UNIVERSITY OF NICOSIA

Development of an online educational tool for adults with type 1 diabetes living in Cyprus, based on carbohydrate counting and incorporating their views and needs.

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PhD (Doctor of Philosophy) in Nutrition and Dietetics

June/ 2024

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Abstract

Background: Type 1 diabetes is a chronic condition affecting many people globally. This chronic disease requires a high level of self-management, which is a challenge for all relevant professions. Improving self-management by developing and enhancing specialised diabetes online applications is a promising area of intervention in the literature to support individuals and HCPs. The findings of available research studies suggest the need for insights in the field with further efforts in research and evaluations.

Objective: This mixed methods study aims to develop a usable and valuable online diabetes learning tool based on carbohydrate counting available to people with T1D and HCPs in Cyprus and to evaluate the usability and user experience.

Methods: Firstly, the research team gathered feedback and constructively discussed it with Cyprus Dietetic Association members to finalise the web application's content and usability. These patients had expressed a desire for a user-friendly and intuitive application that would assist them in managing their diabetes more effectively. Then, the systematic review provided valuable insights into the requirements of individuals with T1D and their support network about the usability of an online educational tool. The findings of this review were useful in forming the design and development of diabetes health web applications that cater to the specific needs of adults with T1D. An experienced information technology informatics professional was recruited to develop a diabetes web application. The web application has been designed and developed with a strong emphasis on security and data privacy. The study is designed to welcome the DiAPPeat web application evaluation from two groups (individuals with T1D and HCPs) following strict inclusion and exclusion criteria. The sample size was determined based on Nielsen and Landauer (1993), who present that the think-aloud protocol cooperates with numerous modest tests with no more than five users per group, as this method ensures the best evaluation results. The mixed methods study used the Triangulation Design Method as a data collection and analysis framework. A variety of instruments were utilised, including remote-moderated qualitative usability testing, a primary questionnaire featuring the System Usability Scale (SUS) by Brooke, John (1995), and the Technology Acceptance Model (TAM) by Davis (1989). Additionally, the researcher included two open-ended interview questions at the end of the verbal online usability test and two more after the main feedback questionnaire. To ensure that all relevant data was captured, the researcher also collected notes of significant phrases or statements provided by participants.

Results: Thirteen persons participated in the survey (6 with T1D and 7 HCPs). All participants from both groups expressed their enthusiasm for the web application's ease of use and usefulness, noting that it was straightforward and intuitive to navigate. The participants also highlighted the satisfaction derived from practising on the actual web application, indicating that this was an effective tool for enhancing user engagement and interaction.

Conclusions: The study suggests that the web application's user-friendly design and intuitive interface could play a crucial role as an educational tool for the self-management of Cypriots with T1D, who live in Cyprus. The study's findings could serve future research for designing and improving educational tools, especially in content, layout, usability and accessibility. Comments and experience could also serve in future research for clinical trials to assess usability and long-term diabetes management and the incorporation of these types of applications into clinical practice and in the community. Furthermore, targeting other specific age groups, such as children and adults over 65 and people with other vulnerabilities, is necessary.

Keywords: Type 1 diabetes; self-management; systematic review; mixed method; health care professionals; online educational tool; carbohydrate counting; usability testing

Dedication

This dissertation is dedicated to my wife, Emilia; my two children, Matilda and Oliver Jan Siekkeris; my supervisor, Dr Eleni Andreou; and all worldwide who suffer from type 1 diabetes.

Acknowledgements

I want to thank my wife, Emilia, for her support, love and care during all the years of studying for this degree. Professor Eleni Andreou provided invaluable personal and professional support, guidance and supervision throughout my PhD. I am honoured to have Dr Andreou as my supervisor because she taught me how an incredible professional can effortlessly demonstrate astonishing interpersonal skills.

On this page, my brother Andreas Siekkeris is an absolute standout. He's been there for me through thick and thin, always ready to lend a helping hand whenever I need it. I can't thank him enough for all his support; I'm lucky to have him in my life.

Thanks to my parents, George and Eleni Siekkeri, for their encouragement and continued support.

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Declaration

This thesis is submitted in partial fulfilment of the requirements for the University of Nicosia University
Degree of PhD (Doctor of Philosophy) in Nutrition and Dietetics
The regulations for the degree are set out in the University of Nicosia Calendar and are elaborated in a practice manual known as House
Rules for the Study of Doctor of Philosophy or Masters Degrees at the University of Nicosia.

Supervisor's Declaration

I confirm that, to the best of my knowledge:
☑ the research was carried out, and the dissertation was prepared under my direct supervision;
☑ except where otherwise approved by the Academic Administration Committee of the University of Nicosia, the research was conducted in accordance with the degree regulations and house rules;
☑ the thesis represents the original research work of the candidate;
☑ the contribution made to the research by me, by other members of the supervisory team, by other members of staff of the University
and by others was consistent with normal supervisory practice.
☑ external contributions to the research are acknowledged. (Delete if not applicable)

Supervisor _____Prof. Eleni P. Andreou-Georgaki_____ Date ___18/6/2024_____

Candidate's Declaration

I confirm that:
☑ this dissertation/thesis (please circle one) represents my own work;
☑ the contribution of any supervisors and others to the research and to the dissertation/thesis (please circle one) was consistent with normal supervisory practice.
☑ external contributions to the research are acknowledged. (Delete if not applicable)

Candidate _____Panagiotis Siekkeris _____ Date _____18/06/2024_____

Pre-Publication of Parts of this thesis.

We confirm that no part of this dissertation has been submitted for publication in advance of submission of the Thesis for examination.

Candidate _____Panagiotis Siekkeris _____ Date _____18/06/2024_____

Supervisor _____Prof. Eleni P. Andreou-Georgaki_____ Date ___18/6/2024_____

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Abbreviation Index

AI	Artificial Intelligence
ASPIRE	Structured Education for Adults with Type 1 Diabetes
BG	Blood Glucose
BMI	Body Mass Index
CSII	Continuous Subcutaneous Insulin Infusion
CySPEN	Cyprus Society of Clinical Nutrition and Metabolism
DAFNE	Dose Adjustment For Normal Eating
DESMOND	Diabetes Education and Self-Management for Ongoing and Newly Diagnosed
DKA	Diabetic Ketoacidosis
DM	Diabetes Mellitus
DSMES	Diabetes Self-Management Education and Support
DSN	Diabetes Specialist Nurse
GHS	General Healthcare System in Cyprus
HbA1c	Glycated haemoglobin
HCP	Healthcare Professional
HIO	Health Insurance Organisation
IDF	International Diabetes Federation
ISPAD	International Society for Pediatric and Adolescent Diabetes
MDI	Multiple Daily Injections
MDT	Multidisciplinary Team
NHS	National Health Service
NICE	National Institute for Health and Care Excellence
NSF	National Service Framework
SDM	Shared-Decision Making
SEREN	Structured Education Reassuring Empowering Nurturing

SHSO	State Health Services Organisation
SUS	System Usability Scale
TAM	Technology Acceptance Model
T1D	Type 1 Diabetes
T2D	Type 2 Diabetes
UNIC	University of Nicosia
WHR	Waist-Hip Ratio
WIP	Work-in-Progress
X-PERT	Expert Education versus Routine Treatment

CHAPTER 1 INTRODUCTION

1.1. Introduction

Diabetes is a persistent autoimmune ailment that affects the beta cells in the pancreas, which are responsible for producing insulin. These cells may be dysfunctional or under-functional, resulting in limited or no insulin production (Ma and Nk, 1994). The lack of insulin in the body, whether for a short or extended period, can lead to acute and chronic complications for those with the condition.

The IDF Atlas report, which provides comprehensive data on diabetes worldwide, reveals that approximately 8.75 million people across the globe are affected by Type 1 Diabetes (T1D). This chronic condition, which is caused by the body's inability to produce insulin, can lead to serious health complications if left untreated.

In Cyprus, the report discloses 4,040 individuals living with T1D. Among them, 401 are children under 10, 2,611 are adults between 20 and 50, and 1,028 are seniors aged 60 or above. These statistics highlight the significant impact of T1D on the Cypriot population and the need for continued efforts to improve diabetes management and prevention strategies.

The author of this PhD study understands that the NHS has a healthcare system similar to the National Health System in Cyprus (GHS). The diabetes education model in Scotland is classified into three levels to support diabetes self-management (McDowell and MacRury, 2015). This has also been adopted by Diabetes UK (Diabetes UK, 2016).

Structured education is the golden standard (Level 3) that meets the criteria set by NICE and SIGN for a national application (SIGN, 2010; NICE, 2011). Structured education is a pedagogical approach founded upon a carefully designed curriculum that is evidence-based and imbued with quality assurance of teaching standards. Regular audit is an inherent component of this approach, ensuring consistency and perpetuating high standards. A Level 2 diabetes education involves ongoing informal learning, such as through peer groups. The first level (Level 1) incorporates advice provided in clinical settings during patient reviews and follow-up appointments, as well as information given by members of multidisciplinary diabetes teams.

According to a report commissioned by Diabetes UK, Level 2 education in diabetes includes face-to-face group-based education, peer-based approaches and technology and internet-based approaches (Wenzel, 2016).

Developing or adopting a structured education is a complex intervention, especially when there is a need for cultural adjustment and employment, such as quality assurance, audit processes, and structured curriculum. The literature supports online education. However, its effectiveness is still debatable. It is worth investigating the quality of applying usability testing in online health applications.

The study's author supports that a newly developed web application, “DiAPPeat”, belongs to level 2 education. The scope of this project is to make a usable and comprehensive online prototype educational tool based on carbohydrate counting in Cyprus. Education in Cyprus is in its infancy, with no structured education programme for T1D. The project suggests an oxymoron process to start with online education using a web app and proceed systematically to improve systematic instruction via this online supplementary route. A recent study suggests that improvements in the accuracy of carbohydrate counting result in better glycaemic outcomes (Kesavadev et al., 2021).

According to the NICE guidelines (2015), last updated in 2022, education is included in the early care plan of a person diagnosed with T1D. Moreover, the above guidance suggests performing cultural and educational assessments on the existing knowledge of diabetes. The individualised approach in providing advice, initiating conversations about the treatment and offering diabetes education programmes is fundamental. Structured education plays a crucial role in the management of T1D. It enables individuals to adapt their diabetes management to changes in their daily lives and maintain a good quality of life.

The number one quality statement mentioned in the National Institute for Health and Care Excellence Quality Standards for adults with T1D in the United Kingdom is structured education programmes. The available data from the above standards suggest that the confidence of individuals with T1D is enabled, allowing them to improve their quality of life by providing them with the knowledge and coping skills to handle the day-to-day management of T1D (NICE, 2023). The National Service Framework (NSF) supports individualised diabetes care and the opportunity for people with the condition to receive diabetes education in line with “The NHS Plan” and “The Expert Patient” by enabling the self-management aspect in their lives (Department of Health and Social Care, 2001).

Examples of structured education programmes in the United Kingdom include SEREN for the paediatric population, the DAFNE, X-PERT, and ASPIRE courses for people older

than seventeen with T1D—the DESMOND (Diabetes Education and Self-Management for Ongoing and Newly Diagnosed) for people with T2D.

Structured education programs should be grounded on empirical evidence, clearly defined objectives and learning outcomes. These programs should aim to facilitate the development of self-care abilities among individuals with diabetes and their family members or caregivers. To achieve this, a structured syllabus should be developed that encompasses critical topics such as hyperglycaemia, hypoglycaemia, blood glucose monitoring, nutrition, exercise, and other relevant issues related to the condition. By adhering to these principles, structured education programs can help individuals with diabetes better manage their condition and improve their overall health outcomes.

Examples of online diabetes education that construct knowledge and confidence in the individual's diabetes management. The My T1D website provides free services, including carbohydrate counting, exercise, living with T1D and diabetes technology such as sensors and insulin pumps (MyWay Digital Health, 2023a; MyWay Digital Health, 2023b). Another website called Diabetes Education Online offers diabetes content about a healthy lifestyle with T1D split into three domains. 1) Understanding Diabetes, 2) Health Management, and 3) Diabetes Treatment (Nolte Kennedy, 2010).

According to a study conducted in two phases by Albanese-O'Neill et al. in 2019, participants preferred online diabetes resources with high-quality design. They also chose accessibility through mobile devices and tablets, concise text with multimedia and interactive features, medical professional endorsement, reminders through text or email, and links to scientific evidence.

1.2. Motivation and Background

The author of this thesis is an adult diabetes nurse with a Nursing and Midwifery Council registration in the Republic of Cyprus and the United Kingdom. My motivation to complete an undergraduate degree in nursing was purely to make an effort to improve diabetes care in Cyprus. Reflecting on this, the passion to offer was a dream not to leave any child with diabetes to loudly or quietly suffer from this silent and devious condition. The decision was made, and I have been accepted to the University of Leicester, in the medicine faculty, for the MSc in Diabetes. Arriving at the University of Nicosia with their innovative ideas and insatiable desire to delve deeper into diabetes research was a thrilling experience for them. Being granted the opportunity to initiate this PhD project was a dream come true. The name of the proposed web application, "DiAPPeat," perfectly aligns with

the academic background needed to provide comprehensive online education about diabetes.

The journey to becoming a diabetes nurse was challenging. It all began when the author attended an International Diabetes Federation European camping event and became a young leader in diabetes. Thereafter, the author supported the local diabetes community by working with the diabetes association and became an inspirational speaker for Diabetes UK in 2017. The right opportunity presented itself, and the writer started building his network in the UK by becoming a diabetes nurse. He gained experience in adult diabetes nursing and eventually became a diabetes nurse leading the insulin pump service in a local hospital in the UK. The author switched to paediatric diabetes nursing to acquire specific knowledge and relevant clinical expertise. It's worth mentioning that the author also became a diabetes facilitator and educator for the Dose Adjustment For Normal Eating (DAFNE) program for young adults and adults, as well as the SEREN (Structured Education Reassuring Empowering Nurturing) program for paediatrics. The motivation behind the author's current project stems from his dedication to providing good diabetes care in all three levels of diabetes education, the influence of professional role models, and the lack of structured education for T1D in the Republic of Cyprus.

Becoming a researcher and diabetes specialist nurse has another motive for the author, rooted in the diagnosis of T1D at thirteen. The author still remembers the exact feeling of the first insulin injection, the overwhelming tiredness that came with diabetes, and the determination to support anyone going through the same experience. Ultimately, this strong sense of purpose, combined with a strong will and informed decision-making, led the author to create DiAPPeat.

The author identifies himself as a pragmatist, influenced by how pragmatism is defined. The pragmatist approach utilises the effort and experience. Pragmatism emphasises practical consequences and empirical explanations rather than introspective contemplations. However, the arguments of pragmatists need to be more uniform, as shown by the four prominent pragmatists presented in this article.

1.3. Research Aim and Questions

This study aims to develop a usable and valuable online diabetes learning tool based on carbohydrate counting available to people with T1D in Cyprus.

Research questions:

What are the views and preferences of adults with T1D regarding the usability of a novel online educational tool for managing their condition?

How can the users' feedback and input be systematically collected for the online educational tool to ensure that it meets the specific needs and preferences of the target population?

What are the views and preferences of adults with T1D and healthcare professionals (HCP) with relevant expertise in Cyprus regarding the usability of the DiAPPeat online educational tool for managing diabetes through carbohydrate counting?

1.3.1. Summary of the Objectives

The study aims to create an online educational tool, consider users' perspectives and needs, and enable users to manage carbohydrate intake. The objectives are to assess usability and user experience, gather input on the online educational tool's functionality and overall user satisfaction, and pinpoint areas where users face challenges or find the tool especially effective and user-friendly. Further details on the project's objectives can be found in Chapter 3, "Philosophy, methodology, methods and materials. 3.4 Objectives".

The project outlines the development of an online educational tool focusing on carbohydrate counting for Cypriot adults with T1D in Cyprus. The tool is culturally sensitive, user-friendly, and accessible. It emphasises incorporating user views and needs, aiming to align the content, format, and features with the expectations and experiences of the target-specific population. The tool aims to empower adults with T1D by enhancing their knowledge and skills related to carbohydrate counting, thereby improving their overall diabetes care.

1.4. PhD Thesis Contribution and Novelty

This research focuses on initiating the T1D educational pathway in Cyprus by standardising the necessity of carbohydrate counting and further diabetes education. The novelty of this project is based on the DiAPPeat web application. The usability evaluation for this tool is the first usability mixed method study for an online diabetes educational tool occurring in the Republic of Cyprus. Our analysis is critical because it represents a significant step forward in diabetes management. By gathering and analysing input from individuals with T1D, we can better understand the challenges and opportunities associated with diabetes management tools. This research provides a unique window into end-users perspectives, revealing what works well and needs improvement.

One of the most notable aspects of this project is the inclusion of two exceptional features that make it stand out among other diabetes management tools. Firstly, the carbohydrate counting section is an essential addition to the web application, endorsed by the research team, as it is valuable knowledge in diabetes day-to-day management. It enables individuals to accurately calculate the amount of carbohydrates they consume and adjust their insulin dosage accordingly, which is essential for effectively managing T1D and consistently achieving optimal glycaemic outcomes. Secondly, the Cypriot food search option is a unique feature that caters to individuals who follow a Mediterranean diet, which is believed to be beneficial for diabetes management (Papadaki, Nolen-Doerr and Mantzoros, 2020). This feature enables users to search for Cypriot foods and access their nutritional information, making it easier to make informed dietary choices. Overall, these two features make this project an exceptional tool for diabetes management, providing users with the necessary resources to improve their health and well-being.

Our focus on enhancing end-user satisfaction is not simply a matter of convenience or preference. Instead, ensuring that individuals with T1D can manage their condition effectively and maintain optimal health outcomes is critical. Through this study, we aim to identify areas where the current tool falls short and develop strategies to address these gaps.

Our team is committed to improving the quality and user experience of diabetes management tools, and we believe that our research will lead to tangible improvements in tool design and functionality. Ultimately, we aim to empower individuals with T1D to take control of their health and lead fulfilling lives free from the burden of diabetes-related complications.

The web application is designed with a user-centric approach, providing end-users with comprehensive features carefully crafted and informed by evidence-based characteristics derived from global literature. The author has accumulated years of experience in diabetes technology, which has helped to shape the application's design, functionality, and usability. Additionally, the author conducted extensive research and drew insights from diabetes associations, where individuals with diabetes generously shared their thoughts, uncertainties, and worries openly and candidly. The application's features cater to the specific needs of users with diabetes, providing them with a personalised and intuitive experience that empowers them to manage their condition confidently and efficiently.

1.5. Synopsis of the thesis

The thesis by Panagiotis Siekkeris is a comprehensive study that aims to develop an online educational tool for adults born and living in Cyprus with T1D. The tool is based on carbohydrate counting and incorporates the views and needs of the target population. The thesis has been submitted to the University of Nicosia as a requirement for the PhD in Nutrition and Dietetics degree.

The thesis comprises several sections, including an abstract, dedication, acknowledgements, declaration, table of contents, list of tables, list of figures, list of appendices, abbreviation index, and five chapters.

The abstract summarises the thesis, presenting its aims, research methodology, findings, and implications. The dedication is a personal tribute to the author's family, supervisor, and people suffering from diabetes and eating disorders. The acknowledgements section thanks the people who contributed to the study, including the author's wife, supervisor, and others who supported the author practically, mentally and spiritually.

The declaration section states that the University of Nicosia regulations were followed and confirmed the originality of the thesis. The dissertation was not previously submitted, in whole or in part, to this or any other institution for a degree, diploma or other qualifications.

The table of contents overviews the study, listing the sections and chapters. The list of tables, list of figures, and list of appendices provide detailed information about the tables, figures, and appendices included in the research. The abbreviation index lists the abbreviations used in the thesis and their meanings.

The five chapters of the thesis cover different aspects of the study. Chapter one introduces the thesis, including its motivation and background, research aims and questions, PhD thesis contribution and novelty, and synopsis of the thesis. Chapter two is a literature review, presenting the results of a systematic review on the topic. Chapter three covers the philosophy, methodology, methods, and materials used in the study. Chapter four presents the analysis, results, and discussion of the study. Finally, chapter five provides the conclusions of the study.

Overall, the thesis aims to contribute to understanding diabetes management and provide a useful tool for patients and HCPs. The study is valuable for anyone interested in diabetes management and education.

1.6. Conclusion

The introduction chapter of the thesis provides a comprehensive background of the research project. It presents an overview of the motivation and knowledge of the study, discussing the challenges faced by adults with T1D living in Cyprus and the need for an online educational tool based on carbohydrate counting that incorporates their views and needs.

The chapter also outlines the research aim and questions, highlighting the study's primary objective and the research questions that address the research aim. Furthermore, the chapter discusses the contribution and novelty of the PhD thesis, explaining how the study aims to fill the research gap and contribute to the existing body of knowledge in nutrition and dietetics.

The chapter concludes with a synopsis of the thesis, providing a brief overview of the subsequent chapters. It outlines the main topics covered in each chapter, giving the reader an idea of what to expect in the rest of the thesis. Overall, the introduction chapter sets the stage for the rest of the thesis and provides a roadmap for the reader.

CHAPTER 2 LITERATURE REVIEW

2.1. Introduction

The present chapter provides an overview of the methodologies employed in the literature to evaluate mobile or web apps and gather quantitative and qualitative data about the development of online applications for diabetes self-management. The outcome of the literature review is carefully examined and scrutinised. In the following sections on discussion and conclusions, the author deliberates on the results, evaluation procedures and techniques of T1D-related mobile applications.

According to ISPAD and NICE guidelines concerning technology, T1D is a chronic condition requiring a high level of self-management and technology (Craig et al., 2022; NICE, 2018). Mobile health apps for diabetes self-management aim to support individuals with T1D and their families to cope with the day-to-day challenges and eventually avoid diabetes complications (Albanese-O'Neill et al., 2019; Ng et al., 2019; Adu et al., 2020; Otis et al., 2020; Harrington et al., 2021; Sharma et al., 2022; Burda et al., 2022). The digital technology aims to connect and unite diabetes services with individuals and their families, increase interaction and avoid diabetes complications (NICE, 2018; Craig et al., 2022).

An integrative review conducted in Sweden on the perceptions of adults with T1D highlighted the challenges of managing this chronic condition. The review could not establish a conclusive outcome due to the limited number of studies available in this field and the heterogeneity of the selected studies. Nevertheless, the findings from the review conducted by Stephen et al. (2022) suggest the need for further large-scale studies to address the gaps in knowledge and improve the mHealth app about T1D self-care.

The review revealed that adults with T1D face numerous challenges, including difficulties in adhering to treatment regimens, coping with the psychological burden of the disease, and managing comorbidities. The limited availability of resources and access to healthcare services exacerbate these challenges. The study by Stephen et al. (2022) suggests that developing more effective interventions can better address these challenges. However, a substantial body of literature exists about diabetes mobile applications and web interfaces designed for individuals with T2D (Davis and Jiang, 2016). Georgsson's 2020 systematic review indicates that additional research is necessary to advance our understanding of the subject matter.

The definition of usability is "How useful, usable, and satisfying a system is for the intended users to accomplish goals in the work domain by performing certain sequences of tasks" (Zhang and Walji, 2011). The definition of usability in the selected articles varies. The collection of studies handpicked for analysis offers a comprehensive and diverse range of perspectives on usability. Each study presents unique insights and findings through various questionnaires and definitions, contributing to a more nuanced understanding of the concept. By examining the different approaches researchers use in measuring usability, we can gain a more in-depth knowledge of the factors contributing to a product or service is considered usable. Overall, the selected studies provide a rich source of information for anyone interested in understanding usability and its various dimensions.

2.2. Methods: Systematic Review

The writer of the present systematic literature review utilised the library database of the University of Nicosia by accessing the following link, https://primo.unic.ac.cy, and the PICO tool (Population, Intervention, Comparison, Outcome) to approach the search (Brown, 2019).

The author applied the above knowledge, and the following terms were used in the database search: (Self-care OR Self-management) AND (Diabetes OR "Diabetes Mellitus" OR diabetic) AND ("Mobile Health" OR Telemedicine) AND ("Usability evaluation" OR "Usability test" OR Usability) between the period of March 2019 to October 2023. Considering the above terms in the database search, 78 articles are shown. Afterwards, the search was specified further with supplementary filters applied to establish this systematic review, such as "Available online", "Open Access", and "Peer-reviewed Journals".

Furthermore, the language filter was set to English exclusively (excluding a Portuguese article found). In addition, text resources (1) and conference proceedings (1) were also excluded from the final count. The last number of articles to screen was thirty-seven (37) from ten (10) different collections/databases following removing the duplicates, as shown below.

ProQuest Central UK/Ireland (34), ProQuest Central (34), PubMed Central (34), DOAJ Directory of Open Access Journals (33), Scopus (31), ProQuest - Publicly Available Content Database (30), Health & Medical Collection (29), Nursing & Allied Health Database (19), MEDLINE (14), EBSCOhost MEDLINE Complete (10), Public Health Database (9), Coronavirus Research Database (6), Library Science Database (6),

EBSCOhost Food Science Source (4) EBSCOhost Academic Search Ultimate (4), Engineering Database (4), Healthcare Administration Database (3), Environmental Science Database (3), Springer Nature Complete Journals (3), ABI/INFORM Collection (2). The following step assessed the articles' titles, which reduced the number of records to fifteen (15). Seven (7) of the sixteen (16) articles have been selected for this systematic review (See Appendix 1).

The author of this review decided on the inclusion and exclusion criteria of this systematic review. The inclusion and exclusion criteria for this systematic review in this thesis section are meticulously designed to ensure the research is comprehensive and relevant (see Table 2.1,2.2). The study design should be carefully planned to incorporate quantitative, qualitative, or mixed-method approaches, depending on the research questions and objectives.

The use of usability testing as an intervention activity should be thoroughly considered and implemented to evaluate the effectiveness of the intervention. The study should focus solely on subjects diagnosed with T1D, including their families and healthcare practitioners, to ensure the intervention is relevant and applicable to the target population. The study should also consider the potential ethical issues and have mechanisms in place to ensure the safety and well-being of the participants. Furthermore, the study design should consider the possible limitations and biases that may arise in the research process and have strategies to minimise their impact on the study outcomes. The systematic review exclusively considered individuals diagnosed with T1D, while other types of diabetes are incorporated in selected studies.

This systematic review included individuals from paediatric, adult population, and combination and age groups, encompassing a wide range of ages and educational levels and making the findings more comprehensive and applicable. In addition, the inclusion criteria allowed for equal representation of all gender identities and ethnicities. The study-specific variables were stringent and only included articles published in English between March 2019 and October 2023. The settings of the interventions comprised online or face-to-face modalities, ensuring that the study consists of some designs and methodologies. Lastly, the review included all counties, enhancing the generalisability of the findings. These comprehensive and meticulous inclusion criteria ensured that the review was academically rigorous and that the results were applicable and relevant to various individuals.

The present review has established the following exclusion criteria to ensure the scientific rigour of the investigation: reviews and studies that exclusively focus on Type 2 diabetes or any other type of diabetes as either the exposure or health condition are precluded from consideration. Therefore, any study design that attempt to explore Type 2 diabetes, or any other type of diabetes as a single exposure or health condition was excluded from the present study. The present study aims to maintain high scientific validity and robustness in its findings by adhering to these criteria.

To ensure a rigorous selection process for the study, we have established a set of exclusion criteria that consider several study-specific variables. Among these variables, we have determined that studies published outside the March 2019 to October 2023 range were excluded from consideration. This is to ensure that the findings of our study are based on the most current and relevant research studies available.

Furthermore, we have established that studies published in languages other than English were also excluded from consideration. This is to ensure that the research included in our study is accessible to the broadest possible audience and that language barriers do not hinder the dissemination of our findings. By adhering to these strict exclusion criteria, we can ensure that the studies selected for our analysis are of the highest quality and relevance and that our findings are based on a comprehensive and standardised set of criteria.

Table 2.1: Inclusion Criteria for the systematic review

Study design: • Quantitative, Qualitative and Mixed method studies • Intervention: Performed or considered usability testing • Exposure to intervention/ or specific health condition: only subjects with type 1 diabetes and their families and HCPs. Studies with other types of diabetes can be included, but only people with T1D were included in the systematic review.
Demographic characteristics: • Age group: Paediatric, adult and combination • Gender identity: All • Ethnicity: All
Study-specific variables: • Date of publication: Between March 2019 to Oct 2023 • Language of Publication: only include English articles • Settings: Online or face-to-face intervention

- Geography: Any geographical location

Table 2.2: Exclusion Criteria for the systematic review
Study design: • Reviews • Exposure to intervention/ or specific health condition: solely Type 2 diabetes and any other type of diabetes.
Study-specific variables: • Date of publication: Outside of the range of March 2019 to Oct 2023 • Language of Publication: Articles in languages other than English.

The systematic review focuses on international evidence for the user-centred design of online health applications for diabetes self-management using mobile and web-based technologies, emphasising usability methods and evaluation factors.

2.3. Results

The seven studies identified used various methods and designs to produce acceptable evidence. Four out of seven (4/7) studies used mixed methods (Ng et al., 2019; Albanese-O'Neill et al., 2019; Otis et al., 2020; (Adu et al., 2020). One used heuristic evaluation (Harrington et al., 2021) with Pareto analysis. One used weighted scoring with feedback (Sharma et al., 2022). The last selected study was a long-term case study (Burda et al., 2022). The authors considered the usability feedback and committed to acting upon the knowledge they received. Articles were studied for secondary outcomes, adoption factors, and limitations.

The seven studies utilised diverse techniques and approaches to generate proof of the evaluation of the diabetes self-management applications examined. The investigation and discussion of the usability testing methods are the focus of this study. However, other factors were identified and will be presented and discussed.

2.3.1. Design and methods

The following discourse aims to offer a detailed account of the selected studies, delineating their salient features and characteristics comprehensively and methodically. In particular, the text will elaborate on each study's sample size, the statistical significance of their findings, and other relevant parameters that have been meticulously analysed and scrutinised. By providing an in-depth analysis of these studies, this text aims to facilitate a

deeper understanding of their scope, methodology, and implications and to serve as a valuable resource for researchers, educators, and practitioners alike.

Ng et al. (2019) conducted a 12-week mixed method study in Australia, including an observational phase and a website usability survey utilising Google and Facebook analytics. They enrolled thirty-four participants with T1D aged between 18 and 35 years to use a mobile application called Diabetes (YES). The study aimed to measure website usage and ease of use using an 8-item website usability survey in Google Analytics and assess peer support engagement using Facebook Analytics. The researchers evaluated the results using Likert scales and open-ended questions.

These findings are crucial for businesses and academics seeking to improve website usability and engagement. Companies can gain valuable insights into how users interact with their websites using well-established measurement tools and analytics. Similarly, academics can leverage this information to understand website user behaviour better and improve website usability. Overall, the study's findings underscore the importance of using reliable measurement tools and analytics in website research (Ng et al., 2019).

In a recent US study, Otis et al. (2020) designed their study as a mixed methods pilot study to collect quantitative and qualitative data in two concurrent phases. The data was collected on the usability and feasibility of the Mobile Educator Tool and the data to find the tool's effectiveness. During the first phase, the measurement tool was the user testing interviews, and during the second phase, it was a single-arm pre- and post-trial assessment. The people enrolled in Phase 1 of the study were at the level of twenty-two participants (eleven parent-child pairs), and in Phase 2, 20 participants (ten parent-child pairs). The duration of the study was four weeks.

The third mixed-method study found in this systematic review process included fathers of children with T1D being questioned about the design, content and infrastructure of an online diabetes material that promotes diabetes self-management education and support (DSMES) to children with T1D and their families (Albanese-O'Neill et al., 2019). The design of this study included three phases. The first phase was exploratory research, the second phase approached the website and subdomain development, and the third was about the website and subdomain evaluation.

The name of the website involved was T1DToolkit.org (Website) and Mobile Diabetes Advice for Dads, or mDAD. The measurement tools utilised for this study varied for each one of the phases of the study. In phase one, the researchers performed one-on-one semi-

structured interviews and an online survey, and in phase two, the authors proceeded with the development of the application prototype. In phase three, they requested the prototype evaluation survey to be completed.

The last mixed methods study designed, developed, and usability tested the application (My Care Hub Mobile-Phone App) in three stages (Adu et al., 2020). Firstly, there was a pre-development stage with the involvement of 8 out of 12 initial testers without diabetes, randomly selected to express ideas about the design, features, and app content. Important issues were the extensive study and utilisation of behavioural change theories, including security features and privacy issues, and a decision-making expert advisory group. Secondly, there was the design and development of the app stage. Thirdly, there was the usability testing of the developed app in two phases: the testing by the people without diabetes who expressed their views and, after the improvement of the app, the testing by four persons with T1D, the new version of the prototype app. The primary users were persons with T1D and T2D.

In the United States, a qualitative study was conducted to evaluate a selection of health applications and collect feedback on mHealth apps in three areas, one of which pertained to diabetes management (Sharma et al., 2022). The study aimed to develop a comprehensive structure for assessing the pros and cons of mobile Health (mHealth) applications, particularly for diverse and low-income communities. Clinical experts and a patient advisory board were presented with the tool to ensure the study was comprehensive. They proceeded with the research following a one-day presentation. The study evaluated three categories of mobile applications, namely diabetes management, smoking cessation, and medication adherence. The study found that the diabetes management apps Glucosio and MyNetDiary provided significant user benefits. Blood glucose monitoring is a crucial aspect of diabetes management, and these apps help users track their glucose levels, monitor their food intake, and manage their medication. Additionally, the apps provided valuable educational resources to help users understand the condition and how to manage it effectively.

For smoking cessation, QuitNow! and Smoke Free-Quit Smoking Now were evaluated. Both apps were effective in helping users quit smoking through a range of features, including tracking cravings, progress, and achievements, as well as providing motivational messages and resources. For medication adherence, Medisafe and MyMeds were evaluated. Both apps were found to help users manage their medications, including tracking dosage times, providing reminders, and organising medication schedules.

However, the author of this review considers only the diabetes management app relevant in terms of information and outcomes (Sharma et al., 2022). Overall, the study provided valuable insights into the benefits and limitations of mHealth applications in managing diabetes and other health conditions. The findings underscore the potential of these apps to enhance patient outcomes and improve access to healthcare, particularly for underserved populations.

A recent qualitative study in the United States evaluated the usability of a mobile health app designed for commercial self-management. The study, conducted by Harrington et al. in 2021, aimed to assess the app's usability through a heuristic evaluation based on Nielsen's heuristic Pareto analysis. The research team, which consisted of informatics experts and research nurses, employed a heuristic assessment to identify and analyse different types of heuristic violations in the app. The heuristic evaluation was based on Nielsen and Molich's 1990 evaluation, Nielsen and Landauer's 1993 and Nielsen's 1994a and 1994b evaluations. The heuristic evaluation involved creating a bar chart to indicate the severity of each type of heuristic violation.

Test results were recorded in an Excel spreadsheet, which included detailed information on the problem location, description, heuristic violated, severity, and recommended solutions. Using an Excel spreadsheet allowed for the easy tracking of results and ensured that the data could be analysed quickly and efficiently. The evaluation based on Nielsen's heuristic Pareto analysis proved to be a practical approach to assess the usability of the self-management commercialising mobile health app. The study results can be used to improve the app's usability and enhance the user experience.

The research conducted by Burda et al. (2022) employed a Long-Term Case Study design and methodology to investigate the development and impact of a mobile app on the self-management of Diabetes Mellitus. To achieve this, the research team created a free application to observe its long-term use, analyse individual feature utilisation, and assess the long-term benefits. Overall, the study provides valuable insights into the app development process and its impact on the self-management of DM, making it a significant contribution to the field. The measurement tools utilised for this intervention were usability testing and server-based systems. (Burda et al., 2022).

2.3.2. Usability outcomes

Referring to the user testing observations and the type of participants involved, the user testing observations provided that some parent-child pairs (six out of eleven) used the tool

together, and for the remaining 4 out of eleven, the instrument was used solely by the child. The study staff deemed the tool's navigation relatively easy despite experiencing some difficulties (Otis et al., 2020).

The findings from the usability analysis indicate that the website was designed to make it effortless for users to navigate and find the information they were seeking. The website's content was also structured in a manner that was easy to comprehend. However, there was a significant drop in website visits during the 12 weeks, while Facebook engagement remained stable. On a positive note, they introduced weekly discussion topics that successfully sparked conversations within the group. Users reported that the emotional support received through these conversations was the most substantial benefit of the intervention (Ng et al., 2019).

The participants in the user testing, i.e. parents and children, demonstrated significant and reasonable levels of engagement, as stated by the observers. The parent-child engagement was noticed to be high or moderate during user testing. This study conducted semi-structured interviews with the parent-child pairs during the User Testing period. The thematic analysis of seven themes included questions on usability, comprehension, engagement (high and low), purpose, satisfaction and suggestions for improvement (Otis et al., 2020). Although Otis et al. (2020) aimed to explore usability and feasibility, this systematic review approached this analysis from the usability point of view.

According to Otis et al. (2020), the participants found the tool user-friendly but encountered two main challenges during usability testing. The first challenge was the need for more guidance, as users sometimes found it unclear what was expected of them on each slide, including whether a fall was interactive and what buttons to press to initiate an activity. The second challenge mentioned involved non-functional activities, which discouraged participants when they could not complete an action or when nothing happened when they pressed a button. However, some problems were simply due to inadequate guidance, such as the understanding that they must select icons sequentially for an activity to function correctly.

The study by Albanese-O'Neill et al. (2019) evaluates the tool in phase three. The participants rated the site as user-friendly and satisfactory, giving it an average score of 85.6 points (ranging from 78 to 90 points). All the participants confirmed their intention to revisit the site in the future. Almost all participants, i.e., 97%, rated the site's quality as excellent or very good, and 91% found the information on the site useful. The majority of

the participants (97%) agreed that the site was well-organized, and everyone saw the layout and design of the site as attractive. Most participants (85%) did not encounter any issues while viewing the videos, and 91% did not or rarely got lost while looking for information on the site.

The Australian study by Adu et al. (2020) recruited people without diabetes to provide their initial opinion on the design and features of the application in the pre-development stage by expressing individual preferences. The primary usability testing was performed in two phases, firstly by the persons without diabetes and secondly by the persons with diabetes, after improvements made considering the comments made by the previous usability testers. This procedure is called the "multi-stage usability evaluation method". Nearly all participants were able to learn how to use the application quickly, and they were satisfied with its features. Specifically, the individuals with diabetes, 75% approved the app in terms of the educational content and the motivational aspect. They also noted (75%) that they would recommend it to others and continue using it.

The study conducted in the Czech Republic has provided valuable insights into the development of applications and their effect on diabetes self-management. The study's findings make it a significant contribution to healthcare and medical research (Burda et al., 2022). The outcomes of the above analysis may serve as a foundation for future research and application development for managing this chronic disease. The study's results are particularly relevant in the context of the growing use of technology in healthcare and the increasing need for innovative solutions to manage chronic diseases more effectively.

According to clinical experts, the two leading mobile applications for diabetes management are Glucosio and MyNetDiary, with weighted scores ranging from 119 to 147. (Sharma et al., 2022). These scores were based on a comprehensive assessment of various domains, including literacy, language, usability, cost, evidence-based content, and cultural sensitivity. Among these domains, literacy and language received the highest scores, indicating that the apps effectively provide clear and understandable information to users. In addition, the usability of both apps is considered to be of average importance across all component domains, suggesting that they are user-friendly and easy to navigate. The cost of the apps is also a factor, with both being affordable and accessible to a wide range of users. Another category that was evaluated is the clinical impact of the apps, which received high scores from experts. This indicates that the apps have a significant impact on the management of diabetes and can provide valuable support to users in managing their condition. Population focus is another area that received high scores,

indicating that the apps are designed to meet the needs of diverse populations, including those with limited literacy and language proficiency. Overall, the high scores for Glucosio and MyNetDiary demonstrate that they are practical tools for diabetes management. The comprehensive evaluation of the various domains provides a clear understanding of the strengths and weaknesses of these apps, making them a valuable resource for individuals with diabetes and HCPs alike (Sharma et al., 2022).

Upon initial inspection, it was found that the opening screen exhibited 51 usability heuristics violations, widely accepted principles for evaluating user interface usability. This represented many violations, with 6 out of Nielsen's 10 broken heuristics. A Pareto analysis was conducted to investigate these violations further to group them according to their root causes. It was discovered that 57% of the breaches involved a mismatch between the system and the real world, meaning that the interface needed to conform to users' expectations or mental models of how the task should be performed. Another 16% of the violations were related to aesthetic and minimalist design issues, such as poor use of colour, typography, or whitespace. Severity ratings were assigned to each violation, with ratings ranging from 1.0 to 4.0, where a higher rating indicated a more severe problem.

The average rating across all violations was 3.01, which suggested that the issues were moderate to severe. Notably, 80% of these ratings were considered significant usability problems, meaning they likely significantly impacted users' ability to complete tasks efficiently and effectively. Additionally, 6% of the ratings were classified as usability catastrophes, the most severe problems that can occur in a user interface and have serious consequences for users. These findings highlight the importance of conducting usability evaluations to identify and address design problems before they impact users. By adhering to established usability heuristics and conducting regular evaluations, designers can ensure that their interfaces are intuitive, efficient, and easy to use, enhancing user satisfaction and productivity (Harrington et al., 2021).

2.3.3. Other outcomes

In the selected studies, other feedback outcomes, such as participants' views on the videos, tasks, and arrangement, received beneficial participation and satisfaction (Otis et al., 2020). According to Burda et al. (2022), the mobile application developed by their team was utilised by two individuals diagnosed with T1D for over four years. The purpose of the application was to allow for the monitoring of glucose levels and insulin dosage rather than tracking dietary intake. The study results show that consistent mobile application use is

associated with stable glucose levels and metabolic stability. These findings suggest that mobile applications like the one developed by Burda et al. (2022) may be valuable tools for individuals living with T1D who aim to achieve metabolic stability and maintain glucose control. The author's observation regarding the effectiveness of diabetes applications following usability testing can be seen as a potential avenue for further research. Specifically, a more comprehensive exploration of the factors contributing to these applications' success or failure in managing diabetes could be undertaken. This could include investigating the impact of user feedback and incorporating design elements that facilitate ease of use and accessibility for individuals with varying degrees of technological proficiency. Ultimately, a deeper understanding of the usability and effectiveness of diabetes applications has the potential to inform the development of more successful interventions for diabetes management.

Burda et al. (2022) conducted an extensive study that included individuals with different types of diabetes, spanning five years. The study enrolled five participants with T2D, two with T1D (one male and one female), and one with an unspecified diabetes type. The study used Mobiab, a tool designed to help individuals with diabetes manage their condition. Each participant used the device for one year and provided feedback on its effectiveness. The study participants were between the ages of 46 and 54, representing a range of individuals in the middle-age group. The study findings could help develop effective interventions and strategies to manage diabetes in people of different ages and types.

