

A User-Friendly Software Platform for Reminiscence Therapy

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Project Dissertation



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Declaration


Statement 1

This work has not been previously accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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Statement 2

This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by citations giving explicit references. A bibliography is appended.

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The University's ethical procedures have been followed and, where appropriate, ethical approval has been granted.

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Abstract

Alzheimer's Disease is currently an incurable disease and one of the biggest challenges to the modern medicine [1].

The main problem addressed in this paper is supporting people living with Alzheimer's Disease (AD). In our document, the focus will be on Reminiscence Therapy which key is to discuss patients' memories and events that took place in the past, with the help of various data and information such as photos, videos, recordings and anything that may be relevant to the patient [2].

With the help of modern technology, we have created an Android app designed for tablets. This app has two modes – patient and carer views. Before a patient with AD can interact with the app, the carer is supposed to set the app up by uploading questions containing a picture related to the question, a question description and 4 answers including 1 correct answer. The questions are then shown in the form of a quiz to the patient.

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1 Introduction

1.1 Motivation

Alzheimer's disease (AD) and other forms of dementia remain to this day one of the biggest challenges for modern medicine. Its symptoms include gradual memory loss, impairment, and confusion. The fact that there is no cure makes this disease a global health issue [1]. Using the table below, the statistics about dementia prevalence among older people in the UK and the estimated cost of dementia care have been shown, according to Alzheimer's Society UK data [3].

	2019 estimated figures		2040 projected figures	
	Prevalence rate among older population	Total Cost (in billion £)	Prevalence rate among older population	Total Cost (in billion £)
Wales	7.0%	1,780	9.00%	4,560
England	7.20%	29,500	8.30%	80,400
Scotland	6.30%	2,580	7.70%	6,800
Northern Ireland	6.90%	810	8.50%	2,360
United Kingdom	7.10%	34,700	8.80%	94,100

Table 1: Estimated dementia prevalence among older people and total cost of care in 2019 and 2040 [3].

Based on the data presented above, we can see that dementia rates are set to rise. Therefore, until no cure is present, we should find an effective way to lessen the symptoms and support patients.

It is important to note, that according to the World Health Organization, Alzheimer's Disease plays a vital role in 60-70% of cases and is the most often diagnosed form of dementia [4]. As a result, in this paper, we will be focused on Alzheimer's Disease.

In 2014 only, more than 100,000 people were reached by health-related apps [5]. Therefore, with the help of modern technology, the idea was to create a mobile app to assist individuals suffering from AD.

The solution to this problem was to, within the app, present AD patients with content that is related to their lives and experiences, such as photos taken either by the individual, along with

relevant questions created by the carer. This type of treatment is called Reminiscence Therapy (RT), which will be explained further in the Background Research section. This application is based on Android and is designed for larger devices such as tablets to increase readability.

1.2 Accomplished Aims and Objectives

- Created an accessible, adjustable User Interface (UI) e.g., font and screen size that changes depending on system settings.
 1. The layout of the UI was sketched on the paper first.
 2. The sketch design was transformed into Android Studio XML layouts.
 3. Carer can easily change accessibility settings using Android built-in tools such as display or font size.
 4. Dark mode was introduced, as research proves beneficial effects such as reduced eye strain [6].
- Developed a working app with separate patient and carer views with photo upload and question creation functionality.
 1. Added the backend to the existing UI designed in the previous step to ask the user for data and save it.
 2. Created patient and carer views to separate quiz usage and creation.
- Constructed databases for storing quiz data, pictures, and history data (reports).
 1. Data (photos and questions) are kept persistent in the database and available upon reopening the app.
 2. Each quiz run statistics data is saved.
- Implemented quiz feature in the patient view.
 1. Quiz is viewable and runnable for the patient.
 2. Each quiz consists of questions created by the carer, containing a picture, a question and 4 shuffled potential answers.
 3. Upon answering, the patient is displayed with the correct answer if they have selected an incorrect answer.
- The app generates a summary of each quiz run.
 1. The data included in the summary is the number of questions answered, the number of correctly answered questions and the timestamp.
 2. The summaries are represented as a list viewable to the carer.

1.3 Pending Aims and Objectives (future work)

- Introducing a points and rewards system based on collected data.
 1. Establish a method of how points and rewards are to be awarded.
 2. Implement them based on how many answers were answered correctly.
- Adding translation to other languages.
 1. Find out what languages to translate.
 2. Perform translation.
 3. Import translation into the application.

2 Background research

2.1 Alzheimer's Key Facts

As explained in the introduction, Alzheimer's Disease (AD) is currently incurable. Moreover, AD may interfere with the ability to accomplish everyday tasks and cause behavioural, personality or cognitive changes such as trouble with remembering information and completing complex tasks [7]. Unfortunately, AD is also ranked sixth in the top 10 diseases that cannot be cured and prevented, in terms of cause of death [8].

2.1.1 Alzheimer's Disease Stages

The AD progression is divided into three stages [7]:

- Early Stage – individuals can do their everyday activities such as using the bathroom and dressing without any help. Problems with short-term memory start to appear, despite that, spoken language is usually fluent, and some minor mistakes can occur in written language [7].
- Middle Stage – patients need more help with their daily activities. Short-term memory worsens, they might have problems keeping attention and may need more time to understand spoken language or to find the right words to express what they want to say or write [7].
- Late Stage – no longer able to perform daily activities, the patient has noticeable problems with movement and memory, although can usually speak fluently with more obstacles than before such as repeating sentences or words. No longer able to use written language and have evident issues with reading [7].

2.1.2 Treatment

According to the NHS website, some medicines can reduce the symptoms. On the other hand, in the context of therapies, currently, there are three treatments [9]:

- Cognitive stimulation therapy – involves working with a therapist, either in a group or individually. The patient is meant to carry out standard, routine tasks designed to improve orientation and memory [10].
- Cognitive rehabilitation – this is individual therapy; it involves the patient and their family working with a therapist to find a goal relevant to the individual and working on that goal to achieve it, such as using a computer or other everyday tasks that they may be struggling with. This kind of therapy can help “activate” brain parts that have been impaired by AD [11].
- Reminiscence and life story work – reminiscence therapy (RT) has been suggested to help improve mood and some cognitive abilities, as well as improve autobiographical memory. RT was introduced in the 1980s, its key is to discuss patients' memories and

events that took place in the past, with the help of various data and information such as photos, videos, recordings and anything that may be relevant to the patient [2].

