



Evaluating mobile application for microlearning vocabulary through self-captured images in real-world contexts

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Abstract

Language skills are fundamental for the social and economic integration of foreigners, and a basic understanding of one's surroundings can have a positive impact on assimilation. Introducing Dansk In Town, a mobile microlearning application that facilitates language learning in context.

This research focuses on the development of a microlearning platform that enhances user engagement by connecting vocabulary with real-world images. Through an iterative process of implementation and validation, the study demonstrates the potential of incorporating engaging features, including push notifications and gamification elements, combined with seamless usability and community of shared images. These factors showed promising results in improving user engagement within the application and encouraging learners to actively engage with the language in their surroundings.

As a result, Dansk In Town emerges as a promising learning tool for beginners embarking on their language learning journey. With further exploration, implementation and deployment to wider audience, Dansk In Town holds the potential to become a language learning tool which empowers learners and facilitate their path to language proficiency.

Contents

List of Figures	I
List of Tables	II
Nomenclature	III
1 Introduction	1
2 Background	2
2.1 Mobile Language Learning	2
2.2 Microlearning	3
3 Related Work	5
4 Methodology	8
4.1 Procedure	8
4.2 Data collection	11
4.3 Data analysis	11
5 First Development Iteration: An MVP	13
5.1 Technical choices	13
5.2 MVP Features	14
5.2.1 Start & Login	15
5.2.2 Camera	15
5.2.3 Translation	15
5.2.4 Library	18
5.2.5 Practice	19
5.3 Deployment	21
6 First Evaluation Round	21
6.1 Interview Results	21
6.2 Data analysis	24
6.3 Summary	26
7 Second Development Iteration	27
7.1 Push Notifications	27
7.1.1 Technical implementation	28
7.2 Practice section improvements	29
7.2.1 Technical implementation	29
7.3 Gamification	30
7.3.1 Technical implementation	31
8 Second Evaluation Round	32
8.1 Questionnaire	33

8.2 Results	34
9 Discussion and Limitations	35
9.1 More quantitative data	35
9.2 Filtering of content and privacy	36
9.3 Spaced repetition	36
9.4 Enhancing the app's usability	36
9.5 Small participant sample size	37
10 Conclusion and Future Recommendation	37
10.1 Conclusion	37
10.2 Recommendations for Future Work	38
10.2.1 Deploy on big scale	38
10.2.2 Further research: evaluating effectiveness	38
10.2.3 Extending with new features	38
11 Acknowledgements	39
A Appendix A	V
A.1 Mockup	V
A.2 Design Inspirations	V
A.3 Source code	VI
A.4 Interview transcripts	VI
A.5 Data analysis	VI
A.6 Notifications scripts	VI
A.7 Schedules	VII
A.8 Questionnaire answers	VII

List of Figures

1	<i>Flowchart of the study procedure</i>	9
2	<i>High level application communication</i>	14
3	<i>App Screens before logging in</i>	16
4	<i>Camera Screen</i>	17
5	<i>Translation Screen</i>	18
7	<i>Practice Screen</i>	19
6	<i>Library Screen</i>	20
8	<i>QR codes for accessing the application</i>	21
9	<i>Number of correct and incorrect answers per user</i>	25
10	<i>Number of taken quizzes and captured pictures</i>	25
11	<i>Number of times users did quizzes and unique translations they stumbled upon</i>	26
12	<i>Notifications</i>	28
13	<i>Daily Streak</i>	31
14	<i>Daily Streak flow on load</i>	32
15	<i>Daily Streak flow on correct answer</i>	32
A1	<i>Initial Mockups</i>	V
A2	<i>Design inspirations</i>	VI
A3	<i>Number of pictures taken per user</i>	VII

List of Tables

1	Summary of the observed approaches in mobile language learning	7
2	Questions for semi-structured interview	12
3	Questionnaire	33

Nomenclature

DSR Design Science Research

EAS Expo Application Services

MALL Mobile-Assisted Language Learning

MVP Minimal Viable Product

USD User-Centered Design

1 Introduction

The availability and affordability of mobile devices have revolutionized how we live our daily lives, including how we learn languages. Mobile applications like Duolingo, with 500 million registered users worldwide (of Apps, 2023) and 14.2 million active daily users have become increasingly popular (Duolingo, 2021). In Denmark, where there are currently over 600.000 immigrants (*Population*, 2023) and over 60.000 people attending danish classes only in first half of 2021 (Statista, 2021), language skills are a crucial part of social and economic integration (Isphording & IZA, Germany, 2015).

However, many language learners do not have the time or resources to devote to an intense learning process. Although the Danish government provides Danish lessons, it is a time-consuming commitment, requiring from 650 to 700 hours of classroom time to reach general proficiency (*Foreign Service Institute - Foreign Language Training*, 2023). Additionally, classes are paid for certain groups of people, which may deter some learners.

Still, the foreigners are surrounded by the Danish language daily - by hearing, but also seeing it around themselves - signs, advertisements, announcements and so forth. Understanding at least the words in their environment could be a first step to integration and learning the language.

In this project, a novel approach to this problem, using microlearning through a mobile application, is proposed. Microlearning emphasizes short and frequent opportunities for practice and focuses on short engagement in learning activities, usually through content delivered in short bites and is designed to elicit a specific outcome from the learner (Kapp, 2016).

With the idea, the question emerges:

How can we design a microlearning mobile application that encourages people to engage with the vocabulary around them, through captured images, in order to learn the language? Is such an application a useful learning tool, and are there users who would benefit from it?

To answer the question, I will build and deploy an application called Dansk In Town, which will provide a contextual translation combined with a microlearning solution that allows learners to translate vocabulary they have stumbled across in the city and later practice the vocabulary on a personal or a community level. Then, to evaluate it, I will conduct a week-long experiment with potential language learners. After that, the participants will take part in an interview, where we will discuss the engagement, the features and the usage of the app. Based on the findings from the interviews and collected data throughout the usage, there will be second round of implementation where the most pressing features and suggestions coming from feedback will be developed. Afterwards, second round of feedback will be collected. The goal will be to target the issues and elevate engagement.

Through this research, I intent to contribute to the field of language learning and provide a tool that can benefit language learners in Denmark and beyond.

2 Background

Before delving into state-of-art or the development of the MVP, it is crucial to gather a foundational understanding of the theories and approaches related to the research question. In the following section, I will explore the realm of mobile application language learning, focusing on engagement within these systems, the concept of microlearning, and the design of microlearning systems. The objective is to gain a comprehensive understanding of the concepts surrounding microlearning through mobile applications and identify factors that contribute to user engagement. This knowledge will serve as a foundation for further progress in the project.

2.1 Mobile Language Learning

Learning a language through mobile applications falls under the umbrella of Mobile-Assisted Language Learning (MALL), which is a sub-area of the expanding field of mobile learning that has gained popularity among scholars (Mosavi Miangah & Nezarat, 2012). According to Mosavi Miangah & Nezarat (2012), MALL encompasses various common learning areas, including vocabulary, listening, grammar, phonetics, and reading comprehension. However, it is important to note that MALL extends beyond mobile applications alone, incorporating other technologies such as Augmented Reality or GPS utilization on mobile devices (Yang, 2013). In this context, the focus is specifically on mobile applications as a component of MALL.

Research findings show that the answers to how users engage with mobile language learning application and what is their effectiveness will strongly dependent on the design and content of the app, as well as the learner's motivation and engagement with the app (Rosell-Aguilar, 2018). However, there are certain aspects of when the language learning through mobile app can be beneficial. According to Rosell-Aguilar (2018), language learning apps can be particularly useful for learners who are unable to attend traditional language classes, or who need to supplement their classroom learning with additional practice. However, it should not be seen as replacement, but used in "conjunction with other learning methods for the best results" (Rosell-Aguilar, 2018). Another study finds that mobile learning can be particularly effective in vocabulary acquisition. The experiments proved that the studied group displayed improvements in their vocabulary knowledge (BaŁal et al., 2016). On the contrary, the grammar learning seems to be challenging to implement in a form of mobile learning. Researchers found that grammar learning applications are "*far from satisfactory*" (Panah et al., 2021).

Some studies claim that learners are actually more engaged in mobile learning than in textbook learning (Kapp, 2016). The question is, what makes people use mobile language learning applications and what keeps them motivated and engaged. Research shows that there are few main approaches, some of them being: gamification, adaptation, feedback (Kamandhari, 2015), (Heil et al., 2016). The research conducted by Liu & Correia (2017) identifies four main factors that impact engagement in mobile learning applications: compatibility, interactivity, usability, and accomplishment. Compatibility refers to the customization and personalization of features, while interactivity includes social interactions

between users and customer-to-application interactions such as push notifications and in-app messaging. Usability involves factors such as ease of use, convenience, interface design, and usefulness. Accomplishment refers to the rewards, such as badges, to enhance engagement (Liu & Correia, 2017). The paper also presents findings from a case study, highlighting the importance of usability in affecting learner satisfaction. The study points out that providing a positive user experience through usability is a key factor in engagement in mobile learning applications (Liu & Correia, 2017). The study highlights the importance of users liking the app and having a positive experience in order to enhance engagement.

Another study proposes a set of features to increase engagement in mobile learning apps, including a card-based interface, responsive design, spaced repetition strategy, personalized adaptive technology, and interactivity through notifications and badges. These features aim to attract users and encourage their continued participation (Pham & Chen, 2019).

It is important to note, that the implementation of mobile language learning can vary depending on the specific learning context and the type of application. However, certain approaches, such as vocabulary learning, can be particularly beneficial. Overall, when it comes to user engagement, factors such as usability, interactivity, and learner satisfaction are crucial considerations in the design and implementation of mobile language learning applications.

2.2 Microlearning

One way of approaching mobile-based language learning is microlearning, which is a teaching method, that focuses on short engagement in learning activities. It is usually delivered through content in short bites and is designed to elicit a specific outcome from learner (Kapp, 2016). Microlearning solution should fit naturally into the daily workflow (Kapp, 2016). Because of microlearning's short form, which requires holding the learners attention, one of the crucial concepts in microlearning is user engagement. It can be achieved through notifying the user, gamification or prompted ("need to know" basis). Additionally, it is important to note that the focus is on short engagement - the experience should not exceed few minutes at time (Kapp, 2016). According to Jahnke et al. (2019), optimal time for a micro-lesson is 8 minutes. Therefore, microlearning solution has no fluff or additional information that creates noise. Another vital aspect is to keep learners active. Research shows that user can gain the most knowledge when involved actively, rather than passively by reading or listening (Freeman et al., 2014).

There are multiple ways to approach microlearning and the focus here will be on the contextual one. Some sources refer to microlearning as being implicitly contextual (Gabrielli et al., 2018). The concept of chunking from cognitive psychology is relevant to contextual microlearning because it suggests that breaking down complex information into smaller pieces can help learners retain information more effectively. By delivering information in a specific context, learners are better able to connect new information to their existing knowledge and understanding, which can enhance retention and comprehension (Kapp, 2016). Important concept that comes up with contextual microlearning is encoding specificity which suggests that people memorise information in combination with contextual cues which aids its retrieval within matching contexts. If a person learns something in connection with cues that

will be present at the time, they are more likely to remember it (Beaudin et al., 2015). There is also concept of spaced repetition, which means that learning is best when content is presented over time rather than in quick succession (Edge et al., 2011). Finally, the concept of situated cognition underscores the idea that knowledge cannot be completely separated from the activities, contexts, and cultures in which it is acquired. In this perspective, language learning occurs not only through explicit study but also implicitly through its practical use in relevant contexts (Edge et al., 2011). This is all quite relevant when talking about Dansk In Town, as it's strength lays in the context of words found by learners.

Research indicates that mobile devices are the most effective medium for delivering microlearning. This is due to their ability to provide accessibility at any time and location, making learning ubiquitous. Mobile devices also allow for just-in-time and on-demand learning, adapting to individual needs and focusing on the learner's preferences and requirements (Nikou & Economides, 2009). Mobile device supports the main objective of microlearning, for example by enabling learners to utilize the unoccupied moments during the day.

It is crucial to highlight the principles that guide the construction of MML systems. Jahnke et al. (2019) conducted a detailed analysis, based on articles, interviews and data, on what are the design principles of a MML system. In summary, the main design challenges in microlearning are: presenting too much information on small screens, no instructor (teacher) contact, the possibility of distraction of the learner on a mobile phone and lastly, accessibility and technical issues since the connection to the internet requirement. Among the essential principles identified, interactivity plays a crucial role in engaging users. Additionally, MML systems should offer courses with concise and focused lessons, provide instant feedback, incorporate system designs that support mobile applications, utilize push notifications, and enable tracking of learning progress. Lee et al. (2021) addressed design principles in microlearning system in a context of efficiency, in terms of learning, but also in terms of the appeal to a user. The paper claims, that the system should be designed for mobile devices and it should be an iterative process of designing, developing and evaluating (Lee et al., 2021). The insights on design principles can be summarized in 4 main components (Jahnke et al., 2019), (Lee et al., 2021):

1. Student should understand why the topic is relevant ("a-ha moment")
2. Student should engage with interactive content
3. Student should apply what he/she learned in short exercises in form of quizzes or gamified
4. Student should receive instant feedback

Well-designed MML system can be a promising technology and be effective in supporting learning (Yin et al., 2021). According to Emerson & Berge (2018) it allows employees to be both productive and increase their knowledge at the same time. Jahnke et al. (2019) however, highlights that mobile mircolearning cannot be applied to any topic but is designed to target specific types of learning topics and outcomes that are simple and have a clear correct answer.

