

Institutionen för teknik och naturvetenskap

Department of Science and Technology

Examensarbete

Digital Learning Designed for Entrepreneurial First-Time Smartphone Users

Examensarbete utfört i Medieteknik
vid Tekniska högskolan vid Linköpings universitet
av

Marcus Nygren

LiTH-ITN-EX--YY/NNNN--SE

Norrköping 2016



Linköpings universitet
TEKNISKA HÖGSKOLAN

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Abstract

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For service design, I want to thank Peter Gahnström at LiU Innovation, who led me to Expedition Mondial, and I especially want to thank Susanna for being a great tutor.

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N N och M M*

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1

Introduction

This chapter is the introduction to the master thesis report. An app for entrepreneurship coaches could, if successful, help coaches to assess and learn to become better with teaching entrepreneurship to youth.

There are both opportunities and challenges for mobile tools for rural areas of Uganda. While entrepreneurship activity is high, and mobile services are growing rapidly, the two fields have not yet been combined for entrepreneurial learning in a developing country context.

The non-profit YoungDrive teaches entrepreneurship to youth in developing countries, with coaches now educating youth in Plan International's project in Uganda, and an ongoing training pilot in Zambia. YoungDrive wants to see if an app can make the coaches even better, and if the data from the app can support monitoring and evaluation.

To answer this need, entrepreneurship education and digital education has been researched together with how to develop apps for web and mobile platforms simultaneously.

The introduction is concluded with related work within digital tools in developing countries, and doing digital assessment and mobile learning, before presenting the research questions.

The research questions takes into consideration both development, design, learning, usability and process, from a developing country context of developing a tool for entrepreneurship learning.

1.1 Purpose

In order for young ambitious entrepreneurs to build sustainable enterprises they need to have basic entrepreneurial skills. This is where a mobile learning platform comes into the picture.

1.1.1 An app for the entrepreneurship coaches

The entrepreneurship education YoungDrive is an initiative of Illiana Björling from YoungDrive, now collaboration with Plan International. Within the project A working future, they have educated, supported and inspired 12 000 Ugandan youth in the process of starting their own businesses. [Nissar, 2016]

YoungDrive now requests two digital modules, to reach even better results and to be able to scale up the operations to more locations with confidence.

The overall aim of the master thesis is to do a Minimum Viable Product (MVP) of a entrepreneurship coach training app. The master thesis is about how to design an app for entrepreneurship education, including evaluating it's effectiveness towards the coaches.

The result is an app which the coaches use during and after the coach training.

1.1.2 Definition of success for the app

By training coaches that can carry out the education in larger groups of entrepreneurs, the education reach many young people at the same time. A mobile learning platform is predicted to improve the effect of the training even more, by fulfilling the following purposes:

- Validate the coaches' level of knowledge during their education
- Train the coaches on distance
- Certify all staff

YoungDrive's experience goal for the app is "It should be easy to understand, pedagogical and enjoyable to use, and the coaches should think it is fun and meaningful to learn via the app". [Björling and Lönn, 2016]

1.2 Theoretical Background

To understand how to reach the objectives of the project, this chapter presents background and relevant theories.

Part 1-2 deals with the design situation, part 3-4 gives introductions to relevant topics, and part 5 presents related work.

Part 1-2: Design situation

For design situation, the client context is described. This also includes a motivation for digital learning, and related work to the thesis.

The first section describes the opportunities for entrepreneurship in Uganda, followed by how Plan International and YoungDrive uses this to tackle child poverty by fostering and educating youth in starting their own businesses. This section concludes by how digital learning and digital tools becomes increasingly demanded, which is why this master thesis has emerged.

Part 3-4: Relevant topics

In this section, an introduction is given into entrepreneurship education, digital education, and hybrid app development.

Part 5: Related work

In this section, first examples within digital tools are named that have either considered a developing country context.

Secondly, two studies within digital learning are named, which have combined learning theory and a mobile or computer platform.

1.2.1 Social Innovation and Social Entrepreneurship in Uganda

This section will present background on working with mobile learning platforms, and understanding the society of entrepreneurs in Uganda.

Why Uganda is the world's most entrepreneurial country

According to Nissar [Nissar, 2016], some facts related to entrepreneurship in Uganda are:

- Uganda is the world's most entrepreneurial country. (28% of the population are entrepreneurs)
- Uganda has the second youngest population in the world (77% of all Ugandans are below 30)
- Uganda has a very high unemployment rate (64 % of people between 18–30 are unemployed)

With a high unemployment rate and little or none social security, starting a business is for many young entrepreneurs simply a tool for survival. But tough conditions can also lead to creativity, and there are as well many innovative entrepreneurs with great ideas and the aim to create positive social impact.

As Mitchel says about entrepreneurship [Mitchell and Smith, 2007], the motivation of entrepreneurship does not need to be solely wealth accumulation anymore. The activity of entrepreneurship contributes to society, in a way that is not captured by the commercial entrepreneurship literature.

No matter the reason of starting a business, Uganda's many entrepreneurs are contributing to the national society by boosting the economy and creating new jobs.

Why mobile services are growing rapidly in Uganda

One of the reasons is that the country has invested heavily in communication networks, even connecting remote rural villages with fibre optic cables and thereby connecting them to a world of information.

As much as 65% of the adults in Uganda owns a cell phone, which has allowed many areas in the country to skip the landline stage of development and jump right to the digital age.

For those who hasn't electricity at home, there are plentiful of charging booths for mobiles all over the country.

Mobile services and social innovations

The wide use of mobile phones has lead the way for the development of several innovative mobile services and in many cases the mobile service are way ahead of us [Nissar, 2016]. In Sweden mobile banking services that allows us to transfer money through our mobile phones were made popular with Swish, introduced in 2012. In Kenya people have had similar services for the last 10 years.

1.2.2 The Client: YoungDrive

In this section, the project that the *client* YoungDrive is in is first described, and then how YoungDrive fit into the structure of the thesis with its entrepreneurship education program. In the last part, future plans of YoungDrive and A working future is presented, giving relevancy to the field of digital education.

The Project: A Working Future

Plan International works towards eliminating child poverty, and their project A working future, supported by SIDA since the year 2012 until 2016, tackles unemployment among youth in rural areas. The project runs for 12 000 youth in Kamuli and Tororo.

The Structure: Youth Savings Groups with Trainings

Because of high tuition fees, saving (financial literacy) and earning (practicing vocational skills) are central.

VSLA (Village Savings and Loan Associations) groups have existed for many years, where a group starts a village savings and loans group together. A democratic process makes the group independent of banks, which rates are in general high and which may not even borrow money, either because of long distances to the bank or of no previous financial history.

For Plan International, VSLA groups have been successful in several countries for a long time. However, while the groups were skilled with saving, they did not always spend the money in the most strategic way.

Plan's pilot with A working future, was to introduce trainings on top of the VSLA structure.

Where CBTs (Community Based Trainers) were previously only responsible for hosting the groups, now they were trained and tasked with carrying out different programs: like agriculture, financial literacy, and the most successful program to date, focusing on running own businesses, YoungDrive.

The Entrepreneurship Program: YoungDrive

YoungDrive is based on a Swedish concept, and had previously had a pilot in Botswana, when tasked with running the entrepreneurship module of A working future. The organization fosters and educates young entrepreneurs in developing countries. They train the CBT's, provide training material, and support the CBT's via direction and direct support through co-project leaders and Youth Mentors (YMs).

YoungDrive moves an entrepreneur to location, becoming country manager. Then, she educates project leaders during four days, followed by educating CBT's, which then roll out the training to the youth groups during 10 sessions, 1 session per week in average. The CBT's also rolls out other trainings, often simultaneously.

Future Plans

For the future of YoungDrive, they want to make the CBT's even better, and collect and take use of data (monitoring and evaluation). Another motivation is scaling and monetization, as Plan International wants to increase the project to more countries, with an increased digital focus, and YoungDrive wants to be independent of project funding (i.e. a social enterprise). This was a great time to introduce digital enablers, where there previously had been no technology-focus, especially towards CBT's and YM's. The master thesis is the first project which focuses on digital enablers for YoungDrive.

1.2.3 Entrepreneurship education

Entrepreneurship education has been a growing field of investigation over the last three decades. While Dickson [Dickson and Weaver, 2008] says there are few empirical studies available, examples include among others Kuratko [Kuratko, 2005], Pittaway [Pittaway and Cope, 2007] and Bae [Bae and Fiet, 2014].

Especially relevant for this work is the recent interest in interventions for teaching and learning entrepreneurship in the developing world: [Oviawe, 2010] [Iakovleva and Stehphan, 2011]

First, Oviawe [Oviawe, 2010] conclude by how teaching of creativity and problem-solving skills seems to be especially beneficial for entrepreneurship in developed countries. In YoungDrive, the youth are tasked with starting their own business from no capital, which fosters creativity and problem-solving skills.

Further, Iakovleva [Iakovleva and Stehphan, 2011] indicated that respondents from developing countries do have stronger entrepreneurial intentions than those from developed countries. This stems from attitudes, subjective norms, and perceived behavioural control. Their encouragement, is that developing countries need to focus on the development of institutions that can support entrepreneurial efforts. YoungDrive is one such example.

Ruskovaara et al. [Ruskovaara and Pihkala, 2015] concludes, that the teacher seems to be the main factor for entrepreneurship education, and that research agrees with them. There seems to be no indication of difference between men

and women, nor previous professional teaching experience. They could find that entrepreneurial activity seems to lead to better entrepreneurship education. Dickson's recommendations for enhancing entrepreneurship education practices were mainly two things. First, the playful side of teaching and learning is mentioned. Secondly, they encourage teacher training that develops the competences as a mentor, enabler or coach. [Dickson and Weaver, 2008]

1.2.4 Digital Education

In recent times, e-learning has had a tremendous impact both outside and inside the classroom. With a growing teacher interest, research so far shows that digital education is hard, risky and possibly rewarding. [Luckin and Noss, 2012] Thus, digital education shows both great potential and great considerations.

Brining research into reality

Clark [Clark, 2014] has done a comprehensive study, which motivates why a digital tool or game is a good thing by showing a .33 standard deviations in intrapersonal learning outcomes, relative to non-game instructional conditions. They also conclude, that design rather than medium alone predicts learning outcomes.

Much of the research to date on digital games has focused on proof-of-concept studies and media comparisons. The study's encouragement, is to focus on how theoretically-driven decisions influence learning outcomes: for the broad diversity of learners, within and beyond the classroom. Literature that have looked at mobile apps for learning specifically, are Godwin-Jones [Godwin-Jones, 2011] and Page [Page, 2013].

E-assessment

There are numerous examples of developments in e-assessment using mobile environments, as well as immersive environments and social and collaborative environments.

Interest in formative e-assessment is increasing. A large amount of development has taken place on diagnostic testing environments, that allow teachers and learners to assess present performance against prior performance. [Luckin and Noss, 2012] For example, it has been shown that multiple-choice tests in e-assessment can be used to good effect [Nicol, 2007].

Luckin says that further consideration should be given to how technology can be used to enable the assessment of knowledge and skills not usually distinguished within current curricula. [Luckin and Noss, 2012] One such example would be entrepreneurship.

1.2.5 Hybrid App Development

The history of app and web development is rich and increasingly intertwined. First, websites were developed for desktop only, and when smartphones became popular, they were made responsive.

With today's possibilities of native mobile development or developing a native app using web technologies, there are numerous viable alternatives available if an app should function on several devices, depending on budget and preferences.

One of the main argument for developing an app in web technologies, is that the whole application, including the server, can be written in one programming language, JavaScript (full-stack).

Tools such as Apache Cordova can compile JavaScript applications into native apps. Thus, they can appear on Apple iOS and Android Play Store, as well as on the web, or installable offline on a smartphone from the computer.

JavaScript is developing rapidly as a language, as well as its ecosystem of frameworks and tools. Frameworks have emerged and matured, like Meteor.js, which makes building full-stack applications in JavaScript reliable and fast.

Previously, web hosting has been troublesome for JavaScript server applications. Today, tools such as Meteor.js and Heroku have introduced free and paid hosting for such applications, with smart bindings to code platforms such as GitHub, which makes collaboration and version handling easy.

1.2.6 Related work

Related work is presented in two parts: apps that have considered their development country context well, and previous apps that have been made for learning via assessment.

Digital tools in a developing world context

One great example of a mobile banking service that is a true social innovation is Ledger Link, developed by Grameen Foundation in collaboration with Barclays Bank. This mobile banking service empowers saving groups in rural areas to save money. It is developed with human centered design methods, and has won several awards. [Nissar, 2016]

The educational app platform iSchool, developed by iSchool Zambia, has been praised and made popular as it was designed to fit the Zambia school curriculum to the point, accessible as a home edition, pupil edition and teacher edition.

Digital assessment and mobile learning

Two studies within electronic assessment (e-assessment) or mobile learning (m-learning) have been done that this master thesis is inspired by. One uses deliberate practices on a mobile learning environment [Yengin and Uzanboylu, 2012]. The other focused on and further validated the research of various experimental studies, that multiple-choice can be a viable auto-assessment method to improving student learning, especially for m-learning [de Marcos and Otón, 2010].

1.3 Research Questions

The overall aim of the study is to create and apply a design process of an application for entrepreneurial learning, to be implemented in a developing country context.

In response, the following specific research questions were raised:

1. How is the development affected by the technical possibilities?
 - Limitation
2. How is the design affected by the contextual constraints, e.g. young entrepreneurs, entrepreneurship education, and culture?
 - The app will be a compliment to the physical YoungDrive training, not a replacement.
3. How can test questions be developed to support entrepreneurship learning?
 - Solely existing YoungDrive teaching material will tested using the app, not new material, or other entrepreneurship programs.
4. How does design affect usability and learning done via the app?
 - Ideally, the master thesis would include measuring how app usage affected their youth session quality, measured by the coach, the youth, and co-project leaders.
If this would have been the case, there could have been three different control groups: A, using the app and the YoungDrive training, B, using only the YoungDrive training, and C, using only the app.
5. How can users' feedback be used to inform modifications of the app?

- Limitation

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2

Methods and Implementation

This chapter presents the methodological framework, via presenting methods to design for learning and motivation.

Then, the setting and research context is described, together with a description of the participants.

Then, application implementation is described, followed by presenting the study design and data collection.

The final topic is data analysis theory, which presents methods to analyse quantitative and qualitative data.

2.1 Methodological Framework

In the methodological framework, useful methods design for learning and motivation are presented, together with methods for creating a design process and data analysis.

2.1.1 Design for Learning

The following sections, are about how to design for effective learning [Dirksen, 2012], by designing for the mind, cognitive psychology.

Cognitive psychology deals with how our brain works in regards to our memory.

The section presents strategies and techniques to design learning for the mind, and what needs to be considered.

Two aspects are especially relevant when it comes to education: how humans can be supported to retaining (the first section) and retrieving (the second section) communicated information.

In how humans learn, the purpose is to find the most powerful strategies and techniques to design effective learning (mapping educational objectives, how to build skills, pattern-matching techniques, and the power of reflection and assessing).

In how people forget, UCLA Bjork's Learning and Forgetting Lab [Bjork, 2016] researches how people forget, and how to design so that people do not forget (retrieval practice and spaced practice).

Learning Entrepreneurship: Mapping Educational Objectives with Bloom's Revised Taxonomy

What to teach should be determined by the learning objectives of the activity.

Konrad:
specify Learning activities often involve both lower order and higher order thinking skills as well as a mix of concrete and abstract knowledge. This needs to be designed for. Here, Bloom's revised taxonomy can provide usable insight into how to design, by the combination between lower or higher cognitive complexity, and concrete (factual or conceptual) or abstract knowledge (procedural or metacognitive). [Cheong and Cheong, 2012] The taxonomy thus provides a framework for determining and clarifying learning objectives. See figure 2.1 from [Heer, 2012]. Each colored block is an example of a learning objective matching with the two dimensions. The figure also explains the different concepts. Depending on the objective, it fits differently into the Knowledge dimension and Cognitive Process dimension of Bloom's Revised Taxonomy. [Krathwohl, 2002]

Bloom's revised taxonomy can be useful both to map learning objectives for entrepreneurship and as an entrepreneurship coach. To craft good multiple-choice questions could be an art, but to map the question to the learning objective makes it into more of a science:

Entrepreneurship topic question: "What is financial literacy?" (= *conceptual* and *remember*)

To simulate a procedural environment, the question can be presented as a scenario:

Entrepreneurship coach question: "It turns out that 10 youth have not carried out the business action, what should you do?" (= *metacognitive* and *evaluating*)

There are several traps that the person formulating the question and answer alternatives can fall into, in the case of multiple-choice, where a good question might be de-amplified because of the answer alternatives.

Consider the coach being asked to give business advice to a fictional youth named Adam: "Adam wants to start a business that is based on a product. which business should he start?". Before, the coach has been given questions on what a service and product is (factual remember), what the difference is (factual understand), and been given examples (conceptual analyze). Now, the skills are being put to a procedural test.

If the answer alternatives are obvious (or memorized), the learning will be lower than scoring high on Bloom's revised taxonomy.

If the answers are high-quality alternatives, all of the answers must be evaluated and considered. In such cases, multiple-choice learning can actually amplify

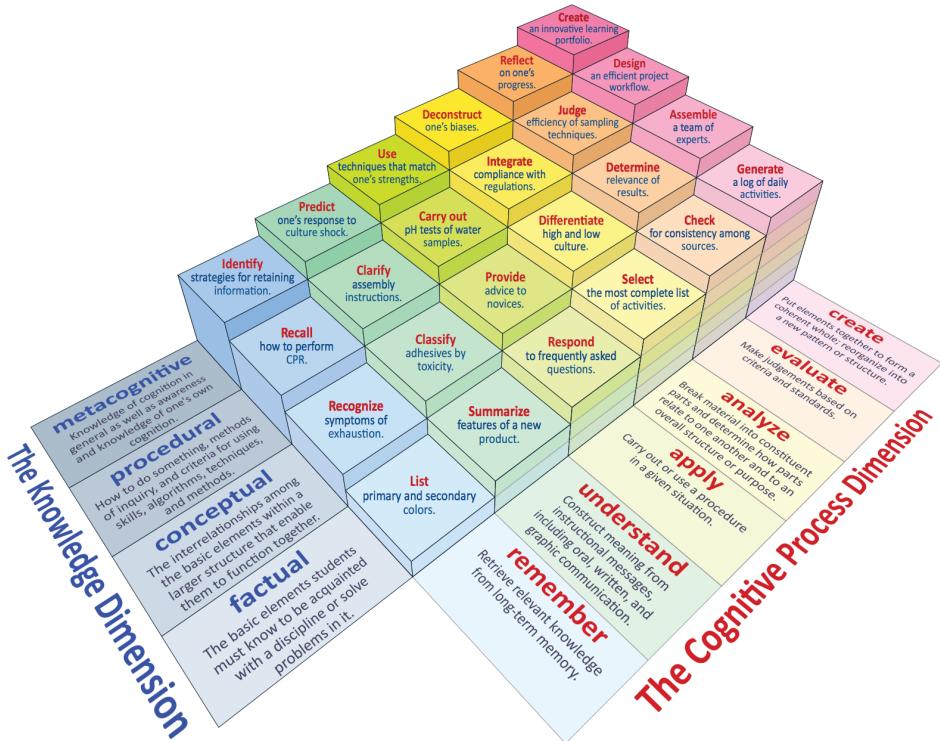


Figure 2.1: Bloom's revised taxonomy visualised with examples of different learning objectives.

learning, via *learning by repetition* or *learning by thinking*.

In this case 3-4 valid alternatives might be: "Start a salon", "Start selling soap", "Start a bricklaying business".

It is still hard to score high on the knowledge and cognitive dimension using techniques such as multiple-choice with entrepreneurship and coaching. This is however necessary, if the app should reach the learning objectives of YoungDrive.

There may need to be additions to the multiple-choice design, and not only content. Such design ideas may be utilizing flip card techniques (don't see answer alternatives until you've thought of your answer), or asking "How sure are you?", both encouraging metacognitive thinking.

More ambitious ideas, would be to simulate the entrepreneur coach environment more accurately than via text (using more channels, like audio, video, voice), or to do simulations instead of using multiple-choice. The advantage of multiple-choice, is that data can be collected easily, and that it serves the target group of first-time smartphone users, and because of ease of implementation.

Building skills: by Spaced practice, Deliberate practice and Perceptual exposure

Spaced practice deals with spreading out learning, with the purpose of not forgetting. E.g. Clark [Clark, 2014] concludes that spaced learning versus massed learning (no rest between sessions) did have a memory benefit in their study.

Taking spaced learning into consideration, could mean making the user apparent on the person's meta-cognitive ability (your personal insight of what you'll remember and when you are likely to forget), and meta-memory (when you need to repeat information in order not to forget).

Clark [Clark, 2014] found no evidence of consistent correlation between total duration and effects on learning outcomes in their study. So how do you design for optimal learning outcomes of skills, particularly if those are entrepreneurial or coaching skills?

When building skills, Sierra suggests deliberate practice [Yengin and Uzanboylu, 2012] [Sierra, 2015]. The goal is to help users practice right, by designing practice exercises that will take a fine-grained task from unreliable to 95% reliability, within one to three 45-90-minute sessions.

Deliberate practice has been proven to be an effective way to build skills. It has also been tested before for mobile learning environments. [Yengin and Uzanboylu, 2012]

Sierra [Sierra, 2015] suggests skills to be divided into three buckets: can't do (but need to do), can do with effort, and mastered (reliable/automatic). The goal then is to move skills from can't do into mastered, in the best way possible. See figure 2.3 from Sierra [Sierra, 2015]. Sierra says, if you can't get the user to 95% reliability within this time, stop trying; you need to redesign the sub-skill. [Sierra, 2015]

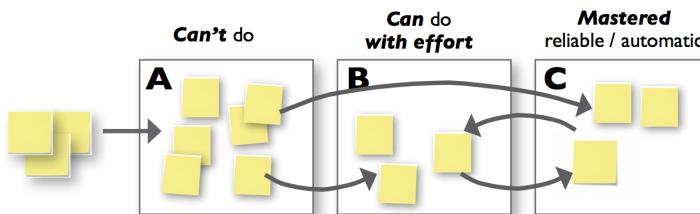


Figure 2.2: Moving skills from A (Can't do) to B (Can do with effort) into C (Mastered) can move different ways, depending on how effective the learning is. Deliberate practices focuses on A-B-C, while perceptual expose enables A to C. Reflection allows knowledge to go backwards, to get better at the skill than previously possible. An example might be to teach "Financial literacy". Concepts and factual knowledge (like what income and profit is) might need to move A-B-C, whereas entrepreneurship skills (like taking financial decisions) can move A-C if it becomes intuitive for the user, e.g. via having been exposed to a lot of trial-and-error examples in the app.

Desirable difficulties applies here, meaning that during deliberate practice, it may feel as if learning gets more and more difficult, but in the long term the user is actually learning more. As a result, less people does true deliberate practice, but they do not get the same reward in return. This needs to be designed for, e.g. using social psychology.

By deliberate practice, you can practice better. The second attribute of those who became experts, were that they were exposed to high quality, high quantity examples of expertise. [Sierra, 2015]

It shows that whenever a skill relies on intuition, we could try exposing the user a well-designed trial and error test. In the case of multiple-choice questions, this could be done by exposing users to very high-quality samples during a very limited time. Perceptual knowledge includes teaching what we think of as expert intuition (like being a good entrepreneurship coach).