2.1.3 Understanding research in the project context

With mobile devices' popularity such as tablets, smartphones, and even smart watches, it seems that these solutions could be used to provide support for individuals suffering from AD [12]. As the research has shown, *“innovative devices such as iPads and tablets, which are mainstream and easy to use, cannot only help determine stage of dementia, but also provide stimulation to improve cognitive functioning”* [12].

In our project, this application is tailored to persons suffering from early to middle-stage AD, as they can still understand writing and remember events or memories. The application applies Reminiscence Therapy by asking patients questions previously created by the carer. Moreover, it does not need any professional or a group so it can be carried out at home at no cost at all.

2.2 Similar Projects

Whilst designing the app one of the important aspects was to look for similar applications to see what could have been done better or differently. For that purpose, our research involved searching the “Alzheimer’s reminiscence therapy app” in the Google Play store.

The first thing that has been noticed, is that none of the featured apps mention “Alzheimer’s Disease” in the application name specifically. Most of them are related to the generic “Brain Training” term or “Meditation” (see figure below). This can indicate that finding the right app, designed precisely for AD patients' needs could either be time-consuming or not possible at all. For that reason, in this section, we will try to find the closest match to our app that is to be designed.

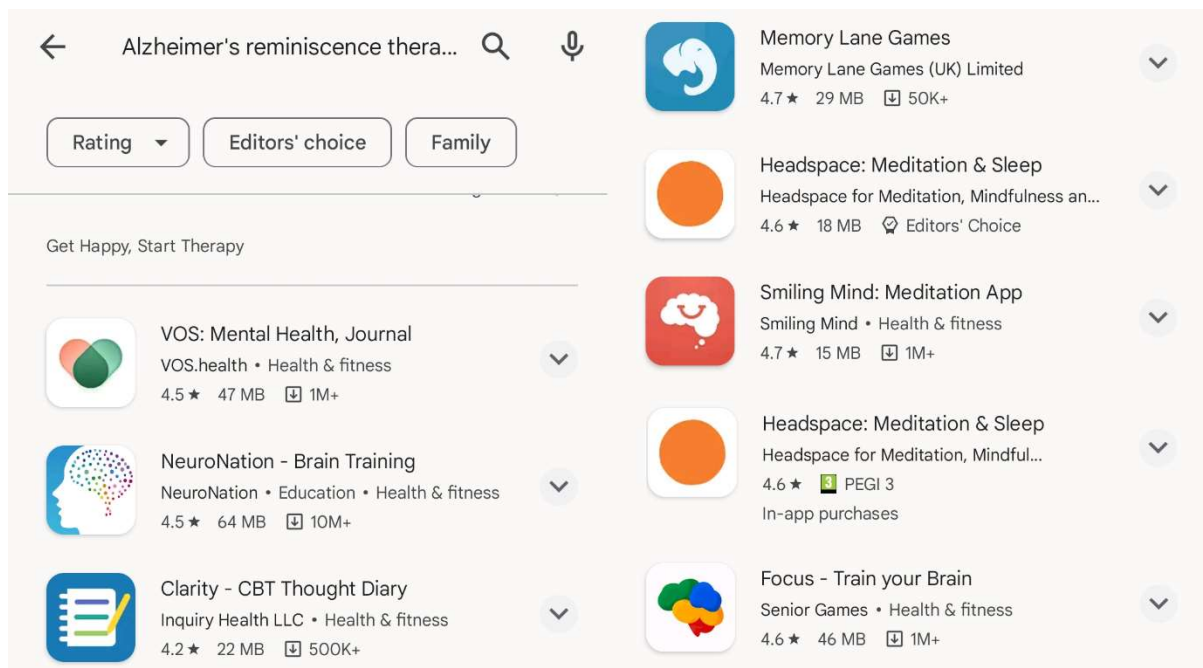


Figure 1: Screenshot from Google Play depicting applications upon searching "Alzheimer's reminiscence therapy app".

An attempt was also made to find an Alzheimer's app based on RT using the Google search engine, instead of Google Play search. Unfortunately, only three apps for Android were found - *DeepVibes Reminiscence Therapy*, *InspireD Reminiscence App* and *LifeBio*.

DeepVibes Reminiscence therapy was not working properly on my device upon installation, not allowing me to register an account and test it, LifeBio was not available to be downloaded in the UK.

InspireD Reminiscence App has been run successfully on my Android tablet with an older Android version (8), it was incompatible with Android 13 running on my smartphone.

2.2.1 InspireD Reminiscence App

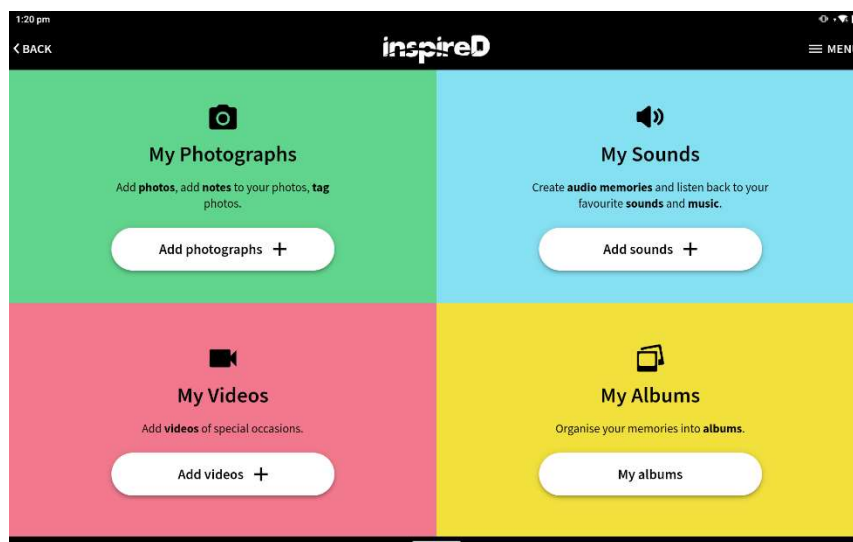


Figure 2: InspireD Reminiscence App main menu.

