistic children see the world. Virtual reality offers a unique opportunity for parents to gain insight into their child's world. Through innovative VR experiences, parents can get a better impression of the impact of the overstimulation their child is going through every day, all to promote more empathy and understanding.

The creation of VR environments shows the real-life challenges that autistic children need to deal with daily, such as sensitivity to sounds and lights. By providing parents with a deeper understanding of their child's experiences, VR interventions aim to empower parents to better support and advocate for their child`s needs.

This article points out the importance of acknowledging and embracing the unique perspectives of individuals on the autism spectrum. Trying to turn the role of parents to be "allies" and supporter in their child`s journey. By using the potential of digital innovations like virtual reality, parents can build a supportive environment that consists of acceptance, understanding, and meaningful engagement in the lives of children on the spectrum. The aim of this article is to promote the awareness of parents of how their children with autism experience the world. The purpose of the article is to describe how the parents understanding of the world of children with autism can be enhanced through digital methods

Keywords: autism, autism spectrum, virtual reality, parents, disorder

4.1   Introduction

Autism - a lot of people have heard of the disease but don't really think about it further. But for some people it's not that easy to push aside. There are a lot of parents of children that suffer from autism who are very overwhelmed with the situation and their lives together. Most of the time the parents don't want to talk about the topic because they are embarrassed, either of their child's behavior or their own inexperience. They often get upset, angry or even disappointed when the child is not behaving the way a healthy child would behave. They simply do not have the knowledge to understand what the child is going through. They are not able to help their children the way they should. Most of the help they need they do not get from both parents but from their mother, which can be very problematic when they grow older because they have to open up to other people as well when they are young adults, which is often a very big problem with autism. (Lorenz, 2020, 14–15; Rabsahl & Röttgers, 2016, 37, 43–44.)

With the help of virtual reality technology, a new world is created. This newly created world is extremely like ours, but with perceptions not perceived by us in the real world. This new world shines a light into the experience one has if they have been diagnosed on the autism spectrum. With is new tool, parents of effected children can dive deeper into their child's experience and help them understand what is going on a day-to-day bases and make it more of a reality for the parents. (Wölfel, 2023, 3–7.)

With this Smart Solution the parents could learn and realize more about the disorder of their child. They find more acceptance and understanding about their behavior, establishing a way of how to react and deal with the child's reactions. The most important part for the parents and the child is to find a balance of love, support and guidance through this hard journey of life with a neuropsychiatric disorder and this innovation could be the first important step of it.

The aim of this article is to promote the awareness of parents of how their children with autism experience the world. The purpose of the article is to describe how the parents understanding of the world of children with autism can be enhanced through digital methods. It is necessary that the parents can help their child find their place in the world.

4.2   Theoretical background

Autism Spectrum

It is estimated that worldwide about 1 in 100 children have autism. This estimate represents an average number. The prevalence of autism in many low- and middle-income countries is unknown. The autism spectrum is a general concept for wide areas and can also be used for good symptoms and variations in development. The terminology of autism spectrum has changed over the decades, and it is still changing. The term autism spectrum and autism spectrum disorder are not the same. The autism spectrum disorder marks that there is a neuropsychiatric disorder and that there is something "wrong", while the autism spectrum describes the people with autism as another human form of existence, only as different not wrong or in this case sick. (Theunissen etc., 2019, 41.)

Autism spectrum disorder is a developmental disorder of the central nervous system, the core symptoms of which are permanent and special features of social interaction and communication that hinder the ability to function, as well as limited and repetitive patterns of behavior. The people who are affected by the autism spectrum share some characteristics, but their expression is often different. Sensory abnormalities are a very frequent feature that often go unnoticed due to communication difficulties. The impact of sensory abnormalities of children with autism spectrum order on their daily lives is considerable and probably underestimated because of their communication difficulties. (Autismikirjon häiriö, 2024; Posar & Visconti, 2018, 343-344,348; Theunissen etc., 2015, 41.)

The disease affects how people interact with others, communicate, learn and behave. They are more sensitive than other people to sensory effects, such as bright lights, loud sounds, clothes, or temperature. A child can be fast-paced, self-willed and resistant to adult guidance. He or she can speak a lot, but only in his own language, where there are no words that can be understood by others. On the other hand, the child may be interested in other people and wants to be the center of the crowd and the object of attention. The child may not be able to regulate his own voice use and sometimes screams in a high voice. (Autism Spectrum Disorder, n.d; Pihlaja & Viitala, 2024, 304–308; Theunissen, 2022, 88–91.)

Scientists do not know the primary causes of the autism spectrum, but research suggests that a person's genes can work together with parts of their environment to influence development in

ways that lead to the disease. Although autism can be a lifelong condition, treatments and services can improve a person's symptoms and daily functioning. Therefore, identifying the features of the autism spectrum is of paramount importance, because good results have been obtained with early intervention, pedagogical measures and modification of the environment. (Autism Spectrum Disorder, n.d; Pihlaja & Viitala, 2024, 304–308.)

View of an autistic child on the world

An autistic child must deal with a lot of things daily. It does not only see the world different than healthy children, but it also has a lot of limitations. They often have severe comprehension problems that lead to misconceptions with family, friends or for example teachers. Most of the time it is not clear for them what the meaning of some phrases are. (Schuster etc., 2020, 89–91.)

Mostly the children with autism are overly sensitive. Different stimulation can quickly lead to overstimulation. That can be for example an irritating ringtone, a high-pitched noise from another human being or a whole crowd or other people running around making chaos. This kind of situation can often take place in a public facility like schools. The children are exposed to this stimulation and must feal with it. Also, different kinds of smells can be very hard to handle for the children, they can be vastly different from child to child and can really be hurtful to them. An example for that would be an overload of a heavy perfume. (Kohl etc., 2020, 14–16.)

Like mentioned in chapter 2.1 lights and being exposed to bright light and different kinds of loud sounds and noises can be very disturbing and cannot be overcome by people on the spectrum. The discomfort caused by sensory overload raises the stress level of the child, which can lead to poorer adaptation and weaken the child's ability to concentrate on the environment. On the other hand, children with sensory under-responsiveness need activation and change of routine to keep them engaged. It is very difficult for autistic people to recover and soothe. They often need a lot of time that they simply do not have. They cannot always take hours of recovery from one social event, even if it would be needed. (Theunissen & Sagrauske, 2019, 50–53; Jussila, 2019, 22–24.)