Microlearning approach prioritizes goals related to understanding but does not emphasize, for example, learning how to conduct in-depth analyses on specific topics. Additionally, there is a criticism in therm of the role of MML system in the context of automating human activities in the digital age. Jahnke et al. (2019) argues that mobile microlearning can be more of "artifacts that think for humans" rather than "artifacts to think with".

3 Related Work

A considerable amount of literature has been dedicated to the topic of foreign language learning, encompassing a wide range of concepts and theories. As the topic of this project is language mobile microlearning, I will investigate literature written on such systems.

I will start with Dansk In Town web version, developed by Mircea Lungu as a demo project for Technical Interaction course at ITU (*GitHub - Dansk In Town*, 2021). Inspiration for the research problem idea was sparked by this project, as my personal goal was to develop a native mobile application. For Dansk In Town web version it seemed like a natural progression and improvement. The web solution has certain limitations that should be acknowledged. Firstly, it lacks the capability to capture images directly; users can only upload pre-existing images. Secondly, it does not offer feedback on exercises, which may hinder the learning process. Furthermore, it is solely accessible as a web app, limiting its availability across different platforms. Additionally, there is a lack of available data or research regarding user usage and overall experience with the solution.

MicroMandarin is a mobile language learning in context system (Edge et al., 2011). The application is made for both English and Chinese learners. The authors divide learners into use-directed and study-directed. They claim that individuals in the first group, who learn and actively use the language in real-life situations, tend to experience higher levels of satisfaction with their learning process. On the other hand, those in the study-directed group often avoid using the language unless it is absolutely necessary, leading to feelings of frustration. MicroMandarin provides vocabulary exercises based on GPS location. Locations are connected to categories, i.e. food category phrases are shown, when user is in a restaurant. The application allows to study the language based on where learner is using it or browsing all phrases that has been seen. MicroMandaring uses flashcards as exercise, which user can flip to see correct response and then select whether he got it correct or not. System implements the Leitner count for correct and incorrect answers tracking.

MicroMandaring authors argue, that by helping learners to study in context, it will result in them being exposed to more opportunities for speaking, which lack of seemed to be a problem when it comes to motivation of students to learn (Edge et al., 2011).

Another app that uses microlearning is QuickLearn, described in the study by Dingler et al. (2017), which utilizes language learning on-the-go. Authors argue, that microlearning studies are typically not optimized for sustained and continuous use. They aim to tackle the issue by implementing push notifications, which prompt users to review foreign language

vocabulary, through flashcards and multiple choice exercises (Dingler et al., 2017). The app tries to utilize the "bored" time of user, by sending the notifications in the right time. The system also incorporates a spaced repetition strategy. The outcome of the study on Quick-Learn concludes that notifications are a great opportunity *"to engage users when they have time in quick learning tasks that only take up a few seconds"* (Dingler et al., 2017). However, it did not find conclusive evidence whether people are more likely to engage in microlearning tasks depending on whether they are bored or not. On the other side, Dingler et al. (2017) concludes that the microlearning system bears great potential for learners who naturally lack time and motivation to tackle a daunting task, such as learning a foreign language and that the people are more open to engage in quick learning sessions when they are mobile.

Another example of microlearning in context is a study by Beaudin et al. (2015), which states that the real benefit to users of such systems would likely come from frequent engagement over an extended time period. The paper attempts to find out whether it is expected that acceptance will decrease after the initial novelty wears off. The exploratory study took place at a house of two participants, where sensors were attached to objects of daily use to recognise daily activates. The participants were asked to place wireless sensors throughout the home using a mobile phone application to register and label their locations. During the experiments, words were playing from the phone related to the person's current activity (opening door, cooking, etc). Users could open app and replay the word. The experiment ended with interviews, in which participants expressed that they got used to the learning, as it was continuously running for a month, however the visual aspect was lacking and they were not being able to review the words later which would have been useful. The paper concludes that context-sensitive interactions could be incorporated onto everyday routines without them being perceived as burdensome (Beaudin et al., 2015), however the limitation here was the set up which was very demanding.

WaitChatter utilizes a concept called Wait Learning, which is considered an extension of microlearning that leverages wait time for education. The app is using brief moments of waiting during a person's conversations for second language vocabulary practice (Cai et al., 2015). Authors goal is to not only focus on what to deliver as microlearning system, but also when. Users of WaitChatter can learn vocabulary during instant messaging, through exercises or flashcards that appears below the chat. The study on WaitChatter revealed that exercises presented during the initial phase of a potential waiting period received increased user engagement, indicating that exercises should be optional and require minimal cognitive effort to minimize disruption (Cai et al., 2015).

Additionally, there are applications available currently on the market that utilize microlearning for language learning, such as Drops, Memrise, Duolingo. Drops, provides personalized learning experience. It has an onboarding part, where user enters how much time they are willing to spend per day. Learners can pick as little as 5 minutes daily, during which they go through small quizzes with words associated with illustrations and pronunciation. However, Drops is not entirely a microlearning application, as it also offers a range of other features and activities that go beyond just short lessons. The same principle

applies to widely popular Duolingo, which also incorporates some microlearning elements, but goes way farther. Memrise is similar, but it provides slightly different approach; users can learn through short quizzes connected to videos of real people who pronounce danish words. However, it also has an option to chat with a bot in language the user wants to learn and other functionalities.

Even though they showcase some differences, all of the apps follow similar approach: using gamification, personalized learning, push notifications, spaced repetition algorithm and variety of ways to learn (writing, listening, speaking). Therefore, they should not be considered microlearning systems per se, as they are quite complicated structures which aim to be a standalone tool to learn the language. However, as the apps incorporate bite-sized learning chunks, inspiration can be drawn there. Below I summarized the approaches in mentioned systems 1. Design inspiration can be found in appendix A.2.

Approach	Description	Example
Vocabulary-focused	Emphasizes learning of vocabulary through short, targeted activities	Flashcards, word games, quizzes, dictionaries
Grammar-focused	Emphasizes learning of grammar through short, focused activities	Fill-in-the-blank exercises, sentence construction exercises
Contextualized	Emphasizes learning of language in context, rather than in isolation	Short dialogues, texts, or videos that provide context for new vocabulary and grammar structures
Gamification	Uses game-like elements to motivate and engage learners in language learning activities	Points, badges, and streaks to encourage learners to complete activities and track their progress
Personalized	Uses data about the learner's performance to personalize the learning experience	Adjusts the difficulty level of activities or provides personalized feedback
Spaced repetition	Involves gradually spacing out the review of information to improve retention	Spaced repetition algorithms to help learners remember new vocabulary

Table 1: Summary of the observed approaches in mobile language learning

In conclusion, nobody has developed a mobile native application for microlearning a vocabulary through self captured images in their surroundings, and evaluated how users engage with it. Some solutions touch upon the usefulness of microlearning applications and the groups that could benefit from them, however as the ideas are slightly different, the

conclusion cannot be the same. Nonetheless, inspiration can be taken from other systems as they all seem to follow similar strategies when it comes to quizzes, spaced repetition and library building.

4 Methodology

The methodology employed in this thesis is based on design science research, a technique that aims to address real-world problems by creating innovative artifacts or designs (DSR) (Brocke et al., 2020). The DSR process involves creating artifacts to address problems, assessing the designed solutions and to demonstrate the results (Dresch et al., 2015). While not all elements of the complete DSR methodology process are included in this study, several key elements are present, including problem identification, artifact design and development, and evaluation (Dresch et al., 2015), (Brocke et al., 2020).

The problem addressed in this study is connected to the research question. Through the related work, it was found that existing mobile applications in the market do not provide a microlearning solution specifically tailored for language learning through captured images. In order to fill this gap, an innovative artifact, the "Dansk In Town" mobile application, was designed and developed. The evaluation of this artifact involved user testing and subsequent analysis the results from the use of the artifact in context (Brocke et al., 2020) in order to answer the research question.

In the Design Science approach, an iterative design and evaluation process is typically followed, consisting of multiple cycles of design, development, testing, and refinement. In this study, a similar procedure was adopted, involving two implementation and validation rounds.

4.1 Procedure

The procedure started with first round of implementation focused on creating the initial artifact, which was a Minimum Viable Product (MVP) of the mobile application. This MVP was then subjected to testing and evaluation to gather feedback and insights from the users.

Based on the findings and feedback from the first validation round, the second round involved implementing new features and enhancements to the application. These changes were aimed at addressing the identified issues and improving the overall user experience.

Below, on figure 1 the whole process is illustrated.

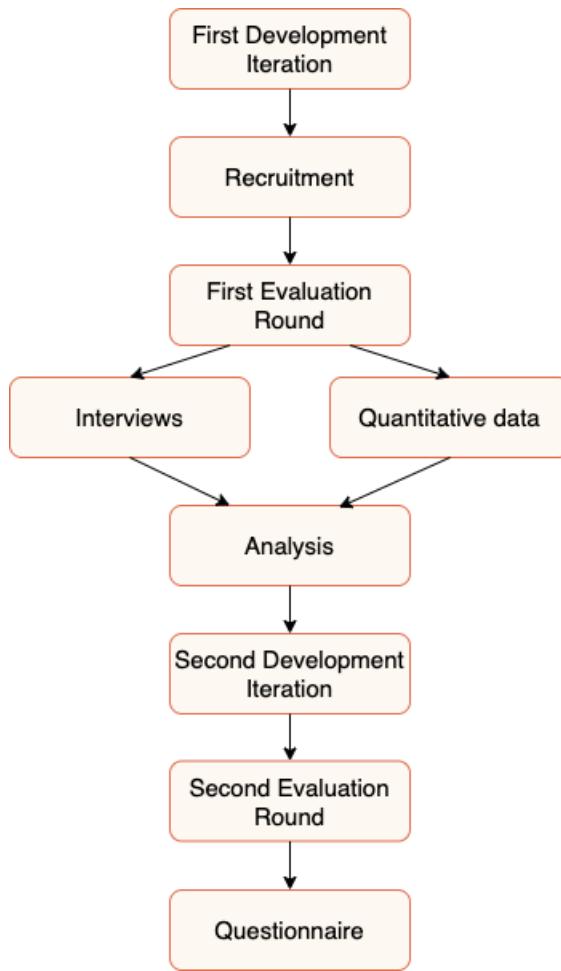


Figure 1: Flowchart of the study procedure

When it comes to the development process, more on the technical details and the features of the application can be found in chapter 5.

The approach for the evaluation phases was based on user-centred design, more specifically the validate part of the user-centered cycle, where a form of usability test is conducted. UCD is an iterative process that involves constant feedback and refinement, usually with research, prototyping and testing phase (Smith, 2021). As the research question aims to answer *How can we design a microlearning mobile application that encourages people to engage with the vocabulary around them [...]?*, it was crucial to create a user-centered experience, where people were involved in the process.

Usability tests are empirical studies involving human participants. Usually conducted in a controlled setting, i.e. lab, where participants work through a set of task scenarios with their behaviour being monitored from an adjacent observer room (Wallach & Scholz, 2012). This approach requires considerable resources for test preparation, creating a test environment, and administering the tests (Wohlin et al., 2003). As the resources and time are quite limited, a favorable alternative is to enable self-testing for users by utilizing remote

asynchronous method, where testers and evaluators are separated by both space and time (Bruun et al., 2009). According to Wohlin et al. (2003), remote asynchronous testing often make use of auto logging, for qualitative data collection, combined with interviews, for quantitative data.

There are some aspect to be aware when applying asynchronous remote testing, one of the being the absence of real-time interaction between researcher and participant, which makes it difficult to clarify and check whether the understanding of the experiment is there (Murphy et al., 1998). That creates the danger of user being confused and not knowing what to do, which can slow the process or stop it altogether. On the other side however, the fact that the researcher cannot intervene during the experiment, supports the idea of creating a real-life scenario and investigating how users truly interact with the app. Another constraint arises from the researcher's limited influence over the testing environment in which the participant operates. Within the specific context of technology usage, particularly important in this case, examples include the level of distraction present while using smartphones or the specific timing and manner in which the application is used (Blease & Bernstein, 2021). Furthermore, an additional aspect of the experiment entails that users have both internet access on their mobile phones and proficiency in using mobile applications. Based on mentioned methodologies, first validation phase ended up as following process:

1. Participants received access to the application and were asked to try to use it daily for a week
2. There were no specific instructions or tasks, since the idea was to imitate a real life scenario where people use the app freely. It was done in order to analyze how do users actually would engage with the application
3. Throughout the use time, quantitative data was collected
4. Afterwards the semi-structured interviews were conducted, to collect qualitative data

The study was conducted on 10 participants, with different backgrounds. Some were recruited through forums, by reacting to the post that described the idea for the app, others through personal network (work, university). Main requirement was for the users not to be fluent in danish.