2.3.4. Factors Affecting Adoption

The critical areas for improving the tool's usability, thus affecting and increasing the level of satisfaction and, therefore, the degree of adoption of the tool, were identified by Otis et al. (2020) study, including duration, directions, and animation. The mix of text, videos and activities increased users' attention and engagement. Furthermore, entertainment and information increase satisfaction. The usability recommendations from the participants of this study can be used to advance the tool's usability and examine the intervention's effectiveness. It is reassuring that the families found the mobile educational device informative, engaging, and feasible for providing diabetes self-management education to parents and children. The factors identified in the study affected the tool's adoption negatively or positively.

The Diabetes YES program presented by Ng et al. (2019) is a website tool that uses a peer support group for participants. The evidence-based information was appreciated. The

regular engagement, interaction, and connection of participants on the Facebook platform with a moderator were exciting and valuable. Participants benefit from such activities regarding new shared experiences, problem-solving, motivation, reduction of isolation, etc. Activities like these are essential features incorporated in parallel with mHealth technology, especially for young adults with T1D and could impact the adoption of such technology. However, the study's assessment process may have needed to be more representative of the target population, which could affect the generalizability of the findings. Further, the results could have been influenced by the participants' pre-existing knowledge and access to diabetes-related resources online, which could have affected their perception of the mHealth initiative. It is important to note that the study's findings may not accurately reflect the reality of diabetes in Australia, particularly regarding gender representation. Therefore, it is essential to consider these limitations when interpreting the results of this study (Ng et al., 2019).

Albanese-O'Neill et al. (2019) utilised scientific evidence to create mobile apps and websites for diabetes management. The application should have attractive animations, multimedia and interactive features, videos, colours, easy-to-understand content, and a simple interface that can be easily integrated into current medical practices. Trustworthy information presenting and reflecting evidence rather than thoughts and opinions is always appreciated and accepted and improves the degree of adoption. Social support and peer learning are considered vital parameters in the process. The study highlights the need to enhance the motivational aspect of participation. As mobile app development constantly evolves and new research outcomes emerge, it may be necessary to improve the design and the various features of apps to make them more valuable and attractive.

Abu et al.'s (2020) methodology showed that incorporating behavioural theories from the initial stages of the development process is essential to such interventions for adoption purposes. Furthermore, the identification of improvements before the development of the prototype and its implementation by involving the users right from the beginning to incorporate their needs and preferences is an essential parameter in the whole process. The features that were evaluated included functionality and aesthetics. The above factors and characteristics affect the adoption and usability of such online applications.

Diabetes is a chronic disease that affects millions of people worldwide. Diabetes management requires significant effort from patients, including regularly monitoring blood glucose levels, medication management, and adherence to lifestyle changes. However, individuals from underserved communities often face additional challenges, such as

limited access to healthcare, inadequate health literacy, and language barriers. As a result, they may have difficulty managing their diabetes and are at higher risk of developing complications. The development of mHealth apps has emerged as a promising approach to address these challenges. mHealth apps that are culturally, educationally, and socioeconomically relevant can potentially improve the accessibility and effectiveness of diabetes management for users in underserved communities. However, the adoption of mHealth apps may be hindered by the need for multiple language support. To overcome this barrier, mHealth apps should incorporate culturally sensitive and specific information, such as recipes, videos, and motivational tools. This approach can potentially improve the relevance and effectiveness of mHealth apps in diabetes management for diverse communities. (Sharma et al., 2022).

The usability of diabetes applications is critical in determining their efficacy and implementation success. To ensure that these applications are user-friendly and can be efficiently utilised by patients, it is necessary to consider the number and severity of heuristic violations during the design phase. The bypassing of clinical informatics experts during this phase can result in negative consequences, as it may lead to usability issues that could have otherwise been avoided.

One effective way to improve usability during the design phase is to debug the user interface to identify heuristic violations. This process involves analysing the user interface design to identify design flaws or issues affecting the application's usability. By doing so, designers can proactively address potential problems concerning the application's user experience. The benefits of improving the usability of diabetes applications through identifying and correcting heuristic violations are significant. Improved usability can lead to better patient engagement and adherence to therapy, ultimately resulting in better health outcomes.

However, long wait times to correct ongoing usability issues while apps are in production can be beneficial, as patients may lose interest in utilising digital health tools, leading to better outcomes. In conclusion, considering the number and severity of heuristic violations during the design phase and debugging the user interface to identify and correct these issues are crucial for improving the usability and associated benefits of diabetes applications. Doing so can enhance patient engagement and adherence to therapy and ultimately improve health outcomes (Harrington et al., 2021).

When the user appreciates how easy the app is to use and continues using it for a long time, the degree of satisfaction increases and the benefits build up. Continuous data recording, contributing to education and information, and understanding the disease improve the user's condition and affect the tool's adoption and usage. Additionally, improvements in technology, interaction, involvement, communication, and support enhance attractiveness and, thus, engagement (Burda et al., 2022).

2.3.5. Limitations

One of the limitations described by the research papers was the discussion on the small number of participants (Otis et al., 2020). In addition, the study had constraints, such as the deficiency of a control group for contrasting purposes, a small follow-up period, and restricted generalisability. The cohort recruited for this study consisted of ethnically diverse individuals from primarily low-income families. Still, on the other hand, this was a limiting factor to control for race and ethnicity.

The Czech study also mentioned the need for more participants (Burda et al., 2022). This presents problems in testing and validating the application and analysing the various modules. Another area for improvement was the integration of more than one glucose meter. Clinicians already used a secondary web-based platform to review data; therefore, the integration was deemed unnecessary (Burda et al., 2022). The study's findings should be interpreted cautiously due to the small sample size and limited analysis. Moreover, the study could not establish the level of discipline among users who registered for more modules. Additionally, the integration of only one glucose meter was a limitation, as clinicians were using a secondary web-based platform to review data, making the integration redundant.

In another study, the research only involved a specific group of individuals, namely fathers, and failed to gather data from other potential users, such as mothers or those with T1D. Nevertheless, the study underscores the necessity of conducting further research to gain a deeper insight into the unique learning needs of minority fathers about managing T1D. Also, observations on how the users navigated and viewed the site are absent from the study (Albanese-O'Neill et al., 2019).

The study by Ng et al. (2019) has certain limitations that should be considered. For instance, the mHealth initiative's assessment may not entirely represent a broader population of young adults with T1D. This could be due to the participants' prior knowledge and access to diabetes-related resources on the internet, which may have

influenced the results. Therefore, the conclusions cannot be generalised for the whole population because the findings may need to be more individualised to the population. Additionally, the study's results may not reflect the Australian diabetes community's reality, particularly regarding gender representation. Considering these limitations when interpreting the study's outcomes and making any relevant conclusions is crucial.

The authors of Abu et al. (2020) mentioned that the small sample may not represent the target population, either. They also noted that another limitation was the withdrawal of people initially interested in participating in the application testing, thus introducing a selection bias. The testers mentioned that the inclusion of a reminder feature is vital.

Sharma and colleagues (2022) have reported findings that suggest a potential bias on the website used to identify the applications for evaluation. The study encountered limitations in its evaluation process due to the unavailability of independent funding, resulting in the inability to download some of the applications under review. Such findings emphasise the significance of ensuring sufficient resources and unbiased selection criteria for a comprehensive and accurate evaluation.

Harrington et al. (2021) conducted a study on the usability of a diabetes management system and identified several limitations during their research. One of the primary limitations was using a heuristic evaluation approach, which prevented the researchers from fully understanding the system's effect on diabetes management and self-care. Additionally, the study needed more input from clinical informatics experts regarding the interface's usability, which may have led to an incomplete understanding of the user experience. Lastly, the study found that certain interface elements needed to be included, which could have negatively impacted the system's overall usability. These limitations must be considered to fully understand the study's findings and implications for future research.

2.4. Discussion

The literature review in question encompassed a limited number of articles. Otis et al. (2020) study demonstrated that users found the tool utilised in each case to be generally user-friendly even though it encountered various challenges and problems. The feedback on the videos, tasks, and arrangement has been positive regarding participation and satisfaction.

Despite encountering problems, the study staff considered the tool's overall navigation easy or moderately easy. In Burda's study, the research has demonstrated that the functionality of a smartphone application and server-based systems could be considered adequate and encouraging. Sharma mHealth apps can potentially improve individuals' management of chronic diseases and extend the reach of healthcare provider visits.

The domains that received the highest score from clinical experts were literacy, language, usability, cost, evidence-based content, and cultural sensitivity. Fields are grouped into higher-level categories, which have varying degrees of importance. Clinical impact and population focus are considered the most significant categories. Usability is given an average level of importance across all component domains.

One challenge mentioned was a need for more guidance, as users sometimes found it unclear what was expected of them, including whether a slide was interactive or not and what buttons to press to initiate an activity. Another challenge was malfunctioning activities, which frustrated users. Studies have shown that research is needed to rate the practical functionality of mob apps, especially for specific target populations.

Otis et al. (2020) discussed that the small number of participants is classified as a study limitation. Specifically, this study had eleven parent-child pairs in phase one and ten parent-child pairs in phase two. The author considers phase one an accurate phase for extracting data because phase one is the usability testing phase. The DiAPPeat study recruited six people with T1D diabetes and six HCPs with experience with diabetes in both phases of the study. Similarly, Burda et al. (2022) share their beliefs about the small user number included in their research. They used eight users, and only two were identified with T1D.

Lastly, Abu et al. (2020) used the pre-development stage with the involvement of the users. They also use double-stage usability testing. This methodology sounds interesting, considering the results of the evaluation. Further research on the implementation of this methodology is needed.

Reflecting on the above information, the author considers the number of participants in the DiAPPeat study adequate for the usability testing method. Barnum (2010) supports this in chapter one. Barnum (2010) cites Nielsen's original text in the electronic book explaining his famous curve (Figure 2.1). "The most striking truth of the curve is that zero users give zero insights. As soon as you collect data from a single test user, your insights shoot up, and you have already learned almost a third of all there is to know about the design's

usability. The difference between zero and even a little bit of data is astounding". As per Nielsen's statement, the user testing should reach five tester users because, after the fifth user, there is no additional benefit to the outcomes because eighty-five per cent (85%) of the findings reach the optimum level. In other words, nothing more is to be discovered beyond the eighty-five (85%) per cent of achievement.

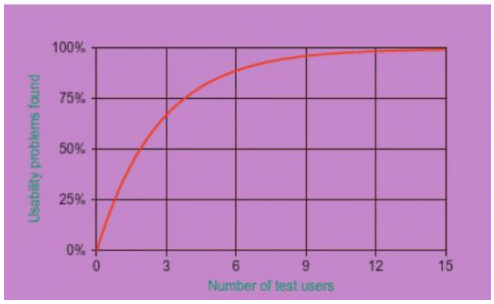


Figure 2.1: Linear evidence for recruiting a small number of participants

Furthermore, the author reports that other researchers supported comparable outcomes by using a similar number of users to perform the usability evaluations. In the years 1990 and 1992, Robert Virzi, a researcher at GTE Laboratories, published the results of his small studies in "Streamlining the Design Process: Running Fewer Subjects" and "Refining the Test Phase of Usability Evaluation: How Many Subjects Is Enough?". These studies aimed to determine the minimum number of participants required to obtain meaningful results in usability evaluations, focusing on streamlining the design process and optimising the efficiency of usability evaluations (Barnum, 2010).

Another limitation of reviewing the literature is the need for a control group to compare the cohorts used for this study (Otis et al., 2020). The author used this information to design the DiAPPeat research with two groups: people with T1D and HCPs. The same study identified the short follow-up period and limited generalisability as limitations.

How the author interpreted the results of this study is that as a prototype web application, there is only one phase of usability testing with no follow-up period as a design. In addition, as the DiAPPeat study includes Cypriot end-users, the web application can be generalised and applied to the general population of the Republic of Cyprus.

The Statistical Service Cyprus (2021) recently released data that sheds light on the internet usage patterns of individuals living in Cyprus. According to the report, a staggering 92.8% of Cyprus's population had internet access as of last year. Furthermore, of those who utilise the internet at least once a week, 90.2% are between the ages of sixteen and seventy-four.

It is worth noting that this percentage decreases as age increases, indicating that older individuals are less likely to use the Internet regularly. However, the data suggests that internet usage tends to rise alongside higher levels of education, with more educated individuals being more likely to utilise the internet. Additionally, the report highlights that 86.1% of Cypriots who engage with social media platforms such as Facebook, Twitter, and Instagram are between the ages of sixteen and seventy-four. These findings provide valuable insights into the internet and social media usage patterns of individuals living in Cyprus.

According to Burda et al (2022), participants attended different modules, limiting the analysis. The design of this study allowed the participants to view all the modules, and the e-learning had all the topics of learning in line with the study's inability to showcase a reflection of high discipline among users who registered for multiple modules was noted as a limitation (Burda et al., 2022). The DiAPPeat study echoed similar concerns, as its design primarily focused on measuring usability outcomes. In a recent survey conducted by Burda et al. (2022), it was found that the study's results needed to reflect a high level of discipline among users who registered for multiple modules, which was seen as a limitation.

This suggests that further investigation is needed to understand the factors contributing to user behaviour and how to encourage more disciplined use of these modules. Similarly, the DiAPPeat study raised similar concerns, as its design mainly focused on measuring usability outcomes rather than user behaviour. This highlights the need for research that examines the relationship between user behaviour and usability outcomes to provide a more comprehensive understanding of how users interact with these modules.

Burda et al. (2022) conducted a study on glucose meter integration and compatibility and found significant limitations. Specifically, the study reports that only one glucose meter is compatible with the DiAPPeat web application, creating a potential monopoly for the device. This concerns users who may prefer or require alternative glucose meters or continuous glucose monitoring devices for their glucose monitoring needs. The development team behind the DiAPPeat application did not have any intentions of enabling compatibility with other glucose meters or devices provided in Cyprus due to the inaccessibility of the national diabetes technology market. However, this decision may limit the accessibility and usability of the application for users who rely on different glucose meters or devices.

Given the importance of glucose monitoring for individuals with diabetes, it is crucial to ensure that available applications address the diverse needs of users. Further research is needed to explore potential solutions to this issue, such as expanding the compatibility range of the DiAPPeat application to include a greater variety of glucose meters and devices.

In their study, Burda et al. (2022) highlighted that clinicians use a secondary web-based platform for data review, which they consider an unnecessary complication. However, it is essential to note that the experienced clinician and other HCPs involved in the DiAPPeat study did not express similar concerns. The use of this secondary platform by clinicians warrants further investigation, as its impact on the clinical workflow and the quality of patient care remains unclear.

Sharma et al. (2022) reported that the website utilised to identify the applications for evaluation was potentially biased, and a few of the identified applications were found to be non-functional. The DiAPPeat web application, on the other hand, employed a link to be shared with users, and no significant issues were raised regarding its accessibility during the study.

It is important to note that the present study shares the same concerns about independent funding needing to be made available. The author of this study bore the entire cost of the research, which may have implications for the generalisability of the findings and the scope of the study. Nevertheless, the study outcomes provide valuable insights into using digital healthcare applications. Such technology, can aid in the development of more efficient and effective healthcare interventions in the future.

Harrington et al. (2021) conducted a thorough heuristic evaluation of the relevant diabetes application in their study, designed to assist diabetes self-management—the assessment aimed to identify usability issues and assess the application's impact on diabetes management and self-care. Despite the comprehensive evaluation, the study could not determine the effect of the application on diabetes management or self-care. The outcomes of the above analysis should be considered with scepticism and be open to further research.

Furthermore, a shared concern regarding the application is the need for input from clinical informatics experts, who could have provided valuable insights into the application's usability. Nonetheless, the application's usability was researched through literature and with the involvement of a multidisciplinary team and the supervisors of the doctorate study. The team assessed the application's usability using a range of methods, including

heuristic evaluation, user testing, and expert review. The team's findings were then used to identify and resolve usability issues and improve the application's overall usability.

Harrington et al. (2021) conducted a study highlighting the absence of certain interface elements in a software tool. Upon evaluating the DiAPPeat tool, the end-users who were part of the usability testing process provided insightful feedback on the various aspects of the instrument. Their feedback included numerous suggestions for improvement, such as adding missing interface elements. This feedback was instrumental in further enhancing the usability of the DiAPPeat tool, ultimately resulting in a more user-friendly and effective tool.

Albanese-O'Neill and her colleagues conducted a study in 2019 to investigate the usability of a mobile application for managing T1D among fathers. While the study provided some valuable insights, it also suffered from several limitations that must be acknowledged.

Firstly, the study only recruited fathers and did not include data from children with T1D or mothers. This is a significant limitation, as children and mothers are essential stakeholders who could provide a unique perspective on the application's usability. Moreover, mothers and children will likely be future application users, and their input could have improved the application's design. Secondly, the study did not collect any demographic data, which could have provided essential insights into the participants' backgrounds, such as their age, education level, and socioeconomic status. This information is necessary to assess whether the study's findings are generalisable to other populations. Finally, the study did not use standard usability tools, such as the System Usability Scale (SUS), to assess the quality of the findings. This is a significant limitation, as these tools provide a standardised and objective way to measure usability and allow for comparing results across studies.

In contrast, the DiAPPeat study, conducted by the author of this review, collected data from people with T1D and HCPs with experience in treating the condition. This inclusive approach allowed for a more comprehensive understanding of the application's usability and provided valuable insights into the needs of different user groups. Furthermore, the study used the SUS to assess the application's usability, providing a standardised and objective measure.

The study conducted by Ng et al. (2019) raises valid concerns about assessing the mHealth initiative in the context of young adults with T1D. One of the study's significant limitations is its relatively small sample size, which may only partially represent the larger population of such individuals. Moreover, the study participants were recruited from online diabetes

communities, which could potentially bias the results due to the self-selection of participants with pre-existing knowledge and access to diabetes-related resources on the internet. Another essential aspect to consider is the gender representation in the study, which may not reflect the reality of Australian diabetes. While the study included a relatively equal number of males and females, the sample size was insufficient to draw any definitive conclusions about gender differences in using mHealth technologies.

This is an essential area of research, as previous studies have shown that gender differences do exist in the management of diabetes, with females often experiencing more significant barriers. The DiAPPeat study has implemented a rigorous sampling strategy to ensure the recruitment of a demographically balanced sample that accurately reflects the population of the Republic of Cyprus. By utilising a comprehensive approach, the study has accounted for various demographic factors such as age, gender, ethnicity, and socio-economic status. This has enhanced the sample's representativeness, a crucial aspect of any study that aims to draw generalisable conclusions. Therefore, the DiAPPeat study can be considered a noteworthy research endeavour that has successfully overcome the challenges associated with sampling in a complex socio-cultural context.

2.5. Conclusion

The involvement of people with T1D, family members, HCPs, and control groups can help them accept and use technology. Effective and validated usability methods and high participation rates are crucial for designing, developing, and evaluating diabetes self-management online applications. Further usability studies should focus on the quality of evaluation and the implementation of new tools. It is essential to analyse and consider the factors affecting the adoption of online applications.

The author of this study considered the strengths and limitations identified in various studies to improve the usability of the DiAPPeat web application. However, these limitations include small sample sizes, insufficient control groups, limited generalisability, and biased selection criteria. To ensure an accurate and comprehensive evaluation of diabetes management systems and applications, it is crucial to acknowledge and address these limitations. Further research is needed to develop practical tools and strategies to support the self-care of individuals with diabetes.

The systematic literature review has identified several areas where the evaluation and usability of online health applications for individuals with T1D can be improved. These include developing more rigorous testing protocols that consider the unique needs and

challenges faced by individuals with T1D, such as continuously monitoring blood glucose levels and adjusting insulin doses throughout the day.

Additionally, the review suggests that more research is needed to identify the most effective ways to incorporate user feedback into the design and development of these applications and better understand the barriers that prevent individuals with T1D from using online health tools to manage their condition. Overall, the review highlights the importance of continued research and innovation in online health applications for individuals with T1D to ensure that these tools are practical, accessible, and user-friendly.

CHAPTER 3 PHILOSOPHY, METHODOLOGY, METHODS AND MATERIALS

3.1. Introduction

In this chapter, the author discusses the philosophy, methodology, methods, and materials utilised for this study. Furthermore, the chapter relates the research problem to the chosen methodological approach and examines the quantitative and qualitative aspects of the mixed method study.

In addition, the researcher describes the data collection approach and justifies the methods applied in the data process analysis. Ultimately, the writer evaluates the methodology presented above, including the barriers and the solutions investigated during the evaluation. Inclusion and exclusion criteria are shown in the following sections to determine the choice of individuals in the study. The requirements were carefully selected to serve the purpose of the proposed research.

3.2. The Philosophical Framework

The writer understands the importance of philosophy embedded in this piece of research by considering the research's ontological and epistemological components (Baldwin, 2014). The researcher's passion for diabetes care, as well as epistemological, clinical and first-hand personal experience in diabetes, drove the decision to express the philosophy by directing this study towards holistic, structured education. The philosophy is described through the necessity of creating an educational pathway based on carbohydrate counting for people who were given the T1D diagnosis and did not receive a structured education to self-manage their condition to the best of their ability and knowledge.

In the literature, there are three main approaches, namely positivism, interpretivism and pragmatism. The present study uses a mixed methods research approach because of the aims, objectives, research questions and the overall context of the study. It collects quantitative and qualitative data and other specialised information, and its tools are carefully designed and used. The analysis of data and the evaluation of findings will guide the author of this study to understand the answers to the research questions better and reach valuable and applicable conclusions and suggestions for clinical application. This research framework and setting and the area of nursing and clinical practice fall under the paradigm of pragmatism.

3.3. Research Questions

To determine feedback from adults with T1D and HCPs with expertise or particular interest in diabetes on a newly developed diabetes online educational tool. To determine the potential improvement in the diabetes knowledge of the study cohorts.
Research questions:

What are the views and preferences of adults with T1D regarding the usability of a novel online educational tool for managing their condition?

How can the users' feedback and input be systematically collected for the online educational tool to ensure that it meets the specific needs and preferences of the target audience?

What are the views and preferences of adults with T1D and HCPs with relevant expertise in Cyprus regarding the usability of the DiAPPeat online educational tool for managing diabetes through carbohydrate counting?

3.4. Objectives

To design, develop and evaluate a web application for diabetes education. To base the educational tool on carbohydrate counting and incorporating the views and needs of adult individuals with T1D. To provide a diabetes educational platform with nutrition information to support the subjects of the study.

The objectives of this study include the development of an online educational tool, the incorporation of user views and needs, and the empowerment of users through carbohydrate counting. The goals are to evaluate the usability and user experience: Gather feedback on the online educational tool's usability and overall user experience. Identify areas where users encounter difficulties or find the tool particularly effective and user-friendly.

Development of an Online Educational Tool: Create a comprehensive online educational tool focusing on carbohydrate counting, a crucial aspect of diabetes management, including a diabetes educational platform with nutrition information. Design the tool to be accessible, user-friendly, and culturally sensitive to the context of adults with T1D living in Cyprus.

Incorporation of User Views and Needs: Systematically gather the perspectives, preferences, and needs of the target audience during the evaluation process. Ensure the educational tool's content, format, and features align with the expectations and experiences of adults with T1D in Cyprus.

Empowerment Through Carbohydrate Counting: Empower adults with T1D by providing them with the tools to potentially improve the knowledge and skills related to carbohydrate counting, a key element in managing their condition. Foster self-management and decision-making capabilities to enhance overall diabetes care.

3.5. Significance

This research is crucial in initiating a T1D educational pathway in Cyprus by standardising the carbohydrate counting method with the relevant tools and further diabetes education.
There is an urgent need for a holistic update on the diabetes-specific education and information the Republic of Cyprus provides the people with T1D and their families, as well as public diabetes services. The author could not present any guidelines for T1D that General Practitioners and clinicians follow nationally or locally. Accessing the website of the Health Insurance Organisation (HIO), it was surprising to investigate that the only guidelines for Cyprus are for T2D, last updated in 2013 (HIO, 2017).

According to Tinelli et al. (2018), Cypriots preferred a shared-decision making (SDM) model for their diabetes care. In addition, it appears that the newly designed healthcare system intended to support shared health system plans to satisfy people with diabetes is not yet able to see evidence of it.

3.6. Study Criteria

The inclusion criteria for both groups were divided into Demographic characteristics, study-specific variables and others. Group A consisted of adult individuals (above the age of 18 years) from all genders and ethnicities who received the diagnosis of T1D a minimum of two years before registering with this research project. All participants with T1D are required to have an established diagnosis of T1D either on Multiple Daily Injections (MDI) or continuous subcutaneous Insulin Infusion (CSII). Moreover, the chance for the individuals to have received a form of carbohydrate education before was vital. Also, the inclusion criteria allow subjects with or without diabetes complications unless they suffer from severe retinopathy that can affect the program's accessibility due to their inability to participate in the program's activities (Table 3.1).

Likewise, the second group (group B) includes HCPs who exercise in the diabetes area, including registered nurses interested in diabetes, diabetes consultants and registered clinical dietitians. A key parameter for group B recruitment was the participants' minimum two years of experience in a diabetes setting with the relevant qualifications (medical specialisation in diabetes, MSc in diabetes, diploma certificate in diabetes) (Table 3.2).

The exclusion criteria the author considered for group A were banding any other types of diabetes than T1D and eliminating potential participants who used a treatment of diabetes biphasic insulin twice daily or any different combination of biphasic insulin. This decision was made with the understanding of the strengths and limitations of web applications. Understandably, diagnosis of severe retinopathy, maculopathy and blindness provided by a specialist clinician, including physical and laboratory examinations, was a limiting factor in the recruitment of the subjects. Combining Group A and B about standard exclusion criteria, it was agreed that the absence of technological requirements (e.g., no internet access, unavailability of laptop or desktop and inability to participate in virtual calls actively), unwillingness to participate in the study failure to provide informed consent and inability to speak fluently in Greek and English language are classified as significant exclusion criteria (Table 3.3).

Table 3.1: Inclusion Criteria For The Study

Group A: Individuals with T1D	**Group B: HCPs**
Demographic characteristics: • Age:18 years and above • Gender identity: All • Ethnicity: All	Demographic characteristics: • Age: 30 years and above • Gender identity: All • Ethnicity: All
Study-specific variables: • Type 1 diabetes at least for two years post-diagnosis. • Treatment of diabetes Multiple Daily Injections(MDI) or CSII (Continuous Subcutaneous Insulin Infusion) • Carbohydrate counting literate	Study-specific variables: • Occupation: diabetes consultants, diabetes specialist nurses and registered clinical dietitians. • Experience: minimum two years of experience in a diabetes setting. • Qualifications: medical

• Healthy eyesight to allow them full accessibility when undertaking the online assessments.	specialisation in Diabetes, MSc in Diabetes, diploma certificate in Diabetes.
Other: • Technological requirements (e.g., internet access, laptop or desktop, and be able to participate in virtual calls actively) • Willingness to participate in all three assessment activities (user testing, online feedback and online diabetes knowledge questionnaire).	Other: • Technological requirements (e.g., internet access, laptop or desktop and being able to participate in virtual calls actively) • Willingness: To participate in all three assessment activities (user testing, online feedback and online diabetes knowledge questionnaire).

Table 3.2: Exclusion Criteria: Group A: cohort with type 1 diabetes

Study-specific variables:

- Other types of diabetes than type 1 diabetes.
- Treatment of diabetes: biphasic insulin twice daily or any other combination of biphasic insulin.
- Inability to carbohydrate count or partial carbohydrate count.
- Treatment of diabetes Multiple Daily Injections(MDI) or CSII (Continuous Subcutaneous Insulin Infusion).
- Diagnosis of severe retinopathy, maculopathy and blindness provided by a specialist clinician, including physical and laboratory examinations.

Table 3.3: Exclusion Criteria: Group A and B

Other:

- Technological requirements (e.g., no internet access, unavailability of laptop or desktop and not able to actively participate in virtual calls).
- Below C2 level in Greek and English language

3.7. Theoretical Perspective

The power of empowerment in diabetes inspired the author of this PhD study. As Betty Brackenridge mentions in the foreword of Anderson's book (2005), "If an empowerment approach is powerful in a single practitioner, it may become unstoppable when a whole team shares the vision". The DiAPPeat web application has been designed to empower individuals with T1D by providing online educational support based on carbohydrate counting and other aspects of the daily diabetes routine. The importance and the significance of the evidence-based knowledge provided in diabetes are essential, as well as the active involvement of the individual in the decision-making of the aspects of his diabetes care (Muhlhauser and Berger, 2000). The informed decisions and the setting of the individual's therapeutic goals greatly support autonomous diabetes management for improved diabetes outcomes.

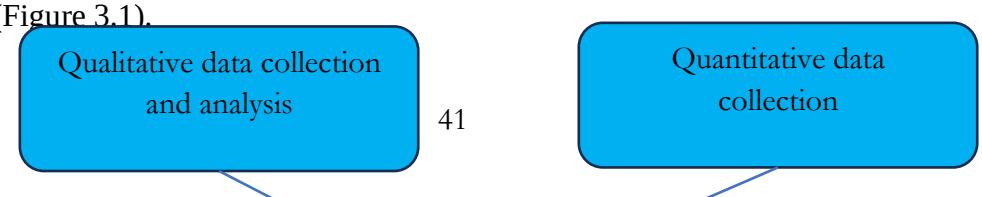
Evidenced-based research supports the diabetes teaching and treatment programme by providing evidence of a significantly improved HbA1c up to twenty-two months after the diabetes teaching intervention. Furthermore, the mean of hospital admissions is from 10 to a median of one per patient each year (Muhlhauser et al., 1983). Although an older study, the author believes in its value as there was no technology to influence the outcome at the time of the evidence produced. The researcher supports that the DiAPPeat web application can support inpatient and outpatient hospital clients with diabetes self-management.

3.8. Research Design and Methodology

3.8.1. Research Design

The Mixed Method Study is a research method that combines and integrates qualitative and quantitative research methods in the same research study. This method includes collecting and analysing various forms and types of data to understand the subject area, answer the research questions, and, after discussing the results, draw relevant and appropriate conclusions. The significance of this research design is the analysis of both types of data, bringing the results together and interpreting them (Moorley and Cathala, 2019; Walker, 2023).

There are various types of mixed methods identified in the literature. The one used in this study is the Concurrent Triangulation Design. With this design, you collect two kinds of data, qualitative and quantitative, at the same time from the same source or different sources, using other methods and techniques. The collected data and results are compared, and the analysis is completed separately from the overall discussion. The researcher attaches the concurrent triangulation design method with the relevant methodology approach (Figure 3.1).



The study used the Triangulation Design Method as a data collection and analysis framework. The researcher behind the study took great care in planning the data collection procedures, as evidenced by the detailed breakdown in Figure 3.2.

To gather the necessary data, the researcher utilised a variety of instruments, including remote-moderated qualitative usability testing, a primary questionnaire featuring the System Usability Scale (SUS) by Brooke, John (1995), and the Technology Acceptance Model (TAM) by Davis (1989). Additionally, the researcher included two open-ended interview questions at the end of the verbal online usability test and two more after the main feedback questionnaire.

To ensure that all relevant data was captured, the researcher also took note of significant phrases or statements provided by participants. All usability tests and structured questions were recorded with consent, and the study's author cross-checked his notes with the video recordings created for this study's purposes to capture every possible statement.

Overall, the researcher's meticulous planning and attention to detail ensured that the data collected was comprehensive and accurate, providing valuable insights into the area under

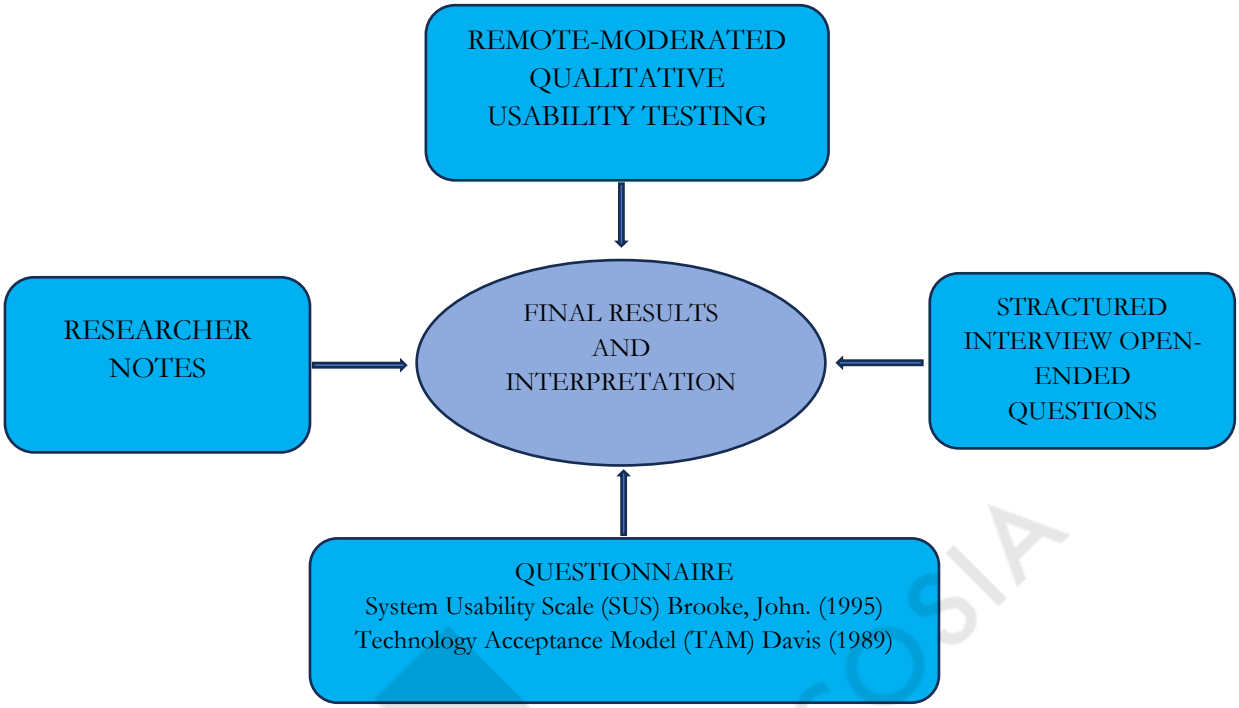


Figure 3.2: The Concurrent Triangulation Design Method: The Study Model

investigation.

3.8.2. DiAPPeat Web Application Design and Development Framework

For this study, an experienced information technology informatics was recruited to develop a diabetes web application based on a literature search on the views and needs of people with T1D. The web application accesses a secure connection via a 256-bit encryption SSL certificate. It utilises the 256-bit encryption SSL certificate to establish a secure connection between the client and server, ensuring that sensitive data is transmitted safely and securely. The application has been built using the PHP Zend Framework, a widely used and respected framework known for its robustness, reliability, and security. The database used by the application is hosted by a qualified and experienced company with a proven track record of providing secure and reliable hosting services.

Access to the application is managed through user permissions, controlled by a user management feature that securely stores each user's username and encrypted password. This approach ensures that only authorised users can access the application and that they can only access the data required for their tasks. The user management feature also provides an audit trail of all user activity, which can help identify unauthorised access attempts or suspicious activity.

The hosting provider takes several measures to protect and secure the software, including using a firewall to prevent unauthorised access and implementing strict access controls to limit access to authorised administration only. The hosting company is also responsible for performing automated daily backups of the database and software, ensuring that data loss is minimised in any unforeseen circumstances.

Using industry-standard security protocols, robust development frameworks, and reliable hosting services, users can be confident that their data is safe and secure when using the application.is developed on PHP Zend Framework with a MySQL database hosted by a qualified and experienced company. The hosting provider protects and secures the software with a firewall; access is limited to authorised administration only. The hosting company is responsible for the automated daily database and software backups.

The web application developer of DiAPPeat used Kanban software to develop the application. Kanban is a widely used software development methodology for project management and workflow optimisation. Originating in Japan, the method is known for its flexible nature and ability to enhance efficiency while reducing waste. The fundamental

principles of Kanban include the visualisation of workflow using boards and cards, the implementation of work-in-progress (WIP) limits, the adoption of a pull system to manage tasks based on capacity, the promotion of continuous improvement through regular reviews, the incorporation of feedback loops, and an emphasis on adaptability.

The above-described system effectively supports projects and systematically approaches pending tasks for successful completion. It is widely employed in academic, professional, and business contexts due to its ability to improve the efficiency of workflows and facilitate the completion of complex tasks in a timely and organised manner. As such, Kanban has become an indispensable tool in the modern world of project management. Initially, the author of this PhD study submitted a request to develop a mobile health application for IT informatics. Due to the limited budget, the decision was made to design and develop a web application.

The DiAPPeat web application is based on evidence from various accurate resources including guidelines (DTN-UK, n.d.; NICE, 2015), consensus (Holt et al., 2021), the Nutrition Guide for Better Regulation of Diabetes Food equivalents Diabetic Exchanges (Andreou, 2022), workbooks, articles (Gillepsie, Kulkarni and Daly, 1998) and reliable websites (Diabetes UK, n.d.; Diabetes UK, 2017).

The following passage provides a detailed account of the evolution and conception of the DiAPPeat web application, which was created to aid individuals with T1D in managing their condition. The study's author was motivated to develop DiAPPeat after gathering feedback from patients who had attended diabetes nurse-led clinics. These patients had expressed a desire for a user-friendly and intuitive application that would assist them in managing their diabetes more effectively.

The author considered this feedback and worked tirelessly to create an application that was easy to use while also catering to the specific needs of individuals living with T1D. Through extensive research and development, DiAPPeat was born, and it has since proved to be a valuable tool for those living with diabetes. Furthermore, Haris Argyriou, a highly skilled graphic designer with extensive experience, voluntarily used his expertise to create an exceptional interactive logo (image). The logo was designed to be visually appealing, interactive, and memorable.

After completing the logo, Haris registered it for EU Intellectual Property Rights. He contacted Lellos P. Demetriades Law Office LLC for assistance with the application process. The Law Office, recognising the value of the author’s work, offered pro bono

assistance to help him with the registration process. Haris's logo was successfully registered with their support, ensuring he retains the exclusive rights to use, distribute, and profit from his creation. The development of the DiAPPeat web application was influenced by a series of empirical discussions in a clinical setting involving medical experts, researchers, and patients. These discussions aimed to identify the critical challenges faced by individuals with dietary restrictions, particularly those with gastrointestinal issues. The insights gained from these discussions were then utilised to inform the design of the DiAPPeat application, which includes features such as personalised meal plans and real-time symptom tracking. The application's design is grounded in research-based best practices and tailored to meet users' unique needs with dietary restrictions.

The author of this study is planning to proceed with the Quality Institute for Self-Management Education and Training accreditation, known as QISMET accreditation. QISMET was founded in 2008 as an independent organisation to assist self-management education providers in delivering consistent, high-quality services. They accomplish this by creating and managing accreditation and standards processes for various self-management education and training services. QISMET also supports self-management education providers by helping them develop their capacity and expertise to improve their services continually. The institute offers specialised advice to organisations in the sector. It encourages people with long-term conditions, professionals, and organisations to participate in developing and implementing self-management education and training. QISMET operates as a non-profit limited by guarantee in England, focusing on independence, transparency, collaboration, and innovation as its core values (QISMET Limited, 2021).

Upon accessing the DiAPPeat website application through https://my.DiAPPeat.com/, users are immediately greeted with the initial screen. This screen serves as the first point of interaction with the application and provides users with a comprehensive overview of the application's features and functionalities. Users can navigate different application sections from this initial screen, browse menus, search for specific food items, view their order history, and manage their account settings. The initial screen is designed to be intuitive and user-friendly, ensuring that users can easily access and utilise all the application features.

To begin using the DiAPPeat web application, users must complete the registration process by navigating to the 'Sign Up' screen (Figure 1). Once there, they were asked to provide their personal information, which includes their name, email address, and phone number.

Additionally, users were prompted to agree to the terms and conditions and consent to collecting and using their data.

Once the registration process has been completed, users receive a welcome email from DiAPPeat confirming their new account. The email included important information about the web application, such as its features and how to use it.

Shortly after receiving the welcome email, users received a second email containing their login credentials, including a randomly generated password. This email was sent to the email address that the user provided during the registration process.

The design of the DiAPPeat startup screen is modern and user-friendly, featuring lively, animated colours intended to create a welcoming and engaging user experience. Overall, the registration process for DiAPPeat is straightforward and user-friendly, ensuring that users can quickly and easily get started with the web application. It starts from the Sign-up page (Figure 3.3).

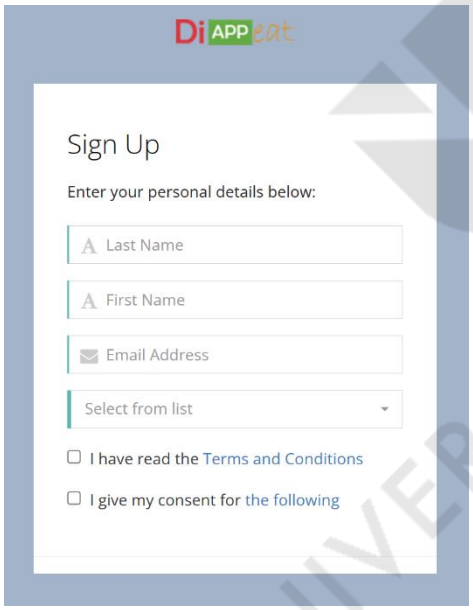


Figure 3.3: DiAPPeat signup

The screen demonstrated in “Figure 3.4” is the login page. This is where the participants and the users use to enter the DiAPPeat tool. The screen requested information as follows. The screen asks for the email address and the password, and if the user is successful, he logs in. If somebody is not registered, he has to register first by clicking Register. If the user forgets his password, he has to request a new one by clicking Forgot Password and following the steps.