Sierra shows how researchers have repeatedly, by well designed tests, been able to quickly build expertise by trial-and-error feedback. A novice would hazard a guess and an expert would say yes or no. Eventually the novices became, like their mentors, masters of the expertise that could otherwise would have been intangible for long.

Learning from Assessment

Knowing what learners know, and don't know, is crucial to effective learning, Luckin [Luckin and Noss, 2012] says.

Assessment can partly help to design for flow, matching challenge and ability [Brühlmann, 2013], which is effective for intrinsic motivation (see next chapter).

Moreover, it also has cognitive benefits. It can help to offer appropriate feedback, increase learners' awareness of their learning needs, and give accurate assessment and analysis, and allows learning to be tailored.

By recognizing differences of students, in their ability to understand what they know and how they can progress, it is possible to ensure that everyone achieves their full potential.

Effective assessment by a teacher or agent includes individual feedback (task-oriented and informal) and appropriate feed-forward advice. Sitzmann Sitzmann and Kanar [2008] has studied how questions used to prompt self-monitoring and self-evaluation benefit learning, showing gradual, positive effect on learning. Regarding multiple-choice tests, Nicol Nicol [2007] gives seven principles of good feedback practice, see figure ??.

Moreover, research on fixed mindset (I can't do X) versus growth mindset (I can't do X yet) talks about how mindset guides behaviour. In a math game with Dweck's research ? as a base, students were rewarded by the mentality of "Not yet" and effort versus getting a grade on existing knowledge. Regarding learning, those exposed to a growth mindset mentality, previously having a fixed mindset, got superior results, especially those students previously having difficulties with learning. Regarding motivation, Dweck's research showed that high achievers played to the end, but in the growth mindset version those still played to the end, but so many more lower and medium achievers also stayed until the end. ?

Konrad:
how?

Viktigt
ta med
detta i
Resul-
tat!

Good feedback practice:

- (1) helps clarify what good performance is (goals, criteria, standards);
- (2) facilitates the development of self-assessment and reflection in learning;
- (3) delivers high-quality information to students about their learning;
- (4) encourages teacher and peer dialogue around learning;
- (5) encourages positive motivational beliefs and self-esteem;
- (6) provides opportunities to close the gap between current and desired performance;
- (7) provides information to teachers that can be used to help shape teaching.

Figure 2.3: Seven principles of good feedback practice Nicol [2007].

Learning by Thinking: Reflection & Retrieval Practice

Stefano [Stefano and Staats, 2015] suggests that that reflection has been an overlooked area of research for a long time. During the act of reflection, the student develops necessary skills and self-awareness to refine their own learning activities. His results suggests that reflection as an activity that can be more effective than additional learning. This surely applies to the teacher as well, Luckin says. [Luckin and Noss, 2012]

Stefano found that individuals who are given time to reflect on a task, outperforms students who are given the same amount of time to practice with the same task. But, similar to deliberate practice, it is a desirable difficulty: individuals in the test themselves, had a tendency to believe that allocating time to practice on the task rather than reflecting on it would benefit them.

When it comes to study technique, Bjork [Bjork, 2016] as well shows that retrieval from memory is more effective than people who repeat reading the same thing to remember: the more effective students, retrieves from memory.

One way to use memory retrieval as a study technique, is to ask "What was in that article?", before checking the answer in the article (the flashcard principle). It is an example of memory retrieval that is extremely effective for learning, their research shows. There is a danger with multiple-choice questions, that the student is given no time to reflect on the question and their prior knowledge, before evaluating the alternatives.

2.1.2 Design for Motivation

Social psychology can guide the design when there is a wish to make people behave differently. One of the biggest areas of research is motivation psychology.

Motivation is commonly divided into three areas:

- Self-determination - the students inner motivation, genuine wishes
- Achievement - the students motivation to achieve
- Expectation value - the expectations on the student

Koballa [Koballa and Glynn, 2007] and Abell [Abell and Lederman, 2007] gives an overview of theories developed for these three fields. Further, Fulmer

[Fulmer and Frijters, 2009] provides a review of methods to collect data which can be used to study motivation.

Deci [Deci and Ryan, 1985] and Ryan [Ryan and Deci, 2000a] studies self-determination theory, Elliot [Elliot and Covington, 2001] studies achievement theory, and Eccles [Eccles and Wigfield, 2002] and Wigfield [Wigfield and Eccles, 2000] studies expectancy-value theory.

If you have designed for the user's compelling context, Sierra says, the users are already motivated. Their motivation is to become better (achieve). [Sierra, 2015].

In terms of effective learning and expectation value, a growing research field is training transfer [Brinkerhoff, 2013]. Before and after is as important as the training itself. To design for this, the leader should be involved with the participants before the training, and communicate expectations. The student should be expected to implement the training in everyday life. [Brinkerhoff, 2013]

Sierra [Sierra, 2015], suggests the focus to be how to help users progress (see "Progress and payoffs", achieve), and what pulls them off (see "Cognitive load theory"). See figure 2.4, for a summary of her focus with designing for building expertise.



Figure 2.4: Sierra shares how to design for "making users awesome", meaning that a strategy for building an appreciated product is to help the user become good in something that appeals to her, i.e. to design for the compelling context. She then mentions barriers to not learning, like motivational aspects like reducing cognitive load and helping the user to progress.

Cognitive load theory

Sierra argues working on what stops people, matters more than working on what entices them. Thus, a focus needs to be identifying and removing blocks.

Sierra [Sierra, 2015] describes how humans have scarce cognitive resources, and how to design for these.

Cognitive load theory (CLT) research is divided into three areas: intrinsic load (stumbling blocks), extrinsic load, and germane load. Below, to design for these are described.

Intrinsic load, needs to be dealt with if the effort is too high. Sierra [Sierra, 2015] describes two strategies. She first says that according to deliberate practice, if you can not get to 95% reliability within three 45-90 minute sessions, split skills that can be done with effort into sub-skills. The purpose is to reduce time spent practising being mediocre.

Extraneous load, is about the way information is presented to a learner, and should be handled via designing to support cognitive resources, Sierra says [Sierra, 2015].

Germane load, is the work put into creating a permanent store of knowledge. To support cognitive resources, escape the brain's spam filter by making the information essential. Either by designing for the compelling context, or desining for just-in-time learning versus just-in-case, Sierra says. [Sierra, 2015]

Scaffolding is a technique to step by step remove the support wheels for the user, e.g. present information in different ways. Clark's [Clark, 2014] report shows that in their research, each category of scaffolding demonstrated significant effects on learning.

Another way to reduce cognitive leaks is don't make users memorise unnecessary things: make the thing you want the user to do, the most likely thing to do (affordances). Everything that takes willpower, reduces cognitive leaks.

In the case of an quiz app, the visual presentation of the questions can reduce extraneous load by removing unnecessary information. Germane load can be increased by giving scaffolding support at the end of each section, for example helping users to remember, by showing them their answers.

The rule of thumb is that you want to decrease extraneous load, bad load, and increase germane load, good load.

Progress and payoffs

Sierra argues that to pull users forward, to stay motivated, progress and payoffs are essential. Both of these, are investigated in terms of motivational psychology.

The feeling of progress can be emphasised by a path with guidelines to help the user know where they are at each step, e.g. for a training. To create a path, she encourages the designer to make a list of key skills ordered from beginner to expert. Then, these are sliced into groups of ranking or levels.

This way, it is possible to design a "belt" path for your context. The first level, should feel like a superpower for the user. The best payoff, is a intrinsically rewarding experiences, according to Sierra [Sierra, 2015]. For an entrepreneur, gaining the skills of selling (the progress) can be as rewarding as having gained the money for it (the payoff).

For motivation, the earlier, lower levels should be achievable in far less time and effort than the later, advanced levels. One practice is to try to have each new level take roughly double the time and effort of the previous level. This highly relates to flow.

Caring for the compelling context, why the user wants to learn the skill, are helpful strategies. A sometimes critiqued way of progression is to give the user high pay-off tips, but if done in a fair way, it is a good way for both learning and motivation.

This kind of path map is superb to simple gamification, says Sierra [Sierra, 2015]. In an app for building entrepreneurship coach skills, the act of becoming certified (getting 100% correct), might not be as rewarding as the progress of getting there. Therefore, gamification of the sort "rewarding effort" might be more beneficial with "rewarding result". Suitable gamification could also mean unlocking new possibilities of adding value to the app (for example adding questions to the quiz), versus getting a badge or a star.

The shown benefits of designing for intrinsic motivation is in-line with self-determination theory [Deci and Ryan, 1985] [Ryan and Deci, 2000a]. Pink [Pink, 2011] says that the surprising truth about what motivates us is that drive is fostered by autonomy, mastery and purpose. Meanwhile, Clark [Clark, 2014] says that simple gamification as well as more sophisticated game mechanics can prove effective. However, he adds that it should be investigated if "simple gamification" (e.g. contingent point and badges connected to learning activities) more frequently focus on lower-order learning outcomes, compared to studies with more sophisticated game mechanics. For the case of entrepreneurship, the goal is on higher-order learning outcomes, meaning simple gamification is not enough to motivate users. Thus, if you do not design for the compelling context, entrepreneurship coaches may well prefer other learning methods instead of using your gamified app.

2.1.3 Design Thinking

Interaction design talks about the creation of digital artefacts specifically. When it comes to the design process, it is influenced by related areas such as human-computer science, and more recently human-centred design.

However, various disciplines suggest different design processes. For example, agile development suggests how to develop software efficiently.

Whenever a project is multi-disciplinary, various design processes may need to be combined. Whenever this happens, design thinking (how to think about design) becomes a skill essential to thoughtfully design the process.

Löwgren [Löwgren and Stolterman, 2007] writes about design thinking and useful techniques in general, from his interaction design perspective.

Service design thinking connects various fields of activity [Stickdorn and Schneider, 2010], and its methodology relies on being close to the users.

While interaction design talks about the creation of digital artefacts specifically, service design talks about the creation of services.

As some digital artefacts are used within a service, or can be thought of as both a product and service simultaneously, the combination of the two can be very useful. Service design could help the designer be aware of how such a artefact would need to interplay with its physical environment.

Each discipline holds efficient methods and tools, that can be modified to suit

the specific situation even better. From the field of graphic design, mental models describes the perceptions of the user. From interaction design, desirability, utility, usability and pleasurability can be useful principles to evaluate a product. While none of these are a mandatory part of service design, these have been useful in service design projects previously. [Stickdorn and Schneider, 2010]

In difficult situations, combining different disciplines places demands on the designer. This is where design thinking becomes relevant.

Below, relevant methods and tools are briefly described, and what it means to be a good designer.

A good designer

The result of a method can not be better than the people engaging in carrying out the process [Löwgren and Stolterman, 2007].

With its user-centered focus [Stickdorn and Schneider, 2010], service design can be said to equip the designer with tools both for reasoning and design ethnography. But it also suits to get to know and design for the learning situation.

In learning, the end goal is that the student raises their level of knowledge and expertise, and the design needs to be adapted for this specifically.

Central to design for learning is to dig deep into the topic being communicated. In this case, understanding entrepreneurship, understanding exactly what is being taught (the training), and adapting the design after this.

A good designer can deal with the complexities of design: a satisfactory (and surprising) solution or design can be achieved while working in a highly restricted situation [Löwgren and Stolterman, 2007]. This can be done e.g. by inventing new design techniques. One such example that would suit designing an app for entrepreneurship training in a development country, would be a *field hackathon*.

A field hackathon would thus allow that during the training, the topic *and* the users are observed and understood. Then, the app can be tested (in this can a quiz assessment of the trained material). Then, users can be invited to give feedback, suggestions of improvements, and ideas. For the next day, an improved version of the app is tested, and then the process is repeated.

More examples of how a service design process can be invented to deal with digital artefacts, can be described in the chapter Digital Service Design. However, to do such field tests (like a field hackathon), requires building trust and having an enabling environment, which is where relationships and roles becomes crucial.

How to deal with relationships and roles

According to Löwgren, "real" design is about finding ways to design a project within the existing preconditions and limitations [Löwgren and Stolterman, 2007]. Being innovative, and communicating well with the stakeholders, becomes crucial.

While a researcher is interested in reality, a designer is interested in what reality could become. [Löwgren and Stolterman, 2007] Being thoughtful means

conceptual clarity from the designer, caring for the vision, and being equipped with appropriate tools of reasoning. These are all good characteristics for a successful project.

There are three roles as interaction designer in particular can take: the computer expert, the socio-technical expert, and the political agent. The trend is increasingly towards socio-technical experts [Löwgren and Stolterman, 2007], the middle ground, as human understanding and collaboration is so important.

This seems to be a perfect fit with service design, where interaction design is both technical skills and design, and service design can be both design and ethnography. Even more importantly, service design suggests making the whole process co-creative, involving all stakeholders. [Stickdorn and Schneider, 2010]

Thinking of a product as a service

Service design thinking is described as a process of designing, rather than to its outcome.

A service's intent is to meet customer needs. If it does, it will be used frequently, and recommended. [Stickdorn and Schneider, 2010]

As this is often not the case, service design can be applicable to fields including social design, product design, graphic design and interaction design.

The result can be a product service hybrid. When designed and considered well, service design shapes the value proposition and desirability of the product for the better.

Starting the project

Löwgren writes about the beginning of a project: This is where the designer gets involved in design work, establishes a preliminary understanding of the situation, navigates through available information, and initiates all necessary relationships with clients, users, decision makers, and so forth. Based on all this, she creates a design proposal. [Löwgren and Stolterman, 2007].

2.1.4 Service Design Methodology

Below, brief descriptions of five principles of service design are described according to Stickdorn [Stickdorn and Schneider, 2010], together with how the work is divided into iterations, and examples of tools that can be applied.

Principles

Stickdorn [Stickdorn and Schneider, 2010] describes five principles that constitute service design thinking, and how to follow these.

He describes how to follow these principles, by making the process user-centered (e.g. via *design ethnography*), co-creative (involve all stakeholders) and holistic (keep the big picture). Sequencing (visualize the service, and make iterations) and evidencing (make the service tangible) are the two last important principles.

Sequencing

Sequencing the process means splitting the design process into iterations, which consists of a number of steps, which are repeated for each iteration. This is a common denominator with the agile methodology SCRUM, which is often applied in software development.

While service design literature and practice refer to various frameworks, regardless of number of steps, every service design project includes: exploration, creation, reflection and implementation [Stickdorn and Schneider, 2010].

Nissar [Widmark and Nissar, 2016] suggests a model where one iteration consists of insights, ideation, trigger material, and interactions. See figure 3.5.



Figure 2.5: In Nissar's model, a iteration consists of Interactions, Insights, Ideation and Trigger material.

1. Interactions, where you are listening, the *Explorative phase*.
2. Insights, which is where you use the Interactions in order to try to understand, the *Understanding phase*.
3. Ideation, where you find possible ideas and when creation of new version of the app is done, the *Design phase*.

4. Trigger material, where material is developed to test the outcome of our evaluation in the next round, the *Trigger development*.

The iterations should come closer and closer to a desired outcome. It is not always obvious what this outcome is. For each iteration, the process takes the project closer, from Why? to What? to How?, often with overlaps [Widmark and Nissar, 2016]. See figure 2.6.

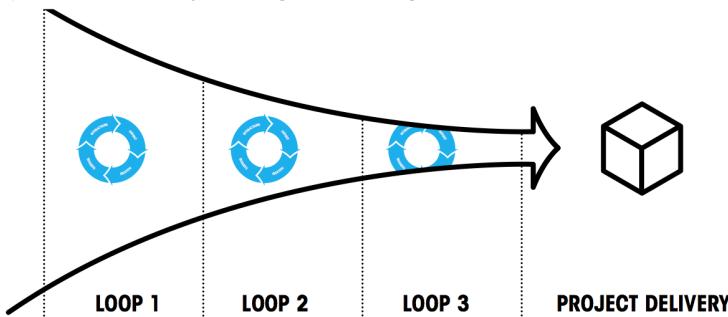


Figure 2.6: The iteration process consists of a number of iterations with different focus, starting with broad strokes, and narrowing down into a concrete product. Between iterations, there is an overlap in "Why?" and "How?", "How?" and "What?", which signals that there is a learning process which means conclusions may need to be quickly questioned as new insights emerge. This is especially important in projects where you work with an unfamiliar target group and there are several uncertainties and constraints.

Service design tools

There are a number of popular service design tools that follows the five principles, e.g. how to make it user-centered. One is Customer Journey Map, in which an activity (like hosting a youth session) is broken into Before, During and After. Another method is Personas, which exemplifies thought users of the app into people with names, having realistic character traits and opinions. The persona's needs can then be thought of when designing. An alternative to Personas are Need groups, where thought users are broken down by their different needs. Instead of designing for a specific person, you design for a person with a specific need. The advantage of Need groups, are that it accepts the view that the same person (Persona) might have different needs, depending on situation. The 5 Why's is a simple method used to dig deep into understanding the interviewee. Variants of the question "Why?" is repeated five times as a rule of thumb, to understand underlying motives. This method is called "Why-why-why" within interaction design [Löwgren and Stolterman, 2007]).

Tools to create and reflect can be done via certain work methodology. When you structure and inspire brainstorms, you can ask "What if...?" and do Co-Creation,

meaning doing ideation together with stakeholders or users. To create, agile development can be used, which is often suitable for software engineering. The manifesto for agile development is Alliance [2001]:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

An example of an agile methodology is SCRUM, where a project is divided into several iterations similar to a service design approach of sequencing, but also introducing concepts like retrospectives (reflecting on one's work) and sprint demo (demonstrating the results of the iteration to stakeholders) Kniberg [2005].

There are also some service design best practices: interviews are often done via open questions (encouraging stories) and dialogue can be facilitated with a questionnaire guide. In workshops, post-its are often used, and followed up with specific questions. Service design methodology encourages taking pictures, filming and recording audio, benefiting the analysis done afterwards. Widmark and Nissar [2016].

2.1.5 Digital Service Design

The method combines the benefits of Service Design, Agile Methodologies (namely SCRUM) and Interaction Design. Its purpose is to contribute a holistic approach to the digital design solution for a specific target group. The methodology was co-created by the current author and Expedition Mondial for the master thesis. [Nissar, 2016]

A "Service Sprint"

In Digital Service Design, an *iteration* is called a *service sprint*. Each iteration includes four steps: insights, ideation, trigger material and interactions. Each step borrows a number of best practices from agile development or interaction design. There are also new methods, like how a *field hackathon* includes *mini service sprints* each day.

Below, the four steps are presented.

Step 1 - Insights: Analysis, Retrospective & Stakeholder feedback

Insights consists of *analysis* (service design), but also a *retrospective* (SCRUM) and *stakeholder meeting* (service design).

In the analysis, the app is evaluated (in terms of interaction design - pleasureability, usability, utility and desirability), and quantitative data is processed (often by clustering data points) and compared with qualitative data (quiz results and questionnaires). This produces an analysis overview of the result.

In the *retrospective*, the design process is evaluated ("start doing, stop doing, continue doing"), and changes to the design process are suggested for the following iteration.

Both the result analysis and the design process analysis is then presented during two stakeholder meetings (service design), structured as *sprint demos*" (SCRUM), with the purpose of getting feedback.

The first "Expert meeting" informs the next iteration's design process, while the second "Partner meeting" informs the next iteration's delivery.

From the insights, a *product backlog* (SCRUM) is converted from needs and ideas into *stories* balancing 1) user needs and 2) stakeholder needs.

Step 2 - Ideation: planning interactions and delivery

Ideation consists of doing *sprint planning* (SCRUM) for the trigger material (a *lo-fi* or/and a *hi-fi prototype*) and the interactions (where tests and workshops and field visits happen).

- Trigger material
 1. Ideas are formulated which would satisfy the user needs. This is often a iterative process, which happens in dialogue with chosen experts and entrepreneurs in technology, design and education.
 2. To plan implementation of the ideas, every technical task are laid out, measured in time and prioritized. The least prioritized tasks can thus be cut or moved to the next iteration, in case it is necessary.
- Interactions planning
 1. If the technical planning has been realistic, it is time to determine what this iteration's interactions should look like. How will this be tested?
 2. The interactions activities are chosen (what, how, when), so that these are communicated to the local partner, who may schedule the days I will visit, and solves the needs to the best of their ability.

Step 3 - Trigger material

Trigger material is about preparing the interactions (field visits, interviews, app tests, workshops) and creating the *lo-fi* (pen and paper) and *hi-fi prototype* (developed app) to be tested with the users.

To track the progress and plan effectively, each day starts by a daily standup, where today's targets are set, ending by reflecting if the targets were met. If they were not, either the design process needs to change, or something needs to be cut short.

Step 4 - Interactions: with "Service Mini-Sprints"

Interactions always consists of a sprint demo with the users with the lo-fi or hi-fi prototype. During the development process, these are *formative tests*, while for final app evaluation, this is a *summative test*.

Group tests are facilitated as workshops. Often, a scenario is presented, devices are given, results are submitted, followed by an open discussion.

Individual tests are facilitated in the field (using the before, during, after technique). I observe how the coach does the job today, tests and observes if the app fits into the process, followed by an interview.

These tests always informs what steps to be taken next, both in terms of app development and interactions. Instead of waiting for the next iteration to do these changes, often a so called Service Mini-Sprint is done.

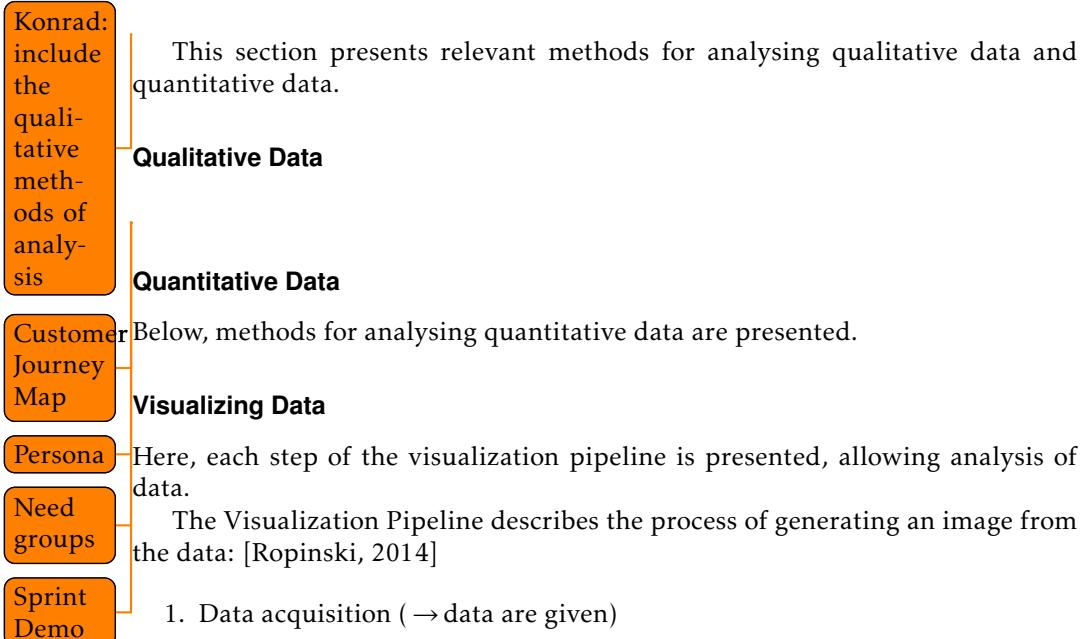
In a **service mini-sprint**, the insights gathered during the day allows for last-minute adjustments of coming pre-planned workshops (*co-define*, *co-create* or *co-refine*) or field visits (change of interview questions), that can sometimes happen the same day.