This app allows the creation of separate accounts for the person “living with dementia” and the carer. Upon creating the account, the app takes us to the main menu shown above, where either the carer or patient can upload photographs, sound recordings or videos into the app. Each item can be then linked to an album and have meta-data added such as location or a voice note. Apart from that, it offers media back-up.

This app is essentially a media album, constructed to suit AD patients’ needs with additional features that standard photo apps do not have such as voice notes or meta-data.

InspireD app compared to my app does not fully use RT potential, as it only represents media without any quiz capabilities.

2.2.2 NeuroNation – Brain Training

This app published by NeuroNation has over 10 million downloads with an average rating of 4.5 stars, out of 5. It is the most popular app among those listed in the search results. During the initial run, it commences a quick memory, reasoning, speed and attention test. After that, the profile is generated with the result of each skill ranked on a scale of 0 to 100%. The app asks to create a personalised training plan where special accessibility needs such as arithmetic impairment or colour blindness can be set. Then it shows personalisation settings about how often and what time are user plans to train every day.

Most of the exercise was based on pattern matching, such as memorising the order in which circles appear and calculating simple arithmetic equations based on adding or subtracting shapes. It seemed that this app was not focused on any particular age group, providing some exercises that were challenging even for me in the age group 20-30.

In conclusion, the main difference is that this app does not use Reminiscence Therapy at all. This app, as the title suggests, is more about training the brain, that is attention, reflexes, and memory. Whilst it may be useful to AD patients to some extent, this app was certainly not designed with any particular age group in mind.

2.2.3 Conclusion

Applications referenced in this section have similar aims – training the brain and supporting its functioning. Nevertheless, both of these applications differ significantly – the InspireD app is focused entirely on patients with AD needs, whereas NeuroNation – Brain Training was not focused on any particular group.

The InspireD app lacks RT functionality, it does not interact with the user in any way. Whilst it might be helpful for AD patients as a safe space to store their memories, it is only the gallery app, in which the user can only upload and see photos, videos or voice recordings with meta-data. The app that we implemented, in contrast, interacts with the user, therefore increasing the chances of having a positive effect of Reminiscence Therapy, as the key to successful RT is to *“discuss patients’ memories and events that took place in the past”* [2] as mentioned earlier in this document.

The NeuroNation – Brain Training was designed to help with brain development, and when it can have some positive effects on brain functioning, it is not relevant to RT therapy, or any kind of AD therapy listed in section 2.1.2.

Therefore, based on these experiences it can be determined that there are minimal choices of digital tools for AD patients on Google Play. The search engines returned results that were either irrelevant to RT, had limited functionalities, or were not available to be tested on any of my devices. This suggested that the app we have developed could potentially fill the gap in the Google Play market.

3 Application Overview

The solution to the presented problem is an Android-based application. It is designed for tablet-sized devices in landscape mode only, as a larger screen size is the key to easier Human-Computer Interaction for older adults [13].

This app was designed in Android Studio using Kotlin programming language, SQLite databases and XML layout formatting. All data uploaded to the app is kept securely in the database and is persistent. This allows for a seamless experience where users do not have to re-upload data after closing the app.

This app contains separate features available to the carer only. It allows them to create a set of questions using built-in tools allowing them to upload a picture, question and 4 answers. In addition, all historical quiz data is shown including every quiz the patient has completed.