Figure 3.4: DiAPPeat sign in and log out

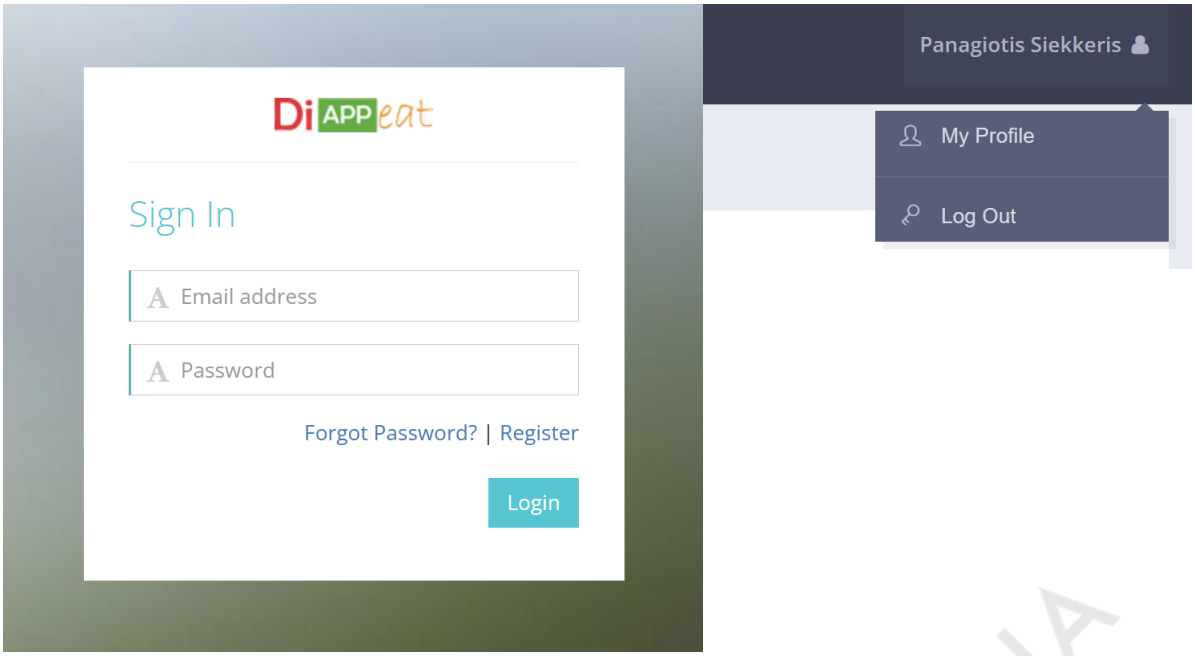


Figure 3.5 is the homepage of the DiAPPeat application with the logo and the Menu content. The Menu includes the following sections that appear on the left of the screen: Dashboard, Guide, DiAPPeat Academy, Applications, Eating, Food Search, DiAPPeat Café, Glossary, Manage Nutrition, and System. Further down, the content of each section is presented in detail.

Figure 3.5: DiAPPeat homepage

The first section of the Menu is the dashboard (Figure 4). This section has been designed and developed for future usage. The individual can place and keep his detailed data and treatment. This includes a logbook and study records.

Figure 3.6: DiAPPeat dashboard

This particular illustration showcases the web application dashboard. It offers a plethora of information regarding the end-user, such as their name, candidate number, account status (Active/Inactive), gender, and date of birth. Additionally, users can customise their homepage by setting the dashboard as the default landing page and editing their profile as needed.

Furthermore, users can monitor their progress through three different progress bars, which track their profile completion status, DiAPPeat academy e-learning progress, and Eating Carb Counting e-workshop progress. Upon completing these assessments, users can earn badges for their hard work. However, this feature was turned off during the usability test as candidates were required to complete all e-learning presentations successfully.

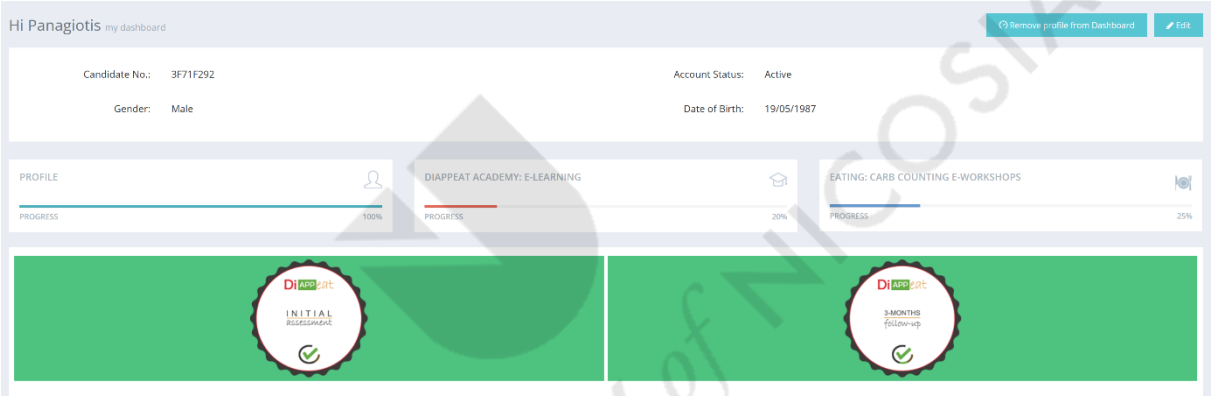


Figure 3.7: DiAPPeat logbook

The DiAPPeat logbook is a tool that has been thoughtfully developed to provide users with a comprehensive solution for managing their diabetes. It allows individuals to keep track of their records, including blood glucose levels, insulin doses, and other essential information that can help them manage their condition effectively. The tool is also a valuable resource for diabetes practitioners, who can offer clinical advice and opinions to individuals needing support.

The author understands that record-keeping is essential to diabetes self-management, and our tool can provide much-needed educational support to individuals with the condition. It offers graphs and other features, including exercise and lifestyle changes that can help individuals manage their diabetes more effectively. The colour-coded glucose indications support the users with the information on whether their glucose level is within target and can be printed.

The record-keeping diabetes management tool is easily accessible online, making it a convenient solution for individuals looking for a reliable and effective way of managing diabetes. Ayatollahi et al. (2016) discussed an online record-keeping tool, demonstrating the improvement of end-user management skills. In summary, this diabetes management tool is a comprehensive solution designed to help individuals manage their diabetes more effectively.

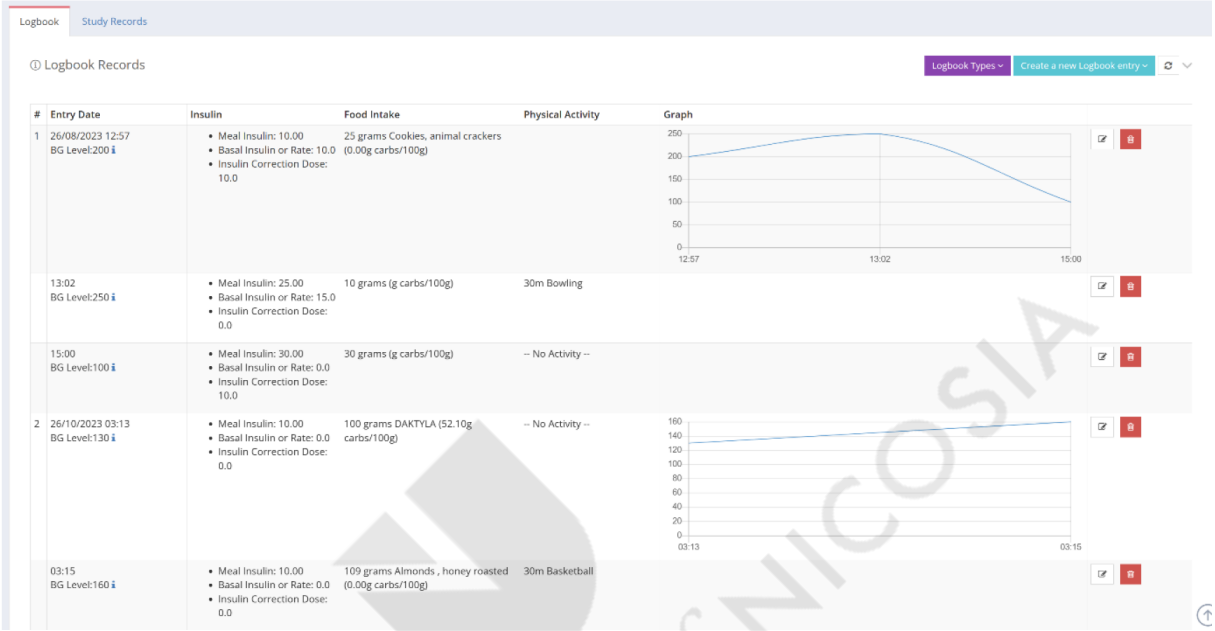


Figure 3.8: DiAPPeat study records

The DiAPPeat study records tool is designed to provide the user and the HCP with information about the HbA1c measurement, hypoglycaemia awareness, Body Mass Index (BMI) and the Waist–hip ratio (WHR) (WHO, 2011; WHO, 2023). This tab is planned to be used in the future as the author hopes that the University of Nicosia will support a study to investigate the effectiveness of DiAPPeat (see Figure 3..8).

WHO has released several reports that guide measuring abdominal obesity. According to a report on diabetes mellitus from 1999, metabolic syndrome is a condition that includes glucose intolerance, impaired glucose tolerance, diabetes mellitus, insulin resistance, and at least two other factors. These additional elements include abdominal obesity, raised arterial pressure, raised plasma triglycerides, and microalbuminuria. Abdominal obesity is identified as a waist-to-hip ratio above 0.90 for males and above 0.85 for females or a BMI above 30.0.

The WHO Expert Consultation on Obesity in 2000 highlighted the need to identify sex-specific waist circumference cut-off points suitable for different populations. The information below shows the sex-specific waist circumference and the risk of metabolic complications associated with obesity in Caucasians:

World Health Organization cut-off points and risk of metabolic complications

Indicator	Cut-off points	Risk of metabolic complications
Waist circumference	>94 cm (M); >80 cm (W)	Increased
Waist circumference	>102 cm (M); >88 cm (W)	Substantially increased
Waist–hip ratio	≥0.90 cm (M); ≥0.85 cm (W)	Substantially increased

M, men; W, women

The information above is based on a Dutch randomised study with a sample of 2183 men and 2698 women aged 20-59 were studied. The report recommends sex-specific cut-off points of 94 cm (men) and 80 cm (women) for increased risk and 102 cm (men) and 88 cm (women) for substantially increased risk (Han et al., 1995).

The author and developer of this tool considered that the sex-specific cut-off points presented in the WHO Expert Consultation on Obesity from 2000 were just examples and not actual WHO recommendations.

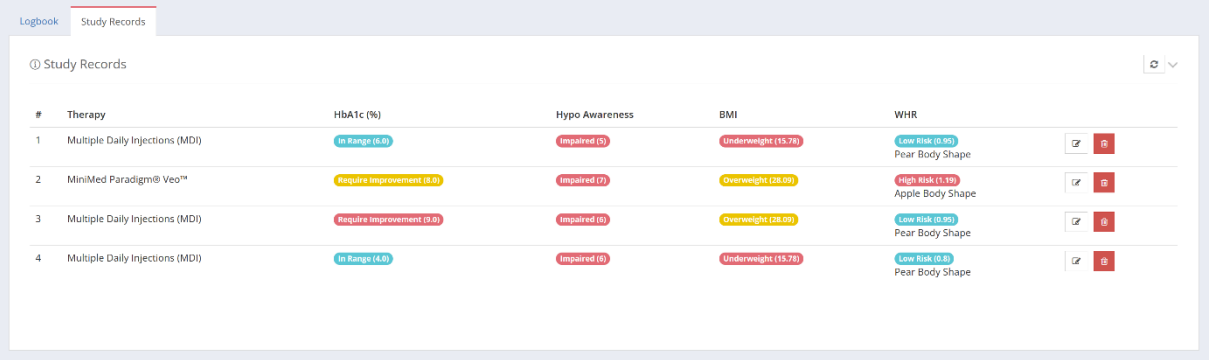
Besides the WHO, the International Diabetes Federation (IDF) has suggested cut-offs for waist circumference and waist-hip ratio(IDF, 2006; Zimmet & Alberti, 2006). The IDF guidelines for waist circumference are gender-specific and specific to the population and geography. The values are indicated below:

International Diabetes Federation cut-off points in Europids:

	Men	Women
Europids	>94 cm	>80 cm

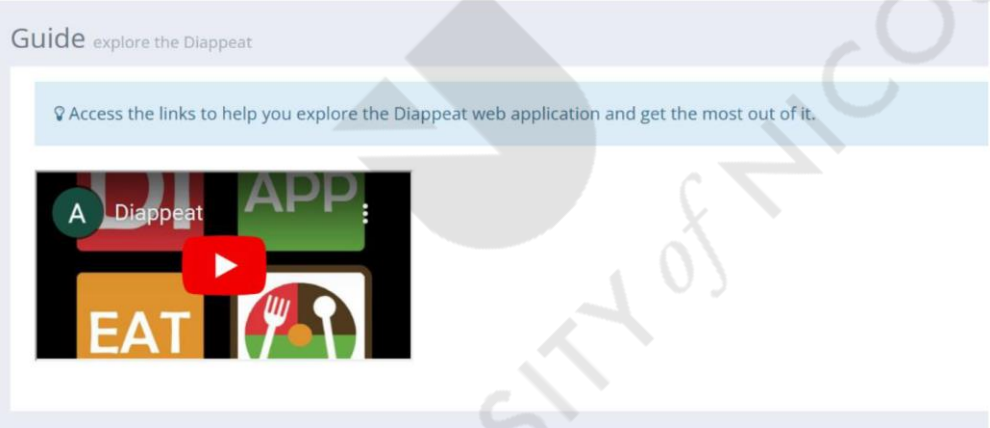
The DiAPPeat research team deliberately decided to incorporate a set of parameters into their tool, taking into account the potential benefits of doing so. These parameters were carefully selected based on their perceived value in the research context.

Figure 3.8: DiAPPeat study records



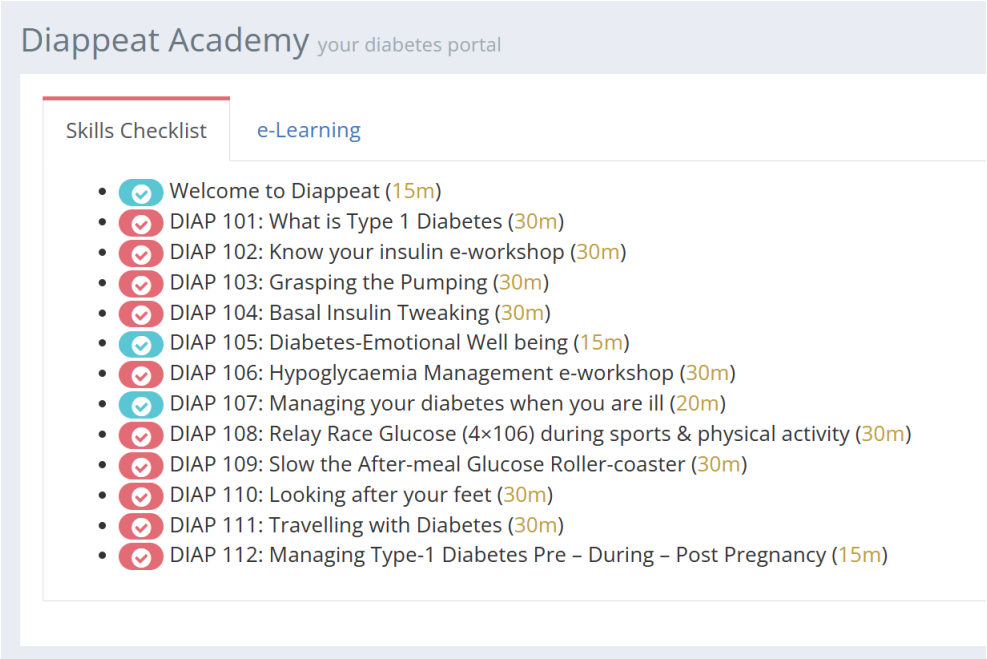
The Guide section (Figure 3.9) gives the user an overview of DiAPPeat, an opportunity to explore all the features of the DiAPPeat web application and to get the most out of it. The four parts of the Guide are Diabetes, Application, Eat and Food Search Engine.

Figure 3.9: DiAPPeat guide page



The DiAPPeat Academy in Figure 3.10, a catalogue of skills, is presented, covering the main relevant areas of diabetes. The content and detailed presentation of each skill in the checklist are shown in the second part of DiAPPeat Academy: e–learning.

Figure 3.10: DiAPPeat Academy: Skill Checklist



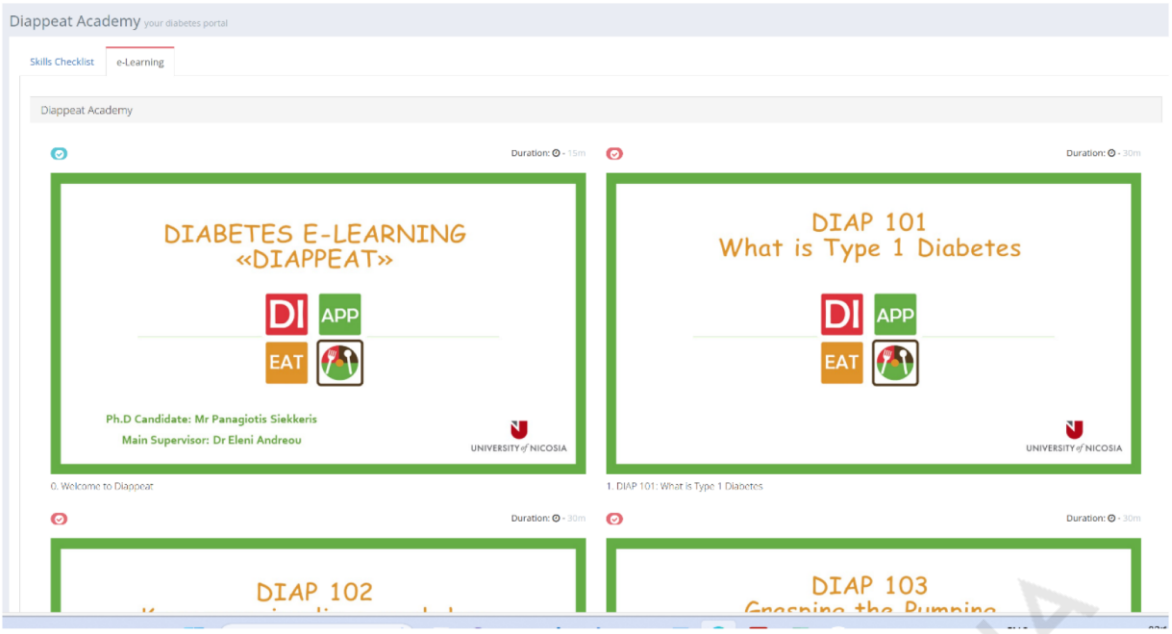
The actual presentations of the 13 learning skills, which are presented in Figure 3.11, are included in the section DiAPPeat Academy: e–Learning.

The DiAPPeat Academy is a comprehensive platform that offers a variety of e-learning resources for individuals with T1D. These resources are designed to help individuals manage their condition effectively by providing the latest clinical guidelines, recommendations, and relevant clinical guides. The e-learning modules cover a wide range of topics related to T1D self-management, including blood glucose monitoring, insulin therapy, carbohydrate counting, and lifestyle modifications.

In developing these resources, the DiAPPeat Academy has worked closely with leading healthcare professionals and diabetes experts to ensure the content is evidence-based and up-to-date. The e-learning modules are designed to be engaging and interactive, using a combination of videos, animations, and quizzes to help individuals understand the key concepts and principles of T1D self-management.

By completing these e-learning modules, individuals can acquire the knowledge and skills necessary to manage their T1D effectively, thereby reducing the risk of complications and improving their overall health outcomes. The DiAPPeat Academy is committed to providing individuals with the support they need to lead healthy and fulfilling lives, and its e-learning resources are an essential part of this mission.

Figure 3.11: DiAPPeat Academy: e-Learning



The following section that is presented in Figure 3.12 is DiAPPeat Applications. These applications are valuable tools that help the user specify carbohydrate to insulin ratio with various methods, manage his insulin dose, be supported with multiple converters, and keep accurate and updated records.

Figure 3.12: DiAPPeat applications

The various application tools included in the web application are analysed and discussed in detail in the DiAPPeat applications section. These are presented in Figures 3.13 to 3.19.

Figure 3.13 explains how to calculate the carbohydrate-to-insulin ratio using the Carbohydrate Grams Method for breakfast, lunch, and dinner. This method offers various measurements for each meal, aiding in precise insulin dosage calculations. Similarly, Figure 3.14 delves into the calculations of the carbohydrate-to-insulin ratio using the Carbohydrate Choices Method, offering a comprehensive breakdown for each meal.

Moving on, Figure 3.15 delves into the crucial topic of carbohydrate replacement for physical activity, providing a range of examples of physical activities alongside the corresponding carbohydrate amounts needed. Additionally, Figure 3.16 offers valuable insights into the conversion back to the injection tool for individuals on insulin pump therapy, facilitating a seamless transition from the insulin pump to multiple daily injections. Furthermore, Figure 3.17 elucidates the conversion of the HbA1c Units/Average Blood Glucose tool, providing users with insights into their average blood glucose control over the last three months. Lastly, Figure 3.18 explains the management of high glucose levels and illness using the "Sick Day Rule," offering crucial guidance for individuals dealing with these circumstances. Figure 3.7 advises on keeping specific and accurate records in a logbook (see page 43).

The Carbohydrate-to-Insulin Ratio (Grams) calculator (Figure 3.13), which can be found under the "Applications" section, employs a mathematical equation to determine the grams of carbohydrates in a food item divided by the corresponding units of insulin. Specifically, the equation takes the form of Result = grams/units. This tool can be helpful for individuals with diabetes seeking to manage their blood glucose levels more effectively by precisely calculating insulin dosages in response to carbohydrate intake.

Figure 3.13: Carbohydrate-to-insulin ratio finder (grams method) app

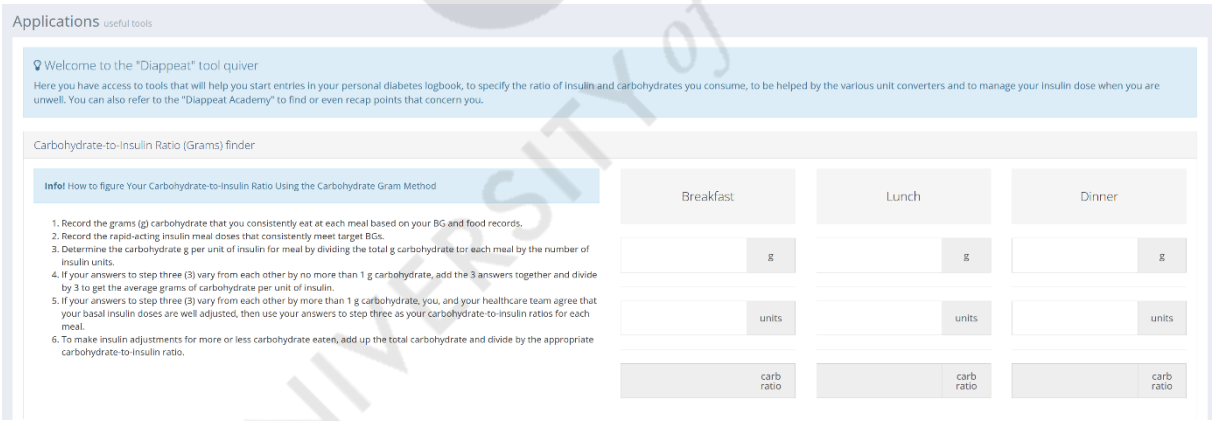
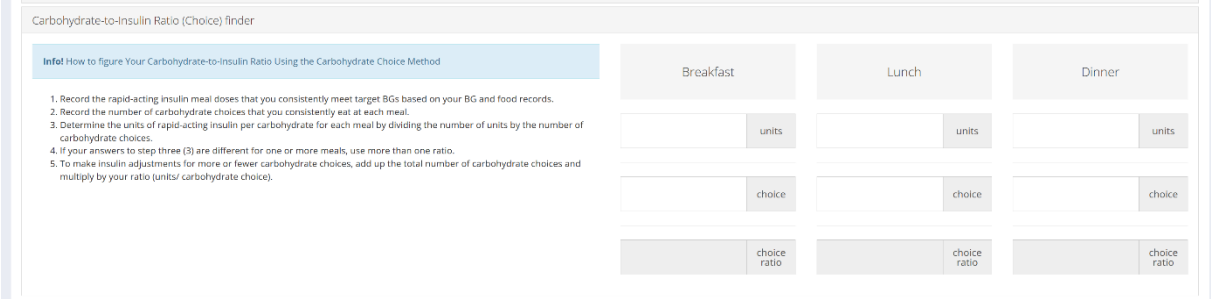


Figure 3.14: Carbohydrate-to-insulin ratio finder (choices method) app

The Carbohydrate-to-Insulin Ratio (Choices) calculator, found under the "Applications" section, utilises a formulaic approach to generate the desired output. Specifically, the calculator divides the grams of carbohydrates by a user-selected quantity of either 10 or 15 grams of carbohydrate per unit of insulin. The resulting quotient signifies the amount of insulin required to process the given quantity of carbohydrates.

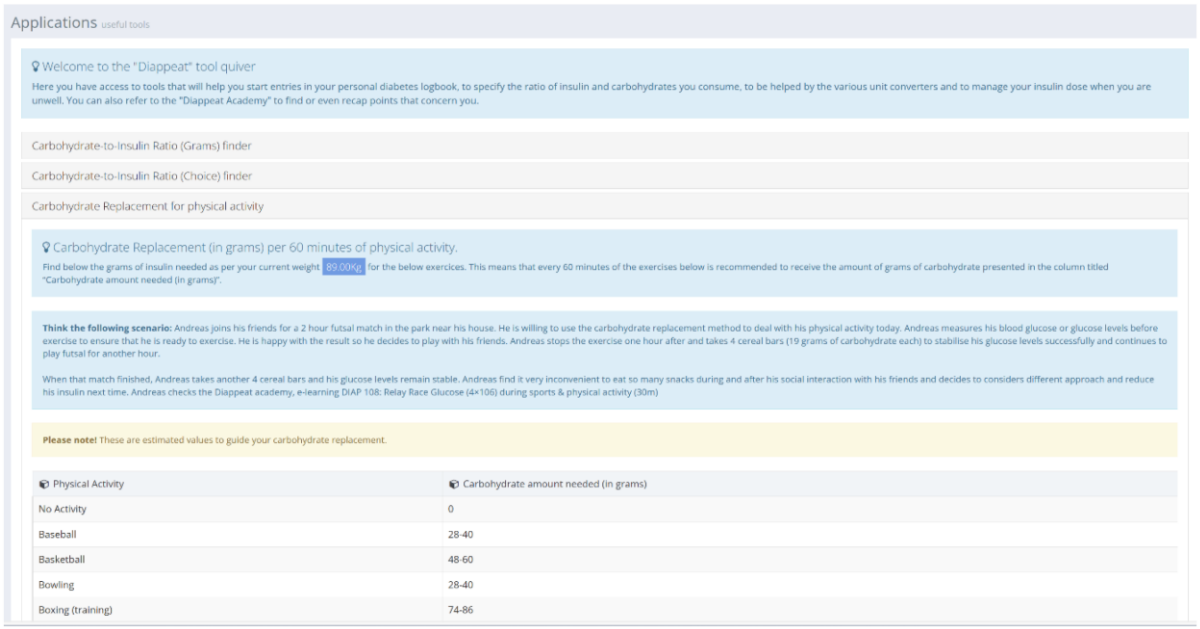
The following formula represents the mathematical expression for this calculation: Result = Grams of Carbohydrates / Choice.

This formulaic representation offers a clear and concise means of determining the appropriate insulin dosage for a carbohydrate intake, providing an invaluable tool for individuals with diabetes.



The DiAPPeat web application is a specialised tool designed to assist individuals living with T1D in preventing hypoglycaemia while engaging in physical activity. One of the standout features of this application is the Carbohydrate Replacement for Physical Activity app, illustrated in Figure 3.15. This app offers a comprehensive approach to managing blood glucose levels during exercise by suggesting that individuals consume 0.5-1.0 grams of fast-acting carbohydrates per kilogram of body weight for every hour of physical activity (Colberg et al., 2016). This strategy can be further complemented by other measures, such as decreasing insulin intake either through the preceding meal or by reducing the long-acting insulin or a temporary basal/target from the insulin pump and looking at the intensity of the activity (Scott et al., 2019). By using these combined measures, individuals with T1D can not only maintain their blood glucose levels but also enjoy their physical activities without the fear of hypoglycaemia (Francescato, Ajčević and Accardo, 2019; Cockcroft, Narendran and Andrews, 2020).

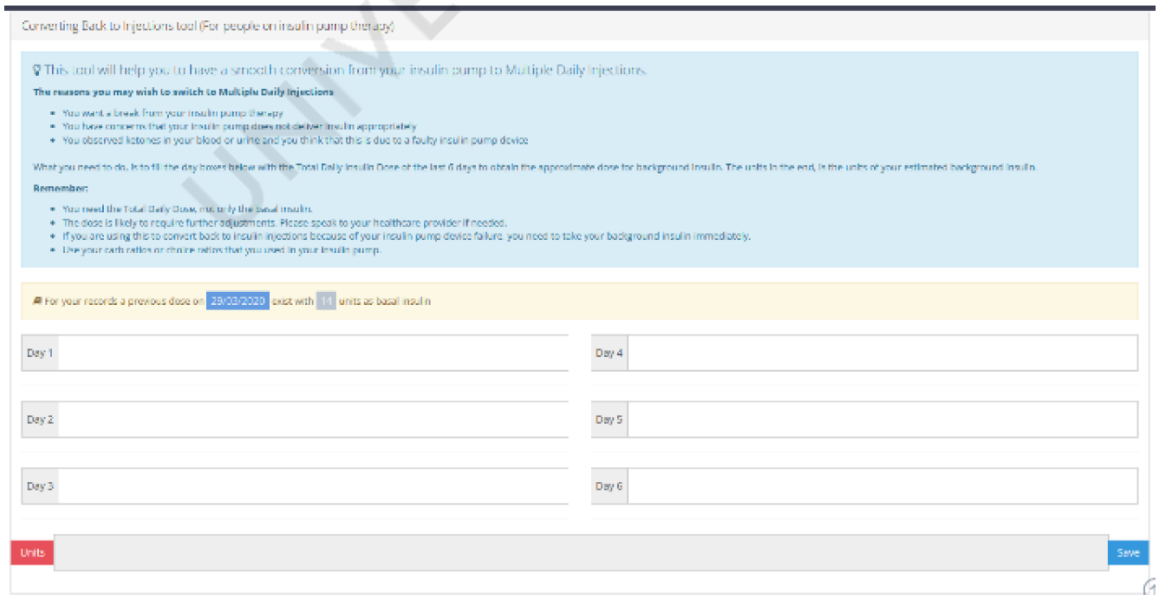
Figure 3.15: Carbohydrate replacement for physical activity app



Displayed in Figure 3.16 is the "Converting Back to Injections" tool, specifically designed for individuals utilising insulin pump therapy. Its purpose is to assist in determining the basal insulin dosage in the event of an insulin pump device malfunction. When faced with a breakdown, the user must either replace the device immediately or switch to MDI.

The tool prompts users to input their total daily insulin doses for six days to calculate the basal insulin dosage. The tool then calculates the average and divides it by two, allocating 50% for the background insulin and 50% for the rapid-acting insulin. This translates to 50% for the background insulin, which the tool then increases by 10% to account for any inaccuracies in the insulin dose. Lastly, the tool saves the answer for future reference.

Figure 3.16: Converting Back to injections tool (For people on insulin therapy)



The concept of the Converting HbA1c Units/ Average Blood Glucose tool (Figure 3.17) is to enter a reading in one of the boxes and then automatically calculate the values of the other three. The following description demonstrates the operation process of the application. The DCCT and the IFCC values are presented with one decimal point. The "mg/dL" values are presented with no decimal points. This action gives the end user the representative value for each result shown (Diabetes UK, 2021).

If the user enters a glucose reading in "mmol/l", then the "mg/dL" is the value of the "mmol/l" * 18.015. The value of "DCCT" is the ("mg/dL" + 46.7)/28.7, and the value is in the form of a percentage. The value of "IFCC" is 10.929 *(DCCT-2.15). Equally, if the user enters an HbA1C reading in the DCCT field, then "mg/dL" is (28.7* DCCT)- 46.7. The value of "mmol/l" is 10.929* (DCCT- 2.15). The value of "IFCC" is "mg/dL"/ 18.015.

Likewise, if the user enters an HbA1c reading in the "IFCC" field, then the "DCCT" value is "IFCC"/10.929 + 2.15. The "mg/dL" value is (28.7* DCCT)- 46.7. Similarly, if the user enters a glucose reading in the "mg/dL" field, then the "mmol/l" value is "mg/dL"/18.015. The value of "DCCT" is the ("mg/dL" + 46.7)/28.7, and the value is in the form of a percentage. The value of "IFCC" is 10.929 *(DCCT-2.15).

The application will calculate the conversion calculation of glucose levels from millimoles per litre (mmol/L) to milligrams per deciliter (mg/dL); you can use the conversion factor of 18.015. The conversion formula is: Glucose in mg/dL = Glucose in mmol/L × 18.015.

Figure 3.17: Converting HbA1c Units/ Average Blood Glucose tool

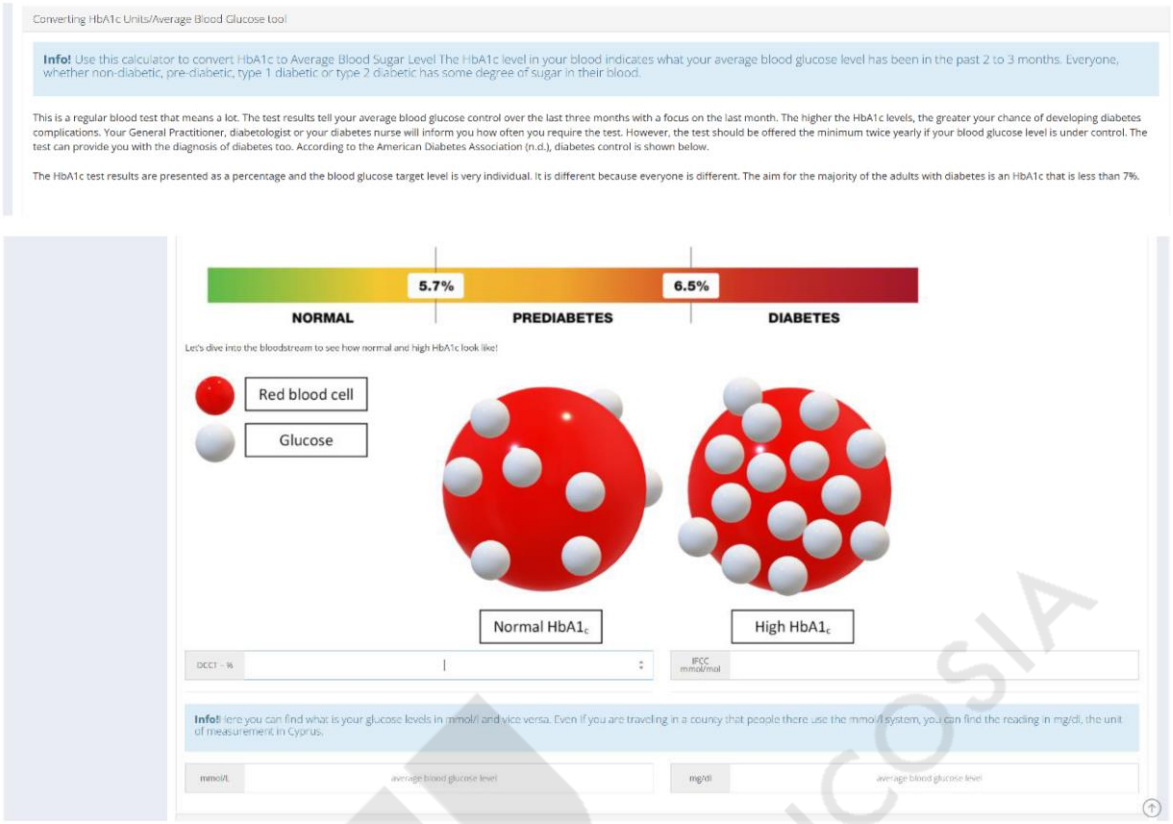
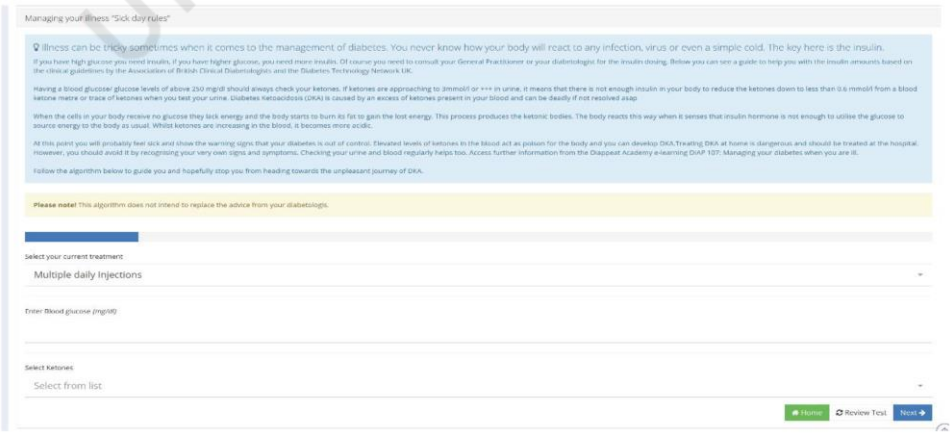


Figure 3.18: Managing your illness <Sick day rules>

The "Sick Day Rules" tool has been expertly crafted to assist those with type 1 diabetes handle illnesses. This tool is founded on global guidelines and best practices for those who rely on MDI and CSII (DTN-UK, n.d.; TREND, 2020; NICE, 2023a). Its significance lies in that even those with a solid grasp of managing their T1D may struggle with adhering to sick day rules, which can lead to DKA (Auchterlonie and Okosieme, 2013). Unfortunately, Cyprus lacks public or research-accessible data on DKA cases. Therefore, a more systematic approach is necessary to support individuals with T1D in self-managing their condition and instilling confidence in their abilities.

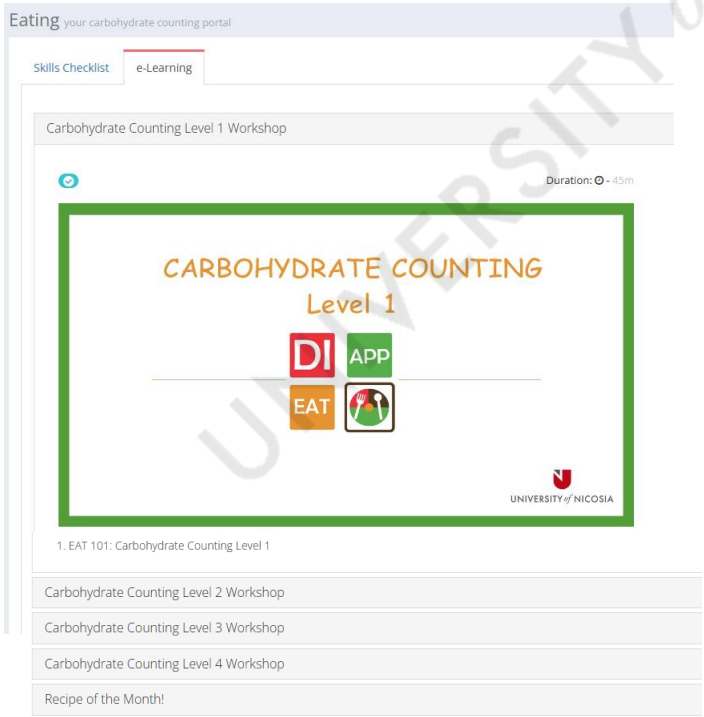


The DiAPPeat Carbohydrate Workshops (Figure 3.19) curriculum has been endorsed by both the American Diabetes Association and the American Dietetic Association, and it is specifically designed to aid individuals in Cyprus. This section is structured into four levels of carbohydrate counting, as mentioned by Gillepsie, Kulkarni, and Daly in 1998. It has been implemented by Dr. Eleni Andreou, a certified diabetes educator and experienced registered clinical dietitian.

The information provided in this category is current and personalised. The workshops are tailored to meet the specific needs of individuals with diabetes and are supervised by Dr Andreou, who has extensive experience in diabetes education and clinical dietetics. The workshops are designed to help individuals better understand carbohydrate counting, a crucial aspect of diabetes management.

In addition to the workshops, the category also features the recipe of the month, which offers organised recipes from skilled chefs and dietitians that you can experiment with. The recipes are tailored to meet the dietary needs of individuals with diabetes and are designed to be nutritious and delicious. Whether users are new to diabetes management or have been managing it for a while, the <Eating> category offers a wealth of information and resources to help them stay on track and live a healthy, fulfilling life.