The role of sensory perception in autism is not yet fully understood, but it is a core feature of autism spectrum disorder, possibly the most primary one. The sensory symptoms are recognized as the earliest, primary characteristics of autism which predict and explain deficits in later social communication. These atypical sensory symptoms can cause avoidance of social stimulation and thereby impact the development of social and cognitive abilities. Sensory abnormalities seem to

be a strong indicator. In Jussila's dissertation the prevalence of sensory-perceptual problems was dramatically higher than in the general child population. (Jussila, 2019, 22-24, 40-42.)

In situations like these, routines are the most important part. Autistic people need structure and routines to get through the daily madness. An example for a daily routine could be waking up, getting the clothes for the day afterwards getting ready in the bathroom, thereafter, eating breakfast and going to school. All of that is timed accurate to the second, example would be, for the whole "waking up process" are fifteen minutes intended. They also need a lot of reassurance and support from people in their lives whether from teachers, family members or the parents. (Kohl etc., 2020, 19–21; Theunissen & Sagrauske, 2019, 50–53.)

Parents of an autistic child

It is clear that neuropsychiatric disorders bring their own additional spice to everyday life. It can be extremely challenging for these children to use, and thus the parents' task is very demanding at times. The role of parents in a child's rehabilitation is significant, and supporting family activities and everyday life is of primary importance. To support the family in everyday life, it is good to be aware of what everyday life is like in special families. The family's everyday life with its routines and rituals are important for the child's development, they create structure in the child's life. (Vierikko & Helminen, 2016, 37.)

The stress experienced by parents of autistic children has been estimated to be up to four times the stress experienced by parents of healthy children. It has been found that stress increases considerably already at the point when the parent first feels that everything in the child's development might not be in order. This often happens in the very early childhood stage, but the diagnosis is not yet made at that stage. This also increases the psychological burden on parents. Even before the diagnosis, the parents may have experienced a variety of difficult situations, as the child's problems are visible in key areas for everyday functioning: communication, social interaction and behavior that is marked by limitations and formality. The more severe the child's symptoms and the more abnormal his behavior, the more stressed the parents are. (Autism, 2024, 38; Yliherva etc., 2018.)

A child's challenges bring their own burden to the family's everyday life. Challenges related to independent survival and operational management require support and help from parents. The everyday life of these families requires more planning and organization. Parents' resources are also consumed by the fact that many problems related to the child's social skills and interaction

have to be solved in everyday life. Challenges related to the child's behavior can also cause the family to become isolated from others and, over time, social networks become limited, and participation in activities outside the home decreases. (Vierikko & Helminen, 2016, 38–39.)

Because of that it is so important to really strengthen the relationship between parent and child and really expand a connection, to eliminate misunderstandings that come along with the disease. If that basis is created and the acceptance and willingness, to learn more about their child, is present the journey can be started. By the time the child is about 15 months old the parents notice the first symptoms and that something is not "normal", most of the time they get professional help about a year later. The whole diagnosis process can take up to three and a half years because the symptoms can vary from light to very heavy. (Aguiar & Pondé, 2020, 149–155.)

There are different kind of support programs for parents with autistic children to help them guide their child through its life. For example, trainee programs for parents, different support groups where the parents can exchange their experiences and their daily challenges or different kinds of specialist literature of internet blogs. The only similar to this Smart Solution innovation is the "Video Feedback". In this, some autism centers give the option of showing the parents how they behave or react towards their children, for example that they easily overview when the child is behaving good but on the other hand are extremely angry and reacting strongly when the child is misbehaving. With showing this kind of behavior to the parents they can adapt their reactions to their parenting skills and can try to be better. (Rabsahl & Röttgers, 2016, 33–36.)

Even though this can be very challenging for the parents they still need to acknowledge their children for what they do and who they are. They need to take the time to treasure good behavior to get their children motivated through their days. Every child and also every adult needs some praise from time to time, weather he or she has a disability or not. (Kohl etc., 2020, 28.)

Virtual reality

Virtual reality is an environment created with the help of technology. The environment can be created in two ways, either by adapting the real world or completely using imagination. For example, the classroom can be made virtual with a 360-camera designed for it. These rooms are alternative locations that are artificially created and represent both invented places and existing places. A virtual world is an illusion of an environment, that can be triggered by internal or external stimulation. (Hemminki-Reijonen, 2021; Wölfel, 2023, 7–8.)

For several years now, in addition to ordinary teaching methods, technological solutions have been used in teaching, such as virtual reality. In addition to the fact that future students will increasingly use digital solutions in their work, virtual learning has also increased the efficiency of learning and motivates students. Digitalization enables shared learning, as the network connects learners around the world. (Wallinheimo & Mäkitalo, 2014, 9–15.)

The possibilities of using virtual reality in teaching have only been studied to a limited extent, which is why more pilot experiments are needed. The price of equipment is dropping, and more and more content is being created, so testing the artificial world is possible for more operators. The possibilities of virtual reality are wide and are based on the fact that VR glasses can be used to get where one would not otherwise be able to go. Although the virtual world is artificial, it seems so real that a person's experience of another world is real. (Hongisto, 2017.)

Virtual reality has been used for various purposes. Virtual reality enables learning on a cognitive and physical level. Adding physical activities can enhance the learning experience. Its main targets have been therapeutic, treatment and educational applications. With its help, it has been possible to treat, for example, therapeutically stress-related diseases and treat users' anxiety. For training, it has been used in pilot flight simulations, physical exercises, safety training and in many different training fields. The results have mainly improved the learner's experience in these studies. (Lee etc., 2017, 153-160; Thompson etc., 2018, 133-134.)

This innovation can be called a serious game. Serious games comprise a set of meaningful choices in a restrictive context with a primary educational purpose. Serious games invite players to adopt a new identity, to become active actors, interact with peers and the game, receive immediate or automated feedback. Serious games prompt learners to think, analyze problematic situations, take decisions, experiment, explore, reflect and keep learning by doing. Serious games can be used as appropriate learning experiences that allow players to enter new zones. A serious game can be a part of a blended learning design or comprise the complete experience of a distance education programmed. Mini learning games are 'bite-sized' educational activities with specific learning purposes and of short duration that can be played in the context of a broader educational program. Studies have confirmed that serious games can be supportive environments for effective learning. (Mystakidis, 2019, 30.)