3.1 UI Design and Frontend

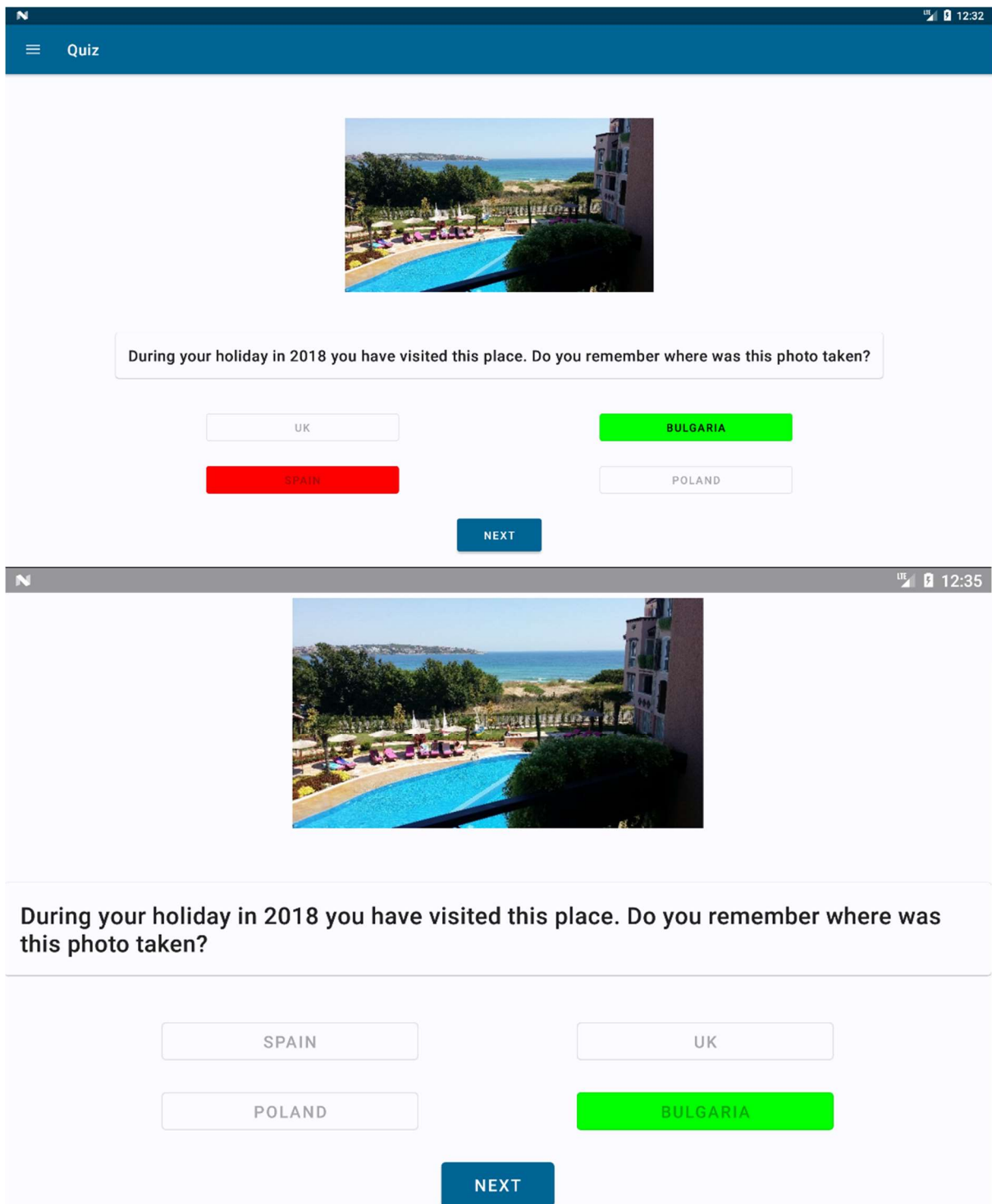


Figure 3: An example of scalable content in the app.

In terms of UI design, it consists of two separate views – the patient view and the carer view. Because this app is designed for people with AD, according to the research about older people and technology, the UI should be scalable and responsive to display or font size changes, it should have big buttons and a user-friendly interface [14]. This app was designed with these particular constraints in mind, as shown in Figure 3 on the previous page. When the user requests visual accessibility features, the content is then scrollable and larger, thus supporting users with sight impairments.

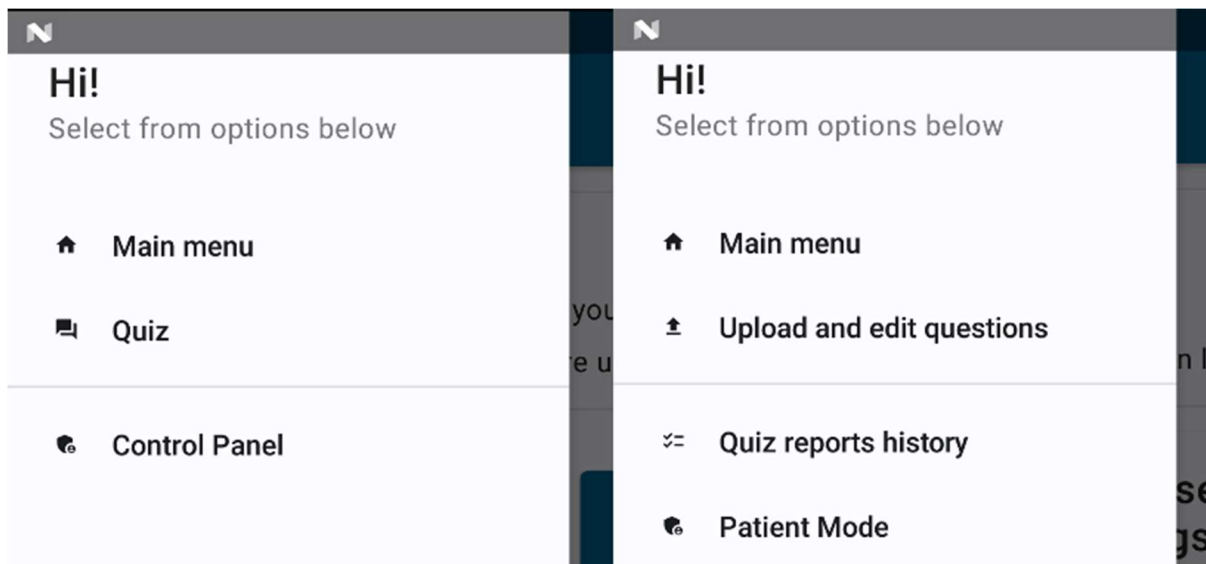


Figure 4: Navigation drawer layouts (left for Patient Mode, right for Carer Mode).

Each view comprises of navigation bar with an activity¹ name and navigation drawer icon (Figure 3 top left corner). When the navigation drawer icon is pressed, the navigation drawer opens. There are two navigation drawer layouts, depending on which mode the current user is in, as illustrated in Figure 4. Each navigation drawer layout contains options relevant to the current mode, containing all features of the app in one place. It is important to note that the patient does not need to use a navigation drawer to access the quiz, therefore simplifying the overall experience.

¹ An activity in Android development “takes care of creating a window for you in which you can place your User Interface” [16]. In simple terms, it is a single file that handles user interaction and displays the UI layout XML file.