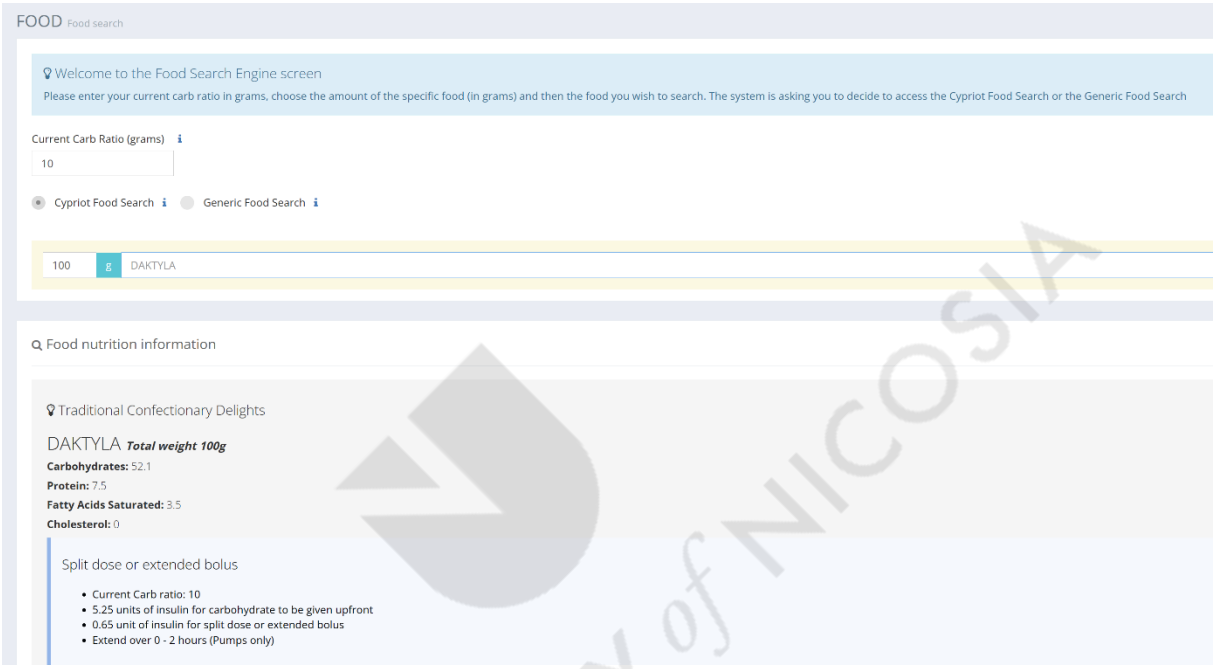
Figure 3.19: DiAPPeat Carbohydrate Workshops



The Food Search Engine in Figure 3.20 can search a pathway if one provides the minimum information needed. This can be a valuable tool for people who know how to search using

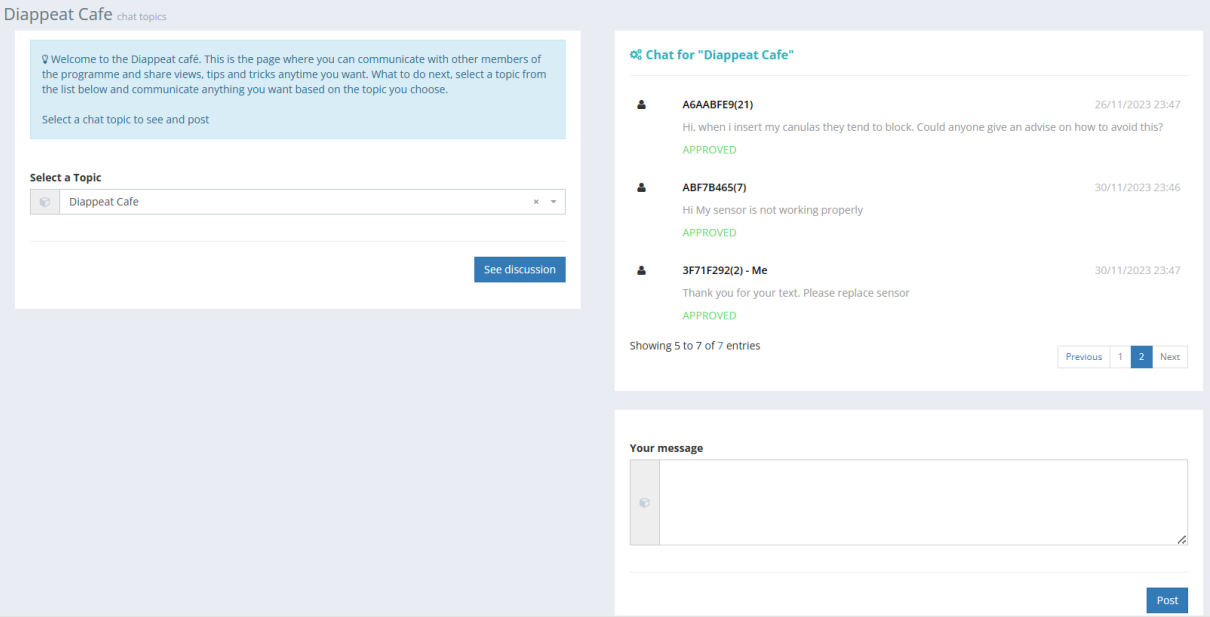
this engine type. The author uses the Cyprus Food Composition Tables for the Cypriot Food Search and the carb factors for the Generic Food Search as a reference. - 3rd Edition (State General Laboratory Republic of Cyprus, 2013). A Canadian study assessing the usability of a carbohydrate counting app using the think-aloud protocol suggests that end-users can successfully use a similar application and improve their HbA1c (Alfonsi et al., 2020).

Figure 3.20: DiAPPeat Food search engine



The DiAPPeat Café is where people can communicate with other programme members. This very quickly can become a place to meet. This is presented in Figure 3.21.

Figure 3.21: DiAPPeat Cafe



Other sections of the menu include a Glossary which describes various items relevant to the subject matter of diabetes; manage Nutrition, which consists of a nutrition list of food with carbohydrates, proteins, fatty acids, and saturated and carb factors; and finally, System, which consists of a list of users and all the presentation that is included in the web app.

3.8.3. Methodological Approach

There are various types of mixed methods identified in the literature. The one used in this study is the Concurrent Triangulation Design. With this design, two kinds of data were collected, qualitative and quantitative, at the same time from the same source or different sources, using other methods and techniques. The collected data and results are compared, and the analysis is completed separately from the overall discussion.

The research question pertains to the views and preferences of adults with T1D regarding the usability of a novel online educational tool for managing their condition. This question was identified through a systematic review, as discussed in Chapter 2 of the research report.

This inquiry aims to ascertain the specific requirements of individuals with T1D and their close network regarding the functionality they want to see in a diabetes mobile health application or a web application. The study aims to gather data on the usability of an online educational tool designed to cater to the specific needs of adults with T1D and help them manage their condition more effectively.

The review collected quantitative and qualitative data, allowing in-depth exploration of the views and preferences of adults with T1D. Data was collected through the selected studies to identify key themes and patterns.

Also, the research team gathered anonymised feedback from people with T1D reviewed in their clinic. The discussions were focused on technology, how Cypriots can access various technological opportunities in the limited market of Cyprus and the exposure that HCPs in Cyprus have to such technology, including insulin pump options and using platforms and structured education as tools to thrive diabetes.

After the design and development of the web application, it was shared with members of the Dietetic Association to share their professional opinions and to proceed with an informal usability test. The research team carefully reviewed and approved 90% of the feedback related to the design, practicalities, and protocols of the web application "DiAPPeat." Both patients and healthcare providers have expressed a strong desire for a user-friendly and intuitive application that can help them effectively manage diabetes.

The systematic review provided valuable insights into the requirements of individuals with T1D and their close network about the usability of an online educational tool. The findings of this review helped inform the design and development of future diabetes mobile health applications or web applications that cater to the specific needs of adults with T1D.

The present study aims to address the research question of how to systematically collect users' feedback and input for an online educational tool to ensure that it meets the specific needs and preferences of the target audience. To achieve this, a technology-enabled approach will be employed, whereby the views and opinions of selected participants will be recorded using a carefully crafted set of inclusion and exclusion criteria. The research will follow a structured approach to capture the shared ideas and opinions of the participants accurately. The findings of this study are expected to contribute to the existing body of knowledge on user feedback collection for online educational tools while also providing practical insights for the development of such devices.

The research question, "What are the views and preferences of adults with T1D and HCPs with relevant expertise in Cyprus regarding the usability of the DiAPPeat online educational tool for managing diabetes through carbohydrate counting?" was investigated through a mixed-method approach. The study aimed to identify the extent of usability of DiAPPeat, a web-based educational tool for managing diabetes through carbohydrate

counting. To accomplish this, the researcher employed various instruments and tools, which will be elaborated further in the following sections.

3.9. Data Collection Methods

3.9.1. Participants

The study is designed to welcome evaluation of the DiAPPeat web application from two groups of people following strict inclusion and exclusion criteria (Table 3.1- 3.3). The inclusion criteria for both groups identified the spoken language as Greek and English. The reason for this is the inclusion of a Greek video to demonstrate the idea of having both languages involved when the web application goes live later. In addition, a crucial condition was that participants had internet access and were technologically literate (Kerr, 2010). The technological requirements of accessing the internet, owning a laptop or desktop, and actively participating in the virtual calls aimed to provide the user testing sessions with organisation and a healthy learning environment to support the users in understanding and absorbing the shared knowledge. Similarly, the participant's willingness to participate in all the assessments and activities is essential to employing their interest and completing the process. The recruitment process was based on a first-come, first-served basis following an advertisement post on Facebook and Instagram. The sample size was determined based on Nielsen and Landauer (1993), who present that the think-aloud protocol cooperates with numerous modest tests with no more than five users per group, as this method ensures the best evaluation results.

3.9.2. Instruments or Tools

The methods followed in this study were classified as a mixed-method design. In particular, I used the user testing approach with usability scenarios and questionnaires, including well-known usability tools and the think-aloud protocol across two groups.

A primary questionnaire was used during the study, along with usability questionnaires and testing scenarios. To ensure the reliability and validity of the questionnaires, a diverse group of individuals, including HCPs with and without diabetes specialisation, members of the general public, and individuals living with T1D and T2D who were not involved in the study, were selected to participate in the validation process. The feedback received during the validation process was meticulously evaluated and recommended changes were incorporated into the questionnaires. The changes primarily focused on the structure of specific questions, a small number of typographical errors, and the formatting of the questionnaire as a whole. For instance, some suggestions were made to modify the line spacing between questions to make them more readable. All of these changes were

implemented to ensure that the questionnaires were easy to understand and use for all participants and that the data collected was accurate and reliable.

According to Burt (2015), the three reasons for applying the mixed-method design are triangulation (handling various approaches), complementarity (two methods share outcomes and expand the results of the second method) and development (one way improves the other process). The writer of this study believes that this research method entirely relates to the above.

The preparation of the equipment was an essential component for a successful project. A further safeguard to ensure effective facilitation was a reliable internet network and access to one of the following video conferencing software, i.e. Microsoft Teams, Zoom or Skype. Besides this, the facilitator provisioned software updates and disruptions to facilitate smooth interventions.

3.9.2.1. Remote-moderated Qualitative Usability Testing Procedure

The usability testing focused on the participants to identify issues by using their experience and interaction via a concurrent think-aloud protocol. Following the above protocol, participants were asked to actively articulate their expertise and reflections whilst cooperating with the app.

The facilitator was present and guided the participant while undertaking the test. The following task-driven scenarios were shared with the participants for both groups (Group A: individuals with T1D or Group B: HCPs).

The usability testing length was approximately one and a half hours. This study's subjects were involved in tasks that the actual users would be affected when the status of the web application changed to "Live". Create an account and log in (e.g., forgot your password and account recovery pathway); navigate and find mapping pathways (e.g., locate and enter the "sick day rules algorithm"); operate the web application and the specifications of the app (e.g., access the material and complete the forms, the questionnaires and the quizzes'); and demonstrating activity (e.g., "add to the logbook a day worth of glucose readings" or "use the relevant section to find how many grams of carbohydrates exist in trahanas").

The usability testing scenarios are listed below.

Scenario 1: Register/Login/ Forgot your password/ DiAPPeat Academy

1. Go to Welcome | diappeat.com and click the register.
2. Add your contact details.
3. Read and mark the Terms and Conditions and consent form.
4. Enter your participation number.
5. Locate and visit the "Sick Day Rules" application.
6. Once you locate the page, view the information and complete the quiz.
7. View the dashboard – What is updated?
8. You can now go to the home page.
9. Sign out – oops, you forgot your password! Where will you go to recover it?

Scenario 2: Eating

1. Go to Welcome | diappeat.com and click login.
2. From the four coloured squared menus, click "EAT."
3. View the "Skill Checklist" tab and say what learning is completed and what is not.
4. Click the "e-Learning" tab.
5. Visit the learning "Carbohydrate counting Level 1".
6. Go through the learning until the end and locate how to view the "Carbohydrate counting Level 1" learning.
7. View the information and complete the quiz.

8. Sign out.

Scenario 3: Food Search

1. Go to Welcome | diappeat.com and click login.
2. From the four-coloured squared menus or the left-side menu, click "Food Search."
3. Enter the current carb ratio as 10 grams/ unit. What does this mean?
4. You want to determine a Cypriot food's carbohydrate value.
5. Find how many grams of carbohydrates are in Fried Poulles.
6. How much protein is in 250 grams of food?
7. You have decided to eat 200 grams of food. What would you do?
8. Sign out.

Scenario 4: DiAPPeat Cafe

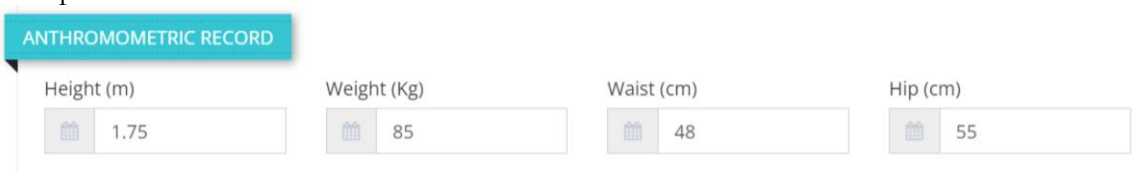
1. Go to Welcome | diappeat.com and click login
2. From the left-side menu, click "DiAPPeat Cafe.".
3. Select the topic "DiAPPeat Café".
4. Write a message "Hello everyone, I am new here" and post it.
5. What happened?
6. You have a question about using the "Applications" section.
7. Select the Applications discussion.
8. Write the following message, "How do I use the sick day rules tool?" and then post it
9. What happened?
10. Sign out.

Scenario 5: DiAPPeat logbook

1. Go to Welcome | diappeat.com and click login.
2. Find a dashboard and create a DiAPPeat Logbook.
3. Make two (2) entries individually, following the facilitator's instructions about the readings, and then save them.
4. Describe what you see.
5. Find the Study records and describe what you see.
6. Sign out.

Scenario 6: DiAPPeat operations

1. Go to Welcome | diappeat.com and click login
2. Visit the screen to see the Guide video.
3. Go to the dashboard.
4. Edit and change the job description to "Unemployed" and then save it.
5. Visit the dashboard and find the study progress. Click the initial assessment.
6. Complete the assessment as follows:



7. Then save the entries.
8. Now find the Candidate number.
9. Sign out

3.9.2.2. Usability Evaluation Tool: Technology Acceptance Model (TAM)

The questionnaire is an adapted version of the Technology Acceptance Model of Davis (1989) and Lewis, J.R. (2019), with additional sections of multiple choice and short answers to allow feedback and demographic information from the study cohort. The two tools can be found below. The Questionnaires were modified and translated into Greek and aimed to evaluate the 'user as a person with T1D or HCP' aspect and the learning aspect of the web application DiAPPeat. For example, the participants can assess the learning material.

The participants selected the extent to which they agreed with each of the choices on the System Usability Scale (SUS) of 1-5 (where 1 = strongly disagree and 5 = strongly agree). On the Technology Acceptance Model (TAM) from Lewis, J.R. (2019) scale of 1-7 (where 1 = strongly disagree and 7 = strongly agree).

The author presents the instructions and the actual questions of the System Usability Scale (SUS) and Technology Acceptance Model (TAM). The SUS is a Likert scale is presented in the Table 3.4. It is often assumed that a Likert scale is simply one based on forced-choice questions, where a statement is made, and the respondent then indicates the degree of agreement or disagreement with the information on a 5-point scale. However, constructing a Likert scale is somewhat more subtle than this. Whilst Likert scales are presented in this form, the statements with which the respondent indicates agreement and disagreement must be selected carefully (1 Strongly disagree/5 Strongly agree).

Table 3.4: The System Usability Scale (SUS)
I would like to use the DiAPPeat web application frequently.
I thought the DiAPPeat web application was easy to use
I believe that I would need a technical person's support to use the DiAPPeat web application.
I found the various functions in the DiAPPeat web application were well-integrated
I thought there was too much inconsistency in the DiAPPeat web application.
I imagine most people would quickly learn to use the DiAPPeat web application.
I found the DiAPPeat web application very cumbersome to use
I felt confident using the DiAPPeat web-application
I needed to learn many things before I could get going with the DiAPPeat web application.

The Technology Acceptance Model (TAM) is designed to allow you to rate the usefulness and ease of use of this product (Table 3.5). To as great an extent as possible, consider all the tasks you do with the product while answering these questions. Please read each statement and indicate how strongly you agree or disagree with the idea. Please read the information carefully, but only spend a little time on each item -- your first impression is OK.

Note that in this questionnaire (TAM), all items have a positive tone, so greater levels of agreement (to the right of the scale) indicate a better user experience. Please indicate the extent to which you agree with the following statements: where 1= = Extremely disagree and 7= = Extremely agree.

Table 3.5: The Technology Acceptance Model (TAM)
The DiAPPeat web application enables me to accomplish tasks more quickly than other products in its class.
Using the DiAPPeat web application improves my job performance in treating people with type 1 diabetes.
Using the DiAPPeat web application increases my productivity in type 1 diabetes management.
Using the DiAPPeat web application enhances my effectiveness in treating people with type 1 diabetes.
Using the DiAPPeat web application makes it easier for me to provide care to people with type 1 diabetes.
I have found the DiAPPeat web application valuable for my job.
Learning to operate the DiAPPeat web application was easy for me.
I found it easy to get this product to do what I wanted.
My interaction with the DiAPPeat web application has been clear and understandable.
I found this product to be flexible to interact with.
It was easy for me to become skilful at using the DiAPPeat web application.
I found the DiAPPeat web application easy to use.

3.9.2.3. Structured Interview open-ended questions

The researcher conducted usability testing to gain insights into participants' perspectives on the DiAPPeat web application. The researcher included two open-ended questions in this

study to gather more detailed information. The first question aimed to identify the application's most attractive and valuable section from the participants' perspective and asked them to explain their choice. The second question encouraged participants to share their thoughts on the application and elaborate on their reasoning.

Furthermore, the researcher also asked participants to provide additional details on any comments they made during the Think-Aloud protocol. Towards the end of the main study questionnaire, individuals with T1D and HCPs were encouraged to suggest thematic educational sections that could benefit DiAPPeat. They were also asked to provide further feedback on their web application. The researcher hoped that the participants' feedback would help them improve the application's usability and make it more valuable for individuals with T1D and HCPs.

3.9.2.4. Researcher Notes

The researcher in this study employed a rigorous and systematic approach to note-taking during the usability testing sessions. The note-taking process was designed to capture a wide range of data, including participants' verbal and nonverbal expressions, reactions, feedback on the tested intervention's usability, and opinions on diabetes-related local topics. To ensure the accuracy and validity of the notes, the researcher cross-verified them with the video recordings of the sessions, which provided a rich source of complementary information.

Using researcher notes in this study was deemed highly beneficial, as it allowed the researcher to capture and analyse a broad range of qualitative data that would have been difficult to obtain through other means. Specifically, the notes helped the researcher to identify patterns and themes in participants' feedback regarding the usability of the tested intervention, the challenges they encountered in using it, and their suggestions for improvement. Additionally, the notes provided valuable insights into the participants' opinions on diabetes-related topics, such as their perceptions of the quality of local diabetes care, the availability of diabetes education and support services, and the social and cultural factors that influence diabetes self-management.

Overall, this study's detailed and comprehensive approach to note-taking highlights the importance of qualitative data in understanding the experiences and perspectives of individuals with T1D and HCPs. The findings of this study have important implications for the design and implementation of diabetes interventions and services tailored to the needs and preferences of local populations.

3.9.3. Data Collection Procedures

Mixed-method studies are commonly used in research as they incorporate various methods that help provide a comprehensive understanding of a particular phenomenon. However, using multiple methods can sometimes pose challenges in structuring and analysing the data collected. In this regard, it is essential to have a well-planned data collection process to ensure that the data collected is effectively researched and interpreted.

The current study involved a rigorous and extensive review process to identify and prioritise the key features that should be incorporated into the DiAPPeat web application. This PhD thesis was meticulously planned and executed, with a detailed timeline provided in Figure 3.2, to ensure that the conclusions drawn from the study were accurate and reliable.

The author ensured ethical research practices were followed, by obtaining and carefully examining the consent form, which was signed electronically. The Cyprus National Bioethics Committee approved the consent form containing specific clauses the researcher reviewed. The researcher also ensured that the consent form was readily available and accessible during the registration process for the DiAPPeat web application.

Overall, the study was conducted with great attention to detail and adherence to ethical research practices to ensure that the conclusions drawn from the study were valid and reliable.

The author of this PhD study was conscious of every participant while "sharing the screen", and he paused the video recording to maintain anonymity and confidentiality. Finally, during the process, the author was not referring to the participants by names unless they wished for their names to be used, and they consented to it.

Referring to Figure 3.2, the procedures employed to collect the data for this study are mentioned. Firstly, the remote-moderated qualitative usability testing initiated the data collection process for this study. Following this video recorder scenario-based usability testing, the facilitator of the usability test asked two structured open-ended interview questions.

The next step for the participants of this PhD study was to answer the main questionnaire of the survey. Participants with T1D and HCPs receive differentiated questionnaires. The author provides the questionnaires as a link for both people with T1D (https://forms.gle/Ua9GrU86vFobA6Ci8) and HCPs

(https://forms.gle/PDKfsAyHKwN8dxdT9). The questionnaires attached include the usability questionnaires System Usability Scale (SUS) Brooke, John. (1995) and Technology Acceptance Model (TAM) Davis (1989). Additionally, the main questionnaire of the study includes two open-ended structured feedback questions for the DiAPPeat web application.

Finally, the researcher's notes were captured during the online usability testing and confirmed via the video recording participants agreed to provide to the researcher.

3.9.3.1. Data Collection

Data was collected through user testing, validated questionnaires and the feedback form at the assessment point for the completion of the study.
User testing comprises two phases: qualitative usability testing and a virtual guided tour evaluation questionnaire.

3.9.3.2. Study Consent

The informed consent was completed and sent to the Cyprus National Bioethics Committee for approval. Consent to this study was mandatory and was obtained by the research team to protect the participants' rights and autonomy. The consent form was provided as an online PDF document and a selection before entering the web application.

3.9.3.3. Data Recording

The author recognises the importance, legal and ethical necessity to ensure the storage of the collected data following the EU general data protection regulation (GDPR). The agreement was made through the application and acceptance of this study by the Cyprus National Bioethics Committee. The participants were informed about the data collection process and the video recording. However, the participants were allowed to abandon their study participation and ask for their data to be permanently deleted.

3.9.3.4. Data collection and storage

The data collected underwent strict data quality control to ensure the accuracy and completion of the questionnaires. In addition to data derived from the questionnaire, the data collected from the user testing procedure was recorded to guarantee the data's precision. Data storage was a high priority for this project because it is mostly online. All data collected from the survey are filled and locked in a cabinet in Dr. Andreou’s office at the University of Nicosia. High-quality safety and security service standards characterise the University of Nicosia facilities.

The data from the questionnaire were collected via the Google application form, and an access code was provided to individual researchers and competent research team members. Their names were documented and clearly stated in the system. Only the mentioned foremost researchers have access to data and information manager support. The collected data was archived anonymously. There is a unique number allocated to every participant, and the research team do not have access to the full details of the participants. Data is planned to be removed from the database ten years after the completion of the study. Undergraduate or postgraduate students at the University of Nicosia may have an opportunity to be involved in the study in the future. The selected students will be required to study in one of the schools relevant to the study (School of Humanities and Social Sciences, Medical School, and School of Sciences and Engineering).

3.9.3.5. Ethical Considerations

This PhD study received approval from the Cyprus National Bioethics Committee with reference number ΕΕΒΚΕΠ2023.01.308. There are no ethical issues, especially concerning the study design and ethical support, data analysis, authorship, conflict of interest, redundant publication and plagiarism. Every participant must have the right to discontinue the whole procedure or test after their wish and without any penalties throughout the project. However, any participant can complain directly to Dr Eleni Andreou (tel: 99464040) or Mr Panagiotis Siekkeris (tel: 99262542). In addition, each patient is free to complain to the project coordinator in person. In addition, each participant is free to complain to Dr. Constantinos Adamides (Research Ethics Committee of University of Nicosia, tel: 22841675). Lastly, complaints can be sent to Ms—Georgia Charalambous as an independent contract for the complaints about the study (22841618. charalambous.ge@unic.ac.cy).

3.10. Data Analysis Methods

3.10.1. Mixed Method Study

Demographic data includes age, gender, race, occupation and education level (including diabetes education). Due to the study's small sample, a decision has been made to refrain from using strict statistical analysis. However, the researcher supports the mixed method nature of this study by continuing to use both quantitative and qualitative methods to discover the answers to his research questions mentioned above.

The author and the research team used descriptive statistics to describe the data instead of employing statistical analysis. Using descriptive statistics, the author provides an

informative description of the usability results derived from the two groups examined in this PhD study and establishes the research standards of the University of Nicosia, Doctor of Philosophy in Nutrition and Dietetics. The author of this study describes the data with the distribution of the frequency of the individual values.

An additional method is to interpret, analyse and discuss the qualitative data collected by the author to answer the research questions (see Chapter 3, section 3.1.2). The qualitative data complement the quantitative data with the participants' views and feedback to the evaluated novel DiAPPeat web application.

3.10.2. Qualitative Analysis

The researcher has undertaken a qualitative analysis of the information received from two cohorts and has found it to be a valuable piece of work. The author has skillfully handled the received data, enabling the reader to systematically understand how each participant from each group experienced the feedback methods provided to them.

The usability results obtained from the usability testing were presented to the reader using a well-designed approach. The six scenarios used for the testing allowed the end-user to have a complete experience with the DiAPPeat web application. This approach enabled the participants to provide feedback on the application's usability, which the researcher then analysed.

Additionally, participants answered structured open-ended questions verbally, followed by the main questionnaire of the study. This approach allowed participants to provide the researcher with qualitative data to answer research questions about the usability and usefulness of the web application. The researcher has meticulously analysed this data and presented it clearly and concisely.

Lastly, the researcher noted complementary elements of the collected data, confirming or contradicting the data collected via the previous routes. The data collected was analysed by group, individuals with T1D, and HCPs. The researcher then individually viewed the data from each participant with T1D and each HCP to provide the research community with a comprehensive discussion and conclusions. This approach has enabled the researcher to provide detailed insights into the data, which are of significant value to the research community.

3.11. Materials and Resources

3.11.1. Physical Materials

Various software programs were utilised to accomplish various tasks to complete the project. Firstly, software was employed to create the logo of the web application, which was crucial in establishing the brand identity of the application. Secondly, a browser was utilised to operate and edit the web application, facilitating the integration of various features and functionalities. Thirdly, programming software was employed to program the application, allowing for customisation and optimisation of the application's performance. Additionally, software and hardware were used to create videos, voice covers, and podcasts, enhancing user experience and engagement. Another software was utilised to create videos and animations, further enhancing the visual appeal of the application. Finally, software was used to initiate and record the video calls for data collection, which was crucial in obtaining valuable user insights and feedback.

3.11.2. Human or Social Resources

The researcher's work was enriched through various collaborations and expert consultations. The programmer Andreas Siekkeris had a significant role in developing and coordinating the web application. The graphic designer Haris Argyriou contributed to the project's visual appeal by creating the logo. The Lellos P. Demetriades Law Office LLC provided indispensable legal support during the DiAPPeat logo registration process.

Moreover, the researcher consulted with experts in various fields to ensure the quality and accuracy of the project's content. For the diabetes and well-being e-learning program, the clinical psychologist Dr. Angeliki Argyriou provided valuable support. Charlotte Cole, the Antenatal Diabetes Specialist Nurse, contributed to the diabetes and pregnancy e-learning program. Lastly, the dentist, Sofia Vatti, provided crucial insights for the diabetes and oral hygiene e-learning program. Through these collaborations and consultations, the project was able to provide reliable and accurate information to its users.

3.11.3. Budget and Funding

This study is primarily self-funded during its current stage. However, it is intended that companies that provide products and services related to diabetes will be invited to participate in the project in the future, potentially as part of post-doctoral studies following the completion of this research endeavour.

The author of this study has funded the registration of the project's logo with the European Union Intellectual Property Office (EUIPO) for €1,350.00. Lellos P. Demetriades Law Office LLC supported this expense under the reference EUTM017375395.

Other costs were incurred for the maintenance of the server and website fees, which amounted to $156.94 and €29.96, respectively. These expenses were incurred throughout the completion of this PhD project.

3.12. Conclusion

The study uses a mixed methods research approach because of the aims, objectives, research questions, and overall context, and it collects quantitative and qualitative data and other specialised information simultaneously. There are various types of mixed methods identified in the literature. The one used in this study is the Concurrent Triangulation Design. This research framework and setting and the area of nursing and clinical practice fall under the paradigm of pragmatism.

The objectives of this study include the development of an online educational tool, the incorporation of user views and needs and the empowerment through carbohydrate counting. The goals are to evaluate the usability and user experience and identify areas where users encounter difficulties or find the tool particularly effective and user-friendly. The research is crucial in initiating a T1D educational pathway in Cyprus by standardising the carbohydrate counting method with the relevant tools and further diabetes education.

The inclusion and exclusion criteria for both groups of participants (adult individuals with T1D and HCPs) are identified. Group A consisted of adult individuals from all genders and ethnicities who received the diagnosis of T1D for a minimum of two years before registering with this research project. Moreover, the chance for the individuals to have received a form of carbohydrate education before was vital. Likewise, the second group (group B) includes HCPs who exercise in the diabetes area, including registered nurses interested in diabetes, diabetes consultants and registered clinical dietitians. A key parameter for group B recruitment was the participants' minimum experience of up to five years in a diabetes setting with the relevant qualifications.

To gather the necessary data, the researcher utilised a variety of instruments, including remote-moderated qualitative usability testing, a primary questionnaire featuring the System Usability Scale (SUS) by Brooke, John (1995), and the Technology Acceptance Model (TAM) by Davis (1989). Additionally, the researcher included two open-ended interview questions at the end of the verbal online usability testing and two more after the main feedback questionnaire. To ensure that all relevant data was captured, the researcher also took note of significant phrases or statements provided by participants. All usability tests and structured questions were recorded with consent, and the study's author cross-

checked his notes with the video recordings created for this study's purposes to capture every possible statement.

The usability testing focused on the participants identifying issues using their experience and interaction via a concurrent think-aloud protocol. Following the above protocol, participants were asked to actively articulate their expertise and reflections whilst cooperating with the app. The facilitator was present and guided the participant while undertaking the test. The six usability testing scenarios are: Scenario 1- Register/Login/ Forgot your password/ DiAPPeat Academy, Scenario 2- Eating, Scenario 3- Food Search, Scenario 4- DiAPPeat Café, Scenario 5- DiAPPeat logbook and Scenario 6- DiAPPeat operations.

The current study involved a rigorous and extensive review process to identify and prioritise the key features that should be incorporated into the DiAPPeat web application. To ensure ethical research practices were followed, the researcher obtained and carefully examined the consent form, which was signed electronically. Overall, the study was conducted with great attention to detail and adherence to ethical research practices to ensure that the conclusions drawn from the study were valid and reliable. The procedures employed to collect the data for this study were remote-moderated qualitative usability testing, which initiated the data collection process, followed by video recorder scenario-based usability testing, and the facilitator of the usability test asked two structured open-ended interview questions. Finally, the researcher's notes were captured during the online usability testing and confirmed via the video recording participants agreed to provide to the researcher. Due to the study's small sample, a decision has been made to refrain from using strict statistical analysis. However, the researcher supports the mixed method nature of this study by continuing to use both quantitative and qualitative methods to discover the answers to his research questions mentioned above.

Various software programs were utilised to accomplish various tasks to complete the project. Firstly, software was employed to create the logo of the web application, which was crucial in establishing the brand identity of the application. Secondly, a browser was utilised to operate and edit the web application, facilitating the integration of various features and functionalities. Thirdly, programming software was employed to program the application, allowing for customisation and optimisation of the application's performance. Additionally, software and hardware were used to create videos, voice covers, and podcasts, enhancing user experience and engagement. Another software was utilised to create videos and animations, further enhancing the visual appeal of the application.

Finally, software was used to initiate and record the video calls for data collection, which was crucial in obtaining valuable user insights and feedback. Collaborations and expert consultations in multiple fields enriched the researcher's work.

CHAPTER 4 RESULTS, ANALYSIS, AND DISCUSSION

4.1. Introduction

In this chapter, the author presents and critically analyses the usability outcomes of this study. Then, the results of the survey are shown in the form of tables in two different sub-sections: people with T1D and HCPs. The sociodemographic data of the participants and the comments and suggestions on any additional topics provided by the participants are presented. Afterwards, the results of the usability test, together with the researcher's notes, are given by scenario – six scenarios in total. Finally, the chapter critically discusses the views of people with T1D and the HCPs.

The analysis of this PhD thesis results critically discusses the outcomes of the usability testing, the open-ended questions from both video recording and the main questionnaire of the study, the actual main questionnaire of the research, and the researcher notes. The author includes elements of the “Researcher Notes” in the “Usability Testing” section to enrich the results of every scenario with the views and opinions of the participants from the two cohorts included in the study. Descriptive statistics were used to describe the answers to the Likert-type questions.

4.2. Results and Analysis

The analysis of results for the people with T1D will follow an order from positive to less positive feedback. The results for the HCPs will follow the order starting from the two registered dietitians who participated. The reasoning behind this decision is highly related to the project's research question, which involves the carbohydrate counting element.

The author of this study decided to present the response from the diabetologist/ endocrinologist and agreed to participate in the study right after the responses from the registered dietitians. This reflects Cyprus' doctor-centred system derived from the participants' opinions in both cohorts (people with T1D and the HCPs).

The DSN possess a vital role in the diabetes MDT in the UK. According to Cable in 2016, a DSN in the UK highlights the necessity of the DSN's role in a healthcare system that protects, empowers and supports people with diabetes. The article above discusses the implementation of the DSN role in South Soudan. According to the DSNs interviewed for this PhD study, the article is highly relevant to the situation in Cyprus.

The DSNs who participated in this study suggested that they have the skills to inform, guide and advocate for their patients despite the limited structure of the services, opportunities and financial restraints. The potential benefit of establishing a structured

DSN role in the General Health System of Cyprus will eventually create robust diabetes MDT with clarified roles, rights and responsibilities towards the care of people with diabetes nationally. For the above reasons, the DSNs selected for this PhD study are considered experts in Cyprus for their significant diabetes experience and current job roles. An additional nurse was added to the participants in the HCP group. The nurse possesses the role of nurse educator with more than ten years of experience in diabetes, including developing a national diabetes nurse education programme for nurses in Cyprus.

Last but not least, the author recruited a clinical psychologist with experience in diabetes. The involvement of a clinical psychologist in undergoing a usability test and sharing her scientific view on the "DiAPPeat" web application, added value to this study. A review study in the United Kingdom by Reddy et al. (2016) suggests that referrals to mental health units with psychological support should be used in clinical practice when signs of diabetes distress or mental health concerns impact a person with diabetes.

An Australian study by Wiley et al. (2013) shares the opinion of 150 adults with T1D, highlighting the importance of the clinician's mindset of practising the patient-centred approach. Also, it highlights the risk of people with diabetes missing the opportunity to access any diabetes care processes or services. Especially if the culture of referring individuals to other specialities in the MDT is limiting.

The study sample consisted of six persons with T1D and seven from various health professions (endocrinologists, diabetes nurses, nurse educators, clinical dietitians, and clinical psychologists) with unique qualifications and interests/ experience in diabetes. Among the participants with T1D, the mean age was 40,7 years (range between 21 – 64), and 67% were females (4 persons). Among the professionals, the mean age was 45,5 years, and 85,7% were females (6 persons). Regarding the education level of persons with T1D and the professionals, nine persons or 69,2%, had a University Postgraduate degree (66,7% and 71,4% respectively).

The vast majority of the participants in both groups had ten years or more experience with diabetes, either as people having the condition (50% on CSII and 50% MDI) or with diabetes professional experience. One professional with 5 years of diabetes experience was accepted to participate in the study because he has T1D. Most participants with T1D noted that they were using the internet between 3-5 hours a day (4/6, 67%) and the rest (2/6, 33%) less than an hour. Concerning the usage of Facebook, 3 or 50% of the persons with diabetes were using it 1-3 hours a day and the other three persons or 50%, less than an hour

a day. Most professionals (4/7, 57,1%) used the internet between 1-3 hours a day; one used it 3-5 hours and two (2/7, 28,6%) more than 5 hours a day. Concerning the usage of Facebook, four persons were using it less than an hour a day, and the other three were using it 1-3 hours a day.

The analysis of the sociodemographic data shows that the sample of both groups is educated, experienced, and knowledgeable in diabetes. Also, they spend satisfactory time on the internet and Facebook. Therefore, they are knowledgeable in handling electronic devices and accessing social media.

4.3. Think Aloud Protocol

The present text concerns transcribing the results of a usability testing study that implemented different scenarios. The data was collected using video call recordings voluntarily provided by twelve participants who consented to participate in the study. Notably, the study's author used the pronouns 'He/him' and 'His' while referring to the participants' data and information. This decision was made considering data protection and confidentiality, as well as the small size of the study sample and the potential for participants to be recognised in the relatively small community of Cyprus.

The author presents the usability test results into two groups to ensure a comprehensive evaluation. The **first group** comprised the feedback gathered from **individuals with T1D,** and this feedback was analysed and scrutinised in detail to extract valuable insights that can help enhance the product's overall usability. The **second group** focused on the input provided by **HCPs**, including doctors, nurses, and other medical experts who are well-versed in diabetes management and care. Both groups' information and data analysis outcomes will be critically analysed and discussed later in this chapter (see 4.3. Discussion). The feedback from the participants of these two groups aims to ensure a better understanding of the tool's usability and identify any areas needing improvement. Additionally, the author focuses on including the expected aspects of the usability testing process, utilising the available data, and obtaining the necessary information from the end users and the experts in the field.

4.3.1. People with Type 1 Diabetes

The results below represent the responses from the study participants with T1D. The answers in the following sections score incredibly high in all the evaluated areas of the web application. The evaluated areas, “Diabetes”, “Applications”, “Eating”, “Food Search Engine”, “DiAPPeat Café”, and “Logbook”, were studied in detail by the author. The author's interpretation of the participants in the first group's positive responses lies in the belief that participants have limited interaction with a web application supporting them with diabetes management. Additionally, the health services are evaluated as poorly organised and inadequately structured. Furthermore, this study's participants characterised the diabetes-related information and counselling provided as low-quality.

The questionnaire for the participants with T1D begins with the usage of the established and well-known System Usability Scale (SUS) (Brooke, John 1995), presented in Table 4.1 below. The Model consists of 10 questions with a 1 (low) to 5 (high) Likert scale. Overall, the six participants with T1D received and evaluated the application positively. The app was found to have no internal inconsistency at all. Also, the app's various functions were well-integrated, and the participants felt confident using it. It was easy to use. Nearly all the rest of the statements received more than-average ratings. It must be mentioned that the oldest participant gave the inferior rating in all cases.

Table 4.1: Participants with type 1 diabetes - 10-System Usability Scale (SUS)

Description	1	2	3	4	5
I think that I would like to use the system frequently.			1		5
I found the system unnecessarily complex	3	2	1		
I thought the system was easy to use				2	4
I think that I would need the support of a technical person to be able to use the system	3	2		1	
I found the various functions in this system were well integrated.				1	5
I thought there was too much inconsistency in this system	6				

I imagine most people would learn to use this system very quickly.			1	2	3
I found the system very cumbersome to use	4	1	1		
I felt confident using the system.				2	4
I needed to learn a lot of things before I could get going with the system	4		2		

All four statements regarding the overall evaluation of the application's content received the highest rating (5) by all six (6) participants. The statements deal with the clearness of the targets, the subsections/themes and the benefits and degree of satisfaction from the application (Table 4.2).

Table 4.2: Overall evaluation of application's content for people with T1D					
Description	1	2	3	4	5
The targets of the application were obvious.					6
The subsections/ thematics aligned with the application's overall targets.					6
The benefits you have obtained from the application DiAPPeat and the degree of satisfaction					6
Overall satisfaction with the application					6

All three statements regarding the "Diabetes" section received the highest rating (5) out of the six (6) participants. The presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and evaluated (Table 4.3).

Table 4.3: Evaluation Section <Di>, <Diabetes> for people with T1D					
Description	1	2	3	4	5
Quality/ Usefulness of the presentations and discussions					6
Overall coverage of the subject					6

matter					
Appropriateness of the mode/ method chosen for distance learning					6

All three statements regarding the “Applications” section received the highest rating (5) by all six (6) participants. The presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and evaluated (Table 4.4).

Table 4.4: Evaluation Section <App>, <Applications> for people with T1D					
Description	1	2	3	4	5
Quality/ Usefulness of the presentations and discussions					6
Overall coverage of the subject matter					6
Appropriateness of the mode/ method chosen for distance learning					6

All three statements regarding the “Eating” section received the highest rating (5) out of the six (6) participants. The presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and evaluated (Table 4.5).

Table 4.5: Evaluation Section <Eat>, <Eating> for people with T1D					
Description	1	2	3	4	5
Quality/ Usefulness of the presentations and discussions					6
Overall coverage of the subject matter					6
Appropriateness of the mode/ method chosen for distance learning					6

All four statements regarding the “Food Search Engine” section received the highest rating (5) by all six (6) participants. That is the quality/ usefulness of the search engine, the

coverage of the subject, the appropriateness of the methods, and the use of its content were very well received and evaluated (Table 4.6).

Table 4.6: Evaluation Section <Food Search Engine> for people with T1D					
Description	1	2	3	4	5
Quality/ Usefulness of the search engine					6
Overall coverage of the subject matter					6
Appropriateness of the mode/ method chosen for distance learning					6
The usefulness of the content of the search engine					6

All three statements regarding the "DiAPPeat Cafe" section received the highest rating (5) by all six (6) participants. That is, the quality/ usefulness of the DiAPPeat Café, the coverage of the subject, and the usefulness/ content of the section were all very well received and evaluated (Table 4.7).

Table 4.7: Evaluation Section <Chat>, <DiAPPeat Cafe> for people with T1D					
Description	1	2	3	4	5
Quality/ Usefulness of the section <DiAPPeat Cafeteria>					6
Overall coverage of the subject matter					6
The usefulness of the content/ discussions of the section <DiAPPeat Cafe>					6

All the statements regarding the "Logbook" and "Glucose Keeping Records" sections received the highest rating (5) except the first one, the quality/ usefulness of the area, which received a slightly lower rating (Table 4.8).

Table 4.8: Evaluation Section <Logbook> and < Glucose Keeping Records> for people with T1D					
Description	1	2	3	4	5

Quality/ Usefulness of the section <Glucose Keeping Records>				1	5
Overall coverage of the subject matter					6
The usefulness of the content of the section <Glucose Keeping Records>					6

All participants with T1D noted that they have educational needs in all areas mentioned in the various sections of the application. This was evident from the usability testing think-aloud protocol showing limited T1D education in Cyprus. The structured approach to diabetes management seemed unknown to the participants.

The author of this PhD study understands that localised tools could support people with the condition to thrive in their diabetes control. It is evident that structured education, including the multidisciplinary approach, is the answer to diabetes support in Cyprus. By keeping individuals informed and educated, there is a huge opportunity to reduce diabetes complications nationally and improve the quality of life. All participants who had T1D in this study noted that they had educational needs in all areas of diabetes management.

The usability testing think-aloud protocol findings indicated that structured diabetes education in Cyprus is limited, with the structured approach to diabetes management seeming unfamiliar to the participants. This lack of knowledge could compromise their self-management and self-efficacy, necessitating urgent attention from the healthcare system.

The study's findings unequivocally demonstrate that structured diabetes education, including a multidisciplinary approach, is fundamental to diabetes support in Cyprus. By keeping individuals informed and educated, there is a remarkable opportunity to reduce diabetes complications nationwide and improve the quality of life.

The study's findings revealed that all participants diagnosed with T1D acknowledged that HCPs have a pressing need for education in various areas, as mentioned in the different sections of the application.