4.3   Methods

For this task, it was looked for examples of similar innovations as well as research data on both autism and the virtual reality. In addition, several experts were interviewed who either research the field or work on the topic. A cover letter with short information about the inventors and the innovation but also about what is specifically asked of the reader and a small-scale questionnaire were conducted, to talk about the innovation and ask the following parties to respond: parents of autistic children, pediatrists, early childhood education experts and specialist staff in the disabled facility named Lebenshilfe where is a special department for people with autism. The experts were at first informed completely about the innovation. After that they were asked if they understand the innovation correctly and asked questions about if they think that this kind of innovation can be used in the day-to-day life and if it is necessary. All respondents to the survey understood it`s idea, considered the innovation necessary and would be willing to try it.

The following progress, on bases of the gained information, began on bases of surveys, literature and research in January 2024. New paths were linked from the search results, and by following them there were more potential experts found to do interviews. Literature and research searches were carried out in databases but were also done on the internet with different keywords around the topic. These, too, produced new potential interviews.

The literature search was carried out from the Finna, Julkari, Medic, PubMed, Cinahl databases and Google Scholar. The search terms used were autism, autism spectrum disorder, parents, virtual reality, VR etc. The results of the search were that there was a lot of information and approaches for people with ADHD. Also, a lot of possibilities for the autistic people but not really for the people in the immediate surroundings like family and friends. The results were interpreted in such a way that those in which virtual reality somehow met autism were shortlisted. Results that even thinly addressed parenting a child with autism were also discussed. Despite searching, we could not find a similar innovation or project that we are developing in this position.

Juha Salmitaival and Erik Seesjärvi have developed a VR game for studying ADHD. They were contacted via E-mail and asked to comment on this innovation. They were provided with the same version of the cover letter and the questionnaire as the participants that were questioned at the start of the project. They agreed to have a Zoom meeting about the topic, but unfortunately could not take the time. They were mainly asked about the challenges and possibilities of making an innovation like this happen, both from a technological and economic perspective. (Salmitaival & Seesjärvi, 2024.)

On the 27.2.2024 was an interview with Kyösti Koskela conducted, who works as a project manager at Kajaani University of Applied Sciences. He works with technology and is an expert in innovations in the virtual world. Koskela was asked to give an overview of the technical implementation of this innovation and how it can be implemented in real life, also how to obtain funding. In addition, Koskela showed different VR glasses which could also be tested out. (Koskela, 2024.)

On the 26.3.2024 was a Teams meeting with Piia Jokelainen held, who works as a digital specialist at Luovi Vocational Institute. Luovi Vocational College is a vocational special education institution that educates pupils in need of demanding special support. Luovi is involved in a project to develop a virtual learning environment for autistic students where they can practice different skills, such as travelling by bus. (Jokelainen, 2024.)

4.4   Innovation and Evaluation

Description of Innovation

The initial idea of this innovation was born in a kindergarten near to Espoo, Finland. There was shown clear that parents of children with neuropsychiatric disorders want and need the help and the guidance from professionals to be able to help their children and be properly there for them. It is a well-known fact that autistic children react very strongly to loud noises and bright lights (Kohl etc., 2020, 14–16; Lorenz, 2020, 14). Because of that there were two different virtual reality rooms created that parents are able to enter with VR-glasses. One room which is created to show how "Sounds" are affecting the children and one for "Lights" which are also very disturbing and distracting.

In these two 3D rooms it is shown how overstimulating and stressful the daily life for a child with autism can be. After that the parents start to understand why the child is acting a certain way. Before they may be thought the child is misbehaving or a brat simply because it couldn't handle the impressions from the world around him/her.

The Room "Lights" is a copy of the real kindergarten room where some of the children go to every day. It is easier for the parents to really dive into the world of their child and see what they must deal with daily. It is important that the room is not exactly like the room in real life but with brighter colors, that the parents can experience what is really intimidating for their child and that

they see something different than the parents themselves. Also, different kinds of forms and sur-faces can be challenging for the children, which are very many available in kindergarten- rooms (Kohl etc., 2020, 14–16).

Figure 1. Kindergarten room (Own illustration)

The illustration figure 1 shows a real kindergarten room with all different kinds of toys, materials and substances. This image was used as a template to build a mockup for the room "Lights". The picture was picked out because it contains a lot of different colors and surfaces to show the in-timidation that children with autism are exposed to in their daily life.

The picture below figure 2, shows an edited version of the kindergarten room and how the room can be customized to illustrate the different objects and settings that can overstimulate the child. Irritating factors are marked in the picture to set a special focus and to really show the parents what these factors are.

Figure 2. VR-Room Lights, kindergarten room edited with marks to show the disturbing factors (Source: own illustration)

When the user enters the room and starts the experience, they are automatically on the same height as the little ones and not on their regular height. This was created to really see what the child sees because the height difference can cause that the parent sees something completely different than the child, or the parent does not perceive it at all. To eliminate that, the parents enter the room on a smaller height. This was also done to strengthen the sensitivity of parents for the perception of their child. (Yu etc., 2008.)

The room "Sounds" was created to get an understanding of what the child is hearing every day when healthy people don't even bother to think about it twice. The room is equipped with different checkboxes, when the parents enter the minimalistic constructed virtual room, they can walk around and go to the different checkboxes and click on them. Every checkbox has its own sound for example crowd noises, traffic or sounds from a construction site. Successively the parents can check the different boxes or hear the same box as often as they like. The boxes are provided each with two different tapes, the first one marked with number one is what healthy people hear and then the second tape marked with number two is, what people or children with autism hear, to really make the difference clear. The tapes are about 8 seconds long, to give the listener time to really understand, but not too long to overwhelm the user. The Microsoft Attention Span Research Report from 2015 statistically proved that the average attention span of a human being is 8 seconds long. (Mohr & Thiesen, 2019.)
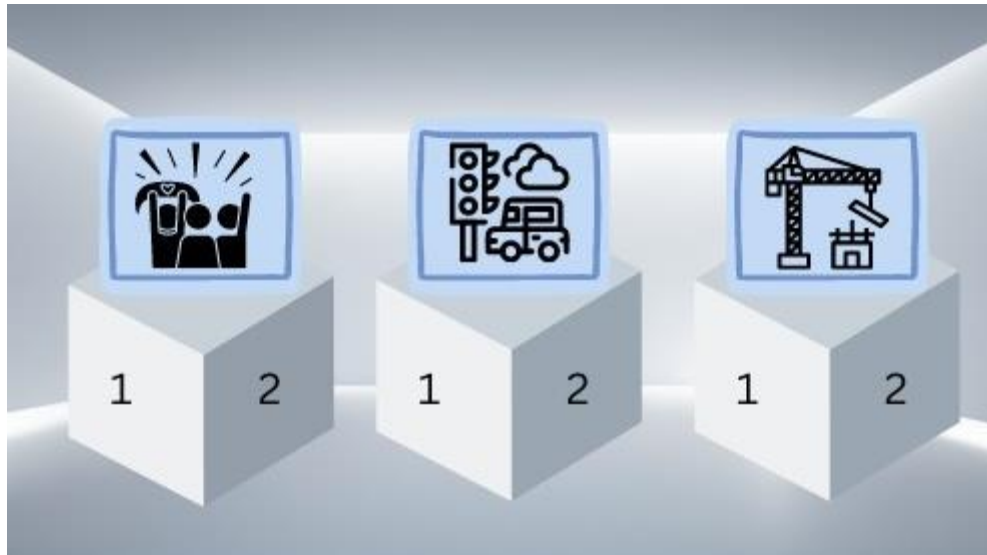
Figure 3. VR- Room Sounds (Source: own illustration)