3.1.1 Patient View

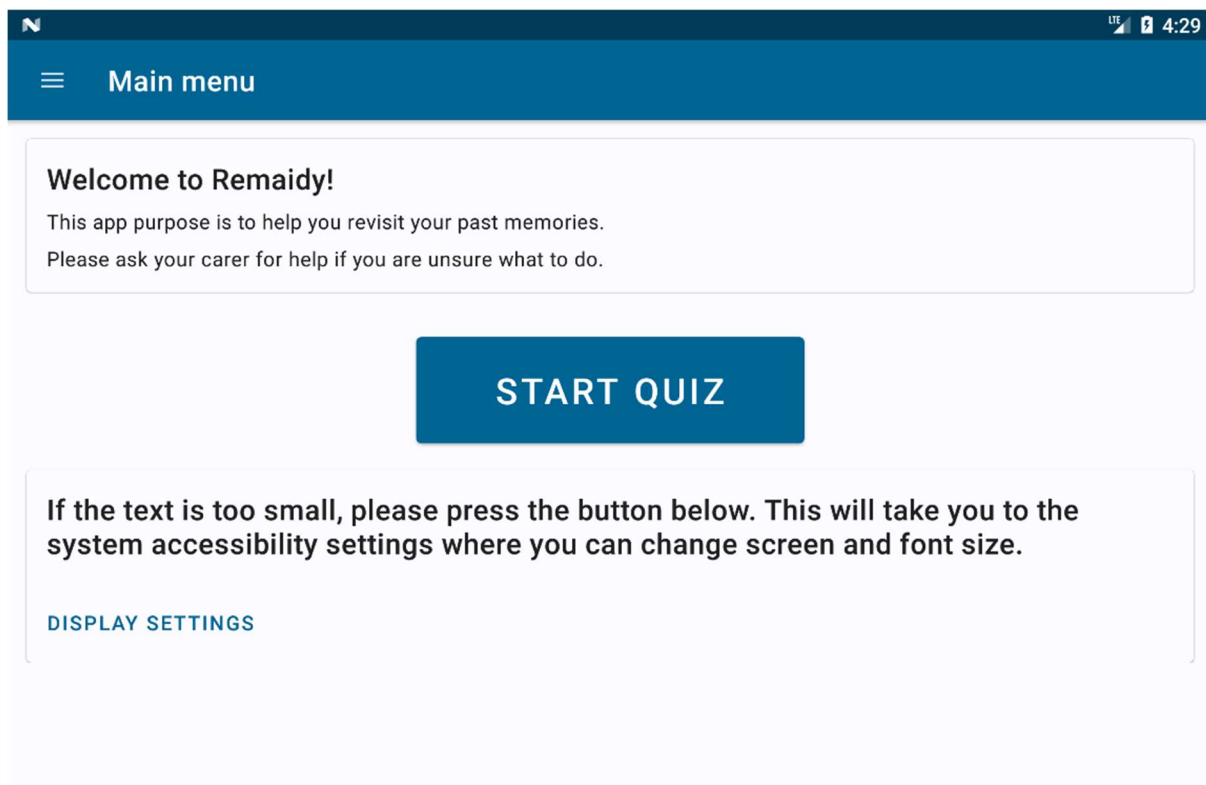


Figure 5: Patient View main menu screenshot.

Before the quiz is started, the main menu activity is displayed, as depicted in the Figure presented above. It holds a welcome message, a large “start quiz” button and a simple instruction informing the user of accessibility features. The key was to limit the distractions for a seamless user experience, so it does not unnecessarily distract the patient. Upon pressing the “start quiz” button, the quiz is displayed (an example screenshot shown in Figure 3).

The main point of this app is to apply Reminiscence Therapy by asking the patient questions consisting of a picture, a question and 4 possible answers. Questions are asked in the form of a quiz as shown in Figure 3, that is each question is shown separately to the patient and upon answering, the application highlights if the correct answer was selected or shows the correct answer if the incorrect one was chosen. After quiz completion, a quick summary is shown to the patient with the number of questions answered and correctly answered with a large button that takes them back to the main menu.

3.1.2 Carer View

The Carer View (named “Control Panel” in the app) is an important part of this project. It allows the carer to create questions and evaluate the patient’s progress. The control panel is available from the patient’s view drawer menu (Figure 4, left-hand side). I will now show some example screenshots of activities filled with dummy data.