The possible reason for this unanimous opinion is their negative experience with HCPs in dealing with the individual diabetes complexities and needs faced in their day-to-day life

with diabetes. Furthermore, the author of this study indicated that the participants were receiving the minimum diabetes care in time, which may suggest that the participants do not trust or believe that their HCPs have adequate diabetes knowledge to support them. Hence, they are taking ownership of their diabetes condition.

This ownership requires education and skills that they may lack, but they enter a survival mode as a coping mechanism. The healthcare system stakeholders ought to understand and change these behaviours strategically and structure to support these individuals and their families with a holistic diabetes care model. Such examples exist globally and provide standards to the care processes with improved diabetes outcomes (American Diabetes Association, 2020).

4.3.1.1. Survey on Google Forms: Open Question for people with T1D

This survey tried to find ways to enhance diabetes education skills among adults with T1D in Cyprus. Therefore, participants were asked to provide suggestions on additional topics that could be included in the app. The objective was to cater to the specific educational requirements of individuals with T1D, focusing on empowering them to manage their condition better.

The responses received from the participants were insightful and highlighted several areas of concern. The most common suggestion was to provide more information regarding sexual health, which is an essential aspect of diabetes management that is often overlooked. Participants also expressed a need for guidance on managing insulin pens and pumps in high temperatures, which is particularly relevant in Cyprus, where the weather can be scorching for prolonged periods.

Another concern highlighted by participants was the management of glucose levels during inactivity. Participants requested practical guidance on maintaining glucose levels during rest periods, which is critical to avoid complications associated with high or low blood glucose levels. Additionally, participants identified the significance of sleep and its impact on diabetes management as an area that requires more attention.

Overall, the responses received from the participants reflect the specific concerns of adults with T1D in Cyprus. The feedback regarding the effects of hot weather and recommended actions during high temperatures may indicate the need for a personalised, Nationally structured education programme. It is concerning that despite living in Cyprus for many

years, participants have never had the opportunity to ask such important questions. Ultimately, the results of this survey underscore the need for specific and detailed education for individuals with T1D to empower them to manage their condition better and improve their overall quality of life.

It is worth highlighting that a considerable proportion of individuals (i.e., two out of six) who participated in the T1D group provided feedback indicating that they found the web applications' content satisfactory and no further additions were necessary. This feedback shows that these individuals had a comprehensive understanding of the web applications' structure, functionality, and usability, which rendered additional support or information redundant. It is worth noting, however, that the reasons behind participants' satisfaction and confidence in the web applications are yet to be explored. It is also essential to acknowledge that the remaining participants may have different perspectives and concerns regarding the web applications' usability, which need to be addressed through further investigation. Therefore, future research should aim to explore the factors that contribute to participants' satisfaction with web applications, as well as identify potential areas for improvement to ensure that the applications meet the needs of all users.

The preceding query was formulated to solicit constructive feedback and suggestions for enhancing the content of the DiAPPeat application. The system received three responses, two of which recommended adding a Greek version of the web application, particularly in food search and carbohydrate counting. The other answer recommended transforming the web application into a mHealth application and incorporating an AI-powered chatbot into the system.

During the user testing phase, the participants were informed that a Greek version of the DiAPPeat web application would be made available before its public release in the Republic of Cyprus. The suggestion of an AI-powered chatbot presents an innovative perspective that could offer novel approaches to diabetes management. However, incorporating such a system to provide diabetes-related recommendations and adjustments carries potential risks, such as data privacy concerns and the need for extensive testing and validation.

As the author of this PhD study, I acknowledge the potential benefits of providing the residents of Cyprus with access to DiAPPeat's information to facilitate safe diabetes learning. Nevertheless, I remain cautious and await further evidence from research assessing the effectiveness of “DiAPPeat” to make an informed decision. As such, it is

essential to consider the potential benefits and risks associated with incorporating an AI-powered chatbot into the system, as well as the potential implications of such a feature on data privacy, patient confidentiality, and the overall effectiveness of the DiAPPeat application.

4.3.1.2. Usability Testing with an Element of Researcher Notes for People with T1D

Presenting the results from the usability testing completed by all participants in the study included six scenarios as shown above (see Chapter 3.3.2.1.Remote-moderated Qualitative Usability Testing Procedure). The author of this PhD study will present the results in this section by scenario for people with T1D. The usability testing relevant to HCPs is discussed in the following subheading (4.2.2. Healthcare Professionals). To maintain anonymity, the participants will be presented with the word participant and a number attached. For example, “Participant 1 and Participant 2 mentioned….”

The ***first scenario*** presented to the participants included the following instructions: To register or log in to DiAPPeat, follow these steps. Start by heading to DiAPPeat.com's Welcome page and clicking the register button. Add your contact details, carefully read and agree to the Terms and Conditions and consent form. Enter your participation number, then locate and visit the "Sick Day Rules" application. Once there, read the information and complete the quiz. Check the dashboard to see the latest updates. When you're finished, you can sign out from the home page. If you forget your password, visit the password recovery page to reset it.

Participant 1

Participant 1 demonstrated exceptional proficiency when utilising the web application's register, login, and forgot password functionalities. The procedure transpired seamlessly, without any disruptions, and the participant displayed high confidence while navigating through the application to carry out the designated tasks. The feedback provided by the participant was overwhelmingly positive, and the individual was forthcoming with oral feedback and screen sharing. Remarkably, the participant could identify key navigation points quickly and accomplish the tasks efficiently, even though it was his initial interaction with the web application. Moving forward, the participant effectively conveyed the candidate identification number discovered on the dashboard of the web-based application.

Navigating the web application was reported to be an effortless and enjoyable experience. The DiAPPeat Academy, in particular, was perceived as a familiar location that was easily accessible owing to its simple and user-friendly navigation system.

The user expressed verbally how he liked the application, including the " Managing your illness Sick day rules", and started the algorithm effortlessly and confidently. While using this algorithm, this participant repeated how good the tool was several times. The participant was excited about the web application and expressed his feelings with the phrase, " I don't feel alone; I don't!".

The participant continued to explain that he agreed with what was suggested because he had used it in the past without knowing the evidence to develop it, and it worked. The user felt he could manage his diabetes and life quickly and from home. He continued that he would need the doctor to support the task of dealing with unwell, but this tool is the way to stop people from needing medical attention earlier, and "I can see it preventing me from going to the hospital. It is a tool to use when you are anxious about managing your illness. The participant continued, " I am impressed, wow!". This participant quickly understood the concept and could explain it to the facilitator using the teach-back technique.

The participant was asked to navigate to the dashboard and was happy to see his name written. I sensed the participant felt welcomed by the web application with this touch of individualisation. He mentioned, "It's cool, it's so cool".

Participant 2

The navigational experience observed during the registration, login, and password recovery process was exemplary for Participant 2. The participant exhibited swift movement between various options, indicating a high level of proficiency in utilising the system's interface.

The candidate initially stated that he had failed to create a new password. However, it can be deduced from the available evidence that the participant clearly understood the requisite procedure for forming the password, albeit having failed to implement it in practice. Navigating to the next task was easy, and the researcher communicated the candidate ID. The participant found the DiAPPeat Academy easy to find.

Accessing the Applications for the "Managing your illness Sick day rules" tool, the participant expressed that he liked the description of the tool very much. The participant was keen to start using the Sick Day rules tool and informed me that he started using the

algorithm immediately. After this comment, the facilitator directed the participant to continue the test with the measurements of the already prepared scenario.

After completing the scenario, the participant wore an insulin pump and was keen to do the process with his settings. He mentioned how easy and relieving it is to have something like this to support you on your sick days. The participant said, " That's indeed a good tool".

Participant 3

Similarly to the previous participants, Participant 3 quickly registered or logged in to DiAPPeat, following the steps described by the facilitator of the online usability testing. Participant 3 entered the DiAPPeat.com website and proceeded with the described steps in the first scenario. The participant found the initial page very welcoming, and the colours left the participant with the desire to start and complete the learning. The contact details section was completed successfully according to the instructions. Then, Participant 3 accessed the "Sick Day Rules" application and completed the algorithm. Participant 3 disliked that the progress bar was unstable and that positions were changing on the screen at every step. The recommendation from Participant 3 is to have the progress bar stable on the top of the screen. Participant sheck the dashboard to see the latest updates. When you're finished, you can sign out from the home page. If you forget your password, visit the password recovery page to reset it.

Participant 4

In accordance with the prescribed protocol, proficiently carried out the assigned tasks, paying close attention to detail and ensuring accuracy in every step. Participant 4, without requiring any guidance or clarification, completed the "Sick Day Rules" application, demonstrating a high level of competence and familiarity with the system. It is worth noting that Participant 4 expressed a great deal of satisfaction with the application's exceptional performance and functionality, specifically highlighting its user-friendly interface and intuitive design. Overall, the experience was highly successful, and the results indicated the effectiveness of the "Sick Day Rules" application in facilitating smooth and efficient workflows.

Participant 5

During the scenario, Participant 5 demonstrated impressive navigational skills in using the web application. The participant completed the assigned tasks effortlessly, suggesting familiarity with the platform. Upon completion, Participant 5 expressed a strong

willingness to use the application immediately, indicating high satisfaction with the overall user experience.

What is particularly noteworthy is the participant's glowing feedback about the web application's features. Participant 5 stated, "I have no words to describe the web application. It is a special tool, and I have never seen anything like it." Such feedback indicates that the web application has unique features that stand out from other tools the participant has used, which could suggest a competitive advantage in the market.

Additionally, the participant underlines the application's utility and helpfulness, further underscoring the perceived value of the tool. Participant 5's positive feedback provides valuable insights into the potential of the web application to meet users' needs and deliver valuable support. This feedback could refine the application further, building upon its strengths and addressing any limitations.

Participant 6

During the user testing of a diabetes care technology, it was observed that Participant 6 exhibited resistance towards learning or adopting new technology. The participant even remarked that the technology was meant for the new generation. Evidently, the individual required assistance from a family member to navigate the first scenario and the web application in general. However, as the user testing progressed with the think-aloud protocol, the participant expressed more interest in learning about the technology. Upon completing the first scenario, Participant 6 emphasised that acquiring new knowledge can lead to feelings of stress and anxiety. It is possible that this apprehension is related to the participant's age and may require repetitive exposure to the system to gain a better understanding.

The instructions for the *second scenario* presented to the participants were as follows: To access the *Eating scenario* on DiAPPeat.com, one must first log in using the provided login details. After logging in successfully, the user must navigate to the "EAT" option from the four coloured squared menus. Subsequently, the "Skill Checklist" tab must be accessed to ascertain which learning objectives have been completed and which are yet to be completed. Next, the user should click the "e-Learning" tab and access the "Carbohydrate Counting Level 1" learning module. The user should proceed with the module until its completion and locate the means to view it. Once the learning material has been assimilated, the user should consider the information presented and complete the quiz. Finally, the user must sign out to conclude the scenario.

Participant 1

During the usability testing, Participant 1 displayed remarkable proficiency in navigating to the Eating section of the website, demonstrating a clear understanding of the layout and organisation of the site. However, the individual appeared to encounter some confusion regarding the checklist feature, which led to a moment of hesitation before clicking on it.

Upon further examination, it became clear that the participant was unsure about the purpose of the checklist and whether it was a required step in the process. This hesitation was likely due to a lack of clarity in the instructions or labelling of the feature.

After the purpose of the checklist was clarified, the participant was able to proceed swiftly to the e-learning section and select the desired presentation without any further issues. Overall, this incident highlights the importance of clear labelling and instructions and the need for thorough usability testing to identify and address potential usability issues.

Participant 2

Participant 2 demonstrated exceptional proficiency in navigating directions with impressive speed and accuracy during the task. His level of comprehension was notable, as they could easily interpret and follow the directions. The directions provided were found to be comprehensive, including all necessary details and steps, which greatly facilitated the participant's navigation. They could quickly identify the correct path and complete the task successfully. Participant 2 exhibited high skill and competence in navigating the provided directions.

Participant 3

The feedback received on the presentations has been overwhelmingly positive. Not only are they visually appealing, but they are also designed to be easily understandable, resulting in a delightful experience for the reader. Participant 3 expressed his excitement over the information presented and found the e-learning platform intuitive to navigate, thanks to its simple submit feature. The use of shapes, colours, and arrows in the presentations stood out to them, and they were particularly impressed by the high-quality production and intricate design of the slides. Overall, the presentations have been well-received, and the positive feedback is a testament to the hard work and dedication put into their creation.

Participant 4

Participant 4 demonstrated an exceptional ability to comprehend and execute the experimental protocol with remarkable speed and proficiency. The participant's prompt and accurate responses to the task prompts suggest an impressive understanding and familiarity. Moreover, the participant displayed noteworthy efficiency and precision, completing the tasks with remarkable enthusiasm and without noticeable delays or hesitations.

Notably, Participant 4 provided highly positive feedback regarding the usability of DiAPPeat, highlighting the user-friendly nature of the platform and its ease of use. The participant expressed satisfaction with the straightforward nature of the process, indicating that the protocol was easy to follow and comprehend. Such positive feedback indicates a positive user experience and suggests that DiAPPeat is an effective and user-friendly platform.

Participant 5

The participant displayed remarkable proficiency in navigating the slides, smoothly transitioning from one slide to another without experiencing any hindrances. The individual also demonstrated a keen interest in the subject matter, specifically in the detailed presentation of carbohydrate counting. Participant 5 appeared to be actively engaged throughout the presentation, asking pertinent questions and providing insightful comments.

Moreover, the participant's enthusiasm for the app was unmistakable and infectious. He strongly desired to learn more about its features and functionalities and was particularly impressed with its user-friendly interface. The individual repeatedly reiterated his satisfaction with the app, emphasising that it was the perfect tool for managing carbohydrate intake. In light of these observations, it can be concluded that the participant's experience with the app was overwhelmingly positive, and they expressed a strong inclination towards using it in the future.

Participant 6

Throughout the scenario, Participant 6 exhibited a discernible improvement in their comprehension of the system and appeared more at ease than in the earlier stages. In particular, it was noted that Participant 6 expressed a desire to participate in the scenario with at least one family member present. Upon further exploration, it was revealed that Participant 6 held the belief that the latest technologies and knowledge regarding diabetes management were primarily intended for younger individuals and those who have been

recently diagnosed with T1D. However, despite this perspective, it was uncertain whether Participant 6 fully appreciated the potential benefits of receiving updated education on diabetes management. Further probing is necessary to understand better Participant 6's perspectives and attitudes towards diabetes education and management.

The instructions to the participants for the *third scenario* were as follows: Scenario 3 involves searching for food on DiAPPeat.com. Firstly, you must go to the website and click the login button. Your login details are available for you to use. After logging in, you can use the four-coloured squared menus or the left-side menu to navigate to the "Food Search" section. Once there, you should enter the current carb ratio as 10 grams/unit and find the carbohydrate value of a Cypriot food, such as Fried Poulles. Additionally, you must determine the protein content in 250 grams of the chosen food and decide how much you want to eat. Finally, sign out of your account before closing the website.

Participant 1

Participant 1 adeptly navigated to the designated section and confidently undertook the given task. The clear and comprehensive task description enabled the participant to comprehend and execute the task efficiently. The participant followed the instructions and completed the task. Participants required some time to consider the information below about the extended bolus advice and the closed-loop systems.

Participant 2

Participant 2 could easily find the food search and quickly commenced searching for Cypriot food as directed. The participant commented positively, "Oh, when you start typing the word, all the options appear below as a list!". Following a successful attempt to document a Cypriot meal, the participant modified the gram measurements per the instructions. The participant fully understood and appreciated the dual insulin advice from the result section and related this to his daily needs.

Participant 3

During the study, Participant 3 successfully completed the "Food search" scenario by following the provided instructions with utmost efficiency. The participant expressed a highly positive outlook on the tool, as he found it immensely helpful and supportive regarding carbohydrate counting. Participant 3 mentioned that the tool's extended bolus advice benefited them, given their use of insulin pump therapy.

The participant also shared his tendency to avoid consuming foods that do not have proper labelling, as it proves to be challenging to calculate the carbohydrates accurately. However, including such foods in the Food Search tool's database has been a significant relief for the participant, as it has eased the process of carbohydrate calculation, allowing him to consume foods they previously avoided.
Furthermore, Participant 3 expressed his appreciation for the tool's effectiveness, mentioning that they were highly impressed by the vast database of Cypriot foods included in the tool. The participant also commended the inclusion of certain Greek foods that have previously posed challenges in carbohydrate counting.

These findings suggest that the Food Search tool has immense potential to be an invaluable resource for individuals managing their carbohydrate intake. The tool's extended bolus advice can particularly benefit those utilising insulin pump therapy. Additionally, including previously avoided foods in the tool's database can significantly ease the process of carbohydrate calculation, allowing individuals to consume a wider variety of foods with confidence. Overall, the Food Search tool appears to be a promising solution for people with diabetes who wish to manage their carbohydrate intake efficiently.

Participant 4
Upon completing the scenario, Participant 4 stood out as a remarkable performer, completing the task with impressive speed. During the usability testing of the "Food Search" application, Participant 4 expressed great admiration for its design, explicitly highlighting the helpful prompts to guide users through the process. Participant 4 went so far as to describe the app as "perfect".
During his search, Participant 4 demonstrated an interest in exploring traditional Cypriot cuisine and looked up a dish called Trahana. This dish often served as a soup, is known for its challenging preparation process and potential to affect glucose readings. It is noteworthy that Participant 4 found information on this specific dish, as it speaks to the effectiveness of the search functionality within the app.

Participant 5

During the usability testing of the web application's "Food Search" feature, Participant 5's remarkable effectiveness, efficiency, and speed in carrying out the task was observed. The testing of this section involved employing diverse methods to ensure that the feature is user-friendly and robust.

After completing the search, Participant 5 expressed ease in navigating the tool and modifying search parameters. He also showed interest in utilising the "Food Search" feature for diabetes management, potentially benefiting a larger population.

However, it's important to note that our web application is still in the testing phase and has not yet been licensed for human use. While we strive to make it as user-friendly and reliable as possible, we must ensure it meets all the necessary standards before making it available to the public.

Participant 6

During the Usability Testing, the author observed that Participant 6 initially appeared hesitant and unsure about their willingness to continue the study. However, as the participant progressed through the task scenarios, their interest in the web application gradually increased. This was particularly evident when Participant 6 reached the Food Search feature, as they became visibly more engaged and curious about the potential benefits of using the web application.

It is worth noting that Participant 6's interest in the Food Search feature was likely because it contained a wide variety of both Cypriot and international food options. This would have particularly appealed to the participant, as they may have struggled to find suitable food options to manage their diabetes. As such, the Food Search feature represented a valuable and effective tool for Participant 6 to help manage their diabetes.

Overall, the author observes that Participant 6's initial hesitation to continue with the Usability Testing was overcome by their growing interest in the web application throughout the study. The Food Search feature, in particular, appeared to be a critical factor in this, as it provided the participant with a highly effective tool for managing their diabetes through access to a wide variety of suitable food options.

The instructions to the participants for the *fourth scenario* were as follows: First, navigate to the Welcome | DiAPPeat.com page and click on the login button. The user's login credentials are provided to access the site. After logging in, navigate to the “DiAPPeat Cafe” section from the left-side menu and select the topic “DiAPPeat Café”. To introduce oneself, write “Hello everyone, I am new here” and post it. The user should then observe and analyse the response. In case of any query regarding the “Applications” section, the user is advised to select the Applications discussion. Here, the user can post a message about using the sick day rules tool. After posting the query, the user should observe and analyse the response. Sign out

Participant 1

During the given scenario, Participant 1 displayed a high level of proficiency by skilfully navigating through it and showcasing a well-rounded understanding of the requested concept. His approach was methodical yet efficient, and he could efficiently complete the task while demonstrating an excellent knowledge of the underlying principles. Participant 1's performance was impressive, and his mastery of the concept was evident throughout the scenario.

Participant 2

During the usability test, Participant 2 demonstrated an impressive level of navigational proficiency. With ease, he accessed the DiAPPeat Café section on the web application. Their swift task completion was exceptional and resulted in a highly favourable outcome. Overall, Participant 2 showcased a remarkable ability to navigate the web application with efficiency and ease.

Participant 3

In the scenario provided, Participant 3 demonstrated an exceptional performance by flawlessly executing the facilitator's instructions. His remarkable results were a testament to their dedication and focus. During the session, Participant 3 expressed his appreciation for the Café philosophy, which offers a refreshing and innovative viewpoint on the subject matter. Unlike a traditional forum, he found the concept of a café particularly appealing.

Throughout the exercise, Participant 3 found the posting process straightforward. However, they suggested it would benefit end-users and administrators if each message was responded to within the corresponding topic. This would ensure that discussions remain organised and streamlined and that any questions or concerns are addressed promptly. Participant 3's participation and feedback were valuable contributions to the session and demonstrated their commitment to achieving optimal results.

Participant 4

The study results revealed that Participant 4 found the "DiAPPeat Café" to be an easy-to-use platform and could complete the given scenario quickly. This suggests that the usability of such online tools plays a crucial role in the engagement and satisfaction of individuals with T1D. Furthermore, the study highlights the importance of social interaction and communication among people with T1D for effective diabetes management. By allowing individuals to connect with others who share similar

experiences, online platforms like "DiAPPeat Café" can contribute to better diabetes self-management and improved overall health outcomes.

Participant 5

As part of the usability testing of the web application, Participant 5 provided specific feedback regarding the "DiAPPeat Café" feature. The participant described this feature as highly user-friendly, easy to use, with a clear and intuitive interface. Notably, Participant 5 expressed appreciation for the social interaction aspect of the "DiAPPeat Café" feature, which allows users to connect with other individuals with T1D and HCPs. During the fourth scenario of the testing, Participant 5 was observed to have posted a question and remarked, "It's so good", indicating high satisfaction with the feature.

This feedback suggests that the "DiAPPeat Café" feature has the potential to significantly enhance user engagement and satisfaction within the context of the web application. Also, Participant 5 provided constructive feedback that suggested the creation of a catalogue feature. The feature would incorporate a frequently asked questions (FAQs) section that would be readily available to all participants.

The primary objective of this feature is to provide participants with a comprehensive list of pre-existing answers to commonly asked questions, thereby reducing the number of questions posted on the "DiAPPeat Café". Participants can quickly and efficiently search for relevant information by providing a detailed catalogue before posting their queries. The feature is expected to reduce the time participants wait for responses to their queries, improving their overall experience on the platform.

Participant 6

During the fourth scenario of the study, it was observed that Participant 6 went through the scenario in the company of a family member. This approach resulted in a more comprehensive understanding of the web application. Upon providing feedback, Participant 6 expressed positive sentiments regarding the potential of the Diabetes Café platform. The participant noted that the platform could benefit individuals who have questions or uncertainties surrounding diabetes and require support.

Additionally, the participant emphasised that the platform could be handy for individuals new to the disease who have yet to develop a profound understanding of the subject matter. The study's findings suggest that including a support system, such as a family member, could enhance participants' knowledge of the web application and its potential benefits. In

the fourth scenario of the study, it was observed that Participant 6 underwent the scenario alongside a family member, which led to a better understanding of the web application.

The feedback provided by Participant 6 was affirmative, acknowledging the potential of Diabetes Café to provide a platform for individuals with queries to feel accepted and supported. The participant further noted that the platform could be instrumental for individuals new to the disease and lacking a profound understanding of the subject matter.

The instructions to the participants for the *fifth scenario* were as follows: To access the DiAPPeat logbook, go to the website Welcome | DiAPPeat.com and click on the login button. Enter your login credentials and proceed to the dashboard. From there, create a DiAPPeat logbook and make two entries individually, following the instructions provided by the facilitator about the readings. Once you have completed the entries, save them and take a moment to describe what you see. Additionally, locate the study records and explain what you observe. Finally, sign out of the website to ensure the security of your information.

Participant 1

Participant 1 accessed the DiAPPeat logbook for the fifth scenario by navigating to the website 'Welcome | DiAPPeat.com' and clicking on the clearly labelled login button. Upon doing so, the participant was seamlessly redirected to a login page where he was prompted to enter his unique login credentials. Once logged in, Participant 1 was directed to the dashboard to quickly create a DiAPPeat logbook by following the step-by-step instructions.

The participant found the information requested on the form relevant and appropriate for the DiAPPeat Logbook tool designed for people with T1D to collect and share data with their healthcare providers. The participant appreciated the level of detail required as it allowed for a comprehensive record of his diabetes management.

Furthermore, Participant 1 could easily locate the study records, which was reassuring as it confirmed the legitimacy of the tool and the research being conducted. Finally, the participant could log off without any issues, demonstrating a high level of usability and user-friendliness of the website.

Participant 2

During the task, Participant 2 demonstrated exceptional performance while extolling the virtues of the logbook as a highly effective tool for diabetes management. The logbook's significance in diabetes management stems from its ability to enable users to add records retrospectively, which can be invaluable in evaluating patterns and reviewing settings later. This feature allows users to record blood glucose levels, insulin doses, and other relevant information daily, creating a comprehensive record of his diabetes management over time.

Moreover, the logbook's retrospective recording feature is precious for diabetes management, as it facilitates a more complete understanding of the patient's condition and assists in making informed decisions about treatment and lifestyle adjustments. The logbook can also be used to identify trends in blood glucose levels, detect patterns in medication efficacy, and provide insight into the impact of diet and exercise on blood sugar levels.

Overall, Participant 2's performance during the task underscored the importance of the logbook as a vital tool for diabetes management, emphasising its capacity to enable users to take control of their health and make informed decisions about his treatment.

Participant 3

During the evaluation of the DiAPPeat Logbook, the participant appreciated the supportive comments provided in the result section, which offered advice or encouragement based on their glucose levels. For instance, when the glucose reading was within range, the message displayed was, "Congratulations, your BG is in range. Keep up the good work". However, Participant 3 noticed some design-related issues with the logbook. Specifically, they pointed out that the text in the table appeared too cramped, and the graph section was excessively elongated.

To address this, the participant recommended shortening the graph section and increasing the width of other boxes. Additionally, he suggested including an option for a summary of glucose levels over time. Participant 1 also provided feedback indicating that the line thickness for dividing the day on the logbook presentation page should be increased. Overall, these suggestions and feedback will help improve the user experience of the DiAPPeat Logbook.

Participant 4

Participant 4's feedback on the DiAPPeat Logbook scenario was resoundingly positive. The Logbook effectively gathered and presented relevant information that not only

individuals with T1D but also HCPs could access. By providing access to a comprehensive range of data, the Logbook could help individuals with T1D make more informed decisions about his care, allowing HCPs to understand his patients' needs better and develop more personalised treatment plans. This approach has the potential to significantly enhance the quality of care provided to patients with T1D, ultimately leading to better health outcomes and improved quality of life.

Participant 5

Participant 5 provided insightful feedback regarding his experience with the DiAPPeat logbook form. He expressed that adding information to the form was seamless, indicating that the form's design was user-friendly and intuitive. Additionally, the participant stated that the requested information was highly relevant to diabetes management, highlighting the importance of capturing specific data points for effective disease management.

The participant also provided detailed feedback on their ease of inputting values into the form. They noted that the process was straightforward, and he could add relevant information without experiencing any difficulty. Furthermore, the participant expressed his opinion on the usefulness of the data collected from the form in his day-to-day life with diabetes, highlighting how the data could help them better manage their condition. They emphasised the importance of HCPs accessing this information, which could ultimately lead to more effective care and better patient health outcomes.

Finally, the participant mentioned that they appreciated using graphs and colours in the form's design. These features helped them visualise his data more meaningfully, making it easier to track his progress over time. Overall, Participant 5's feedback provides valuable insights into the effectiveness of the DiAPPeat logbook form in supporting individuals with diabetes in managing their condition.

Participant 6

During the fifth scenario, Participant 6 demonstrated a high level of engagement, interacting with both the family member and the facilitator. The participant showed a keen interest in exploring the web application and was enthusiastic about adding value to the scenario example, which led to a more positive and open dialogue about their concerns.

While the participant preferred the DiAPPeat Logbook and its features, they were reluctant to input their blood glucose readings during the usability testing session. When asked why, the participant mentioned he had a busy schedule and needed more time to dedicate to the

logbook. However, the participant's willingness to engage with the web application and explore its features indicated a growing interest in the product and its potential benefits.

The instructions to the participants for the *sixth scenario* were as follows: The following instructions outline the necessary steps for successful DiAPPeat operations. To begin, navigate the Welcome | DiAPPeat.com website and click the login button, ensuring your login details are on hand. Once logged in, view the guide video to learn more about the platform. From there, access the dashboard, modify the job description field to reflect an "Unemployed" status, and ensure the changes are saved. Next, locate the study progress section of the dashboard, open the initial assessment, and complete the evaluation according to the readings provided in a prepared form data form. After submitting the evaluation, it is essential to save the entries and locate the candidate number by logging out before finalising this process.

Participant 1

During scenario six, Participant 1 demonstrated a remarkable ability to navigate the instructions easily and proficiently. The participant meticulously entered the required values into the form, showcasing high accuracy and attention to detail. The process was deemed highly transparent and understandable in the participant's feedback, with clear guidance provided at each step. Furthermore, the participant recognised the value of a comprehensive and representative presentation of data, emphasising the significance of effective data collection and management practices. This underscores the importance of utilising sophisticated data management strategies to generate meaningful insights and outcomes. Ultimately, Participant 1's performance exemplified the benefits of leveraging best-in-class processes and technologies to achieve optimal outcomes while ensuring superior efficiency and effectiveness.

Participant 2

Participant 2's performance during the task was impressive and noteworthy, as he expertly navigated the form and demonstrated a keen understanding of its effectiveness and appropriateness for its intended use. The tool in question is a valuable asset in healthcare, allowing users to enter and track their health data. This feature is crucial as it enables patients to record their medical history, which can be shared with their clinician for better diagnosis and treatment.

Furthermore, the tool's capacity to enable users to add records is particularly beneficial as it allows for data collection over time, facilitating the identification of trends and patterns in patient health. Sharing the captured data with the clinician provides a more collaborative approach to healthcare, leading to improved treatment outcomes.

Overall, the tool's tracking feature is essential in effectively managing patient data, which ultimately translates to better quality of care. Participant 2's positive experience with the tool further highlights its potential as a valuable tool in healthcare settings.

Participant 3

Participant 3 demonstrated proficiency in completing the sixth scenario by following the instructions. The participant expressed enthusiasm for the proposed web application to raise awareness about hypoglycaemia levels among individuals with T1D. The participant found the application to be an incredible idea as it would help people with T1D understand the awareness levels of hypoglycaemia, which can be life-threatening at times.

The participant also found the diabetes distress questionnaire to be a practical tool that could help monitor diabetes-related distress levels. The feedback provided by the participant was upbeat and optimistic about the information provided, highlighting its user-friendliness, ease of use, and accessibility on both phone and web versions. The participant also commended the developers' efforts to create a functional and valuable tool for people with T1D.

Participant 4

Participant 4 has proficiently executed the operational scenario in question. The participant's grasp of the conceptual framework of the application is noteworthy, as evidenced by the ease with which he completed the task. This proficiency attests to the application's user-friendliness and the clarity of information provided, indicating its potential to serve as a valuable tool in the academic sphere. The participant's skilful handling of the application underscores its usability and intuitive design, which could contribute significantly to enhancing the user experience. Overall, Participant 4's successful completion of the operational scenario reinforces the application's potential to facilitate academic endeavours by providing a seamless and user-friendly experience.

Participant 5

Participant 5 was tasked with executing the sixth scenario and completing all the assigned tasks as part of the study. The participant demonstrated high proficiency in performing the

tasks easily and accurately. Upon completion, Participant 5's perspective of the tasks was similar to that of the other participants, indicating a shared understanding of the web application's functionality.

Participant 5 expressed satisfaction with the web application's ease of use and usefulness, noting that the web application was straightforward and intuitive to navigate. The participant also highlighted the satisfaction derived from practising the actual web application, indicating that the web application was an effective tool for enhancing user engagement and interaction.

These findings provide valuable insights into the effectiveness of the web application in facilitating user engagement and interaction. The study suggests that the web application's user-friendly design and intuitive interface could be crucial in enhancing user satisfaction and engagement. Furthermore, the study highlights the need for continued research in web application design and development to optimise the user experience and promote user engagement and interaction.

Participant 6

During the sixth scenario of the study, Participant 6 was assisted by a family member who supported them with a laptop for the online assessment. Despite the assistance, the participant encountered some difficulties navigating the web application. However, it is noteworthy that the feedback received from the participants was neutral, with no negative comments about the assessment process or the content of the form completed.

4.3.1.3. Structured questions and Researcher Notes for people with T1D

This section includes the results derived from the structured questions of the relevant questionnaire and the researcher notes, discussed in sections 3.3.2.3 and 3.3.2.4. The author presents the information below and captures each participant's views accurately.

Participant 1

During the user testing, he started commenting about how pleasant, smooth and engaging colours the web applications were. In response to a presentation focused on diabetes and well-being, the participant aptly underscored the importance of incorporating such information into the pedagogy of the DiAPPeat app. The participant elucidated that he

found the content relatable and further expressed his conviction that his concerns were often undervalued during consultations with diabetes consultants.

During the session, the participant engaged in a discourse on the various levels of carbohydrate counting. Specifically, the inquiry pertained to the distinctions between the levels of carbohydrate counting and their primary differences. The participant sincerely appreciated the tool, citing its comprehensiveness, pragmatic applicability, and interactive nature. In particular, it was observed that the tool provides theoretical grounding and practical examples that facilitate better comprehension. Furthermore, the tool allows for applying knowledge to address critical queries at the opportune moment. The participant cited several useful features of the tool in managing blood glucose levels beyond the normal range, including the hypoglycaemia e-learning workshop, sick day rules, and hyperglycaemia treatment.

The participant has expressed notable enthusiasm regarding the "Travelling with Diabetes" e-learning program, which he perceives as a crucial topic that necessitates assistance for individuals with diabetes. The participant further explained that the intricacies of managing diabetes while travelling are multifarious and necessitate careful consideration of numerous variables and factors.

Another helpful topic is pregnancy. This is useful because it provides general advice before, during and after the pregnancy. The essential factors are during pregnancy, after pregnancy, and unplanned pregnancy. The participant picked up the positive message on the slide that “most women with diabetes have a healthy baby”, “Oh my god, it is so interesting, I will read it, I will read it, it is such a helpful tool”.

Participant 2

Upon completing the DiAPPeat web application presentation, the participant responded enthusiastically, "It is perfect!" This response indicates the participant's high level of approval and suggests that the application met or exceeded his expectations. Further analysis of the participant's feedback and engagement during the presentation could provide valuable insights into the specific features and functionalities that were particularly well-received and could inform future development and marketing strategies for the application.

Participant 3

The study evaluated the participant's feedback on the DiAPPeat web application, which aims to provide e-learning opportunities about diabetes. The participant found the web application welcoming and engaging, wanting to stay and continue exploring its contents. The variety of presentation modes, such as animations, videos, and podcasts, was praised, with the participant characterising the web application as "fantastic." Additionally, the participant suggested that the presentations could be printed or displayed electronically in diabetes clinics, such as waiting areas, for easy accessibility.

The feedback from Participant 3 was equally positive, with the participant commending the catchy presentations and interaction of the web application. The recipe of the month section received excellent feedback, with Participant 3 expressing admiration for the multiagency approach. Participant 3 also believed in the project's value, calling it fascinating and praising the charming images and comic-style presentations. The participant appreciated the convenience of having the application accessible on his phone and saw no issues with its use by individuals of different age groups. Moreover, Participant 3 noted the web application's potential as a tool for individuals with diabetes and their caregivers, as it could provide clarity and guidance during illness.

Participant 4

Participant 4 had a highly favourable reaction to the DiAPPeat web application after receiving a detailed demonstration. Specifically, Participant 4 strongly preferred the web application's usability for newly diagnosed individuals, stating that it should be considered the "Driving Licence for diabetics". Participant 4 explained that the application's e-learning component and other features offer a complete and informative education that can support individuals and their families manage their day-to-day lives with diabetes. Participant 4 was highly impressed with the content and structure of the application, remarking, "I find it very good; it seems that everything you need is there".

Moreover, Participant 4 suggested that the government should provide this web application as a mobile health application for everyone with T1D. Participant 4 characterised DiAPPeat as a "Multitool" with the potential to be used not only by adults but also by parents with children who have T1D, particularly during the difficult period of diagnosis.

Furthermore, Participant 4 emphasised the importance of the online material provided by the web application, noting that they are similar to those required for obtaining a driving license. Participant 4 went so far as to suggest that attendance should be mandatory for all individuals with T1D. Following the demonstration, Participant 4 rated the DiAPPeat web

application with a high score and provided specific recommendations for improvement. For example, Participant 4 recommended adding an AI chatbot to support individuals in treating hypoglycaemia. Additionally, Participant 4 suggested reducing the amount of text containing hidden information. Finally, Participant 4 praised the high quality of the web application and acknowledged the significant effort that went into its development.

Participant 5

The participant's five initial responses were overwhelmingly positive during the web application presentation. When asked to describe his impressions of the application, the participant said it was exciting and excellent. He went on to explain that he could envision the application being of significant value to individuals who have recently received a diagnosis of T1D, as well as those more experienced in managing his condition.

In particular, the participant noted that the application could serve as an opportunity for individuals with T1D to communicate and share their experiences and concerns with others. He expressed optimism that this could lead to a supportive community where individuals could freely ask questions and receive support from others going through similar experiences.

Overall, the participant's five feedback on the web application was highly positive. He expressed their belief that the application could be a valuable resource for individuals with T1D, providing support and helping them manage their condition more effectively. The participant concluded his interview by stating that he was impressed with the application and had nothing further to add. These findings suggest that the web application has significant potential to improve the lives of individuals with T1D.

Participant 5 mentioned that the web application, in general, is a very clever and convenient tool. It is good that the primary language of the web application is English. The participant believes that for Cyprus, it would be more beneficial to have the web application available in the Greek language to breed the usability and the adaptability of the DiAPPeat application to a broader range of people with T1D. The author understands the important role of the language is such a development and its significance in usability (Sharma et al., 2022).

The participant found the web application very detailed, obvious, and self-explanatory. The participant was very positive about using the web application and specifically mentioned, "I am so excited that I can simply post a question to my diabetes daily questions and receive an answer this way! I feel that this can support people in learning from the

DiAPPeat Café and communicating with other people with T1D". The participant continues to say, "Everything that I was saying through the usability testing. I can see an important value of having access to the tools to support you for the carbohydrate counting by adding the specific grams and receiving the value to use immediately".

Also, participant 5 mentioned, "I liked the recipe of the month supplement because this can help you to find new ideas and experiment with your food options; it is beneficial to the point that I want to go and add my food to see the nutritional analysis of my meal". Furthermore, participant 5 continued saying that, being 22 years old, she cannot know all the carbohydrate values of the meals he eats by heart. This application will support individuals in finding the carbohydrate values to count accurately the values in their meals.

Participant 6

Initially, Participant 6 made the author sense the resistance towards learning or adopting something new to his diabetes care. The individual asked for help from a family member because he considered himself unable to deal with the first scenario. This contradicts the comment of the participant who accepted the recommendation from his clinician to commence the insulin pump therapy. While the user testing with the think-aloud protocol was in progress, the participant got more interested and wanted to learn more about it. Furthermore, the individual thought of “leaving this technology” to the new generation or a newly diagnosed person with T1D. The participant was more engaged in topics such as “Cypriot Food Search”, the carbohydrate counting level one to four, the logbook, the learning about hypoglycaemia, “Managing your illness (Sick day rules)”, and recipes.

Specifically, the person expressed the desire to continue his diabetes education. However, some features of the web application DiAPPeat could support her in answering some diabetes-related questions using perhaps the “DiAPPeat Café”. When the researcher requested a diabetes question to be made as a post to the “DiAPPeat Café”, the question that was given was related to a personal question. This participant did not have the opportunity to raise it with his diabetes consultant. The individual with diabetes was shocked when the author revealed that in other countries, such as the United Kingdom, blood ketones are checked when the glucose/ blood glucose levels are higher than 250 mg/dl. Although the participant recognised the necessity of using the ketone meter, it seemed something uncomfortable and disturbing to use. When the guidelines were discussed, blood glucose and ketones were recommended to be checked every two hours until the ketones resolved. The participant admitted that the ketones were never studied in

his entire life, but he recognised the importance of having to check ketones during illness. The participant felt overwhelmed by the thought of using the application independently, as the author understands that the participant feels technologically illiterate.

Positive comments were received when the participant realised there were questionnaires to identify the hypoglycaemia awareness and diabetes distress on the assessment form. The individual mentioned that no HCP ever cared about the psychological aspect of diabetes. However, it has been reported that the doctors never asked for hypoglycaemia awareness in the clinic until after he presented with severe hypoglycaemic episodes. In addition, the participant likes having the information about hypoglycaemia awareness and diabetes distress collected and presented to the HCPs to enable people with diabetes to receive support in these areas without further delays. Participant 6 made no comments about the colours or the automation of the system. In addition, participants did not comment on the animations and videos of the tool even after the prompt and encouragement to share as many thoughts as possible. The session ran relatively smoothly, and the author had no issues navigating the web application. He felt that he could trust the web application to give information, although this person commented that he fears making changes.

4.3.2. Healthcare Professionals

The survey with the HCPs starts the same way as those with T1D. The questionnaire for HCPs begins using the established and well-known System Usability Scale (SUS) - Technology Acceptance Model (Davis, 1989). The Model consists of 10 questions with a 1 (low) to 5 (high) Likert scale. Overall, the application was very well received and evaluated by three of the HCPs. The app was found to be easy to learn and used confidently. Three others found the system without inconsistencies, not cumbersome and without a need to learn many things to use the system. Comparing the opinions of the HCPs with those of the participants with T1D, it can be underlined and strongly proposed that the professionals are more confident about the value of the application and its usage by both the persons with T1D and themselves. The author believes that the professionals have heard or read somewhere about the design and development of such applications. Indeed, such valuable applications and tools can assist them in their everyday contact with persons with diabetes and will be an essential tool for diabetes self-management in the short and long run (Table 4.9).

Table 4.9: Healthcare Professionals - 10-System Usability Scale (SUS)					
Description	1	2	3	4	5

I think that I would like to use the system frequently.				1	6
I found the system unnecessarily complex	6		1		
I thought the system was easy to use					7
I think that I would need the support of a technical person to be able to use the system	6	1			
I found that the various functions in this system were well-integrated.				1	6
I thought there was too much inconsistency in this system	7				
I imagine most people would learn to use this system very quickly.					7
I found the system very cumbersome to use	7				
I felt confident using the system.					7
I needed to learn a lot of things before I could get going with the system	6				1

The answers of HCPs below align with the attractiveness and usability noted with their answers in the next set of statements. The high rating given to all comments by HCPs shows their confidence in these types of web applications for all users (Table 4.10).