When it comes to the second validation round, due to time limitations, the testing phase was kept shorter. It followed a similar asynchronous remote testing procedure as the first round but lasted 3-4 days. I invited the initial testers, and managed to gather 7 participants. Since the users were already familiar with the app, I set more specific feedback goals and time limits for this phase.

To gather feedback, I incorporated an element from the User-Reported Critical Incident Method (UCI) (Bruun et al., 2009) and requested that users report any issues they encountered while using the app. Additionally, users were encouraged to freely explore and use the app, similar to the first testing phase.

Afterwards, questionnaire was used to collect the feedback from participants, with the specific questions tailored to the outcomes of the first testing phase, therefore more on it further 8.1.

4.2 Data collection

Interview

The primary method employed for data collection was through semi-structured interviews. These interviews are characterized by open-ended questions or topics that are pre-determined, allowing the interviewer to delve into specific areas of interest and follow-up on emerging points as the conversation progresses (Denzin & Lincoln, 2011). One of the advantages of a semi-structured interview is that it enables the interviewer to follow up on intriguing or unforeseen responses, which allows for a more comprehensive understanding of the participant's perspectives and insights (Denzin & Lincoln, 2011). As the study searches to find the answer to what people find engaging, responses can be very personal and vary greatly, therefore the ability to dig deeper is of great utility.

The interview followed a structured form, however with the space for participants to express themselves freely and for me to ask more questions when something interesting in regards to main topic was mentioned. The process was split into 2 phases: "Introduction", where users shortly introduce themselves and answer questions about their danish learning journey and "Questions about the app", were they answered on variety of topics related to the use of the app, their motivation and functionalities. All the questions, the aspects and the rationale behind them can be seen on figure 2. Interviews were conducted in person or online, during which I made notes with key points, as well as recorded them.

Database

Secondary way of collecting data was tracking some of the actions of participants. The way to do so was to save the events in the database. I have predefined 5 types of events: user picks correct answer to the quiz, user picks the wrong answer, user uploads an image with translation, user logs in and out. All the events were related to a user, and if necessary to a specific translation, and were accompanied by timestamp.

4.3 Data analysis

For the interviews, since the questions are quite extended and semi-structured 2, the analysis was conducted by aspect (theme) instead of question-by-question basis. The idea was to extract the most valuable information which would help answer the research question, which is finding out what is the most engaging design for a microlearning application. The process started with transcribing the interviews, in the form of audio files, with a software named "Good Tape". My decision to use this specific tool was motivated by its accuracy in comparison to Google Cloud transcribing or Ottet.ai. Having the documents ready, I started coding the interviews manually, both based on the notes I made as well as the transcripts, searching for the key points and most prevalent answers. As a result, common answers were grouped in 3 to 4 categories in each theme.

In the end, the concepts that were found to be most commonly mentioned, are described in the analysis. Additionally, to support the findings, the most insightful quotes were picked. The aim was, based on the findings, to figure out which functionalities and improvements should be included in the next phase of implementation, so it offers more captivating design

Aspect	Question	Rationale
Background	Your occupation, age, nationality? Your level of danish? Are you attending Danish classes? Did you attend classes in the past? Why did you stop? Are you using mobile apps for learning danish? Did you use them in the past? Why did you stop? Do you wish to learn danish? What has been stopping you?	Introduction, to gain insight into the participant's attitude towards learning as well as background
Engagement	Did you feel motivated to use the app? Why? If not, do you have improvement ideas? What was prompting you to open the app? Was there something in the app that made you particularly interested in coming back to using it the next day? Which element? What would make you engage more?	To understand what motivates and engage the users into the app in their own words, to gather potential ideas on what would increase it
Usage	How much did you use it for taking photos and how much for exercises? If they did not use the exercises - why? Any suggestions? How often were you using it? Daily? How long? How easy was the application to use?	To understand how participant use the app
Features	Did you find the images uploaded by others relevant? Do you have comments on the upload flow? From making or selecting the picture to translation. What did you like the most? What do you think is missing?	To gain insight on how participants feel about specific features and the app in general
Effect	Did you feel any different about your surroundings? Did you feel like the app made you more interested in Danish vocabulary? Potentially in learning it? Did you consider the app to be somewhat a learning tool? Would you recommend the app to somebody else?	To understand what kind of potential effect the application has on learners

Table 2: Questions for semi-structured interview

and encourages people to engage with vocabulary around them. Additionally, the analysis aimed to answer the question: *Is such application a useful learning tool and are there users who would benefit from it?*

When it comes to the quantitative data, a script in Python was written for the analysis purposes, which can be found in Appendix A.5. The angle was to get an overview on how many images individual users have uploaded, how much did they use the application for exercises and the relation between those. Some data visualizations were also created. This served as a support for the findings discovered during qualitative analysis, as it allowed to verify how participants were actually engaging with the application as well as gain some statistical insight into the usage.

5 First Development Iteration: An MVP

In this section I will dive into the app development process, including the tools, software, and programming languages used to build the app. Further on, I will explain the features and functions of the app, and how it aligns with the research questions and objectives.

5.1 Technical choices

The app was developed with React Native and Expo. Expo is a set of tools and services built around React Native, a popular framework for building mobile applications using JavaScript. It provides a comprehensive set of tools that help developers build, deploy, and manage their React Native applications. Expo provides a set of pre-built components, such as camera, maps, and push notifications, as well as tools for building UI components and managing app state (*Expo Documentation*, 2023).

As Expo allows to build universal native apps, the Dansk In Town mobile will be available on both iOS and Android. For development, I used Xcode iPhone simulator and Android Studio emulator to run the application on my local computer. Another option is to scan the QR code, which gets generated when starting the development mode, on a physical device and run the application in Expo Go. For versioning and maintaining the code repository I used GitHub. The link to the source code can be found in Appendix A.3.

The decision to choose Expo and React Native over Flutter with Dart, despite Flutter's popularity among developers in 2022 (Post, 2022), was primarily driven by my prior experience. I researched the advantages and disadvantages of both options, however the outcome was that they are equally good in its own ways. Having previously developed applications with React Native and utilized JavaScript in the past, I believed that I could continue learning and expanding my skills in this area. Deciding for React Native for Dansk In Town felt intuitive as it allowed for a smoother learning curve, enabling me to enhance my knowledge further in this technology. However, it is important to mention that Expo does come with some limitations, such as restricted customization (*Expo Documentation*, 2023). Because of Expo's abstractions and additional layers, the app can face potential performance issues. Additional limitations are enforced, such as 600 push notifications per second per project can be send and limited amount of builds is granted for a free tier account (*Expo Documentation*,

2023). When it comes to React Native, since it is a JavaScript-based language, it can create performance issues and make debugging difficult. Implementing transitions and animations can also be challenging. Furthermore, React Native has its own components optimized for mobile development, which provides developers with less control.

For the Backend part, I reused the Back4App solution from the original DIT web version. In summary, Back4App is a BaaS (Backend as a service) platform that offers a managed version of Parse as a service. It allows developers to set up and manage their backend infrastructure without worrying about servers, databases, or scaling issues. Therefore, I did not have to build my own APIs, as Back4App provided the backend services, which had all the CRUD (Create Read Update Delete) operations built in. The calls to the APIs were made through HTTP and they returned data in JSON format. On Frontend, I used Parse SDK package for React Native, through which I could connect to the server and make calls to the database. Most of the database tables from original DIT could be reused, however changes and addition had to be made.

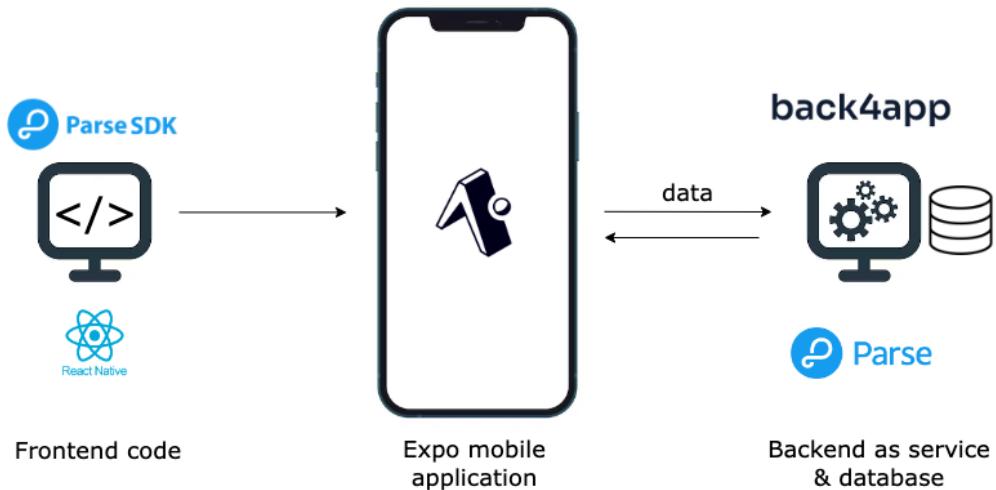


Figure 2: High level application communication

5.2 MVP Features

The minimum viable product (MVP) of Dansk In Town serves as a prototype and platform for conducting the study. Thus, the goal was to incorporate essential functionalities that are relevant to addressing the research problem. As mentioned in 2.1, 2.2, the way to create and engage and beneficial experience is to incorporate interactivity, usability, potentially gamification, exercises and so on. The goal was to create an application which incorporates those elements. A key focus was placed on providing users with a seamless image capturing experience, as it lies at the core of the application. Additionally, an interactive exercise in the form of a quiz was implemented to ensure user engagement, while maintaining a user-friendly interface. To add on top, social aspect was integrated into the exercise, by

allowing users to practice on others' images, along with gamification element such as level progression within the library section. When it comes to interface design of the app, firstly I gathered inspiration by investigating the interfaces of other language learning application. I found that common points are: vibrant color schemes, interactive elements, and a seamless user experience (UX). Then, I created some initial mockups; the results can be found in the Appendix A1. In the following sections, I will describe the features that have been developed into Dansk In Town.

5.2.1 Start & Login

When opening the app, the first screen contains small introduction to what the app is about and call to action button to log in (see figure 3). User can either create a new profile or log in with own credentials. The interface follows a standard way of implementing logging flow. Parse provides built in functions for logging in and out.

The challenging part here was to manage the state of the app once user logs in and out, as there are 2 different menu types which should react to the event. The solution was implemented with higher-order component (HOC) pattern, using props and callback functions.

5.2.2 Camera

The built-in camera was implemented in order to make it easy and fast to capture and add images. As images are at the center of the idea, it was important to create a user-friendly experience that allowed and also prompted users to take them, therefore the big call to action button is at the center of the start screen (see figure 4).

The functionality was created with npm package named *expo-camera* and *expo-image-picker* for enabling selecting pictures from phone library. The camera had option to put a flash on and change the screen view between front and back camera. The image flow starts in the main page, however has 2 components inside which communicate through props and callbacks: CameraPreview component, which is a middle-man between image and translation; and translation component that handles the input and translation of the word, and returns data back to CameraPreview. Preview displays the chosen or taken image and provides the option to re-take the image or start translating. The aim was to design a straightforward flow that simplifies the process of capturing pictures for users, as the intention is to promote and encourage user engagement in this activity.

The technical challenge here was saving the image to the database. It required a pre-defined data type "file", which was not aligned with what the *expo-camera* was initially returning. The solution was to specify the format of captured image to base64, then the photo uri had to be encoded using *expo-file-system*. Finally, when saving the image, some modifications had to be done to the encoded string and the picture was saved correctly.