To take advantage of the precious time with the coaches, at the end of the day, app improvements are made and tomorrow's design process revisited.

This means, that already the next day, an improved version of the app can be tested. Similarly, if I was not satisfied with a workshop format, it has been modified.

These mini-sprints allows for very fast iterations, which can sometimes accelerate the outcome of the visit.

2.1.6 Data Analysis



2. Data enhancement (\rightarrow data are processed)
3. Visualization mapping (\rightarrow data are mapped to for example a geometry)
4. Rendering (\rightarrow images generated)

Data acquisition presents how data was acquired.

Data enhancement explains how the data was processed.

Visualization mapping is the process of mapping data to e.g. a geometry.

Finally, rendering allows images to be generated, presented in 2D.

Calculating Correlation

Calculate means, follow formula. Cumbersome to do with all of the axes against all the axes.

This can be done in Google Sheets as well as the R programming language.

In Google Sheets:

It is clear that analysis in Google Sheets can only go so far. It can be greatly helpful to sort by multiple columns (e.g. first by Manual?, then by School level, then by Quiz 3). However, it takes a long time to filter the data on multiple parameters, and the work easily becomes tedious. For some applications, it may not be viable to discover the data using this approach.

One approach is to calculate and compare means on a "control" with a response variable.

Pseudo-code in R would be:

```
x1 = c(1,2,3,1,5,6)
x2 = c(2,3,4,NA,6,7)
cor(x = x1, y = x2)
cor.test(x1,x2)
```

Visualizing Correlation

In Google Sheets, color scale can be used to give different column values different colors.

It is still hard to compare all of the axes towards all the axes, and it is not a scientific approach.

In R programming language there are more powerful tools for visualizing correlation, e.g. using a "Correlation Heatmap".

Include figure

Pseudo-code in R would be:

```
random_matrix <- matrix(rnorm(100), nrow = 10, ncol = 10)
random_matrix[1,1] <- NA
colnames(random_matrix) <- paste("V",1:10)
cor_mat <- cor(random_matrix)
heatmap(cor_mat, keep.dendro = FALSE)
```

The result would be:

Include figure

Calculating Logistic Regression

A limitation with correlation is that only two dimensions can be compared with each other.

With multiple-variable data, Logistic Regression is helpful if our response variable can be a logistical dimension (e.g. women or male, used manual or not), while linear regression needs to be used if it is a linear or nominal scale (e.g. age and city respectively).

In either case, the first step is to determine a response variable: the variable I want to compare against, e.g. is there a difference between men and women? In my case, it needs to be a quantitative measure of: "Have you learned anything?".

If I add more variable, e.g. also adding if a manual was used, this is called my "control". It is possible to add as many controls as possible.

If linear regression, then I need to determine a quantitative measure of ("How much have you learned?").

In Google Sheets, this is not effective to do. R, however, is a very suitable tool.

First, the data is loaded, e.g. as a CSV file. Then, we tell R which the N/A values are, e.g. "N/A" or "Vet ej". We use this to filter the data.

Then, each column we want to use is converted into a factor.

When factors, a model can be created, e.g. using the General Linear Model. A different family can be selected, e.g. binomial.

Then it is possible for R to show this data, showing the coefficient, the Pr value, and others. See code below.

```
mydata <- read.csv("Development/R/quizResults.csv", na.strings = c("N/A", "Vet ej"))

mydata$y = ifelse(test = is.na(mydata$Quiz.9..y.n.1st), yes = 0, no = 1)

mydata$y <- as.factor(mydata$y)
mydata$Help <- as.factor(mydata$Help)
mydata$Sex <- as.factor(mydata$Sex)

mymodel <- glm(formula = y ~ Pre.test.score + Sex, data = mydata, family = binomial)

summary(mymodel)

plot()
```

For analysis, looking at the summary, coefficient (e.g. -1.0704) shows either a negative or positive correlation (in this case -7%) for what I compare with as a response variable.

To be significantly significant, a common measure is that the Pr value ("the p-value") needs to be higher than 0.05. If the p-value is higher than 0.05, meaning it is significant with a 95% probability.

Analysing data with a Parallel Coordinates Visualization

To learn how to analyse the data, Une-terre [Lopez, 2016] was consulted. He writes "||-coords are a data visualisation which allow you to "read out" the relationships and trends between your dimensions. Positive relationship (correlation), negative relationship (invert), or no relationship (random)."

2.2 Setting and Research Context

In setting, the people that are involved with the project is presented. In research context, the physical environment is described.

2.2.1 Setting

There are two groups, with the current author included in both of them, which gather at the end of each sprint for a check-up meeting.

The Expert group consisted of Expedition Mondial and LiU Innovation. Expedition Mondial could help with the design process, and LiU Innovation could offer input on social innovation. The meetings mostly lasted for one hour.

The Partner group consisted Iliana Björling from YoungDrive, and Lena Tibell and Konrad Schönborn from Linköping University. In Partner meetings, The Insights from each iteration was presented and discussed. Then possible decisions were laid out, followed by discussing the alternatives.

Outside of these groups, these people can also give advice in certain situations. For specific areas, there are also some experts which have been beneficial during the projects. Below, the whole team is explained:

Supervisors

The supervisors are from YoungDrive and Linköping University.

The YoungDrive team consists of Iliana Björling, founder of YoungDrive, and Josefina Lönn, country manager in Zambia. They are both helpful in giving knowledge on the entrepreneurship education program, and giving support.

The Linköping University team consists of Lena Tibell, Professor, and Konrad Schönborn, Doctor, within the Department of Visual Learning and Communication.

Stakeholders

The stakeholders are YoungDrive, Plan International and Linköping University.

YoungDrive is the client of the work, and their needs should be satisfied. This person is mainly represented by Iliana Björling, who is part of the YoungDrive Strategic Management Team.

Using service design, the project leaders in Uganda and Zambia, are also considered stakeholders: Josefina Lönn in Zambia, and Patrick John Obbo and Christine Achom in Uganda.

Finally, the most important stakeholder of all according to service design, is the actual users: the coaches. They should be the main consideration of the work.

Plan International is the organization allowing for all the interactions with the end users in Uganda. A similar organization is operational in Zambia. They are the ones that are providing facilities, organizes transport, etcetera. They in turn, have the organization Community Vision, which organizes the coaches. If Plan International or Community Vision does not approve of my work, then the interactions with the coaches will not be possible.

Linköping University is a stakeholder, as the supervisor (Lena Tibell) and examinator (Camilla Forsell) determine if the work is a valid master thesis or not. Also, LiU Innovation is interested in supporting continued work with the project, and their representative Peter Gahnström gives advice on social innovation and how this project can continue in the future during expert meetings.

The designer and developer

It is needed to take on several roles in the project: most notably that of a designer, developer, but also product owner. It is needed to balance all different opinions and requirements, caring for the vision (like mentioned in the chapter "A good designer"). The motivation doing the master thesis is three-fold: learn as much as possible, create a successful project, and finish the master thesis.

Experts

Since the development country context is new to me, there are also experts involved in the project.

For design process, Susanna Nissar and Erik Widmark from Expedition Mondial has supported with all of their knowledge within service design.

For technical development for rural areas, Julien Tantege, Research Specialist at Grameen Foundation, has offered support before and during the work, sharing their insights from related work, and giving feedback during ideation.

For pedagogical development, Henrik Lundmark from edtech startup Knownly in Sweden has given support with regards to building skills within digital learning.

2.2.2 Research context

Include a photo or two showing the setting of the workshops / data collection

The biggest challenge with regards to time constraints and cultural differences is that it is difficult to understand the audience.

Therefore, the whole design and development process will take place in Uganda, with several interactions with the intended users.

The work was carried out from Hive Colab, a co-working space and an innovation hub.

The interactions took place in either Uganda or Zambia, in the locations where training of the coaches and youth takes place.

Add reference

There were a number of resources made available to support the work, e.g. the *YoungDrive manuals*.

Each youth is given a *Participant manual*, describing each week of the 10-week YoungDrive program.

Coaches are also given a *Coach guide*, which describes how to carry out and teach each week's topic during the youth training.

Working mainly from Kampala, because that is where YoungDrive is situated, means that there is still a long distance to the coaches and youth in Tororo, which is located near the Kenyan border.

Another challenge with being in Uganda compared to Sweden is that internet speed and access is worse, especially outside Kampala.

2.3 Understanding the YoungDrive participants

The following section describes roles, businesses, and coach descriptions for Uganda and Zambia.

2.3.1 Roles

The *country manager* trains the project leaders. It is also the main person responsible for partnerships and the quality of the YoungDrive program in the respective country.

The *project leaders* trains the coaches. They oversees the coaches, manages the coach training, and also collaborates with local stakeholders for quality assurance and to oversee daily operations.

The *coaches* trains the youth. In Zambia, a coach only has responsibility for training youth in the YoungDrive program. In Uganda, this is called a *Youth Mentor*, in contrast to being a *Community Based Trainer (CBT)*, which also trains the youth in other programs and leads the youth saving groups. Most of the CBT's in Uganda holds sessions together with a Youth Mentor, or divides work between them, instead of being alone. The coaches are often volunteers, receiving a small scholarship from the partner organization. They are often business owners themselves. The coaches could be described as social entrepreneurs [Mitchell and Smith, 2007]. Many of the YoungDrive coaches (and youth) are driven by that their business can have an impact on their community, *as well as* take them out of unemployment or increase their current livelihood.

The *youth* are the ones receiving the training from the CBTs and the YMs, being encouraged to start their own businesses.

Country Managers

In Uganda, the country manager is Iliana Björling. She is located in the Uganda capital, Kampala, which is a strategic location because it is the same city in which the national office of the main partner, Plan International, is located.

In Zambia, the country manager is Josefina Lönn, who previously was project leader in Kampala, and has held all the trainings up to this point. Now, she leads

the operations and has trained the coaches in Zambia, in the new role of country manager and project leader.

2.3.2 Social characteristics

According to statistics gathered by YoungDrive during 2015 evaluations Lönn [2015], there are a number of considerations to make regarding the coaches in Uganda. This regards entrepreneurship experience, technical access, and language, see a summary in figure 2.7.

	# Roles	# Respondent	% Respondents	Running business	Has cell phone	Internet on phone	Electricity at home	Solar energy at home	Can write on computer
Project Leaders (Zambia)	1	1	100%	100%	100%	100%	100%	0%	100%
Project Leaders (Uganda)	6	6	100%	100%	100%	17%	33%	50%	100%
Tororo Coaches	27	26	96%	100%	100%	12%	0%	12%	15%
Tororo Youth	6000	225	4%	73%	44%	5%	2%	13%	12%

Figure 2.7: Table showing entrepreneurship experience, technical access, and language between coaches and project leaders in Uganda and Zambia.

All of the Tororo coaches run a business (26/26 respondents), with a majority running more than one. This means, they do have practical experience of running a business outside of the YoungDrive coach training.

While all have a cell phone, smartphones are very uncommon - only 3 uses Internet on the phone, every day or weekly, mostly for Facebook or email. Regarding power, none (0/26) has power at home, 3/26 has solar, and only 4 can write on a computer. Taken together this means that their technical skills are low, and needs to be in consideration.

Regarding language, English can be used in the coach app. While about half of the asked Uganda youth can not understand (129/225), read (133/225) or write (132/225) English, most of the coaches in Uganda are proficient.

These characteristics can be used for youth and project leaders as well.

2.3.3 Tororo businesses

The coaches in Tororo are divided into three different regions. Based on region, income and experience, they run different kinds of businesses.¹

In Tororo, the coaches' businesses range from: ananas, water melon, onion, chili, bakery, catering, corn, beans, fabric, plastic products, bird farm, milk, fish, ground nuts, cabbage, tomato, hairdresser, sewer, shop and rice. For reference of environment, see figure ??.

In Tororo, there are 2 Project Leaders. Christine's business ranges from: bakery, corn, pig farm and plastic products. Patrick's business ranges from: silver fish, beans, corn, and bird farm. In comparison, in Kamuli, there are 4 Project Leaders. Their businesses ranges from: selling office supply, boda boda, bird farm, pig farm, green pepper, corn, cabbage, tomate, aubergine, chipati ("bread"), chilli, and charging of cellphones.

¹In Uganda and Zambia, a small-scale business is typically not registered. Thus, the coaches' definition of a business can be more generous.



Figure 2.8: Local project leader Patrick showing the rural part of Tororo, where crops are growing close to where he lives.

Among the youth, the top 8 most popular businesses in Tororo, with 134 respondents, are corn, cassava ("potato"), saloon, fish, making of bricks, beans, brooms and rope. These range from 9 for corn (6.7%) to 5 for rope (3.7%).

2.3.4 Zambia coaches

The Zambia coaches in Kabwe are better educated, and have better access to technology, compared to the ones in Uganda. Regarding sociology, ages ranged from 21-39 years old (26.8 average). 3 were mentioned as being shy during the interviews. They lived from 10-90 minutes outside of town (33 minutes average).

Regarding motivations for being a coach, 50% had an emphasis on benefiting the community, and 90% had personal reasons. The following statistics has been derived from the notes of the Zambian coach job interviews ?.

Regarding experience, 8 had trained youth before, 8 had been a leader before, 9 had business experience.

Regarding YoungDrive, they said they could handle training between 8-30 youth (19.8 on average) per group. They could have 1-5 groups per coach (average 3.0), totalling a range between 8-101.5 youth (average 59.8).

During the visit in Zambia, the coaches had not yet formed their youth groups, and started their own sessions.

2.4 Study Design and Data Collection

As a computer expert with social skills needing to design and develop an app for a unfamiliar cultural and socio-economic context, it was needed to quickly become a good designer.

The technical aspect of the project was but one. It was needed to learn how to develop hybrid apps in JavaScript that worked offline, and had an online backend. However, those are merely the technical demands.

It was needed to quickly become a good designer, not mainly from a perspective of graphic design or interaction design, but *how* to explore, design, and implements what the user needs from the requirements "fun, user friendly, and good for learning". The approach used to learn design from these perspective was to read extensive literature, consult a diverse set of experts, and be humble and curious in interactions with the end-users and stakeholders.

In the following section, the creation and implementation for a suitable design process is described, together with the study design and data analysis for each iteration of the project.

Creation of Design Process

As there was a unfamiliar target group - mostly young Ugandians with little or no experience of smartphones - service design thinking would benefit true understanding of cultural context and in-depth empathy for the end users.

Tools and methodology in service design were chosen with the help of Expedition Mondial in Stockholm, who provided education and coaching.

At the same time, the end result would be a digital artefact (an app), which is not common in service design.

While this product could be thought of as a service, the tools and methodology would benefit to borrow from Agile methodology and Interaction design.

I'm the computer expert kind of designer [Löwgren and Stolterman, 2007], adjusted to agile methodology and interaction design, but aspiring to be a socio-technical expert. Expedition Mondial are experienced with service design, aspiring to be more of computer experts.

This led to the joined development of a Digital Service Design method, co-created by the both.

The result is that the design and development phase in Uganda is an iterative process with the human in focus. The process is built on top of service design process and methodology, while in-line with digital design practices.

Implementation of Design Process

See figure 2.9. There were four iterations. The first iteration follows Service Design, not starting the app development, while the other three follows the new methodology, Digital Service Design.

In iteration 1, there is a very broad scope, without digital focus, where iteration 2, 3 and 4 introduces and narrows down the project into a digital solution.

In Tororo iteration 1 it was chosen to observe the youth sessions. In Zambia iteration 2 it was decided to observe the coach training. In iteration 3 in Tororo it was chosen to observe the coaches preparing the youth sessions.

Expedition Mondial gave support in each iteration, helping with refinements of each iteration as learnings happened along the way, and they were able to educate me during the different stages with methodologies whenever necessary, see figure 2.10.

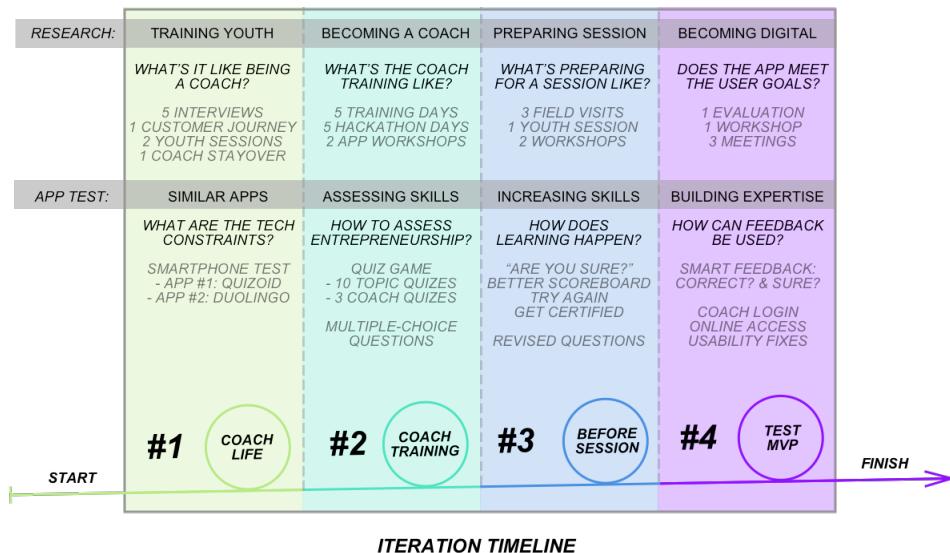


Figure 2.9: The iteration timeline shows the process from iteration 1-4, by different colors. Each iteration leads to a loop, with the design situation as the focus, in which interactions can happen that is related to either research ("What's ...?") and an app test ("How can we ...?"). This output from the loop, then gives force to the next iteration.

2.4.1 Implementation of methods for data collection and data analysis

This section describes the implementation of methods for each iteration's interactions, in regards to collecting and analysing qualitative and quantitative data. Figure 2.11 is made to assist the reader in which methods were used together.

2.4.2 Iteration 1

Following the service design sequencing, the first iteration had a very broad scope and truly is a service design iteration: "From your perspective, what is it like being a coach?".²

Lowgren's thought about how to start the project was used, meaning that the purpose was to get a preliminary understanding of all important aspects, and build relationships with all stakeholders.

Insights depended heavily on interviews with all the stakeholders (2 with Plan International, 3 with YoungDrive), and local experts (1 visit each at Grameen Foundation and Designers without Borders, 1 workshop with Mango Tree), since

²A coach meaning either a Community Based Trainer (carrying out all the trainings), or a Young-Drive coach, depending on who was asked the question.

Completed the Methods and Analysis table

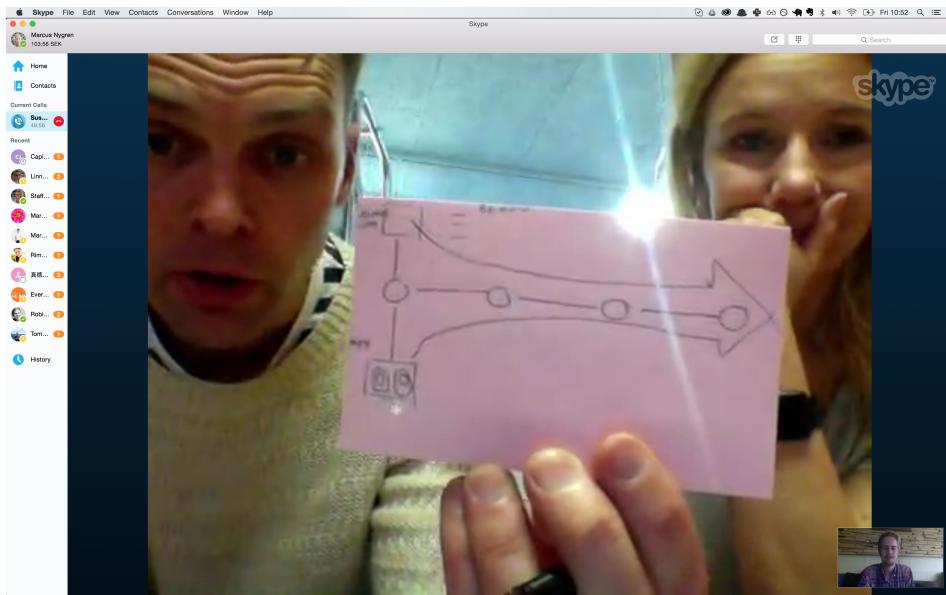


Figure 2.10: In preparation for new situations, like meeting coaches and doing interviews, Nissar and Widmark gave support via Skype videos, sharing service design methodology tips or giving feedback on ideas.

no interactions with users had been made yet. Also, I immersed myself with the Uganda tech scene as possible, from the new home and office in Kampala, working at the tech hub and co-working space Hive Colab.

Ideation were about creating a questionnaire guide for the interviews, a co-creation workshop using "Customer Journey Map", and identifying how the app test should be designed to test their existing knowledge (and be informed of the design preferences of the YoungDrive app).

Trigger material was the finished questionnaire guide (constructed with Expedition Mondial) a written plan for the co-creation workshop ("A day as a coach"), and a written plan for testing the quiz app Quizoid and the language learning app Duolingo, and a schedule for the interactions.

The interactions were focused on design ethnology, getting to know and learn from people in a different culture, namely the coaches. The focus was on the their needs, motivations, and context.

To accomplish these, four days were spent in Tororo, with one day of travel. There were four face-to-face-interviews, one meeting with Plan, one meeting with the local partners, two workshops, one coach stay-over, and two youth session visits (one of the youth sessions are observable via figure 2.12).

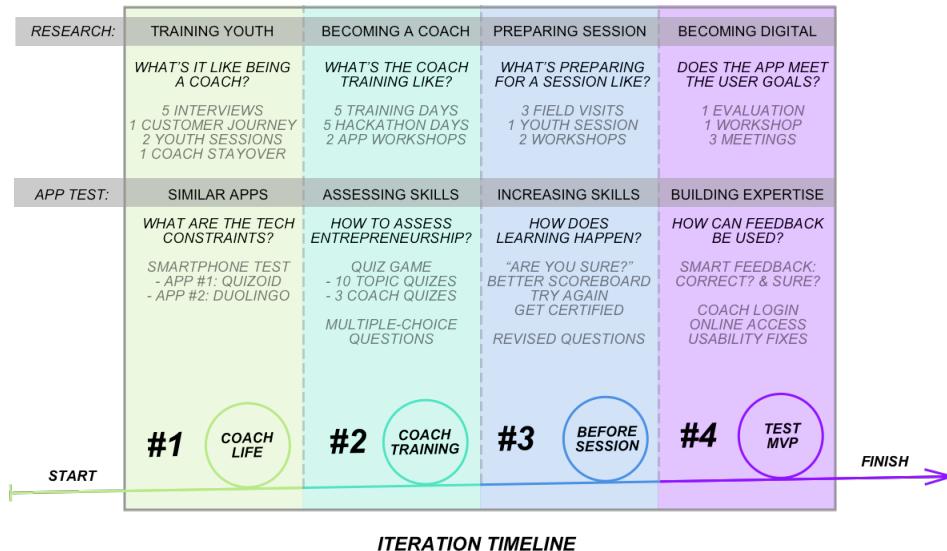


Figure 2.11: Should this be a table?