Table 4.10: Healthcare Professionals -The Technology Acceptance Model (TAM)

Description	1	2	3	4	5	6	7
The DiAPPeat web application enables me to accomplish tasks more quickly than other products in its class.						2	5

The DiAPPeat web application improves my job performance in treating people with T1D.							7
Using the DiAPPeat web application in my job increases my productivity in T1D management.							7
Using the DiAPPeat web application enhances my effectiveness in treating people with T1D.						1	6
The DiAPPeat web application makes it easier for me to care for people with T1D.							7
I have found the DiAPPeat web application valuable for my job.							7
Learning to operate the DiAPPeat web application was easy for me.							7
I found it easy to get this product to do what I wanted.							7
My interaction with the DiAPPeat web application has been clear and understandable.						1	6
I found this product to be flexible to interact with							7
It was easy for me to become skilful at using the DiAPPeat web-application							7
I found the DiAPPeat web application easy to use							7

All four statements regarding the overall evaluation of the application's content received the highest rating (5 or 4) by all seven (7) participants. The statements deal with the clearness of the targets, the subsections/ themes and the benefits and degree of satisfaction from the application (Table 4.11).

Table 4.11: Overall evaluation application's content for Healthcare Professionals					
Description	1	2	3	4	5
The targets of the application were obvious.					7
The subsections/ thematics aligned with the application's overall targets.					7
The benefits you have obtained from the application DiAPPeat and the degree of satisfaction				1	6
Overall satisfaction with the application				1	6

All three statements regarding the "Diabetes" section received the highest rating (5 or 4) by all seven (7) participants. The presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and evaluated (Table 4.12).

Table 4.12: Evaluation Section <Di>, <Diabetes> for Healthcare Professionals					
Description	1	2	3	4	5
Quality/ Usefulness of the presentations and discussions				1	6
Overall coverage of the subject matter				1	6
Appropriateness of the mode/ method chosen for distance learning				1	6

All three statements regarding the "Applications" section received the highest rating (5) by all seven (7) participants. The presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and evaluated (Table 4.13).

Table 4.13: Evaluation Section <App>, <Applications> for Healthcare Professionals					
Description	1	2	3	4	5

Quality/ Usefulness of the presentations and discussions					7
Overall coverage of the subject matter					7
Appropriateness of the mode/ method chosen for distance learning					7

All three statements regarding the “Eating” section received the highest rating (5 or 4) by all seven (7) participants. The presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and evaluated (Table 4.14).

Table 4.14: Evaluation of the section <Eat>, <Eating> for Healthcare Professionals					
Description	1	2	3	4	5
Quality/ Usefulness of the presentations and discussions				1	6
Overall coverage of the subject matter				1	6
Appropriateness of the mode/ method chosen for distance learning				1	6

All four statements regarding the “Food Search Engine” section received the highest rating (5 or 4) by all seven(7) participants. The quality/ usefulness of the search engine, the subject's coverage, the methods' appropriateness, and the usefulness of its content were all well received and evaluated (Table 4.15).

Table 4.15: Evaluation Section <Food Search Engine> for Healthcare Professionals					
Description	1	2	3	4	5
Quality/ Usefulness of the search engine				1	6
Overall coverage of the subject matter				1	6
Appropriateness of the mode/					7

method chosen for distance learning					
The usefulness of the content of the search engine					7

All three statements regarding the "DiAPPeat Cafe" section received the highest rating (5 or 4) by all seven (7) participants. That is, the quality/ usefulness of the DiAPPeat Café, the coverage of the subject, and the usefulness/ content of the section were all very well received and evaluated (Table 4.16).

Table 4.16: Evaluation Section <Chat>, <DiAPPeat Cafe> for Healthcare Professionals					
Description	1	2	3	4	5
Quality/ Usefulness of the section <DiAPPeat Cafeteria>					7
Overall coverage of the subject matter				1	6
The usefulness of the content/ discussions of the section <DiAPPeat Cafeteria>				1	6

All the statements regarding the "Logbook" "Glucose Keeping Records" section received the highest rating (5) (Table 4.17).

Table 4.17: Evaluation Section <Logbook> and < Glucose Keeping Records> for Healthcare Professionals					
Description	1	2	3	4	5
Quality/ Usefulness of the section <Glucose Keeping Records>					7
Overall coverage of the subject matter					7
The usefulness of the content of the section <Glucose Keeping Records>					7

All HCPs who participated in the survey noted that the persons with T1D have educational needs in all areas mentioned in the various sections of the application. The professionals know the needs of the individuals with T1D because they clinically review them in a clinical or outpatient setting. Also, the caseload of the specialists is high, or individuals with T1D choose not to see them. This makes the interaction between them limited. Therefore, a tool like DiAPPeat would be handy for both groups in developing self-management skills for individuals with diabetes and supporting them with accurate and relevant diabetes information, spending less time. The other benefit demonstrated here is that there is an indication that HCPs and individuals with T1D will be able to use the same language by using the newly developed online tool. The DiAPPeat web application can be available during and outside the professionals' working hours. This means their customers will be more active and knowledgeable while self-caring. The author is hopeful that experts with a well-informed logbook can support individuals in tracking their progress, worries, queries, and concerns.

The application designed to support HCPs in managing T1D patients highlighted the need for localised and national T1D educational resources. Although HCPs possess the scientific knowledge and expertise to help their patients, they often face time constraints and lack access to current resources. As a result, an online tool like DiAPPeat could serve as an excellent resource for them.

After conducting usability testing with the think-aloud protocol, the author discovered that all HCPs who used DiAPPeat found it highly beneficial for their practice. They expressed that DiAPPeat should be made available as a national tool accessible to the community to support T1D education. Furthermore, they emphasised the importance of funding and government provision of the DiAPPeat tool for people with T1D and HCPs. This could significantly improve the quality of care delivered to T1D patients and help them manage their condition more effectively.

4.3.2.1. Survey on Google Forms: Open Question for HCPs

In this section, the author presents and discusses the HCPs' responses to the survey's open-ended questions. The open question was to suggest other topics that could be included in the app to meet the educational needs of adults with T1D and improve practical diabetes education skills.

This study recruited seven HCPs to assess the usability of DiAPPeat as an educational tool for individuals with T1D seeking to enhance their skills through diabetes education. The

results revealed that four participants unanimously agreed that the tool was comprehensive and that no other theme needed to be included to cover the educational needs of the target population. However, one of the participants, a psychologist, suggested that it was crucial to have a method of recording emotions after a hypoglycaemic episode.

The proposed DiAPPeat Hypo Logbook was designed to address this concern. This feature lets end-users record hypoglycaemic episodes and their emotions in the comment box. Given that experiencing hypoglycaemia can affect cognitive function, it is recommended that this feature be highlighted to users. Recording the frequency and emotional impact of hypoglycaemic episodes is essential because the body releases epinephrine and norepinephrine during such episodes, leading to a distinguished arousal rating and decreased positive mood states.

Incorporating this feature in the DiAPPeat tool can help individuals with T1D better manage their condition and improve their overall quality of life. A recent Australian research that recruited participants from eight countries suggests that less than fifty per cent of three hundred twenty-four (324) adult participants needed to have a regular conversation about severe hypoglycaemia with the HCP (Mojdami et al., 2021). The author trusts that the DiAPPeat Web application could generate this conversation if the end-users record hypoglycaemia's level, frequency, and severity.

There is evidence to suggest that hypoglycaemia exaggerates the fear of hypoglycaemia and diabetes-related distress as well as affects the mental well-being and quality of life in the adult population with T1D. Therefore, it is crucial to address this issue and incorporate relevant features into educational tools to enhance the management of T1D (Chatwin et al., 2021).

The DSN recommended that the learning tool incorporate a video or animation demonstrating the insulin administration technique and how to check the blood glucose levels on the blood glucose meter to improve user engagement. This recommendation is based on the belief that incorporating visual aids can enhance the learning experience, particularly for complex tasks such as insulin administration. Previous studies have also shown that videos and animations can improve engagement, as they help to break down complex information into more manageable pieces and provide a more interactive and engaging learning experience.

Moreover, incorporating videos and animations could make the learning experience more approachable and less burdensome. It could help alleviate anxiety and stress associated

with learning new tasks, particularly when it comes to managing a chronic condition such as diabetes. It could also help increase user confidence and self-efficacy, which are essential to successful diabetes self-management.

It is worth noting that DiAPPeat includes other videos, such as advice for travelling podcasts. This demonstrates the platform's commitment to providing a comprehensive learning experience that addresses the diverse needs of its users. By incorporating various media types, DiAPPeat can enhance the user's learning experience and increase user engagement, ultimately leading to better diabetes self-management outcomes.

As part of the recent survey conducted on the DiAPPeat app, several HCPs were asked to share their suggestions for improving the app. Of the seven professionals who participated in the survey, three did not have any tips to offer. However, one of them rated the web application as "Excellent".

The endocrinologist and clinical dietitians who participated in the survey recommended adding images of measured meals and foods to assist individuals with T1D in insulin adjustment and carbohydrate counting. They suggested that such images would help users better understand portion sizes and make more accurate insulin adjustments.

However, one clinical dietitian reported issues with links not functioning correctly on the iPad, which is an area that needs improvement. The dietitian suggested that the development team should look into resolving these issues to improve the user experience.

Lastly, one community DSN expressed a keen interest in the web application and recommended its utilisation within the community. This indicates that the app could be a valuable tool for HCPs looking to help patients with T1D manage their condition more effectively.

4.3.2.2. Usability Testing with an Element of Researcher Notes for HCPs

The *first scenario* presented to the participants included the following instructions: To register or log in to DiAPPeat, follow these steps. Start by heading to DiAPPeat.com's Welcome page and clicking the register button. Add your contact details, carefully read and agree to the Terms and Conditions and consent form. Enter your participation number, then locate and visit the "Sick Day Rules" application. Once there, read the information and complete the quiz. Check the dashboard to see the latest updates. When you're

finished, you can sign out from the home page. If you forget your password, visit the password recovery page to reset it.

Registered Dietitian 1

The performance of the Registered Dietitian during the scenario mentioned above was exemplary. The participant believed the process was easy to comprehend, with high clarity and ample opportunities to rectify errors. The algorithm was executed by the participant with consummate ease, and the participant expressed satisfaction with the colour scheme, the accuracy of the information, and the user-friendly design of the Sick Day Rules tool.

Furthermore, Registered Dietitian 1 confirmed that blood ketone meters are not readily available to individuals with type 1 diabetes in Cyprus, but some people use urine sticks to check their ketones. However, it was also noted that individuals can purchase these meters if they desire. This additional information augments our understanding of the scenario, highlighting the nuances of providing proper healthcare to individuals with type 1 diabetes.

Registered Dietitian 2

The registration process was easy, and the participant went through the emails to verify the account. The participant used the interactive squares of the web application to navigate through the algorithm for the Sick day rules. Registered Dietitian 2 provided feedback that the explanation in the section was clear and made the experience more accessible. The participant applied the images and the clear instructions in the “managing your illness sick day rules” tool. The participant gave positive feedback on noticing a note telling the end-user to contact their doctor for safety purposes.

According to the Registered Dietitian 2, the above tool is straightforward and comprehensive. The detailed explanation gives you a good understanding of what is expected from you. The participant believes that even someone with limited computer literacy could do well with this tool.

Diabetologist/ Endocrinologist

Like the above HCPs, the diabetologist/endocrinologist followed the process of the first scenario successfully. The register, login and logout processes were apparent, and the information was provided at every step. According to the doctor, the “Managing your illness sick day rules” tool is a simple algorithm that meets the participants' expectations. According to the doctor, the tool is practical, and there is potential to support people with

T1D. The doctor is familiar with the guidelines used and found them suitable. Also, the doctor mentioned that its effectiveness will be proven when tested live in practice. The doctor confirmed that there is no serum ketone testing available in Cyprus. There are only a few meters that present the ketone levels. However, they are unavailable to the public. The doctor supports the blood ketone testing but cannot recommend it as there is no scope for the meters to be available to people with T1D (neither by GHS nor privately).

Diabetes Specialist Nurse

The registration process was straightforward, and the participant could efficiently complete it. After registering, the participant went through the emails to verify his account. To navigate through the algorithm for the Sick day rules, the participant utilised the interactive squares of the web application. The DSN provided valuable feedback, acknowledging that the explanation of the section was clear and made the experience more accessible.

Based on the feedback received, it has been observed that the tool developed for managing the illness is highly comprehensive in its approach and offers a wide range of features and functionalities that cater to the diverse needs of users. The tool is designed to be user-friendly and intuitive, facilitating ease of use and reducing the user learning curve. It provides a centralised platform for users to manage their illness, including tracking their symptoms, recording their medication regimen, and monitoring their progress over time. Additionally, the tool offers personalised recommendations based on the user's profile and history, enhancing the program's overall effectiveness. Overall, it can be inferred that the tool significantly adds value to the DiAPPeat platform and is a crucial driver of user engagement and satisfaction.

Community Diabetes Specialist Nurse

The community DSN performed well during the first Usability Testing scenario. The confidence in navigating between the web application and the email inbox to verify the account created was successful. The trial of the Sick Day Rules tool made him provide very positive feedback for the performance and the quality of the tool. The individual's proficiency in navigating between the web application and email inbox to verify the successful creation of an account was noteworthy. The community DSN completed the task without significant difficulties, indicating high confidence in using the platform.

During the trial of the Sick Day Rules tool, the community DSN provided positive feedback for the performance and quality of the tool. The individual found the tool highly effective in managing sick days and appreciated the ease of use. The community DSN's

feedback highlights the importance of user-centred design and the significance of providing tools that meet the needs of HCPs.

Furthermore, the community DSN's perception of DiAPPeat was favourable, indicating the usability and value of the tool. The individual found DiAPPeat to be a valuable resource in managing diabetes and appreciated the ease of use. The positive feedback regarding DiAPPeat highlights the importance of providing HCPs with user-friendly and practical tools to manage chronic conditions. DiAPPeat is usable and valuable.

Nurse Educator

The Nurse Educator demonstrated an impressive performance during scenario one, displaying consistent competence throughout. Although there was a slight hesitation initially, it was quickly overcome, and the Nurse Educator carried out the task with ease and precision. The feedback received after the performance indicated that the web application registration process was straightforward, with no issues encountered during the entire process. The trial of the Sick Day Rules tool, which was the main focus of the performance, was completed effectively by the participant, who expressed satisfaction with the experience. It was evident from the participant's expressions that the nurse educator was expecting something more challenging than the task presented, which indicated a high level of confidence from the outset.

Overall, the Nurse Educator's performance was excellent, and the feedback received was overwhelmingly positive, highlighting the usability of the web application and perhaps the Nurse Educator's ability to apply the skills learned in real-world scenarios.

Clinical Psychologist

The HCP participant shared his experience of registering with the web application DiAPPeat. The participant provided detailed feedback regarding the registration process, indicating that it was straightforward. He expressed confidence in registering and using the application, even without the assistance of a facilitator. The participant further described the colours used in the application's logo as sparkling and encouraging, despite his dislike of the orange. The clinical psychologist found the colours intriguing and expressed interest in exploring the application further, indicating he intends to use it with his clients.

Upon navigating to the "APP" section, the psychologist completed the algorithm and provided detailed feedback regarding his experience. The participant reported that the instructions were clear, concise, and easy to follow. He appreciated using images in the

application, which improved the overall experience. Additionally, he described the screen as positive and evocative, citing colour and design as contributing factors.
The participant completed the remaining scenario tasks and found the web application a helpful resource due to its provision of detailed information customised to his profile. He appreciated the application's individualised care, which increased his sense of security. The participant expressed satisfaction with the overall experience and indicated his willingness to continue using the application.

The instructions for the *second scenario* presented to the participants were as follows: To access the Eating scenario on DiAPPeat.com, one must first log in using the provided login details. After logging in successfully, the user must navigate to the "EAT" option from the four coloured squared menus. Subsequently, the "Skill Checklist" tab must be accessed to ascertain which learning objectives have been completed and which are yet to be completed. Next, the user should click the "e-Learning" tab and access the "Carbohydrate Counting Level 1" learning module. The user should proceed with the module until its completion and locate the means to view it. Once the learning material has been assimilated, the user should consider the information presented and complete the quiz. Finally, the user must sign out to conclude the scenario.

Registered Dietitian 1
According to the assessment by Registered Dietitian 1, the presentation on carbohydrate counting was deemed excellent. The presenter's adeptness in facilitating the smooth transition from one slide to another, coupled with vivid colours and tables, greatly supported the learning process and enhanced the readability of the information presented. The use of shapes in the presentation also proved beneficial, as it prevented the slides from appearing too cluttered with lengthy texts. Overall, the positive attributes of the presentation are expected to encourage the audience to engage more actively with the material presented.
The Registered Dietitian 1 mentioned that the process of the Carbohydrate Counting presentation was perfect; the transition from one slide to the other ran smoothly, and the use of colours and tables supported the learning and allowed the user to scan the information. The presentation uses shapes and is better for the reader than boring slides with long texts. This will encourage the person to attempt to read it.
The following excerpt presents the evaluation of a Carbohydrate Counting presentation by Registered Dietitian 1, along with his recommendation to include the Eat Well Plate in the

presentation. Based on the experiences of Registered Dietitian 1, individuals with diabetes often lack adequate knowledge regarding the importance of carbohydrates in their diet, which often leads to the avoidance of carbohydrates. To address this issue, the Registered Dietitian recommended adding the Eat Well Plate to the presentation to visually promote the foods that should be included in a healthy diet, thus reducing individuals' resistance to avoiding carbohydrates.

Furthermore, the Registered Dietitian emphasised the importance of practising carbohydrate counting skills to maintain efficacy. Failure to do so may lead to developing bad habits that are difficult to change, particularly among young people. The Registered Dietitian also highlighted the issue of carbohydrate denial, which becomes particularly problematic when diabetes complications arise. The management of carbohydrates becomes more complex in such cases, and convincing individuals about the benefits of including carbohydrates in their diet becomes challenging.

To address these issues, the Registered Dietitian recommended using a structured tool like DiAPPeat to provide accurate and evidence-based information to individuals. This can save time during clinical appointments, allowing for more individualised care. Moreover, precise recording of food intake can enable the Registered Dietitian to identify areas where individuals struggle and provide appropriate support. DiAPPeat can also aid in finding complex foods with carbohydrates, allowing individuals to learn from their mistakes safely. DiAPPeat can aid in the psychological aspect of carbohydrate counting, as it promotes trust and honesty between the Registered Dietitian and the client, leading to targeted clinical dietetic advice.

Registered Dietitian 2

A Registered Dietitian 2 was assessed for the second scenario, who provided positive feedback on the process and the carbohydrate counting workshop presentations. The presentation was well-structured, with a seamless flow of information that was effectively delivered. The participant's feedback emphasised the importance of having detailed information about carbohydrate counting readily available for end-users, including individuals with Type 1 Diabetes and healthcare practitioners.

This feedback highlighted the need to improve the accessibility of information to enhance the learning experience and update the target audience's knowledge base. The feedback also indicated that the presentation successfully delivered the intended message, making it highly relevant for individuals seeking to improve their knowledge of carbohydrate counting.

Overall, the feedback was encouraging and demonstrated the significance of providing accessible and accurate evidence-based information for individuals managing diabetes and healthcare practitioners seeking to improve their knowledge and skills.

Diabetologist/ Endocrinologist

The physician has demonstrated exceptional proficiency in executing the assigned scenario with remarkable ease and efficiency. The process was conducted with great attention to detail, and the presentation was submitted promptly according to the researcher's specifications. The feedback obtained regarding this particular section of the project has been remarkably positive, with many users commending the application's ease of use and user-friendliness.

Furthermore, the physician has provided invaluable insights regarding the application's accessibility, suggesting that it should be available in Greek. This recommendation has been taken into consideration, and the development team is currently working to incorporate this feature into the upcoming phase of the project. This enhancement will undoubtedly improve the application's reach and accessibility, making it more widely available to individuals who prefer to use it in their native language.

Overall, the physician's contribution to the project has been invaluable, and his expertise has significantly contributed to its success. The team looks forward to working with them in the future.

Diabetes Specialist Nurse

Upon completing the second scenario, the DSN found the system's performance exceedingly satisfactory. The system not only navigated through the tasks with ease but also completed them efficiently. The DSN was impressed with the system's ability to carry out the requested tasks seamlessly, indicating that the system was user-friendly and easy to operate.

Furthermore, the DSN was particularly impressed with the "Recipe of the Month" section on the EAT page. The DSN expressed that this feature was an excellent idea for engaging individuals with diabetes, providing them with a fresh and exciting culinary experience each month. The innovative approach to diabetes management was deemed commendable by the DSN, who applauded the system's ability to cater to diverse dietary requirements and preferences.

The DSN's experience with the system was positive and highly satisfactory. The user-friendly interface, coupled with creative features such as "Recipe of the Month," makes the

system an excellent tool for individuals with diabetes to manage their condition satisfactorily and satisfactorily. The user-friendly interface and creative features such as "Recipe of the Month" make the system an excellent tool for individuals with diabetes to manage their condition easily.

Community Diabetes Specialist Nurse

The community DSN was evaluated on his ability to complete the second scenario in all the requisite tasks, which included navigating through a website and accessing e-learning material. The results indicated that the participant could perform the functions highly, suggesting that the community DSN had the necessary skills and knowledge.

The community DSN found the presentation visually appealing, with engaging colours and exciting shapes. The community DSN's use of multimedia technology was also well-received, as it helped to enhance the overall learning experience.

Furthermore, the study revealed that accessing e-learning material was relatively straightforward, with no reported issues or technical glitches encountered by the participant. This is particularly noteworthy, as easy access to e-learning material is critical in promoting digital diabetes literacy in all age groups.

These findings underscore the importance of community-based learning initiatives and the need for effective e-learning platforms to facilitate knowledge acquisition and skill-building activities. The community DSN's initiatives have demonstrated his potential to empower individuals with the necessary digital skills and knowledge to thrive in the digital age.

Nurse Educator

The Nurse Educator, aided by his experience and expertise, performed the second scenario with exceptional proficiency without encountering any delays, troubleshooting, or technical issues. The technical aspect of the scenario functioned optimally, indicating a high level of proficiency in its development. The practical component of the web application operated smoothly, which was a testament to the developer's skill and attention to detail. The Nurse Educator, impressed by the web application's quality, inquired about the research duration for its development, intending to understand the level of effort and dedication that went into its creation. Through his competence and diligence, the Nurse Educator completed the practical tasks, and the feedback he received was overwhelmingly positive. He admired the EAT section's performance and design, indicating the web application's excellence.

Clinical Psychologist

Upon completing the scenario, the participant was found to have completed all tasks. In addition to this, feedback from the participants was gathered and found to be overwhelmingly positive. The participant lauded the application's use of engaging colours, which made the experience more enjoyable and immersive. Furthermore, the operational accuracy of the application was also commended, with participants finding it easy to navigate and complete tasks with minimal errors. The combination of these attributes is expected to be highly influential in motivating participants to engage with the application, spurring them to achieve more tasks and explore further features.

The instructions to the participants for the *third scenario* were as follows: Scenario three involves searching for food on DiAPPeat.com. Firstly, you must go to the website and click the login button. Your login details are available for you to use. After logging in, you can use the four-coloured squared menus or the left-side menu to navigate to the "Food Search" section. Once there, you should enter the current carb ratio as 10 grams/unit and find the carbohydrate value of a Cypriot food, such as Fried Poulles. Additionally, you must determine the protein content in 250 grams of the chosen food and decide how much you want to eat. Finally, sign out of your account before closing the website.

Registered Dietitian 1

The DiAPPeat web application's Food Search feature has proven to be a valuable tool for Registered Dietitian 1 in his practice. The feature allows for accurate and efficient carbohydrate counting, which is crucial for dietitians in supporting their clients. While using this feature, the experienced Dietitian identified a typographical error in the section related to Fatty Acids Saturated. Additionally, the participant suggested viewing the total carbohydrates by portion in the Food Search, enhancing the tool's user-friendliness and value.

The Cypriot Food Search feature has emerged as a unique and indispensable tool for dietitians, given the absence of any other accurate tool that can aid in carbohydrate counting to this extent. The traditional approach of calculating based on 100 grams can be time-consuming and requires more effort. Hence, the Food Search feature is a valuable and efficient alternative in supporting dietitians in their daily practice.

Registered Dietitian 2

The study participant exhibited a high degree of efficiency in completing the scenario. The participant's feedback indicated a positive experience, with evident enthusiasm towards the Food Search tool. The participant successfully inputted all requested information and expressed appreciation for the variety of Cypriot foods in the tool. The participant confirmed that the Food Search is a valuable resource for supporting individuals and healthcare providers in carbohydrate counting.

Registered Dietitian 2 noted that the tool helped MDI and insulin pump users manage fat and protein with split or extended boluses. This aligns with Registered Dietitian 2's practice of recommending pre-bolusing or insulin adjustments for high-fat and protein meals. The ease of access to bolus information was found to be beneficial.

The ability to adjust the food weight in the Food Search tool was beneficial, as many resources provide carbohydrate amounts primarily in 100-gram increments. Customising dose is valuable, and the tool's usability was rated highly. Registered Dietitian 2 expressed confidence in the potential for this web application to be utilised in practice by individuals with diabetes and healthcare providers alike.

Overall, this study's findings suggest that the DiAPPeat web application is a well-designed tool that supports individuals with their carbohydrate-counting skills. Healthcare providers, such as Registered Dietitian 2, expressed excitement about the potential for this tool to be used in clinical practice.

Diabetologist/ Endocrinologist

With remarkable proficiency, the Doctor completed the third scenario, demonstrating a sense of self-assurance and ease in navigating the activities. During the execution of the section, the doctor expressed a sense of uniqueness in the design and commented on its potential to support individuals with T1D significantly in achieving accurate carbohydrate counting. The Doctor's observations were based on distinct features and provided a clear understanding of the process, which would be invaluable to people with T1D. Overall, the Doctor's execution of the scenario was a testament to his expertise and familiarity with the subject matter.

Diabetes Specialist Nurse

The DSN performed remarkably well in the third scenario, as it exhibited high flexibility and efficiency in enabling the user to navigate the tasks efficiently and accurately. Specifically, the DSN identified the Food Search feature as one of the most innovative and user-friendly sections of the DiAPPeat web application. Incorporating a comprehensive Cypriot food database was especially appreciated, as it is critical in supporting individuals with T1D in Cyprus. The database contains a vast range of traditional and international foods and accurate nutritional information, thus significantly enhancing the efficacy of the DiAPPeat system in promoting healthy dietary habits among T1D patients in the region.

Furthermore, the DSN's performance in the third scenario can be attributed to its intuitive design, which allows for a seamless user experience. The system's interface is highly intuitive, enabling users to easily locate critical features and functionalities. The DSN's comprehensive search algorithm also ensures that users can access relevant information quickly and accurately.

The DSN's outstanding performance in the third scenario, particularly its Food Search feature and incorporation of the Cypriot food database, highlights its potential to significantly enhance the quality of life for individuals with T1D in Cyprus. The system's intuitive design and robust search algorithm make it an invaluable tool for promoting healthy dietary habits and improving patient outcomes.

Community Diabetes Specialist Nurse

In the third scenario, the community DSN exhibited a noteworthy performance by navigating the tasks flexibly and efficiently while maintaining high accuracy. The Food Search feature of the DiAPPeat web application was recognised as a novel and user-friendly section, contributing to the community DSN’s successful performance.

Nurse Educator

During the third scenario, the Nurse Educator demonstrated a high level of proficiency by completing all the tasks assigned to him. Moreover, he did not encounter any technical issues with the application or disengaging display, indicating that the web application was functioning seamlessly. The feedback provided by the Nurse Educator was overwhelmingly positive, with him expressing his excitement and enthusiasm for the project.

The Nurse Educator was particularly impressed by the web application's innovative design and functionality, believing it could be a game-changer in Cyprus's healthcare system. He explicitly stated that the web application should be promoted widely to the people in

Cyprus as this was the first time he had encountered something like it. The Nurse Educator further emphasised the importance of the web application in advancing healthcare education in Cyprus, stating that it could significantly improve the quality of healthcare delivered to patients.

The Nurse Educator's positive feedback regarding the web application's functionality and design provides valuable insight into its practical application in Cyprus's healthcare industry. His endorsement of the web application's innovative features suggests that it could be a game-changer in the healthcare education sector, improving the quality of healthcare delivered to patients.

Clinical Psychologist

During the third scenario, the participant could complete all the assigned tasks with remarkable proficiency, demonstrating an impressive understanding of the web application. As a result, the psychologist was highly impressed and expressed positive feedback towards the participant's performance. In particular, the participant's execution of the tasks was exemplary, with every aspect of the web application being well-tended and organised. The psychologist's feedback is a testament to the participant's diligence and competence in mastering the web application's features and functions.

The instructions to the participants for the *fourth scenario* were as follows: Consider the following scenario: First, navigate to the Welcome | DiAPPeat.com page and click on the login button. The user's login credentials are provided to access the site. After logging in, navigate to the "DiAPPeat Cafe" section from the left-side menu and select the topic "DiAPPeat Café". To introduce oneself, write "Hello everyone, I am new here" and post it. The user should then observe and analyse the response. In case of any query regarding the "Applications" section, the user is advised to select the Applications discussion. Here, the user can post a message about using the sick day rules tool. After posting the query, the user should observe and analyse the response. Sign out

Registered Dietitian 1

The concept of using DiAPPeat Café as a means of communication among individuals with diabetes has been positively acknowledged by Registered Dietitian 1. The utilisation of this platform serves as an effective tool for individuals seeking support and assistance regarding various diabetes-related concerns. As an HCP, Registered Dietitian 1 acknowledged the importance of promoting networking and communication among

individuals with similar health conditions. Through DiAPPeat Café, individuals with diabetes can connect with others who share similar experiences and gain valuable insights into managing their condition. The platform allows individuals to seek help and support, which can ultimately improve their overall health outcomes.

Registered Dietitian 2

Upon conducting a thorough analysis of the test results, it has been determined that the participant under review did not encounter any noteworthy difficulties while completing scenario number four.

DiAPPeat Cafe among the participants is conducive to their comfort level. The participants are allocated a unique username, "diappbuddy", followed by a number to ensure anonymity. This practice instils a sense of security and privacy among the users, which is crucial in research settings. Such measures aid in promoting genuine responses from participants, leading to more accurate and reliable data collection.

During the exercise, the participant experienced some connectivity issues, which temporarily disrupted the operation of the web application. However, it is essential to note that these issues did not impede the overall success of the scenario, as the application remained functional despite the intermittent disruptions. It is worth mentioning that the web application performed optimally once the internet connection was restored. Overall, the participant's performance was commendable, and all objectives were accomplished within the designated timeframe.

Diabetologist/ Endocrinologist

Upon completion of the scenario, as mentioned earlier, it was found that all tasks were executed with a high degree of effectiveness and proficiency, with no concerns or issues reported. The attending physician, who was responsible for carrying out the scenario, displayed a sense of confidence and assurance throughout the execution of the task. The physician completed the scenario relatively quickly, indicating familiarity and comfort with the process.

No further concerns or issues were reported or raised about the usability of the DiAPPeat Café, the facility where the scenario was carried out. This indicates that the facility is well-equipped and functional and that the attending physician could handle the scenario with minimal hindrances.

Diabetes Specialist Nurse

The current study evaluated the DSN for his performance in navigating the DiAPPeat web application. The DSN was observed to perform well, with its navigational skills becoming more natural over time. The research team collected the participants' feedback regarding the DSNs' performance, which revealed a positive response.

The DSN appreciated the team's efforts in adding this feature to the application, improving user experience through social interaction. Furthermore, the successful integration of the DSN into the DiAPPeat web application suggests that it can be a valuable tool for assisting users in navigating health web applications.

Community Diabetes Specialist Nurse

During the fourth scenario, the community DSN demonstrated commendable performance, attributed to improved navigation skills resulting from increased interaction with the DiAPPeat web application. Notably, the community DSN displayed a supportive attitude towards the social interaction among end-users, facilitating the discussion of various diabetes-related topics. Additionally, the nurse clearly understood the process of sending electronic messages and obtaining post approvals. Furthermore, the nurse successfully sent a message, utilising the anonymity feature that shields messages' functionality and security while preserving the participant's privacy.

Overall, the community DSN's performance underscores the importance of effective communication and the utilisation of technology in enhancing diabetes management practices.

Nurse Educator

During the fourth scenario, the Nurse Educator exhibited a high level of competency by completing all the tasks assigned to him. The Nurse Educator expressed great appreciation for the DiAPPeat Café feature, which enables end-users to interact and offer support to each other under the veil of anonymity through usernames. This functionality was perceived as an innovative and useful tool for fostering communication among individuals within the web application.

Furthermore, the Nurse Educator provided positive feedback on the benefits of the DiAPPeat Café feature. He recognised that communicating anonymously within the web application was a significant advantage, as it provided a safe space for end-users to share their experiences, ask questions, and offer support without fear of judgment or ridicule. The Nurse Educator also commended the user-friendly interface of the feature, which made it easy for individuals to engage with one another and initiate conversations.

Overall, the Nurse Educator's positive experience with the DiAPPeat Café feature highlights its potential to improve end-user communication and support.

Clinical Psychologist

During the study, the participant displayed remarkable efficiency and confidence while completing the assigned scenario. The participant's ability to navigate the given task with ease and precision indicated its familiarity with the web application and its functionalities. Moreover, it is essential to acknowledge the participant's confidence in his ability to use the web application effectively. The participant's confidence may be attributed to its prior experience with similar web applications or familiarity with the application's specific features and functionalities.

Overall, the participant's performance in the study signals his readiness to use the web application in a real-world setting. It is worth noting that the participant's confidence and efficiency are crucial factors to consider when evaluating the usability and effectiveness of the application.

The instructions to the participants for the *fifth scenario* were as follows: To access the DiAPPeat logbook, go to the website Welcome | DiAPPeat.com and click on the login button. Enter your login credentials and proceed to the dashboard. From there, create a DiAPPeat logbook and make two entries individually, following the instructions provided by the facilitator about the readings. Once you have completed the entries, save them and take a moment to describe what you see. Additionally, locate the study records and explain what you observe. Finally, sign out of the website to ensure the security of your information.

Registered Dietitian 1

The scenario was conducted under the guidance of the researcher to the Registered Dietitian 1. It was executed successfully, with the logbook as a critical component in ensuring accurate and comprehensive tracking of the participant's health information. The logbook was found to be an effective tool in capturing the participant's attention, with its easy-to-use interface making it simple for the participant to input information regarding daily glucose entries while also providing a clear representation of this data.

The logbook's functionality proved to be a critical factor in ensuring the participant's engagement with the process, with the prospect of viewing this information during clinic visits as a motivating factor. The entire process of adding a logbook entry was executed

smoothly, with the participant displaying proficiency in navigating through the logbook form and the result section.

The result section proved particularly useful, providing comprehensive graphs and pertinent information regarding the daily glucose entries, enabling the participants to understand their health status better and make informed decisions regarding their dietary and lifestyle choices. Overall, the scenario conducted by Registered Dietitian 1 proved to be a valuable learning experience for the participant, with the logbook as an effective tool for achieving optimal health outcomes.

Registered Dietitian 2

The participant in the scenario completed the given task swiftly and efficiently, displaying a remarkable level of proficiency in navigating the DiAPPeat logbook. The platform's straightforward and user-friendly interface allowed for a smooth process, and the results were presented as expected, completed with colour-coded identification of glucose levels, meal details provided by the end-user, and a graph representing self-inserted glucose levels.

After reviewing the data presented, Registered Dietician 2 expressed his satisfaction with the logbook's presentation, stating that it would be ideal for HCPs to analyse their client's data. The Registered Dietician was particularly impressed by the features provided in the logbook, such as the comprehensive meal details and the level of activity recorded, which can be immensely helpful in managing diabetes. The feedback provided by Registered Dietician 2 underscores the potential of the DiAPPeat logbook in facilitating informed decision-making by HCPs in delivering the best possible care to their clients.

The participant in the scenario expressed his optimism towards the DiAPPeat logbook, noting the amount of information that can be added and how it is presented. The logbook's user-friendly interface and the detailed feedback generated could benefit individuals with diabetes, as it allows for the convenient and comprehensive management of their condition. The scenario highlights the potential of the DiAPPeat logbook as a valuable tool in managing diabetes, providing detailed and organised data that can benefit both the end-user and HCPs.

Diabetologist/ Endocrinologist

The scenario in question was executed meticulously, focusing on every detail. The attending physician thoroughly assessed the logbook's usability and functionality, considering its various features and capabilities. After careful evaluation, the physician

concluded that the logbook was highly effective and could be efficiently utilised in a clinical setting. The success of this scenario can be attributed to the seamless integration of technology with medical practice, resulting in improved recording, efficiency and accuracy.

However, the Doctor expressed his concern regarding the Logbook feature, finding it cumbersome to input glucose readings into the application. He felt that individuals with T1D have several tasks to consider and complete with their insulin or insulin pump injections, and using the web application to add glucose readings may be an additional task that people with diabetes may not be willing to undertake. The Doctor acknowledged the importance of the Logbook in tracking glucose levels and keeping a record of blood sugar readings. He noted that the Logbook is an essential tool, but he remains to determine if people with T1D would commit to completing the logbook entries due to the additional effort required.

Diabetes Specialist Nurse

Completing the fifth scenario using DiAPPeat instilled confidence and comfort in the Diabetes Specialist Nurse (DSN), who could easily complete the prescribed tasks. However, the DSN identified a potential challenge associated with the DiAPPeat Logbook section, which requires patients with diabetes to maintain records of their glucose levels, activity, and dietary patterns. The DSN observed that patients are often reluctant to keep track of their records, citing reasons such as forgetfulness and inconvenience.

To address this issue, the DSN recommended using this web application that could motivate patients to improve their record-keeping habits. By utilising a logbook, patients can establish the habit of maintaining records, even when they do not have their blood glucose paper diary with them. The logbook could be designed to include features that encourage patients to keep track of their glucose levels, such as notifications, reminders, and rewards.

The DSN emphasised that record-keeping is crucial for diabetes management, as it helps patients and healthcare providers to identify patterns and make informed treatment decisions. The logbook could enable patients to track their progress, identify areas that require improvement, and consult their healthcare providers accordingly. Furthermore, the logbook could be designed to allow patients to share their records with their healthcare providers, promoting collaboration and improving the quality of care.

In conclusion, developing a web application logbook could lead to a more consistent and reliable record-keeping practice among patients with diabetes and promote better health outcomes.

Community Diabetes Specialist Nurse

The community DSN's successful completion of the fifth scenario reflects his proficiency in executing the logbook form and comprehending its outcomes, encompassing a comprehensive graphical representation. The community DSN's performance was particularly noteworthy, as he showed a firm understanding of the logbook's purpose and significance, indicating his in-depth knowledge in this area. The community DSN's mastery of the logbook form and his ability to interpret the findings suggest that he possesses the requisite expertise to execute this procedure accurately and efficiently.

Nurse Educator

The Nurse Educator completed the fifth scenario in the DiAPPeat Logbook, which involved recording various details related to diabetes care. The Nurse Educator meticulously followed all the directions in the scenario, including documenting the date, time, current blood glucose level, food intake, exercise, insulin dose, and other relevant data. The Nurse Educator's attention to detail was evident in the completeness and accuracy of the information recorded in the various fields of the form.

The feedback about the form's usability was positive, with the user finding it easy to navigate and complete. The form's design was deemed user-friendly, with clear and concise instructions. Moreover, the completeness and accuracy of the information entered contributed to a successful logbook. The information recorded in the form, such as the blood glucose level, insulin dose, and food intake, was essential in monitoring and managing diabetes care. Overall, the Nurse Educator's proficiency in managing diabetes care was demonstrated by his successful completion of the fifth scenario in the DiAPPeat Logbook.

Clinical Psychologist

During the sixth scenario's usability testing, the clinical psychologist expressed positive feedback for the DiAPPeat logbook. The HCP participant particularly appreciated the appropriateness of the questionnaire and the automatic storage of information in a secure system. Notably, having an electronic logbook to record glucose levels, insulin dosage and other relevant information is a novel feature in Cyprus. The colour-coded labels and prompt advice make the DiAPPeat logbook even more unique. Lastly, the ability for

individuals with T1D to use different logbooks can serve to personalise their diabetes achievements further.

The instructions to the participants for the *sixth scenario* were as follows: The following instructions outline the necessary steps for successful DiAPPeat operations. To begin, navigate the Welcome | DiAPPeat.com website and click the login button, ensuring your login details are on hand. Once logged in, view the guide video to learn more about the platform. From there, access the dashboard, modify the job description field to reflect an "Unemployed" status, and ensure the changes are saved. Next, locate the study progress section of the dashboard, open the initial assessment, and complete the evaluation according to the readings provided in a prepared form data form. After submitting the evaluation, it is essential to save the entries and locate the candidate number by logging out before finalising this process.

Registered Dietitian 1

According to the assessment made by Registered Dietitian 1, the scenario was deemed to be reasonably straightforward. It was observed that the participant displayed a high level of confidence and speediness in answering the questions, which indicated a clear understanding of the process. Additionally, the participant expressed satisfaction with the web application's form, stating that it covers all the essential questions that should be asked during every clinical appointment. This feedback highlights the effectiveness of the form in capturing relevant information required for proper clinical evaluation. Moreover, the participant's comment, "It makes me realise my measurements," adds further value to this section, as it demonstrates the helpfulness of the web application in providing insights that aid in self-reflection and improvement.

Registered Dietitian 2

In the given scenario, an electronic form was utilised to collect information from participants. The form was reported to function optimally with no delays or issues in appearance or performance. The electronic form was user-friendly, and the information entered into it was accurately captured. Once completed, the information was successfully obtained, indicating the electronic form's effectiveness.

The feedback provided by Registered Dietitian 2 indicated that the form was easy to follow and complete. However, it was noted that some individuals may encounter challenges in completing the form owing to their lack of technological literacy. It was suggested that individuals may require the assistance of a family member or healthcare provider to

complete the form. This feedback highlights the importance of considering the accessibility of electronic forms for individuals with varying degrees of technology literacy.

According to the participant, the form accurately captured the necessary information. However, concerns were raised regarding the applicability of the form to the general population. The participant suggested that not all individuals can perform this task, which calls for developing alternative solutions to make the electronic form accessible for all.

In light of this, the participant proposed implementing two account types within the web application - one for individuals with diabetes and another for healthcare providers. This would enable healthcare providers to complete the forms for their clients if necessary or keep them for their medical records. This solution highlights the importance of ensuring that electronic forms are accessible for all users, regardless of their technological literacy level or other personal characteristics and circumstances.

Diabetologist/ Endocrinologist

The physician exhibited exceptional proficiency while completing the final scenario, meticulously following the prescribed process and comprehending the instructions with remarkable ease. Despite the physician's concerns about patients' noncompliance with form completion, the web application's user-friendly interface and straightforward instructions made the process easy to navigate and complete.

