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Mobile Application Design That Supports Motivations for Crowdsourced Species Identification

Master's thesis in Interaction Design and Technologies

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That Supports Motivations
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Identification

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Abstract

One way in which scientists strive to conserve and learn about biodiversity of the Earth is by mobilizing crowds to collect and share species sighting data. This thesis explores the design space and user goals for one biodiversity data collecting application. The studied application aims to at the same time be a photo sharing social media. It aims to not only produce value for science, but also for its users. The main user segments of the application are biology experts and nature novices. This thesis focuses on the nature novice group while going from web-based to mobile.

The design exploration in this thesis is grounded in a motivational framework from previous research. User motivation is critical in order to attract large crowds and build a sustainable business around a crowdsourcing application. In iterations, user research was performed, then goals, requirements and prototypes were interpreted and constructed. These design artifacts were then mapped against the motivations in the motivational framework.

Keywords: Interaction design, Mobile application, Citizen science, Motivation

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1

Introduction

The Earth has in relatively recent years begun to lose species and habitats more rapidly and it is explained as being due to human activity [1]. In order to prevent resulting catastrophes, in order to increase our understanding of our world, and in order to save our own species, conservation of species and biodiversity has been pursued by scientists, communities and governments. As a means towards the goal of saving biodiversity, species distributions are being tracked. Distribution tracking is often done by biologists who classify which species are seen in which areas. But due to limited resources in time and funding, biologists' ability to research biodiversity is limited. Often studies with larger scopes come with larger costs.

A currently expanding approach which lets scientists increase the scope of their studies without heavily increasing budget is crowdsourcing, or citizen science. A citizen scientist is a volunteer who reports and/or examines data for scientific purposes. The citizen science approach dates back to the beginning of modern science, but currently has an upward trend catalyzed by new technology which provides new and more effective possibilities to engage a scalable amount of volunteers and organize the data that is produced. [2]

There are many applications that allow people to input data about species sightings. The design of the used technology has impact on the volunteers' motivation. For the success of a crowdsourcing project it is critical that participants are motivated to contribute. Without participants there is no crowd to crowdsource from. High levels of participation correlate with more data, faster accumulation of data, greater public exposure, more funding, more project resources, and enhanced ability to meet more ambitious scientific goals [3]. Designing functionality and interfaces in a way that supports motivation can result in better outcomes. Since participant motivation is so important, studies on this theme have been made. One such study has investigated intercultural participant motivation in biology related citizen science projects, and created a framework of motivational themes both for initial and sustained participation [4].

Technology that enables people to input data about species they have sighted can have other purposes than purely scientific ones. BioNote is an application for species identification that simultaneously aims to build a sustainable business around the idea. One of their slogans is "Connect with the life around you". The application is photo centered and aims to create an online community, a social media, around the user uploaded images. The resulting species identification data consists of pho-

tographs mapped to species names that users have identified in them. The data can be used in research, for business purposes and for user value.

Like many similar applications, BioNote has prioritized their web version over a smartphone application. However they see potential for a mobile version and intend to build one. The building of a mobile application coincides with an effort to reach non-biology-expert users. In this thesis I investigate how a mobile version of a BioNote-like application can be designed in order to match user motivations. The study is grounded in the motivational framework in [4] by Dana Rotman. User research is performed from which goals, personas, requirements and prototypes are interpreted and constructed. These design artifacts are then mapped against the motivations in [4].

The result is the process and the design artifacts, along with a mapping of these design artifacts against motivations for participating in crowdsourced species identification found in previous research. Goal-directed design is implemented and the design aims to bring together user, business and science goals, while discovering them and prioritizing them against one another.

1.1 Research question

This thesis seeks to provide a mapping between user motivations for collaborative species identification and smartphone technology. It aims to aid designers by providing motivated ideas for the design of similar applications as well as an example of implemented methods. The result will be a set of design goals and artifacts that connect to participant motivations and are evaluated through the motivational framework by Rotman in [4]. Given the thesis aim, the following research question was formulated: “What mobile application design can support motivations for collaborative species identification?”