5.2.3 Translation

As for translation functionality, user needs to write the word or phrase himself. It is motivated by the fact that it is simpler and less time consuming to implement than some

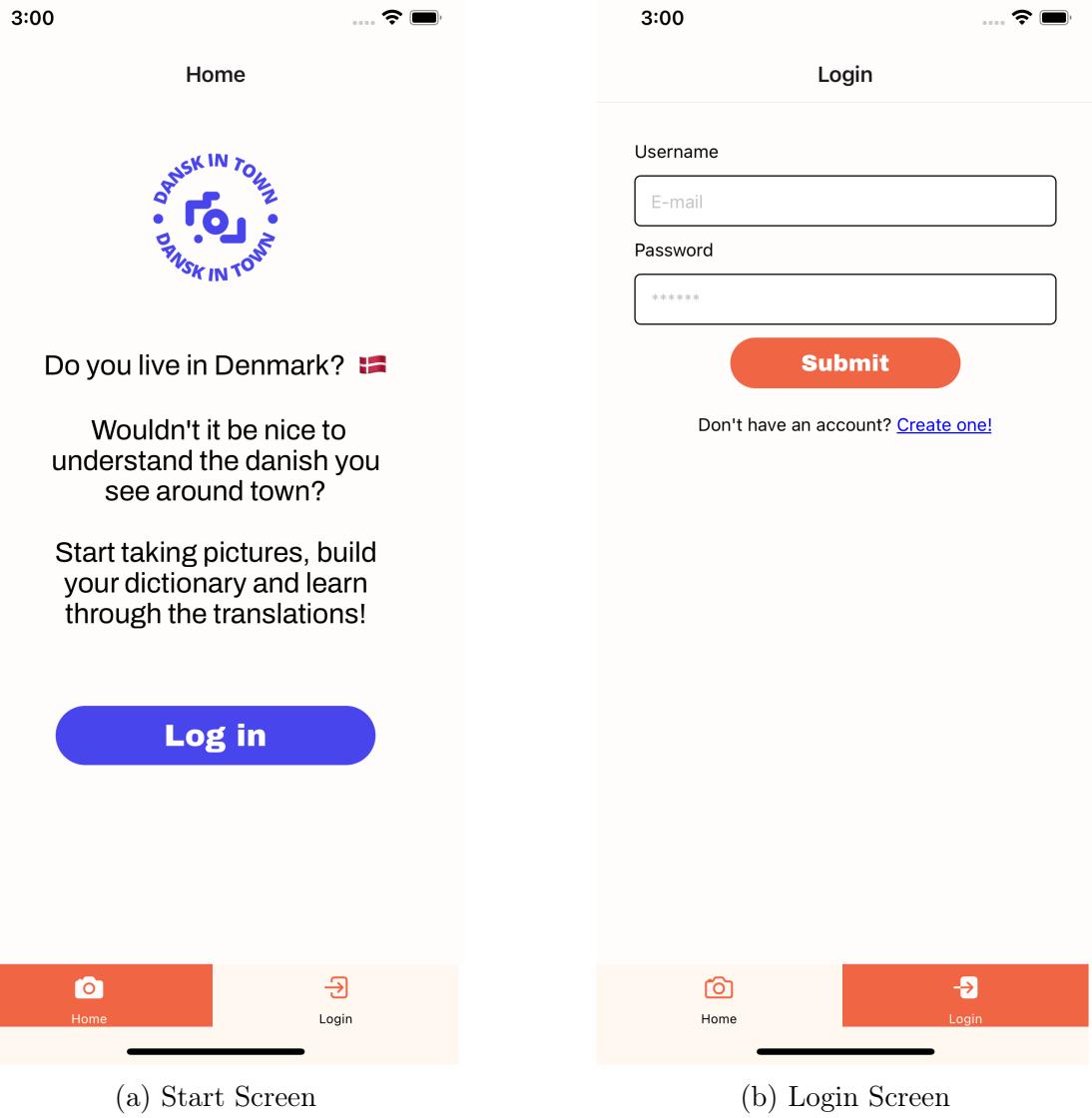


Figure 3: *App Screens before logging in*

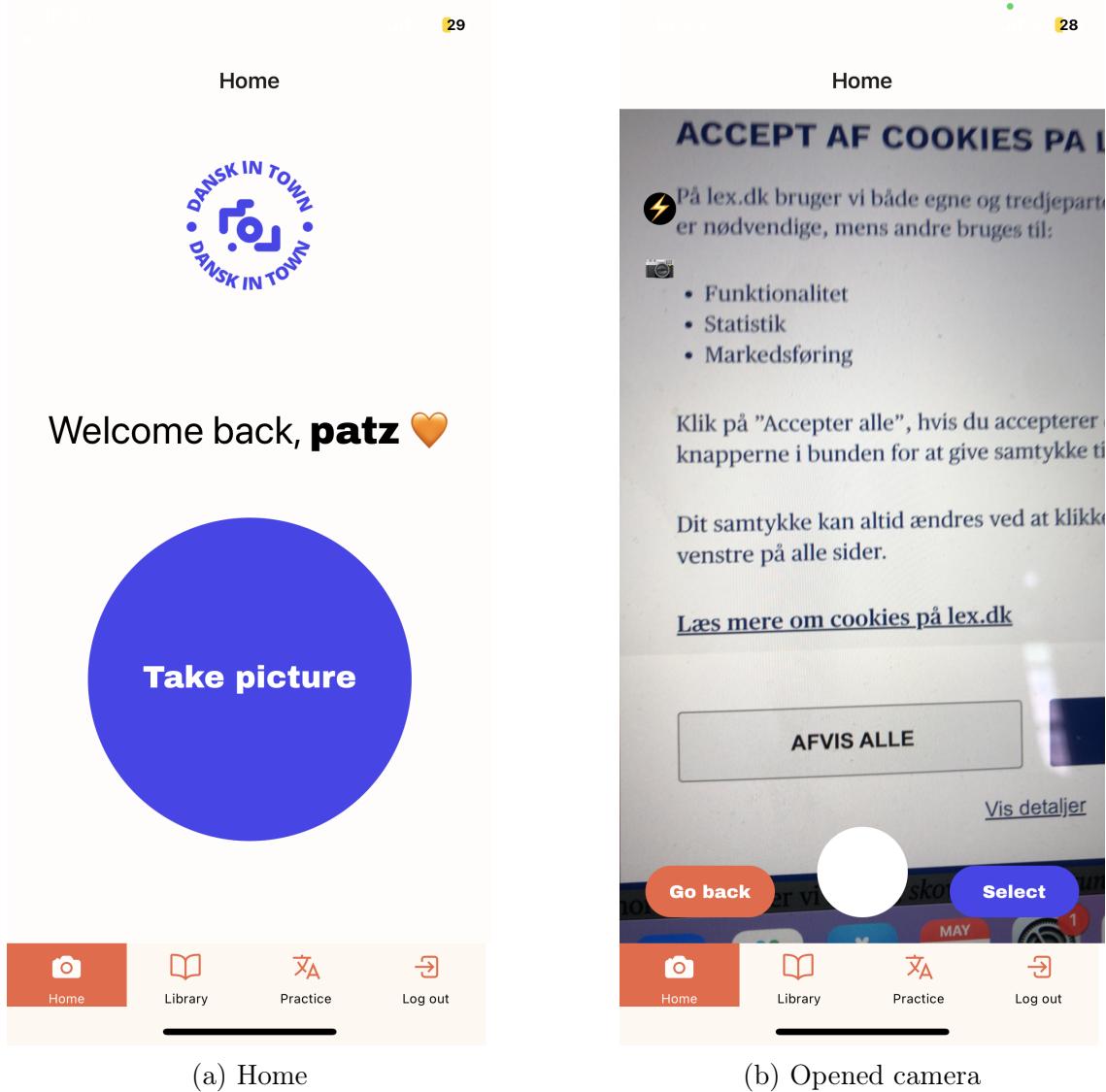


Figure 4: *Camera Screen*

kind of image recognition solution where text would be read automatically. Additionally there could be a value in writing in terms of learning - while typing user could improve the writing proficiency. The translation from Danish to English is handled by Google Translate API. I used the Cloud Code function in Back4app, which, for each translation is being called from inside the repository and returns the English phrase.

The challenging aspect was to create a friendly UI (see figure 5), for example making sure the keyboard is not overflowing the input field, the image size is optimal and not cropped and that it is clear what user has to do in order to create translation.

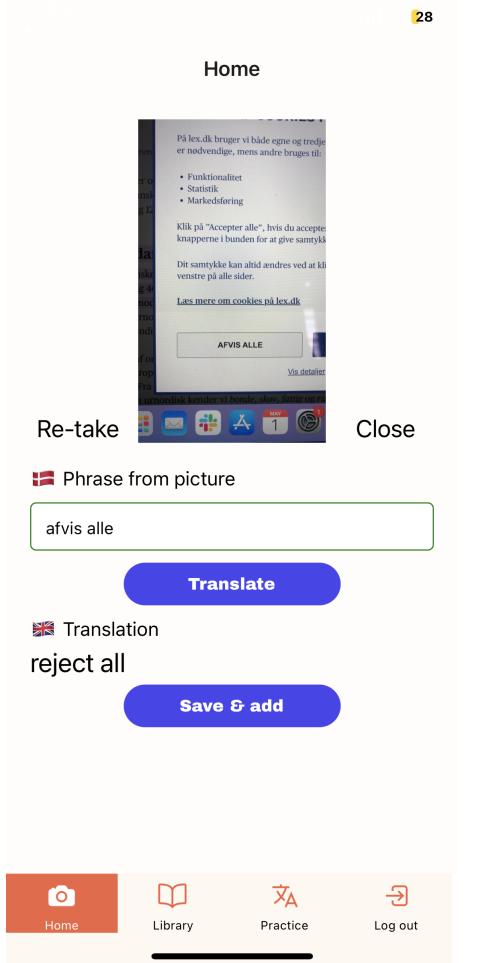


Figure 5: *Translation Screen*

5.2.4 Library

User gets taken here after saving an image. Library provides overview of all added words, with respective dates. User can switch between seeing the original phrases without translations and with the English translations (see figure 6). Small gamification element was added here, in a form of levels, based on the amount of words added in total by user. The

level increased with each 10 words added and user can see how many words are missing until next level and how many were added last week. Lastly, users have the option to click the call to action button "Practice your library" which takes them to Practice section.

The most demanding part was to implement the levels, as it was set up on frontend. Therefore, a small algorithm was created, which calculated current level based on the amount of words added by a user returned by the database.

5.2.5 Practice

Practicing part is implemented as a form of small quiz. When in community mode, which is the default mode, users get a random image from the pool containing all pictures added by users into the database. When in library mode, users get to practice on the words they added. Then, there are 4 potential answers from which one is the actual and correct translation and the 3 others are randomly chosen translations from the pool (see figure 7). The array of answers is shuffled to prevent the correct one always being in the same position. Once user clicks "Check", the pop up with "Good" or "Wrong" shows up, depending on whether the right answer was chosen, and the quiz moves onto the next image. Another option is to click "Too easy" which will mark the translation in the database with user id, which will result in user not seeing the image again.

Designing the interface was demanding task, as it is the main learning activity and it should be reliable and engaging.