As a result, all assigned tasks were accomplished to a commendable standard, reflecting the physician's meticulousness and commitment to delivering high-quality healthcare. The physician's expertise in navigating the web application and adhering to the prescribed process indicates his extensive knowledge and experience in the medical field.

In conclusion, the physician's performance in completing the final scenario was exceptional, and his commitment to delivering high-quality healthcare is commendable.

Diabetes Specialist Nurse

During the Usability Testing, the Diabetes Specialist Nurse (DSN) demonstrated exceptional confidence and proficiency while completing the final scenario. The DSN navigated the DiAPPeat application easily, completing the assigned tasks. The assessment form required the DSN to provide detailed and comprehensive responses, which requested information that would benefit the inclusion in the web application utilised by individuals with diabetes to track their progress.

The DSN acknowledged the importance of the collected data, stating that it could be helpful to all HCPs involved in diabetes care. However, the DSN emphasised the need for

individuals with diabetes to understand the values presented through the form. The DSN further elaborated that the collected information could be useful for HCPs to monitor the progress and determine the appropriate treatment plan for the individual.

In summary, the DSN's successful completion of the Usability Testing and her detailed responses to the assessment form showcase her expertise in the subject matter. Her acknowledgement of the collected data's significance and potential benefits for diabetes care professionals highlights the importance of the usability testing process for developing practical healthcare applications.

Community Diabetes Specialist Nurse

Throughout the last simulation, the community DSN exhibited an exemplary performance, characterised by a high level of competence and meticulousness in executing the assigned tasks. In particular, the community DSN demonstrated exceptional attention to detail in inputting the required information accurately, and the production of the DiAPPeat logbook entry was carried out with utmost care and precision without any technical hitches.

Both the community DSN and the facilitator noted the nurse's outstanding performance during the various stages of the simulation. The community DSN's ability to complete the tasks competently and efficiently was impressive, and it was evident that the community DSN was well-versed in the procedures and protocols involved.

The community DSN also expressed his satisfaction with the clarity and presentation of the form. The form's clarity and structure made it easy to navigate and complete, and the nurse found it to be a valuable tool in ensuring accurate and efficient record-keeping. Overall, the community DSN's performance was exemplary, and his attention to detail and proficiency in executing the tasks bodes well for their future practice.

Nurse Educator

The Nurse Educator adeptly and effectively performed all requested tasks. As a result, the study's author received highly positive feedback on the assessment form. The Nurse Educator found the form easy to assemble and straightforward while containing all the essential information necessary to support data collection, which could be valuable for a follow-up study.

The Nurse Educator demonstrated exceptional proficiency and resourcefulness in executing the assigned tasks. In particular, she accomplished all the duties with great attention to detail, ensuring the necessary steps were taken to achieve the desired outcomes.

The assessment form, as deemed by the Nurse Educator, was meticulously designed and well-structured. It contained all the pertinent information necessary for the successful collection of data, which could serve as a valuable resource for future studies. The Nurse Educator's upbeat assessment of the form's usefulness highlights its effectiveness and demonstrates the importance of its design in facilitating data collection.

Clinical Psychologist

The Clinical Psychologist has completed the sixth scenario and received positive feedback from the concerned parties. The psychologist provided feedback on the information displayed on the form and commented on the structure of the questions to provide insightful feedback. The feedback yielded a satisfactory outcome, indicating that the scenario was adequate and met its objectives. The sixth scenario completed by the Clinical Psychologist has generated positive feedback, attesting to its success. The psychologist provided feedback on the information displayed on the form and the structure of the questions.

4.3.2.3. Structured Questions and Researcher Notes for HCPs

In the upcoming section, the author analyses the responses provided by the HCPs to the structured questions that were asked during the assessment. The questions were designed to gather detailed information about the HCP's perspective on the subject matter. Additionally, the notes taken by the researcher during the assessment have been included to provide a comprehensive overview of the HCP's responses and to highlight any areas that may require further investigation.

Registered Dietitian 1

The following feedback is from Registered Dietitian 1, who has used the DiAPPeat web application. In his experience, the application has been a structured and helpful tool for supporting diabetes management. The participant had a positive experience with the DiAPPeat web application, finding it easy to use and navigate. The explanation video provided was informative and easy to understand, which helped the participant to start using the application independently.

The participant mainly found the Food Search section the most valuable application feature. This feature provided accurate and targeted information to support carbohydrate counting, which is essential for people with diabetes. The participant believes this feature can significantly help individuals who fear delivering insulin or matching it to the

carbohydrates they consume. However, the participant also acknowledges that using such web applications depends on the diabetes experienced by each end-user and their learning and education preferences.

The DiAPPeat Logbook was another feature that the participant found to be useful. With accurate record-keeping, dietitians can recognise patterns and provide advice that matters to the person's life, which can improve the overall diabetes management experience. This feature can also help dietitians understand and support their clients better.

The participant found the DiAPPeat web application user-friendly, easy to navigate, and a complete and organised tool for supporting people with T1D. The participant was also impressed by the web application's promotion of the MDT approach. The participant did not get the feeling of just relying on the web application without the guidance of the MDT. The participant favours the web application because health professionals develop it, it is evidence-based and accurate, and there is control over the system, which gives confidence to individuals to use it.

The participant believes the web application's expected benefits can benefit people with T1D and HCPs. They recommend the web application as a structured tool to support diabetes management. The participant also believes that using the application can help individuals access the web application independently and receive its benefits.

Registered Dietitian 2

According to Registered Dietitian 2, the user-friendly app has everything needed to manage T1D. The participant who provided feedback on the app wanted it to be available in Greek and used in clinical practice and in the community.

Registered Dietitian 2 said “insulin calculation” was the app's most important feature. The app includes a Food Search tool with Cypriot food options that can be adjusted to different serving sizes. This is an improvement over other tools in the market, which only provide information for 100-gram servings. The participant felt that the information in the Food Search results was clear and easy to understand, especially for high-fat foods.

The dietitian’s views on the e-learning presentation were that the web application provided accurate information about various diabetes-related topics. This can be used to support new knowledge or to update existing knowledge.

Diabetologist/ Endocrinologist

The Doctor's evaluation of the DiAPPeat web application for managing diabetes reveals several noteworthy observations. Firstly, he commends the application's practicality,

particularly the tools in the "APP" section, which include the conversion to MDI and Food Search functionalities. The Doctor believes that these tools are instrumental in managing the illness and can be immensely beneficial to individuals with T1D, particularly those residing in Cyprus, where there is a need for more carbohydrate counting in the community.

Additionally, the Doctor raises concerns regarding the web application's accessibility to individuals who lack computer literacy. Although the application may be suitable for younger individuals, the doctor believes that older individuals who are less familiar with technology may need help using it.

Despite the concerns mentioned above, the Doctor believes that the DiAPPeat web application is helpful for individuals with T1D and recommends its use in his clinic and with his patients. The application's practicality and convenience make it a valuable resource for managing diabetes, and its potential benefits outweigh the challenges associated with its use.

Diabetes Specialist Nurse

During a recent conversation, the DSN (Diabetes Specialist Nurse) expressed their keen interest in DiAPPeat, a web application they believe has no comparable alternatives currently available in Cyprus. According to the DSN, while some international diabetes-related applications are available, the unique Food Search feature of DiAPPeat is fascinating as it can be challenging for people with diabetes to find accurate carbohydrate values. The DSN also appreciated the APP section of DiAPPeat and was impressed by the team's hard work in completing the web application.

The DSN was enthusiastic about the project and complimented the team on their profound and hard work. They found the EAT section to be the most helpful aspect of the application, which provides users with a list of foods with accurate carbohydrate values. The DSN recognised the need for more carbohydrate-counting education in Cyprus and was confident that DiAPPeat would be a valuable resource for many people with diabetes. They also noted that poor carbohydrate counting can have negative consequences and believe that DiAPPeat will help people with diabetes make better and more informed choices regarding their diet.

Community Diabetes Specialist Nurse

The DiAPPeat web application was subjected to comprehensive Usability Testing, during which the community DSN provided detailed feedback on various aspects of the application. The community DSN praised the application's usefulness and simplicity, noting that individuals from diverse backgrounds and levels of technological proficiency could easily use it. Additionally, the community DSN was impressed with the application's overall performance, which was fast, responsive, and highly functional.

The EAT section and the Food Search feature were identified as the most critical aspects of DiAPPeat, and the community DSN provided detailed feedback on these features. The EAT section was highly useful, providing users with various options to track their meals, monitor their calorie intake, and manage their carbohydrate consumption. The Food Search feature was also highly praised, with users finding it an efficient and effective way to find information on different foods and their nutritional content.
Also, the managing the illness tool supports people in managing their diabetes safely during their illness.

Nurse Educator

The Nurse Educator demonstrated a palpable sense of excitement and anticipation regarding the upcoming Sick Day Rules tool trial. The educator's positive feedback on the tool was particularly noteworthy, as it reflected high interest and enthusiasm. The educator expressed a strong affinity towards the tool and conveyed a positive outlook towards its potential to enhance patient care. The educator's keen interest in trialling the tool further emphasised their commitment to providing quality care and using innovative tools to achieve this end.
The nurse educator believes individuals with diabetes can benefit substantially from the web-based application DiAPPeat. This platform provides a wealth of information and resources to help patients improve their self-management skills, which is critical in managing diabetes effectively. The application offers simple yet practical advice on various aspects of diabetes management, such as diet, exercise, and medication management.
The nurse educator emphasised that patients often struggle with self-management, leading to complications and reduced quality of life. However, with the help of DiAPPeat, patients can receive personalised guidance and support that can significantly improve their health outcomes. The application offers a range of features, such as tracking tools, reminders, and educational resources, which can empower patients to take control of their diabetes.

The nurse educator expressed admiration for DiAPPeat and the exceptional work it has accomplished in improving diabetes self-management. The application has been designed with a patient-centred approach, ensuring patients receive the best support and guidance. The nurse educator believes that DiAPPeat represents a significant step forward in diabetes management and has the potential to revolutionise the way patients manage their condition.

Clinical Psychologist

The clinical psychologist provided detailed and positive feedback on the structured questions and the researcher's notes. The feedback session commenced with the psychologist expressing appreciation for the voice in the video, which was described as encouraging and impactful for viewers. Moreover, the psychologist commended the clear instructions presented in the video, which were deemed comprehensive and explanatory.

In addition to the video, the clinical psychologist evaluated the web application and found it beneficial for individuals with Type 1 Diabetes. The application was praised for its well-organized information guides, directives and tools that could be utilised to train and manage different real-life scenarios. The psychologist also appraised the combination of images and colours, creating an attractive and engaging user interface.

The psychologist further commented on how the web application positively impacted the users, creating a feeling of well-being due to the abundance of knowledge available. The psychologist also appreciated the holistic approach to learning, ensuring that users received a comprehensive understanding of the condition and its management.

The feedback was detailed, positive, and constructive, providing valuable insights for developing and improving the web application and video.

4.4. Discussion

The discussion chapter provides a critical discussion on the views of people with T1D using the System Usability Scale (SUS) and HCPs' evaluation of the DiAPPeat web application using the System Usability Scale (SUS) and Technology Acceptance Model (TAM). The study investigated HCPs' confidence in web applications and their evaluation of the DiAPPeat application across various sections.

The data from the study revealed that people with T1D and HCPs expressed high confidence levels in web applications. The DiAPPeat application was positively evaluated across all sections by the participants. These results align with recent research studies (Otis et al., 2020; Ng et al., 2019; and Albanese-O'Neill et al., 2019). Specifically, evaluations

of the overall content, Diabetes, Applications, Eating, Food Search Engine, and DiAPPeat Café sections, were positive, with all statements receiving the highest rating of 4 or 5. Or 1 and 2 as appropriate.

The participants highly evaluated the methods' quality, usefulness, coverage, and appropriateness. In the overall content section, the participants rated the clearness of the targets, the subsections/themes, the benefits, and the degree of satisfaction from the application as highly satisfactory. In the Diabetes section, the presentations and discussions, the subject's coverage, and the appropriateness of the methods were all well received and highly evaluated. Similarly, the Applications section highly considered the presentations and discussions, the subject's coverage, and the appropriateness of the methods.

In the Eating section, the quality/usefulness of the presentations and discussions were rated highly, with the overall coverage of the subject matter and the appropriateness of the mode/method chosen for distance learning also receiving high ratings. The Food Search Engine section received high ratings for the quality/usefulness of the search engine, the overall coverage of the subject matter, and the usefulness of the search engine's content. Finally, the DiAPPeat Café section was highly evaluated in terms of the quality/usefulness of the DiAPPeat Café, the coverage of the subject, and the usefulness/content of the section. This social networking section is highly rated in recent research studies (Otis et al., 2020; Ng et al.,2019).

These findings suggest that the DiAPPeat web application is a valuable tool for HCPs in managing diabetes, and it is well-designed to meet their needs. The study contributes to the growing literature on web applications for HCPs and highlights the importance of designing user-friendly and practical applications that meet HCPs' needs. The development of such online apps improves and adds value to the existing resources and tolls of the healthcare system. (Ng et al., 2019). Further research could investigate the application's effectiveness in improving diabetes management outcomes.

The results of the usability test and comments expressed by both groups of participants underline the suitable identification of users' needs and preferences and incorporate these into the design and development of the various sections of the online application DiAPPeat. Furthermore, as in other design and developmental activities, an MDT involving all relevant professions is needed for the better utilisation and incorporation of this type of technology for the provision of health services (Sharma et al., 2022)

4.4.1. Summary of the Results

This doctoral research study comprehensively analyses the perspectives and preferences of individuals diagnosed with T1D. The study is based on the most recent research in the field and explores the various approaches to accessing diabetes-related information online that are preferred by individuals with T1D.

The study found that individuals with T1D prefer user-friendly approaches to accessing diabetes-related information online for improved diabetes outcomes. Such applications provide easy access to educational information, primarily to complement and supplement what is provided in the clinical setting (Adu et al., 2020; Albanese-O'Neill et al., 2019). The usability of each participant varied depending on their diabetes experience, technological involvement, and exposure to health information. Interestingly, the study found that participants with T1D scored highly on usability scales and praised the DiAPPeat web application beyond the author's expectations.

Some individuals suggested formalising DiAPPeat as an educational tool in Cyprus. The uptake of the web application was remarkable, and participants' emotional responses moved the author during usability testing. As someone with T1D, the author profoundly values the perspectives of those with this condition and believes their input is crucial in developing effective interventions and tools.

The study explores the experiences of individuals living with T1D in Cyprus, particularly their interactions with the healthcare system. The findings suggest that individuals with T1D often feel frustrated and let down by the healthcare system, as they perceive a lack of support and resources to manage their condition. This frustration is not one-sided, as HCPs also express disappointment with the system's inability to provide adequate resources and support for diabetes self-management.

The study highlights that individuals with T1D feel they must take control of their own lives and manage their diabetes in a survival mode, which can be mentally and emotionally challenging. They also express concerns about the lack of education and awareness about diabetes management among the general public and HCPs. Specifically, the study notes that educating individuals with T1D to identify and manage DKA during illness is crucial but often lacking. Individuals with diabetes can benefit from the reduction in diabetes emergencies after receiving structured education (Speight et al., 2016).

The experience of constantly being in survival mode was once a common one for many people, especially those with diabetes. Unfortunately, HCPs and people with diabetes often share a sense of frustration with the system's failure to provide adequate support and resources for diabetes self-management skills. This is particularly true in Cyprus, where education about diabetes is a pressing concern for both groups. For instance, educating people with type 1 diabetes about checking their ketones and glucose levels when they are sick is essential to avoid DKA emergencies. Such an application can provide much-needed support for individuals with T1D in hospitals, outpatient settings, and the community, thereby improving diabetes management and reducing the burden on patients and HCPs.

The need for better education and support has led people with diabetes to feel shocked at the lack of resources available to them. HCPs are calling for the development of the DiAPPeat Sick Day Rules management app to be made available in hospitals, outpatients, and the community. This app would help to streamline and simplify the process of managing diabetes during times of illness, ultimately leading to better outcomes for people with diabetes and less stress for HCPs.

Overall, the study underscores the need for greater awareness, education, and support for individuals living with T1D in Cyprus and highlights the potential for technology-based solutions to improve the lives of those with this condition.

Carbohydrate counting is recognised as a critical issue in diabetes management by individuals with diabetes and HCPs alike. The skill of carbohydrate counting is essential for individuals with T1D to maintain their blood glucose levels within the target range (Holt et al., 2021). According to Laurenzi et al. (2011), individuals using CSII and practising carbohydrate counting can benefit from improved HbA1c (intervention group −0.4 vs −0.05% in control subjects; Δ −0.35%, P = 0.05) and a better quality of life. However, the complexity of this skill often leaves individuals with T1D feeling vulnerable and guilty. The responsibility of counting carbohydrates and adjusting insulin doses is overwhelming, and people with diabetes may experience guilt or shame when they make mistakes (Coffen and Dahlquist, 2009). Additionally, there is an unrealistic expectation by some HCPs that individuals with T1D should acquire comprehensive knowledge of carbohydrate counting. This adds to the individuals' pressure and anxiety.

HCPs are aware of the challenges faced by individuals with diabetes in managing their condition. They often rely on diabetes educators to support them with the tremendous amount of information and skills that must be embraced, including carbohydrate counting

(Coffen and Dahlquist, 2009). To address this issue, a recent study suggests that a multidisciplinary team (MDT) approach is the way to manage diabetes (Steinke, O'Callahan and York, 2017). A recent systematic review and meta-analysis suggest that after a careful second analysis, the carbohydrate counting improves the HbA1c compared to a standard diabetes intervention, SMD-0.52%, 95% CI−0.82 to−0.23 (Builes-Montaño et al., 2022). The MDT approach involves a group of HCPs working together to provide comprehensive care to individuals with diabetes. This approach acknowledges that diabetes management requires a team effort and that each team member has a unique role in supporting individuals with diabetes.

The study participants unanimously agreed that an MDT approach is crucial for effective diabetes management. All members of the Diabetes MDT, including doctors, nurses, dietitians, and diabetes educators, have a role in promoting carbohydrate counting as a critical diabetes management skill. The onus lies with all members of the MDT to encourage carbohydrate counting and provide evidence-based support to enable individuals with diabetes to make informed decisions. This approach requires collaborative efforts and shared responsibility to ensure that individuals with diabetes receive the education and support they need.

The study also highlights the importance of access to online accurate information and registered clinical dietitians for carbohydrate counting education. In many countries, there is limited access to diabetes education, and people with diabetes may not have access to a clinical dietitian. The study emphasises the need for improving access to diabetes education and empowering individuals with diabetes to manage their condition effectively. The study highlights the need for a collaborative approach and shared responsibility in promoting carbohydrate counting as a critical diabetes management skill.

The research study aims to evaluate the usability of the DiAPPeat web application through a mixed-method approach. The methodology involves using Likert-type questionnaires, usability testing, and open-ended questions in the primary survey to gather participant feedback. The author of this study has opted for multiple methods of capturing feedback to ensure the comprehensive and representative view of the participants for DiAPPeat's usability.

To ensure the study's credibility, the opinions of individuals with significant experience in diabetes have been captured. This includes both people with T1D and HCPs. The involvement of HCPs with first-hand experience with T1D lends prestige to this study,

mainly if such professionals belong to the dietetic science and possess extensive experience in carbohydrate counting. By including the views of these individuals, the study seeks to guide the usability outcomes of the web application.

4.4.2. Strengths and Limitations

4.4.2.1. Strengths identified

The text describes a usability test of a web application conducted in Cyprus for the first time. The study's primary objective was to evaluate the application's usability and effectiveness in educating people with T1D on multiple daily injections and insulin pump therapy key stakeholders, the Nutrition and Dietetic Association and experienced HCPs with diabetes.

The PhD study conducted by the author involved thirteen participants who actively participated in the study. According to the participants, the DiAPPeat web application was user-friendly, accessible, and valuable in providing accurate and evidence-based diabetes education to people with T1D nationally. The study's methodology, which involved multiple research methods and tools, contributed to the project's success.

The study recruited people with T1D aged 22 to 65, ensuring that the participants represented a diverse age range and contributing to the study's credibility. The study participants appreciated the DiAPPeat brand's clever, catchy, and promising nature, which holds excellent potential for launching diabetes education in people with T1D. The study was conducted online, and the participants were recruited remotely from their homes and offices, making the study more comfortable and convenient. Both groups of participants found the web application's simplicity and beauty pleasant to use and easy to navigate.

The author wanted to highlight Professor Eleni Andreou's exceptional role in supervising the study. Her extensive knowledge of diabetes and expertise in carbohydrate counting proved to be invaluable in ensuring the success of the research. Moreover, her networking skills and representation of registered dietitians on the National Diabetes Committee made her the ideal supervisor for this study.

Aside from her supervisory role, Professor Eleni Andreou is a private clinical dietitian and Associate Professor at the University of Nicosia/Intercollege, where she teaches and coordinates programs in Dietetics and Nutrition while actively engaging in research and consulting within the food and pharmaceutical industry. She is a Scientific Advisor and

member of several Health Associations, including the Cyprus Association for Cancer Patients and Friends, the Cyprus Diabetes Association, and the Cyprus Heart Association.

Professor Eleni Andreou has authored numerous scientific articles and books on dietetics and has held several prestigious positions throughout her career. She is presently serving as the President of the Cyprus Dietetic and Nutrition Association, the President of the Cyprus Society of Clinical Nutrition and Metabolism (CySPEN), the Vice President of the Cyprus Registration Board for Food Scientists, Technologists, and Dietitians, and a board member of the Cyprus Atherosclerosis Association.

The author of this research has made a significant contribution to the project owing to his unique and extensive experience with diabetes management. The author was raised in Cyprus, where he experienced the day-to-day struggles of living with diabetes from a very young age, as he was diagnosed with the condition at the age of thirteen. This experience has given the author a deep understanding of the challenges individuals with diabetes face, particularly in Cyprus.

Furthermore, the author has worked as a DSN (diabetes specialist nurse) in both Cyprus and the United Kingdom, allowing him to gain valuable insights into the healthcare systems of both countries. This experience has enabled the author to appreciate the strengths and weaknesses of these systems and to understand how they impact the management of diabetes.

In addition to his practical experience, the author possesses certifications in diabetes facilitation/education for DAFNE (Dose Adjustment for Normal Eating) and SEREN (Structured Education for Type 1 Diabetes), indicating their expertise in providing diabetes education and support to patients. The author has significant experience providing structured education to paediatric and adult patients with diabetes, which has undoubtedly contributed to their ability to provide valuable insights and perspectives to this research. The expertise of Professor Eleni Andreou in the American system and the author's experience with the British way of carbohydrate counting were initially viewed as a limitation. However, this is considered to be a strength, as the web application can now support people using both systems with its unique design.

Overall, the unique combination of personal experience, practical knowledge, and educational expertise that the author possesses has been a significant strength in this research project and has undoubtedly contributed to its success.

4.4.2.2. Limitations

Many participants expressed the need for a Greek version of the program during the usability evaluation process. This feedback highlights the importance of language accessibility in mobile health and web applications. Using a foreign language to access information can be a significant obstacle for individuals with limited proficiency in the language used in the online material. This can lead to confusion, misunderstanding, and poor user experience.

The significance of language accessibility has been well-documented in the mentioned literature above. Studies have shown that providing content in the user's native language can improve usability, engagement, and overall user satisfaction. It is, therefore, essential to consider language accessibility during the development of mobile and web applications, especially those designed for international audiences.

It is worth noting that the participants in this study were recruited based on specific research criteria, which required them to have an existing knowledge of the English language. This limitation may have resulted in an underrepresentation of individuals facing language barriers while using the program. Nonetheless, the participants' feedback highlights the importance of language accessibility and the need to provide content in multiple languages to cater to diverse user groups.

In conclusion, as expressed by the participants, the need for a Greek version of the program underscores the importance of language accessibility in mobile and web applications. Developers must consider language accessibility during the design and development stages to ensure their products are usable and accessible to a broader audience. This suggestion is consistent with other research conclusions, which noted that multiple languages remain a worthy goal (Sharma et al., 2022).

To conduct a successful study, the research team consciously tried recruiting HCPs from diverse backgrounds and areas of expertise. This may be perceived as a bias, but the aim was to include professionals from various disciplines, including medicine, nursing, dietetics, and psychology. The researchers collected invaluable perspectives, insights, and feedback from these professionals. Considering the GHS, the research team strongly believes that selecting HCPs on an island with a population close to a million, who have unique roles and are hard to find, can only be viewed as a strength rather than a limitation.

The input given by these experts was constructive, as they have unique knowledge and expertise. This allowed them to provide detailed and distinctive perspectives on the research questions. Moreover, they were proficient in conveying their feedback clearly and concisely, which made it simpler for the research team to implement their suggestions efficiently. Furthermore, the perspectives of these HCPs were taken seriously and validated by the research team. This helped to ensure that the study's results were accurate, valid, and reflective of the diverse perspectives and experiences of the participants. In summary, the feedback provided by HCPs from various disciplines was a critical component of the study's success and contributed significantly to the accuracy and validity of the research findings.

The present study has a potential limitation that needs to be noted: the absence of a follow-up usability testing phase. Due to time constraints, the research team and the study supervisor found incorporating only one usability testing phase appropriate. However, it is essential to mention that despite this limitation, the positive outcomes of the usability testing were well substantiated by the other research methods employed to address the research questions in the present study. The study's findings have opened up new avenues for further exploration. As a result, this is a proposal for the University of Nicosia to consider the DiAPPeat research study as a postdoctoral research offer. This decision is expected to provide additional opportunities to explore the benefits of the DiAPPeat app for individuals who struggle with overeating.

During the usability test of the DiAPPeat web application, which aimed to help participants with T1D better manage their condition, several participants expressed their desire to have the application available as a mobile health application. They cited the convenience and accessibility that a mobile app would offer as reasons for this request. However, the application was initially developed as a web-based application due to the expensive nature of developing a mobile health application and the limited experience of the programmer supporting the project. Despite this decision, the team behind the DiAPPeat project is continuously looking into the possibility of developing a mobile health application in the future.

As a consequence of the COVID-19 pandemic, the project's timeline was extended beyond the initially anticipated duration. The details of this delay have been meticulously recorded and documented in both the Semester Student Supervision Record Sheet and the Annual Student Progress Report forms that were subsequently submitted to the esteemed University of Nicosia for thorough evaluation and analysis.

The study size of the research may have specific limitations, primarily attributed to the small sample size since only 13 participants (6 persons with T1D and 7 HCPs) were recruited for the usability testing. (Otis et al, 2020, Burda et al, 2022, Adu et al, 2020, Barnum et al, 2010). While this sample size is generally accepted for usability testing, the statistical analysis of the results may not be entirely significant due to the small number of participants. It is important to note that larger sample sizes can generally lead to more accurate statistical analyses. Thus, if the research team wishes to reveal more significant statistical results, conducting future studies with more participants may be ideal. This would give the research team a more comprehensive and conclusive understanding of the findings and help establish more accurate conclusions regarding the research in question. A review of the literature indicated that, at the time of the review, there was a lack of mobile applications providing educational content. This gap was identified among the available mobile applications (Chomutare et al., 2011).

The field of diabetes management has made great strides in recent years, with the development of various applications aimed at improving patient outcomes. However, there is still a need for future research to evaluate the usability and long-term effectiveness of these tools. One approach to achieving this goal is through clinical trials, which can provide valuable insights into the efficacy of these applications in real-world settings. Such trials can also help identify scenarios that best suit individual patients and provide evidence for incorporating these applications into clinical practice and patient homes.

In addition, research involving more participants/users is necessary to effectively evaluate usability and long-term self-management. This is particularly important because diabetes management is a complex and multifaceted process that requires ongoing attention and care. By studying a more significant number of patients, researchers can gain a more nuanced understanding of the challenges and opportunities associated with diabetes management and develop more effective interventions.

Furthermore, it is essential to target diverse age groups, such as children and persons over 65, to ensure that the needs of all individuals with diabetes are met. For example, children may require different types of support and guidance in managing their diabetes than adults. Likewise, older adults may have unique challenges associated with diabetes management, such as cognitive decline or mobility issues, that need to be taken into account when designing interventions.

4.5. Conclusion

This chapter analysed and discussed the project's results from individuals with T1D and HCPs, with positive feedback on its ease of use and usefulness. The discussion facilated with the presentation of literature to support the usability method and evidence for the usefulness of "DiAPPeat" web application as a self-management online tool for people with T1D in Cyprus.

CHAPTER 5 CONCLUSIONS

5.1. Introduction

The statistics highlight the significant impact of T1D on the Cypriot population and the need for continued efforts to improve diabetes management and prevention strategies. In this framework, developing or adopting a structured education is a complex intervention, especially when there is a need for cultural adjustment and employment, such as quality assurance, audit processes, and structured curriculum. The literature supports online education. However, its usability is an ongoing process. It is worth investigating the quality of applying usability testing in online health applications.

According to a report commissioned by Diabetes UK, Level 2 education in diabetes includes face-to-face group-based education, peer-based approaches and technology and internet-based approaches (Wenzel, 2016). The study's author supports that a newly developed web application, "DiAPPeat", belongs to level 2 education. This project aims to make a usable and comprehensive online prototype educational tool based on carbohydrate counting in Cyprus. Diabetes education in Cyprus is in its infancy, without semi-structured or structured education programmes for T1D. The "DiAPPeat" focuses on educational material, including practical tools and carbohydrate counting. A recent study suggests that improvements in the accuracy of carbohydrate counting result in better glycaemic outcomes (Kesavadev et al., 2021).

Although the web application "DiAPPeat" was designed and developed with a focus on T1D, other groups can benefit from this tool with the expansion of the scope of this application, such as children, parents, people with T2D, people with nephropathy and others diabetes complications (Aberer, Hochfellner and Mader, 2021; Gong et al., 2020a; Gong et al., 2020b; Schrauben et al., 2022).

The international literature suggests that self-management of diabetes can be supported by various features such as blood glucose monitoring, weight management, physical activity tracking, dietary monitoring, insulin and medication management, and blood pressure monitoring. Additionally, research findings have indicated the availability of education on diabetes management. Features such as diabetes-related alerts and reminders, integration of social media functions, data export related to diabetes, and communication functionalities were found to support end-users with diabetes. Furthermore, the synchronisation with personal health record (PHR) systems or patient portals was identified as a key parameter that mHealth applications use to support end-users (Chomutare et al., 2011).

5.2. Reflection on the research questions

The study's research questions encompassed the views and preferences of individuals with T1D about the usability of the DiAPPeat web application and how they can be accurately captured. The systematic online feedback provided by the participants shed light on the usability and usefulness of the newly developed web application while highlighting areas for improvement. Since the tool is based on carbohydrate counting, the individuals with T1D and HCPs involved in the study believe it can significantly impact end-users diabetes management in real-life scenarios. The individual preferences and views of people with T1D were taken into consideration while researching the usability of the DiAPPeat web application. It was essential to capture their feedback accurately. The online systematic feedback provided by the participants of this study provided evidence of the usability and usefulness of the newly developed web application and highlighted areas for improvement. As the tool is based on carbohydrate counting, both groups, people with T1D and HCPs, believe it can support end-users diabetes management in real life with a significant impact.

The systematic literature review has identified several strengths and limitations of online health applications for individuals with T1D. After an in-depth review and analysis of these studies' findings and conclusions, DiAPPeat has been developed. The web application is designed with a user-centric approach, providing end-users with comprehensive features carefully crafted and informed by evidence-based characteristics derived from global literature. The author has accumulated years of experience in diabetes technology, which has helped to shape the application's design, functionality, and usability. Additionally, the author conducted extensive research and drew insights from diabetes associations, where individuals with diabetes generously shared their thoughts, uncertainties, and worries openly and candidly. The application's features cater to the specific needs of users with diabetes, providing them with a personalised and intuitive experience that empowers them to manage their condition confidently and efficiently.

This mixed methods study aims to develop a usable and valuable online diabetes learning tool based on carbohydrate counting available to people with T1D and HCPs in Cyprus and to evaluate the usability and user experience.

The research question, "What are the views and preferences of adults with T1D and HCPs with relevant expertise in Cyprus regarding the usability of the DiAPPeat online educational tool for managing diabetes through carbohydrate counting?" was investigated through a mixed-method approach. The study aimed to identify the extent of usability of

DiAPPeat, a web-based educational tool for managing diabetes through carbohydrate counting. To accomplish this, the researcher employed various instruments and tools.

The data from the study revealed that people with T1D and HCPs expressed high confidence levels in the web application. The DiAPPeat application was positively evaluated across all sections by the participants, both persons with T1D and HCPs. These results align with recent research studies (Otis et al., 2020; Ng et al., 2019; and Albanese-O'Neill et al., 2019). Specifically, evaluations of the overall content, Diabetes, Applications, Eating, Food Search Engine, and DiAPPeat Café sections, were positive, with all receiving the highest rating of 4 or 5, or 1 and 2 as appropriate.

Most HCPs who participated and were involved in the usability test expressed their enthusiasm regarding the quality of the DiAPPeat application and its prospects. They underlined their willingness to use it and promote it. In collaboration with other stakeholders like the Ministry of Health and the State Health Services Organisation (SHSO), UNIC could officially improve, accept and support it and promote it for implementation in clinical practice and the community.

The research team must prioritise improving the "DiAPPeat" web application based on feedback from individuals with T1D and healthcare professionals involved in this usability study. This is expected to impact the effectiveness of the web application when it is evaluated in the future. Suggestions regarding AI implementation and the use of images, animations, and videos can enhance end-user engagement. It is also important to ensure the educational material is current and relevant to the local health system to support adults with T1D in Cyprus.

5.3. A final thought on the application

The study suggests that the web application's user-friendly design and intuitive interface, with some modifications and improvements, could play a crucial role as an intervention tool in the self-management of T1D based on carbohydrate counting.

However, modifications suggested from the usability study indicate some areas for improvement. Participants with T1D suggested some realistic modifications for the "DiAPPeat" web application. The usability study suggests that people with T1D and HCP recommended using limited text and more visual educational material. Specifically, Cypriots want to see food images on the "Food Search" items. Similar concepts are

suggested in the market, i.e. Carbs and Cals; although costly to create and maintain, it is a valuable development of the concept that the web application “DiAPPeat” is providing.

Other recommendations received by people with diabetes from the usability study suggest using AI technology in the web application. Unfortunately, the use of AI has limited application in this project as it requires reconstruction of the whole programme to be able to support this type of advance. However, the author is ready to explore funding resources to explore the possibility of adding some elements of AI if possible.

Some HCPs recognise the difficulty that different age groups may experience using the web application. The evidence informing the international literature about using web applications to support various patient groups and provide educational material exists. The web application "DiAPPeat" was originally developed to primarily address the needs of individuals with T1D. However, through the expansion of its scope, this versatile tool has the potential to offer valuable support to a diverse range of users. Beyond those with T1D, the application can also cater to the needs of children, parents, individuals managing T2D, as well as those dealing with nephropathy and other diabetes-related complications. By broadening its scope, the application can extend its benefits to a wider population, providing essential support to various users.

The web application is due for several updates, as the author plans to make significant changes. These updates will incorporate the Greek language script and translate all existing content into Greek. Additionally, the author intends to enhance the user experience by including high-quality images of Cypriot foods with more detailed and accurate descriptions. Furthermore, the author aims to secure research funding to support the expansion of the web application into a mobile application. To improve the overall quality of the content, the research team will conduct a thorough review and create engaging videos to supplement the existing material. Finally, the author is considering the possibility of integrating an AI element into the web application. However, it's important to note that this AI element will not provide any form of medication advice.

The upcoming web or mobile application changes have been designed in response to feedback gathered from extensive usability testing with users. These changes will enable our research team to carry out further usability tests, allowing us to evaluate the impact on usability scoring. Usability is a critical factor as it significantly influences the success and appeal of the application among end-users.

Overall, the research findings evaluating the usability of diabetes management tools will have significant implications for patient care and outcomes. By identifying the most effective applications and interventions, researchers can help improve the lives of millions of people living with diabetes.

5.4. Future research

The study's findings could serve future research for designing and improving educational tools, especially in content, layout, usability and accessibility.

In this study, it was decided to incorporate only one usability testing phase for time constraints. Future research can include the second usability testing phase. As a result, this is a proposal for the University of Nicosia to consider the DiAPPeat research study as a postdoctoral research offer. This decision is expected to provide additional opportunities to explore the benefits of the DiAPPeat app for individuals who struggle with overeating.

During the DiAPPeat project, which aimed to help participants with T1D better manage their condition, several participants expressed their desire to have the application available as a mobile health application. The design and development of a mobile health application is another challenge for future work.

The study size of the research may have specific limitations, primarily attributed to the small sample size. While the small sample size is generally accepted for usability testing, the statistical analysis of the results may not be entirely significant due to the small number of participants. It is important to note that larger sample sizes can generally lead to more accurate statistical analyses. Thus, conducting future studies with more participants may be ideal.

There is still a need for future research to evaluate the usability and long-term effectiveness of these types of online tools. One approach to achieving this goal is through clinical trials, which can provide valuable insights into the efficacy of these applications in real-world settings, clinical practice and patient homes.

In addition, research involving more participants/users is necessary to evaluate usability and long-term self-management effectively. This is particularly important because diabetes management is a complex and multifaceted process that requires ongoing attention and care. It is essential to target diverse age groups, such as children and adults over 65, to ensure that the needs of all individuals with diabetes are met.

5.5. Conclusion

The thesis focuses on the development of an online educational tool for adults with T1D living in Cyprus, based on carbohydrate counting and incorporating their views and needs. The study used a mixed methods approach, gathering feedback from individuals with T1D and HCPs to assess the usability of the newly developed web application prototype. The reflection on the research questions. The study's findings and insights could be valuable for future research in the design and enhancement of educational tools for diabetes management. This marks the first attempt to create and develop such a web application in Cyprus.

