



University of Bergen

Faculty of Social Sciences

Department of Social Science and Media Studies

Master thesis

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# Gamification of Drivers Ed Theory

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## Abstract

Faculty of Social Sciences

Department of Information Science and Media Studies

Masters degree

### **Gamification of Drivers Ed Theory – Class B**

by Nicolai Gulbrandsøy

The principal goal of this thesis was to research gamification and its relation to user satisfaction and user retention, and to see how gamification can be implemented to achieve a satisfying user experience. The main research questions posed for this thesis were: “*How can gamification offer more engaging interaction in an application?*” and “*Can elements from gamification make users more inclined to keep using an application?*” In order to answer these questions a set of methods were utilized. These methods included interviews, review of existing services, “quick and dirty”, user testing, and guerrilla testing. For the purpose of having a clear focus, a specific domain was selected, namely the education of prospective drivers. A prototype was iteratively developed with the participation of drivers ed professionals, people with a drivers license, people without a driver’s license, and finally people currently in pursuit of their license. Ultimately, the last iteration with a prototype deemed worthy was tested with the aforementioned students currently in pursuit of their drivers license class B.

## Preface

This thesis concludes my Master's degree in Information Science at The University of Bergen (UiB). The thesis was carried out over two semesters, fall 2016 and spring 2017, at the Department of Information Science and Media studies.

Many people have been a part of the process that has led to the work presented in this thesis and I would like to express my appreciation to all of them.

Firstly, I would like to give a special thanks to my thesis supervisor Barbara Wasson, whose guidance, patience, and wealth of knowledge has helped me throughout the thesis. Her assistance has been instrumental to the project.

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## Nomenclature

HCI	Human-Computer Interaction
TEL	Technology Enhanced Learning
ID	Interaction design
UX	User experience
MOOC	Massive open online courses
QOC	Questions, Options and Criteria

## Chapter 1 - Introduction

The internet used to be accessed via the desktop for many years before introducing the mobile phone and other cellular tools. With the internet becoming more and more a part of people's lives, it opens up more and more ground for the pioneers in development. With new technologies and inventions, we open the door to new ways of doing things. One of these new approaches is gamification, which simply speaking, means to make non-gaming software fun and engaging in a new way.

With this thesis I want to look at the connection between gamification and learning, specifically how the users feel engaging with a gamified application in regards to retention and enjoyment in a voluntary self-regulated environment. This will be done by developing a gamified prototype for quizzing prospective drivers on their theory, and evaluation how well the prototype is received.

The domain in which we will be developing a prototype is drivers education in their approach to earning a drivers license class B – Car. Drivers education has been a hot topic for a while due to people not knowing enough theory (Andersen, 2017), while at the same time more and more people have success on passing their theory test. The publicly released results from 2000 to 2016 show the success rate of drivers ed theoretical exam go from 36% in 2000, to 62% in 2015, and 58% in 2016 (Vegvesen, 2016). Autoriserte Trafikkskolers Landsforbund (ATL, 2017), Trygg Trafikk (Trygg-Trafikk, 2017), and Statens Vegvesen (Vegvesen, 2017), who are three organizations or businesses engaged in keeping the roads safe and the drivers well educated, argue we need to look into how the drivers license is obtained because too many people pass without knowing enough of their drivers ed theory (NRK, 2015).

This thesis will thus involve techniques from development, design and evaluation methodologies.

### Motivation

The motivation behind the research being presented in this thesis is based on personal experience with digital tools for multiple choice quizzing and using several gamified applications and websites. With personal experience using Habitica (Habitica, 2017) to form and maintain good and productive habits, using Fitocracy (Fitocracy, 2017) to keep track of



our progress in personal fitness, or tools like To-Doist Karma (To-doist-Karma, 2017) to keep track of your tasks with to-do lists.

While gamification has seen its popularity rise in the later years with big parties like Verizon (Verizon, 2017), Evry Consulting (Nysveen, 2017), and even the U.S. Army (Army, 2017) implementing it, it would be nice to see gamification brought into the educational sector.

### **Research questions**

The main goal of this thesis is to evaluate the value of gamification in modern software. To be able to present valuable research to this effect, two research questions have been formulated:

RQ1 - Can elements from gamification make users more inclined to keep using an application?

RQ2 - How can gamification offer more engaging interaction in an application?

To answer these questions a gamified prototype for testing a person's drivers ed theory will be developed and tested with users actively engaged in their driving education. The resulting evaluation of these sessions will answer these questions.

### **Thesis contents**

This thesis is organized into 8 chapters. Chapter 2 presents theory and related works within the field of interaction design and technology enhanced learning, before introducing different variations of gamification. Chapter 3 presents the potential technologies that can be used to research the effects of gamification on drivers ed theory. Chapter 4 presents the research strategy utilized in this research, including tools for data gathering and the DECIDE-framework. Chapter 5 presents how we gathered the user needs and how we derived our system requirements from the user needs. Chapter 6 presents our design framework, our design iterations, and our prototype. Chapter 7 presents the details of each evaluation conducted and presents the data, before validating our research approach. Finally, chapter 8 concludes the thesis with a discussion around the contribution of our research and suggestions for future work.

## Chapter 2 - Fields of research and related work

The research presented in this thesis is based on research within Human-Computer Interaction, Interaction design and Technology Enhanced Learning. This chapter will present these fields of research and other research applicable to this project.

### Human-Computer Interaction and interaction design

Interaction design is an interdisciplinary approach which includes Human-Computer Interaction (HCI). To design a good user experience (UX) for a specific product, one needs to understand the users and what they want from the product, and not just what functionality they require.

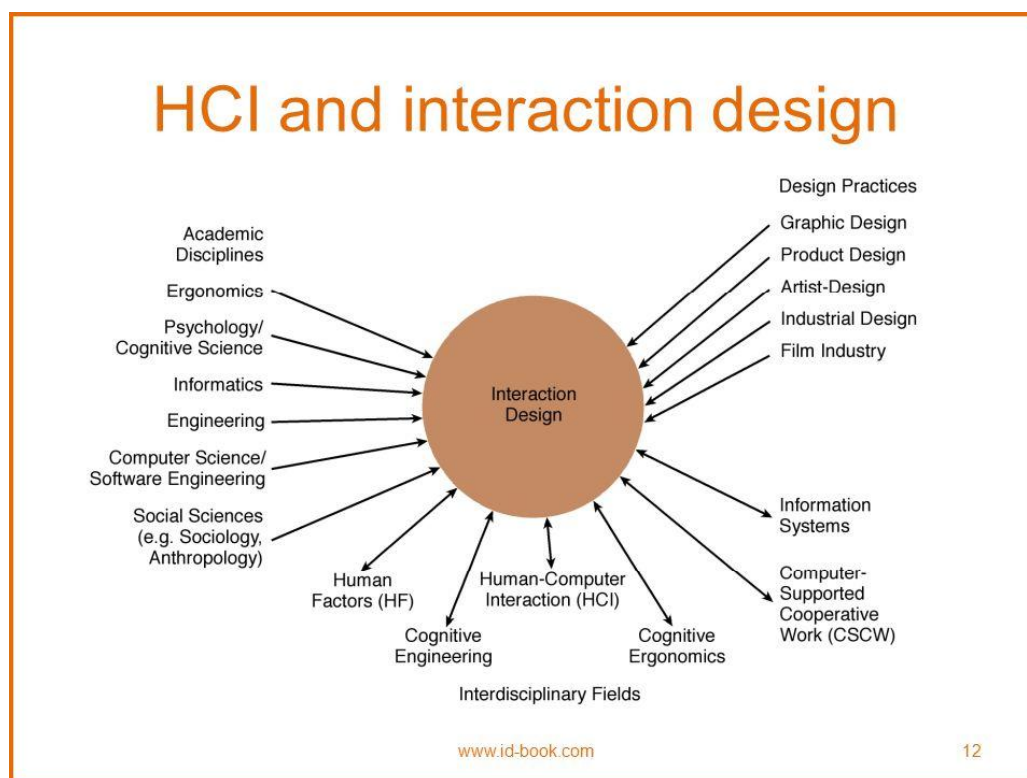


Figure 1 - HCI and Interaction design

Human-computer interaction, while being a broad field of study that goes beyond an “easy to use” user interface – is defined as a discipline concerned with the study, design, construction and implementation of human-centric interactive computer systems. More specifically within the field of HCI, one should put great effort into the interaction design to create a good user experience, especially in cases with high requirements to motivation and self-driven and self-regulated learning.

Sharp et.al. (2011) posed an interesting analogy while explaining the difference between the job of an interaction designer, and that of a software developer. They discuss how an architect, while designing a house, will focus on the relative placement between kitchen and eating areas, and common rooms to private rooms, while an engineer will be concerned with completing the project and focus more on structural integrity and having the right amount of rooms according to the buyers request. In this way, a software engineer would focus on implementing the necessary functionality to a system, while an interaction designer would focus on the relation between functions and their placements.

The medium being developed for is always changing with technology, going from news papers, to screens and remotes, to cellular devices like mp3 players and phones, and many many more, which has opened up for several practitioners of interaction design, such as graphic designers, animators and photographers (Sharp, Rogers, & Preece, 2011). Interaction designers must put emphasis on the specific user groups, necessary interactions, and technologies for the system they are developing (Sharp et al., 2011). Interaction designers should start early with data gathering and analysis before implementation begins, as interaction designers tend to be more focused on what the users do with a system or need from a system, while developers listen to what the users say (Silva da Silva, Selbach Silveira, Maurer, & Hellmann, 2012). Users don't actually know what they want and designers shouldn't design specifically after what they say. It's like when a child says they want candy, but the parent insists on something healthier because it's what the child actually needs.

Rogers et.al. (2011) identify four key activities of interaction design

1. Identifying needs and establishing requirements.
2. Developing alternative designs that meet those requirements.
3. Building interactive versions of the designs so that they can be communicated and assessed.
4. Evaluating what is being built throughout the process.

These activities support each other and are supposed to be iterated during the design process. Such as the system evaluation could reveal weaknesses in the design that shows it fails to meet a requirement, and then you can create an alternative design that better suits that requirement and reevaluate.

## HCI research on testing - Usability

To promote continued use of a system that the users are not required to use, it's very important to emphasize the usability of the system. If the users feel uncomfortable using a system for whatever reason, that might make them less inclined to pick it up again. One way of achieving this, is a heuristic evaluation (Nielsen, 1995), where you gather a small group of evaluators to examine the interface and look for problem areas in compliance with the recognized heuristic principles. When determining how many evaluators fit your project, Nielsen's studies show that somewhere between 5 and 10 evaluators are best for most projects, depending on a cost/profit analysis, as the increase in evaluators does not increase the number of problems found to a very strong degree. Nielsen argues more evaluators are only necessary for critical systems where a failure could be devastating. This is also why the heuristic evaluation is popular in smaller projects, as it's a cost effective form of evaluation.

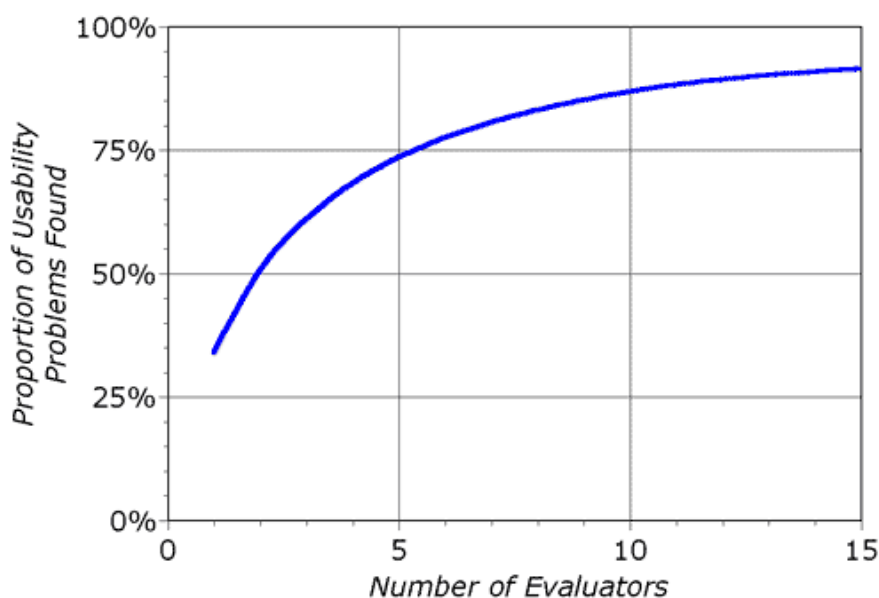


Figure 2 - Nielsen's Heuristics

### The principles

The heuristic principles started off with as many as a thousand principles to follow. However, this showed to be too many and deter the use of the evaluation method, so Nielsen later revised them down to 250. This was still too many so he derived a set of 10 key heuristics with what he describes to have the maximum explanatory power;

- *Visibility of system status*

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

- *Match between system and the real world*

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
- *User control and freedom*

Users often choose systems functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.
- *Consistency and standards*

Users should not have to wonder whether different words, situations, or actions mean the same thing.
- *Error prevention*

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
- *Recognition rather than recall*

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
- *Flexibility and efficiency of use*

Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
- *Aesthetic and minimalist design*

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information

and diminishes their relative visibility.

- *Help user recognize, diagnose, and recover from errors*

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

- *Help and documentation*

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

(Nielsen, 1995)

The heuristic principles presented by Nielsen, 1995 has been further extrapolated to be used outside of an heuristic evaluation and other methods has adopted some of their principles, specifically the amount of users needed for usability feedback (Pirker, 2017).

### Questions, Options and Criteria

Questions, Options and Criteria (QOC) is a method used to identify design space problems, discuss the options for solving them and use certain criteria to support these choices (Maclean, Young, Bellotti, & Moran, 1991). Using this method to evaluate the options will validate the research approach used in this thesis.

### Design principles

While heuristic evaluation is traditionally seen as a way to evaluate the system post-design (summative), the design principles as described by (Sharp et al., 2011) used while creating the design (formative).

The design principles

- *Visibility*

To ensure that the important functions are highly visible to promote the users to click the correct actions. For instance, a number pad indicates a pin code to be entered.

- *Feedback*

The principle of feedback is related to the concept of visibility. It's important for the

device or system to give constructive feedback based on the use of the artifact.

Feedback is important to show the user that an action has been executed and what the results for that action would be. A good example for this is if you click something on a remote or physical device for a virtual environment, if your click on the device doesn't make sense with what happens on the screen, it's difficult to understand the use.

- *Constraints*

Constraints are effective tools for limiting the users' chance of error, and increase the visibility for the correct or productive functions. It's a way to restrict the options for the user in terms of clarity. Examples of this in a virtual context is to gray out certain buttons or options so the users can see they are not active, or in a physical context you can look at the external cable slots on a computer to see the option, but it's not directly usable or active at this time (Sharp et al., 2011).

- *Consistency*

Consistency, while being somewhat self-explanatory, means to design similar elements to have similar operations and functions throughout the device, and according to device design principles. This ensures the system is easy to learn and easy to use. For instance, switching out left and right mouse button to do different tasks in different systems is a strategy that is prone to user error. While the concept of consistency sounds like something that shouldn't be too hard, in some cases with an abundance of functions, this can cause some issues as there simply isn't enough space to work with.

- *Affordance*

Affordance explains how to make functions promote the easy understanding of its uses. In the physical world this is often explained by a hammer, as it's intuitive to see that the grip of the hammer invites you to grip it (Sharp et al., 2011). In the virtual world, this can get a lot trickier, as there is an abundance of icons that can get confusing in a complex interface. However, there are tools to highlight affordance in the virtual world as well, such as shading on a button to invite the users to press it, creative use of icons, or tools such as a scrollbar is intuitive to most users to promote that there is more content in the screen.