1.2 Stakeholders and Relevance

I imagine four main stakeholder groups for this thesis:

1. Interaction designers
2. BioNote
3. Citizen science project designers
4. People who would like to engage in collaborative species identification

Yoland Wadsworth et al categorize the stakeholders of a social research problem into four categories: the group it seeks to benefit, the group it seeks to influence, the group it seeks to investigate, and the research group [5]. Following this categorization, the group that I hope will benefit from the study are all four above mentioned groups. Designers can learn about how to design for crowdsourced species identification and about implementation of the methods I have used. They could learn about user motivations and view examples of how designs have been mapped to these. Citizen science project designers could learn about the motivation of their

participants and the role smartphone application design can play in their projects. BioNote could benefit from the user research and design artifacts such as personas, goals, requirements, prototypes, evaluations and my perspective on their product. Last but not least, people who would like to engage in collaborative species identification could benefit from designs that are aligned with their motivations. If not the designs in this thesis then possibly ones that could be inspired by it.

The main group of investigation is people who would like to engage in collaborative species identification, as they hold knowledge which is of importance for the groups the thesis seeks to influence: interaction designers, BioNote and citizen science project designers. From here on I will refer to this main group of investigation: people who want to collaboratively identify species, as “users” and “potential users” in order to simplify reading. While they are the main source of research data, I will also question experts in relevant domains.

2

Background: Crowdsourced Species Identification

As mentioned in the introduction, crowdsourced species identification means that people collect and share data about which species they have seen along with where and when. The data that the individual people share is put together in a database. The most basic way of gathering biodiversity data are so called bioblitzes. When performing a bioblitz, a group of people together identify all species in an area in a short period of time [1]. Common technology involving the internet, Smartphone cameras and databases can be used to optimize and scale species identification work.

The situations in which species identification is performed varies from project to project. People might be asked to enter in data sporadically when they are in nature, or on a regular, scheduled basis. Different geological areas and species can be specifically targeted. Targeted species can be certain plants, fungi or animals. The data can consist of just names of species, of accompanying pictures or of other accompanying meta-information such as location, date and time. The collection can be performed alone or together with others. If participants do field observations they might not have internet connection so they might have to remember their sightings somehow before inputting it, or they can be added into an application anyway and are then automatically uploaded when internet connection is obtained. In some projects there might be personal benefits, for example when collecting bird sighting data bird enthusiasts might personally enjoy building a collection of their sightings and to keep this collection somewhere in an organized way. In other projects it might just be sterile insertion of data. In some projects the volunteers will not be asked to submit data, but to classify species in already present data while using guides. The amount of help the volunteers receive when classifying species varies. The projects are carried out globally and they are not concentrated to just one country or area.

The citizen science community has great interest in collaborative species identification and are commonly the ones to organize crowdsourced species identification endeavors. Citizen science broadly describes citizen involvement in science [1]. A majority of citizen science projects are research on biology, conservation and ecology [6]. Other common fields of application are geography research and health research. The motivation for scientists to initiate crowdsourced data collection is most often to give their research a bigger scope in a resource-efficient way. Sometimes there are other incentives such as bringing awareness of nature and awareness of the state of nature to citizens, or it can be performed as a learning activity for learners.

Often a citizen science project in biodiversity conservation or species identification is lead by a biology scientist or by a group of biology scientists. The most common form of citizen science is that these leading scientists design the pursuit and then recruit people from the public to collect data for them. However citizen science is grouped into five different groups depending on participant involvement. In Preece's words, they are [1]:

1. *contributory projects*, which are designed by scientists with citizens primarily taking the role of data contributors.
2. *collaborative projects*, which are designed by scientists with citizens taking on roles that involve refining the project design, analyzing data, and disseminating findings, in addition to collecting data.
3. *co-created projects*, which are designed by scientists and citizens working together on most, if not all, steps in the scientific process.
4. *contractual projects*, in which communities ask professional researchers to conduct a specific scientific investigation and report on the results.
5. *collegial contributions*, in which non-credentialed individuals conduct research independently with varying degrees of expected recognition by institutionalized science and/or professionals.

In recent years the practice of citizen science has gained momentum due to more widespread use of Smartphone technology [1]. High-resolution cameras in Smartphones are particularly usable in species identification [1]. This thesis is especially interested in applications where photographs are used for species identification, and where the identification is made by humans. Another interesting and adjacent topic is computer vision and photo-recognition software, by which species in photographs can be directly identified by the computer, instead of manually by humans. Computer vision is discussed below in chapter 2.2 after chapter 2.1 where the example application BioNote is presented a bit more elaborately than in the introduction. Lastly the design of ten similar applications is reviewed in 2.3.