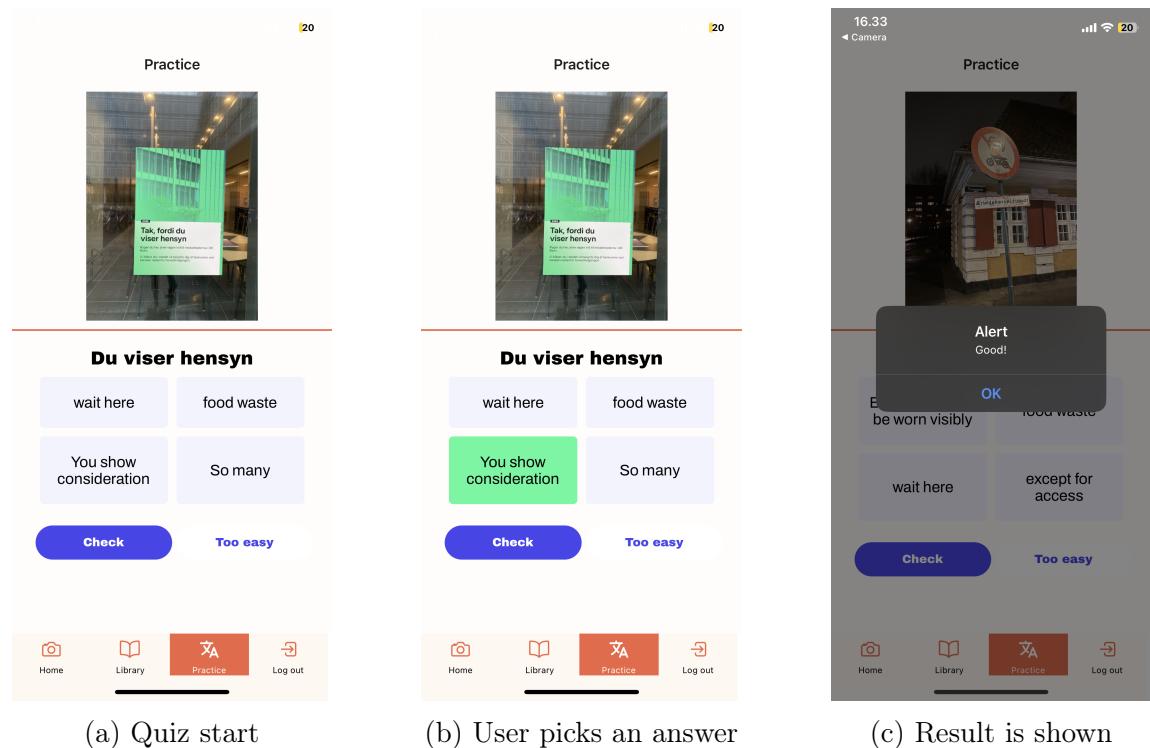


Figure 7: *Practice Screen*

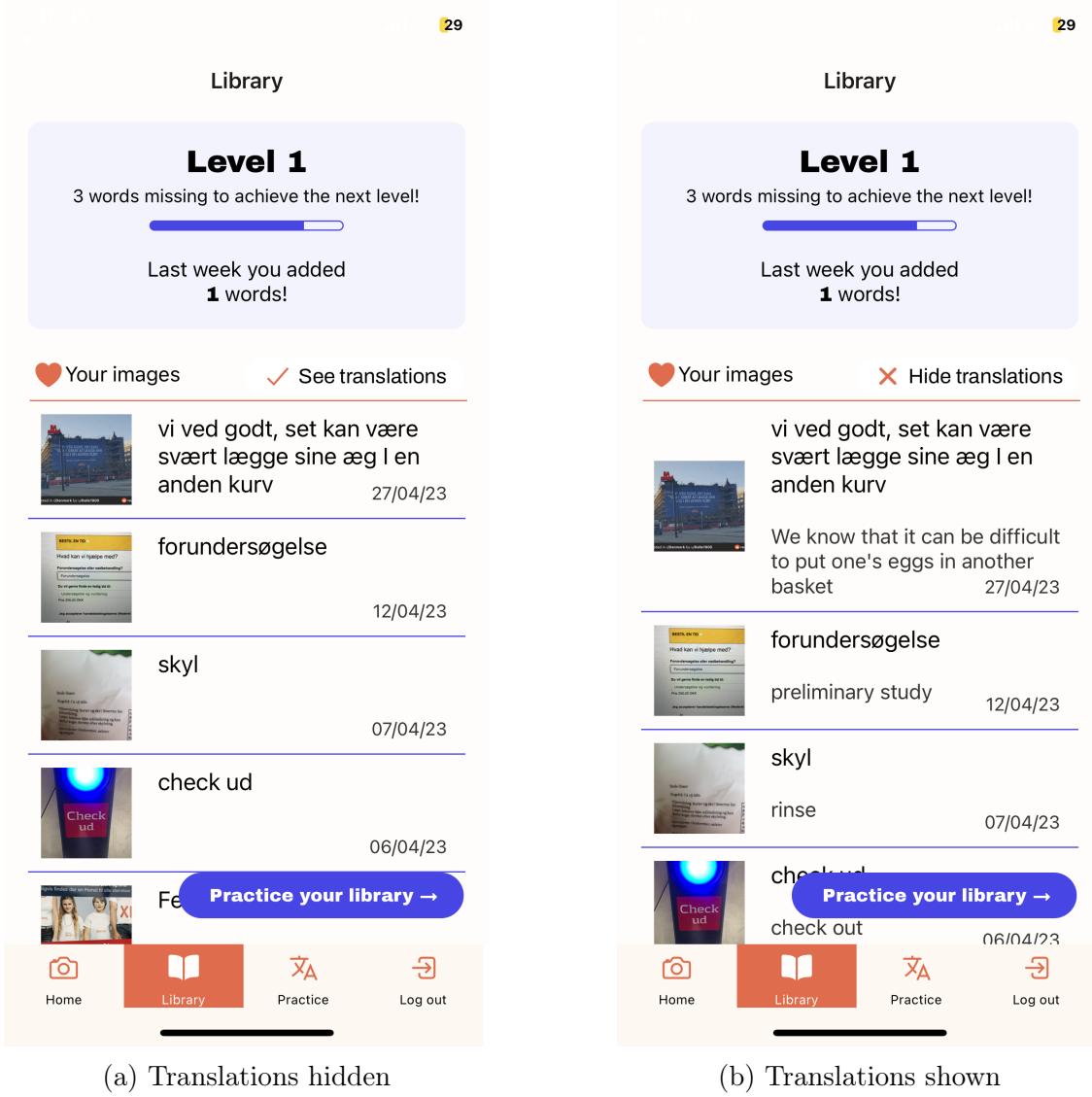


Figure 6: *Library Screen*

5.3 Deployment

For testing purposes, the app was released inside Expo, through EAS (Expo Application Service), using *eas update* command. It is a limited service, intended to be used internally. As the testing phase was involving 10 users, it seemed like a reasonable idea, also in terms of saving time on deployment to actual Apple Store and Google Play. Users could access the mobile application through Expo Go app, available both for iOS and Android. Sharing the app happened through QR code, which was assigned to a specific update (version) of the app. That came out to be helpful, when discovering, for example, that some features which worked on iOS have been buggy on Android; users of different operational systems received separate version QR codes. Below, the QR codes can be found (see figure 8); scanning them in Expo Go, which is available in App Store and Google Play, will give the access to the application.



(a) Code for Android phones



(b) Code for iOS phones

Figure 8: *QR codes for accessing the application*

In a real life scenario, or when scaling, the builds for iOS and Android would have to be created separately, through *eas build*. After successful builds, they can submitted through *eas submit*. IOS provides a TestFlight service, which enables testing, and Google Play has a internal testing track. Actual release needs to be accepted by the stores and comply with data and transparency rules.

6 First Evaluation Round

6.1 Interview Results

The study obtained data from ten participants, aged between 24 and 30, representing eight different nationalities. The interview data, which was transcribed and can be found in the appendix A.4, should be interpreted with the understanding that the interviews were semi-structured. As such, some topics were discussed out of order, as follow-up questions occasionally related to questions asked later in the interview. In the subsequent section, the

experiment results are presented thematically.

Background

Majority of interviewers claimed their level of danish was either basic (A1 - A2) or on the intermediate side (B1). Only one on the participant claimed to have a good understanding of written danish, due to being fluent in Swedish. 7 out of 10 interviewers have been attending danish classes in the past, and when asked why did they stop, the main answer would usually point to motivation, however some people mentioned corona and classes being online which was demotivating. Others stated that "*life happened*" and they did not have time anymore. One interviewee said: *"And I think I wasn't that motivated at the end of the module to continue. Because there was still Corona, I was like, I don't want to take the classes during lockdown. That was actually the reason. And then the time passes and never get back to it. But actually, probably I'll turn up again".*

8 out of 10 participants said they have been using mobile app for learning danish, in particular Duolingo. When asked why did they stopped using the app, the majority again pointed to motivation, time, laziness and losing their daily strike. When asked *"Do you wish to learn danish?"* 8 out of 10 participants answered yes. When questioned about what is stopping them, the answers again pointed to motivation and time.

Engagement

When it comes to motivation question, 7 out of 10 participants stated that they were motivated to use the application, and usually expressed something positive about the idea for the application. One person said: *"Yes, I felt motivated, definitely. [...] I really appreciated the fact that I can make these words out of the context when I pass by shops or products or restaurants or city center. [...] And then actually the fact that you have created the option to practice this out of others' content, that was something that really seemed to be interesting, but also kind of motivating because you kind of want to see, oh, what others see, what I cannot see or like what I didn't spot and so on"*. However, multiple participants also mentioned that their commitment to testing and curiosity in the project added additional aspect to feeling motivated.

Some interviewees mentioned that taking pictures was difficult for them in the context of engaging with the app. Either it was challenging to remember about making them: *"But I must say that it's been a bit like hard to remember to take pictures."* or they felt like they did not have the time when being outside. One user explained: *"So first of all, I think I only took a few pictures in the first days because I found it difficult to like when I'm walking in a city that I would be taking pictures at the same time. So like it was impossible for me because when I'm going from place to place, I am in a hurry".*

Interviewees highlighted the factors that they believed could increase their motivation. The most commonly mentioned feature was push notifications, with 4 out of 10 participants expressing that notifications had the potential to increase their engagement with the app and encourage them to take more pictures. Furthermore, when asked about what would make them engage more, a similar response prevailed. I further inquired some users about their thoughts on the frequency of push notifications, as a few mentioned being annoyed by excessive notifications. The general consensus was that daily notifications were preferable.

4 of the participants also mentioned that gamification elements, such as streak series, milestones or levels would make them use the app more. When it comes to answering the question on what particularly drawn users to coming back to the app, Practice part was mentioned often. Two of the participants stated: "*I didn't take that many [pictures], but actually the practice part was very engaging*"; "*But like I found myself sometimes going in the app and then checking the practice and then just going through what I'm guessing is other people's pictures*". Even though users claim to really enjoy the idea of the community-based images for learning the vocabulary, making the pictures themselves emerges to be the challenge. On the other hand, the practice part is promising when it comes to engaging the users.

Usage

When asked about the usage in terms of taking pictures and practicing ratio, more than half of the participants estimated that they used it more for the practice: "*Yeah, I would say like probably like 70 percent exercises, 30 percent taking pictures*". 2 users mentioned, however, that they mostly took pictures. Majority of users stated that they have not been active on the app daily, but used it every second day or 3-4 days a week, some specified that it was 10 - 15 minutes at one session.

Most of participants stated that the app was easy in use, quoting: "*I mean, it's pretty straightforward. Like the button is huge. So it's pretty easy to understand what you're supposed to do*", some mentioned that they liked the design. There was also feedback on bugs, such as long saving time for taken picture, or potential UI improvements, for example, "log out" button placement which was very easy to click and multiple users voiced that they logged out by accident many times. One person mentioned that it was a bit disappointing that she has never came across her own pictures while practicing.

Features

During this part of the interview, participants could freely answer the open-ended questions about what they liked and what is missing, in the context of what the app has to offer and which features can be found in the application. When asked what did they like the most, two main responses dominated, the most popular being the social aspect of the practice part. One interviewee said: "*I like the idea of the general database or like library is also user, crowd based. [...] It motivates you a bit as well, I guess, if you're using the practice, since you know, other people are adding to it, to try to add something as well*". The second most prevalent element was the library of own images: "*The fact that I could see how many words I learned and see them all in one place and also see the image next to it. That would remind me where I saw them and in what situations I took the picture*". Some respondents mentioned the built-in camera and the easiness of access to it.

When it comes to what's missing according to testers, the common thing seemed to be improvement of the practice part, such as the gamification aspect, mentioned in different forms; either as progress tracker, leveling up or reward system. Participants also felt that the practice is too easy, because they could guess the correct word based of the length of the answers, or because the pictures were repeating often. Some proposed a spaced repetition like solution, where you do not see the guessed words again for some time. In words of one of the testers: "*The thing you guessed today should not be seen next time*". Additionally,

push notifications were mentioned once again.

When asked about the upload flow, testers mentioned long waiting time for saving the image, proposed "delete image" option, as well as provided some ideas for library section improvements. There were also some positive comments on the UI, however 2 users mentioned the icons in the camera were confusing.

Effect

In this section of the interview, testers were supposed to answer more of a general type of questions related to the impact of using the application. When asked if they felt any different about their surroundings, 3 of the participants answered straight "*no*". However, few others mentioned that they were "*maybe a bit more aware of danish*" or that they have noticed more danish words, for example on the road signs. Question about whether the app made them feel more interested in learning Danish vocabulary was, however, more unanimous. The answers were positive, testers mentioned that it "*rewoke*" the idea to learn; someone said it created the thought: "*I should learn danish*".

When it comes to users considering the app as a learning tool, the majority responded affirmatively. One participant mentioned, that he does not consider it a substitute for classes, but a nice addition for vocabulary. Other called it a "*helper*".

Things got insightful when asked about whether users would recommend the tool. 5 of the participants answered yes, but they would do so to a person who has just moved or is a beginner in danish: "*I would recommend it to everyone who's new to the country and just wants to have a little bit of fun and like see where the language is going*". Others simply answered yes, they would, but only when the improvements which they suggested are made.

6.2 Data analysis

This section focuses on the numerical aspects of the experiment, describing the process and outcomes. The objective is to examine correlations between the data and participants' feedback, while also obtaining an overview of the overall performance.

Firstly the data needed a bit of cleaning. As one person dropped out after the first day and needed to be replaced, I removed her records from data. Two users had to be merged, as it was the same person, who forgot the password and created another account. The events table was filtered by date, as I was only interested in the events from when the official testing phase started. Additionally, I filtered out the events for logging in and out, as they came out as not very useful in current analysis.

During the study, 57 images were added and on average each person added approx. 5,7 pictures. On top, 318 events were captured in regards to the Practice part. 114 unique translations were practiced during the experiments, out of total 242 available in the database by the end of it.

Starting with analysis of how individuals performed in the quizzes, below we can see the graph of correct and incorrect answers per user 9. It can be seen that the number of positive answer overpowers the negative ones greatly for each user. As mentioned in the

interviews by participants, the quizzes seem to be too easy, as the answers proposed are way too different and the answer can be guessed from context.