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Appendices

Appendix 1: Systematic Review Selected Articles

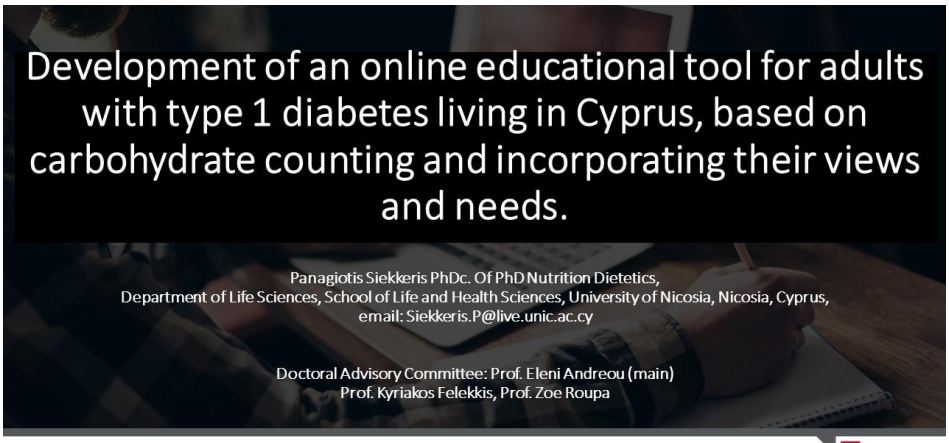
Authors	Country	Aims/ Objectives	Design/ Methods	Diabetes experience	Participants number/ gender	Age (years)	Type of mHealth/ software platform	Usability Definition	Measurement tools
(Sharma et al., 2022)	US	Developing a structure to assess the pros and cons of mobile Health (mHealth) applications for diverse and low-income communities.	Qualitative study and survey: Framework development and application study Literature review, selection of health applications, evaluation and feedback on mHealth apps in three areas, one of them in diabetes management	Clinical experts Patient advisory board	Clinical experts: Not Specified Patient advisory board 4(F)	Clinical experts: Not Specified Patient Advisory Board 35-75	Diabetes management: (1) Glucosio, (2)MyNetDiary Smoking cessation: (1)QuitNow!, (2) Smoke Free-Quit Smoking Now Medication Adherence: (1) Medisafe, (2) MyMeds	Domain definitions and scoring table 1 .	Weighted scoring methodology

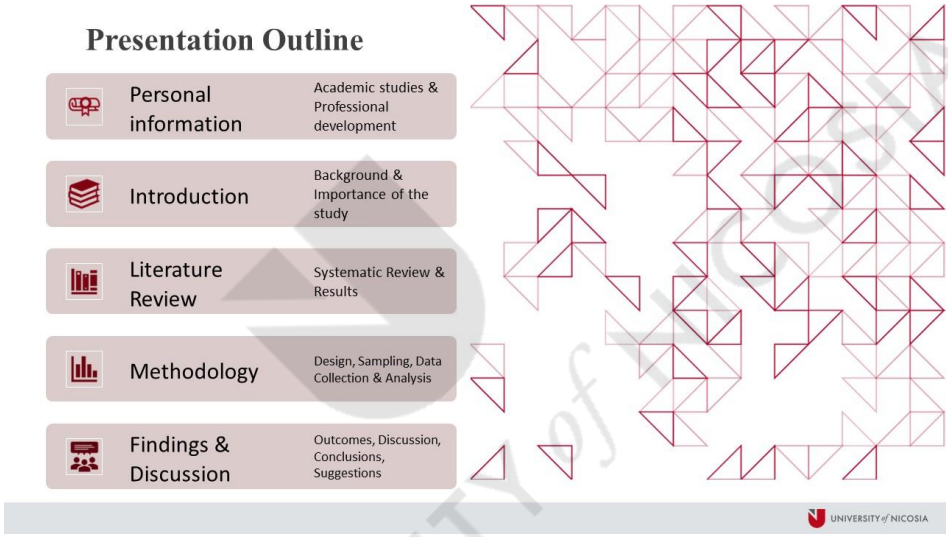
(Otis et al., 2020)	US	Phase 1: Gathering of qualitative data on the usability and acceptability of the Mobile Diabetes Educator. Phase 2: Assessing the feasibility and preliminary efficacy of delivering the MDE in a clinical setting	Mixed methods pilot study Incorporates two concurrent phases with differing study participants. Phase 1: Qualitative data collection on the usability and feasibility of the tool. Phase 2: Quantitative data collection regarding the tool's practicality and effectiveness.	T1D + parent	Phase 1: 22 (11 parent-child pairs) Phase 2: 20 (10 parent-child pairs)	5-14	Mobile Diabetes Educator (MDE) Tool	Comprehension, High Engagement, Low Engagement, Purpose, Satisfaction, Suggestions for Improvement	Phase 1: User testing interviews: 90 min and consisted of an observational component and a semistructured interview.- Think- aloud protocol Phase 2: A single-arm pre- and post-trial assessment- paired t tests for continuous outcomes and the Fisher exact test for categorical outcomes. Statistical analyses were conducted using SAS version 9.4. The data were considered to be statistically significant at an alpha value of .05.
(Ng et al., 2019)	AUS	Testing usability and acceptability of a patient-informed mHealth support program	Mixed methods study Observational study and website usability survey Facebook and google analytics	T1D	34 (6M, 28F)	18-35	Diabetes (YES)	Utah State University. Website Usability Questionnaire 2019, https://www.dropbox.com/s/ne871fz0dvop61k/Website%20Usability%20Survey.pdf?dl=0 (2019, accessed 3 October)	8-item website usability survey Google analytics - website useage, website usability survey- ease of use, Facebook analytics - peer support engagement, Evaluation - Likert scales and open-ended questions
(Harrington et al., 2021)	US	Evaluating usability of SM app	Qualitative Study: Heuristic Evaluation The diabetes app was chosen for the diabetes condition Heuristic evaluation on the usability of the app based on Nielsen's heuristic Pareto analysis (Each type of heuristic violation, bar	Single-domain expert in informatics and research nurses	n=4	N/A	Commercializing mobile health app	Usability refers to “the extent to which specified users can use a product to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use	Nielsen and Molich in 1990 heuristic evaluation and add the test results to an Excel spread sheet to show the problem location, description, heuristic violated, severity, and suggested solution

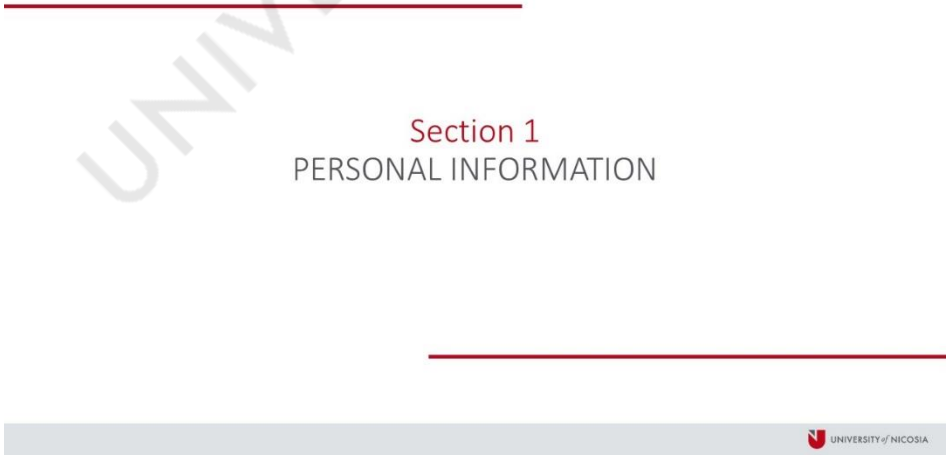
			chart to show associated severity)						
(Burda et al., 2022)	CZ	Describing the process of development of a mobile app and investigating how individual features are used and the long-term advantages analysed the impact of the app on the self-management of DM	Long-Term Case Study The research team developed and provided a free application to study long-term use.	T1D T2D No DM	T1D (1M, 1F) T2D (5) No DM (1)	46-54	Mobiab	elements of usability described in the study	external clinical study.
(Albanese-O'Neill et al., 2019)	US	Soliciting and incorporating input from fathers of children with T1D into the design, content, and infrastructure of a suite of online diabetes self-management education and support (DSMES) resources.	Mixed-method study Phase 1: Exploratory research Phase 2: Website and subdomain development Phase 3: Website and subdomain evaluation	Fathers of children with T1D	Phase 1: n=30 (M) Phase 2: Participants not included Phase 3: n=33 (M)	Mean 47.8	T1DToolkit.org (Website) and Mobile Diabetes Advice for Dads, or mDAD	Ability to access the site, review content, and navigate the site) SPSS Statistics	Phase 1: One-on-one semi-structured interviews and an online survey Phase 2: App prototype development Phase 3: Prototype evaluation via survey

(Adu et al., 2020)	AUS	Development of a mobile phone app for supporting self-management in people with T1 or T2D. Report a full description of the development and usability testing process prior to use in a pilot trial.	Mixed Methods Study Design A user-centered design approach	T1D T2D No DM Expert advisory group App developers	Phase 1: 8 testers without diabetes Phase 2: 4 persons with T1D (1)+T2D (3)	28-76	My Care Hub Mobile App	My Care Hub Usability Questionnaire Tests the functionality with questions assessing performance, ease of use, navigation, gestural design See the views on Aesthetics with assessing the layout, general graphics, visual appeal, graphic visual appeal of analytics, overall rating Additional Questions for participants who have diabetes on Satisfaction with My Care Hub for Diabetes Self-Management Asks about the usefulness, target group, Quality of information, app feedback, awareness of the My Care Hub improving the knowledge and awareness of diabetes self-management, the motivation to engage with the self-management activities, intention to use, recommendation Three close-ended questions if the user liked or disliked anything about the My Care Hub and any other observations.	Phase 1: Online survey questionnaire. The testers were asked to rate the app's funcionality (performance, ease of use, navigation, gestural design) and aesthetics (layout, graphics, visual appeal). Phase 2: In addition to functionality and aesthetics, the testers also provided feedback on their satisfaction using various measures

Appendix 1I: Final VIVA presentation slides







Professional Experience

11/2022: Paediatric Diabetes Specialist Nurse Band 7– Milton Keynes University Hospital

03/2019: Diabetes Advanced Nurse Practitioner Band 7 – Milton Keynes University Hospital

03/2019: Diabetes Specialist Nurse Band 6- Northampton General Teaching Hospital

07/2016: Cardiac Intensive Care Staff Nurse: Bristol Heart Institute University HospitalsBristol NHS Foundation Trust

01/2015: Staff Nurse (Medical Ward) Band 5- Royal Albert Edward Infirmary Hospital

09/2014: Staff Nurse (Medical Assessment Unit)- Band 3-5 Leighton Hospital

UNIVERSITY of NICOSIA

Academic and other Experience

Remote DAFNE Educator (Dose Adjustment For Normal Eating),

SEREN Educator (Structured Education Reassuring Empowering Nurturing),

2023: Certificate Management of Childhood Diabetes (Postgrad.) - Birmingham City University

2017: present: ***Ph.D. candidate*** – Depart. of Life and Health Sciences- University of Nicosia, Cyprus.

2013-2015: ***M.Sc. in Diabetes***- Faculty of Medicine, University of Leicester, United Kingdom.

2009-2013: ***B.Sc. (Hons) in Nursing***- Department of Nursing, Technological University of Cyprus.

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Research Experience

Undergraduate Dissertation: Systematic review titled: "Investigation of Quality of Life in Children and Adolescents with Type 1 Diabetes on insulin pump therapy" passed with distinction.

Postgraduate Dissertation: A retrospective observational cohort study titled: "7-Year Experience From A Tertiary Centre Insulin Pump Service And The Impact Of Dafne Structured Education On Metabolic Outcomes" passed with distinction.

PhD Thesis: Development of an online educational tool for adults with type 1 diabetes living in Cyprus, based on carbohydrate counting and incorporating their views and needs.

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Journals due for publication

Systematic Review

Systematic Review on the existing online education in type 1 diabetes

Panagiotis Siekkeris[1], Zoe Roupa[1], Kyriacos Felekkis[1] and Eleni Andreou[1*]

Qualitative Study

Identifying the views and preferences of adults with T1D and healthcare professionals (HCP) with relevant expertise in Cyprus concerning the usability of the DiAPPeat online educational tool for managing diabetes through carbohydrate counting.

Panagiotis Siekkeris[1], Zoe Roupa[1], Kyriakos Felekkis[1] and Eleni Andreou[1*]

Contribution to developing Guidelines, Local Policies, PILs & Audits

Conference Proceedings (with ISBS)

- 11th CyDNA Conference (2021)

Dose Adjustment For Normal Eating (DAFNE) Insulin Pump – Case study

Oral presentation

20+2 YEARS LET'S TALK DIETETICS: COLLABORATION TO EVOLVE PRACTICE, IMPROVE NUTRITION CARE

11th Cyprus Dietetic & Nutrition Association International Conference

19-21 November, 2021

- 12th CyDNA Conference (2023)


EXCELLENCE IN NUTRITION & DIETETIC RESEARCH AND PRACTICE 177

PP 005

A systematic Review of the Usability Methods and other factors in the Evaluation of online Health Applications for Type 1 Diabetes

Section 2
INTRODUCTION

Research Aim and Questions

- **Aim:** To develop a usable and valuable online diabetes learning tool based on carbohydrate counting available to people with T1D in Cyprus.
- **Research questions:**
  - **What** are the **views and preferences** of adults with T1D regarding the usability of a novel online educational tool for managing their condition?
  - **How** can the users' **feedback and input** be systematically collected for the online educational tool to ensure that it meets the specific needs and preferences of the target audience?
  - **What** are the **views and preferences** of **adults with T1D** and **healthcare professionals (HCP)** with relevant expertise in Cyprus regarding the usability of the **DiAPPeat** online educational tool for managing diabetes through carbohydrate counting?

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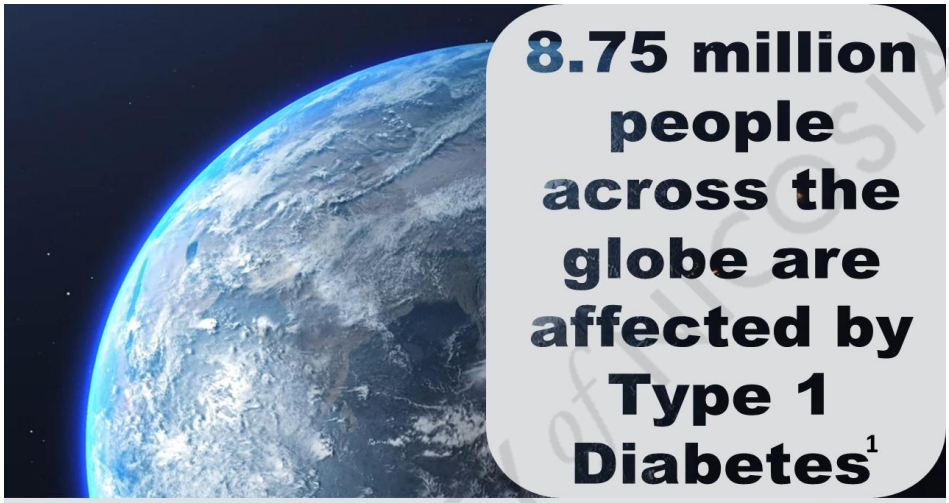

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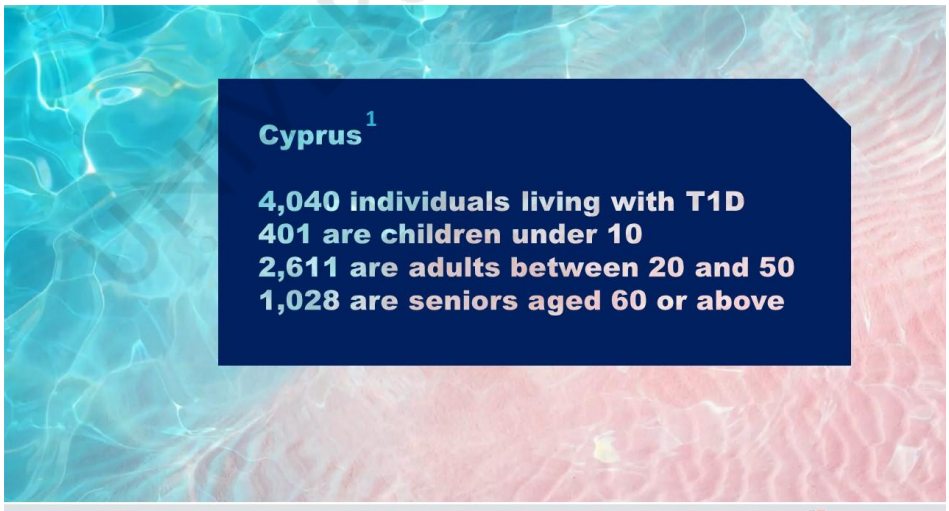

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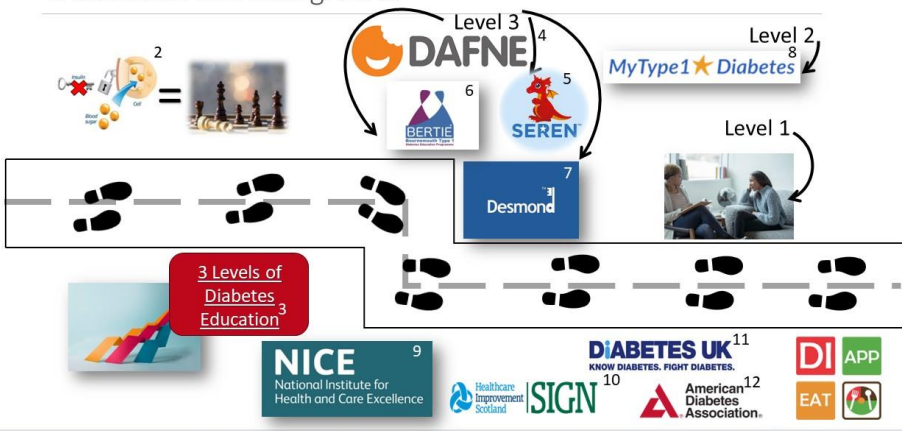
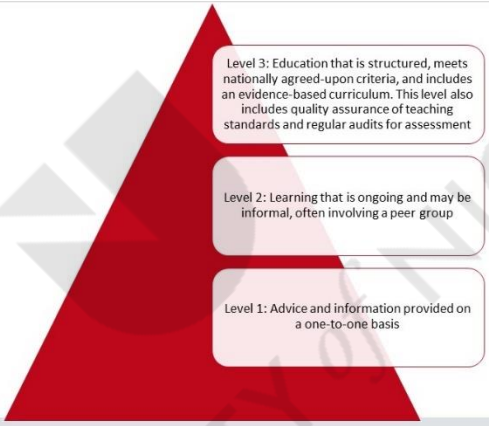
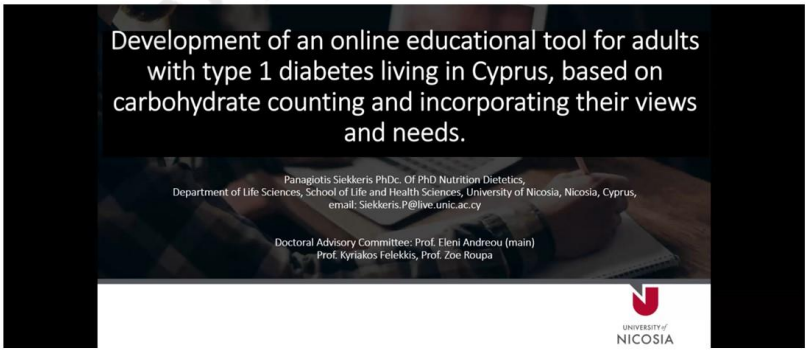
Motivation and Background



Levels of Education in Diabetes



An overview of the web application



Terminology

- **Usability**: "How useful, usable, and satisfying a system is for the intended users to accomplish goals in the work domain by performing certain sequences of tasks" [13],
- **Usability Test**: It evaluates a product, system, or service by observing the actual end-users during their interaction with the element [13],
- **Carbohydrate counting**: Counting the total carbohydrates of a food or meal to ensure that you match the amount of insulin with the carbohydrate counted [14],

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Current Situation

- National situation: Diabetes education for people with T1D in Cyprus is at its infancy level.
- Identified the need of designing and developing an online diabetes tool,
- Test the usability of the online practical and educational diabetes web application,

↓

Responses received by people with T1D and HCP

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Rationale of Research

- Diabetes education is the **cornerstone** of diabetes care as an intervention to delay or avoid diabetes complications [15, 16, 17],

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Section 3
LITERATURE REVIEW

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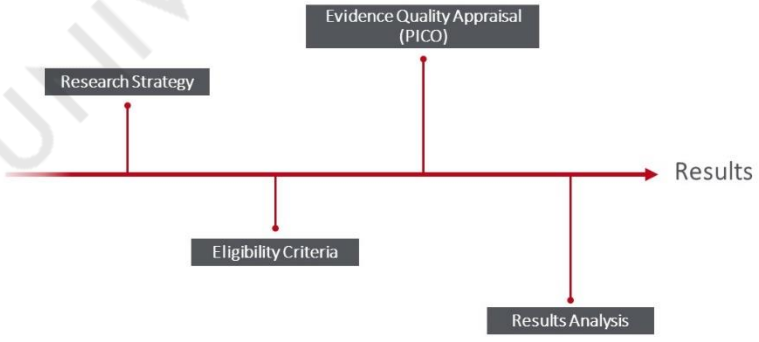
What the author gathered from the Systematic Review

- The systematic review provides an overview of the methodologies used to evaluate mobile or web apps for diabetes self-management,
- This highlights the challenges adults, children and cerrers face with T1D and the need for effective interventions,
- Usability definitions,

Materials and Methods



Systematic Review Introduction

- The writer conducted a systematic literature review on self-care and self-management interventions for diabetes using library databases and the PICO tool,
- **Keywords:** Systematic Review, Type 1 Diabetes, Usability Methods, Online Health Applications, International Evidence, Diabetes Self-Management, User-Centered Design, Mobile Technologies, Web-Based Applications, Evaluation Factors.

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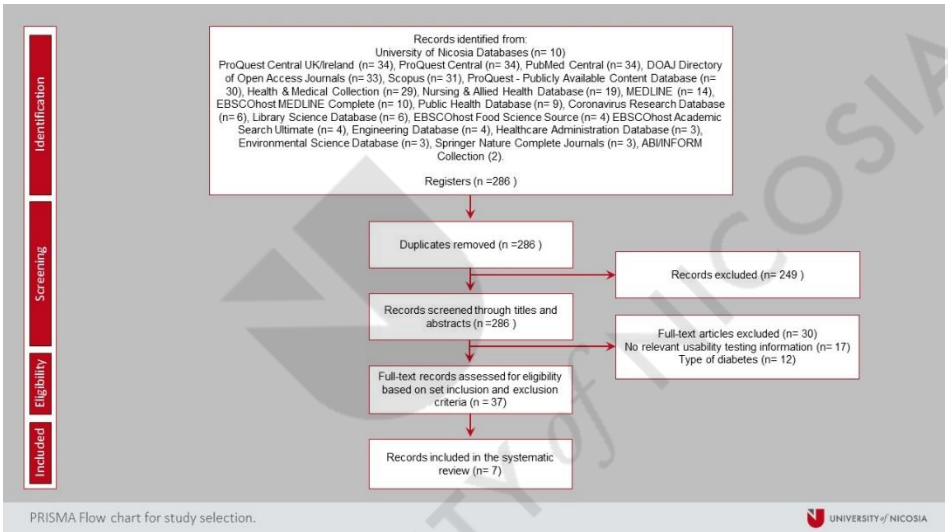

PRISMA Flow chart for study selection.

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Systematic Review Results

- The **seven** studies identified used various methods and designs to produce acceptable evidence [18-24],
- **Four out of seven** (4/7) studies used mixed methods [18-21],
- One used heuristic evaluation with Pareto analysis[22],
- One used weighted scoring with feedback[23],
- Articles were studied for secondary outcomes, adoption factors, and limitations,

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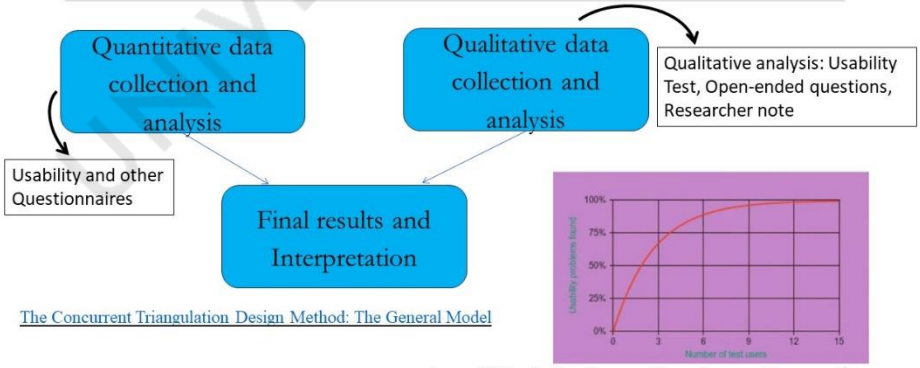
Discussion

- The current systematic review of the 7 selected studies demonstrates the significant effect of the usability of the mHealth applications.
  - The methodology mainly used is Mixed methods
  - The author of the PhD study adopts the Mixed method methodology to evaluate the web application Diappeat.
- The author used the feedback discussed in the selected articles to pre-empty errors or mistakes in the prototype application Diappeat.

Section 4
METHODOLOGY

Mixed-Method Triangulation[25]



As per Nielsen's idea, linear evidence for recruiting a small number of participants [26]

The Philosophical Framework[26]

- Emphasis on the importance of philosophy in research,
- The study aims to set the scene for structured educational pathway for people with T1D based on carbohydrate counting,
- The study falls under the paradigm of pragmatism,

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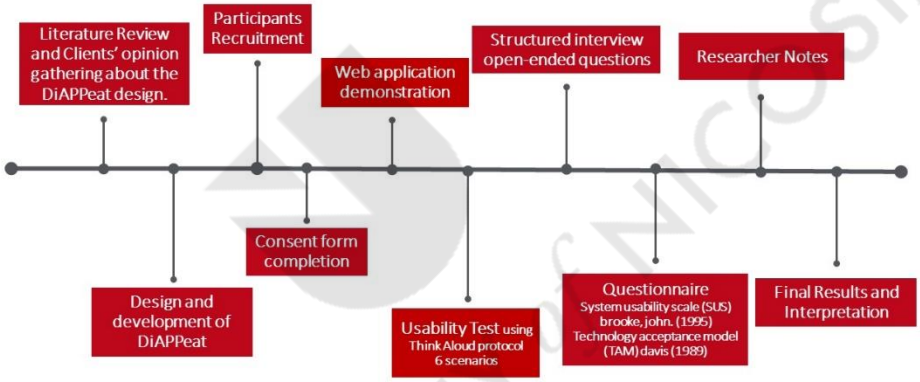
Materials and Methods



Cyprus Bioethical Committee Approval Number: EEBK/ΕΠ/2020/65

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Sample of the study

	People with T1D	HCP
Population	6	7
Gender	4 female 2 male	6 female 1 male
Mean age	40.7	45.5
PgD degree	66.7%	71.4%

	People with T1D	HCP
Regime	MDIn=3 CSIIn=3	N/A
Time on internet	3-5 hours – 67%	1-3 hours – 57.1%
Time on FB	<1 hour – 50% 1-3 hours – 50%	<1 hour – 57.1% 1-3 hours – 42.9%
Diabetes Experience	More than 10 years*	More than 10 years except one**

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Data collection

- Data collection procedures were well-planned and adhered to ethical research practices.
- Bioethics approval provided, reference number ΕΕΒΚΕΠ2023.01.308.
- Data was collected through user testing, validated questionnaires, and a feedback form - Informed consent was obtained from participants.
- Data storage was secure and followed EU GDPR regulations.

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Materials and Recourses

- **Various physical materials:** software programs
- **Human or social resources:** programmers, graphic designer, and legal support, consultations with experts in various fields,
- The study is primarily self-funded,

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DiAPPeat security

An experienced IT Informatic was recruited to develop a diabetes web application based on the literature search about the views and needs of people with T1D.	The web application has been designed and developed with a strong emphasis on security and data privacy.	The application utilises a 256-bit encryption SSL certificate to establish a secure connection between the client and server, ensuring that sensitive data is transmitted safely and securely.	The PHP Zend Framework has been used to build the application, known for its robustness, reliability, and security.
The database used by the application is hosted by a qualified and experienced company with a proven track record of providing secure and reliable hosting services.	Access to the application is managed through user permissions, controlled by a user management feature that securely stores each user's username and encrypted password.	The hosting provider takes several measures to protect and secure the software, including using a firewall to prevent unauthorised access and implementing strict access controls to limit access to authorised administration only.	The hosting company is also responsible for performing automated daily backups of the database and software, ensuring that data loss is minimised in any unforeseen circumstances.

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Section 5
FINDINGS & DISCUSSION

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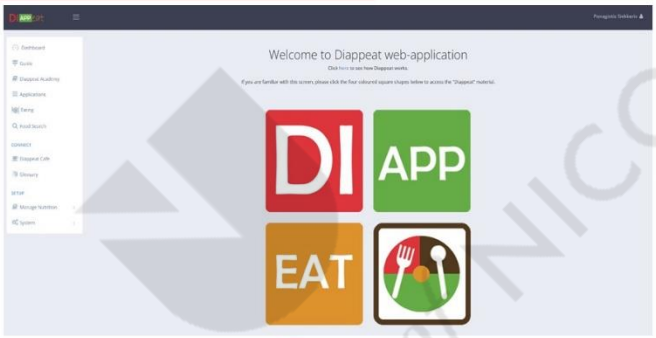
Diappeat
Web application home screen



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People with T1D post DI APP EAT demonstration outcomes

Usability Test
+
System Usability Scale (SUS)
+
Structured interview open-ended questions
+
Researcher Notes

The study evaluated participants' feedback on the DiAPPeat web application, which provides e-learning opportunities about diabetes.	Participants found the web application welcoming, engaging, and informative.	Various presentation modes, such as animations, videos, and podcasts, received praise.
The recipe of the month section received excellent feedback, with participants expressing admiration for the multiagency approach.	Participants suggested that the presentations could be printed or displayed electronically in diabetes clinics for easy accessibility.	Overall, the participants found the tool comprehensive, pragmatic, interactive, and useful in managing blood glucose levels beyond the normal range.

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People with T1D own words

The participants were more engaged in topics such as "Cypriot Food Search", the carbohydrate counting, the logbook, learning about hypoglycaemia, "Managing your illness (Sick day rules)", and recipes

Participant " I don't feel alone; I don't!".

Participant " I am impressed, wow!".

Participant was highly impressed with the application, remarking, "I find it very good; it seems that everything you need is there".

Recommendation presentations could be printed or displayed electronically in diabetes clinics, such as waiting areas, for easy accessibility.

Recommendation adding an AI chatbot to support individuals in treating hypoglycaemia.

Recommendation reducing the amount of text containing hidden information.

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HCP post DI APP EAT demonstration outcomes

Usability Test
+
System Usability Scale (SUS)
+
Technology acceptance model (TAM)
+
Structured interview open-ended questions
+
Researcher Notes

The DiAPPeat web application received positive feedback from various medical professionals. All HCPs recommended the DiAPPeat web application for managing T1D.

The Diabetes Specialist Nurse praised the app's unique Food Search feature and believed it would be a valuable resource for people with diabetes.

The diabetologist commended the practicality of the application and its tools, but raised concerns about its accessibility to older individuals who lack computer literacy.

Both dietitians found the application user-friendly and helpful, with the Food Search and Logbook features being particularly valuable.

The Community Diabetes Specialist Nurse praised the app's usability, speed, and effectiveness of the EAT section and Food Search feature.

The Clinical Psychologist praised the clear instructions and well-organized information guides and found the app beneficial for individuals with T1D.

The Nurse Educator expressed admiration for DiAPPeat's patient-centred approach and believed it had the potential to revolutionise diabetes management.

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HCPs own words

The ability to adjust the food weight in the Food Search tool makes it a unique tool.

Well done to your team, what I am seeing is beyond expectations.

I can see its success in the clinical and community setting to improve the diabetes knowledge

Suggestion: Adding images of measured meals and foods to assist individuals with T1D in insulin adjustment and carbohydrate counting.

Suggestion: To make the web app available in all browsers.

Recommendation: Incorporating a video or animation demonstrating the insulin administration technique and how to check the blood glucose.

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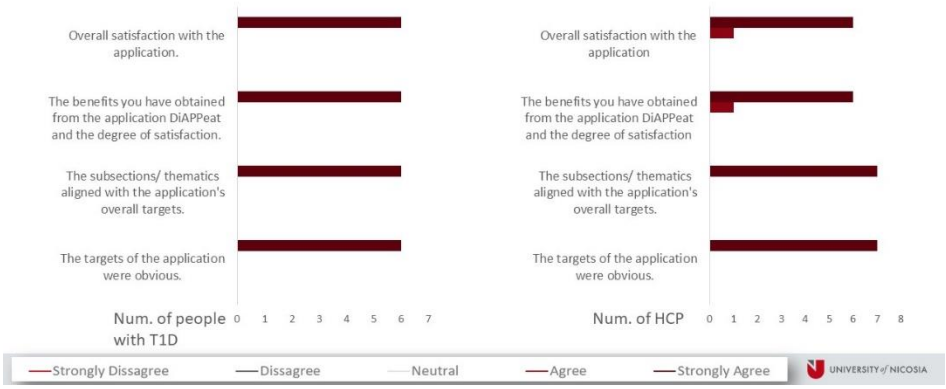
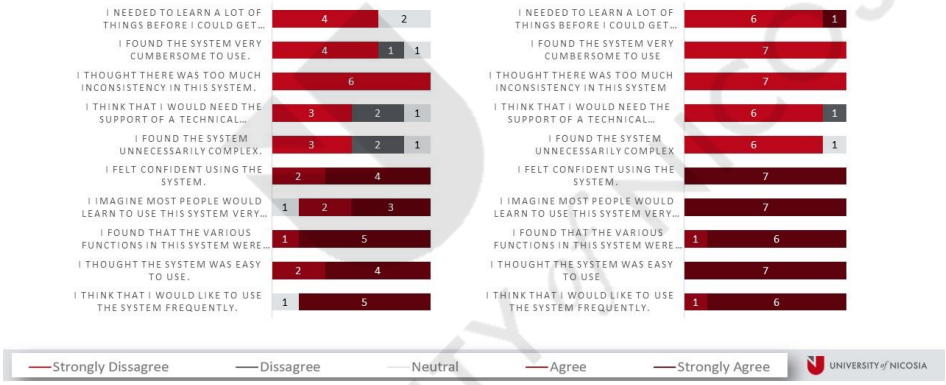
What People with T1D & Healthcare Professionals overall think about DiAPPEat



People with T1D & Healthcare Professionals 10- System Usability Scale (SUS)



THE TECHNOLOGY ACCEPTANCE MODEL – TAM HEALTHCARE PROFESSIONALS

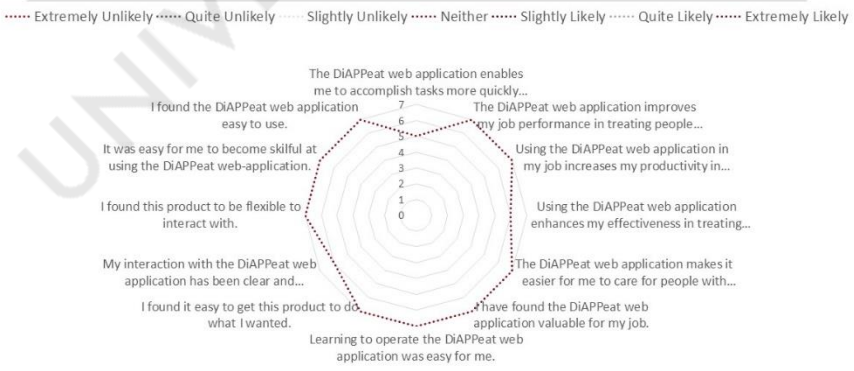


Table 4.10 in the thesis

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Let's see the usability evidence for the Web application

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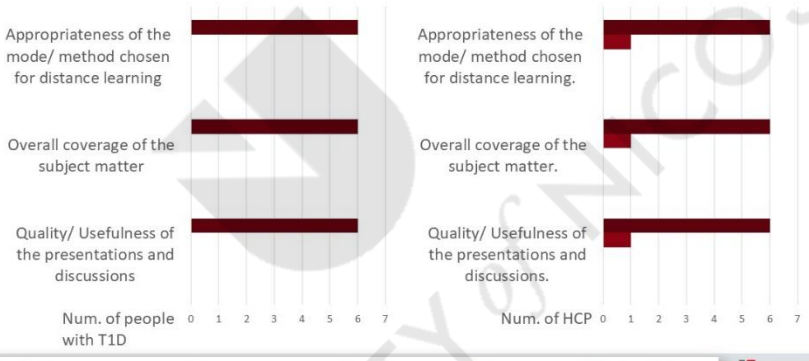
What People with T1D & Healthcare Professionals think about DI



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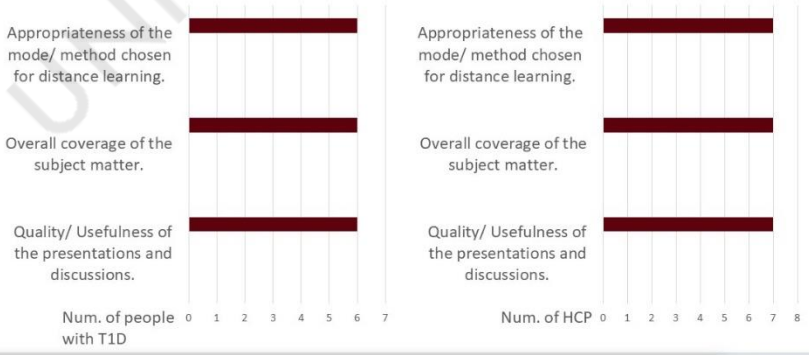
What People with T1D & Healthcare Professionals think about APP



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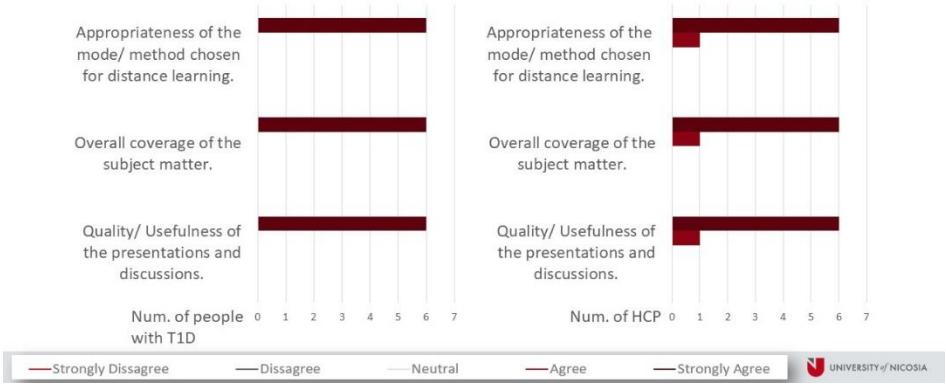
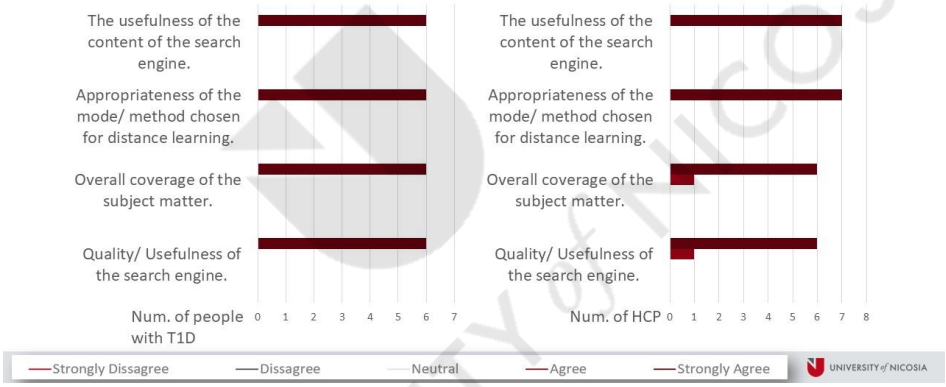
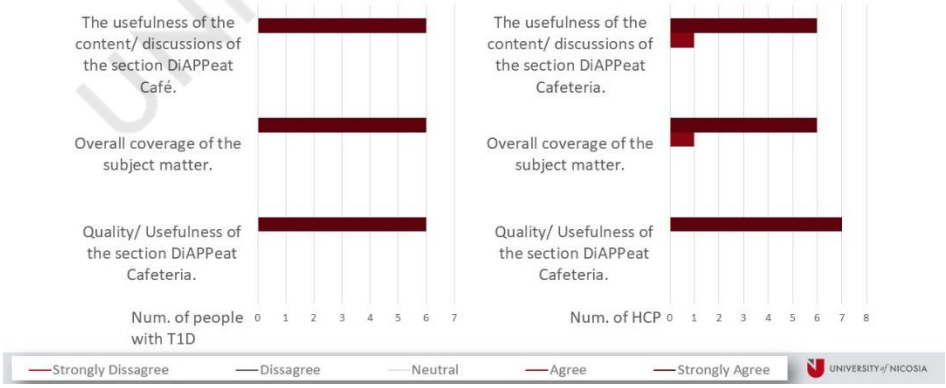
What People with T1D & Healthcare Professionals think about EAT



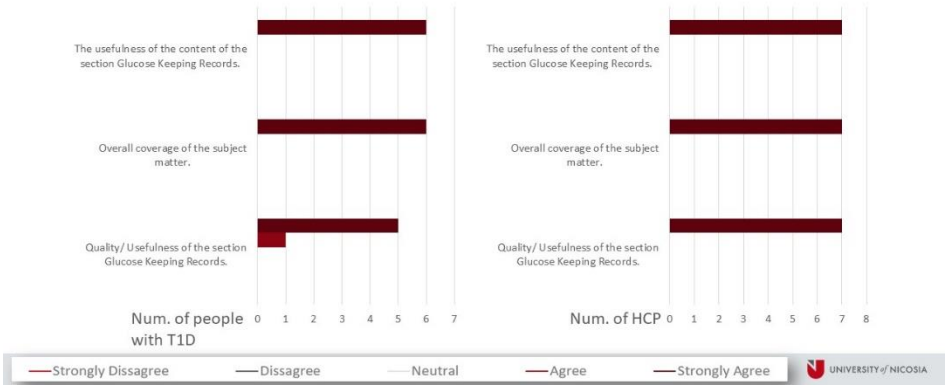
What People with T1D & Healthcare Professionals think about



What People with T1D & Healthcare Professionals think about Diappeat Cafe



What People with T1D & Healthcare Professionals Think about Section Logbook- Glucose Keeping



Summary of the Results

The study evaluated the usability of the DiAPPeat web application for people with type 1 diabetes and healthcare professionals.

The System Usability Scale (SUS) and Technology Acceptance Model (TAM) were used to evaluate the application.

Both people with T1D and HCPs expressed high confidence levels in web applications.

The DiAPPeat application was evaluated positively across all sections by the participants.

The quality, usefulness, coverage, and appropriateness of the methods used in the application were highly evaluated by the participants.

The study highlights the importance of designing user-friendly and practical applications that meet HCPs' needs.

The study contributes to the growing literature on web applications for HCPs and end-users with T1D.

An MDT involving all relevant professions is needed for the better utilization and incorporation of this type of technology for the provision of health services

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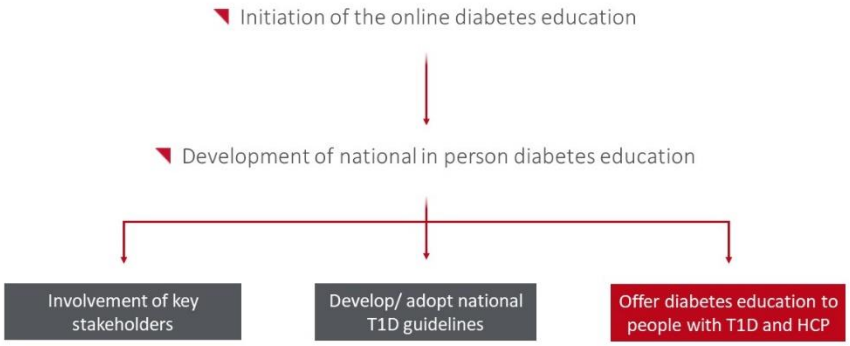
The main Conclusions

The **design and usability** of web applications play a crucial role in supporting self-management for individuals with T1D in Cyprus.

The findings from this study can inform future research aimed at improving the design, content, and functionality of educational tools for **diabetes management**.

Future studies can explore the effectiveness of the application in **clinical settings** and **its adaptability for other demographic groups**, such as children and the elderly

- How to develop the national diabetes education pathway?



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PhD Thesis Contribution and Novelty

- Initiation of a T1D educational pathway in Cyprus by standardising the necessity of carbohydrate counting and further diabetes education,
- The DiAPPeat web application is a novel tool with essential features such as carbohydrate counting and a Cypriot food search option for individuals with T1D,
- Usability evaluation: The first usability mixed method study for an online diabetes educational tool occurring in the Republic of Cyprus,
- Long-term aim: To enhance end-user satisfaction and empower individuals with T1D to manage their condition effectively and maintain optimal health outcomes,
- The web application is designed with a user-centric approach, providing end-users with comprehensive features carefully crafted and informed by evidence-based characteristics derived from global literature and the interaction with people with T1D attending a local diabetes clinic,

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Limitations

- Delays experienced during with Covid-19 and the design and development phase of the web application due to financial constraints and limitations.
- Language accessibility with Greek as an available language.
- According to some participants, the web application should have been developed as a mobile application.
- Use of mixed resources from the UK and USA diabetic exchanges and carb counting.

Strengths

- Use of mixed resources from the UK and USA diabetic exchanges and carb counting.
- The first study in Cyprus was to design and develop a T1D web application and investigate its usability among people with T1D and HCP.
- Methodology uses a variety of methods.
- The web application includes
  - Accurate diabetes information
  - Carb counting material, Diappeat Café allows users to communicate with other Diappeat end-users. Catchy appearance.

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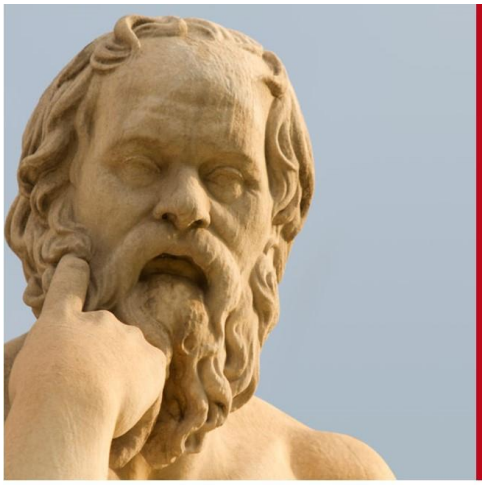

"I cannot teach anybody anything. I can only make them think."
Socrates.

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Thank You

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- My wife Emilia Siekkeris, Matilda and Oliver
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  - Prof. Zoe Roupa
- Mrs Haris Argyriou
- Dr Angeliki Argyriou
- Mr Tasos Christodoulou
- Dr Maria Aristeidou
- Dr Sofia Vatti

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