3.1.2.1 Questions edit panel.

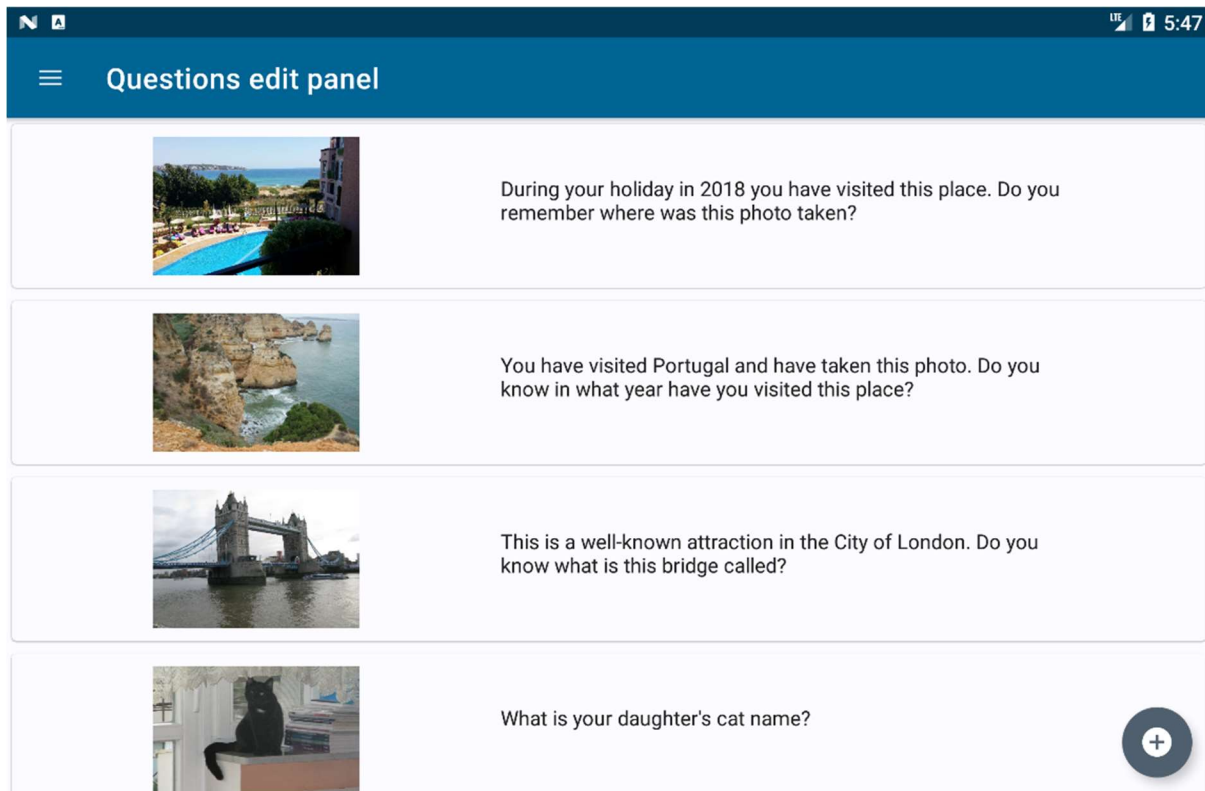


Figure 6: Questions edit panel screenshot - listing created questions.

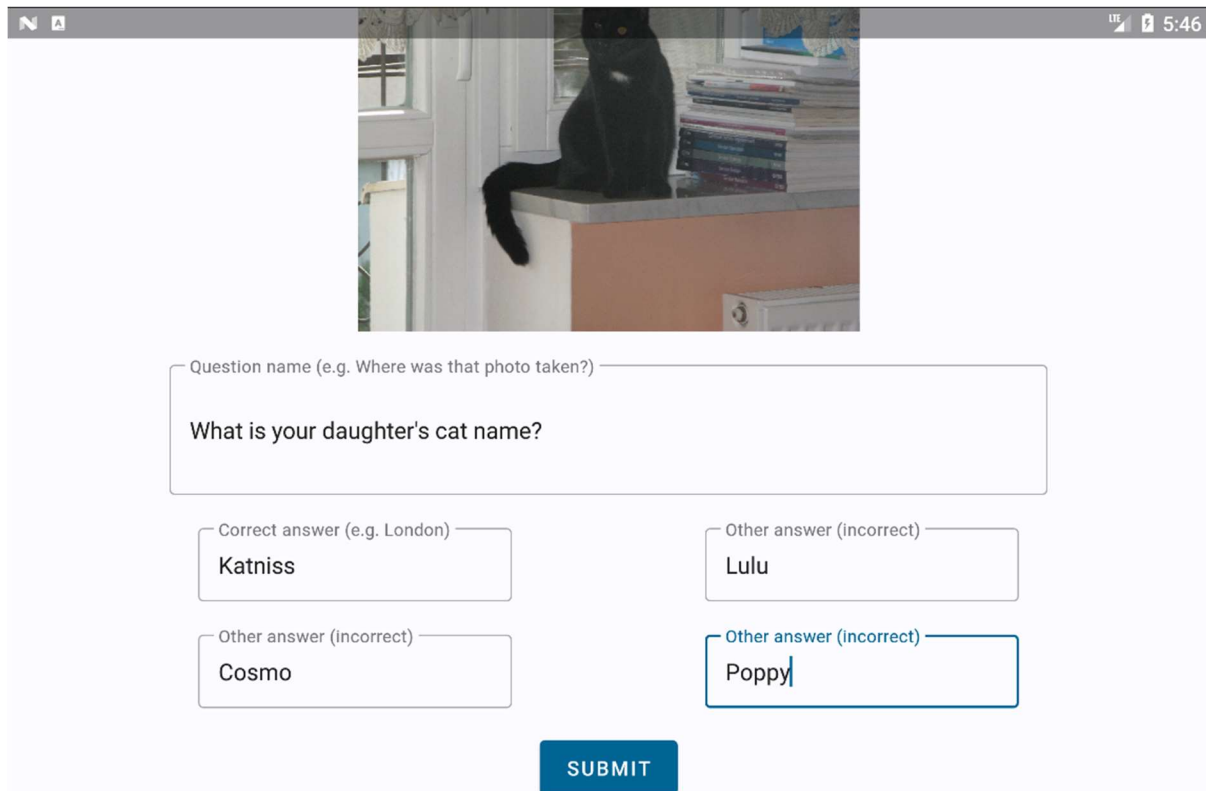
In Figure 6 the questions edit panel is shown. It allows the carer to create and view all questions uploaded and existing in the database. It is constructed using RecyclerView² and lets the user scroll through all questions' summaries, where each question summary comprises a picture and question description. In the case when any question is selected, the app supplies question data from the database and runs another activity called "Edit question" which will be explained in the later paragraph.

In the right bottom corner, the Floating Action Button (FAB)³ with "+" icon is located. The plus icon implies adding, which indeed takes the user to question creation activity. As explained in the footnote, the FAB is static so it stays in its place even when the screen is scrolled.

² RecyclerView is a scrollable list of elements with multiple rows. It consists of rows designed to meet developers' needs. Then data is supplied in the runtime and displayed.

³ Floating Action Button (FAB) "is a circular button that triggers the primary action in your app's UI" [17]. It is static, that is when the content is scrolled up or down it stays in its place for an easy access.

3.1.2.2 Edit question panel.



Question name (e.g. Where was that photo taken?)

What is your daughter's cat name?

Correct answer (e.g. London)

Katniss

Other answer (incorrect)

Lulu

Other answer (incorrect)

Cosmo

Other answer (incorrect)

Poppy

SUBMIT

Figure 7: Question edit panel screenshot.

This activity is run when the user presses the FAB button mentioned in paragraph 3.1.2.1. As shown in the Figure 7 screenshot, there is already an example cat photo uploaded. However, before the photo is selected, the grey placeholder with the text “Add photo” is shown, indicating to tap on the placeholder in order to invoke photo selection intent. This opens an Android built-in photo selection tool where user can easily pick any photo from their library.

Below the picture, there are five text boxes with labels suggesting the correct usage. The largest text box is the question name shown in the question list summary. Underneath, there are four text boxes intended for answers. The first text box (top left) is the correct answer, whereas the remaining three are incorrect answers.