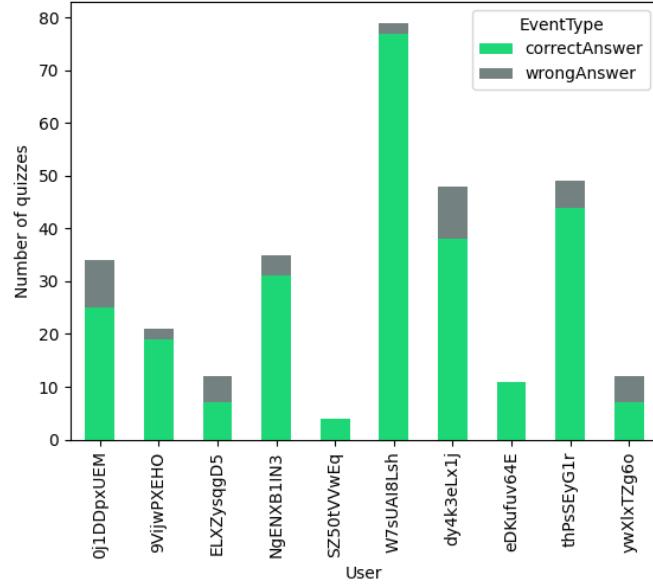


Figure 9: Number or correct and incorrect answers per user

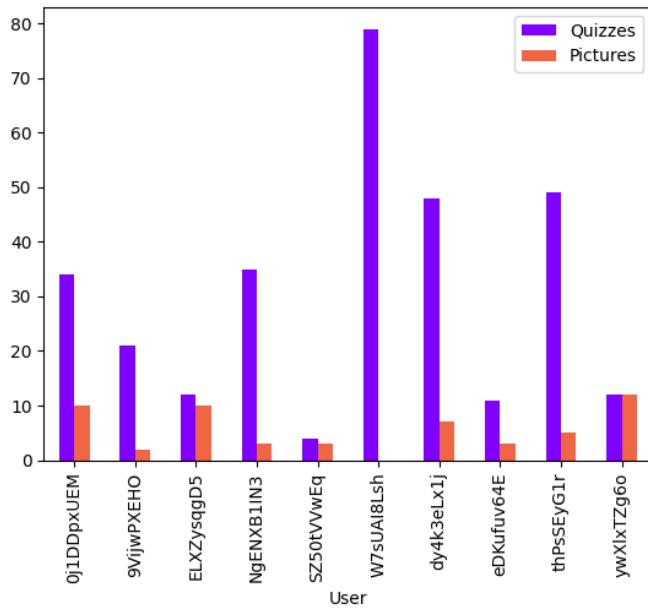


Figure 10: Number of taken quizzes and captured pictures

On figure 10 we can see the juxtaposition of number of images taken and number of quizzes taken (the sum of all answers). It shows that users who took the most quizzes are

not the ones who take the most pictures as well. However, it can be seen that majority of users took some pictures.

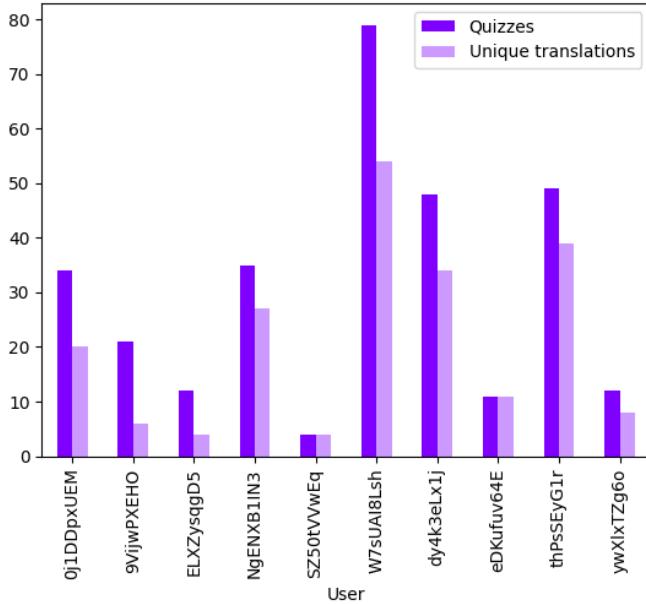


Figure 11: Number of times users did quizzes and unique translations they stumbled upon

Something interesting that came up in the interviews was that users were unsatisfied with repetition of the images in Practice. As summarized earlier, only 114 unique translations were practiced, even though 242 are available. In figure 11 we can see the number of total quizzes taken and number of unique translations in them. It can be concluded, that most of the user experienced repetition, even though there were still images to see available in the database.

6.3 Summary

After conducting a thorough analysis of the results, it became clear that certain topics and issues were mentioned repeatedly by the participants and also backed up by the data analysis. While there were positive responses towards the concept of the language learning app, issues related to engagement and motivation have also been identified.

Some common threads were identified, and two main areas for improvement were suggested. Firstly, the Practice section, which now is too easy and repetitive, however vital for the application engagement and learning value. It could benefit from advancing the difficulty or a spaced repetition algorithm. Secondly, Dansk In Town is missing additional engagement features, to encourage users to take the pictures as well as remind them about using the application. This could be tackled by push notification, which were also mentioned by users as potential improvement they would like to see. Additionally, gamification was mentioned by participants, which could be incorporated into the app to make it more fun and engaging.

Some usability related bugs were also mentioned, which are not direct tools for driving the engagement, but as mentioned in 2.1, they do affect the users in terms of encouragement. One of the prevalent issues was "log out" button placement, which made people log out by accident multiple times. Another issue was long waiting time for saving an image, which could be connected to the testing environment.

In terms of the target audience, the interviews provided some insight into who would benefit from such an application. It was suggested that the app could be particularly useful for people who are at the beginning of their Danish language learning journey or those whose level is not too high. However, the app could also serve as a helper for those who are actively learning and looking for additional support. Furthermore, the study provided insight to whether the app can be considered a useful learning tool and, according to users, the answer is yes.

Overall, the study provides valuable insights into how to design a language learning app that can effectively engage and motivate users and partially answers to the research question. By incorporating the suggested solutions into the app design, I hope that users will experience increased motivation and engagement in their language learning journey, leading to a better overall learning experience.

7 Second Development Iteration

Ultimately, we want to design an application that maximizes the engagement of users with the vocabulary around them through images. To reiterate, from our analysis it comes out that users do enjoy the application and the idea, but there are some issues:

1. Users forgetting about using the application and taking pictures
2. The practice component, not being optimally designed, can become discouraging over time
3. Usability issues

7.1 Push Notifications

Notifications were mentioned multiple times in our analysis, mostly in the context of being a reminder to use the app. Many apps are forgotten and abandoned even before users discover all the great features of the app (Fernández et al., 2014). Well-timed and relevant push notifications have the ability to effectively reach users, capture their attention, and, when executed correctly, improve user retention by acting as reminders of an app's presence and encouraging ongoing usage (Fernández et al., 2014). However, according to Pham et al. (2016), if push notifications do not provide any value to the consumer, they can be ignored—or because of their intrusive nature—viewed as spam. As a result, users can become annoyed even delete the app. This connects to our study results, where users' mentioned that notifications are a useful reminder but can be annoying. My objective is to establish notifications that serve as reminders to users, aiming for their long-term engagement with

the application, while also avoiding overwhelming them. One of the notification types, which Pham et al. (2016) refers to, is a reminder about the new content. In our case, the content are the new pictures captured by the community. Other types mentioned in the paper to implement notifications involved reminding users to revisit the app to review their learning progress or encouraging them to engage in a daily test to assess their performance (Pham et al., 2016).

The social aspect came out to be very engaging for users, as people noted that seeing images taken by others was interesting 6. Therefore, it appears beneficial to integrate these concepts into the notification system. Additionally, I would like to encourage users to take the pictures. Thus, the integrated push notifications are:

1. Type 1: Reminding to take a picture of a new phrase
2. Type 2: Notifying about the amount of new images added by community in the context of taking quiz

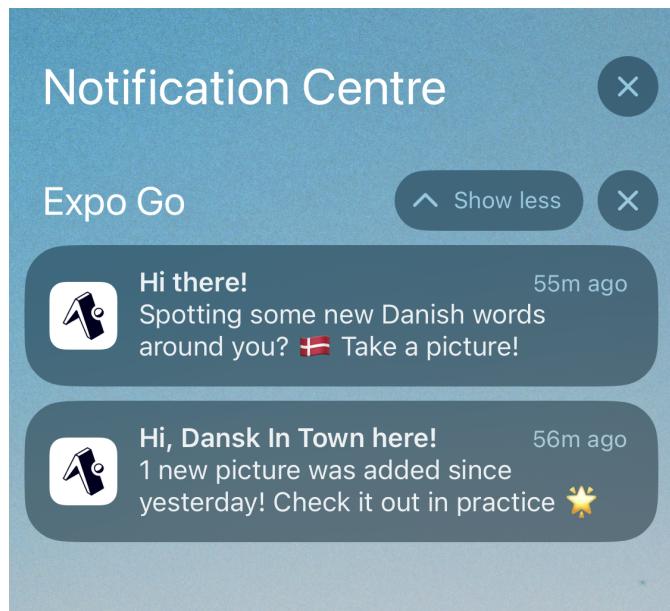


Figure 12: *Notifications*

Notification Type 1 was set to be sent to users every second day, at 17:15, since this is the time when users finish work and potentially are outside or on a way home. Type 2 is running the remaining days, in the evening, when learners potentially have free time. This way maximum amount of daily notification will be 1, which was mentioned by users as an acceptable amount 6.1 .

7.1.1 Technical implementation

As the solution is deployed in Expo, the notifications system is adapted to that. Expo provides a service, which handles the sending of the notifications to the users' devices. It

happens through POST request from Dansk In Town. The request needs unique token, body and title. The process of developing the notification system was as follows:

1. Expo Push tokens are saved into Back4App database, once users permit the push notifications on their phone
2. A script in Python for each type of notification is written, which retrieves the tokens and then sends the data through POST to Expo Notification API, using cURL
3. The type 2 7.1 requires additional call to the database, as it contains a variable. The notification is only sent if the value of recently added images is higher than 0
4. Crontab schedules, which run the scripts at specific time and day, need to be set up. Notifications are then sent to users.

The scripts are running on my local computer and they can be found in the Appendix A.6, as well as the Crontab schedule A.7. As mentioned in 5.3, since this is a testing set up, I did not deploy the application to iOS store or Google Play. If that was the case, the solution would be more complicated, and would involve 3rd party services such as Firebase and Google Cloud.

7.2 Practice section improvements

Practice section came out to be the vital part of Dansk In Town, as users seemed to enjoy the community aspect of quizzes. However, the interviews as well as data analysis concluded that the practice was too easy, i.e. users could guess which answer is correct based on length of the answers. Additionally, some participant complained about the repetitiveness of the words and not being able to see their own words in the exercise. To solve those issues, I decided to make use of an algorithm that selects potential answers which are more similar to the correct one and also case-insensitive. For the repetitiveness, the retrieval of the words from the database has to be changed.

7.2.1 Technical implementation

My first idea to achieve the similarity between the answers was to apply regex when querying the database for answers. However, corner cases and special behaviour had to be taken into consideration; i.e. situations where there are no phrases of the same length available in the database. One way was to create a min max solution, where the algorithm iteratively searches for a range of length, instead of specific match. However, Levenshtein algorithm, which measures the difference between two character sequences, came out to be a better match, since it would always return the most similar string with no concerns of something not existing in the database. The Levenshtein distance between two strings is determined by identifying the smallest number of actions required to convert one string into the other. These actions can involve inserting, deleting, or substituting a single character (Navarro & Baeza-Yates, 2001). The development was made easy due to the npm package

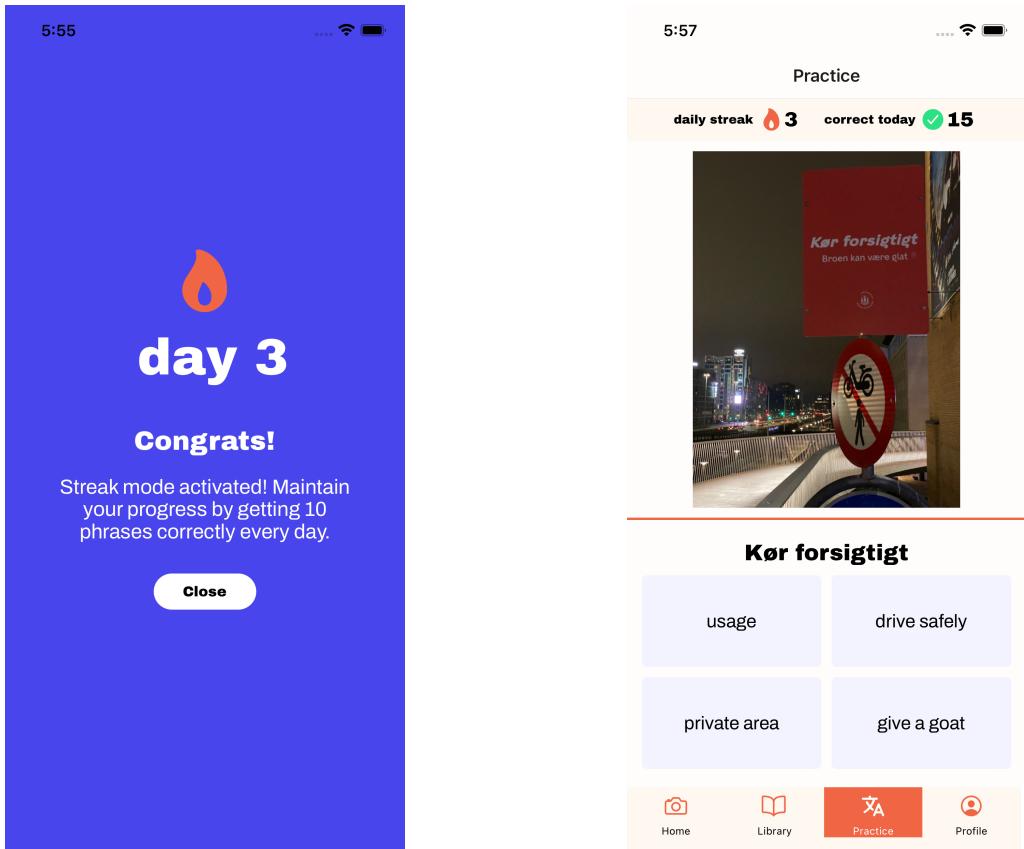
fast-levenshtein which implement the algorithm within Javascript. The distance is calculated between the word in question (the correct translation) and words in the database. Then, the results are sorted by the smallest distance (the least difference). I filtered the results by excluding the correct translation, in case there are duplicates, and picked the top 3.