Figure 2.12: Photo from the location where one of the youth sessions were held. Here, a CBT in Tororo teaches youth in basic sales and marketing.

2.4.3 Iteration 2

This time, the iteration has a more detailed scope, with a hypothesis on what needs the app should meet in the end, and create lo-fi and hi-fi trigger material to meet those needs.

A co-creation workshop started the interactions, followed by repeated app tests at minimum one session per day, always followed by a feedback round, so the app and the tomorrow's question set creation could be improved for the next day. At the end of the week, there was a co-refinement workshop of the current hi-fi material, and also lo-fi material for the new version of the app.

Creation of questions

Project leader Josefina in Zambia refined Iliana's first question sets, prepared for my visit in Zambia. Josefina created question sets with Bloom at the back of her head, also taking into account the structure and the order of the coach manuals, what it means being a coach within the topic, and lastly scenarios.

Trigger material used

A hi-fi trigger material was done, a very basic quiz app, keeping it as simple as possible (see Application Implementation, Iteration 2). All of the devices (tablets and smartphones) that I had available were brought to Zambia.

I added Josefina's questions to the app, and installed the app to all of the devices. This process was repeated for all the days, Sunday-Friday.

Design workshop #1 in Zambia

The coach training started with me having a design workshop with the coaches, see figure ??, not showing them the app that I had created. The co-creation workshop was made to identify important functionality in the minds of the coaches.

1. Since the knowledge about smartphones and apps were low, I started by introducing these topics.
2. All were familiar with Facebook, so thus I showed the Facebook app. Me wanting to know what the app would look like if the coaches would have designed the app, I first needed to train them how to design an app via drawing wireframes.
3. Using postits, they started with during limited time drawing the start view from the Facebook app.
4. Then, they were asked to draw what they thought happened on the friend icon click, drawing the view on another postit.
5. Then, the mission of the YoungDrive app was described. They were then divided into two teams, having limited time to draw the best imaginable YoungDrive coach quiz app they could. First, they designed the app from the top of their heads. They then pitched their results to each other.
6. On the next iteration, they were to suggest and design improvements how the app should be designed to improve learning, not only assessment. They then again pitched their results to each other.



Figure 2.13: Each person designed a YoungDrive app first for assessment, then adapting the app for learning. They were allowed to test the smartphones and tablets, and use the apps Quizoid or Duolingo for reference.

Assessment via quiz

At the end of each day, the app was used to test the coaches' knowledge. Each coach got either a smartphone, tablet or computer. The coach first took the quiz for the most recent session, and could then choose what to do next.

As there were no back-end developed, Josefina by hand documented the scores of each coach, writing the name of the coach, the session, number of correct answers, and what questions had been answered wrong.

Josefina then, when planning the next day, looked at the statistics, looking for trends that would inform the sessions for the following day.

She also evaluated the quality of the questions, before creating the new question sets for the next day.

Experimenting with quiz before or after the session

Since the coaches appreciated the app so much, we felt tempted to try what would happen with fun and learning if we tried using the app *before* a session instead of only after. During the rest of the week, we continued, finally finding preferences and tendencies from the coaches, via observation, interviews, and survey.

Experimenting with design of questions

During the week, extra tests were done to test the following:

- Number of questions per quiz
- Single-answer questions or multiple-answer questions

- Framing of questions
- Challenge level of questions
- Determining what made a question hard

Interviews with Josefina

At the end of each day, an evaluation interview was held with Josefina. At the end of the week, a final interview was held.

At the end of Day 5, Josefina and I discussed what it would look like to not record the answers manually, but pushing the results online. A co-creation workshop was held, where she drew an Educator Dashboard.

Design workshop #2 in Zambia

In the last day of training, another workshop was held, where the question was: "What do you need in order to feel self-confident for your session?". This question was informed from iteration 1.

The coaches was asked to write down one need per post-it during limited time, then choosing the most important need, and then writing a motivation why that need was important to them. Finally, they were asked to sketch what an app would look like, that addressed this need to them.

2.4.4 Iteration 3

Because of the many research and functionality needs, the study design of Iteration 3 became very important. A lot of development and ideation needed to be done.

Iteration 3: Purpose

Iteration 3 had an even more detailed scope. Since the app now succeeds with the first use case, the coach training, now the focus could be on "learning at distance".

Pedagogical model

It was chosen that "Are you sure?" + Improve would be included in the hi-fi material, a flip-card approach would be tested as a lo-fi material, and to "record answer via voice" could only be presented as an idea during a field interview (experts said there would be usability issues, and the 1st-time smartphone user agreed). The Gold/Silver/Bronze method was included into the hi-fi material.

Test on a Kampala entrepreneurship student

Also, instead of only testing the app in Tororo, a test was held in Kampala, to get feedback from an entrepreneurship student.

Test in Tororo

As Plan International staff are not allowed to support visiting coaches in the field during local elections, the co-project leaders in Tororo were consulted to carry out the field trips, so that it was still possible to attend the youth group meetings.

For the interactions, a big app test was held, a group interview was held, and then they were divided into co-creation workshop groups, with a presentation in the end.

There was another partner meeting, with Plan International and Community Vision present. There was an app test with all of the coaches, "Testing the Young-Drive coach app", followed up by splitting into six workshop groups based on solving different problems discovered during the test.

The following day, there were three field visits to CBTs, observing how they prepared themselves for a youth session, and then testing the app for assessing and becoming prepared for a session.

After the app tests, it was tested with a lo-fi prototype that the coach thinks aloud about the question, *before* receiving the multiple-choice answers. This approach proved to be great for learning, and could be a great addition to the hi-fi material. Interestingly, this test was done as a live quiz, and if the interviewee could not answer the question directly, the audience were asked and tested if they knew the answer (raised hands), and if nobody knew the answer, it was tested which of the multiple-choice alternatives they found most likely.

During the afternoon, we divided into 5 groups focusing on improving the app experience for the coaches.

On Wednesday, I met with the same coaches from the field visits. I wanted to see how they acted when I gave them the challenge: "Get 100% correct answers in one go, on the hardest quiz". A co-creation workshop ("Educator Dashboard") was held in parallel, with 3 CBTs and 1 project leader respectively.

2.4.5 Iteration 4

The focus of iteration 4 was a summative test.

First, a pre-test was carried out in paper, including questions about the coach and an entrepreneurship quiz, based on a well-known study [Walstad and Kourilsky, 1998], see Appendix ??.

During the test, this was the first time that the app could send data to the server. Data was sent whenever a quiz was started, and whenever a quiz was finished.

The group was divided into two, the ones who brought manuals and they who did not. Those that had brought manuals, could use these with the app, see figure 2.14.

After the test, every coach was divided into one or three groups, on random. In these groups, they were asked:

1. Why do you think you were correct or incorrect?
2. Do they like the app?



Figure 2.14: Coaches answering the app questions for topic quiz 3 on Financial Literacy, and the coach guide quiz 9 on Action Plan.

3. Are you stimulated by the app?
4. What did you like?
5. What did you not like?
6. When do you want to use the app?
7. When are you not able to use the app?

To analyse the paper-submitted data, all of this was combined first into a Google Spreadsheet.

The app results were also recorded in paper, but only as a backup.

Data collection was done by the app itself, which pushes data to server whenever online (it saves quiz start, and quiz finish).

The next day, a small app evaluation and co-creation workshop was held for the Educator Dashboard, and the final version of the app.

Also, a test was done with the Plan Tororo staff.

Back in Kampala, a presentation was held with Plan International.

Back in Sweden, a presentation was held with the YoungDrive Strategic Management Team.

2.5 Application Implementation

In this section, the prerequisites for the app is described, from the perspective of the user, stakeholders, and the developer.

2.5.1 User needs

The technical constraints for the project, would need to affect the technologies used, if the project would be user-centered.

On the client side, the app would need to be mobile and web based, consider non-access to internet, and not use a lot of battery, to work for the coaches of YoungDrive.

That the app should be simple to use in this cultural setting leaded to design constraints and needs for evaluation.

2.5.2 Stakeholder needs

As the project was only three months, and the first month would be without digital development, time constraints were massive. However, to be able to answer research question #2, evaluation needed to be done via data collection.

If no evaluation, there would be no need to write code, instead working with a lo-fi prototype using pure design tools. Now, a data-driven approach was needed to measure, and therefore an app needed to be developed.

On the server side, a database and API would be needed, to pull data from the database and push data from the client. Since internet was not always available, the client must be smart in its usage of pushing and pulling data. This would need to be investigated further into the project.

2.5.3 Devices are prepared

As most of the coaches did not have smartphones or tablets, enough smartphones and tablets were brought with me from Sweden, either donated, borrowed or bought devices. These were a combination of Android and iOS, smartphones and tablets, so the app could be tested on as many platforms as possible. During the user tests, also using a laptop would be tested.

2.5.4 Choosing frameworks for creating the app

In the start, Ionic and Meteor were both tested and compared with each other. It was decided that Meteor was the best way forward, partly because it would allow the app to be accessible on the web as well.

React.js was chosen as the front-end framework, having integration with Meteor and being relatively easy to learn and fast for development.

Since Meteor was chosen, a multiple-choice quiz tutorial in Meteor was used to guide the first version of the app. Modifications were made, e.g. making it responsive and changing it to YoungDrive's graphic profile.

The app was pushed to GitHub, and first hosted on Meteor free storage, available via youngdrive.meteorapp.com. For Android and iOS, it was made possible to install the app from the computer. For each day of the training in Zambia, new quizzes were added to the app, which created a belt path (see 2.1.2).

After iteration 2, a different hosting platform was needed when the Meteor free tier was removed, where Heroku was chosen. Staging environment using

Heroku allowed changes on specific GitHub branches to deploy updates automatically on Heroku servers. The MongoDB database was created using the Heroku plugin MongoLab. A Meteor build-pack was used to allow Meteor to be used with Heroku.

It was also tested to upload the app to Android Play Store. The necessary steps from Cordova needed to be followed, screenshots needed to be uploaded, and some administrative tasks. After this, it only took a day for the app to appear on the Play Store, and everything worked satisfactory.

For iteration 3, as components grew, there was a need for a client-side router. The Meteor plugin Flow Router was used, as it was very popular with good integrations.

For iteration 3, there was also a need to store data per individual, partly because the feature was prioritized from YoungDrive, but also because of the purpose of data collection. In order to store data per individual, a database and login would be needed. Because of technical difficulties, login and automatic data collection was not implemented until iteration 4, which can be read more about in the Discussion in 4.1.2.

2.5.5 Login

To record data per user, would require login. This would be a usability issue for most problems, being 1st-time smartphone users. They need to find it intuitive, user-friendly, and be able to remember the password in the future. A lot of different suggestions were through the ideation phase.

The simplest login possible was chosen, after evaluation and discussion with experts: a 3-digit code, which was to be given to each coach during the test.

Meteor had limitations with their auto-login module, which is very fast to implement. It forces username and password, and instead I wrote the login myself. This was

To summarize, the front-end was not problematic, however, implementing server-client communication so that it worked online and offline, was.

Online and offline database

If data was to be sent from the client to the server, there needs to be a database with Meteor Collections. An example app was made first, only using Meteor Collections. Meteor's use of Distributed Data Protocol (DDP), made app pushes feel immediate, even though data was not sent until there was Internet access.

However, it was found out that if it took more than 15 minutes to get online, the push would be aborted. For users that are seldom online, this would not be viable.

An offline database was needed, and the plugin GroundDB was implemented. As it was cumbersome to get right, pushing the data whenever online, and hard to test (needed to wait 15 minutes each time), this was not ready for the interactions until Iteration 4. As a consequence, until iteration 4 of the app, no results were saved online via the app whatsoever.

For iteration #4, data collection was done by the app itself, which pushes data to server whenever online (it saves quiz start, and quiz finish). The server receives JSON data from the client, stored in the MongoDB database hosted on Heroku. Each data point is saved in a database called Results, with the signed in user (from the Users database). In the database, there are collections for Users, Quiz Lists, and Quiz Results.

2.6 Data Analysis Theory

2.6.1 Iteration #1

2.6.2 Iteration #2

2.6.3 Iteration #3

2.6.4 Iteration #4

Lägg till överall data table

Data analysis is done first by a general overview in Google Sheets, by statistical analysis in R, and by a parallel coordinates visualization. The process to do this, is described below.

Data Acquisition from Server

It was desired to store the data in Google Sheets, thus it was necessary to collect the MongoDB database content, and convert JSON format into a Google Sheets-readable format, like CSV.

Multiple approaches were tried, and the Google Chrome extension called Magic Json by agaze_dev_team (last updated October 29, 2015) was the one that worked without problems. [Team, 2016].

Data Acquisition from Pre-Study

The Pre-study data acquisition was done by instead of looking at the paper-submitted pre-study evaluation forms, using the data processed into Google Sheets.

Data Enhancement of Server Results

This section presents how data from the server was processed, to enable visualization mapping.

To make the data easier to work with, the columns were reordered, and made sortable and filterable.

Some columns were given conditional formatting, so it would be easier to spot irregularities. After this, some observations could be made.

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To be able to compare the test results with the pre-test results, it was clear that it would not be viable to test every dimension against every dimension.

Instead, since goals of the app evaluation had been predefined in the following way, the quiz results were summarized into a new sheet so that the following could be derived:

- % correct 1st try
- number of tries until 100%
- number of tries until 100% in 1 try

These could be calculated by having columns for:

- Quiz 3
 - Start time training
 - % correct 1st try
 - number of tries until 100% in 1 try
 - Time difference start to end time certification
- Quiz 9
 - Start time training
 - % correct 1st try
 - Time difference start to end 1st try
 - Time difference start to passed training
 - Time difference 1st try to certified

Then, to see trends, I again added color scales. With ordinal values, a sequential color scheme is used (e.g. fastest time, from green to red), and with nominal values (like if they are female or male) where there is no right value, a qualitative color scheme is used. Now, it was easier to spot outliers and trends.

Date Enhancement of Pre-study Results

To see differences in answers more clearly, the data from the pre-study was made sortable and filterable. Then, the data was resampled for each column that had numerable (sortable) data in text instead of numbers, so e.g. "The day before" was changed to -1 and "The same day" to 0. In a similar way, school level was divided into four different groups, from 0 to 3, where 0 meant secondary, year unknown, 1 meant lower secondary, 2 meant upper secondary, and 3 meant tertiary.

After this, each column was given conditional formats using a color scale, using Google Sheets built-in functionality. This gave a visual way to quickly get a overview of the pre-test data.

Data Enhancement by joining Pre-test and Results Summary

I joined the summary sheet and the pre-quiz sheet, meaning I had created a multiple-variate data set (several dimensions that I needed to compare with several dimensions), see figure 2.15.

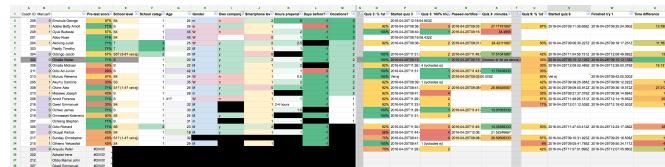


Figure 2.15: The multi-variate data set, made filterable and sortable in Google Sheets. Color scales and calculating means makes it easier to compare characteristics of the coach together with pre-test and quiz results. However, it is cumbersome and hard to quickly filter data on multiple parameters.

I met with my university supervisors, so they could further support me in how to properly analyze the data. Since the two control groups showed similar means on the pre-quiz results, the two control groups were determined comparable.

To meet the challenges of using Google Sheets, a multivariate analysis software or a visualization was suggested to discover the data in less time.

It was hard to determine a suitable multivariate analysis software suitable when having so few data points. Principle Component Analysis or Cohen's kappa would not be suitable, neither was it believed applicable to do Linear correlation on all dimensions.

After discussion with other Master thesis students working with analysing data from various disciplines, parallel coordinates was suggested. It would allow me to very quickly filter the data, find correlations, and distinguish outliers and common characteristics.

To guide the usage of the parallel coordinates (as there is so much to discover in the data set), using R to do Logistic correlation was also done. A disadvantage with this method, is that to be statistically significant, many data points may be needed, and it was now known before-hand if the method would be useful. Probably, parallel coordinates would be the best method with analysing a small multi-variate data set.

Visualization Mapping

The goal with visualization mapping is to generate renderable data, in my case for the parallel coordinates visualization.

Thus, I added a new spreadsheet, specific for visualizing the data.

I deleted columns that would serve no visual purpose (e.g. timestamps), gave all cells data values (even N/A when undefined), deleting users that did not have data, and shortened the column names so they would fit on the screen.

The data was then exported from the Google Sheet into CSV.

Rendering

For rendering, the JavaScript library D3.js was chosen. It supports data-driven documents for visualizing data with HTML, SVG and CSS. It supports both JSON and CSV data.

A visual framework for multidimensional detective for D3.js was found, called "Parcoords.js", written by Chang Kai (2012).

The example code from "Linking with a Data Table" provided the basis for the rendering. It would be a great benefit to be able to see both a parallel coordinates visualization, and to see the same values present in the Google Sheet.

The example CSV file was replaced with the data from exporting the Google Sheets data. Eventually, also the colors were changed, and added the toolkit's functionality to drag the axes titles around to reorder the dimensions, since the goal was to quickly compare and find correlations. The result is visible in 2.16.

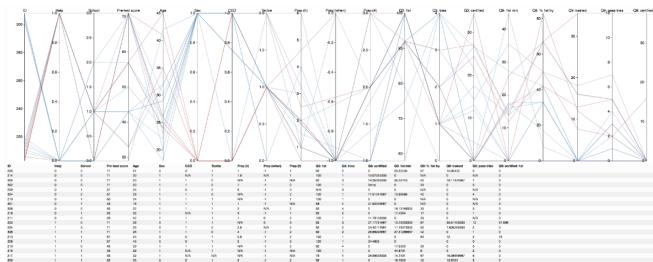


Figure 2.16: The parallel coordinates visualization, done in d3.js. The visualization support draggable axes, filtering of data via dragging the sliders (which synchronize with the data table), color assignment (like blue and red for men and women in the example), and hovering over a specific data point.

3

Results

In this chapter, the results are presented, so that in the next chapter, these results are analysed.

3.1 Developed Application

In figure 3.1 the end results of the app from iteration 1, 2, 3 and 4 are shown. The final app works on web or as an app, online or offline, on all of YoungDrive's Android and iOS devices. The app is fast to use, the back button on the phone can be used to go to the previous view, and the font size and images are consistent for each screen (which was not the case iteration 1-3, see figure 3.1 E-3. The goal was to provide a great learning experience, with a strong YoungDrive feel (embracing the values of fun, plus using the YoungDrive logo and colors).

The quiz flow during iteration 1-2 was a standard multiple-choice quiz game, designed for assessment, but not for learning. In a scoreboard, they could see which questions they were awarded points for and not, with a total score, see figure 3.1 H-1. In the end of iteration 2, whey were encouraged to go back to the start screen, to redo the same quiz again, or select a new one. 1 point is awarded for correct answers, whereas 0 points is given for incorrect answers.

In iteration 3, feedback for self-reflection was introduced. The coach answers Yes or No on "Are you sure?" for each question (figure 3.1 C-3), with the aim of increasing meta-cognitive skills, and being able to give personalized feedback in the score board.

Thanks to recording both if they were correct and confident, the app can give very precise learning feedback (e.g. showing that the coach answered alternative B with confidence, but showing that A was actually the correct alternative).

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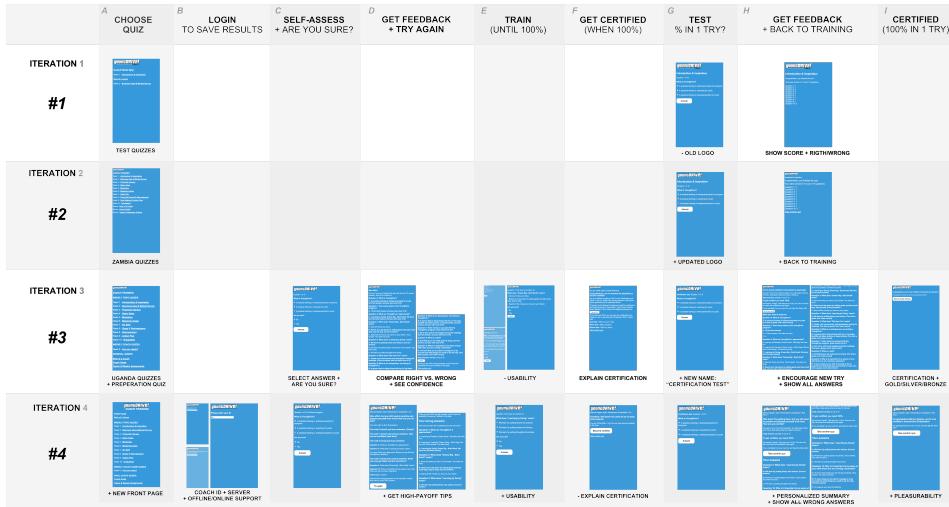


Figure 3.1: The app flow described as a timeline (A-I), per iteration (1-4). E.g. in iteration 4, login (B4) appears after choosing quiz to take (A4).

In iteration 3-4, after observing their incorrect answers, and learning their correct ones (closely compare figure 3.1 D-3 and E-3), they could retake the wrong answers immediately.

In iteration 3, the score board was simply showing each correct question with the answer the coach provided versus the correct one. After giving feedback, the coach can train, and improve on incorrect answers and guesses, and when being 100% correct and confident, ideally take the whole quiz without faults.

For iteration 4, the score board is more personal, encouraging the coach to reflect on her own learning process. The feedback is designed to give a self-confidence boost ("You were correct, and you were sure" or "You guessed, but you were correct. You can answer with confidence the next time"), unlearn knowledge ("You were incorrect, but you were sure"), or encourage studying more when unsure and wrong ("You were incorrect, and you were not sure").

To discourage guessing during training, since iteration 3, the coach is shown number of tries on the quiz if they do not get 100% in their first try (see the top bar of figure 3.1 E-3). For iteration 4, the coach will also get a minus point (-1) for answering incorrectly but confidently "Are you sure?": "Yes". If uncertain, the coach should answer "Are you sure?": "No", and no penalty will be given. The coach will later receive feedback, either "You can be confident next time" (if correct but unsure) or "How can you get these correct next time?" (if unsure and incorrect).

The coach is encouraged to be well-prepared before trying again (either consulting the answers or the manuals). At 100% correct answers, they can get certified, by getting the whole quiz correct without faults. Failing a question on the certification would show that they have not *reliably* learned all the answers during the training. The more effort the coach has put into the training, the more likely the coach will be to pass the certification.

This certification quiz is the same as in training, but no longer do they need to answer "Are you sure?". If the coach can again get 100% correct answers, without any faults, they have proved they are correct and confident with the topic they should teach the youth.