The virtual reality, to visualize this project, was selected because it's the most similar option to the real world. You can do all different kinds of things in the VR-world like you would in your own life. The animations are very realistic and a perfect option to portray a real room. The only difference between the real world and a simulation or a virtual reality is, that the simulation needs an input- and an output unit. (Wölfel, 2023, 6.)

To use the rooms, you do not need much equipment. You simply need some kind of VR-glasses and the matching controllers, which are needed for the room "Sounds". It does not matter which brand the glasses have or how expensive they are, for this innovation every VR- glass should work. For testing purposes, the Meta Quest 3 was used. At first the innovation is tested in kindergarten environment, where the parents can try out the different rooms. Later if the parents want to use the innovation also at home, they can use whatever glasses they want and can afford. It is also possible to rent the glasses from the kindergarten for a period, for those parents who cannot afford glasses by their own.

Evalution

With the held interviews the process of developing this innovation could continue and grow. The interviews that were held at the beginning of the innovation process with parents of autistic children, pediatrists, early childhood education experts and specialist staff in the disabled facility Lebenshilfe gave clarification, that the innovation is needed and would be accepted if they had the

possibility to try it out. All parts of these different groups of people had the opinion, that the innovation should be pursued.

After getting that feedback the process continued and led to an E-Mail conversation with Salmitaival and Seesjärvi, who are working on a project for children with ADHD at the Aalto-University. They gave encouraging feedback on the innovation via E-Mail, they said they liked the idea and think it is necessary and the topic should be pursued further. The topic was considered as "very important" and "needed to be supported by the best people in the field". (Salmitaival & Seesjärvi, 23.1.2024.)

Following that an interview with Kyösti Koskela was held. At first, he gave an overview about the whole VR- topic about what is needed and what stands behind it. After that he went for the basics of virtual reality and after that he was specific about this innovation. In his professional opinion two VR- rooms with the imagined construction can be easily made by professionals. The game makers need precise details on how the room should look and what it should contain, after that it is easy for them to construct the two rooms. Furthermore, he talked about how it could be realized financially, as the rooms are not particularly cost-intensive to build the investment costs for the rooms are about 500€. After this interview the following framework conditions were decided: A room with about 5 on 5 meters is recommended to really experience the innovation, the Meta Quest 3 is used for the innovation, as a recommendation from Koskela. Also, the funding should be divided in two parts, 20% should be made available by the owners and 80% are funded for example by the autism society. Also, the KAMK University, on the part of Koskela, would be interested in being a part of the innovation project. (Koskela, 2024.)

On the 26.3.2024 was a Teams meeting with Jokelainen held, who works as a digital specialist at Luovi Vocational Institute. The innovation was presented, and the aim and purpose were pointed out. She, too, felt that this innovation was necessary and useful and should be taken further. According to Jokelainen, there are still those in the guardians of vocational college students who do not understand the world of their autistic child and that this must be changed. She also gave an insight on her innovation of the VR- world for autistic youngsters to practice a normal life, like travelling solo by bus. She gave information about her project started and where she got the money to build it from the ground, also how she and her team created the virtual reality world and how she is working with it. (Jokelainen, 26.3.2024.)

4.5   Discussion and conclusion

No similar innovations were found in the literature review. Kajaani University of Applied Sciences has developed a simple aging game, where with the help of a virtual world you put yourself in the position of an old person and get to experience the challenges that age brings, for example in motor skills. In terms of learning, the virtual world is perceived as a more effective method than reading or other traditional methods. (Simppeli Aging, 2019.)

One study on the Maryland University, the researchers tested whether people learn better through virtual, immersive environments, as opposed to more traditional platforms like a two-dimensional desktop computer or handheld tablet. According study educational use of VR and found that people remember information better if it is presented to them in a virtual environment. One of the strengths of virtual reality is the experience of presence through immersion that it provides. (Krokos etc., 2019, 10–12.)

The virtual world is a potential alternative for illustrating things because it makes it possible to create a very realistic environment. According to studies, digitization enables effective means of teaching, illustrating and understanding. Studies have found that results improve in teaching implemented in the form of active learning, where learning is assisted by virtual reality. Students' motivation is better and their interest in the subject grows, and they reflect more on what they have learned. Learners are obtained to perform activities thus engaging them in studying better and making them learn in a pseudo-natural context. In multimedia learning, the student can be offered more emphasis on important information to help create links between the image and the verbal message or sound. In addition, the use of image, sound and video is very easy in virtual reality. Virtual reality works as an aid and offers the opportunity to illustrate difficult concepts visually, innovatively and using immersion. The concepts are thus accessible and thus learning can be controlled. In order to keep up with development, we have to innovate new digital methods to support learning. (Puranen, 2019, 21-27.)

According to the study, parents' attitude towards the child's autistic traits depends on what kind of previous experiences the parents have with autism. Some parents look down on the child's different ways of acting, while other parents can understand their child better. Those parents who have a positive attitude towards their child's autism have usually encountered the issue before in some context. While some parents are happy about their child's special features, others feel that the features destroy the child's future. (Gentles etc., 2020.)

Parents need alternative methods to better understand the world of an autistic child. It is possible that both the child and his parents will benefit from this. The virtual world has been used in other ways to illustrate and understand neuropsychiatric symptoms. (Seesjärvi, 23.1.2024.) In the future, it will be possible to use the Step into my world innovation in education programs in social and health care and early childhood education, for example. Students can benefit from new digital learning methods and get the opportunity to experience the world of an autistic child concretely. This can help them when working with children.