When designing an interface, these principles will often contradict each other, and the designer will have to create a trade-off between them. For instance, constraining certain functions in one state of the program might contradict the principle of consistency as the function is available or constrained in another way in another state of the program. However, this can have constructive pay offs, as the system may be harder to learn, the system can be easier to use over time (Sharp et al., 2011).

### **Mobile Environment**

There are specific considerations to take when designing and developing for a mobile interface. Mobile interfaces offer their own functionality such as vibrations and gps, but they also come with their own restrictions, such as limited screen size and download speeds. Among the researchers working in the mobile environment, we find Nielsen and Budiu from the Nielsen Norman Group (Budiu, 2015), that has formulated 85 design guidelines for mobile interfaces that aim to enable better usability. Some of these include how to use dropdown menus, spacing between interactive objects to avoid clicking the wrong task, and prioritizing content.

### **Technology Enhanced Learning**

Technology enhanced learning (TEL) has been around since the 1960s, and in the late 60s to early 70s they introduced microworlds, allowing students access to a certain topic and allowing them to explore it without interference from a teacher. In the 80s, artificial intelligence was introduced to give intelligent tutoring systems the ability to adapt to the users of the system and give feedback based on what the user knows. In the 90s collaborative learning and virtual classrooms was introduced, giving students access to a collaborative website for discussing subjects and working together on tasks. Also introduced in the 90s was the Massive Open Online Courses (MOOC) which is a way to take classes without having the physical presence of a class room, giving teachers the ability to broadcast the lectures that can be viewed at different times, give homework and grade papers. Mobile learning was introduced in the 2000s, which allowed for digital learning while on the go, which tools such as phones, sensors, GPS and NFC. The benefits from engaging with the digital world open up the possibility for analyzing the subject area and engage the constructionist environment and higher thinking. Meaning instead of just absorbing knowledge, the subjects are actively engaging with it which can improve the cognitive experience. While all of the different forms of technology enhanced learning presented here are still growing, the latest development is from 2010 with the participatory environment, which builds upon the collaborative learning



introduced in the 90s. The participatory environment allows users everywhere to contribute to each other's learning. It's also called learning 2.0 after web 2.0 where everything is connected and people can learn together using social media like twitter or wikis.

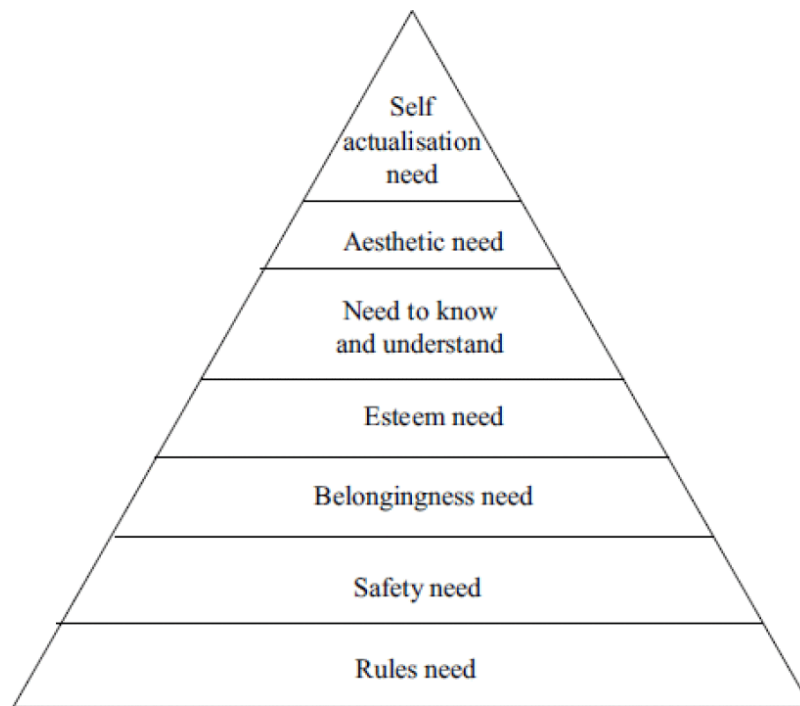
The interesting thing about mobile learning is that it allows for a more informal learning (Conejar & Kim, 2014). When you bring the user away from a desk reading a book, you have a whole new contextual learning situation. The user can be at the bus, on a train ride, on a hike in the woods, or simply killing time, while at the same time learning in a fun way. Conejar & Kim, (2014) further argue that the future holds a great deal of societal changes when it comes to mobile learning, as in 2011 there were 270 million apps linked to education downloaded, which is a tenfold from 2009 (Conejar & Kim, 2014).

### **Learning Theory**

Being motivated is certainly important to learning, especially over time, but the design of the learning experience must also be considered. A study on learning theory conducted by Siang & Rao, (2003) depicts that when a player understands the basic rules of the game, they will start to think cognitively how they should respond when facing new challenges, and actively update existing knowledge. They discuss how to entice long-term memory; they need to allocate more information to the current information at hand. They further argue how being bombarded with information or new information on top of old before it's brought into long-term memory will simply erase the former. Therefore, it's important to allow time or tasks to overcome one obstacle before starting on the next.

### **Motivation**

Motivation is the internal process that activates, guides and maintains behavior over time (Siang & Rao, 2003). It's key to keep motivation up when we are talking about a learning application that is driven on self-regulation. Siang & Rao further argue that to keep a player motivated throughout a game, it's a good principle to follow Maslow's hierarchy of needs when designing your learning game (see figure 3 below).



*Figure 3 - Siang and Rao, 2003*

You first have to establish the rules of the game, allowing the players to sense the safety and belongingness in knowing they can complete it. Then the players should feel comfortable using the application. When a user feels comfortable with the system they will try to climb the system and will need a harder challenge. Naturally an application will not stand only on the aesthetics. Finally, the players want to feel that they have conquered the game and feel empowered.

### **Gamification**

While you can utilize the principles of gamification without technology, e.g. giving out physical badges or collecting points on the blackboard in a classroom, my interpretation of gamification in the modern life is digital.

Gamification was first coined in 2002 by a British-born computer programmer named Nick Pelling, and became popular in 2010 (Deterding, Khaled, Nacke, & Dixon, 2011). Since then we've seen it used in various contexts, such as in business to promote sales, education, social communities, marketing, as well as personal health. According to Deterding et al. 2011 it has also spread into several other terms such as:

- *Productivity games*

Games that aims to develop and maintain good and productive habits. One example of this is Habitica (Habitica, 2017), a tool I'm personally using. Habitica

allows you to input and manage to-do lists, and once you complete them you get experience and level a virtual avatar.

- *Playful design*

Playful design is design that is not really relevant to what the system is supposed to do or promoting a function, but is endearing the users to continuous use of the product. For instance when attempting to show content that has yet to be created by using the product, like a history log, you could display an interesting animation or illustration instead.

- *Serious games*

Serious games are typically games used by industries such as health care, city planning, engineering and simulations. For instance a flight simulator is a serious game as it is game-like but used for education.

However, gamification is arguably the most common term and has been linked to the same physiological experiences as games normally do (Hamari, Koivisto, & Sarsa, 2014). In their research they found most of the subjects being tested reported positive on motivation and attitude. Gamification also shows an increase in sense of accomplishment and progress. However, some studies suggested subjects reported negatively to the same aspects.

A challenge with learning applications is that they can become tedious and repetitive, and this is an even bigger issue when this is elementary to the success of the learner (badgeville.com, 2016). This is where gamification, if administered correctly, can help the learner stay interested and engaged. We have formulated a list of elements from gamification that can be introduced:

- Adding points or value to tasks that needs to be completed
- Define badges/rewards to be given out after a criterion is met
- Create a leader board to show top performers
- Define levels to repeat tasks or to perform harder tasks
- Earning trophies for certain accomplishments, such as speed, success rate, overall completion
- Earning of badges can be tied to unlocking higher levels
- If suitable for your application, provide opportunity for 1 on 1 player competition

- Creating a profile/statistics page for speed/success rates
- Self expression (Username, Avatar)
- Earning a viewable status

Gamification has become very widespread in the later years as companies have started seeing its value. In Norway a piece of software called Salescreen (Salescreen, 2017) has been extremely successful. This is a tool to help salesmen sell faster and sell more by motivating them via scoreboards that show the top seller at the office or in the business. Another modern example is Norway's biggest IT-company Evry, that in May of 2017 reported using gamification as a part of their hiring process (Nysveen, 2017).

This chapter has explained relevant research in interaction design research including usability evaluation and design guidelines. In addition, related research on gamification has been summarized.

## Chapter 3 - Potential Technologies

This chapter describes the different technologies applicable to creating the prototype, including native app development, web technologies, and prototyping tools. Other tools used in the project that are not directly related to the prototype, are also introduced.

### Native application technologies

One of the options that could be used to develop the mobile prototype required for testing on students actively engaged in their drivers ed learning is native app development.

In 2015 there were as many as 7 billion “mobile cellular subscriptions” active in the world, while 2.6 billion of these were “smartphone” subscriptions. Among the operating systems, we see Android in the lead with 82.8% of the market share, iOS as the runner up with 13.9%, Windows on third place with 2.6%, Blackberry with 0.3%, and other operating systems has a combined market share of 0.4% (Pawel, 2016). With this clear distinction, it would be natural to consider Android as the primary operating system to develop for.

One big advantage with this option is that you can deploy the application and store user data over time, which could yield valuable data on how the students engage with drivers ed theory. Such as how often they use the app, at what times they use it and their progress in the application. Access would be granted to certain functionality that is limited to native apps, such as the camera, GPS, and vibration. It would also allow for storing the quiz’ questions in a database and could therefore randomize the questions you’d get.

However, there are certain disadvantages that should be addressed; with an low personal experience with development it would take a considerable amount of valuable research time to get a working application. It would also increase the development time of each iteration, making changes and adaption more challenging.

### Web technologies

With a web based mobile application you could give the impression to the user that they are using an application, while taking advantage of the benefits of the web; such as easily adaptable interface for different screens and a deployable prototype without worrying about operating system. While also being able to utilize some of the aforementioned advantages such as storing user status and randomized questions from a server.

While making a web based application would be lighter on the development work load, it would still offer challenges that could mislead the focus of our research. As it has similar disadvantages to that of the coding approach, being time consuming to learn and to develop, delaying the first round of testing and ultimately the later iterations.

### **Lower fidelity Prototyping tools**

Instead of developing a prototype in local software, website or hybrid web-application, it could also be done without developing any sort of code. A growing way of prototyping is to use tools like Origami Studio (Origami, 2017), Marvel App (Marvelapp, 2017), or InVision (InVision, 2017), which allow designers to quickly pitch ideas by creating wireframes in different tools like Adobe Photoshop or Illustrator (Adobe, 2017), and then add buttons or interactions on the wireframes.

Prototyping this way is very efficient as you can develop the wireframes in any tool you are familiar with, or you can quickly learn some new software for designing graphic interfaces. The prototyping tools are also very easy to use, making for swift iterations and redesign. If you create the designs in a tool that allow for scaling, also called a vector-based application, the resulting screens will also be scalable to fit different screens.

The biggest drawback with prototyping this way is that the prototype will be completely static and cannot store information over time like the other options. An interesting element in this research would be to evaluate the effect gamification has on user interaction with the learning environment. Since the system does not store any information over time, it would also be meaningless to deploy it to testers, and the method of evaluation must be chosen thereafter.

### **Chosen technology**

There are many different paths that can ultimately lead to a quality prototype for evaluating the effect gamification can have on motivation and enjoyment of a system. Using the QOC-method presented in chapter 2 – fields of research and related work, we have identified the positive and negative elements of design decisions, and a decision to use the prototyping tools with which I was already familiar, Adobe Illustrator and InVision has been made.

While acknowledging the missed opportunity of deploying the prototype with users and have them use the system for a period of time, it opens the doors to different and exciting methods of evaluation, read more about this in chapter 4 – methodology and research strategy.

### **Adobe Creative Cloud**

Adobe (Adobe, 2017) being the market leading software for design, it seemed natural to go with this option, over other design tools such as Gimp (Gimp, 2017), Sketch (Sketch, 2017), or Photofiltre (Photofiltre, 2017). Adobe creative cloud offers many tools for creating designs, but for this thesis the main software was Illustrator, while Photoshop was also used to some degree.

### **InVision**

InVision (InVision, 2017) is a prototyping tool that creates engaging and interactive prototypes with only the use of static images. By layering navigation on top of static images, it can give the illusion of a fully functioning prototype in a fraction of the time it takes to create functioning software.

Some of the key features of InVision are:

- Adding almost instant navigation to static images
- Design-driven development with collaboration in one place
- Their Inspect-tool that allow programmers to withdraw specific measurements from the prototype, like pixel width and relative container placements
- Traditional “to-do”-boards that allow you to separate design elements that are completed, needs work or are in progress

InVision was chosen for this project because it's a renowned tool used by many big companies such as Netflix, Twitter and Dropbox (Invision-Customers, 2017). It is also a tool we had previous experience with.

### **Other tools**

For audio recording we used Voice Recorder by Samsung (Samsung, 2017) and later transcribed using wreally.com (Wreally, 2017), which is a company that offer great services for interviews.

This chapter has presented the potential technologies for our research and discussed the technologies we have used.

## Chapter 4 - Methodology and Research Strategy

The methodology used in this research combines interaction design and the DECIDE-framework for evaluation. This chapter describes what each of these are, and why they were appropriate for this research. Then present the different research methods that have been used, including methods of data gathering, the methods for testing, and the system development methods are presented.

### Interaction design methodology

The interaction design methodology as presented by Rogers et.al. 2011 is a user-centered design approach that values involving users in every stage of the development. They describe that the goal of interaction design is to “create user experiences that enhance and extend the way people work, communicate and interact” (Sharp et al., 2011, page 6). As mentioned in chapter 2 – fields of research, the key element of interaction design is to focus on the users and their experience with the system, which differs from the traditional software engineering focus on functionality according to the system specifications (Sharp et al., 2011, page 6). The first step consists of establishing the requirements of the system and the needs of the users, and to do this we need to talk to the user groups or a representative for the user group. The second step is to develop a prototype that can be evaluated with the users, and then to redesign and reevaluate the design until the system is of satisfying quality.

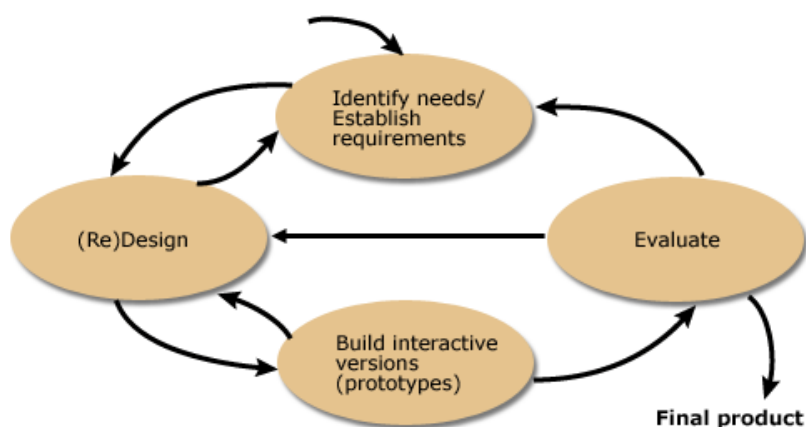


Figure 4 - Interaction Design Model

Following the interaction design model presented by Rogers et.al., (2011), emphasis is placed on constant evaluations throughout the process, instead of doing the evaluation at the end. Interaction design and agile development are inherently iterative processes. The requirements will adapt over time as the researchers and the users see what is possible with a system and



how it could influence their lives (Sharp et al., 2011, p203). We will further discuss the requirements in chapter 5 – establishing requirements. The iterative process will be used in relation to design and development as we identify needs and create a prototype, it will be tested on users and evaluated, before we go back to the design table and make changes accordingly.