If they fail a question, the score board will encourage more training and that they did not get certified, see figure 3.1 H-4. Since the coach did get 100% correct in the training (maybe after a couple of tries) but not in the certification, the knowledge can be described as "Can do with effort". The coach can choose to take a new quiz, or take the same quiz from the beginning of the training.

For passing the certification on the 1st, 2nd or 3rd time the coach is awarded a Gold, Silver or Bronze medal respectively (after certificate try 3, no medal is given, only the certificate). Compare figure 3.1 I-3 to I-4: for iteration 4, the "certificate" mentions the persons name and the topic certified in, which is a form of gamification in addition to the intrinsic motivation of rewarding deliberate practice.

In the following sections, you can read more about what data guided the development of the final app, as well as the results from the final app evaluation.

3.2 Uganda Coach Visit

Here the results from the qualitative and quantitative data for iteration 1 are shown, together with conclusions.

3.2.1 Qualitative data

Below, the most important results from the stakeholder and coach interviews are presented.

Stakeholder interview findings: Entrepreneurship education considerations

Through early interviews with YoungDrive staff, it is clear that YoungDrive's entrepreneurship education methodology goes hand in hand with the presented theory. It's mottos are: "Dream big, start small", "Learning by doing" and "We have fun!" [Lönn, 2016].

Both in regards to designing for the users and for the above reason, the app should be a complement to YoundDrive's existing training material and the structure of the program.

A challenging part of the work is that YoungDrive consists of both the practical skills of the entrepreneur, theoretical material of running a business, and an entrepreneurial mindset. Therefore, both how to assess knowledge, and build habits, needs to be examined.

As the stakeholder interviews answered "What's it like being a coach?", their perspectives could now be understood and summed into a early understanding of the coach situation. The stakeholder interviews heavily informed the Questionnaire guide, highlighting aspects that had previously not been taken into account.

Coach interview findings: Teaching with confidence

The purpose of the coach interviews was to understand "What's it like being a coach?", from the coaches own perspective. Thanks to having similar interviews with stakeholders, their views could be compared. Also, more detailed answers on background, desires, experience and situation could be provided.

From the interviews it was understood that CBTs can be responsible for from 7 up to 12 different youth groups in different programs, and such a high number places huge demands on the CBT. Even if there are only 7 groups, being behind on schedule or not being confident, can be very demanding.

The interviews with CBTs, Project Leaders and stakeholders led to the realization that different coaches handles this differently well. All coaches possess high self-confidence in varying degrees in various situations, and as a result, quality among coaches is unbalanced, which they see as a challenge. Depending on the situation, everything is going according to plan, you are not confident, or you are falling behind with the schedule, you can be in one of these three Need groups:

- The ideal coach
- The realistic coach
- The challenged coach

It was discovered that coach confidence comes largely from being able to have good youth sessions. This is important, because according to the interviews, being a high-quality YoungDrive coach to a large extent means having high-quality youth sessions. For having a high-quality youth session, these are the most important attributes:

- Correct information
- Correct structure
- Time management
- Fun atmosphere

These findings were used to inform the Customer Journey Map workshop. In addition to the findings here, questions were also asked around ethnography.

3.2.2 Quantitative data

Two workshops were held, which together would inform future development of an application. These were the findings from those two workshops:

Customer Journey Map: "A day as a coach"

The first workshop had the three interviewed coaches as participants. See figure 3.2. A Customer Journey Map would be created, with the purpose to understand all activities involving "A day as a coach". The structure of the timeline was: "Before", "During", and "After" a youth session. To understand how these activities differentiated between different coaches, three Personas were co-created based on the previously discovered types of coaches: "the ideal coach" (John), "the realistic coach" (Joan), and "the challenged coach" (Suzan).



Figure 3.2: Two local project leaders and one coach mapping out the activities a coach does before, during and after hosting a youth session, in what is called a Customer Journey Map.

They understood the concept of the workshop surprisingly effortlessly, although the concept of postits and Customer Journey Map and Personas were unfamiliar to them. Contributing to the energy, was probably that the timeline and personas were largely informed by their interview answers. The workshop gave great insights for understanding the coach situation and the coaches themselves, both observing their behaviour during the workshop and learning about all the unknown activities involved in being a coach.

The first workshop was finished with many important insights. Thanks to using Personas, it was discovered from the workshop that the difference between coaches and the quality of the youth training was more diverse than originally thought.

This is especially true when the coaches prepares for their youth session, an activity which was regarded as important as the coach training, but where quality of preparations were very divergent. This could be a great opportunity for delivering the app's promise of distance learning (see section 1.1). The teacher Josefina in an after-interview commented that while she can influence the coach training by her physical presence, she currently has no influence or insight into how the coach prepares, more than the co-project leaders' reports. When preparing for a session, there is a wide variety of *when* the planning happens, and how a coach judges what amount of preparation is enough.

Most coaches plan their next session during the morning, or immediately after a session with their group. Since a coach has somewhere between 7-10 groups (some even more), and the youth groups are at different modules, there is a lot of knowledge for the coach to handle - not only theoretical knowledge, but also the struggles of the youth, assignment presentations, workshops to be facilitated, etc. It is easy for a coach not to do everything as planned or as specified in the manual. Most of the coaches are said to be motivated by the possibility of becoming a better coach.

According to the workshop, most of the coaches assess if they were ready for a topic *after* a youth session. The feedback from the youth, as well as their questions and how well the coach can answer these, are the biggest informant. The exception is if the local project leaders comes to visit the youth session, but they do seldom have time to visit all of the coaches during a month, and during a month coaches should have taught 4 topics to all of their groups.

Smartphone Test using Quizoid and Duolingo

Quizoid (see figure 3.3) and Duolingo (see figure 3.4) were tested to understand the technical possibilities of the coaches.

Two of the three test users used a smartphone for the first time. The attitude towards using a smartphone was overwhelmingly positive. One of the coaches even mentioned: "Marcus, today one of my dreams have gone true." He even asked if he could borrow one of the devices during the remainder of the stay. Even for coaches that had never touched a smartphone before, some concepts were easily understood (like using the camera and Quizoid).

Other concepts were harder (accidentally getting to the settings menu, unlocking the device, understanding advanced games, or training languages using Duolingo with advanced interactions). Point and click is easily understood, whereas sliding is much more unnatural.

The result was that the app can place itself somewhere in the middle of the two, regarding difficulty level.

3.2.3 Discussion

During a evaluation meeting with Linköping University and YoungDrive, it was determined that Iteration #1 did provided answers for research question #1, #2, and #3, and partly #5. Thus, the iteration could be considered very successful, and now, the development of the app could begin.

It is clear from the data that the motivation of the app should be to assess and strengthen the entrepreneurship knowledge and skills of the coach. For coach quality to improve was a desire from the stakeholders as well as the coaches themselves, even if they were also satisfied with the current results. This lead to a challenging situation how an app can address becoming a better-performing coach.

An app could increase accuracy of correct information. With an app, the coach could keep a record of the module content, and see when and if they do

need to refresh their skills. It was discovered that a coach app can benefit not only the coach training, but also in a surprisingly precise way, what was called "distance learning" in section 1.1. Accountability if the coach is ready for a session by automatic assessment. A very important aspect to increase learning and confidence will be to give good feedback (see section 2.1.1).

With all the possible benefits of an app, it is definitely a problem that so few coaches have smartphones. Either continued development could be guided solely by the use case of having an app tailored for the coach training (where donated devices are available). But this would be to ignore that an app helping the coach to prepare for a session would be extremely beneficial, which discovered during the field visits to youth sessions and during interviews.

The motivation for using technology is very high, so one way forward would be that the app for distance training will reach only the users that can be given access to a smartphone, counting that more coaches will get smartphones in the future. Not using smartphones but feature phones (which all coaches possess), would mean building an SMS-based service (see 6.1).

As most coaches are already motivated to become a better coach and using technology, Sierra's [Sierra, 2015] advise of designing for their compelling context can be followed. From a YoungDrive perspective, this might mean "Given a teaching situation among the youth group, a great coach can teach an entrepreneurship topic more consistent with what the coach material said". Their performance in the YoungDrive app could translate into: "Given a question in the app, a great coach will get the right answer more often, and increasingly leverage the correct answer to their coach situation".

3.2.4 Next iteration

It is agreed with Josefina that the most important found skill of a YoungDrive coach is having great youth sessions. It is a challenge that the coach surely needs to feel, but does not always possess, self-confidence for its youth session. This partly stems from the lack of practical experience being put into realistic situations during the coach training.

If self-confidence comes from being able to deliver Correct Information, Correct Structure, Time Management and Fun Atmosphere, an app strengthening these will surely improve youth session quality. According to Josefina, assessing and increasing Correct Information is the parameter she values the most highly, and this will be the continued primary focus of the master thesis.

It is agreed with Josefina that preparing for a youth session can have an increased focus. It is a worry that designing for both the coach training and preparing for a session might be too ambitious within the given time frame. If so, designing for the coach training is deemed more important.

3.3 Zambia Coach Training

Here the results from the qualitative and quantitative data for iteration 2 are shown, together with conclusions.

3.3.1 Qualitative data

Lessons learned from unbiased app design by coaches

The result was fantastic, in the sense that it gave an unbiased look at what the coaches expected from the app, what functionality wasn't important, and into their technical preferences. A simpler design than originally thought was deemed sufficient, and the simple sketches guided continued development of the app during the week. From using the devices, it was found that most coaches prefer using the tablet (5 for tablet, versus 2 for smartphone and 2 for computer). Both the designs and insights gained were used throughout the week to further improve the simple app created at the end of iteration 1. The workshop gave great insights to who the coaches were and their thinking.

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Lessons learned from app test observations: motivation

Regarding motivation from the coaches, one coach wished the app to be available on the Google Play store immediately, so that "The app could be used on my spare time". Another coach, without a smartphone, said "I'll buy one", because the utility of the app seemed so high. There were also suggestions for improvements, like "The app should have notes, not only questions". Regarding usability, low resolution screens made the text barely visible. This showed, that the app needed to be tested on a lot of different devices. This is particularly true, as on day 1, the coaches did not know how to zoom, which could cause accident refreshes, frustration or confusion. Even more importantly, the app needs to work offline! To be online on the phone is too expensive for the coaches, and too unreliable to give a satisfactory experience. Also, during testing, relying on internet can cause a lot of problems, especially if the teacher is alone.

When asked about what they thought about doing one quiz ("Graduation") as a pre-quiz (before the session), 10/10 said they liked doing the quiz before, and that it benefited their learning during the session. When asked why it helped, these were the results:

- "During session, it is easier to follow" - 10 (100%)
- "Giving the paper manuals before, scanning headings and pictures etc, would not help" - 10 (100%)

It was also tested to work in group or individually. The ones who answered, said that you learned more individually (3/3), and more fun doing it together (3/3). Doing it together, was enjoyable as it was "Very easy because of using different minds" and "We can collaborate to do better". It can be argued that the quiz being easier is not a valid motivation, but describes the learning in the app as a desirable difficulty.

When doing a post-quiz ("Goal setting") immediately afterwards versus at the end of the day (doing spaced versus massed learning), quotes were "I thought it was fun and challenging to do the quiz immediately afterwards", with another coach commenting "The mind was still fresh". After a discussion with the teacher, these were the results:

- 3/10 wants to do the quiz both before and after a session
- 1/10 wants to do the quiz before and at the end of the day
- 7/10 wants to do the quiz only immediately afterwards
- 10/10 wants to do the quiz immediately afterwards, and then again at the end of the day
- 7/10 wants to do the quiz immediately afterwards, and then a joined quiz with other topics at the end of the day

The high scores on using the app a lot indicates that they like the app. The teacher wants to listen to coach opinions, at the same time not spending more time than necessary on assessment.

Regarding motivation from the teacher, asking Josefina what would hinder her from using the app, she says: "Not doing data collection digitally works whenever they are 10 - but not with bigger numbers than that." Also, according to the final interview with Josefina, she does not wish the app to replace her. She enjoys teaching, thinks she has an important role, and suggests the app to be designed to support her and the coaches, not replace her. She accnolodges that bugs in the app was a hindrance to functionality, and that a lot of testing (both high-dose, and high-scale) is very important.

Lessons learned from app test observations: learning

Regarding assessing knowledge, coaches had surprisingly high quiz results, and at day 3 they wished harder questions when asked. The response was to give harder questions the other days, e.g. by introducing similar answers, and testing 4 alternatives instead of 3. This was appreciated. The app was later tested on a university student in Uganda after the Zambia training, both on early and later quizzes. The university student from Makarere University scored 100% correct, in spite of not having any entrepreneurship training. This showed that guessing was possible, or that the quizzes were too easy.

The teacher Josefina commented that this might not be a problem, as the YoungDrive coaches are not as skilled with using a process of elimination, and had indeed scored lower results on average with the later quizzes. When testing the app with refugee innovators during Humanitarian Innovation Jam in Uganda, similar results to the YoungDrive coaches were found. She explains this by that the cultural context is different, and that thanks to coaches in rural areas not being equally educated and skilled with reasoning, the problem is not as big as could be. Josefina is very happy with the app, and reviewed the app in the following way to Plan International after the training:

"The (YoungDrive coach training) app is a great tool to measure how much the coaches learned and understood from the daily training; it provides a clear overview of what the coaches truly understood and what they actually still don't completely understand. Based on that information I as a tutor can adjust the

training for the following day to make sure that the coaches understand everything correctly. The app also works as a motivator for the coaches; it's clearly reflect their own daily performances. If they score high they become very happy and satisfied, if they score low they are eager to check their wrong answers".

A coach scoring only 9/19 showed the relevancy of the quiz, as Josefina did not think she would have discovered that the coach was lagging behind otherwise. In the data, it was observable that the coach had done well together with others, but 3/7 when done individually. Josefina said about the 9/19: "This is where a control group would be beneficial". "He is often passive during open questions, but active during the team exercises."

According to Josefina, if you have a high score, you are ready. If not, you need to redo the quiz. If you are 8/10 or lower, you are in the red zone. If lower than 10/10, they are not ready, the motivation being that what they don't know, they will teach in an improper way: affecting hundreds of youth. This is why Josefina thinks they should need all of the answers correct.

Up until now, merely Correct Information has been assessed, not the other three factors. The fact that the app already is appreciated with assessing Correct Information, makes starting to assess the other factors interesting. Josefina informs that Correct Structure, Time Management and Fun Atmosphere would be the most viable to test *after* a youth session, not before. She notes, that *some* assessment could be made via the app before a session. This could be further investigated.

3.3.2 Quantitative data

Results from the coaches

Day 4

Tested using the quiz before the session. Using the quiz before the session increases learning, slightly decreases fun of the session, according to coaches. It is "Fun and encouraging".

Day 5

On day 5, the schedule was:

- "Goal setting" part 2
- App test: "Goal setting" after-quiz and "Graduation" pre-quiz.
- "Graduation"

In "Goal setting", one coach were an outlier to the other high results, scoring 9/19 answers correct.

Results from workshop #2

During this workshop, the focus was to examine what builds confidence among the coaches. The following clusters could be determined: "I believe in myself" (3 coaches), "I believe in God" (2 coaches), "I am well prepared" (4 coaches) and "I am certified" (1 coach). See figure ?? for the different clusters.

Josefina comments after the workshop: "I have a problem: There is no way I can control them how they have prepared themselves for a youth session.", says Josefina.

Bonus results: Testing the app on refugee innovations

Back in Uganda, a test was done with refugee innovators, at the Humanitarian Innovation Jam.

The test with the refugee innovators were surprisingly intriguing and successful.

It was found that refugee innovators say they would have a great need for such an app.

3.3.3 Discussion

The quantitative and qualitative data from iteration 2 shows that the app works for "validating the coaches' level of knowledge during their education", which was the main purpose of the master thesis (see section ??). Now, the app should be tested in Uganda as well, and there can be an increased focus on "distance training" and "certify all staff".

Iteration 2 has translated the theoretical understanding of answering research question 1, 2, 3 and 5 into practical experience. Now there are observable evidence for what the interactions from Iteration 1 showed:

- The purpose of the coach training should be to prepare the coach in having great youth sessions
- Therefore, this is what the quizzes should assess
- What it really means being a good YoungDrive coach, is having good youth sessions
-

Validating the coaches' level of knowledge

Also, work on research question 4 has started. While the teacher has appreciated the multiple-choice assessment, challenges of designing test questions to support entrepreneurial learning has been found. It is clear that the app is valuable for assessment, increasing coach self-awareness and being a valuable indicator for the teacher. However, the questions formulated scores low on Bloom's revised taxonomy ? compared with YoungDrive's educational objectives for the topics.

There are previously found issues with using multiple-choice for assessment and learning, but they seem to become especially relevant in the context of teaching entrepreneurship.

Either question formulation needs to be improved, or creative design solutions needs to be experimented with which can increase coach understanding and identify and reduce guessing. This needs to be further investigated for iteration 3.

Test with university student scored 100% correct, means that common sense can go a long way, and that the results can't be 100% trustworthy, and that multiple-choice questions has serious issues - this, we already knew during and before the coach training - but it needs to be taken care of.

Distance learning

In addition to the formative app tests, workshop # 2 heavily informs what is necessary when designing for use case 2, distance learning: preparing a session in regards to building confidence. The results from the workshop are somewhat surprising, factors not only those that relate to the four parameters from iteration 1 ("I am well prepared" and "I believe in myself"), but for some also "I believe in God" or "I am certified" (which relates to purpose 3 of the app). These should be considered for iteration 3.

Further, app tests expose how the app is currently not actively designed with learning in mind, and thus not distance learning. This is unfortunate, both because distance learning is important, and as the app test with refugee innovators shows that there is an opportunity doing entrepreneurship training in rural areas outside of YoungDrive's coverage area. In order for online coach-training to work for distance learning, learning and feedback, and not only assessment, is however essential.

While it may be technically possible, the teacher desires the app support her during the coach training, not replace her. Therefore, completely replacing the teacher with an app should be avoided. The teacher is very important for giving coaching and educating in a way that the app can't. But the teacher can also be empowered by the app. For the future, Josefina would have liked to be able to stop coaches from having taught, if they do not have 90-100 % correct information on the subject. Today, Josefina can not assess this. This means that some coaches, are teaching incorrect information to hundreds of youth. Here, the quiz has a very good need to fill.

If wrong on an answer, the app today has no means of giving high pay-off tips to get to 100%, or exposing you to deliberate practice or perceptual exposure. If the coach gets 9/10 correct answers reliably, or gets 5/10 answers with guesses, the coach still needs to retake all answers, not having learned the correct answer before taking the quiz again.

How to develop the app to solve these issues, is not obvious. Multiple strategies could and should be used. The app could benefit from introducing smart feedback encouraging a growth mindset ("You did not get 100% yet") ?.

3.3.4 Next iteration

After the meeting with the partner and expert group, the following was concluded from iteration #2:

- The app is partly working on assessment now, but not for learning. Are coaches really learning via the app, especially learning to be better coaches?
 - Multiple-choice is flawed in its current form. How can guesses be identified and reduced in a multiple-choice format? How can answering questions improve confidence and encourage learning?
 - How can questions be formulated in a way that teaches entrepreneurship, which is so practical?
- The need for a field app still feels relevant (especially for sessions long since the coach training)
 - An app could be used, either before you start planning (to guide what you need to study the most on), or after you think you are ready (so you can assess and improve).
 - When designing the app, it is concluded that an app for coach training, and an app to use before a youth session, should be able to be the same app if possible, since the purpose of preparing the coach to be great with its youth session is the same.
 - Discussing the importance of self-reflection after a youth session with Josefina, led to asking more of such questions in coach quizzes. While Fun Atmosphere can be hard to assess using multiple-choice, can Correct Structure and Time Management be assessed?

After the partner and expert meeting, it was decided that the following needs to be done for iteration 3:

- Make sure that the coach actually learns the desired educational objectives
 - Create a new quiz guided by Josefina, "Are you ready for Session 9?", also to test if Correct Structure and Time Management could be assessed using multiple-choice
 - See if design additions to multiple-choice can increase learning in-line with Bloom's revised taxonomy
- Design quiz app for learning, focus on field app, and have a design that works stand-alone from the YoungDrive coach training in mind.
 - Investigate the effect of giving growth mindset feedback in the app (The Power of Yet approach)
- Test if the app created in Zambia could work also in Uganda
 - This also means converting all the questions from the new (Zambia) manual to the old (Uganda) manual, since both structure and content of the manuals has changed.

3.4 Uganda Formative Test

Here the results from the qualitative and quantitative data for iteration 3 are shown, together with conclusions.

3.4.1 Qualitative data

Observations from Kampala test

The entrepreneurship student in Kampala, informed the following changes:

Instead of "Become certified", he would be more motivated by unlocking the opportunity to apply the skills.

"Improve" should be renamed "Try again", because it is more intuitive.

His overall opinion on the app was:

"Can you give me the link, because I'd love to do more of this. I think it's amazing."

Verified relevancy of separating Training and Certification

When asked for an opinion, Josefina answered: "I like the idea that when the coaches have answered all of the questions correctly, they can consolidate the knowledge by the certification test, when the coach should get 100% correct on their first try."

Field visits

The first thought was to use Gold/Silver/Bronze in the Training mode, and "Are you sure?" in the Certification mode. User tests showed that the other way around was better.

Big app test

Learning: The app test simulated the app being used to assess preparedness for a youth session. They clearly showed evidence between the difference between designing for Assessment and Learning:

Given a coach having prepared for their youth session on week 9, and then only scoring 5/10, what should happen? In a similar way, what should happen if 9/10 correct answers?

For the coach training, the assessment was okay, since Josefina could pick up and give feedback.

Before a youth session, leaving the coach there is not viable. If the coach has 9/10, that coach should not only be let be, and especially if the score has been 5/10.

Feedback was that one user did not want to press "Improve", until having read the manual. The motivation was: "Not because that is what the info says, but because I can learn more from the manual, about more than what the questions says."

This is indeed the preferred behaviour from Josefina, and the app should continue to encourage only using the app training or certification mode after having prepared via the manual. This way, the app is still assessment, but it is "learning by thinking", with feedback.

3.4.2 Quantitative data

Observable trends from the coaches

Usability: The most notable thing from the app test, was that the app was not user friendly at all for 1st-time smartphone users. There were a lot of bugs, e.g. resizing of the font size for each new question. This forced some coaches to try to zoom on the devices, even if they did not know how. This could in turn cause refresh of the web page, and sometimes there was no Internet available. Thus, the data can not be fully reliable.

This was the first time true frustration was shown. Out of 23 respondents, 7 rated the app easy, 11 medium, and 6 hard. This was not viable.

Related to assessing Correct Structure and Time Management Using a "Are you ready?"-quiz the multiple-choice-structure was tested to assess and train Correct Structure och Time Management. This was not shown very effective. While it does test Factual Remember, e.g. "How many minutes should you spend on X?", since the answer to a lot of questions are retrieved from memory, instead of analyzing, questions often does not score higher on Bloom.

The data and observations shows that learning Correct Structure and Time Management via multiple-choice is not effective for learning. To score well on such a test, the coach would retrieve from memory using a clear mental image.

Related to mobile experience Before the quiz started, the coaches were asked to raise their hand if they felt proficient with using a smart phone. 8 out of 23 said yes.

After the quiz, 16 said they were proficient (25% increase), while 5 said low proficiency, and 2 said no (we don't yet feel proficient, still fear).