2.1 BioNote

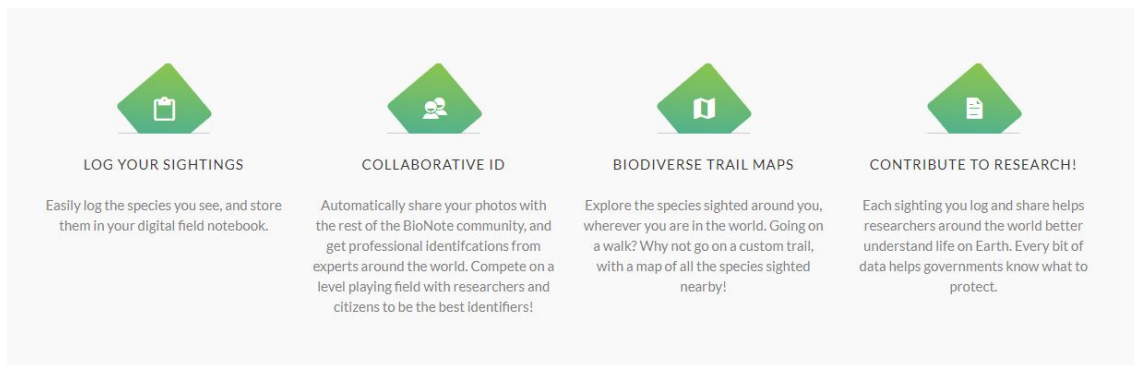
BioNote is a web application that enables people to engage in species information sharing by photograph sharing [7]. Users can upload images of species they have sighted at a location and identify species in their own and other people's images. Through the application, users could learn about the species they have sighted and/or contribute with their knowledge by identifying species in the images of other people. The application is meant to create a community around species and biodiversity. At the start of this thesis, the product was in an alpha-state. The BioNote project is supported by among others the European Research Council, the University of Gothenburg and Chalmers Ventures.

I interpret the BioNote concept as a community around photos of nature. The community collaboratively identifies species in the photos uploaded by its members. A main business or stakeholder goal is to use the data created by its users to aid biodiversity research. Additionally the resulting data would in the future be used to

create computer vision algorithms with which species identification can be made by the software instead of or in collaboration with users. I interpret the BioNote concept as bringing together people who are curious about what it is they observe in nature and people who have the expertise and identification skills to make identifications.

Further functionality in BioNote which is in early stages of design is that users can compete to be the best and most accurate identifiers of species, and one can see all species sightings on a map and go for customized biodiversity walks in areas one finds interesting. BioNote is also intending to create functionality supporting bioblitzes. A bioblitz is when a group of people identify all species in an area under a short period of time. BioNote is also looking into gamification opportunities. The main functionality of BioNote is shown in Figure 2.1 which is copied from their website.

Figure 2.1: Functionality in BioNote [7]



BioNote is currently web based, but looking to create a mobile version of their product. It could be tempting to think that a mobile version should be the first step because users would have a smartphone with them wherever they go, and so it would be easy to upload photographs of things they see in nature while they are out. However, the BioNote team learned that their early adopters did not use the mobile application. The reason was that they already had a workflow of taking photographs with high-end cameras. These photographs were then loaded onto a computer and from there uploaded to a sharing platform. They already had this workflow since they were already invested in the niche, and that is why they were early users. Another reason could be that cameras with telephoto lenses are often needed when photographing animals. Developing a mobile version could be a way to “cross the chasm”, i.e. proceed to a more mainstream user base. While more and more people use smartphones with high-resolution cameras, better quality in photographs increases the value of the mobile application.

2.2 Computer Vision

An even more effective and efficient way than letting crowds classify species might be to program computers to classify species through machine learning. For example a machine learning system that classifies birds by their sound has been created and evaluated [8].

The state of the art in computer vision for species identification is not satisfactory from a user perspective. When inputting a clear photograph of a tulip into two different mobile applications for garden plant recognition the applications did not identify a tulip, instead the output was a completely different flower. When a clear picture of a toucan was inputted into Google's photo recognition software the output was "bird". When I inputted less clear and more realistic images of animals from the local indoors rain-forest, the results were even worse. Photo recognition technology is trending and promising but needs to mature in order to be useful for species identification.