### **DECIDE-Framework**

The DECIDE-Framework (Sharp et al., 2011, p348) is a framework developed to assist with the evaluation process. It describes an appropriate 6 step plan for conducting evaluations.

#### **Determine the goals**

The goals of the evaluation are separated into two sections:

- The goals for the prototype
  - A prototype of a high enough quality so that the evaluation is not clouded by a poor user interface or an otherwise buggy or incomplete prototype.

and

- The overall goals for the research
  - Evaluate the benefits of gamification
  - Evaluate the correlation between motivation and learning

To be able to answer the research questions and ultimately reach a conclusion on the research, the quality of our prototype will have to be good enough for the final testing with students actively engaged in drivers' education. Therefore, the goals are separated into those to be tested by fellow students and the driving instructors, and those to be tested by students representing the end user group in a final evaluation.

#### **Explore the questions**

In order to reach the goals, specific questions that we need answered must be identified.

To discover if we have met our goal for the prototype and can proceed to the final testing, we have identified the following questions that need answered:

- Does the prototype support all the functionality required for a multiple choice quiz?
- Is the navigation intuitive?
- Will the users understand what to do in the prototype?
- Does the prototype offer adequate feedback to the user?

- Does the prototype meet our criteria to be considered a gamified application for drivers ed theory?
  - Element of growth
  - Collectionism – Reward system
  - The ability to do its job without the gamified elements

Specific criteria for acknowledging that it is in fact a gamified application have been chosen; specifically that it has the ability to be used without interacting with the gamified elements, which allows it to perform its primary function. That is has an element of growth, and that it has a reward system that can ultimately be completed and therefore appeals to a collectionist.

To conduct the evaluation on the effect of gamification and ultimately answer our research questions, we have in turn broken down our research questions into sub questions:

RQ1 - Can elements from gamification make users more inclined to keep using an application?

- Would the user respond positively to the elements of gamification, or would they ignore them?
- Does gamification add to the experience or is it distracting?

RQ2 - How can gamification offer more engaging interaction in an application?

- How does the user feel towards having a personal profile where they build up a collection of trophies?
- Would the user want to continue playing to earn more trophies?
- Does the user understand what purpose the gamified elements has or what they do?

### **Choose the evaluation paradigm and techniques**

The choice of evaluation techniques depend on many factors, such as available resources, number of participants and how hard they are to come by or ethical limitations. The techniques and approaches used in the research will be discussed.

### **Domain**

The domain of drivers ed theory was chosen because of its development into a digital learning environment in the recent years. Several quiz services for drivers' education have been developed, as well as several services for learning the necessary theory, which focuses more on teaching rather than testing. During the preliminary domain research conducted before starting this project, it was discovered that there is an abundance of drivers ed companies in

Bergen, as well as many students taking their license every year, therefore needed participants should be able to be recruited.

### *Sample group*

When conducting research, it's important to hit the right sample of people that properly reflect the views and needs of the final user base. In this research the sample group we will be using consists of people currently engaged in drivers' education in their pursuit of a driver's license. The sample group will likely be from around the age of 17 to perhaps the late 30s. Most of the test subjects will likely be of an average or higher than average skill level when it comes to familiarity with mobile applications. As far as sample size goes it's wise to get enough participants to obtain theoretical saturation. Theoretical saturation means there is very little – to no – informational benefit from bring in more participants, which is closely related to Nielsen's aforementioned guidelines for participant size in testing.

### *Formative data gathering*

Formative evaluations are the evaluations conducted during design to show that the product continues to meet the user needs (Sharp et al., 2011, p323).

Before development begins the user needs will be gathered by a combination of looking at existing services that offer the same functionality as the prototype we will create, and talking to experts of the domain to get a better view at what our end users need.

### *Evaluation of existing services*

The evaluation will begin by looking at the available services and evaluating what makes them work, or what makes them fail. These can be separated into topics from which the requirements can be derived.

### *Interview with driving instructors*

Interviews will be arranged with driving instructors of drivers ed companies around Bergen that are willing to participate. The interviews are semi-structured so that information that is comparable between participants can be obtained, and the option for follow up questions if more information is needed. By talking to the experts in the domain we are conducting our research, we will get access to the most up to date information about the process of obtaining a drivers license, and the students currently in the process of obtaining their license. The results from these interviews will be part of the foundation on which the prototype will be built.

### **“Quick and Dirty”**

Rogers et.al., (2011) present an interesting evaluation technique called “Quick and dirty”, which is a technique used to get quick feedback without focusing on heavy documentation and planning. It’s a technique used as an informal way of asking people for feedback about a mockup or an idea. This technique will be used in the early stages of the design process with fellow students and colleagues.

### **User testing**

To declare the prototype ready for the final evaluation with the end users, user testing with the driver’s ed instructors will be used. User testing is a method of evaluation where you aim to discover if the system allows its users to achieve their goals. User testing is traditionally used to compare two or more designs or sections of design to see how fast the users can complete a task, or how they navigate through the system.

In this study a combination of user testing and semi-structured interviews will be used, in an attempt to gather more in depth feedback on both how the prototype operates, and how the user feels using it. The users will also be instructed to follow the think aloud principle, which means to say what you are doing, what you are thinking and what you are trying to do, in an attempt for the researchers to get a better understanding of the usability of a system (Sharp et al., 2011).

### ***Summative data gathering***

Summative evaluations are used after a development phase is considered complete and the product is ready for the end users. It’s often used to please stake holders and rate the success of a system.

For the final evaluation that with the students actively engaged in drivers’ education, the Guerrilla testing method was chosen due to a very helpful and constructive drivers’ ed instructor participating in the project. This participant has granted access to their facilities and client base, opening up a new and interesting way to do evaluations.

### **Guerrilla testing**

Guerrilla testing is an evaluation method first described by Jakob Nielsen in 1994 (Nielsen, 1994), which has grown in use and popularity in the later years due to technological development allowing mobile prototypes (Pirker, 2017). Guerrilla testing is a low-cost evaluation method compared to other methods of evaluation, in that it does not require users for a long time, or has the same requirements for prototype quality. David Simon at

uxbooth.com even describes that it's useful to go out with an idea on a napkin as long as it gives you feedback.

Guerrilla testing got its name from the idea of pouncing on someone unexpected, and that's exactly what it does. It's described as a method to ask strangers if they would like to test out your prototype for 10 minutes and give it a review in return for a cup of coffee or something relevant to where you find them. Like a cafe or an office park.

Time will be allocated to sit at the drivers ed company that offered us this possibility, and ask every student that comes in to have a driving lesson if they got 15 minutes to try out the application and give feedback.

### **Identify the practical issues**

People, and at times software alike, both share the fact that they can be unpredictable, so to be able to conduct an evaluation that holds up in quality control, it's important to have a plan on how to deal with the eventualities (Sharp et al., 2011).

### ***Lack of participants***

There is always a risk of not getting participants for a research project, especially if the research is not valuable to the individual or entity, and an incentive is not offered. Due to cost constraints of the project, no incentives were applicable. To try to avoid the issue, or limit the risk of having too few participants, a preliminary search on the drivers' education situation in Bergen was carried out, which showed over 30 different offices with driving tutors and, therefore there should be someone willing to help with testing and evaluations.

### ***Limited resources***

Due to the aforementioned cost constraints of this project, there is a limitation on how much money can be put in the project. Therefore free options to use instead of purchasing licenses were looked at. For instance; we already had access to the Adobe Creative Cloud, and InVision offer one free project to every account. Samsung's Voice Recorder application to record was used instead of investing in quality audio equipment, and really (Wreally, 2017) for transcribing because they offer a free trial.

### ***Time constraints***

A thesis of this size is no easy feat to carry out in a limited time, therefore the research strategy was adjusted accordingly. Specifically the guerrilla testing method is faster and easier scheduling wise, than holding bigger test sessions.

### Decide how to deal with the ethical issues

When doing any research involving humans, it's important to keep ethics in mind. Misuse of private or personal information can be devastating to a person, such as the damage that can be dealt to a political figure for sharing personal content with researchers. The Economic and Social Research Council (ESRC, 2015) has developed an ethics guidebook for conducting research and have listed a set of ethical principles and expectations:

1. Research participants should take part voluntarily, free from any coercion or undue influence, and their rights, dignity and (when possible) autonomy should be respected and appropriately protected.
2. Research should be worthwhile and provide value that outweighs any risk or harm. Researchers should aim to maximize the benefit of the research and minimize potential risk of harm to participants and researchers. All potential risk and harm should be mitigated by robust precautions.
3. Research staff and participants should be given appropriate information about the purpose, methods and intended uses of the research, what their participation in the research entails and what risks and benefits, if any, are involved.
4. Individual research participant and group preferences regarding anonymity should be respected and participant requirements concerning the confidential nature of information and personal data should be respected.
5. Research should be designed, reviewed and undertaken to ensure recognized standards of integrity are met, and quality and transparency are assured.
6. The independence of research should be clear, and any conflicts of interest or partiality should be explicit  
(ESRC, 2015)

Norwegian researchers also have to follow a few extra principles concerning ethics and data storage, as defined by Data Protection Official for Research (NSD.uib.no, 2016):

1. Will directly identifiable personal data be collected?
2. Will directly identifiable personal data be linked to the data (e.g. through a reference number which refers to a separate list of names)?
3. Will there be collected background information that may identify individuals (indirectly identifiable personal data)?
4. Will there be registered personal data (directly/indirectly/via IP or email address, etc.) using online surveys?

## 5. Will there be registered personal data using digital audio or video files?

If data can be directly linked to an individual and the information will be stored, the researcher will have to submit a notification to NSD (NSD.uib.no, 2016) and get your research approved.

When engaging with people there are more to the exchange than the words themselves. The best option would be to conduct the sessions with an observer as well as an instructor. If you also video tape the session you get the full range of emotions that make up a user experience, and you can store it for later analysis. Due to the chosen methods for evaluation, mainly due to the “quick and dirty”-approach and the guerrilla testing approach, it was deemed less natural to video tape these sessions and instead use audio recording. All participation with the research is anonymous, and no direct quotes or personal information will be used in the presentation of our research, therefore it was not required to get the study approved by the NSD (NSD.uib.no, 2016).

### ***Informed consent***

In most research projects, informed consent is a required element (with the exception of non-intruding covert observation) and this project is no different. Since the study includes interviews and user testing, informed consent was required (see appendix a – consent form).

### **Evaluate, interpret, analyze and present the data**

When choosing the paradigm and techniques for an evaluation, it's important to be clear on what kind of data is to be collected, as that further detail which methods are applicable. For this research we are going with a qualitative approach, as the subject matter is highly subjective and is hard to quantify. When conducting qualitative research, a few questions must be answered (Sharp et al., 2011, p355);

- *Reliability*
  - Reliability describes how consistent the techniques used would produce the same or similar results under the same circumstances on a separate occasion.
  
- *Validity*
  - Validity describes how well the methods and techniques chosen actually measure what they are supposed to measure.

- *Bias*
  - Bias describes how a researcher's view on a subject can cloud his or her judgment and distort the results or otherwise make the researcher miss certain types of behavior.
  
- *Scope*
  - Scope describes how well the section evaluated represents the full use of a system, or how well the participants in a study reflect the end user group.
  
- *Ecological validity*
  - Ecological validity describes how the testing environment can influence the results. For instance testing something in a class room for 7 year olds may not reflect what would happen in a class room with 17 year olds. The Hawthorne effect or the observer effect also comes into play, which is when test subjects who know they are being observed adapt their behavior when they know they are being observed. The Hawthorne effect can also describe the way a test subject, intentionally or unintentionally attempts to give the researchers what they want, or attempt to please the researcher to a strong degree (Monahan & Fisher, 2010).

This chapter has presented the methodology and research strategies used in this thesis, as well as individual methods used for data gathering, methods for testing, and the system development methods.



## Chapter 5 - Establishing Requirements

As described in chapter 4 – methodology and research strategy, the requirements for this prototype were gathered by interviewing drivers ed professionals, and an analysis of existing services for learning and/or testing drivers ed theory.

The chapter begins with a description of how the interviews were conducted and what the findings were, before describing how the existing services were analyzed and present the findings, and finally a discussion around the findings which makes up the foundation on which the prototype was built.

### Interviews

Early in the development cycle, contact was established with drivers ed professionals around Bergen. A total of around 20 individual offices were contacted and three driving instructors from separate companies accepted to participate in the research. Three individuals were sufficient to gather the requirements needed, as they had three distinctively different backgrounds and fields of expertise to draw upon. Specifically being a branch manager for over 10 offices, a relatively young instructor focusing on younger students, and a driving instructor focusing on older students and those that wish to get the license for the automatic gear shift, as opposed to the traditional manual one.

In any agile project, or any IT project for that matter, things are subject to change. These participants were therefore asked to which degree they would like to participate, and they all agreed to help with whatever was needed. One participant went above and beyond in this, and granted me full access to their office with a private room to conduct any testing. They were then not only used for initial requirements, but used as testers during the iterations as well.

The interviews were held at their offices in a 1 to 1 setting with audio recording. This was done before first iteration, in what called iteration 0 with paper sketches of the concept. That allowed the participants to get a feel for the domain we are working in and what separates this project from similar services. The interview (see appendix b – interview Guide - norwegian) was separated into four sections:

- Section 1 – Introduction and briefing
- Section 2 – Background about learning and testing drivers ed theory in Bergen,
- Section 3 – Technological tools for learning and testing drivers ed theory

- Section 4 - debriefing where they were asked to what extent they would like to participate.

## Findings

Section 2 – Background gave the following findings:

- 80% of the clients are 16-20 years old.
- The success rate at the practical driving exam seems about average between both genders, but men tend to fail their theoretical exam more than women.
- The respondents assumed this was a correlation caused by the male students neglecting to study their theory until the very end, while females were better at continuous study.
- The most challenging subject seems to be traffic regulation. Knowing the different signs, light regulation, police- or temporary roadwork regulations and the hierarchy of these.
- Some clients would give up drivers ed all together after a failed theory exam.
- Language barriers cause a lot of issues both with the practical and theoretical practice, as there are an increasing number of clients that don't know Norwegian or English.
- Theory courses used to be mandatory during drivers education, but were removed and are now voluntary, something very few take advantage of.
- During the mandatory introduction to driving that you have to take if you are under 25 years of age, they found visual aids like videos and .gifs/animations to help keep the students attention.

Section 3 – Technological tools for learning and testing drivers ed theory gave the following findings:

- The most used tool for both learning and testing drivers ed theory is Teoritentamen.no (Teoritentamen, 2017). This service is also recommended by several drivers ed companies.
- The respondents did not freely trust some of the available services, especially the free ones as they were often too vague or downright wrong.
- The more and more common multiple choice quiz-format for testing drivers ed theory, which is designed after the official theoretical test at Vegvesen.no (Vegvesen, 2017) does not offer support for those with dyslexia or otherwise reduced reading/writing

capabilities.