Field tests During field tests, 3 CBTs were visited, to further observe usage of the app after having prepared a youth session.

Some things were notable from the interactions with John:

- "Are you sure?" is understood intuitively (you can't progress without answering), but some coaches deliberately answer "Yes" even if they are not sure.
- Idea to highlight different words of similar answers, to increase speed
- In summary, if wrong, show the other alternatives either way, not only the wrong answer

It was also here, that it was first observed that this is a light version of both deliberate practice and perceptual exposure. It is just that the app as of now is quite inefficient, especially in terms of speed.

From the interactions with Juliet, this was discovered:

Add idea for future work:
Show how a persons

- Idea for future work: "Go to participant manual" within the app
- If correct and unsure, she says "I still feel good". "Include it in wrong, because maybe I was still guessing". (This later informed the Certification quiz-insight)
- Change button to "Become certified", to increase likelihood to press the button. As of now, it was not obvious.

When she did get certified, she said "I feel good". When asked why, she said: "They have appreciated what I have done".

"Are you ready?" app test The next day, the three CBTs gathered at the Plan International office to do an app test on the hardest quiz.



3.4.3 Conclusions

For iteration 3, the coaches could not only assess, but also *learn* Correct Information, which was successful, but needs to be done more effectively.

It took an unacceptable amount of time to reach 100% proficiency on all the quizzes. This was especially evident, on the quiz on Correct Structure och Time Management, "Week 9: Are you ready?", when it took a coach 2.5 hours to reach 100% without errors. In iteration 2, when "Improve" did not exist, it probably would have taken even longer.

The focus had been on "I am well prepared", but also including "I am certified.". It was shown that most coaches does not care about "I am certified" (which the workshop already had shown), but that they do care about their learning progress and learning results.

Pedagogical model

There were four ideas originally, for the pedagogical model:

1. The coach result from Iteration 2: "Try again"-button. When clicked, your wrong answers are repeated.
2. If 100% on the 1st try, gold. On 2nd try: silver. On 3rd try: bronze.
3. Ask meta-cognitive questions, e.g. "How sure are you?", at the end of each question.
4. Record your answer to the question before you are shown alternatives.

Option 1, 2 and 3 were determined good after the interviews, while item 4 had too many challenges (difficult to use, difficult to implement, cumbersome).

To improve Deliberate practice: not satisfied. Goal: design practice exercises that will take a fine-grained task from unreliable to 95% reliability, within one to three 45-90-minute sessions.

If not possible, don't continue trying: split into smaller tasks, Sierra says. This could be reinforced in various ways.

To improve effectiveness, it was determined that "learning by thinking", regarding metacognitive skills, could be one of the most beneficial methods. This would help the coach to analyze and evaluate its own learning, possibly improving faster in the app. Using the theory from Sitzmann and Kanar [2008], questions can prompt self-monitoring and self-evaluation.

Youth session While there was now an MVP for the coach training, there was not yet a MVP for the youth session; only an MP (minimum product, but not viable yet).

Bonus results

The Kampala test showed how well the app works for learning entrepreneurship also outside of the YoungDrive context. Some modifications would greatly improve this further.

Data collection needs to be online

Data collection manually was not viable with coaches more than people, it got to hectic. To do it online means that there needs to be a database, but also a login, so individuals are traceable.

Collecting the data on Are you sure?

If there is one thing learned during the iteration, it is the notion of "data is knowledge, and knowledge is power". A realization is that both the developer, the coaches, the teacher, and the project partners can gain important insights. Adding "Are you sure?" to each quiz question, this was amplified, because now, also the coach's attitude can be evaluated. See more about this in the Discussion chapter.

For the next iteration

- Divide the learner's expertise according to Sierra [2015], "Can't do", "Can do with effort", and "Can do effortlessly".
- Increase the use of questions to prompt self-monitoring and self-evaluation
- Implement login and a database in a suitable way, to store quiz results online

Add reference

3.5 Uganda Summative Test

Here the results from the qualitative and quantitative data for iteration 4 are shown, together with conclusions.

3.5.1 Qualitative data

In the final app test, everyone thought the app was good and easy to use ($n = 26$). The interview answers of what the coaches said about the app were clustered into areas of Learning, figure 3.6, Interaction Design, figure 3.7, and Service Design, figure 3.8.

3.5.2 Quantitative data

In this section, the findings from each data analysis method are presented.

Google Sheets

Add table from Google Sheets

Early observations from the pre-test data when inserted into Google Sheets was that a surprising number of cells were left blank. One user had not done the pre-test, where some had left questions unanswered (most commonly "Do you own a company?" (should have used the word "business"), plus "Hours of preparation" and "Occurrences for a youth session" (there is a tendency this might be because they were not proud of their answers, because of correlations with low quiz results).

Missing cells was not as obvious with the app results, were users could not progress in a quiz without answering both the question and the confidence. However, none of the passed quiz 9 certification answers had been submitted. Thus, it was needed to add these from the manual recordings, which had been used as a backup in case anything like this would happen.

There were a number of quick insights that could be drawn before the parallel coordinates visualization: there was a surprisingly low number of answers where the user answered the question without confidence. Also, more users had started a quiz without finishing it than anticipated. Finally, a lot of users had done quizzes that were not Topic quiz 3 and Coach quiz 9, which might indicate high interest (if they did more than 2 quizzes) or confusion (if they did not do 3 or 9, but they did do other quizzes) during the app evaluation. This meant that on some aspects, there were less data than anticipated, (which was troublesome, as there were already few data points), and some aspects where there was more data than anticipated (that were overlooked).

First-hand insights before the parallel coordinates were that there was a strong correlation between pre-quiz results and quiz 9 try 1 (slightly visible also in quiz 3 try 1, but with more outliers). Also, with manuals there was a higher probability to finishing quiz 9 training and certification (see also findings from the parallel coordinates visualization below).

Statistical analysis

Statistical analysis in R unfortunately showed that none of the results were statistically significant to be notable using linear regression, or any of the other statistical methods detailed in the methodical framework. As such, a larger data set would be needed to be efficient in the future. It was believed that statistical anal-

ysis could at least give insight into what to look after in the parallel coordinates visualization, but also for this, a larger sample would be needed.

Parallel coordinates visualization

The interactive parallel coordinates visualization could give many more insights, more faster than the static presentations in Google Sheets.

There are an almost unlimited number of findings and observations that are interesting looking at the parallel coordinates visualization. Even if there are no clear correlations (which are often found immediately when working with large data sets and parallel coordinates), tendencies can be found. As nothing is statistically significant (mostly because of the small data sample), the only thing that could be found are tendencies, and to analyze outliers. Then, these findings could be critically analyzed to characteristics, and observations made from the app tests and research. As such, the data should be seen as indications of where future research is interested, and not as universal truths. For further research into the data, see figure ??.

Findings From the pre-test data, it can be seen that only CBTs said they didn't feel comfortable with smartphone ($n=2$, of which there were 6 Youth Mentors and 14 CBTs). A reason might be age, as CBTs were older than the Youth Mentors. Also, youth mentors had higher school level than the CBTs.

In quiz 3 and 9, there is no unison difference in performance between Youth Mentors and CBTs. In quiz 9 however, the Youth Mentors are top performers compared to CBTs, which goes in line with the project leaders opinion in the field that Youth Mentors are slightly better in the field than the CBTs. It is important to note that there is nothing statistically significant to draw confident conclusions. Further research needs to be made, as a connection between how a coach performs in the field versus the app is valuable.

If the app is indeed an indicator if the coach performs well, the data shows that female coaches should be hired for YoungDrive. It is very clear from the data that women have better quiz results and prepares more for their youth sessions, even though they have lower school education. More than average, for example in quiz 9, the women have a higher lowest threshold, and a much higher record, than the men. Only women ($n=2$) passed the quiz 9 certification. Today, the balance between male and female coaches is reversed from what the data says: in Zambia only men have been hired, and in the data collection for Uganda, only 30% (6/14) were women.

Only two people were fast enough to get certified on the final quiz before the app evaluation ended, see figure 3.9.

Social characteristics, other than that they were women, were that both were CBTs (not youth mentors), and were in the middle of the age groups (24 and 26 years old). Regarding performance, they had a good pre-test score (57% or 71%), had top scores on quiz 3 try 1 and 9 try 1. Also, both of them used the manual, they looked at themselves as medium-skilled using a smartphone, and they prepared many times per youth session (2 or 3 times).

What didn't seem to matter for top performance, was number of tries for pass-

ing the training of quiz 9 (one coach did 2 tries on quiz 9, the other 12 tries!), or time to pass training quiz 9 (35.5 minutes on the slowest versus 12 minutes on the fastest). Neither did it seem to matter when they prepared their session (1 did preparations the same day, 1 the day before). Regarding social characteristics, one had a business, one didn't, and their school level were both low.

Finally, it is interesting to observe the differences (and lack thereof) between control group A and B. In A, the paper manuals could be read before improving on the quiz results (not during the actual test). The B group were only allowed to observe the right answers within the app, from the score board. In quiz 3, where almost all coaches had 92% or 100% immediately, there is no difference observable. However, in quiz 9, the hardest quiz, 5/7 that passed the training were in control group A, and 2/2 that passed the certification were in control group A. An explanation could be that the large amount of questions made the correct answers hard to memorize versus actually learning, or that the ones with manuals felt more supported or motivated because of the extra support.

While these findings could be true for a larger sample, further research needs to be done. The same methods of data analysis are increasingly relevant with a larger data set, and there seems to be correlations and tendencies which are very valuable to look further into.

3.5.3 Conclusions

Add everything from the mindmap

In three months time, an app was developed with precision to the needs and context of the end users. The design has been heavily influenced by the end users, from day 1 of the project, in conjunction with relevant research, and in balance to stakeholder goals and considerations, and supervisor advice.

The results show that the ideal coach, according to the quiz app, would be a woman, since she has better knowledge in spite of having less formal education. She prepares more, is more aware of her own knowledge and has a better study technique, respecting the app feedback for meta-cognition and meta-memory. This can be seen by higher quiz results, faster learning, and more honesty in "Are you sure?".

It could be that first-time smartphone users have a disadvantage with the app, since they will not learn as fast as experienced users. The interactions show however, that at the second session, almost all of the coaches felt intermediate instead of beginners, using the smartphone and the YoungDrive app. The quiz data verifies this, with no direct correlation between technical skills and quiz results.

The final version of the app shows users can get 100% on quiz results much faster than the previous version, where the score board had been improved. Since the target group in Zambia and Uganda was different, it is hard to say if it went faster getting 100% with the possibility of repeating only the wrong questions, asking "Are you sure?", and providing individual feedback. The qualitative study does show however, that 100% thought the feedback was good for learning, and that they appreciate the app.

The data shows that being honest and deliberate during the training increases the likelihood that a coach can get 100% without faults, and has truly learned. Further, when a coach has passed the certificaiton, they do feel more confident about teaching the topic, since assessment of "Am I ready?" can happen already before the session, and they feel the quiz has been a fair way to measure their knowledge in the topic.



Figure 3.3: Quizoid is a simple multiple-choice game [Apps, 2016]

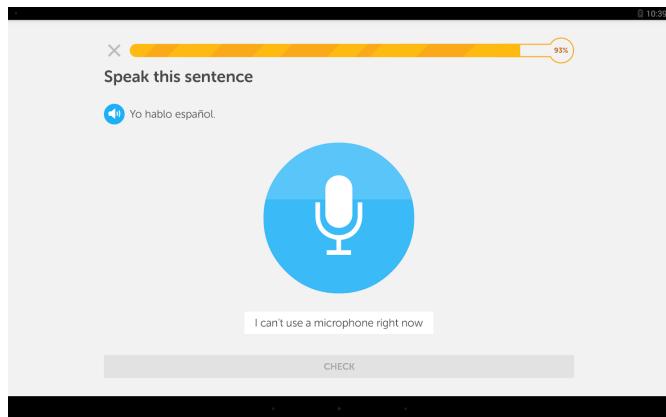


Figure 3.4: Duolingo is a praised app for language learning [Duolingo, 2016]



Figure 3.5: The clustered postits with needs, together with included design proposals.

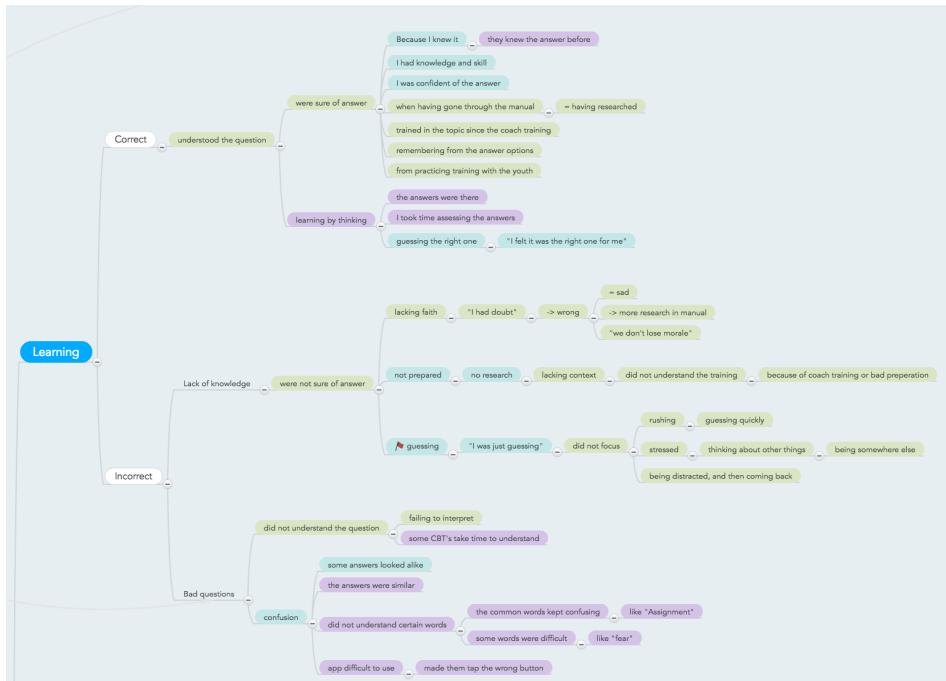
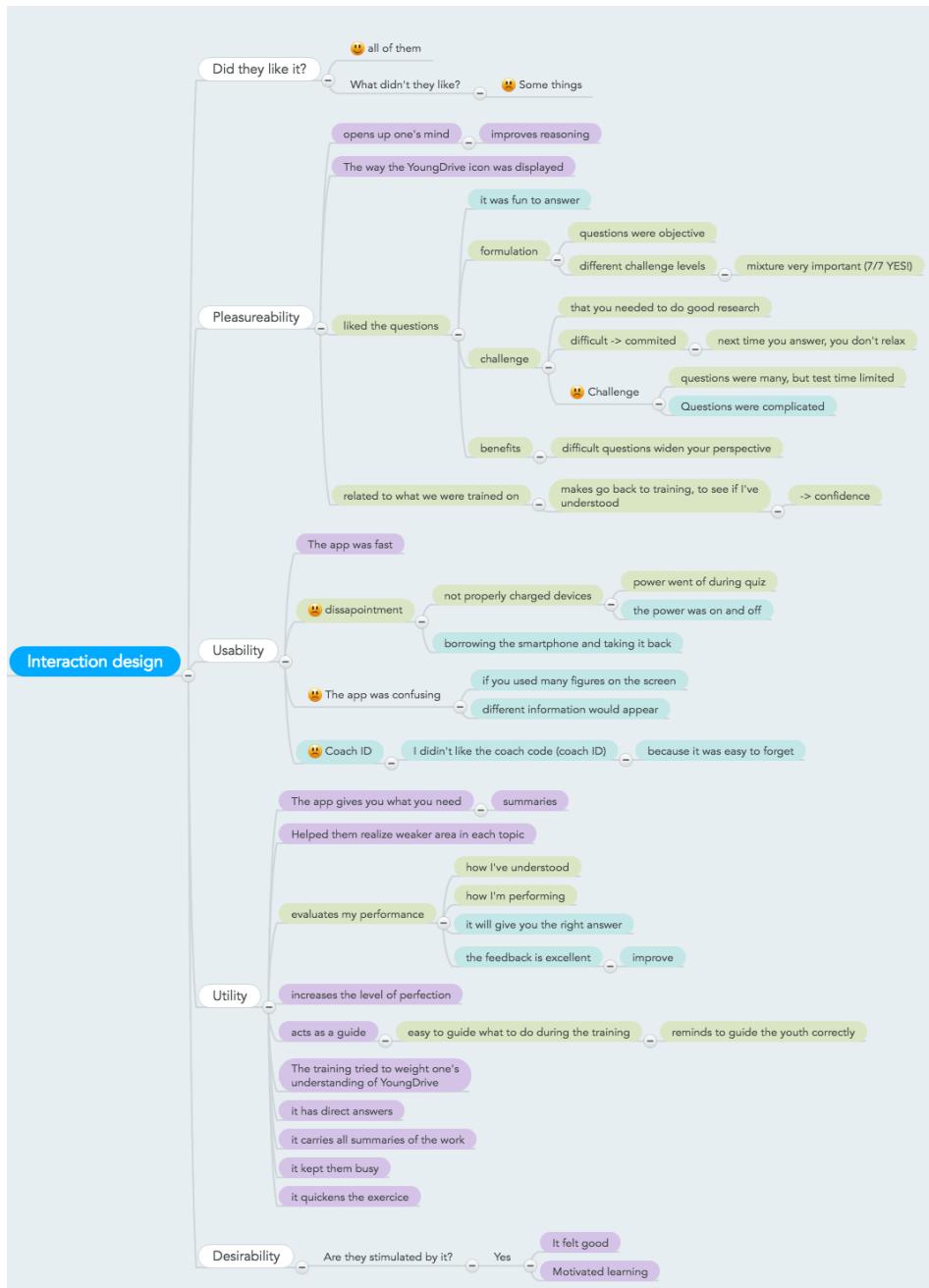


Figure 3.6: Coach comments regarding learning

**Figure 3.7:** Coach comments interaction design

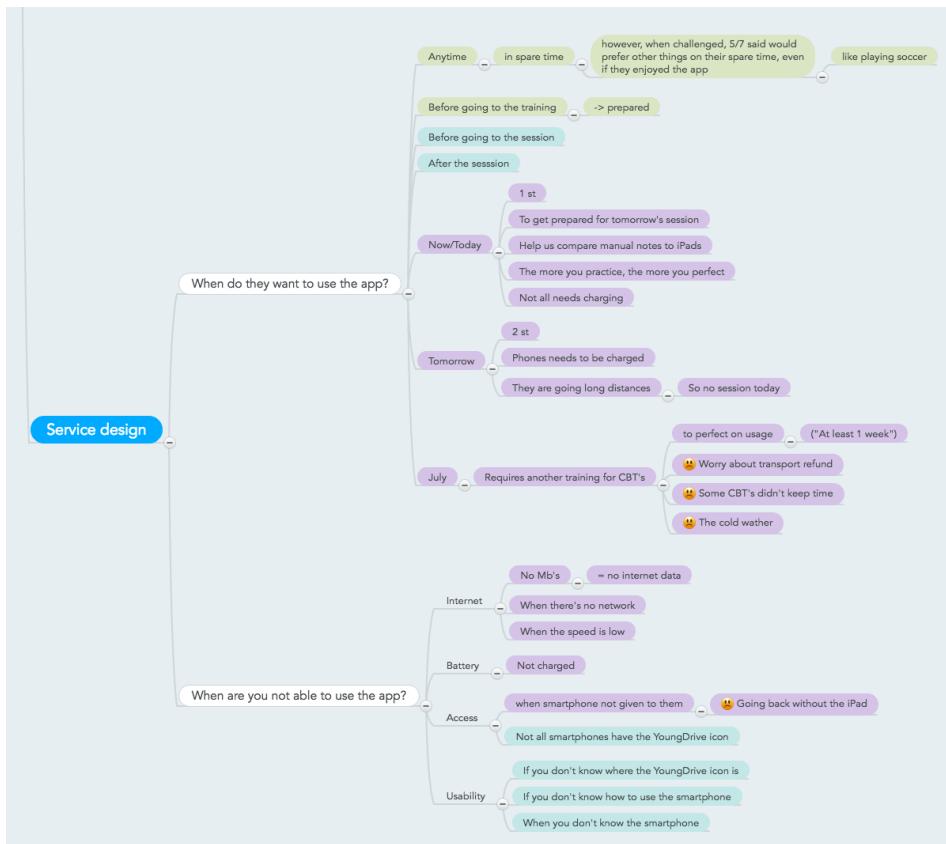


Figure 3.8: Coach comments regarding service design

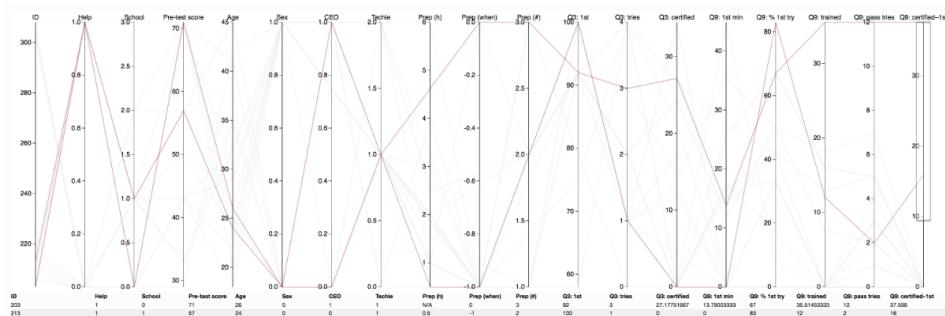


Figure 3.9: The parallel coordinates visualization showing the characteristics of the two coaches that passed the quiz 9 certification.

4

Discussion

The discussion is divided into the five research questions. For each questions, important aspects are considered, often comparing with the literature. This then leads to the conclusions of the master thesis, and future work.

4.1 How is the development affected by the technical possibilities?

As devices were limited, a goal was to make the app available on as many devices as possible. Creating a hybrid app using web technologies using Meteor made the app available both as a native app on Android and iOS devices, as well as on the web. On the other hand, this is not enough: the pre-evaluation showed that only 3 out of 16 had a smartphone today Lönn [2015].

As internet is accessible but expensive and often used seldom, the app does not provide rich media or simulations, but focuses instead on creative design possibilities using multiple-choice, also having cognitive load and scaffolding in mind. The interviews and observations from iteration 4 details that the coaches are happy with the user friendliness of the app, and that the training in its current form has high value for the coaches. On the other hand, images could probably be used to lower misconceptions in language, and a future wish of the coaches is to have the manuals accessible via mobile as well, which includes both text and images.

Most of the coaches have been first-time smartphone users. Letting them continuously test and co-create the app has created a tailor-made app from their needs and conditions. It may be surprising how simple design solutions using text and clear visuals can provide rich learning feedback, mentioned by Nicol [2007]. On the other hand, since it is so tailor-made, it needs to be exam-

ined if to make the app work in other countries than Uganda and Zambia, where design and technology preferences might be different.