The virtual world can also be used with children. Research has shown that being in the forest calms the mind, relaxes and increases overall well-being. It is also possible to bring the calming elements of the forest indoors with the help of new technological methods. The experience of nature is based on sight and hearing, so by projecting an image of the forest or creating a virtual world on VR glasses, the experience can be mimicked when the physical forest is inaccessible. (Tyrväinen, 2023.) For example, in early childhood education, it is possible to create a virtual forest where children can calm down and experience the benefits of the forest during the daycare day. In addition, various learning games can be found for VR glasses that can be used with children. In this way, VR glasses can be used as much as possible in early childhood education.

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5 MentalMates - Playing for mental well- being

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Abstract

Mental health problems, especially depression and anxiety, have increased worldwide. That is why it is important to invest in the promotion of mental well-being, which can be influenced, for example, through the development of digitalization. Various technology applications are already in use in health care, which allow customers to monitor their own well-being. This article describes the promotion of mental health through gamification and a digital application. The MentalMates application uses a reward system familiar from the gaming world, the purpose of which is to get people to use the application as much as possible. The application has been created to work alongside therapy, allowing therapists to monitor the progress of assigned tasks and, if necessary, offer targeted support to the client. With the help of market research in the article, various applications for the development of mental health have been outlined. This app differs from other mental health apps with its own "Smart Animal" character that grows and develops as it completes the given tasks. As the avatar grows, the user of the application gets successful experiences, through which he is motivated to use the application and thereby his own therapy process. The application is built to be as clear and easy to use as possible, so that the threshold for using it is as low as possible. The aim of the article is to promote the mental well-being of the mental health client to support life management. The purpose is to describe how digitalization can promote the mental well-being of mental health clients.

Keywords: Mental Health, mental well- being, anxiety, depression, gamification, smart animal

5.1   Introduction

In recent years, the topic of mental health has become increasingly important worldwide. Depression and anxiety are widespread and affect the well-being of many people. (Lim et al., 2023.) People with depression in Germany and Finland can benefit from digital applications as a supplement to conventional psychotherapy, as studies have shown that they are similarly effective and can meet the growing need for treatment options (Sonnenmoser, 2012).

In 2023, more than 100,000 Finnish people stayed sick long term for mental health reasons. Mental health disorders as the reason for long term sickness have increased since 2016. In 2023, mental health disorders were the main reason for being away from work for a longer period. The number of it due to anxiety disorders has considerably increased in recent years. This number increased from 2022 to 2023 by seven percent. In 2023, slightly less than 50,000 Finnish people received sickness allowance due to an anxiety disorder. The number of depressive disorders as a reason has not increased in recent years. In the same year, slightly less than 40,000 Finnish people received sickness benefits due to depressive disorders. (Kansaneläkelaitos [Kela], 2024.) 120,000 Finnish people were on disability pension at the end of 2022. Among these, 53,000 people received a disability pension due to behavioral and mental health disorders. This group formed the largest group of disability pension recipients with 44 percent. Mental health reasons as grounds for receiving a disability pension increased for the younger age group. Mental health reasons were the main reason for receiving a pension in 2022 (82%) among the proportion of those under 35 on disability pension. (Eläketurvakeskus, 2022, 8-10.)

In 2020, the Ministry of Social Affairs and Health published a "National Mental Health Strategy and Programme for Suicide Prevention 2020–2030". The purpose of the program is to draw attention to the societal effects of mental health. The strategy consists of five different points: "mental health as capital, mental health of children and young people, mental health rights, services and mental health management". (Ministry of Social and Health, 2020.) Depression is also a widespread illness in Germany. A recent study by the Robert Koch Institute (RKI) examined various aspects of mental health among adults in Germany. Self-assessed mental health was considered as an indicator. (Mental Health Surveillance, 2023.) The acceptance of digital services to support mental health has increased in recent years. In 2020, 55% of respondents already considered online applications to be a helpful support. These apps not only offer a way to bridge waiting times for personal therapy, but also strengthen patient autonomy. (Thom et al., 2023.)

The following image (Figure 1) shows the percentage of people suffering from depression in relation to the total population. The mean value is 7.2% in 2019. The percentages are above average in both Germany and Finland. (Eurostat, n.d.)
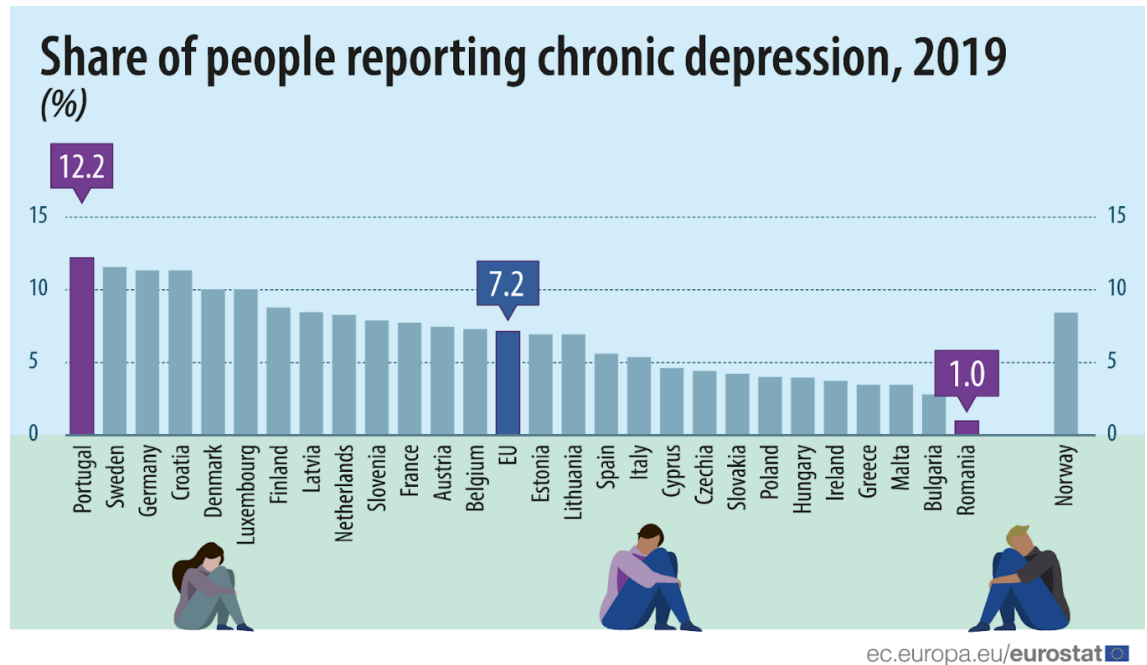

Figure 1. Share of people reporting chronic depression, 2019 (Mental Health Surveillance, 2023)

The idea of a new product is to help people with mental illness to better manage their lives and promote their mental well-being. By using digital technologies, the aim is to find a way in which digitalization can make a positive contribution to the health of people with mental illness. Various gamification elements are used to increase user loyalty and motivate those affected to use the application regularly. These are designed to give users the feeling that they are "playing" for their well-being and making progress by interacting with the app. The more interesting and attractive the app is designed for the end user, the greater the success of the therapy and the continuous use of the application. This is why great importance is attached to an appealing design and an entertaining user experience.