- However, the official test does offer support for this as you can request either a translator or a representative to explain the questions to you.
- In regards to this project being a gamified application, one respondent told about a project in Australia where the students got to use a driving simulator during their drivers ed, but unfortunately the project failed, as the students didn't take it seriously and played it like a game.
- One respondent told about an issue discovered by NRK (Døvik, 2016), where prospective drivers attempt to cheat their way through the official theoretical exam. According to the police and NRK, this is a very common problem in Norway and is almost exclusively carried out by internationals.
- All respondents said they were concerned with the multiple choice quiz-format being so popular as they believe it can draw attention away from actually reading and learning the necessary driving theory. Instead the students just learn the questions in the quiz, and not the knowledge as to why a question is right or wrong.

The cheating problem discovered by NRK was also supported by another respondent who says that it's alarming how often students show up with their approved theoretical exam, but during the practical driving show no signs of knowing any of the necessary theory.

### Existing services

There are many existing services for teaching and testing prospective drivers. Some more popular than others and some more expensive than others. This section aims to highlight some of these services and finally discuss the findings.

Here are some of the existing services:

- Teoritentamen.no (Teoritentamen, 2017)
- Teoriappen (Teoriappen, 2017)
- Vegvesen.no (Vegvesen, 2017)
- Trafikkforum (Trafikkforum, 2017)
- NKI-forlaget (NKI-forlaget, 2017)
- Bil-teori.no (Bil-teori, 2017)
- eTeori (ETeori, 2017)
- Prove.no (Teori-prover, 2017)
- Teori24.no (Teori24, 2017)

- Førerteori.no (Førerteori, 2017)
- Trafikktesten.no (Trafikktesten, 2017)
- Teoriprovengratis.no (Teoriprovengratis, 2017)
- Teoritester.no (Teoritester, 2017)
- Nettlappen.no (Nettlappen, 2017)
- Teori-prover.no (Teori-prover, 2017)

With so many services available, a closer look was taken at the most used ones and those identified in the interviews by the drivers and instructors:

- Teoritentamen.no
- Teoriappen
- Prove.no
- eTeori

A comparison of these services is undertaken, before going into detail (see figure 5).

Name	Learning	Testing	Mobile	Web	Price
Teoritentamen	✓	✓	✓	✓	55 - 399,-
Teoriappen		✓	✓		85,-
Prove.no		✓	✓	✓	50 - 250,-
eTeori	✓	✓		✓	475,-

*Figure 5 - Comparing existing services, prices in NOK*

With learning it is meant that they offer a separate section with explanations and illustrations that aims to teach about both the practical and theoretical aspects of driving. Testing is the traditional multiple choice quiz-format. Mobile means any mobile OS, however, most of them, with the exception of prove.no, only supported android and iOS. Web contains any web interface, such as PC, Mac or tablet.

Testing is the common denominator in all of these services as that is by far the most popular tool among the user base. The prices vary based on which package you purchase and for how

long you want access. As you can see the prices correlate to whether or not you want the learning-deal.

### Teoritentamen.no

The most used tool for both learning and testing drives ed theory is Teoritentamen.no (Teoritentamen, 2017). It is available on android, iOS and in web. This service is also recommended by several drives ed companies. It is supported by Statens Vegvesen (Vegvesen, 2017), the official organ for regulating and maintaining the roads in Norway. As well as being supported by Autoriserte Trafikkskolers Landsforbund (ATL, 2017).

Teoritentamen is also the biggest of these services with a massive 6500 questions in their quiz. They offer a vast learning section as well, with comprehensive digital courses for most licenses available in Norway. They offer audio read out of both their learning and testing sessions, in an attempt to support those with reading difficulties. They give explanations after you answered a question, so you can learn why an answer is correct, before moving on. You can also see these explanations at the end of a test. The high quality animations and videos you come across throughout this service are quite good. Their cheapest subscription/deal at 55,- is a 24 hour access to only their quiz, while the most expensive deal at 399,- is a 30 day access to every part of their services including learning, illustrations, quiz and a bonus pass guarantee for the official theoretical test at Statens Vegvesen.

### Teoriappen

Teoriappen is a mobile-only service released in 2017 that only contains a quiz containing over 1000 questions. It is a fairly straight forward service available for android and iOS, with only one price as there is only one type of content. For the seemingly sensible price of 85,-,

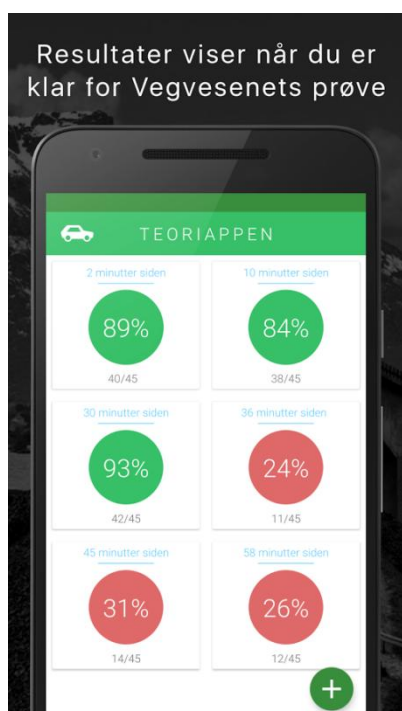


Figure 6 - Teoriappen

Teoriappen is the only service here that does not offer limited service, so once you purchase the application you have it forever. They offer explanations after a completed test so you can learn why something is correct, and they tell you in which domain or subject you answered correct or wrong in, so you know where you need to study more.

An interesting element in this application is a design element that is not exactly gamification, but it borders on it. After a test is completed, and in the history or previous results section, you can see your % score, whether or not you passed, how many correct you had and when you did the

test. While the enjoyment is in the fact that you pass the test, getting a visual representation of green was to us a motivational factor as well.

### **Prove.no**

Prove.no is another quiz tool that offers 644 questions. You can purchase a 24 hour access for 50,- or a 30 day access for 250,- which also include explanations to the questions and an additional test specifically about traffic signs. Of these 4 it is the only one that supports Windows operating system. They use 3D illustrations accommodating the questions that help purvey the meaning of a question or help clarify it. It is argued that this service is lack luster unless you pay for the 30 day access since they limit the explanations for the premium users, and if you are going to spend 250,- we would rather recommend you go for Teoritentamen.

### **eTeori**

eTeori is another services recommended by some drivers ed companies that offer thorough learning and testing of every aspect of driving. While the official text book for drivers ed in Norway is called The road to your license, eTeori's slogan is the digital road to your license. Their vision is to be a complete alternative to the text book. While being the most expensive option at 475,-, it has only one subscription option that gives you access to their service for 5 months. While Teoriappen's access is unlimited, this is arguably an equivalent to a 5 month access, as most users only engage with these services for a limited amount of time. They do not focus on quizzing and testing knowledge as much as other services, but they do offer them. Their selling point is in digital courses, specifically one that lasts for about 5 hours, with 3D animations, text, audio and pictures. While I did not take the digital course, the previews were found to be thorough and understandable.

### **Gathering questions**

Instead of reinventing the wheel with the questions needed for our quiz, and risk the potential of making a mistake and teaching something wrong, questions were borrowed from the existing services (see appendix c – questions used in prototype). 10 questions were gathered from Vegvesen.no (Vegvesen, 2017), 11 questions were taken from Teoritentamen.no (Teoritentamen, 2017) and 9 questions were taken from bil-teori.no (Bil-teori, 2017) for a total of 30 questions used in our prototype. These specific questions were gathered for their variety and clarity in what they were asking, as well as good illustrations to go with the questions that needed them.

## The Requirements

Rogers et.al. (2011) talk about two aspects we wish to achieve with establishing requirements. The first aspect is to better understand the needs of the user, how they engage with a system and what demands are asked of the system. After identifying the needs, the second aspect is to achieve a set of requirements that we can use to start thinking about the design (Sharp et al., 2011, p202). The nature of requirements will change over time, so one should not spend too much time perfecting them into something rigid. We separate our requirements into functional and non-functional requirements.

## Functional requirements

Functional requirements are the requirements that detail what a system should be able to do, such as an ATM should be able to check a user's balance and a user should be able to withdraw currency if the balance is high enough.

For this mobile application the following functional requirements are specified:

1. The user should be able to take a test
2. The user should be able to see available trophies
3. The user should be able to view see what trophies they have earned
4. The user should be able to view completed tests and their results
5. The user should be able to see a result screen on how they did and what their rewards were
6. The user should be told why a question is correct or incorrect
7. The user should be able to sign in to their personal account
8. The user should be able to sign out
9. The user should be able to abort a test at any time

The functional requirements have been prioritized and ordered accordingly.

## Non-functional requirements

Non-functional requirements detail the constraints on the system and its development. In tone with the ATM example, non-functional requirements could include that the environment in which an ATM is operated is often in an open and public space, making audio input a challenging way of interaction (Sharp et al., 2011, p201). Non-functional requirements are often separated into several sub-categories.

## *Environmental requirements*

Environmental requirements are again separated into four sub-categories:

### *Category 1- Physical environment*

considers the physical context in which the system operates, and for this project the interesting elements to look at are lighting, noise, and distractions. Being a mobile application expected to be used “on the go”, often outdoors or otherwise non-stationary, these are genuine concerns that will change how the interaction is designed. The following tools are utilized to avoid any problems:

- The user should be able to pause at any part of the application if they need to, without being punished. To achieve this, the tests will not be timed.
- The user should not be at a disadvantage or perceive the questions as harder if there is poor lighting. To achieve this, easy to read text will be used and the illustrations should not be vague or contain too much detail.
- The application will not require audio to be utilized, and audio will be looked at as a bonus.

### *Category 2- Social environment*

considers the relationship between people or systems, and how the application would handle this. Again, using the ATM example, should the system be synchronized so that if a bill is paid at the same time as the session at the ATM, should it be automatically updated and perhaps deny the withdraw, or should it be asynchronous so that you could still withdraw and then remove the balance with the bill afterwards. It’s obvious in this case that it should be synchronized, as it could cause conflict of balance if it wasn’t. For this project there are no personal relationships of collaboration, and only the one access point to the system, so there are no clear social environmental requirements that should be addressed.

### *Category 3- Organizational environment*

considers the business, maintenance and support behind a product. For instance how good will the customer support be. For this project, as an application that will not be deployed to the users, and will only be active during test sessions, there are no specific organizational requirements to consider.

### *Category 4- Technical environment*

considers what technologies will be used in the system and what it needs to be compatible with. As covered in chapter 2 – potential technologies, our technological



environment is web interface for any device, which is inherently compatible as long as the device has a browser.

Other non-functional requirements of a system can include *user requirements* and *usability requirements*. User requirements consider what kind of users will be using the system and what skill level they are likely to have. These skill levels are often separated into user profiles and a design is created that can suit multiple profiles at once, for instance with shortcuts for the advanced or frequent users, and a structured menu for the novice users that require more step by step instructions. As shown in the findings from the preliminary interviews, an estimated 80% of our user groups are young adults, and therefore we can make the assessment that they are frequent users of mobile phones and therefore are familiar with conventions for mobile interaction. At the same time it is desired not to exclude users that are not frequent users, so the design should be intuitive and useful regardless. To meet this middle ground it has been chosen to create our design following Google's material design framework (Google, 2017b), since it offers guidelines on how certain elements are meant to look like, and includes symbols and icons for intuitive use. The material design guidelines will be discussed further in chapter 6. The specific steps we take to achieve this are:

- Intuitive navigation without unnecessary steps between screens
- Shortcuts for the frequent users of our system

*Usability requirements* contain the steps one takes to achieve the usability goals (Sharp et al., 2011, p14);

*Effective* to use – How good is the system at doing the job it's supposed to do?

The tool should afford the necessary interaction and functions that are needed to test their knowledge in drivers ed theory.

*Efficient* to use – Is the system fast and efficient to use, or does it have unnecessary steps?

The system should not waste the user's time with unnecessary steps or forcing the users to use functions they don't need or want at a given time.

*Safe* to use – How good is the system at avoiding potentially dangerous or undesirable outcomes?

One way to reduce undesirable outcomes is to give clear warnings and pop ups if the user, for instance, tries to exit an active quiz, so that it's not instantly executed.

Have good *utility* – Does the system offer enough utility to be able to complete the desired tasks?

High utility means the system has all the utility needed for what the users need to do and what they want to do. In the application the scope of functions is fairly limited seeing as it really only serves as a quiz app, so the utility will not afford anything outside of that

Easy to *learn* – How long does it take to learn how to use the system?

Users do not like spending time learning how to use a system as they just want to get started (Sharp et al., 2011, p16). Thus, the system will be limited in its functions, making it an easier system to learn. The aim is to help the learnability by using the material design palette which offers hundreds of icons commonly seen in google and android software, which makes for a more intuitive experience.

Easy to *remember* how to use – If you take a break from the system, how many of its functions do you remember how to use?

In tune with the learnability and utility, the system with its limited amount of functions should offer good memorability.

The final requirements to be addressed are the *user experience* goals. In tune with a gamified application, the idea of our users enjoying the system intrinsically as well as extrinsically is a key factor to benefiting from the tools of gamification.

These user experience goals aim to address how a user feels when engaging with the system. The system should be satisfying, enjoyable, fun and entertaining. One should not feel bored by something that could be avoided if designed differently. Satisfaction, motivating, rewarding and emotionally fulfilling are some of the key aspects to a gamified application, since it's based around earning rewards for completing something. The aim is to make the application aesthetically pleasing by the use of creative trophies and interesting pictures and illustrations throughout the quiz.

This chapter has presented the results of the collected data, we have formulated our specific goals, our requirements and how we wish to achieve them, and finally presented some overall requirements of the system.

## Chapter 6 – Designs

This chapter documents the initial design choices and paradigms choices made before any development started. Then the iterations and how the design changed over time is presented.

### Material Design

Google's Material Design (Google, 2017b) was chosen as the guidelines for the design due to its commonplace in Google software and Android services. As presented in chapter 2 – potential technologies, the android operating system has over 80% of the market share on smart phones, and with Google's name and position in the world, people will be used to these tools and it will make for an intuitive experience. The Material Design Guidelines present specific guidelines for container placements, relative placements between different elements, color choices and how they go together, how to deal with responsive screens, and offer hundreds of scalable vector-based icons and much more. The Material Design guidelines are based on a tactile reality-like design that help users understand the affordances, specifically by using layers and shades to promote meaningful interaction. Some of the specific design guidelines we will be utilizing include:

- Shades to imply clickable objects/widgets
- The material design color palette which includes accent colors to accompany the main color choice
  - o Color choices can be used to convey hierarchy in the level of importance of content
- The seam principle
  - o This means that content that share a seam across the width or length of a screen, have the same level of importance and can be viewed as alternatives or options

As mentioned in chapter 2 – fields of research and related work, there are specific design principles to keep in mind when designing for mobile (Budiu, 2015). Some of these that are relevant to this project are presented and later how they have been used is illustrated.

- Clickable areas should be 1 by 1 cm in size.
- Leave enough room around clickable areas to avoid clicking the wrong item.
- Avoid hiding content with which you want the users to engage.

Having an easy to use mobile interface with clear usability, intuitive interface and limited functionality promotes “on the go” use of the application, which is a constructive concept to keep in mind when designing a learning application.

As introduced in chapter 4 – methodology and research strategy, the prototyping was done in iterations. It's worth to mention that iterations 0, 1 and 2 are meant to increase the quality of the prototype, before the testing with students actively engaged in drivers education.

### Iteration 0

To get early feedback on the concept and design ideas they were sketched on paper, referred to as iteration 0.