Another issue was repetition of the words. This was caused by the fact that Parse is returning by default maximum of 100 first rows. Therefore, all users always received the same first 100 images, which eventually resulted in repetition, if someone was using the application long enough. My solution was retrieving the most recently added images.

Some user experience improvements also took place in the Practice section. "Check" and "Too easy" buttons were removed, so when user picks a tile it automatically checks whether the answer is correct or not. Then the tile changes color to green or red accordingly. This allowed me to get rid of pop ups, which were taking users time, and potentially improved usability.

7.3 Gamification

Gamification was coming up in section 2, as well as in the interviews 6.1. As it can be a valuable tool for engaging and motivating user (Su & Cheng, 2014), it felt almost necessary to incorporate some kind of gamification feature. Gamification can create positive learning environment, by rewarding effort, not only mastery Su & Cheng (2014). In the interviews, participants mentioned the daily streak as a driving force to return to the app, when using Duolingo for example. The application implements a daily streak as an achievement for spending a few minutes per day on an exercise. I decided to implement the daily streak as a reward for getting 10 words correctly in a day. It came with a progress tracking function, where users could see how many correct answers they got in that day.



(a) Streak Pop up

(b) Daily points and streak in Pracitce

Figure 13: *Daily Streak*

7.3.1 Technical implementation

I used the Back4app cloud database for storing and retrieving the information about daily streaks. The table contains of date information, user associated, number of correct answers in a day, and daily streak count. The 2 flowcharts below describe the process in detail. All is handled in the queries to the database, where I used dates and user identification to filter the rows. The tricky part was specifying the date, as the records are stored with timestamps and, when calling for data, it would not be possible to know exact hour and minute of when the streak was saved. Therefore, I used a range of date, so the start and the end of the day for a given date. As each user should only have one row per day, there won't be an issue with knowing which streak is the correct one. Flow 14 shows what happens when the Practice page loads. It is necessary to know on which streak day the user currently is and if they have gained points in the ongoing day. Returned values are saved as variables, so when user starts doing the quiz 15, the information is already displayed. When learner answers correctly, the system knows what is the current daily streak and passes it as a parameter. It is needed in situation where user had a streak from yesterday, but there is no record for today, therefore the system would not know what number to increment. It's also

important to check, that even if a user has a record for yesterday, if there were 10 correct answers - otherwise streak will discontinue. When doing the quiz, upon answering correctly for the 10th time, the pop up 13a shows up. Wrong answers are not breaking the streak.

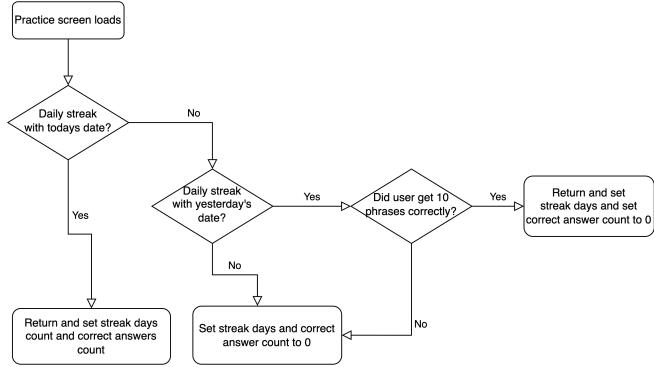


Figure 14: *Daily Streak flow on load*

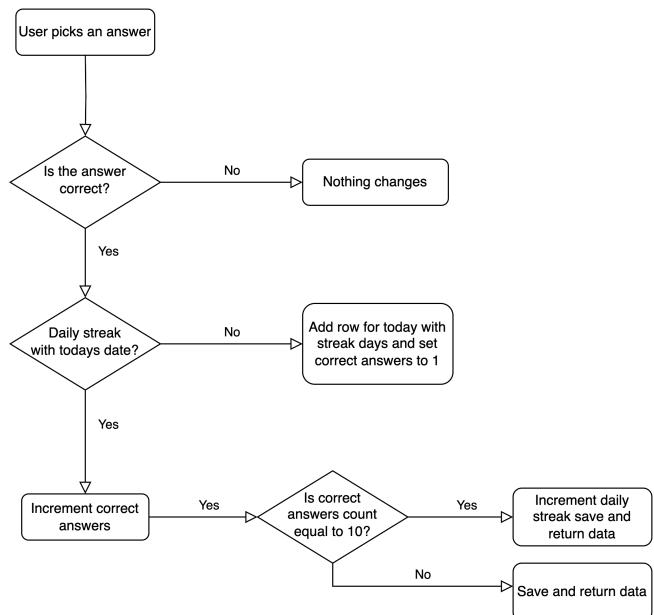


Figure 15: *Daily Streak flow on correct answer*

8 Second Evaluation Round

The purpose of this testing round was to validate the improvements made in the second round of development, in context of the research question - focusing on enhancing engagement and usability. Participants were provided with a new QR code that contained the

Questions
Feelings on improvements
Did you observe any improvements since the previous version?
<i>if yes:</i> Did they improve your overall experience? What did you like the most?
Were you prompted to open the app more often?
Was there something in particular that prompted you to use the app?
Was your motivation to use the app the same, lower or higher?
Daily streak
Did you understand how to achieve daily streak?
<i>if yes:</i> Was the daily streak motivating?
Notifications
Did you act upon the notifications?
Did you make more pictures?
Comments on push notifications
General
Was the app easy to use?
Would you recommend the app to someone else?
Do you see yourself using this version of the app long term?
Open feedback: anything to add?

Table 3: Questionnaire

improved version of the application. They were instructed to use the application for a few days, and we maintained the communication to address any bugs or issues that arose. To ensure unbiased feedback, I did not disclose the specific changes made to the participants beforehand. After the testing phase, participants were sent a link to a questionnaire, which included follow-up questions from the previous interview and specific inquiries about the implemented improvements.

8.1 Questionnaire

The questionnaire was created using Google Forms and predominantly comprised multiple-choice questions with 'yes/no' options. Additionally, a few open-ended questions were included to provide participants with an opportunity to provide feedback or share additional thoughts if needed. The questions are summarized in table 3. The analysis was done by examination the result which Google Form summarized.

8.2 Results

During my communication with the testers to gather feedback on immediate errors, I gained valuable insights into the errors present. One area that required improvement was the setup of notifications, as some users' tokens were not saved immediately, which needed app reinstallations. However, the overall response to the questionnaire regarding improvements was highly positive. The individual responses can be found in Appendix A.8. All respondents, without exception, acknowledged the enhancements and affirmed that their overall experience had improved. Notably, 100% of users confirmed that they now open the app more frequently, which is a significant achievement as one of our goals was to increase user engagement.

When asked about the primary reason for opening the app, six out of seven participants mentioned notifications. One user, however, mentioned that the timing of the notifications was not ideal for them. Regarding users acting upon the notifications, five out of seven respondents indicated that they sometimes take action, while two respondents confirmed that they always do. This suggests that there is room for improvement in terms of timing, although it is unrealistic to expect users to respond to every notification consistently.

Two users provided interesting feedback about notifications, expressing a desire to see the added pictures when receiving push notifications, one participant stated: "*While receiving the push notification of the added pictures, I would actually like to see the added pictures*". In terms of motivation, five users reported higher motivation levels compared to before, while two users expressed similar sentiments. Once again, notifications were mentioned as a favorable aspect by users, followed by the daily streak feature, which was described as innovative and motivating. Six out of seven users claimed to understand how to achieve the daily streak, and an equal number found it motivating.

When asked if users took more pictures, four out of seven answered affirmatively. Considering the previous results 6 and acknowledging that not everyone is inclined to take pictures, this can be considered satisfactory. In response to the question, "Do you see yourself using this version of the app long term?" four users responded "maybe", while three users responded "yes." One user provided open feedback, stating, "*I don't see myself using the app long term, but it is good and enjoyable for the first few months of learning. If I want to take it seriously, I feel this app is not sufficient at some point. But it is good and joyful to use it for the very beginning of my danish language interest*". This aligns with our earlier finding that the app is well-suited for beginners. Additionally, some user suggestions included utilizing loading time for the next quiz picture and enabling the ability to skip "already known" pictures. In open questions users also appraised the usability improvements, such as getting rid of the log out button in the menu and automatically advancing to next quiz.

It is worth mentioning that the testing phase was brief and involved a relatively small group of testers. To gather more comprehensive feedback, additional time and a larger testing group may be necessary. Nonetheless, the newly implemented features show promise in increasing user engagement and enhancing their experience, with push notifications being particularly impactful. Although users have highlighted areas for further improvement and expressed concerns about long-term usage, the overall response has been overwhelmingly positive.

9 Discussion and Limitations

The silver lining observed across both validation phases is the potential for improvement in engagement and overall user experience through the implementation of user feedback. Let's deconstruct the research question and summarize the findings:

RQ 1: How can we design a microlearning mobile application that encourages people to engage with the vocabulary around them, through captured images, in order to learn the language?

Reflecting on the study and aiming to answer the research question, I identified several vital aspects that influence the design of engaging microlearning application. Firstly, the involvement of users in the process and their feedback proved to be invaluable and insightful. In terms of design, the role of capturing images feature was influential in engaging users. However, what proved to be even more significant was the engagement with vocabulary within a community setting. Learner activities such as quizzes were also found to be beneficial for the design, while features like gamification and push notifications positively influenced user engagement. Usability and ease of use emerged as crucial factors for microlearning apps to avoid overwhelming experiences. Additionally, addressing technical errors and ensuring fast performance is important as they can discourage users from utilizing the app.

RQ 2: Is such an application a useful learning tool and are there users who would benefit from it?

As the study did not primarily focus on measuring actual knowledge improvement, the evaluation centered around whether users perceived the microlearning application as a useful tool for their learning needs. The feedback received was largely positive, indicating the potential usefulness of the application. However, the long-term impact and continued usage remain unknown. The study indicated that beginners in Danish, such as people who recently moved to Denmark or learners in the early stages of their language journey, could benefit from the app as it was seen as a valuable additional tool that assist learners in their language acquisition process. Nevertheless, as it currently stands, learners may encounter a "glass ceiling" in their advancement.

With that being said, the following part reflects on the process, respective limitations and improvement suggestions:

9.1 More quantitative data

Although the app received positive feedback from the users during the study, it is important to note that the study duration was short. As a result, it is challenging to determine the long-term usage and whether users would continue using the app once the initial excitement of something new diminishes. Moreover, the quantitative data gathered during the experiment was not comprehensive, and incorporating app tracking, for instance,

would be advantageous to measure participants' actual usage. To provide a more accurate answer to the question of long-term usage, additional quantitative data and analysis would be required.

9.2 Filtering of content and privacy

Upon reflecting on the study and app development, an important aspect that emerges is the content filtering, although it may not directly impact user engagement. Currently, in the app, when a user takes a picture, it becomes instantly accessible to the community via the Practice section. This openness leaves room for potential inclusion of profanities or unintentional errors, such as uploading images that are not in Danish. In fact, such occurrences were observed during the study. In order to fix that, some kind of filtering algorithm would have to be implemented. Furthermore, it is essential in context of privacy to provide users with an option to consent to sharing their images with the community, considering that some users may not feel comfortable with such sharing.

9.3 Spaced repetition

The challenge during the process involved prioritizing and selecting which features to include, considering the various approaches available for mobile language learning and the time constraint. Among the features worth noting, the spaced repetition algorithm deserves mention. Although it was not implemented due to the mentioned reasons, it was referenced by participants in the study (see results, 6) and discussed in the related work section (see related work, 3). One possible approach to address this would be to incorporate the Leitner system into the Practice section (see related, 3), which would also give more control over what users see in the quizzes and potentially remove the risk of random repetition. It is worth emphasizing that the inclusion of a spaced repetition feature could have enhanced the learning experience and effectiveness, as it is commonly employed in language learning exercises.

9.4 Enhancing the app's usability

Upon reflection on the development process and the final version of the app, it is apparent that implementing additional usability tweaks would have been beneficial. As discussed, usability plays a crucial role in user engagement. Although it was given priority, not every feature could have been implemented. Looking back, incorporating animations in the quiz, relocating the library button to the practice section or enabling users to edit the translations would have been worthwhile. It is important to note a technical limitation that affected the app's performance. Slow saving times, attributed to Back4App, were experienced during the process. Instead of having users wait during the saving process, it would have been beneficial to incorporate exercises or additional functionalities to keep users engaged during that time.