The aim of the article is to promote the mental well-being of the mental health client to support life management. The purpose is to describe how digitalization can promote the mental well-being of mental health clients. The application we presented in the article motivates the parties to use the services. It is clear and simple enough to make it as easy as possible to use. The user can feel that he is playing for better well-being. We are convinced that the more interesting the

applications are designed for the end user, the greater the success and continued use of the treatment.

5.2   Theoretical backgrounds

In promoting health, it is essential to consider not only physical health but also mental health. The main goal of promoting mental health is to develop the well-being of individuals, communities and society. As resources increase, a person can experience more satisfaction with their life, which improves his well-being. (Wahlbeck et al., 2017, 985.)

Mental health is crucial for overall health and is an indicator of physical well-being and lower mortality. Conversely, mental disorders are associated with increased mortality. In today's digitalized society, the demands on cognitive abilities are rising, highlighting the importance of mental health for the success of society and the economy. Globally, mental health problems are increasing and causing significant health burdens. Therefore, promoting mental health and preventing substance abuse are central challenges for public health. (Wahlbeck et al., 2017, 985.)

Promoting mental well being

At the societal level, it is crucial to establish policies that support the development of mental health and well-being, fostering a sense of safety and trust in various institutions. Beyond health services, mental health is also influenced by social services and environmental planning, which can create opportunities for social interaction and access to nature. At the community level, mental health can be enhanced by building individuals' social capital, such as providing a sufficiently large support network. Promoting mental health at the individual level involves healthy lifestyles, curiosity about life, and practicing mindfulness skills. (Wahlbeck et al., 2017, 987-990.) In its mental health action plan for the years 2013-2030, the World Health Organization has specifically highlighted the importance of developing legislation and services for the development of mental health. The action plan also includes the development and provision of community mental health and social services as a goal. (World Health Organization [WHO], 2021, 2, 9-10.)

Among the most prevalent therapies for depression and anxiety are Cognitive Therapy (CT) and Behavioral Activation (BA). Cognitive Therapy helps individuals identify distorted or harmful thoughts that contribute to depression. By altering these thought patterns, people can enhance

their mood and develop better coping mechanisms. In cases of anxiety, CT assists in recognizing and challenging irrational beliefs. Behavioral Activation encourages individuals to engage in enjoyable activities, even when they feel low. This approach helps disrupt the cycle of withdrawal and isolation. (Brenner 2021; Smith, 2023.)

When discussing positive mental health, it is often mistakenly equated with simply being free from illness. In truth, someone with a mental health disorder can still achieve psychological well-being. Conversely, a person who is mentally healthy might feel their life is empty and lonely. (Wahlbeck et al., 2017, 987.) Mental well-being is not the absence of problems; it is the ability to succeed despite them. Regardless of the underlying mental illness, the goal is to help the sufferer function fully in social life. Mental well-being means being successful in different areas of life, such as relationships, work and play, even if you face challenges. It is the knowledge that people are separate from our problems and the confidence that we can handle them. (WHO, 2022.)

Anxiety and Depression

Everyone encounters anxiety and fear at some time in their lives. These emotions are beneficial because they serve to alert individuals to potential dangers. Anxiety is characterized by a state of fear, tension, restlessness, or worry, often concerning current or future events. Worry involves both conscious and unconscious elements. (Isometsä, 2019; Rovasalo & Eerola, 2023; Huttunen 2023; Terveyden ja hyvinvoinninlaitos [THL] 2024a; WHO, 2023a.) Symptoms of anxiety manifest in several physical ways, including sweating, chest pressure, palpitations, elevated blood pressure, pain, dizziness, dry mouth, shortness of breath, loss of appetite, a lump in the throat, tremors and dilated eyelids. Additionally, individuals might experience fatigue and difficulty concentrating. (Mielenterveystalo, n.d.c; Rovasalo & Eerola, 2023; WHO, 2023a.) Anxietydisorders are classified into panic disorder, general anxiety disorder, fear of social situations and fear of public situations (Isometsä, 2011, 17-34; Kandola et al., 2020; WHO, 2023a).

Alongside anxiety, depression is a prevalent condition. Depression is categorized into mild, moderate, severe, and psychotic based on the severity of symptoms. To be diagnosed with depression, symptoms must persist for at least two weeks and include more than one symptom. Depression is associated with a drop in mood, loss of pleasure, fatigue and reduced functioning. Common symptoms also include sleep disturbances and changes in appetite. Individuals often lose interest in activities, feel more fatigued, and struggle with concentration. Those who are depressed often feel worthless, lose confidence in their ability to manage life, and experience low self-esteem and

hopelessness. In severe cases, individuals may have thoughts of death or self-harm. (Isometsä, 2011, 17-34; Lenora et al., 2019; Rovasalo, 2022; Depressio, 2024; WHO, 2023b.)

5.3   Gamification in Mental Health

Gamification is being increasingly suggested as a method to enhance engagement with mental health and wellbeing technologies. However, its application has been criticized for lacking theoretical grounding, particularly concerning behavior change and game studies theories. Definitions of "gamification" vary widely across academic fields, and its effectiveness is yet to be empirically proven. Even if digital approaches to mental health therapy exists, it has shown a high dropout rate. Despite this, the development of gamified mental health interventions is on the rise. It is essential to determine the best ways to implement gamification in mental health technologies that balance rapid production cycles with the need for empirical research and a solid evidence base. To enhance user engagement, gamification, defined as the application of game design elements in non-game contexts, is proposed as a strategy. Although there are various definitions and approaches in the literature, the use of gamification in the health sector, particularly in mental health, can be promising. (Cheng, 2020.)In conclusion, Gamification can have a positive impact on health and wellbeing, particularly on health behaviors. However, due to the small number of studies, the effects must be investigated further. (Johnson et al., 2016.)