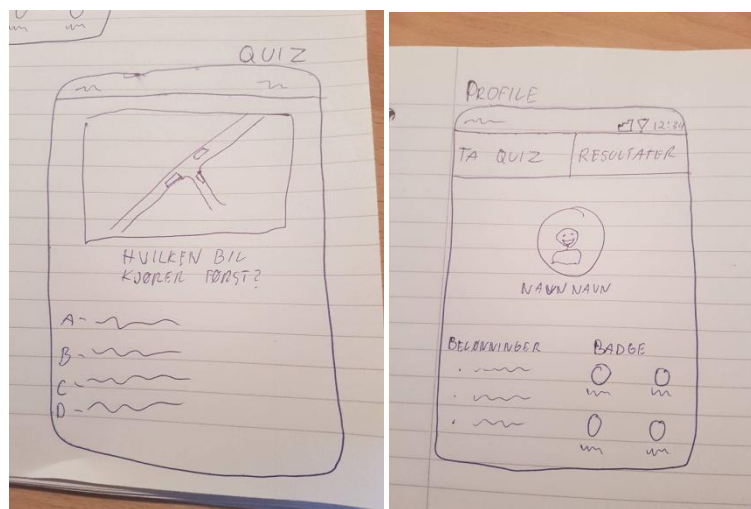


Figure 7 - Iteration 0 wireframes

Since iteration 0 was meant to be a quick and efficient way to pitch ideas, the wireframes are of low fidelity and of a low quality in terms of precision and are not meant to look pretty. It is however an efficient tool for retrieving feedback before starting any digital development.

In this iteration the focus revolved around what different screens were needed for the prototype, what the navigation could look like and the position of different elements. In this iteration a discussion was started with fellow students and colleagues in our network.

### Iteration 1

Iteration 1, or the first official iteration, is where it starts to get interesting. The feedback received in iteration 0 did not warrant any big changes and the designs were ready to be digitalized. In this iteration the focus was getting a small prototype that could be played through, meaning a home screen, a profile, a quiz, a result screen and an updated profile with the trophies you earned from the quiz were needed.

The application was not able to track how you did on the quiz at this point, due to the limitations of the InVision prototyping tool. These limitations specifically being static images playing through a story instead of content being generated in the prototype. Meaning if a user answered correct on all questions, it would only be able to see what you clicked on the final page of the story.

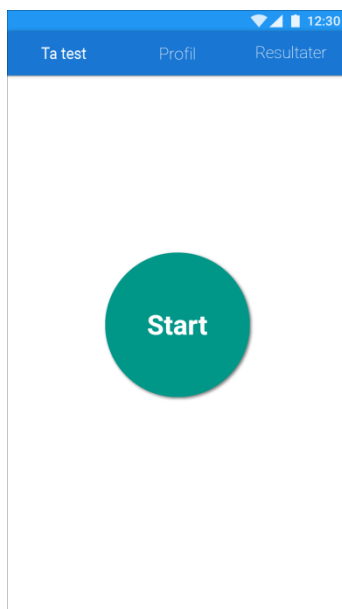


Figure 8 - Home screen iteration 1

This is the first screen you get to when you open the prototype (see figure 8). From here you can get right into taking a test, which was a design choice made specifically to follow the requirement of efficiency. Where the users just want to get started and not waste time.

The color choices you see here are a set of colors specified by the material design palette for colors that work well together without being a strain on the eyes or adding distracting elements.

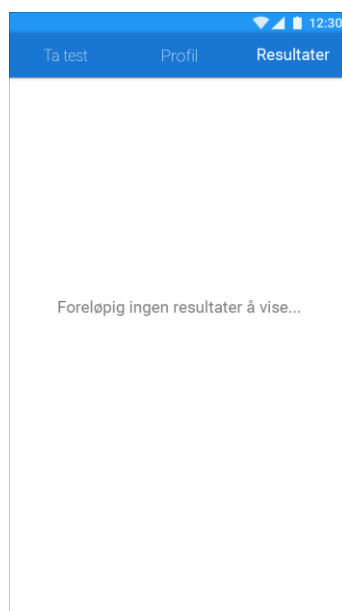


Figure 9 - Empty result screen iteration 1

If the user was to navigate to the results before taking a test, they would be directed to an empty result screen (see figure 9).

Should the user navigate to the profile before taking a test, they would get this empty profile (see figure 10) displaying available trophies. In line with the non-functional requirement to cater to different user profiles, a shortcut in the heart were you can start a quiz without going through the navigation was included. In this way we support both the frequent user and the novice user that get clear indication from the navigation on where to go next. The icons used for the trophies are a few of the many available material design icons that they offer. They are minimalistic in design to avoid clutter and are scalable, so they support any screen size.

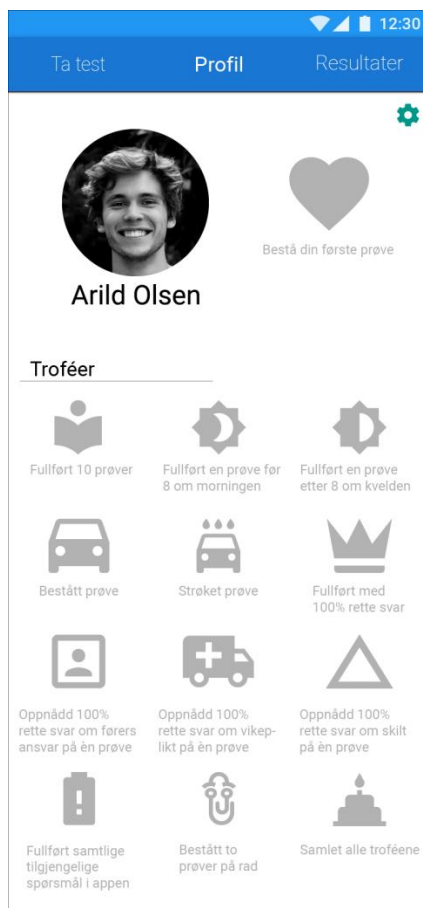


Figure 10 - Profile iteration 1

Now, if they direct themselves through the “Ta test (Take a test)” navigational button, or click on the heart, they will start the quiz and get their first question.

The quiz itself is fairly straight forward and did not warrant any changes throughout the iterations (see figure 11). In line with our non-functional requirement for safe use, there is a pop up if you click the stop sign to exit the test, so you do not accidentally exit and lose your progress.

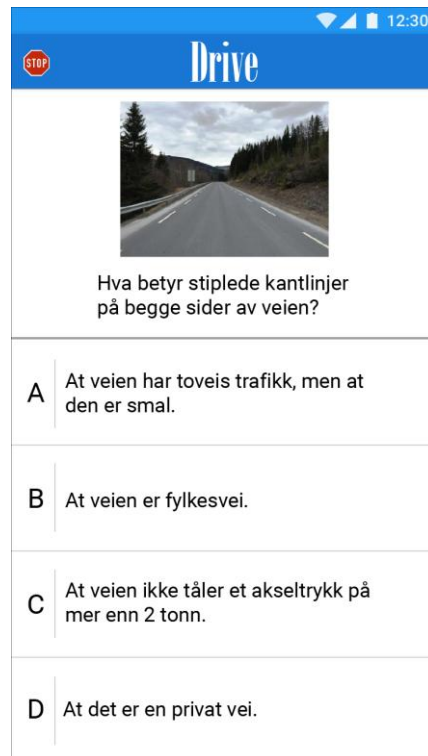


Figure 11 - Quiz example

When you finish the quiz you get a result screen (see figure 12). Due to the aforementioned limitations met while using InVision's story based prototyping, a result could only be displayed based on what you answered on the final question in the quiz at this point. However, in this short version of the quiz, with only a few questions, it was good enough to yield a constructive user test. The result screen you see here is an example of what a pass could look like. In the case of developed software, this would be able to tell you specifically which questions you got wrong, and what you need to work on, but for this prototype the best possible option was examples.

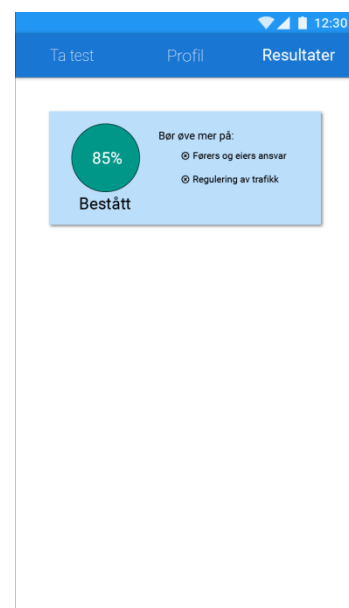
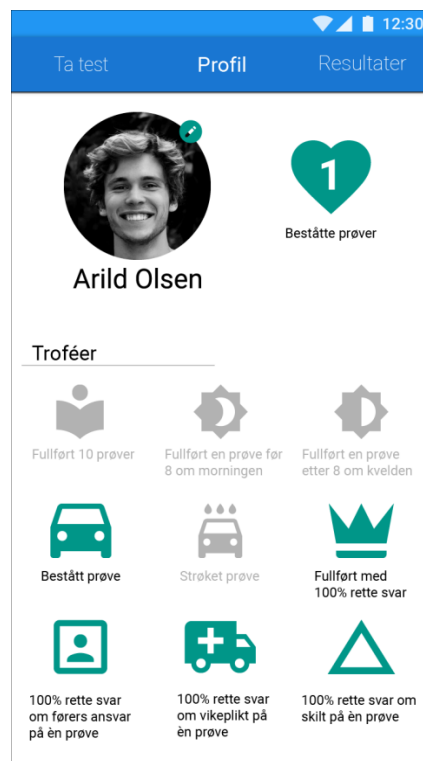


Figure 12 - Results iteration 1

If the users were to navigate to their profile after a quiz, they would now see the updated trophies and what they got (see figure 13 below). The heart has now changed to a counter that tells you how many tests you have completed thus far. This design element was added in an attempt to keep motivation up, even if you did not earn any trophies for a specific test. As trophies are inherently harder and harder to get as you earn them due to the easy ones being earned right away.



*Figure 13 - Profile with trophies iteration 1*

While the details on how the testing was conducted will be described in chapter 7 – evaluation and discussion, feedback received in iteration 1 will now be presented. This iteration, while also tested with fellow students and colleagues, they were not tested the same ones who tested in iteration 0. Our opinions and solutions to this feedback will be addressed at the start of the next iteration.

#### Feedback

- Some users found the navigation bar at the top to be tricky to use, since it's so far away from the thumb.
- Some users also didn't fully understand the navigation bar and where they were at all times.



- Most users asked for more trophies, as they imagined they would quickly burn through the ones available and then want more.
- The users found it was hard to see which trophy you earned from a specific test.
- Some users mentioned the profile screen was too cluttered due to all the trophy text.
- Naturally the users requested a post-game screen where you can see more about how you did. E.g. which questions they got right and wrong.

## Iteration 2

In this iteration the aim was to solve the issues presented in the testing of iteration 1, as well as make the prototype as complete as possible before the final user testing with students actively engaged in drivers' education, also known as our user group. The iteration began by going through the feedback section by section.

### Feedback on navigation

- Some users found the navigation bar at the top to be tricky to use, since it's so far away from the thumb.
- Some users also didn't fully understand the navigation bar and where they were at all times.

It was decided to redesign and put the navigation at the bottom of the display, replace the text strings with icons that show the essence of the tab they represent, as well as add more clarity to which tab you are currently at. This also allowed the addition of another material design guideline element to the list, namely the bottom navigation (Google, 2017a).

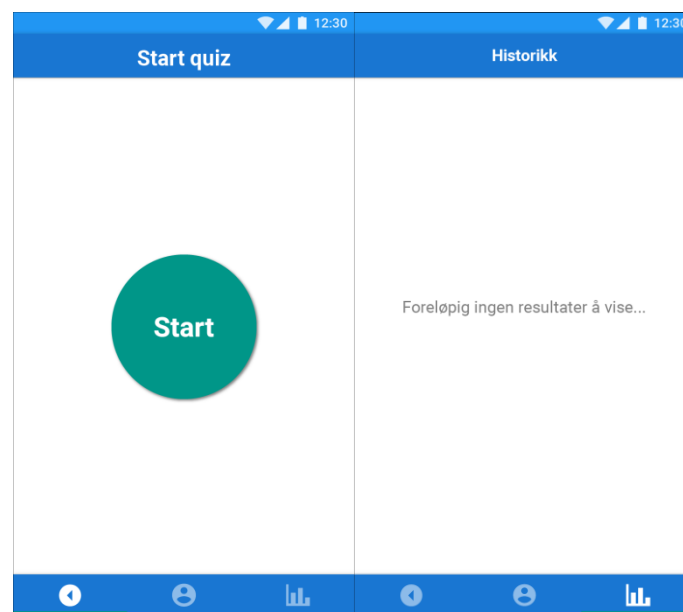


Figure 14 - Bottom navigation iteration 2

With the navigation now at the bottom, it was possible to have a title at the top, for added clarity. Bottom navigation also complies with the material design guideline for mobile.

#### Feedback on trophies

- Most users asked for more trophies, as they imagined they would quickly burn through the ones available and then want more.
- Some users mentioned the profile screen was too cluttered due to all the trophy text.

Many new trophies were added to the quiz, and the profile page was redesigned to better highlight the trophies as icons instead of a big clutter with text (see figure 15 below). The trophy details are now available through clicking on them and getting a popup which shades out the rest of the interface.