The submit button saves the question in the database and checks if none of the answers are the same. Moreover, it ensures that the user has filled in all the necessary information before proceeding. After submission, the app takes the user back to the Questions edit panel (paragraph 3.1.2.1).

3.1.2.3 Quiz reports history.

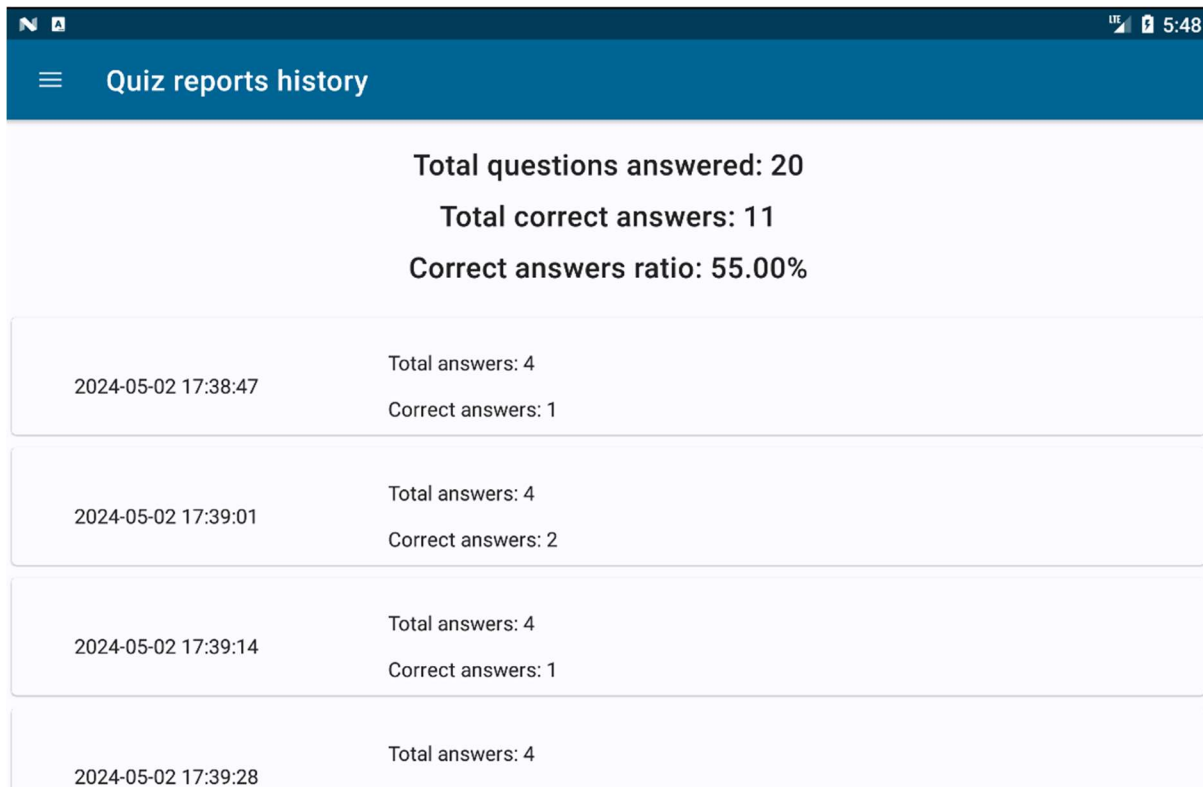


Figure 8: Quiz reports history screenshot.

As depicted in Figure 8, the total number of questions answered and correctly answered at the top of the activity is shown. The backend also calculates the “correct answer ratio” so that the carer can track the progress more easily.

Underneath, the quiz reports history uses RecyclerView to display quiz summaries. Each summary is one quiz session composed of timestamps, the number of questions answered and correctly answered. That allows the carer to check individual progress for each quiz, therefore they can examine whether there is any improvement in answering the questions.

The data is supplied by the database, which securely stores historical data.

3.2 Backend

This app is designed for Android tablet devices, therefore the IDE I used is Android Studio. I have chosen to use Kotlin instead of Java as it is “*more compact*” and it “*makes a few common Java annoyances less frequent*” [15].

I have decided to use SQLite databases for organised and persistent data handling. Overall, there are 3 tables containing questions and quiz details.

3.2.1 Kotlin code structure

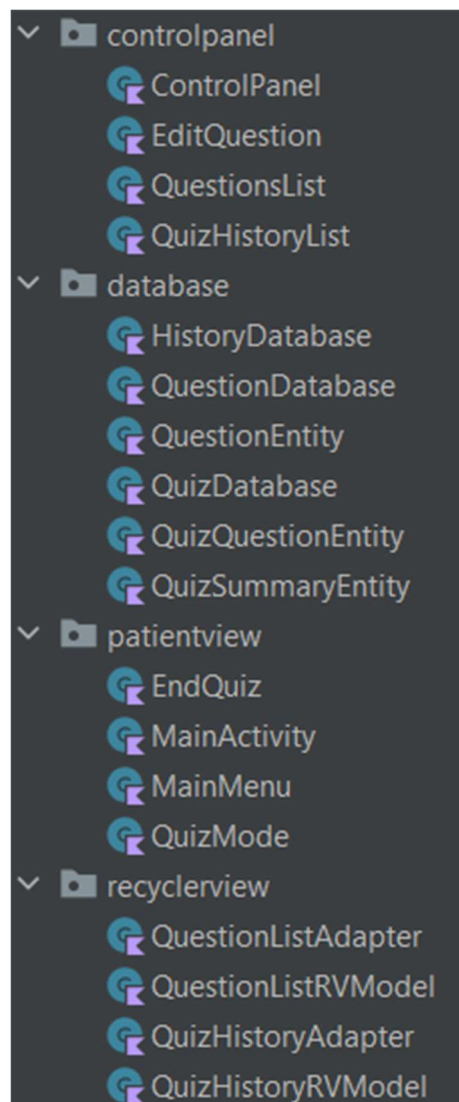


Figure 9: Screenshot from Android Studio depicting Kotlin source files.