That the app should work offline, and still be able to push quiz results when it gets online, has been a challenge. It can be hard to find good existing approaches for some technical platforms, but for Meteor plugins such as GroundDB proved very usable, since it is also automatic. In other apps in developing countries sometimes the user decides themselves when to push data, but in this case, quiz results are so small in size that it was unnecessary. This might be reconsidered in the future, for example if answers are no longer solely multiple-choice.

Below, reasons the development was negatively affected by the technical constraints are highlighted.

4.1.1 Online data collection was needed earlier

To test on all of the coaches in Uganda, it would have been preferable if data collection would have happened via the app instead of manually already in iteration 3, since there would be more than 10 test subjects, which had been the limit in Zambia. This was planned for, but technical implications with Meteor made it delayed. Done manually, not all data was recoded in iteration 3, which made it harder to draw conclusions from the quiz results. Both Lopez Lopez [2016] and ? explains how visualization techniques (like parallel coordinates) are more suitable for large data sets. This can be read more about below.

Problems with internet access

In day 3 of the Zambia coach training in iteration 2, iOS no longer allowed uncertified app installs from computer: you needed to have paid a license even for unreleased apps, being a "Trusted developer". This stopped the app from being able to be installed on all the iOS devices, so that only the web version could be used. Thus, only the web app was tested from Wednesday and onwards. This was a problem, as the app regularly crashed at refresh because of low internet capacity. Sometimes, it was needed to go to the other office where there was wifi, to refresh the webpage, and go back to the location. This of course would not work for Josefina. While it was positive that these issues were found thanks to testing, valuable time testing the actual functionality of the app was lost, with less feedback for continued development as a result.

4.1.2 Backwards capability issues

Upgrading from version 1.2 to 1.3 during Iteration 3 was a good example of technical limitations. It took a lot of time, but when it was discovered that version 1.2 did not work for old Android devices, the changes needed to be reverted. In another project, new Andorid versions might have been acceptable, but here a "better" version of software was not viable.

Meteor 1.2 had several disadvantages: while it worked for all devices, it did not support React.js Meteor 1.3 was released, which promised a better developer

experience, with JavaScript ES6 support, and access to Node Package Manager (npm), plus official support for React.js. In 1.2, only some npm packages had been adapted for Meteor, and tools such as Webpack could not be used.

The downsides was discovered after implementation: there were missing backward compatibility to the older of the Android devices. The backup would be the web version, but at the time of iteration 3, there were no Heroku build-pack for Meteor 1.3, making the website to crash. This was however fixed before iteration 4, which is why Meteor 1.3 was kept.

4.1.3 No time assigned for writing Automatic tests

The project would have benefited from passing automatic tests before doing user tests. While automatic tests were never written because of time constraints, since iteration 3, beta releases and production releases were separated into different domains, using Heroku's staging environment, with a different GitHub branch for each new iteration.

Even so, doing automated tests would have helped finding things that had worked previously but not in a new version, or finding bugs with new functionality like client-server communication. This would have made interactions with coaches more efficient, since the users would have been exposed to an app with less accidental errors.

4.1.4 Difficulties comparing quiz results between iterations

The idea was that app tests for iteration #3 would be carried out in a way that allowed comparison of usability and learning done between iteration #2 in Zambia and iteration #3 in Uganda. This was however never implemented during the app test. This would have been useful, but the coaches and the usage of the app in Zambia and Uganda was determined to be too different. See more about this in Future work.

4.2 How is the design affected by the contextual constraints, e.g. young entrepreneurs, entrepreneurship education, and culture?

An insight is how quickly the coaches have increased their fluency with using the smartphone and the app. Even though the design at first needs to be very simple, as long as features are introduced slowly and as intuitive, the app could become more complex over time, to the point where no compromises need to be made.

When it comes to design constraints in regards to overcoming cultural differences, learning from the expertise of local partners and tech companies can not be overestimated. They have been very willing to share previous mistakes, learnings and successes. This has saved a lot of time, and made the sparse amount of interactions and development time so much more efficient. Also, the value of getting to know the coaches on a first-hand basis has been greatly beneficial. The

app has been designed together with them as co-creators, with a developed mutual interest and understanding, having a common goal of creating an app that works for their needs.

The design was heavily influenced by starting the project with an iteration to truly understand the target group and context, and see the needs before starting thinking about ideas. It was good that this iteration did not have a digital focus, but even questioned if the best way to solve the needs would be an app altogether. Thanks to service design, everything in the app is informed by needs, which is an example of being a thoughtful designer Löwgren and Stolterman [2007] Stickdorn and Schneider [2010].

Service design methodology allowed the design to be embraced by the contextual constraints. Since service design involves looking at the whole context, both the digital context and the physical context, it was possible to understand in what situation the app can be used, and the situation of the people using it.

When it comes to designing for entrepreneurship, the focus for this thesis was on the educators: both the teacher, and the YoungDrive coaches. This goes in line with Ruskovaara and Pihkala's Ruskovaara and Pihkala [2015] insight where the teacher seemed to be the main factor for qualitative entrepreneurship education. However, contrary to Ruskovaara and Pihkala Ruskovaara and Pihkala [2015], women did perform better than the male counterparts in the quiz results. Similar results have been found in other developing countries as well: from the pre-test, it is noticed that women puts more work into preparation, even if they have a lower school level. This could be one reason why their results were better.

More so, the interviews with coaches shows that the app has been fun to use, which was a recommendation from both YoungDrive and Dickson's Dickson and Weaver [2008] research on recommendations for entrepreneurship education. Secondly, the app has focused on another best practice from Dickson Dickson and Weaver [2008], which is that the app should develop the competences as a mentor, enabler or coach. This can be noticeable by interview answers such as "open's up ones mind" and that it "evaluates my performance" with "how I've understood", "how I'm performing" and that "the feedback is excellent".

From computer expert into a digital service designer

The study method used in this research took me a long way, to the point where research, experiments, and constant improvements could lead to increasingly well-informed decisions.

I now have new-found skills in:

- ethnology (getting to know and learn from people in a different culture)
- human-centered design
- design thinking
- service design thinking
- interaction design

- digital learning
- data analysis

It has placed high psychological pressure and leadership demands on me as a new designer, to:

- always be in charge of balancing all the different perspectives, with the end user's best in mind
- be able to change the planned process when new learnings or opportunities emerge (leading an agile design process)
- always implement new functionality from customer needs instead of designer or engineer bias
- continually design and run workshops and tests suitable for the target groups

The reason why this has been especially hard, is that simultaneously to learning design and technological skills, I have been in a different cultural setting than the designer is used to. This has also been extremely rewarding, at the same time exhausting.

Having many people involved in the design process to adapt to the contextual constraints

The contextual constraints affected the design in the way that more expertise and guidance was needed than otherwise, from a diverse set of people. Service design research proposes to have a diverse team to build with a holistic perspective Stickdorn and Schneider [2010], and this has been followed.

In the project, working with service design in another culture has been one of the hardest and most exciting challenges. When the interactions for iteration 1 were cancelled the day before the trip because of local elections, experts could empower and affirm that this was not out of the ordinary. A learning was that it is only possible to plan to a certain extent, but then changing the plan in the last second, is needed more than when one's own culture. This support has been very helpful, having several people familiar with working in a different cultural context before.

To seek out people and situations that were not obvious, gave new insights into the work. The project partner Plan International, did not only back up the interactions and provide their own expertise, but also allowed interviews with experienced consultants from Grameen Foundation and Designers without Borders. Another examples includes involving Expedition Mondial in the design process, testing the app on university students and refugee innovators and at startup hubs, and involving the local YoungDrive project leaders more than originally thought.

It was very valuable to combine having a diverse team with the designer having a clear direction and caring for the vision of the product. Otherwise, the product might have ended up in many different directions

The fact that the end users and stakeholders has been involved from the start, made them feel and have actual ownership of the product. This has many benefits, among others that *everyone* involved is satisfied with the *final* app, since their opinions and expertise has been taken into consideration and implemented. The fact that they can notice this further increases trust, and the likelihood of them supporting future work, which goes in line with Stickdorn [2010]. To conclude, the design has been affected heavily by the contextual constraints, to the point where the end users are more likely to use the app as they have contributed to making a tailor-made product for themselves.

Spending time in the real-world training

The original time plan stated that the interactions for Iteration #2 would have been in Tororo, and that it would not be possible to test the app during coach training whatsoever.

However, during a Skype meeting with YoungDrive project leader Josefina, it was announced that it would be possible to participate in the coach training in Zambia during Iteration #3.

A new work plan was created, which would allow travel to Zambia and to develop the app and participate in the YoungDrive coach training together with the coaches.

Now, it was shown already at Iteration #2, that if I would have created the app myself, I would have assumed more functionality was necessary and requested. The field hackathon, designing and developing together with the users, was fantastic - already for iteration 1, the purpose "Validate the coaches' level of knowledge during their education" could be fulfilled. The two following iterations could not focus on "Train the coaches on distance", and "Certify all staff".

Also, without the 5 days of the training, questions for each topic would not have needed to be created, and this would then have been a must-have for Future work.

The intense training in Zambia gave a lot of time to discuss and interact with the trainer, Josefina Lönn. One important contextual constraint that was noticed, was that Josefina did not want to be replaced, but appreciated having the YoungDrive to the point where the app should not replace her, even if it in the future would benefit YoungDrive in terms of for example monetary reasons. This might not only be personal preference, as Ruskovaara et al. [Ruskovaara and Pihkala, 2015] claims how important the role of the teacher is for effective entrepreneurship education.

Without visiting the Zambia training, it would have been much harder to focus on the coach training purpose of the app, since the Uganda coach training was already over. A consequence might have been that the app would have been more focused solely on "Train the coaches on distance". This shows that spending time in the real-world context of the situation you are developing for, is very important. - especially when it is unfamiliar to you. This goes in line with the service design principles Stickdorn and Schneider [2010].

4.3 How can test questions be developed to support entrepreneurship learning?

The problem identified with multiple-choice questions, regardless if the recommendations by Nicol [2007] were taken, is that they first could only measure lower-order learning objectives, see figure 2.1. While entrepreneurial *knowledge* objectives might be considered A-B 1-2, building entrepreneurial *skills* is definitely related to C-D 3-6.

When assessing the first question sets according to Bloom's revised taxonomy, some characteristics were shown, which guided future creation of questions. Most notably, to reach C-D 3-6 on Bloom, there were some techniques: intelligent multiple-answers could encourage the coach to *evaluate* instead of using process of elimination or encouraging guessing. Putting the coach in a coach scenario (how to act in X situation?), the coach could be tested on a *procedural* and *metacognitive* level to *apply*, *analyse* and *evaluate* skills, and get feedback.

Previous research by for example Nicol [2007] had already shown how multiple-choice can be powerful, e.g. by following the principles in figure ???. The same articles mentions the approach taken with using a confidence-meter similar to "Are you sure?". These recommendations have been utilized.

Some bad questions have still existed, where coaches did not understand and failed to interpret the question, because too advanced English language was used. This points out the value of testing.

Regarding testing and improving the quality of questions, the initial plan was that YoungDrive would only produce questions for two YoungDrive training weeks, not all 10. To have questions for all of the weeks have greatly benefited the master thesis, and increased the value of the final product. If not all quizzes would have been developed and tested, this would have been a Future Work.

From a question assessment, it is shown that all of Bloom's levels can now be reached via the app, but two: *create*, and *apply*. This is because users can not create anything in the app, and because of the multiple answers are shown immediately, they are not encouraged to apply their own thinking to the question, before seeing the alternatives.

4.3.1 Learning effect

To the largest extent, the questions have been praised, in regards to formulation and challenge, which can be seen in figure 3.6 and 3.7.

The lack of a post-test makes it hard to see if the test questions in the app has a real-world effect. Ideally, the post-test in Uganda would have been to observe coaches having their youth session, and compare their correctness and confidence behaviour when not having used the app.

The lack of data (not least from the pre-quiz), makes it hard to draw reliable conclusions from the data. Regarding the pre-quiz paper submissions, the submissions should have been checked for blanks before handed in. Another mistake was that school level was not always exactly specified, and this means that school level and quiz results might have a stronger correlation that can be shown now.

Regarding recording test question results, this should have been done manually already in iteration 3. The fact that it was done automatically in the app for iteration 4, made so that more data could be recorded, more reliably, than when the project leaders filled them in by hand whenever a coach raised her hand to say she was finished with a quiz.

The biggest evidence for a learning effect, is the coaches who had a low score on their first try with a quiz, but after the training could pass the certification test, getting 100% in 1 try.

Improve
this
section

4.4 How does design affect usability and learning done via the app?

The quiz design is made with Kathy Sierra's model of deliberate practice in mind. Sierra [2015] Depending on the combination of correct and sure, the coach knowledge for each question is put into three different buckets: "Can't do", "Can do with effort" och "Can do effortlessly". By retaking the "Can't do" questions with Try again, reflecting on the "Can do with effort" questions (e.g. correct but unsure), and waiting to test the "Can do effortlessly" questions until the certification, all questions are eventually put into "Can do effortlessly".

The coach can choose to leave the training without doing the certification quiz, later repeating the test. This is to make the learning self-directed and just-in-time, and to allow the coach to do its own scaffolding. If the coach uses the app before a youth session, and has a low result, the coach will get feedback as such (e.g. "Nice effort, but you still need to practice and prepare yourself even more! How can you do that?").

The goal is to allow the coach to move knowledge from "Can't do" to "Can do effortlessly" to "Certified" in a pace that suits the coach. This might be necessary, instead of a one-fits-all solution, as the coaches' preferences are so different.

The learning goes faster in iteration 4 than in iteration 3, which is most notably shown by the fact that the speed from try 1 into getting 100% in 1 try has increased. This is largely because usability issues has been addressed, and because design choices has been made that stimulates and makes learning more efficient. Most notably, the score board has been improved to show which questions the coach is correct and sure of ("Can do effortlessly"), unsure but correct on ("Can do with effort"), and were wrong on ("Can't do"). One mistake made, was no not think about reducing cognitive load Sierra [2015] until iteration 4, when usability issues were identified as serious problems in iteration 3.

The YoungDrive app is the first known application which uses a confidence metric (in this case "Are you sure?") for the student's own sake, and not only assessment, like in the case study detailed by Nicol Nicol [2007]. The effect is reaching meta-cognitive on Bloom's.

4.4.1 Benefits with confidence level and correctness in combination

If a coach is wrong and sure about a lot of questions, it might be the indication that the coach is teaching the wrong information to the youth, which might potentially hurt hundreds of their youth's businesses.

If the coach is correct but not confident, it could be considered a guess. In Sierra's framework of building expertise, it would be called "Can do with effort". In the app during iteration 3, dampened for iteration 4, there were troubles when coaches passing the training with too many correct guesses, knowledge that were not yet "Can do effortlessly". This meant that they would fail the Certification, because they could not answer reliably, providing the wrong alternative. This in turn meant, that they were put back into training instead of getting a medal, which was not motivating. The conclusion was that the coach should not start the Certification mode before being truly ready.

One solution could have been that "Improve" would not only include repeating wrong answers, but also answers where the coach had been correct but said "No" on "Are you sure?". However, coaches seldom believed they would be wrong, or at least did not determine it worthwhile to be honest. Some preventative measures were taken to try to make the coach more honest. Unfortunately, for iteration 3, only some coaches took notice of number of tries as an indication that they should pay more attention. For iteration 4, the design had improved by giving coaches minus points for being sure and wrong, but here as well, not everyone payed attention. This goes in-line with research both from deliberate practice being a desirable difficulty (learning being hard might make the coach more likely to want to "cheat", or take an easier route like guessing instead of putting more effort).

The bigger problem was that the knowledge were not yet reliant, not that coaches were not honest. The solution for iteration 4 was to improve learning in the app, partly by a more personal score board with feedback, which could show the coach which kind of questions she needed to repeat ("Can't do" or "Can do with effort"), but instead of forcing the coach to redo correct guesses ("Can do with effort"), she could reinforce the correct answers by personal feedback. Sierra Sierra [2015] calls this "high pay-off tips", which can be very effective.

4.4.2 Deciding on learning methods

There was a lot of work behind choosing the learning design methods in Iteration #3. The way to progress, was to brainstorm various solution, discuss them with experts, and then create trigger material and test some of these approaches.

Retaking questions that were wrong ("Try again", called "Imrpove" in iteration 3) was inspired by deliberate practice Sierra [2015], and is already common in e-learning driver license softwares to learn traffic signs or how to act in various situations.

Showing the coach how many quiz tries they have done, was inspired by Linköping University's work with the e-learning tool NTA Digital, where they

reward students with badges for getting 100% in few tries. Their goal with this kind of "gamification", is to reward students for studying before taking the test. Similarly, for the training mode, the coach seeing number of tries was a method of studying the correct answers more thoroughly. For the certification, where the coach was supposed to have trained before taking the test, badges worked with the same purpose as NTA Digital, to reward students that had studied properly.

"Are you sure?" was inspired by a Swedish teacher, and has been used before by others. Nicol [2007] It has then been used to determine if a right answer should award a point or not. Nicol and the pedagogical expert for this thesis, Henrik Marklund, suggested that the teacher had overlooked a learning benefit of this approach: the student reflecting on their own knowledge, which is proved great for learning. This was extended in this thesis where personalised feedback has the goal of the coach getting both confident and correct. In a school situation, this might not be necessary, but in the YoungDrive context, the purpose of the app was to build both correctness and confidence with the material. To pass the certification after training, getting 100% without faults, made the coach feel that confidence, at the same time reassuring the teacher that the coach had learned the material.

After iteration 4 a bonus test was made with Plan Tororo staff, which showed the relevancy of the certification mode: one group that were 100% correct on the first try, did get 100% correct on their second try, meaning guesses had been present. On the other hand, a person have 1 wrong answer, passing the training on the second try, did then pass the certification on the first try, with confidence. It can therefore be determined, that when all of the answers are answered correctly, after having gotten all answers correct once, that the coach has both correct information and confident - this is a good example of deliberate practice: the information has gotten reliable.

Other learning design methods were considered, as previously discussed. It was discussed if multiple-choice answers should be completely abandoned, replaced with flashcards. Challenges were that the coaches had no previous knowledge of typing on a keyboard, and analyzing recorded answers would be too technically demanding. The integration and benefits of flashcards was however discussed in various ways, see Future work.

4.5 How can users' feedback be used to inform modifications of the app?

The number one time waster, has been spending time building ideas that is not informed by the users' feedback, and not immediately realizing the mistake. Such ideas will not be used, are often not supported by research, or does not fit the context. This is the same finding that Stickdorn has made Stickdorn and Schneider [2010], and is a violation from service design principles of making the process user-centered. Luckily, almost all of the work with the master thesis has indeed been user-centered.

Getting enough feedback to evaluate each component of the app has been im-

portant. Enough feedback, means that modifications to the app can be made with confidence. The faster this can happen, the faster the app gets better. This is why the field hackathon, and service mini-sprints, were so beneficial, see 2.1.5. It ensured that fast iterations could happen with enough feedback to provide effective modifications and additions. The use of service mini-sprints was so effective that the interactions in Tororo could be expanded with even more days, as long as this is properly planned for.

As long as the users understand the purpose of the app, and how it should benefit them, they can be part of the creation process, not only the testing. This is an extraordinary opportunity, that should not be underestimated. To involve the users and get to know them, is essential to understand the true needs of the coaches, and can greatly inform modifications of the app.

The app evaluation shows that not only should users' feedback inform modifications of the app, they should be the *basis* of the app. To do this, this report has provided but one approach, via Digital Service Design. It is also a service design principle, making the process co-creative Stickdorn and Schneider [2010].

The presence of different perspectives (from users, stakeholders, experts, and the designers care for the vision) lead to a holistic view when designing, inline with Stickdorn Stickdorn and Schneider [2010]. The designer can balance these, as long as the views are present during the whole development process, and not only in the end of the project. For the questionnaire made for iteration 1, stakeholder views were very important. From their views, the questions could be improved and put into context, and lessons were learned which otherwise would not have happened. In iteration 1 it was felt that maybe too much time was spent with stakeholders, almost to the point where the process where no longer user-centered.

By asking Why-why-why continually, the true needs of the coaches could be gradually exposed. Similarly, by hosting co-creation workshops, the coaches can be part of designing lo-fi app prototypes that addresses these needs. The role of the designer then, becomes putting these ideas into a context, and comparing with best practices and relevant research (in this case, most notably learning design), modifying, developing, and testing. As Löwgren and Stolterman says, the output will not be better than the designer carrying out the process Löwgren and Stolterman [2007]. To embrace the role of a socio-technical expert, more so than the computer expert or political agent, has been one of the enablers for co-creation. Service design thinking and methods, gave a framework to have all of these perspectives in balance and consideration, always with the end user as the most important person.

5

Conclusions

In response to the research questions questions, the master thesis has:

Contributed to the domain of entrepreneurship education in a developing country context

This research shows that an app can be effectively used during and after training to assess and learn entrepreneurship. Furthermore, the app can also prepare coaches before youth sessions, training them both in entrepreneurship and preparing their lessons.

In *addition*, this has been done in a developing country context, with coaches having no prior smartphone experience. The app is used for coaches in conjunction with a physical entrepreneurship training today, and does not yet address the youth themselves, or replaces the physical training.

However, the research shows that both the teacher and the coaches greatly appreciate the support the app has given them. As entrepreneurship to its nature is practical in many aspects, one finding is how multiple-choice questions can still simulate real learning, by design solutions such as asking "Are you sure?", giving personal feedback, and formulating questions as scenarios.

Demonstrated how certain technical constraints and design constraints can be overcome in a developing world context

Provided methods of investigating usability and learnings with a digital training tool in the real-world training context

To investigate usability, observations using think-aloud in the real-world training context proved the most effective. In big groups, data could give tendencies on common problems that needed to be addressed. In smaller groups, ideas and precise feedback was more common. It helped having a framework to compare usability against, in this case the interaction design principles of desirability, utility, usability and pleasurable.

To investigate learning in the real-world training context, literature research and data analysis of quiz results was highly beneficial, but mostly when put into the context of the observations made in the real-world training context.

Surprisingly often, comparing research and expert opinions with what coaches thought was best for learning, was in unison. When this happens, the self-confidence of the designer can increase, and the designer can be more daring and experimental.

Having much testing and co-creation was a very rewarding approach. To make it truly testable, lo-fi and hi-fi prototypes should be used instead of hypothetical questions. While research before starting to develop is a great start, it was trying different solutions, all based on user advice, expert opinion and research, that gave great results.

Created new methods in service design, when co-designing digital artefacts in a developing country context

Short iterations is a challenge, especially when time is sparse and the culture is different than one's own. Often in projects, testing is overlooked. In this project instead, service design helped to look at the users as not only testers, but as co-creators. This is not new in itself, but the creation of Digital Service Design, and methods within this discipline, were new. Examples include service mini-sprints and field hackathons.

Interactions with the coaches always included Service Mini-Sprints (see 2.1.5), allowing the most important feedback and insights to be addressed in the app and workshop formats already the next day. This allowed for very effective use of the sparse interactions with the coaches, and there was no need to wait for the next iteration to test the coaches' feedback.

The "field hackathon", in which the app was refined and tested each day of the coach training, was the most important piece of the whole master thesis. More than the opportunity to develop the app with the coaches, it had the extra benefit of giving the opportunity to observe the YoungDrive training and understand the coaches.