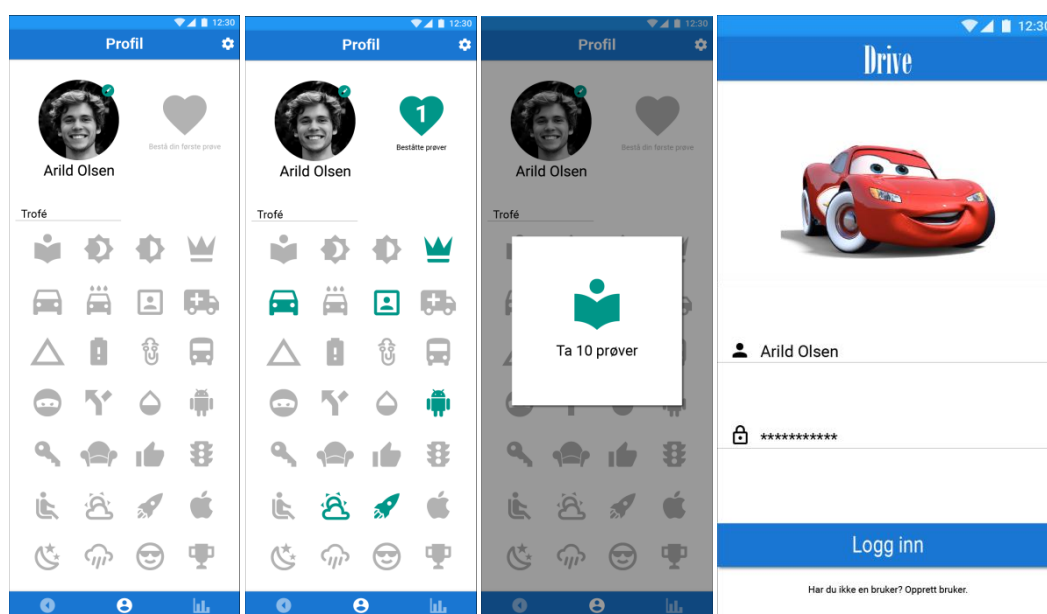


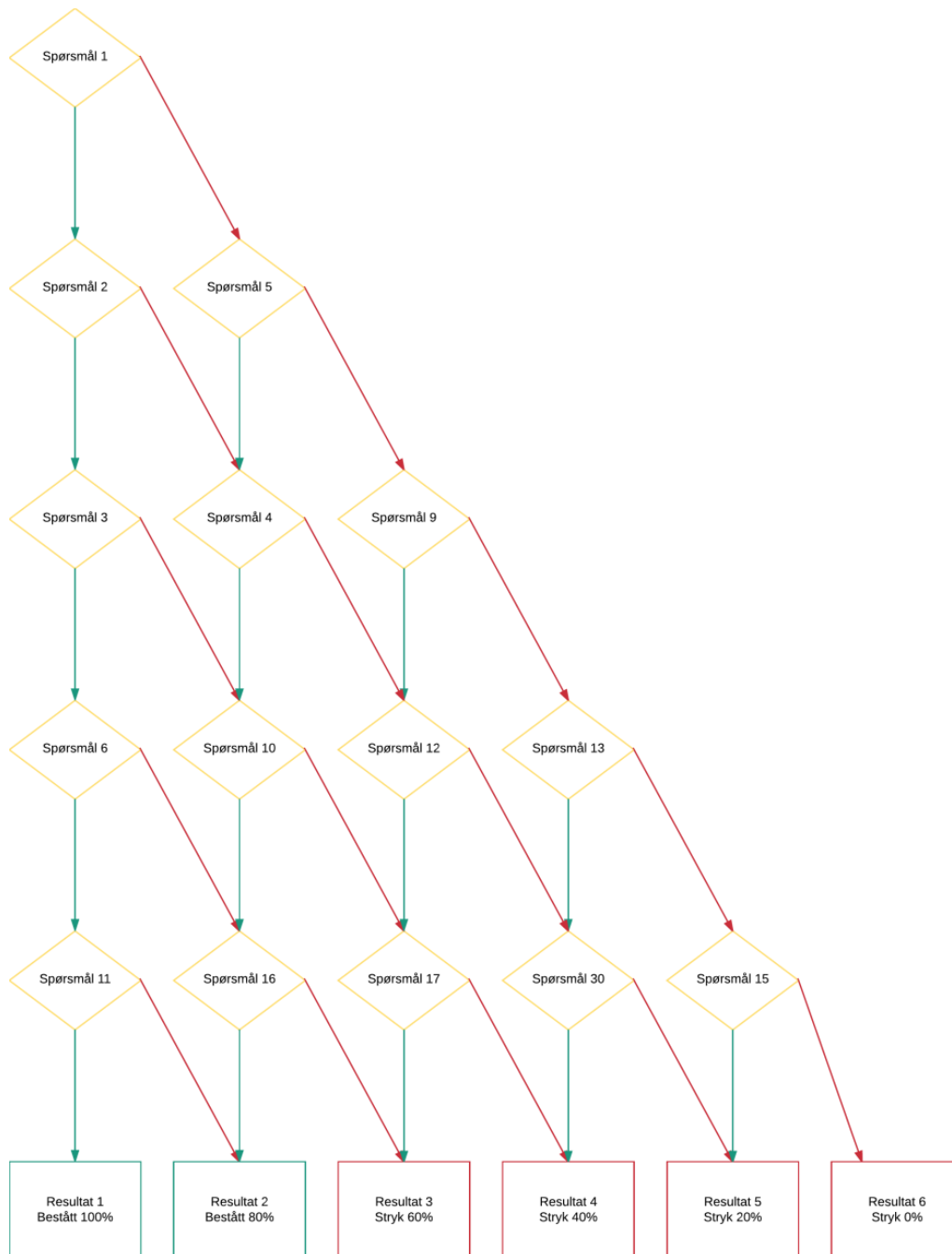
Figure 15 - Sign in screen and redesigned profile screen iteration 2

A settings button that allows the user to sign out if they would want to was added. Also it is naturally that if you can sign out you should be able to sign in as well, thus, a sign in page was also added.

Now for the final piece of feedback from iteration 1

- Naturally the users requested a post-game screen where you can see more about how they did.
- The users found it was hard to see which trophy you earned from a specific test.

To be able to tell which trophies the users actually earned from a quiz, one would need to know which questions they got right, and that proved to be no simple task. Due to the aforementioned limitations with the InVision prototyping tool's story based design, some adjustments to our prototype had to be made.



*Figure 16 - Model for predicting outcome*

By structuring the prototype's story after a model we created (see figure 16 above), we were able to predict where the story would go, based on whether or not they got the question correct. A green line symbolized correct answer and red line symbolizes incorrect answer.

This means if they answer correct on a question they go downwards, and if they answer one of the other 3 options which are then by definition incorrect, they go to the right. This means it is possible to know how many they got right, and give them a correct pass or fail on their quiz, as well as showing the correct trophies they earned. It is not known, however, the specifics of which question they got correct or incorrect, considering you can end up with result 2, getting 80% correct and passing, by several combinations of answer. Thus, it is unable to tell why a question was correct or incorrect with explanation.

By using the model to predict the outcome, it was possible to come up with 6 versions of this screen that now correctly show which trophies they earned, if they passed or failed, and how many they got right (see figure 17 below).



Figure 17 - Result screen iteration 2

Now that result screens specific to a single test have been added, the result screen from iteration 1, that shows completed tests, was renamed to history (historikk). This square now highlights two of the trophies you earned, and you can click on it to open the results from that specific test (see figure 18 below).

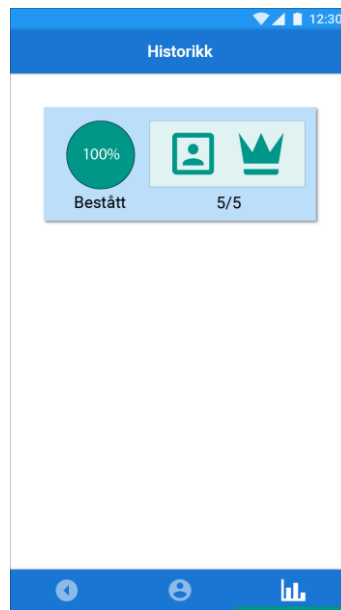


Figure 18 - New history iteration 2

The feedback from iteration 2, which was tested with the driving instructors participating in the project, is now described, and then the changes made according to the feedback is presented.

- One instructor pointed out that it seemed wrong to click on an arrow pointing backwards, to move on from the result screen after finishing a test
- The instructors requested information on which questions they got correct and incorrect.



Figure 19 - Adding text string for clarity iteration 2

To fix the issues with navigation proposed in the feedback above, a text string to help make it more intuitive was added (see figure 19 above).

It was still not possible to find a way to display the questions after a test and explain why an answer was correct or incorrect, a loophole that at least helped with the test session itself was found. In InVision, you can set the animations you want to have when transitioning between screens, so two visually separate animations for correct or incorrect added, and the test

subjects were made aware of this during the test briefing, so at least they know which question they get right or wrong during the quiz.

This chapter has described the different iterations, the feedback received and the changes made to accommodate them.

## Chapter 7 – Evaluation and Discussion

This chapter describes the process of evaluation that was conducted throughout the iterations, and then the findings are discussed and validated. Each iteration is presented separately and it is described how it was conducted and iterate on their findings. Then the practical and ethical issues that were met and how they were handled are presented, before validating the approach and results.

### Iteration 0

As presented in chapter 4 – methodology and research strategy, the “quick and dirty” method of obtaining feedback during early iterations was used. According to the method instructions to “quick and dirty”, these sessions were held informally wherever the participants were at. A total of 6 “quick and dirty” evaluations were held throughout iteration 0 as the concepts became more specific, some were held at the university study rooms, some at friends’ houses and some were held “on the go” and out in the streets. The concept sketches were presented and ideas were pitched to people in our network accompanied with a few questions:

- What did you think of the presentation of our quiz, and how the question and answers were presented?
- What colors would you affiliate with a learning app for drivers ed theory?
- What kind of rewards could you imagine getting for completing a quiz?

The participants in the “quick and dirty” evaluation naturally didn’t have too many visual tools to evaluate seeing how it was in our iteration 0, and before any development had been conducted, which is the sketches were accompanied with questions in an attempt to draw more information out of them. They mentioned they would imagine seeing the traffic light colors in the app, because they are tightly connected to theory. It was decided to use those colors, specifically red and green to imply positive and negative outcomes in the prototype. Red was used to accompany a failing result, as well as the option to abort or cancel a quiz in progress. Green was used to show a passing result, and it was used to symbolize a go-sign for starting a quiz. Blue was used as our primary color for the prototype, since it is a neutral color in this domain and should not promote a positive or negative outcome.

The participants had a varying level of experience with gamification and what it meant and how it could be used to benefit an application. Some had great experience with it and used some of the tools discussed in this thesis, namely Fitocracy (Fitocracy, 2017) for maintaining

exercise habits, and To-Doist Karma (To-doist-Karma, 2017) for creating and managing their work loads, while others had never used anything gamified. Thus, when it came to what kind of rewards they could imagine, they drew ideas from their experience. The specific elements they mentioned as options were:

- Experience so you can see yourself level up as you use it.
- Some kind of collection like equipment/cloths, gold, or badges.
- Rewards you input yourself, so you can say “if I do 3 quizzes today, I get to buy ice cream”.
- Trophies and badges so you can show off a cool thing you managed to do.

As presented in chapter 6 – Designs, it was decided to go with trophies because they visualize the rewards well and it is possible to experiment with different icons and see how they are received. Trophies support several engaging elements we wanted to address, such as collectionism – the ability to fully complete or collect all available items, and progression/growth in the application.



*Figure 20 - Trophy example*

With having made the design choices of which direction to take the gamification, and what colors to use, it was possible to move on to iteration 1, where the designs became digital.

### **Iteration 1**

The main method of evaluation used in iteration 1 is user testing with the resources available in our networks. These sessions were held one to one in a private environment without distractions and as presented in chapter 4 – methodology and research strategy, were audio recorded. The user testing was started with a scripted explanation of the research, interests, and the procedure of the user test, to ensure all participants got the same instructions so that our results wouldn't be obstructed by situational phrasing, and to ensure that all participants have the same starting point (see appendix d – test guide – norwegian). After they were



introduced to the user test, they were given access to the prototype on a mobile device and given 10 minutes to try it out. To further enhance the comparability of the feedback, they were presented with tasks to solve in the prototype:

- Check out your profile and look through the available rewards
  - Find two rewards you wish to get
  - Earn these rewards
- Play until you earn 100% correct on a quiz

This ensured that every participant visited every part of the prototype and would be able to give us feedback regarding the entire prototype. After they completed their tasks or the time ran out, they were asked a series of questions to get the feedback and to quality check the user test approach:

- How did you like the tasks we presented?
- Did you have enough time to complete them?
- Did you run into any problems?
- Was it easy to navigate? Did you know where to go next?
- Is there anything you feel is missing or that you would like to see in an application like this?
- Do you see any value in having a personal user profile that grows as you take tests?
- Anything else you would like to add?

After the questions the participants were debriefed. This is where the participants got the opportunity to share additional information around the concept, the design and their feelings after using the system. This section is harder to operationalize and compare to the other testers, but it deemed a valuable way to get further information.

Before presenting the feedback from iteration 1, the current designs being evaluated at this stage are summarized. Specifically relevant is the top navigation bar and the profile with trophies and descriptions.

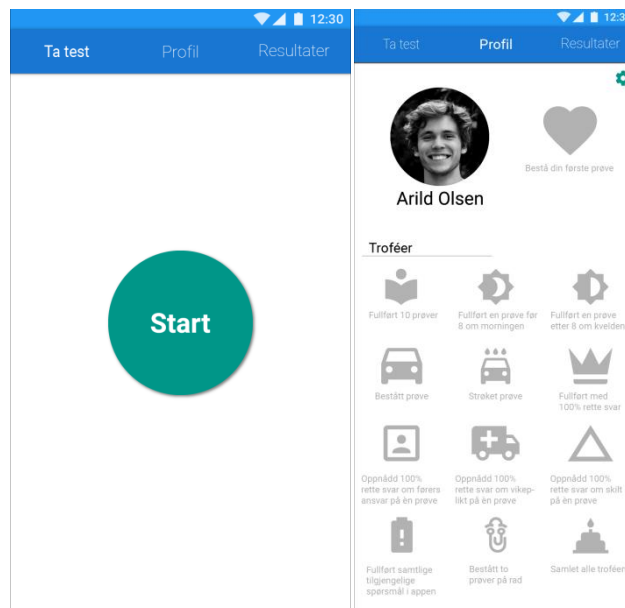


Figure 21 - Summarizing designs from iteration 1

A total of 3 user tests were held as described above and 2 more “quick and dirty” conversations in this iteration. As presented in chapter 6 – designs, they yielded the following feedback:

- Some users found the navigation bar at the top to be tricky to use, since it’s so far away from the thumb.
- Some users also didn’t fully understand the navigation bar and where they were at all times.
- Most users asked for more trophies, as they imagined they would quickly burn through the ones available and then want more.
- The users found it was hard to see which trophy you earned from a specific test.
- Some users mentioned the profile screen was too cluttered due to all the trophy text.
- The users requested a post-game screen where you can see more about how you did, for example, which questions they got correct and incorrect.
- All but one user responded very positively towards the idea of gamification and our use of trophies and freely mentioned that they believe it could be something that

would make them want to keep playing. The last participant felt no connection to the trophies or gamification in general.

The gathered feedback showed that there were some issues with clarity and navigation that would need to be addressed before moving further and ultimately meet the end user base. The gamification elements, specifically being the trophies, appeared to be a hit among almost all test participants, and it was decided to move forward with the use of trophies.

## Iteration 2

The main method used in iteration 2 is, similar to iteration 1, the user test method. However, in this iteration it was conducted with the driving instructors participating in the project. At this point, a satisfying level of quality was reached, and it was time to have the domain experts evaluate it before moving on to the end users. These test sessions were held in their offices around Bergen, with a total of 3 driving instructors from 3 different offices. The participants were given the same instructions as in iteration one, but with further work on the prototype we were able to give them a few more tasks, specifically to sign in and sign out. After they were done they got the same questions and debriefing as the participants in iteration one.

Before presenting the findings from iteration 2, a summary of the current designs being evaluated in iteration 2 is presented (see figure 22).

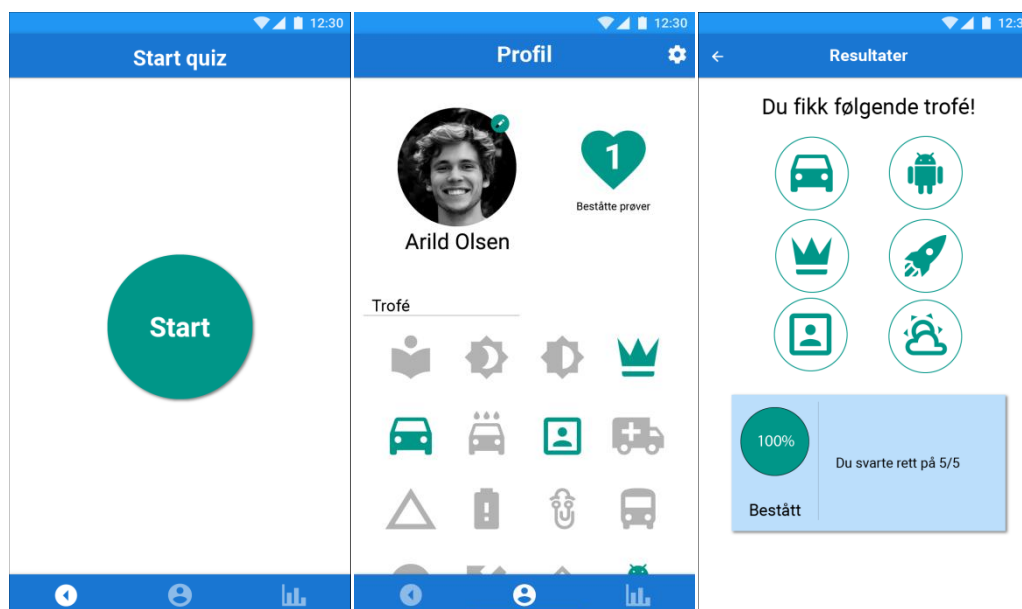


Figure 22 - Summarizing designs from iteration 2

The navigation was moved to the bottom for mobile friendly accessibility, and the previous text strings were replaced with intuitive icons. The current page you are at is also highlighted

with the accent color accompanying the prototype. The trophies got a cleaning and instead of messy text boxes now offer a leaner look with clickable icons that show its description. The ability to sign in and sign out was also added.