A market analysis was carried out at the start of the project, and it showed that there are already many different applications for mental health. They all have different designs and cover most services. The demand for mental health support is increasing worldwide. Mobile apps play a crucial role in delivering on-demand and accessible mental health services. Deloitte Global predicts that global spending on mobile mental health applications will reach an annual growth rate of 20%, which is conservative considering the 32% growth observed from 2019 to 2020. The majority of these apps are easy to access, integrate into daily routines, and provide an enjoyable user experience. Notably, mental health apps are more resistant to disruption than traditional therapies, although they are not a substitute for professional mental health treatment. The potential market for mental health apps is substantial, with nearly 800 million people worldwide (approximately 11% of the global population) living with a mental health condition. The COVID-19 pandemic has exacerbated mental health concerns, leading to a rise in issues like depression, anxiety, and stress. (Auxier et al., 2021.)

The constant and rapid technological development of modern society is leading to an increase in digital treatments for depression, for example. The development and adoption of smartphone technology offers a new opportunity for mental health interventions at the population level. Such technology reaches most of the population. (Firth et al., 2017, 288.) More than 6.5 billion people own a smartphone, which is being checked several times a day. Therapeutic content delivered through the app is thus available anytime and anywhere, allowing users to practice the critical therapeutic skills necessary to prevent the onset or escalation of symptoms at the time of need. (Linardon et al., 2024, 139.)

Recent meta-analyses have documented that smartphone interventions can have positive effects on mental health problems (Firth et al, 2017, 288). Studies have found small but significant benefits of smartphone apps in treating depression and anxiety and in symptom relief. Smart phone apps help to provide access to care in situations where access to mental health treatment is challenging. (Firth et al., 2017, 287; Linardon et al., 2024, 147.) Given these findings, further research should be conducted on what methods should be created to implement smartphone-based interventions in the healthcare system (Firth et al., 2017, 297).

In Germany, digital health applications (E-Mental-Health) have the potential to complement existing healthcare services effectively. The introduction of the "App auf Rezept" (app on prescription) in 2020 marked a step toward digital health provision. (Weitzel et al., 2021, 1121.) The German market is a significant player in the mental health app landscape. It continues to dominate the European Mental Health Apps Market by country. In 2020, the German market achieved a value of $683.2 million and is expected to maintain its dominance until 2027. The UK market is exhibiting a CAGR of 15%, while the France market is projected to grow at a CAGR of 16.9% during the same period. (Knowledge Based Value, 2022.)

Finland also embraces digital health solutions. For instance, the health app YOU, developed by Health Puzzle, utilizes user health and preference data to inspire healthy, sustainable actions. It recognizes that gaming can motivate voluntary behavior change. (Gopalkrishnan, 2014.) While specific data on Finland's mental health app market isn't mentioned in the provided resources, it's essential to recognize that the demand for mental health services extends to countries like Finland as well. Finland has been proactive in promoting mental well-being and digital health solutions, so it's likely that the mental health app market is growing there too.

The market research revealed that many apps are rather simple and very conservatively designed. The following table 1 shows a few examples. If you compare the apps with each other, you quickly

realize that they are very monotonous. In contrast, the American apps for mental health are somewhat more advanced and offer almost the same packages, but in a different form: better design, more features and different reward systems for successful use of the app. A few selected and frequently used applications in the USA are shown in the following table 1.

Table 1. Competitor's Apps in Germany and USA, own representation based on DiGa Verzeichnis, (2023) and JMIR Ment Health (2021)

App Name	Diagnosis	Features	Country
Elona therapy depression	Depression (mild)	Interaction with psychotherapist, exercises, evaluations	Germany
Mindable: Panic Disorder and Agoraphobia	Agoraphobia, Panic disorder	Recognizing symptoms	Germany
Selfapys online Course for Depression	Depression (mild)	cognitive behavioral therapy, Exercises information about depression, diary, recognizing symptoms, evaluation, contact to the psychologist, warning system	Germany
HeadGear	Depressions and anxiety	30-Day challenges, Relaxation, mindfulness and breathing exercises, coping strategies to help manage life's challenges and reduce stress, getting active and staying healthy	USA
SupperBetter	Mental Health Illnesses without Suicidal Ideation	Identify and purpose epic wins, adopt a secret identity, Recruit allies for support, choose from pre-made Power Packs or design your own activities, activate power-ups, battle bad guys, and complete quests each day, build and track four types of resilience, join the SupperBetter Official Community Group	USA
Happify	Depressions and anxiety	activities and games to boost mood and well-being, weekly new challenges based on goals, including improving relationships, managing stress or increasing work satisfaction	USA

Absolutely, integrating game elements into a mental health app can significantly increase user engagement and motivation. Through achievements and badges, users experience moments of success and become more self-confident as a result. By integrating the different game elements thoughtfully into the mental health app, you can create a dynamic and immersive experience that not only helps users improve their mental well-being but also makes the process enjoyable and rewarding, increasing user retention and overall app effectiveness. (Do, 2023.) In addition, research has shown that digital interventions in the form of games can have a positive impact on mental health and general well-being. These interventions focus, among other things, on promoting the mental health of adults. (Aschentrup et al., 2024.) In addition to market research, literature on the theoretical background of anxiety, depression, and gamification in mental healthcare has been reviewed.

5.4   App Description

The application functions as an adjunct to conventional therapy, enabling therapists to monitor its usage and maintain a form of contact with patients between regular therapy sessions. This innovation surpasses traditional mental health apps, which often provide only descriptions and text-based exercises or informational content. This app distinguishes itself by incorporating a "Smart Animal," which acts as a partner, friend, or motivational companion to encourage patients to complete their at-home exercises.

The primary focus of the app is on young adults experiencing depression and/or anxiety, aiming to sustain their motivation through the gamification element provided by the Smart Animal. The app is structured like a game, wherein the user interacts with an avatar that can be leveled up and customized. Progression within the app is dependent on the completion of exercises and assigned homework, thereby promoting self-help practices to address the motivational challenges frequently encountered by patients.

The app's design allows users to identify with the avatar, as patients are given a choice among five different animals at the beginning of their therapy, as illustrated in the accompanying image (Figure 2). Providing the user with a choice of avatars is for giving them their individual choice and pick an animal they like and can see liking throughout the usage of the app. Maybe the user has a preference or can even identify with any of the animals.