I have divided Kotlin code into 4 packages:

- controlpanel – it handles control panel behaviour and contains activities displaying the XML layout files, along with button listeners.
- database – responsible for managing the database, which will be explained further in the next paragraph.
- patientview – similarly to controlpanel package, it has activities accountable for displaying XML files and handles button listeners behaviour.
- recyclerview – it contains classes managing the RecyclerViews, they retrieve data from the database and pass it on to the relevant controlpanel or patientview classes.

3.3 Databases

For databases, I have used built-in Android SQLite libraries. Classes in the database package are responsible for handling the databases, that is adding and retrieving data using pre-programmed SQL queries. Classes ending with “Entity” were created for “transferring” the data between SQLite database and Android activities. Within my app, there are three databases:

- **QuestionDatabase** – this table stores questions created by the carer. The table schema is structured as follows:
 - id – unique, automatically generated integer id of each record.
 - description – is the question description.
 - answer1correct – is the correct question answer.
 - answer2, answer3, answer4 – are the dummy answers used for the quiz purposes.
 - imgpath – stores the path of the picture uploaded by the user.
- **QuizDatabase** – it is a temporary database created each time a new quiz is started. It is kept separate from QuestionDatabase as the question-and-answer order is randomly shuffled each time a new quiz starts. The table schema structure:
 - id – unique, automatically generated integer ID of each record.
 - description – is the question description.
 - answer1, answer2, answer3, answer4 – shuffled answers obtained from QuestionDatabase.
 - imgpath – stores the path of the picture uploaded by the user.
 - correctAnswerId – as the answers are shuffled, the algorithms need to know which question is correct. Therefore, a single integer is stored indicating which question is correct, for instance, correctAnswerId equal to 2 would mean that answer2 is correct.
 - isCorrectlyAnswered – is a boolean indicating whether the question was correctly answered by the patient.
 - was Answered – a boolean specifying if the question was already answered by the user.
- **HistoryDatabase** – holds historical information about quizzes completed by the patient. It is used by the reports activity for purposes of displaying patient statistics. The table schema is structured respectively:
 - id – unique, automatically generated integer id of each record.
 - time – text timestamp automatically generated at the time of the record creation.

- totalAnswers – the total number of answers answered.
- totalCorrectAnswers – the total count of answers correctly answered.

4 Testing

4.1 Functional Software Testing

Software testing is “*the process of testing the functionality and correctness of software by running it*” [16]. Therefore, to test my app I have decided to use Functional Testing, which is part of the black box testing. I have developed a plan of testing each activity one by one:

- Patient View
 - Main menu:
 - Checking the start quiz button behaviour if no questions are supplied to the database.
 - Quiz view:
 - Testing the next button if it is unavailable to click when no answer is selected yet.
- Carer View
 - Questions edit panel (list):
 - Opened edit pane when no questions were added to ensure no null pointer exceptions were thrown.
 - Automated adding 25 questions to the database to check if UI does not become unresponsive. As a result, the photo size RecyclerView limitation was found and the need for photo compression was discovered and implemented.
 - Edit question panel:
 - Checked if the button “submit” is only clickable if the user has supplied all the data.
 - Tried supplying the non-distinct answers to each text box.
 - Created questions consisting of every ASCII character.

5 Results

5.1 User Experience Survey

Surveys in Software Engineering “*are one of the most frequently used research methods for conducting empirical investigation studies*” [17]. Hence, I have decided to utilise a survey to gather feedback about user satisfaction. Therefore, I have created a Google Form questionnaire and provided 10 test subjects with working applications for testing.

Test subjects have been asked to add example questions using photos stored on their devices, then run the quiz and access the reports. After testing, they were asked to fill in the Google Form provided.

The questionnaire consisted of 7 questions, each measuring different aspects of app functionality on a scale of 1 to 5. I have focused my questionnaire on ease of use almost entirely, considering this app targets elderly people. The questionnaire resulted in the following average response:

- Your overall satisfaction with the app? Averaged response rating: 4.5
- How would you rate functionality and features? Averaged response rating: 4.2
- How would you rate accessibility features? Averaged response rating: 4.3
- How easy was it for you to upload photos? Averaged response rating: 4.2
- How easy was it for you to create questions? Averaged response rating: 4.6
- How easy was it for you to use the quiz? Averaged response rating: 4.6
- Do you think it is likely that this app will have a positive effect on people living with Alzheimer's Disease? Averaged response rating: 4.3

5.2 Survey Evaluation

The most important aspect was to have an easy-to-understand quiz, considering the age group this feature is targeted to. Looking at the results we can see that it was a feature that had the highest rating, therefore we can assume that this part of the app is unlikely to cause unnecessary confusion. Creating questions was also highly rated, possibly due to the clear instructions shown next to each textbox.

The lowest rating was given to the photo upload feature. One reviewer commented that “the placeholder with Add Photo text was a bit confusing and I was not sure where to tap to upload the photo”. This might indicate the need to re-evaluate the design of this feature.

Despite that, the overall satisfaction was rated at 4.5, therefore users were generally satisfied with the app.

6 Summary

In conclusion, the main point of this document was to present a working solution for a User-Friendly Software Platform for Reminiscence Therapy. The app contains RT methods and is designed to support early to middle-staged Alzheimer's Disease (AD) patients.

It allows the carer to create questions including a picture, question description and 4 answers. Then, the questions are shown to the patient whose progress is saved and available as a report for the carer.

Similar projects have been shown and have proven that the AD-supporting app using the RT technique is not prevalent on Google Play. Therefore, this app might fill the gap in the existing market.

This application was written in Kotlin programming language in Android Studio IDE. It consists of two views – Patient and Carer mode. In patient mode, only a quiz is available, whereas in carer mode questions can be created and the patient's progress can be tracked.

The main emphasis was on accessibility, that is app's UI is scalable so can easily display a larger font and UI structure.

Functional testing was used to ensure that the app was up to the standards and a Google Form survey to measure user experience satisfaction.

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