To use a service design approach when co-creating digital artefacts in a developing country context proved highly effective, and it is recommended that this are further studied. It does demand bravery of the designer to get to know the users so well, and design for their needs and dare to question the client, but in the end, as in this case, both the users and the client may end up more satisfied with the result.

6

Future Work

The future work section is divided by research question, and proposes additions that would strengthen the app goals (see 1.1).

6.1 How is the development affected by the technical possibilities?

Some of the wished development were too complex to be implemented during the master thesis. Below, it is described what future work is wished in the area.

6.1.1 Data analysis improvements

Today, data analysis of quiz results takes a tremendous amount of time, and is not easily accessible or understood by the stakeholders. The data needs to be acquired into Google Sheets, and then needs to be enhanced in several ways to be filterable and visualized.

A lot of future development time should be spent so that most of this work is made automatically. Some of this work, is related to the way that the data is saved. Today, whether the coach was correct or incorrect on a question, and how many coaches answered that question incorrect after the first try, needs to be done by process of elimination, because the data is not properly structured in the database.

There were also a small number of errors with quiz submissions in iteration 4. Most notably, certification tests for coach quiz 9 were not submitted, which is why the paper submissions proved very valuable as a backup. To discover more errors regarding offline-online functionality, is important, as it is cumbersome and time-costly to test these manually. A good way to discover such errors, would

be automatic tests (or regression tests), so that the app can be used by the coaches with confidence, without extra personnel present, checking that the app works.

6.1.2 Code quality

Since the app will be continually used and developed by others in the future, code quality is important. React.js makes it easy to structure the code in a way that gives a new developer a good overview of the different components, and its functionality. Even so, refactoring the code into smaller components would be a good idea.

To increase speed of the app, refactoring the code to ensure that loading of assets happen more effectively (especially quiz questions), and also that data is cached in a logical way (saving necessary information so that it does not need to load the same information again, and vice versa), would be helpful.

As the YoungDrive program grows and more people will use the app, there will be a lower tolerance for the app being slow. The app, especially on native, takes a long time to load, mostly because of asset loading.

6.1.3 Internationalization

During the Zambia tests, they were given a Zambia version of the app, and in Uganda, they were given a Uganda version.

In the future, it would be advisable if the coach ID used for login would affect if the Zambia version or the Uganda version should be shown.

Today it is acceptable that the app is solely in English, as it is understood by both the Zambia and Uganda coaches. As more countries are introduced, the app should be available in different languages.

A challenge today is that the Zambia uses a newer manual, and e.g. the national currency is different than Uganda's. That Zambia has updated manuals, means that some questions are new, some are removed, and some are reformulated. But the teacher still wants to be able to compare quiz results between the different countries. Today, the quizzes were simply replaced between versions. This has the advantage of being easy to implement, but the clear disadvantage that the teacher can not compare quiz results between countries.

A good solution to internationalization of quizzes would be that each question in the database should include an unique ID, with different texts depending on country and coach manual. This would allow the teacher to keep track of some coaches have difficulties with a question, regardless of location.

6.1.4 Availability on old Android devices

Since the introduction of Meteor 1.3, older Android devices are no longer supported. For the YoungDrive coaches, this is an issue, as most often devices use older Android operating systems, and does not have great performance. Today, a Meteor 1.2 version of the app is available on the AppStore. Also, the newest version is available on the web. However, in the future research should be put

into if the app should abandon Meteor 1.3 altogether, or if there is another way to ensure backwards capability.

6.1.5 Availability on feature phones

As far from all coaches does not currently possess smartphones, few coaches will currently be able to use the developed app for preparing their youth sessions. Therefore, what was discovered in iteration 1, that all coaches possess feature phones, could guide the development of a SMS-based service. While this was not viable for the scope of the master thesis, research has been made into related work.

A recommendation is to try VOTO Mobile ?, which supports multiple-choice questions and internationalization. Today, this solution has been used mostly for doing evaluations in rural areas, via automatic phone calls where the caller can be given responses in text. However, research on using such a solution for educational purposes seems promising.

6.2 How is the design affected by the contextual constraints, e.g. young entrepreneurs, entrepreneurship education, and culture?

6.2.1 Replacing the teacher

In iteration 2, Josefina (the teacher) mentions that she does not want to be replaced by the app. However, there would be many benefits to YoungDrive if the coach training could happen 100% digitally, for example access in locations where YoungDrive currently has no funding.

How could it be done in practise? Also, when Josefina does not want to be replaced? In practice, a freemium model could be proposed, where it is possible to take the coach training for free digitally, but pay for a physical training. Currently, this contextual constraint has affected the app in the way that it should complement the physical training, and ease the burden for the teacher.

6.2.2 Scaffolding the coach guides

Josefina says after iteration 2 that it is indeed valuable if the training prepares the youth more actively for holding youth sessions, an insight that was discovered in iteration 1.

She mentions two challenges with introducing coach guides for each topic. In the end, a solution is suggested:

- The coaches are not ready the first day, as they have not gotten used to the app yet. *As such, they should be introduced in the middle of the training.*
- A recurring issue is that the Friday, the last day of training, should be dedicated to preparing a session, but the time has never been there. If so, the

coach guides will not be used. *One idea could be to make the topic quizzes smaller, and mix topic questions with coach guide questions.*

6.2.3 Designing the app for different Need groups

Already since iteration 1, different need groups have been identified. It is shown from the tests that the idealistic and realistic coach might be more probable to have a growth mindset, where challenged coaches might have a more fixed mindset. Research could inform how to design for these different mindsets.

Also, there are tendencies that different need groups are more present in different countries. While a lot of research was done about the cultural dimensions of Uganda, the research done on the Zambia and local Kabwe population was more sparse. It was known that the socio-economic differences were large, but not much more. For future work, it is recommended to put more work into how the local and national culture in a country affects the mentality of the coaches and the design. It is not possible to assume that the Zambia and Uganda culture should be similar, and it will be similar with other countries in other developing countries, or elsewhere.

Since doing app development together with the coaches has been so beneficial to discovering different needs, a wish is to have done more so with the coaches in Tororo. While in Zambia, the development was done in the real-world training, which was superb. In Uganda, more of the trigger material could have been created in Tororo instead of Kampala. Even if it would have been more costly and internet is slower, it would have been valuable being closer to the coaches.

6.2.4 Training the coaches with using a smartphone

An additional insight from the smartphone test in iteration 1 was that using a smartphone operation system like iOS or Android needs to be made as easy as possible. This to avoid confusion with things like not finding the YoungDrive icon, or accidentally hitting a button, or click the power button: all of which relates to ease of using the operating system, and not to the app in itself. A lot of training is needed to avoid errors, and should be taken into consideration from a service design standpoint.

In iteration 3, such a co-creation workshop was held after the app test. This resulted in that for iteration 4, all of the devices had the YoungDrive icon on the home screen of the device, and was the only noticeable app. This lowered confusion a lot with finding the app, and realising where to click. If a coach accidentally clicked the home button, they immediately found their way back.

In the future, for new coaches, training how to use a smartphone is needed, before they are handed the device. While the YoungDrive is now simple to use to maybe not need an introduction, it would still help how to act in the app (for example encouraging to be honest with answering "Are you sure?").

6.3 How can test questions be developed to support entrepreneurship learning?

6.3.1 Designing for honesty with "Are you sure?"

One idea during the ideation of iteration 3, was to give the student two scores: one showing how correct they were, and one with how confident they were. You can be correct, but still not be empowered (you are unsure but correct). Similarly, you can be incorrect but confident (not empowered).

The reason for not having a "empowerment bar" (combining correct and sure, giving a summative score), was given by Josefina from YoungDrive: "The coaches might want to game the system to get a better score, or be confused by how they got their score". For this reason, the coaches have stated they accept getting minus points if they are sure but incorrect, which is easily understood by them and feels fair.

In the app now, there is still a struggle with coaches answering positive on "Are you sure?", even if they are not. Reasons are among others that they say they are *partly* sure, and sometimes that they think they will be more punished for not being sure *than* being sure and incorrect. As this is not the view of the teacher, this needs to become much more clear in the app. One idea is to ask "How sure are you?", but keep the binary scale of only two answers. This would mean, that the coach needs to think about *how* sure she is about the answer, instead of *if* she is sure, which could have metacognitive benefits.

Lägg till mer om att designa för empowerment

6.3.2 Self-reflection after a youth session

When discussing the goals for iteration 3, Josefina talks about a need she has noticed during the coaches' rollout in Zambia, where the app could help: doing self-reflection after a youth session. She says that this is at least as important as the coach training, especially in cases where Josefina or other project leaders don't have the resources to visit the coaches physically.

It is determined that while physical follow-up meetings are essential, the app can be used to help the coach in a smart self-assessment and self-reflection. Also, on encounters with the teacher, it can guide the coach-teacher discussion.

This does not need to be a new app. Questions can be asked in a way that they are indeed meta-cognitive, encouraging learning by reflection.

Josefina mentions that when she is there to give feedback, it is very clear to the coach that he or she lacks knowledge and has not prepared enough.

An app with self-evaluation and monitoring, would help keep the coach thoughtful and give the coach important insights. They are described to sometimes overestimate their own knowledge.

6.3.3 Avoiding memorization

To avoid memorization, the alternatives should be randomized in the future. While it is unlikely that a coach has an easier time remembering the correct answer by order instead of content, since they only repeats the wrong answers until the certification test, it is an extra measure.

6.3.4 Improving the questions

Data analysis of results on specific questions could give a lot of insight, both into coach behavior, and misunderstandings of questions, in the future. Here, a lot of data is already collected to be able to guide conclusions. Not only are questions recorded with correct and if answered confidently, but also number of tries per coach, and if it is a training quiz or certification quiz.

Simple analysis could be for example mean seeing what are the most difficult questions, where most people have answered wrong repeatadly. From the interviews in iteration 4, it is explained that some answers might be answered wrong becuase of for example difficult wording of questions, not neccesarily because of lack of knowledge. To avoid this, data analysis could be effective, together with getting input from the teacher and coaches.

Improving the questions today has mostly been made from direct feedback from the coaches, or comparing quiz question formulation with current and desired level on Bloom's revised taxonomy. Regarding mapping educational objectives, it needs to be made sure that there are questions for each educational objective of the topic, which has not been done today. In Yengin citepyengin, questions were designed to support gradual knowledge building with an alignment to Bloom's Taxonomy, which could also be a viable alternative for this app, where questions are currently formulated as information appears in the participant and coach manual respectively.

6.4 How does design affect usability and learning done via the app?

6.4.1 Assessing coach guide knowledge before the youth session

When asked about the Zambia coach rollout, Josefina points out several challenges. "It feels like some of the coaches forgets the coach guide, even if it has been improved and better integrated with the participant manual. Some of them, don't even use the coach guide."

This speaks for that the app should include quizzes for all coach guides as well. When asked if the coach guide quiz are more important than the topic quizzes, she answers that the correct knowledge is more important, because that is the one that needs to be explained correctly to the youth. Therefore, it should be moved into Future work.

6.4.2 Using a flashcards approach

In the ideation for iteration 2, flip cards are discussed again, with Henrik Marklund.

In iteration 3, this was tested as a lo-fi material with successful results, but more work should be done.

In the ideation of iteration 4, a proposal was given that did not have time to implement. Therefore, the idea is described here:

At the coach's second quiz try (having assessed and reflected on the knowledge), flashcards could be introduced to assist the coach in retrieving from memory, before getting the multiple-choice.

For future work, when in Training after the first quiz try, The question should be shown *before* the answers are shown, and prompt the coach to think aloud about what they think the answer is, before receiving the alternatives. The coach might be hindered from progressing to the multiple-choice answers until the app has understood the coach has thought hard about their answer to the question.

This is a good use of scaffolding, slowly introducing complicated app features. The hypothesis is inspired from Bjork [2016], that knowledge is strengthened if the coach retrieves from memory, versus looking up the answer or choosing the most likely answer.

6.4.3 Improvements to the Certification mode

Following Sierra's advice of quickly giving the user a feeling of a superpower, this should be becoming a Certified coach in the future. From the end results of iteration 4, we can learn that notably the intrinsic motivation is high, deliberate practice is present, and the coach can feel the intrinsic reward of having pushed herself and learned the material when certified. This is very positive.

This reaction, could and should be even more amplified when certified. It is discussable if this should be done by simple gamification, but an opinion by a coach was that medals earned should be more visible and that sounds could strengthen the feeling of achievement. Also, the quiz list could show these results, increasing motivation to take other quizzes that you have not yet mastered, or to better your score in a topic where you had not become certified.

6.4.4 Improvements training Correct Structure and Time Management

During all app tests (iteration 2-4), it has been shown that since Correct Structure and Time Management are both ordinal, the Training mode for such topics would be more suitable as interactive exercises than multiple-choice. The proposal is to first use drag-and-drop to place each activity of a youth session in the correct order, and then selecting the right time for the each activity. This assists the coach in creating a mental model, which can be used to retrieve from memory during the assessment.

6.4.5 Scaffolding with Flashcards

After the coach's first new try, Flashcards could be introduced to assist the coach in retrieving in memory, before getting the multiple-choice. To do this after the first assessment, is partly because of technology scaffolding (introduce new concepts in steps), partly because the knowledge is strengthened if the coach retrieves from memory versus looking up the answer or choosing the most likely answer Bjork [2016].

6.4.6 Memory design

For the ideation of iteration 4, Henrik Marklund pointed out that if knowledge is to be memorized, memory techniques could be used. One such e-learning tool is Memorize ?. The tool has interactive learning modes, aiming to learn facts and terms with speed. This was underprioritized because of time constraints working with technical features that were not essential. Also, the idea was never proposed by users, only by experts. Moreover, the teacher opposed the idea of remembering answers that were not in the factual remember category. To do so, would oppose the learning objectives, which score higher on Bloom's revised taxonomy. However, to study how the coaches can remember better via an app, and learn memory techniques via the app, could be a future work which is advisable.

6.4.7 Sharing with one another

In future versions of the app, mechanics of sharing content and co-creation would add value connected to Bloom's, reaching Create and Apply. Adding these game elements goes in line with Clark's research, which showed a positive correlation with learning and games that required multi-player collaboration [Clark, 2014].

6.4.8 Including the paper manuals in the app

Already in iteration 2, it was proposed by coaches if the participant manual and coach guide could be included in the app, instead of as paper. The teacher agreed in principle, especially as the paper coach guide is often overlooked (reading the digital version could be designed to be made mandatory before unlocking other features), but also saw several challenges. Because of broadband limitations the manuals would take a lot of space to download. Also, the manuals are designed in A4 format, while a smartphone screen or even tablet is much smaller, making it cumbersome to read the whole manuals in the same way you would with the paper versions.

However, for the ideation of iteration 3, it was realized that if the manuals could be converted into smaller chunks, there is an opportunity for bite-sized spaced learning, instead of massed learning. How to split the manuals into these small parts? Well, by extracting the important parts for understanding an answer to a specific question, see figure 6.1. The teacher emphasised that this would take time for her to do, but that the effort would be worth it. While there were no time

for including the whole manuals, there was an idea the teacher thought acceptable for iteration 4: including on which page the coach would find the answer to a specific question. This was not one of the most prioritized features of iteration 4, which it was never done, but for further work, this should be investigated.

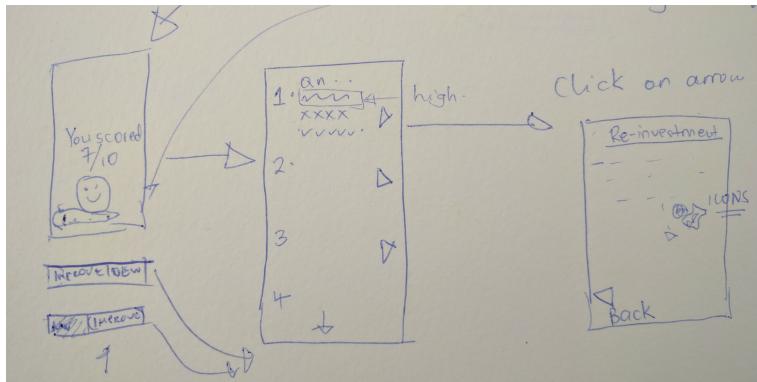


Figure 6.1: By clicking on an arrow next to the question showing the correct answer compared with your answer, the coach could read an extract from the YoungDrive manuals, which includes the right answer. The learning benefit compared to just observing the right answer, is that the coach gets the answer in context, which improves memorization and understanding. An idea would be to no longer give the coach the correct answer in the score board, but to instead let the coach choose the right answer after reading the text.

A major opportunity doing this would be to replace the paper manuals. Today the manuals are the most expensive post of YoungDrive, which is why this would be attractive. While a smartphone or tablet could be returned after a YoungDrive program has ended, this is not possible with the paper versions, so there might be a monetary incentive to do so. A problem that would need to be addressed is that the manuals also have written exercises in them. These exercises could be made interactive in the app, which would also allow for smart features such as automatic assessment, financial literacy simulations, etcetera. While this was not a scope of the master thesis, it is interesting further work to test if such interactive exercises and simulations would be effective in the developing country context of learning and teaching entrepreneurship.

6.5 How can users' feedback be used to inform modifications of the app?

6.5.1 Educator Dashboard

Josefina has no means of accessing live quiz results today, as there is no educator dashboard developed. Instead, quiz results today needs to be transferred from a database into Google Sheets, which is cumbersome and not user-friendly.

There was not enough time to develop an educator dashboard, even if this had been a goal. Instead, low-fi trigger material was created, and co-creation stakeholder workshops were held, both for iteration 3 and 4.

In the future, this will be a must-have, and it ties well into YoungDrive's future wish of strengthening its quality assurance via monitoring and evaluation. Exactly how powerful the educator dashboard should be, might turn into a ethical discussion. One could argue that measures needs to be taken so that the app focus is to keep supporting the coaches to become better, and not to punish those coaches that doesn't have the same quiz results as others. As the combination of "Are you sure?" and correctness can give insight into the attitudes and care of the coaches, carefulness must be taken.

From an empowerment perspective, the Educator Dashboard can guide both the teacher in her teaching, allow her to have better coach feedback sessions, and doing future improvements of the YoungDrive program.

6.5.2 To answer the research question more elegantly

Working with user feedback to inform modifications of the app should be as central as has been during the master thesis. To further answer the research question, new situations and methodology could be tested. The new methodology Digital Service Design has been a success, and could be shared to other organizations than YoungDrive, especially (but not exclusively to) when working with technology in other developing countries.

Future work should also include to look at research suggesting how to work with balancing user feedback, stakeholder opinions and research. Such findings would be especially relevant when prioritizing and working the backlog and doing sprint planning.

When it comes to user feedback, it comes in various ways: both qualitative data like interviews, and quantitative data such as quiz results, could be seen as a form of feedback. As such, it would be interesting to measure how the app is used after this finished master thesis, and if the usage of the app suggests what additional work needs to be done. The main output of the app should be better-performing coaches, and as long as the coaches are part of and feels ownership of the product development, the app will continue to give great results for the youth sessions.

Appendix

A

Appendix 1

In appendix 1, the original time plan is presented together with the revised time plan, done for the half-time evaluation with the examiner.

A.1 Original Time Plan

A.1.1 Before Uganda

Week	Focus
2	Workshop with Lena Tibell and Konrad Schönborn on Research questions & Proposal of method.
3	Start writing "Planeringsrapport". Study interaction design via guest lecture Jonas Löwgren, and reading the book "Thoughtful Interaction Design".
4	Interview with Take Aanstoot, Social entrepreneur in Kenya. Submission "Planeringsrapport". Education day in Service design in Stockholm (by Expedition Mondial). Meet Joachim Svärdh about Entrepreneurship research.
5	Approval "Planeringsrapport" with Camilla Forsell. Meeting with Lena Tibell and Konrad Schönborn (2016-02-02). Travel to Uganda.

A.1.2 In Uganda

Times specified are in local time to where I am. Uganda time (EAT - Eastern Africa Time) is 2 hours forward of Swedish time (CET - Central European Time). Meetings with Swedish partners are generally done via Skype, where Uganda meetings are preferably done in person.

Note that during all of this time, writing the master thesis will progress. After the time in Uganda, the report will be a 100% focus.

1 day per week will be spent on report writing, including Analysis work for the meetings.

Week	Focus
6	Cultural adaption. Land, set up wifi, set up my apartment, learn about the YoungDrive organization, meet people. Be prepared for stomach disease. Get familiar with the transportation system in Kampala. Get familiar with the city. Iteration 1. Prepare Iteration 1 with Iliana. Start-up meeting with partners. Start report writing: analyze, collect material, sort, structure and plan.
7	Iteration 1. Prepare Interactions. Analyze Start-up meeting with partners. Write on report. in order to create <i>Questionairee guide</i> . Understand technical tools, without working on an app solution - the goal is to get familiar with the tools.
8	Iteration 1. Travel for Interactions. Do 8 face-to-face interviews, with no digital focus, hypothetical situations. Do minimum 2 field visits to understand the coach's situation, ideally living in Kamuli or Tororo a couple of days. This is a good opportunity to learn coaches how the tables and smartphones work.
9	Iteration 1. Analysis & Compilation. Thursday: Expert meeting (March 3rd, 6-7 PM). Friday: Partner meeting (March 4th, 11-12 AM). Iteration 2. Determine Needs. Ideation. Create low-fi Trigger material (pen and paper) and determine what the hi-fi (digital app) material should be.
10	Iteration 2. Design and Develop the hi-fi trigger material. <i>Half-time check-up with examinator</i> .
11	Iteration 2. Interactions, control group #1 & #2.
12	Iteration 2. Interactions, control group #1 & #2.
13	Vacation with fiancee.
14	Iteration 2. <i>Analysis #2</i> (What choices needs to be made? What path should be taken? Start formulate Customer path. If needed, document how people see apps, document limitations, document experience needs, document risks.) & Compilation. Thursday: Expert meeting (April 7th, 4 PM). Friday: Partner meeting (April 8th, 11-12 AM). Continued Development Creative Brief. Determine what actions needs to be taken outside of the development of the app. Create Behovsgrupper.
15	Iteration 3. Develop and Modifications phase.
16	Iteration 3. Develop and Modifications phase. Interactions: App Tests with Interviews & Measurements (with time allocated for late arrivals and missing participants).
17	Iteration 3. Interactions: App Tests with Interviews & Measurements. Analysis & Compilation. Friday: Partner meeting (April 29th, 11 AM) & Expert meeting (April 29th, 4 PM).
18	Final analysis. Finalize the app. Travel back to Sweden.

A.1.3 After Uganda

Week	Focus
19	Write on Master thesis report. Attend Auscultations.
20	Write on Master thesis report. Attend Auscultations.
21	Write on Master thesis report. Attend Auscultations. Find opponent for Master thesis.
22	Submission of report to examinator, after approval by supervisor. Examinator decides on date and time for presentation. Send report to opponent, and get the opponent's report.

A.1.4 After Semester

Week	Focus
35	Presentation of my Master thesis, with supervisor, examinator and opponent. Hand over publication approval to the administrator.
36	Opposition of another person's Master thesis.
37	Do changes to report if requested. Upload report to X-sys for approval (within 10 days). Write Reflections document and submit on X-sys within the 10 days. Publish master thesis in X-sys.

A.2 Half-Time Evaluation Time Plan

B

Appendix 2

Insert
pre-test
here

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