Figure 2. Choice of Animals in Mental Mates

Throughout the therapy, the animal remains a constant partner, participating in the assigned exercises alongside the patient. As patients progress in their therapy, their in-app progress mirrors this advancement. By completing various at-home exercises with their Smart Animal partner, the animal grows, providing the patient with a sense of reward and maintaining motivation to continue their exercises.
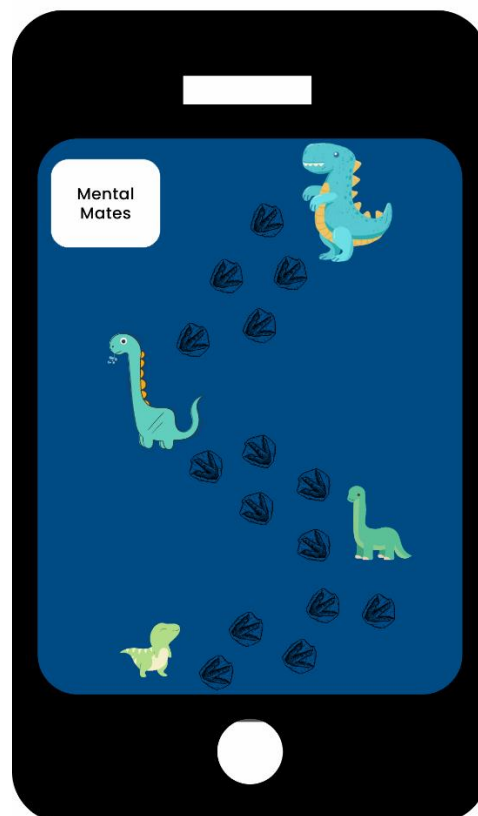

Figure 3. MentalMates Mockup

Figure 3 illustrates the app's interface, demonstrating how users can advance by completing a specified number of exercises. In addition to nurturing their mental health companion, patients can earn new accessories as rewards. Unlike conventional therapy, which may involve completing exercises in isolation, this app offers a supportive partner that guides and motivates the patient

throughout the process. If the user neglects their exercises, the Smart Animal sends a notification, requesting assistance to grow. This approach frames the task as a collaborative game rather than a chore, making it more approachable and engaging.

The therapist's role

Therapists play a crucial role in the app's functionality, as they can monitor their patients' engagement with the assigned tasks and exercises, intervening if necessary. The exercises are grounded in cognitive-behavioral therapy principles, designed to help individuals overcome daily challenges through straightforward behavioral modifications.

The therapist can integrate the game into forthcoming therapy sessions by inquiring about the patient's experiences with the game and related exercises and investigating reasons for any incomplete homework. This facilitates more effective monitoring of the patient's progress. Also data security is crucial, ensuring that only the assigned therapist has access to the patient's progress data.

Exercises in MentalMates

The app contains exercises related to the contents of selfcare programs on the mielenterveystalo.fi website. The app offers a wide range of ways to support mental health. Physical exercises, such as breathing and relaxation exercises, help to calm the mind and body, while thought exercises provide tools for managing one's thoughts and dealing with worries. Functional exercises, on the other hand, help with everyday management and activity planning, which can be especially useful in alleviating mood symptoms. (Mielenterveystalo, n.d.d; Mielenterveystalo.fi, n.d.e; Stenberg et al, 2015, 26-27, 38.) The selected avatar displays the exercises to the user, and this is how the user learns the exercises.

As a breathing exercise, the app includes diaphragmatic breathing, which is a particularly good way to bring awareness to your breathing and help calm your body and mind. Often a person when anxious breathes shallowly and the body reacts to it by increasing the feeling of anxiety. (Mielenterveystalo.fi, n.d.b; Terveyskylä, n.d.; Stenberg at al., 2015, 38–39). Relaxation exercises help a person find a moment of rest in the middle of a busy time (Mielenterveystalo, n.d.c; Stenberg et al., 2015, 38).

Mindfulness exercises, such as short mindfulness break, offer a way to stop for a moment and bring attention to your thoughts and feelings (Mielenterveystalo, n.d.e). Thought exercises such as worry time and problem-solving help manage worries and find solutions to deal with them, which reduces anxiety and mood symptoms. In worry time, people can worry only one time per day. A functional exercise that focuses on observing one's own actions and planning changes helps to identify which factors contribute to mental health symptoms and what changes can be made to promote one's own well-being. Together, these exercises offer a diverse and comprehensive approach to mental health support. (Mielenterveystalo,n.d.a; Stenberg et al., 2015, 55, 103, 144-152.)

5.5   Conclusion and reflection

There are many ways to promote mental health and life management. There are many ways in which people can influence these, and there are also policies and structures in society that promote them. Mental health is increasingly important because of the growing number of challenges people face in today's world. Stress, performance pressures and social isolation are contributing to mental health problems and more and more people are suffering from mental health problems such as depression or anxiety disorders. It is important to take measures to raise awareness of mental health and provide support (Narala, 2023). Its use in mental health promotion has increased. However, its full potential has not yet been realized. Some digital applications may be paid for by their users and this may prevent some groups of people from using them, e.g. with low income. The development of digital applications creates many opportunities to improve people's mental health and life management, provided they are accessible and easily used by all. Digitalisation is moving forward inexorably. Most people use apps on their mobile phones to simplify and organise their lives. Innovative technologies are being developed to enable fast and easy sharing of information and access to digital services (Firth et al., 2017, 287.)

MentalMates offers the opportunity to promote mental wellbeing through a digital app. It's easy to use and carries with you on your phone. The app contains elements that provide the user with tools to promote mental health and life management. The playful approach increases user motivation and engagement. Rewarding elements such as point systems, medals and virtual tokens further motivate users to engage with the app on an ongoing basis. This not only promotes mental health, but also achieves a sustainable learning effect. Mental Mates can also be used as part of

traditional therapeutic work. In summary, MentalMates represents a paradigm shift - an innovative combination of digital technology and gamification that allows individuals to engage in their mental health journey. However, the mechanisms of impact should be clarified to realise the full potential of this revolutionary approach (Aschentrup et al., 2024; Johnson,2023, 123; Smith, 2023).

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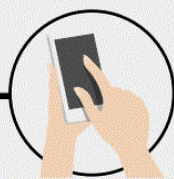
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