9.5 Small participant sample size

The study's sample size consisted of 10 participants, which is relatively small. However, this decision was motivated by the broad nature of the interviews and study. Reflecting on the process, managing the participants, ensuring users downloaded the app, and arranging interviews proved to be time-consuming. While a larger sample size would have definitely been beneficial for the study, including more users would have cost too much time. On a positive note, all but one of the recruited users actively participated in the interviews and had experience using the app. In the second round, seven participants continued to use the app. To obtain more robust results, it would have been ideal to include a larger number of users in the second testing round, or even new users who could compare the results with the updated version. However, once again, time and resource constraints caused challenges in this regard.

10 Conclusion and Future Recommendation

10.1 Conclusion

In this thesis, I presented Dansk In Town: a mobile, microlearning solution for vocabulary learning through images. The research aimed to investigate the design of an engaging solution that motivates users to learn Danish by incorporating vocabulary from their surroundings through the development of the native application and a comprehensive study consisting of two implementation and evaluation phases. The first round focused on creating an MVP of the application and evaluating it, while the second incorporated the feedback from the evaluation and implemented new features, to later validate it again with the same participants. User feedback played a crucial role in shaping the application and assessing its potential as a language learning tool for a specific user group.

The study findings revealed that Dansk In Town could be a promising learning tool suitable for Danish beginners and individuals at early stages of their language learning journey. The importance of engaging design features, such as gamification and push notifications, satisfactory overall app usability, as well as the social aspect of interacting with images made by others were highlighted as key factors in enhancing user engagement.

The results were encouraging, Dansk In Town could be a promising idea for learners, however, there is still more room to explore the effect of the app's design and its impact on user engagement. Conducting studies with a larger population, over longer period of time, might reveal new insights into the app's engagement and potentially effectiveness.

In conclusion, this research lays the foundation for Dansk In Town as a viable mobile microlearning solution for vocabulary acquisition. The study's outcomes highlight the importance of user engagement and provide a basis for future enhancements and investigations to maximize the app's effectiveness in supporting language learners.

10.2 Recommendations for Future Work

In the context of what could have been done differently in the process, the Discussion section already presents some observations that suggest directions for future work. However, it is valuable to dedicate a separate section to explore ideas for future research that can build upon the findings and insights of the current study. I present following ideas for future work:

10.2.1 Deploy on big scale

As emphasized throughout the paper, Dansk In Town was initially released internally on Expo Go for testing purposes. The logical next step would be to deploy the application on app marketplaces such as the App Store and Google Play. However, this transition would need various adjustments to ensure compliance with marketplace regulations, implement security measures, comply to GDPR guidelines, and prioritize user safety. Deploying the app on a larger scale would provide access to a wider audience and generate a substantial amount of data, which could offer valuable insights into Dansk In Town usage and will contribute to generating a more definitive answer to the research question.

10.2.2 Further research: evaluating effectiveness

In this research, the primary focus was on user engagement with the app. However, it is crucial to recognize that Dansk In Town is ultimately a language learning application, and assessing its actual impact on language skills would be interesting. To further explore the app's effectiveness in vocabulary acquisition, additional research and studies should be conducted. One approach could involve measuring users' language proficiency levels before and after using the app, allowing for a comparative analysis of their language skills. This would provide quantitative data to evaluate the app's impact and determine its effectiveness as a language learning tool. Such research would provide a more complete understanding of the app's overall effect on language learning.

10.2.3 Extending with new features

While the discussion section briefly mentioned the potential for improvements of the current features of Dansk In Town, it is important to emphasize that the app has considerable potential for growth and expansion in various directions. One of the possibilities is extending beyond vocabulary learning and implementing multiple learning exercises, for example integrating speech recognition technology and providing feedback on pronunciation accuracy. Additionally, a possibility would be to develop a personalized learning course centered around the images used in the application, which would offer learning pathways based on user preferences and proficiency levels. Another idea would be to expand to other languages, and enable users to switch between them.

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A Appendix A

A.1 Mockup

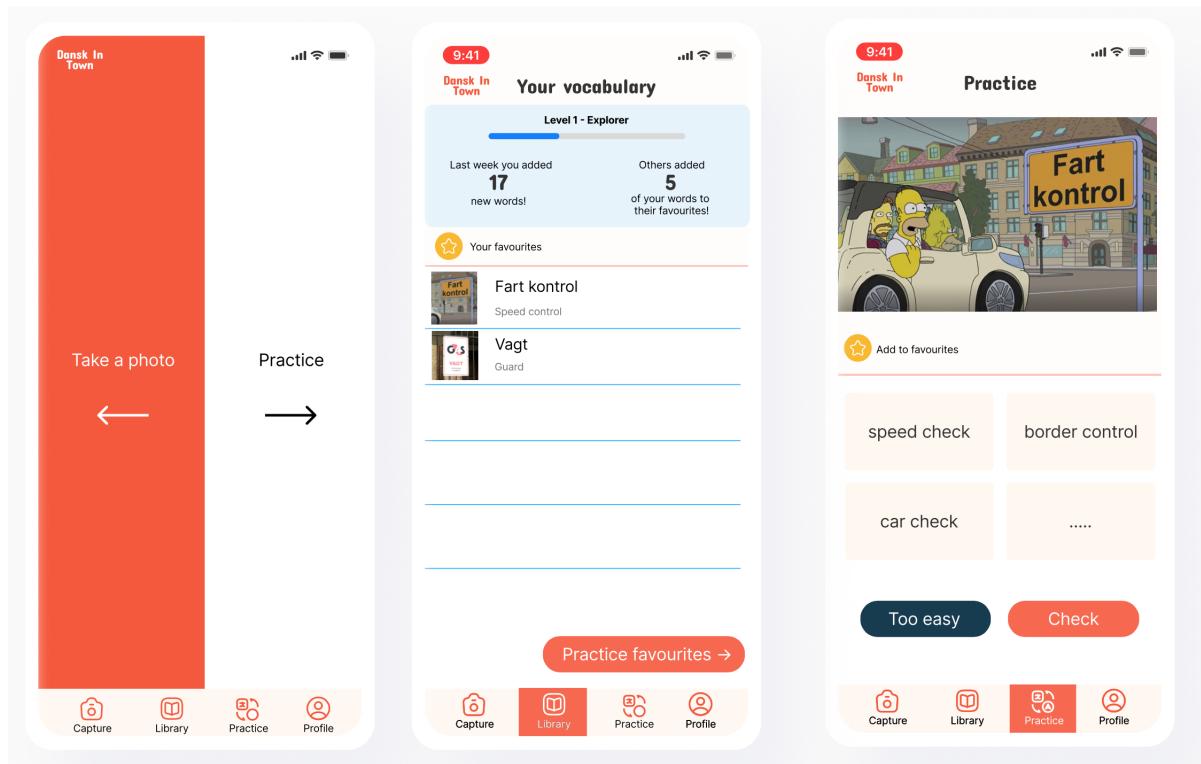
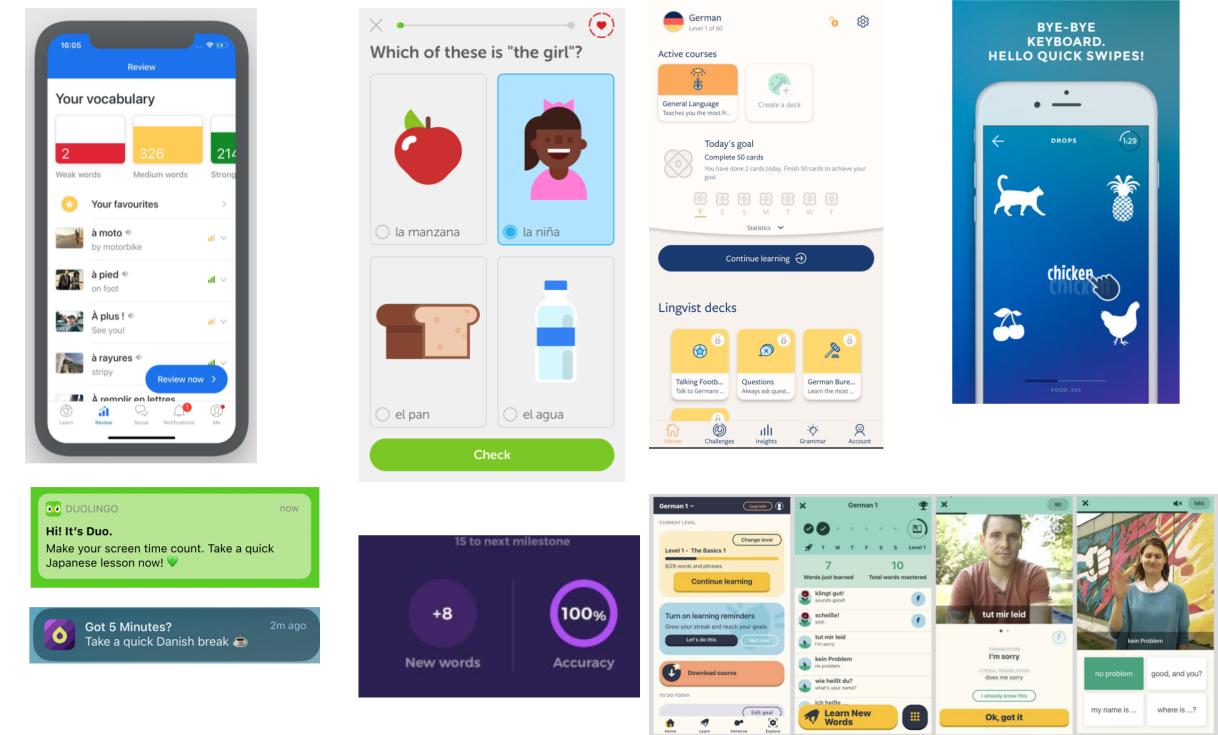


Figure A1: Initial Mockups

A.2 Design Inspirations

Collected below are inspiration takes from related work applications such as Duolingo, Memrise, and Drops.



(a) Part I

(b) Part II

Figure A2: *Design inspirations*

A.3 Source code

The source code for Dansk In Town the mobile application can be found here: https://github.com/zawropati/dansk_in_town_mobile

A.4 Interview transcripts

The interview transcripts, organized by timestamps, can be found here: https://github.com/zawropati/dansk_in_town_mobile/tree/master/interviewTranscripts

A.5 Data analysis

The data in CSV format and the Python script for the analysis can be found here: https://github.com/zawropati/dansk_in_town_mobile/tree/master/dataAnalysis

A.6 Notifications scripts

The Python scripts for sending the push notifications can be found here: https://github.com/zawropati/dansk_in_town_mobile/tree/master/notifications

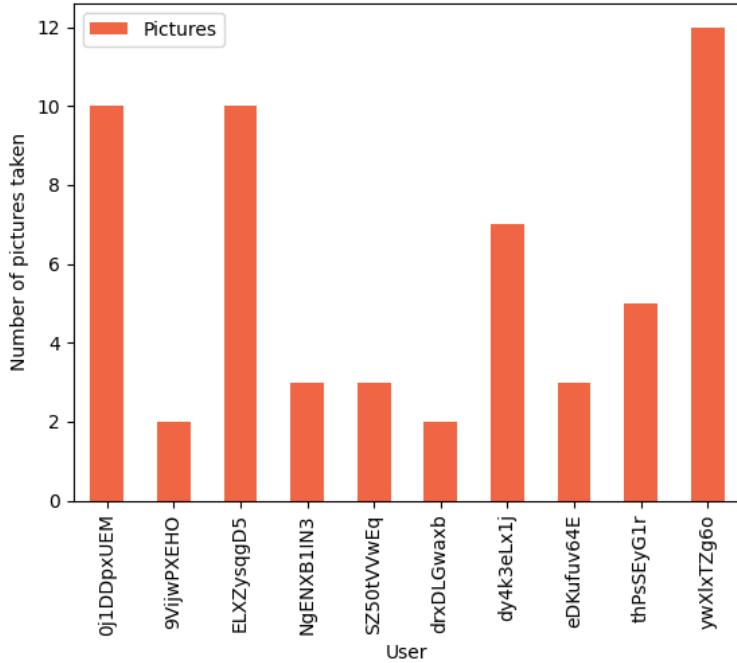


Figure A3: *Number of pictures taken per user*

A.7 Schedules

Below I present the script for running the schedules for push notifications:

```
15 17 * * 1,3,5,7
/Users/patrycjazawrotniak/PycharmProjects/service/venv/bin/python3
/Users/patrycjazawrotniak/dansk-in-town/get.py
>> /Users/patrycjazawrotniak/Documents/output.log 2>&1

30 18 * * 2,4,6
/Users/patrycjazawrotniak/PycharmProjects/service/venv/bin/python3
/Users/patrycjazawrotniak/dansk-in-town/not2.py
>> /Users/patrycjazawrotniak/Documents/output.log 2>&1
```

A.8 Questionnaire answers

The answers from second round of testing questionnaire can be found in a spreadsheet under following link: https://github.com/zawropati/dansk_in_town_mobile/tree/master/questionnaireResponses