At this stage of development, the prototype was almost fully functional, with the exception of our limitations with static images not allowing us to display which question they got right and wrong, and the feedback received in iteration 2 can be separated into two sections;

#### Functionality and usability feedback

- One driving instructor pointed out that it seemed wrong to click on an arrow pointing backwards, to move on from the result screen after finishing a test
- The driving instructors requested information on which questions they got correct and incorrect.

#### Conceptual feedback

- One instructor really loved the idea already from the interviews, and mentioned during evaluation of iteration 2 that the respondent thought their students would like our prototype.
- The instructors showed great interest in the prototype and said that anything that can make students study more on their theory is very welcome.
- The instructors liked the element of fun introduced with the trophies.

The biggest element of feedback from iteration 2 was that they want a post game screen with the correct and incorrect answers to the test, and an explanation as to why an answer is correct. As mentioned in chapter 6 – designs, it was not possible to create such a post-game screen due to the limitations in InVision, and instead opted to go with the solution of separating the animations when you get the correct or incorrect answer, so that the users during testing will know if they got a question correct or incorrect. A text string was also added that accompanied the backward pointing arrow in the result tab, to properly indicate its functionality. In terms of the conceptual feedback, the instructors were overwhelmingly positive and had little negative to say at all.

### Iteration 3

The final and most important iteration, iteration 3, used the guerrilla testing method in combination with a semi structured interview. As presented in chapter 4 – methodology and research strategy, one of the participating drivers ed companies granted access to their

facilities and their clients, giving us the option to use this exciting method of evaluation. The driving instructor in question said that students often come to their office awhile before their driving lessons, and that we were welcome to sit in their waiting room and ask if any of their students wanted to try out our prototype. I sat there for a total of 15 hours divided on two days in their waiting room approaching the students that sat down. When doing guerrilla testing it's important to remember not to be biased in who you approach, as that could influence the results. The participants received information on the research and our position as independent from the drivers ed company, and what was wanted from them. They were informed that the testing was voluntary and they could at any time choose to end the testing. They were given 15 minutes to try the application, with the same tasks as the previous iterations, namely:

- Check out your profile and look through the available rewards
  - o Find two rewards you wish to get
  - o Earn these rewards
- Play until you earn 100% correct on a quiz

After they completed the test session, they were asked a set of questions aimed towards answering our research questions, opposed to earlier iterations focusing more on functionality and appearance;

- How did you like the application?
- Do you have any experience with gamification?
- What do you think of the trophies?
- Do you see any value in having a personal user profile that grows as you take tests?
- Is there anything in specific you liked about the prototype?
- Is there anything you feel is missing from the prototype, or if there is anything you would've liked to see?
- Would you download it if it was released?
  - o Why not?
- Anything else you would like to add?

After they finished answering the questions, the participant were debriefed where they got to talk about anything on their mind, before thanking them for their contribution and ending the session.

Over these two days a total of 12 guerrilla testing sessions were held. The test subjects that agreed to participate were – or rather perceived to be – between the ages 16 to 30 and did not

seem to have any trouble with the technologies at hand. Out of these 12 sessions, one withdrew their participation, leaving a total of 11 test sessions from which to draw feedback:

- Two respondents got lost in the navigation after completing a quiz, specifically in the result screen.
- One respondent did not understand that the trophies were clickable, and therefore did not know how to earn them, as they couldn't see the description.
- Three users did not respond to the trophies at all and played it like they weren't there.
  - o One participant responded they did not appreciate the trophies and thought they were just in the way.
  - o The rest of the responders liked earning trophies.
- 8 out of the 11 respondents reported that they would try the application out, if it was released. 2 out of the 3 that said they would not use it said they preferred learning from the book. The last person that said no did not offer a reason.
- One respondent reported that they would like to have a leveling system as well as the trophies.
- 6 of the respondents wanted to take another quiz after earning their 2 trophies as per the task description, because they had another trophy they wanted to get.
- Three participants said they liked the color choices, while one participant said they would have liked the theme to be red and green, the remaining participants did not touch on the subject.

As presented by the feedback above, the overall view on gamification and the prototype was positive, with the exception of a few that did not see a positive side of gamification. Seeing how two participants got lost in the navigation and one didn't realize the trophies were clickable, further work is required upon the user interface as well. Shading the trophies to make them follow the material design guideline of shading clickable widgets could be tested, but there is a risk of clouding the clarity of the profile and more research is required to reach a solution. The current design for the result tab is to have the navigation on top, as it does not offer navigation between the top-level main pages of the application, however, as it is causing issues with users, it should be considered adding the bottom navigation bar to results as well.

Three users did not seem to react to the gamification at all, and played as though it wasn't there, but this was a possibility planned for, and as described in chapter 5 – establishing

requirements, it was with intention that the gamified design was such that the application could be used without engaging with the gamified elements.

7 out of the 11 participants responded positively towards the trophies and liked the idea of earning more than a pass/fail after finishing a test. 3 out of these 7 made a big deal out of the icons and showed that they enjoyed the playful design that went into them.

8 out of 11 said they would download and try out the application if it was released, which supports the finding that 7 out of 11 liked the gamification elements in the trophies. It was one of the participants that ignored the gamified elements that were the 8<sup>th</sup> person that wanted to download it.

It was interesting that one of the participants mentioned they wanted a leveling system as well, as that is something that has been identified as a possibility to go forward with in a future iteration.

### **Evaluation quality control**

As described in chapter 4 – methodology and research strategy, when dealing with qualitative data that is going to be analyzed by the researchers, it's important to keep an open mind and not influence the findings (Sharp et al., 2011, p355). To ensure the research has adequately measured what it set out to measure and enable the research questions to be answered, the questions asked by Rogers et.al., (2011) will be addressed:

- *Reliability*
  - The Guerrilla method for testing is of medium reliability, in that another researcher following the same procedure should get similar results. An attempt was made to increase the reliability by having specific instructions which distances the individual researcher from the outcome. I am satisfied another researcher following the same instructions under the same circumstances would get similar enough results.
- *Validity*
  - I feel that validity is supported by our choice of methods. Due to our earlier iterations where an attempt to remove usability errors and increase the intuitiveness of the system was made, before showing the application to - and testing it with - real students actively engaged in obtaining their driver's license, I feel I was able to obtain the information I was searching for. I feel

the data gathered was valid data in terms of usefulness for the post-testing analysis and that it has helped us reach a valuable conclusion.

- *Bias*

- Admittedly I am biased towards the prototype due to the work that has gone into developing it and the motivation for the research itself. However, by standardizing the evaluation method and asking questions meant to invoke a positive response, open up for a negative response, and open ended questions that the test subjects can take where they want, I feel that I have distanced myself from the evaluation as much as possible. Due to the use of the Guerrilla method that instructs one to approach everyone one can, I feel that I have successfully removed selection bias as well. The only remaining risk of bias is that of the test subjects themselves, as they are in the user group, they could be biased towards the domain. However, I do not feel this has influenced the research.

- *Scope*

- Especially thanks to the driving instructor going above and beyond to supply the test subjects, I feel the scope with the sample group adequately represent the real life user group of our prototype, and since the focus is on the elements of gamification, and not the drivers ed theory per say, I feel the results can be extrapolated to other domains of learning as well.

- *Ecological validity*

- The research is subject to be skewed by ecological validity. Specifically since all the testing is conducted in a controlled environment with software and the test subjects right there, meaning they know they are being watched and analyzed, so the research is subject to the Hawthorne effect (Sharp et al., 2011).

This chapter has presented the findings through the evaluations and discussed the results. The findings have been analyzed and discussed, and given value, and necessary changes have been proposed.



## Chapter 8 – Reflection and Conclusion

This chapter will conclude the thesis with a summary of findings, reflection on research, discussion on the limitations of the study, and finally a presentation of possible future research on the topic.

### Research questions

To answer these questions a series of methods were used. A literature review with focus on existing methods to develop and evaluate the prototype, as well as discover today's framework for developing gamified applications. An iterative development phase to obtain a prototype good enough to yield valuable data from the end users in our domain was executed. And finally a guerrilla testing phase with the prototype.

The literature review helped uncover several different ways to utilize gamification, such as serious games, playful design and productivity games, as well as different ways of conducting our evaluation.

The iterations with development and testing allowed the prototype to reach the desired quality before meeting the prospective drivers, and rather successfully – with the exception of the 3 users that ran into usability errors – were able to yield valuable data and help answer the following research questions:

#### **RQ 1 - Can elements from gamification make users more inclined to keep using an application?**

As presented in chapter 7 – evaluation and discussion, 7 out of the 11 students actively engaged in drivers' education that accepted to participate in the guerrilla user testing responded positively towards gamification during the testing. These 7, in addition to an 8<sup>th</sup> participant, also reported that they would download and try out the application if we released it. These are strong results that show that users would enjoy the rewards from gamification, and play more to earn more rewards.

However, I believe that this finding could potentially be skewed by the Hawthorne Effect presented in chapter 4 – methodology and research strategy, and due to the researchers position as students, the participants may be over-reporting on their willingness to use the application.

**RQ2 - How can gamification offer more engaging interaction in an application?**

While with RQ1 the aim was to look at user retention and whether the users would continue using an application due to its gamified elements, research question #2 focuses more on the enjoyment in the moment.

It was interesting to see how well the prototype was received. As mentioned in chapter 7 – evaluation and reflection, under findings of the final iteration that as many as 6 out of 11 testers wanted to take another quiz to earn another trophy they wanted, after completing the task of earning 2 trophies. Thus it seems that gamification used with the playful design and the use of rewards increases the enjoyment of our prototype.

However, due to the limitations in InVision’s story based prototyping tool that does not allow one to deploy the prototype and let it grow with users over time, the research fails to answer for how long the charm of gamification lasts.

**Future research**

Gamification as a field of research is still relatively young, and will continue to grow in the coming years. One sees more and more companies and organizations adopt the mentality of promoting fun learning and fun work in everyday tasks. While this thesis focuses on drivers’ education specifically, the results can be extrapolated to other domains with further research. The results from the research show that people like gamification, but this research on its own is not sufficient to answer the big questions in gamification; “How does it work?”, “How well can it work?” and “How to utilize it?” thus, further research is required.

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## Appendix A - Consent Form

I agree to participate in the study conducted by the Nicolai Gulbrandsøy, as part of a Master's thesis at the University of Bergen.

I understand that participation in this study is voluntary and I agree to immediately raise any concerns or areas of discomfort during the session with the study administrator.

Please sign below to indicate that you have read and you understand the information on this form and that any questions you might have about the session have been answered.

**Date:** \_\_\_\_\_

**Please print your name:** \_\_\_\_\_

**Please sign your name:** \_\_\_\_\_

**Thank you!**

We appreciate your participation.



## Appendix B – Interview guide

### Effects of gamification

#### **Kort om prosjektet:**

Det skal utvikles en mobil webapplikasjon som et hjelpemiddel for å øve på trafikkteorien på vei mot sertifikatet. Applikasjonen skal bygges på et prinsipp som heter spillifisering. Dette handler om å ta spillelementer inn i noe som ikke er spillrelatert, noe som har en kjent effekt på motivasjonen til brukerne. Formålet med forskningen er å bedømme hvorvidt spillifisering har en plass i en læringskontekst. Denne type forskning har stort potensial for fremdriften innen teknologi i opplæring, helt fra barneskole og opp til profesjonell yrkesopplæring.

#### **Deres deltagelse i prosjektet:**

Intervjuet vil bli anonymisert og data behandlet konfidensielt. Det skal ikke deles og skal kun benyttes i forskningssammenheng. Dere er å se på som eksperter på fagfeltet og dermed den beste kilden til informasjon om hvordan trafikkopplæring fungerer i Bergen.

Forbehold om at noen av disse spørsmålene kan være vanskelig for deg som kjørelærer å svare på, men forsøk å gi ditt beste inntrykk. Du står fritt til å hoppe over spørsmål hvis du ikke ønsker å svare.

#### Generelt om opplæring

1. Til hvilken grad er dere involvert i teoriopplæringen?
  - a. Hvordan fungerer teoriprosessen ved deres kjøreskole?
    - i. Lengde i dager/uker/kurs, timer per sesjon m.m.
  - b. Gir dere ekstra kurs til de som ønsker det, eller tilbys det kun obligatoriske kurs?
  - c. Hvor lang tid bruker en gjennomsnittlig student på å innhente den nødvendige trafikkteorien før en teoriprøve?
2. Har dere et anslag på hvor mange forsøk den gjennomsnittlige studenten trenger for å bestå teoriprøven?
3. Hvilke områder sliter studentene mest med ift trafikkteori?
  - a. Skilt, generelle regler(som høyreregel og forkjørsrett), spesielle regler ift forskjellige kjøretøy eller bremselengder.
4. Hvilke områder finner studentene enklest?
5. Hvilke aldersgrupper ser dere og hvilke er mest representert?
  - a. Ser dere noen kjønnsinndelinger?
    - i. Både ift kurstagere og suksessrater på teorien
6. Opplever dere at folk gir opp/tar en pause fra trafikkopplæring etter å stryke på teoriprøven?
7. Av de som stryker på selve oppkjøringen, vet dere noe om årsakene til dette? Skyldes det nervøsitet, lite fokus, eller mangel på kunnskap både praktisk og teoretisk?
8. Annet de ønsker legge til om deres rutiner eller generelt om studentene og teoriprøven?

## Spesifikt om læringstjenester

1. Fra 2000 til 2014 rapporterer Statens Vegvesen en økning fra 36% til 59% bestått ved første forsøk på teoriprøven. Hva tror dere skyldes denne økningen?
  - a. Tror dere denne økningen skyldes at studentene blir flinkere i teorikunnskapene sine, eller kan det være andre ting som påvirker denne statistikken?
2. Hva slags tjenester vet dere om til å hjelpe studenter lære trafikkteori?
  - a. Foreslår/anbefaler dere noen slike tjenester? Om så, hvilke?
  - b. Vet du hvilke som er mest benyttet?
3. Vet dere om noen mangler eller begrensninger ved denne typen tjenester?
4. Ser dere noen positive sider ved denne typen hjelpemidler?
5. Ser dere noen negative sider ved denne typen hjelpemidler?
  - a. Et av punktene jeg ønsker se på i denne forskningen er om disse tilgjengelige prøvene går for fort frem, og ikke tilstrekkelig forteller studentene hvorfor et svar er korrekt og et annet er feil. Og at studentene dermed ikke egentlig lærer seg den nødvendige kunnskapen, selv om de kan svaret. Hva tenker du om dette?
6. Annet de ønsker legge til om hjelpemidler til trafikkopplæring?

Er det i orden om jeg kontakter deg senere per epost hvis det skulle komme opp noen oppfølgelsesspørsmål?

E-post:

I siste del av prosjektet har vi behov for studenter som skal ta sertifikatet til å teste applikasjonen. Er det i orden om jeg kontakter dere i den sammenheng i håp om å komme i kontakt med ekte studenter? Dette vil bli i februar/mars.



## Appendix C – Questions used in prototype

### Spørsmålene fra Vegvesen.no

#### **Trofe 7**

Spørsmål 1 - Hvordan skal barn lavere enn 135 cm sikres i bilen?

**Svar alt.1 - I tilpasset barnesikringsutstyr**

Svar alt.2 - I baksetet med bare bilbelte

Svar alt.3 - På fanget til en voksen

Svar alt.4 - I forsetet med bilbelte

#### **Trofe 7**

Spørsmål 2 – Hvilket av disse krav stilles til øvingskjøring i klasse B?

Svar alt.1 – Ledsager må ha fullført eget kurs

Svar alt.2 – Det kan ikke være med passasjerer

**Svar alt.3 – Den som øvingskjører må ha med gyldig legitimasjon**

Svar alt.4 – Det er ikke tillatt å øvingskjøre med tilhenger

#### **Trofe 7**

Spørsmål 3 – Hva er riktig om krav til lys bak på bilen?

Svar alt.1 – Ryggelys skal være røde

Svar alt.2 – Det er ingen krav til bestemt farge

**Svar alt.3 – Baklys skal være røde**

Svar alt.4 – Baklys skal være hvite

Spørsmål 4 – Du skal svinge til venstre i et kryss. Hvilket møtende kjøretøy vil det være vanskeligst å vurdere avstanden til?

Svar alt.1 - Lastebil

Svar alt.2 - Varebil

**Svar alt.3 - Motorsykkel**

Svar alt.4 - Traktor

Spørsmål 5 – Du står i ro langs vegen i mørket for å vente på en passasjer. Hva er riktig bruk av lys?

**Svar alt.1 - Parkeringslys**

Svar alt.2 - Nærlys

Svar alt.3 - Tåkelys

Svar alt.4 - Kjørellys

### **Trofe 7**

Spørsmål 6 – Du får motorstopp på en trafikkert veg og må gå ut av bilen. Hva er riktig om bruk av refleksvest i slike situasjoner?

Svar alt.1 - Skal bare brukes når det er mørkt

Svar alt.2 - Brukes bare hvis det er trafikk på vegen

Svar alt.3 - Brukes dersom jeg føler meg utrygg

**Svar alt.4 - Skal alltid brukes**

### **Trofe 20 – Regulering av trafikk**

Spørsmål 7 – Hva sier trafikkreglene om høyeste tillatte fart etter at du har passert dette skiltet (Gatetun)

**Svar alt.1 - Gangfart**

Svar alt.2 – 30 km/t

Svar alt.3 - 40 km/t

Svar alt.4 - 50 km/t

### **Trofe 20 – Regulering av trafikk**

Spørsmål 8 – Du kjører på landeveg. Hva er høyeste tillatte hastighet etter dette skiltet? (60 sone opphører)

Svar alt.1 – 60 km/t

Svar alt.2 – 70 km/t

**Svar alt.3 – 80 km/t**

Svar alt.4 – 90 km/t

### **Trofe 20**

Spørsmål 9 – Hva betyr skiltet? (Enkel vei blir til tofelts)

Svar alt.1 – Felt A er for buss i rute.

Svar alt.2 – Felt B er felt for avkjøring.

**Svar alt.3 – Felt B er forbikjøringsfelt.**

Svar alt.4 – Felt A er for lastebiler over 3500kg.

### **Trofe 20**

Spørsmål 10 – Du skal kjøre rett frem i lyskrysset. Lyssignalet blinker gult. Hva sier reglene om vikeplikt?

Svar alt.1 - Jeg har vikeplikt for kryssende trafikk

**Svar alt.2 - Jeg har vikeplikt for trafikk fra høyre**

Svar alt.3 - Jeg har vikeplikt for trafikk fra venstre

Svar alt.4 - Jeg har ikke vikeplikt

Spørsmålene over er hentet fra <http://www.vegvesen.no/Forerkort/ta-forerkort/Teoripr%C3%B8vequiz>

Spørsmålene under er hentet fra Teoritentamen(Link nederst)

#### **Trofe 7**

Spørsmål 11 – Hva er minimumskravet til mønsterdybde for sommerdekk?

Svar alt.1 – Minimum 1 mm

**Svar alt.2 – Minimum 1,6 mm**

Svar alt.3 – Minimum 2 mm

Svar alt.4 – Minimum 2.6 mm

#### **Trofe 7**

Spørsmål 12 – Oppgaven handler om alkohol og bilkjøring. Ta stilling til påstandene.

Svar alt.1 – En bilfører med en alkoholkonsentrasjon i blodet på 0,3 promille kan ikke straffes.

Svar alt.2 – En bilfører er alltid påvirket av alkohol etter lovens bestemmelser dersom han har alkohol i blodet

**Svar alt.3 - Ved over 0,2 promille regnes du alltid som påvirket**

Svar alt.4 - Ved promillekjøring blir førerkortet inndratt i minst 2 år

Spørsmål 13 – Du møter en annen bil i mørket. Når skal du skifte til nærlys?

**Svar alt.1 - Når avstanden er 200 - 300 meter.**

Svar alt.2 - Straks jeg ser at jeg møter den andre bilen.

Svar alt.3 - Når møtende bil skifter til nærlys.

Svar alt.4 - Når avstanden er 400 - 500 meter.

Spørsmål 14 – Du kjører i 20 km/t og bremses maksimalt. Det er litt glatt, og bremselengden blir 5 meter. Hva ville bremselengden blitt om farten hadde vært 80 km/t på samme føret?

Svar alt.1 – 20 meter

Svar alt.2 – 40 meter

Svar alt.3 – 60 meter

**Svar alt.4 – 80 meter**

Spørsmål 15 – Hva menes med fartsblindhet?

Svar alt.1 - Føreren klarer ikke å vurdere hvilken hastighet møtende trafikk har

**Svar alt.2 - Føreren har problemer med å vurdere egen hastighet; fartsmåler er nødvendig som hjelpemiddel**

Svar alt.3 - Føreren klarer ikke å vurdere hvilken hastighet kryssende trafikk har

Svar alt.4 - Føreren klarer ikke å vurdere hvilken hastighet trafikken bak har

Spørsmål 16 – Hva er riktig om mobiltelefonbruk i bil?

Svar alt.1 – Hverken passasjerer eller sjåfør har lov til å benytte mobiltelefon i bil

**Svar alt.2 – Som sjåfør har du lov til å snakke i telefon så lenge mobilen er håndfri eller plassert i holder.**

Svar alt.3 – Som sjåfør har du ikke lov til å benytte mobiltelefon i bil.

Svar alt.4 – Det er kun yrkessjåfører som har lov til å benytte mobiltelefon i bil.

### Trofe 20

Spørsmål 17 – På hvilken side av dette skiltet skal du kjøre? (P-skilt med streker som senkes mot høyre)

**Svar alt.1 – På høyre side.**

Svar alt.2 – På venstre side.

Svar alt.3 – Det er ingenting som tilsier at jeg skal passere dette skiltet på noen bestemt side.

Svar alt.4 – Det er valgfritt om jeg vil passere

### Trofe 20

Spørsmål 18 – Hva betyr dette skiltet? (Tvungen feltskifte m/ vikeplikt)

Svar alt.1 – Kjørende er på vei med sammenfletting og det er gjensidig vikeplikt

Svar alt.2 – Kjørende som er i høyre felt kommer til et fartsøkningfelt

Svar alt.3 – Kjørende i felt som slutter skal skifte felt og regler om fletting gjelder ved feltskifte

**Svar alt.4 – Kjørende i felt som slutter skal skifte felt og har vikeplikt ved feltskifte på høyre eller venstre side**

### Trofe 20

Spørsmål 19 – Hva er riktig om dette skiltet? (Fartssone 110)

Svar alt.1 – Dette er vanlig hastighet utenfor tettbygd strøk.

Svar alt.2 – Dette skiltet benyttes på de fleste motorveier i Norge.

Svar alt.3 – Dette skal benyttes i Sverige og Danmark, men ikke i Norge.

**Svar alt.4 – Dette skiltet viser særskilt fartsgrense og brukes bare på noen få veistrekninger.**

Spørsmål 20 – Kan du parkere i busslommen på høyre side?

Svar alt. 1 – Ja dersom det er plass til bussen

**Svar alt. 2 – Nei**

Svar alt. 3 – Ja, dersom du bare skal parkere noen få minutter

Svar alt. 4 – Ja, dersom du er på forkjørsvei

Spørsmål 21 – Denne skiltekombinasjonen betyr at...

Svar alt. 1 – at forbudet gjelder fra skiltet og til nærmeste kryss.

**Svar alt. 2 – at forbudet gjelder før skiltet.**

Svar alt. 3 – at du kan parkere foran skiltet.

Svar alt. 4 – at du ikke kan parkere etter skiltet.

Disse er hentet fra <https://teoritentamen.no/teoriproven-for-bil/> 18.04.2017

## Spørsmålene under er hentet fra bil-teori.no

### Trofe 20 – Regulering av trafikk

Spørsmål 22 – Hva betyr skiltet? (Forkjørsvei)

Svar alt. 1 – At man har vikeplikt for høyre.

Svar alt. 2 – At man kjører på en motorvei.

Svar alt. 3 – At fartsgrensen er 60 km/t.

**Svar alt. 4 – At man kjører på en forkjørsvei.**

### Trofe 20 – Regulering av trafikk

Spørsmål 23 – Hva betyr skiltet? (Innkjøring forbudt)

Svar alt. 1 – Smal vei

**Svar alt. 2 – Innkjøring forbudt**

Svar alt. 3 – Parkering forbudt

Svar alt. 4 – Stopp forbudt

### Trofe 20 – Regulering av trafikk

Spørsmål 24 – Hvilken skiltgruppe tilhører dette skiltet? (Forbudsskilt, 12 tonn)

**Svar alt. 1 – Forbudsskilt.**

Svar alt. 2 – Fareskilt.

Svar alt. 3 – Opplysningsskilt.

Svar alt. 4 – Påbudsskilt.

Spørsmål 25 – Hvilken rekkefølge er riktig når man er førstemann til ulykkestedet?

Svar alt. 1 – Redde – ringe – kjøre.

Svar alt. 2 – Ringe – sikre – redde.

**Svar alt. 3 – Sikre – varsle – redde.**

Svar alt. 4 – Varsle – redde – sikre

Spørsmål 26 – Hva betyr stiplede kantlinjer på begge sider av veien?

**Svar alt. 1 – At veien har toveis trafikk, men at den er smal**

Svar alt. 2 – At veien er fylkesvei

Svar alt. 3 – At veien ikke tåler et akseltrykk på mer enn 2 tonn

Svar alt. 4 – At det er en privat vei

Spørsmål 27 – Hvem har vikeplikt når man rygger?

Svar alt. 1 – De som kommer fra høyre

Svar alt. 2 – De som kommer fra venstre

**Svar alt. 3 – Den som rygger**

Svar alt. 4 – Både den som rygger, og de som kommer fra høyre

**Trofe 20 – Regulering av trafikk**

Spørsmål 28 – Har du vikeplikt for en syklist som kommer inn på veien fra en sykkelvei?

**Svar alt. 1 - Nei**

Svar alt. 2 – Ja, dersom du kjører på forkjørvei

Svar alt. 3 – Ja, dersom du ikke kjører på forkjørvei

Svar alt. 4 – Ja, Så lenge sykkelene befinner seg inne på selve kjørebanelen

Spørsmål 29 – Hvordan avregistrerer man en bil?

Svar alt. 1 – Man leverer inn vognkortet

**Svar alt. 2 – Man leverer inn bilskiltene (kjennemerkene)**

Svar alt. 3 – Man leverer inn bilens understellsnummer

Svar alt. 4 – Man sender en melding til den nærmeste trafikkstasjonen

**Trofe 20 – Regulering av trafikk**

Spørsmål 30 – Når har du vikeplikt for en buss som gir tegn til å kjøre ut fra en holdeplass?

Svar alt. 1 – Når fartsgrensen på veien er 70 km/t eller under

**Svar alt. 2 – Når fartsgrensen på veien er 60 km/t eller under**

Svar alt. 3 – Når du kjører på forkjørvei

Svar alt. 4 – Når du ikke kjører på forkjørvei

## Appendix D – Test guide - Norwegian

For å sikre at alle deltagerne får samme informasjon og starter med samme utgangspunkt til sammenligning har jeg valgt å gjennomføre brukertesten med et manus.

Hei, og takk for at du tar deg tid til å støtte prosjektet. Aller først vil jeg spørre om det er i orden at jeg tar opp lyd av brukertesten. Jeg ønsker også informere om at all deltagelse og kommunikasjon i prosjektet er anonymt for alle utenfor prosjektet, og blir slettet når prosjektperioden utløper.

Planen for brukertesten er først å gi deg informasjon om prosjektet, prototypen og formålet med prosjektet. Deretter skal du få utlevert noen oppgaver jeg ønsker du skal forsøke å løse i prototypen, før vi avslutter med et intervju. Det er løsningen som testes, og ikke deg. All feedback er konstruktiv feedback, så ikke bekymre deg for å gjøre noen feil eller si noe galt.

Formålet med prosjektet er å se på sammenhengen mellom motivasjon og læring, for så å se om vi kan forbedre motivasjonen ved å bygge tjenesten på et prinsipp som heter spillifisering. Spillifisering handler om å ta spillelementer inn i noe som ikke er et spill(eller som er ment som ren underholdning), som for eksempel med belønning, status, trofeer eller lignende.

Prototypen er en mobilapplikasjon som ligner på dagens quiz-tjenester, men som da er spillifisert. Prototypen er utarbeidet slik at du kun må igjennom 5 spørsmål før du ser resultater. På den måten kan vi holde fokus på det som skiller den fra andre tjenester. Prototypen inneholder 2 tester, og utfallet varierer på dine svar.

Når du løser oppgavene er det viktig for oss at du prøver å tenke høyt: si hva du ser på, hva du prøver å gjøre, og hva du tenker.

### Oppgaver (utlever kort med oppgavene på)

1. Sjekk ut profilen din og se igjennom tilgjengelige trofé.
2. Finn 2 troféer du har lyst på.
3. Skaff trofeene du ønsket deg.
4. Oppnå 100% på en prøve.
5. Logg ut.

Hvis du har noen spørsmål underveis må du bare spørre, men jeg vil ikke alltid kunne svare på dem med en gang ettersom vi er interessert i å se på hva folk gjør når de ikke har noen der som kan hjelpe dem.

Har du noen spørsmål før vi begynner?

### Intervju

1. Hvordan syns du oppgavene du fikk av meg gikk?
2. Hvordan syns du designet var?

3. Var det enkelt å finne frem?
4. Var det noe du likte godt?
5. Tror du trofeene hadde fått deg til å spille videre?
6. Hvordan var helhetsinntrykket ditt av prototypen?
7. Er det noe du kunne tenke deg å se i prototypen, eller noe du følte manglet?
8. Føler du noen gevinst av å ha en mer personlig profil hvor du opparbeider deg trofeer imotsetning til andre tjenester som bare viser resultater?
9. Har du noe annet du ønsker å legge til?

## De-briefing

Noter ned ting her du ønsker ta opp etter brukertesten