There are several challenges in the path towards better photo-recognition software. Sharp images are needed but both plants and animals can be hard to capture in a photograph. Animals have a tendency to be afraid of humans and to move unpredictably. Plants cannot move but they often grow together in such a way that it can be hard to decipher in a photograph where one plant ends and the next begins. This is often harder for computers to determine than for humans. It is also often harder for a machine to determine which species in the photo is meant for identification than for a human.

Another challenge to be addressed in order for computer vision to mature is the need for large sets of training data. This training data would in the case of species identification consist of large amounts of photographs of different species mapped with the name of the species in the photograph. Such data sets are created for example when humans identify species in photographs in citizen science applications.

In conclusion, computer vision software that identifies species would be superior to collaborative species identification by humans, but collaborative species identifications by humans through mobile applications are a way to create the training data needed to make the computer vision algorithms effective.

2.3 Related Applications

There are countless citizen science applications in many different research domains: astronomy, geography, environmental sciences, health etcetera, but a majority of the current citizen science applications target biology, conservation and ecology sciences and use the applications to collect and classify data [6]. Of the species identification applications many are primarily web-based but mobile applications are also common.

I reviewed the design of ten mobile applications that collect species data. I only tried free applications. In all of them user uploaded photographs have an essential

role. The reviewed applications differ in complexity and which domain they target. Five of them target all species: iNaturalist[9], NatureNet[10], Naturtjek[12], Map of Life[18] and iRecord[19]. They all collect species data for biodiversity conservation purposes. iNaturalist is one of the larger platforms. Identifications can be made collaboratively similarly as in BioNote. If you upload an image you can either give a species identification yourself on it and/or species identifications can be added by other users. The photographs can be commented and the species identifications can be given upvotes and downvotes. Data quality is assessed through a form that is filled in by members. An example question is whether the species was found in the wild or in captivity. There are leaderboards showing the users who have contributed the most. iNaturalist is from the US and has a similar sibling from the UK: iSpotnature.org[13]. NatureNet is similar to iNaturalist and iSpotnature in that photographs can be uploaded and that anyone can identify a species in a photo. NatureNet's speciality is that much emphasis is put on creating a sense of ownership of the design and application and that the community itself designs the application by submitting recommendations. Map of Life and iRecord have similar core functionality. Naturtjek is built by Danmarks Naturfredningsforening in Denmark and has a bit different structure. They work with gamification and use both collaborative and competitive game elements in their design such as individual leaderboards and a community goal and score. The photographs in Naturtjek are not shared with other users and from a user-perspective there does not seem to be any data quality check. PlantNet[17] is also a species identification application but it only targets plants and has photo recognition functionality with which the software attempts to identify the plant species in the uploaded picture with varying accuracy.

Two of the reviewed applications: Garden Flower Identification[15] and Garden Tags[16], are in the domain of garden flowers. Garden Tags is very community and photograph sharing focused. The design is very similar to Instagram[40]: a popular photo sharing application. Garden Flower Identification is an application using photo recognition where a photo can be uploaded and the software tries to identify a garden flower in the photograph.

The last two applications have their respective niche: birding and fishing. A search for "birds" in Apple Store yields a long list of results. Birds seem to be especially popular animals with a large community around sighting them. eBird[11] is a web-based tool for bird spotting which had 9.5 million entries in May 2015 [1]. It is curated by The Cornell Lab of Ornithology. Quality of data is important and is controlled by filtering and expert reviews. There is also a mobile version which is the one that was reviewed. The fishing application that was reviewed was Fishbrain[14], since it has quite successfully built a mobile application social community around fishing data uploaded by users and is photocentric.

Below follows a list of the ten reviewed applications. Their names and features are stated, and a picture of their interface is shown. Their features are further abstracted into keywords. Links are also given which lead to the applications on Google Play and Apple Store.

2. Background: Crowdsourced Species Identification

iNaturalist[9]: Add observation. Leaderboards. Geographical map with sightings marked. Notifications. Add species identification to photo. Agree or disagree on identification. Comment. Add post to favorites. Share post. News. Projects. Join with Facebook.

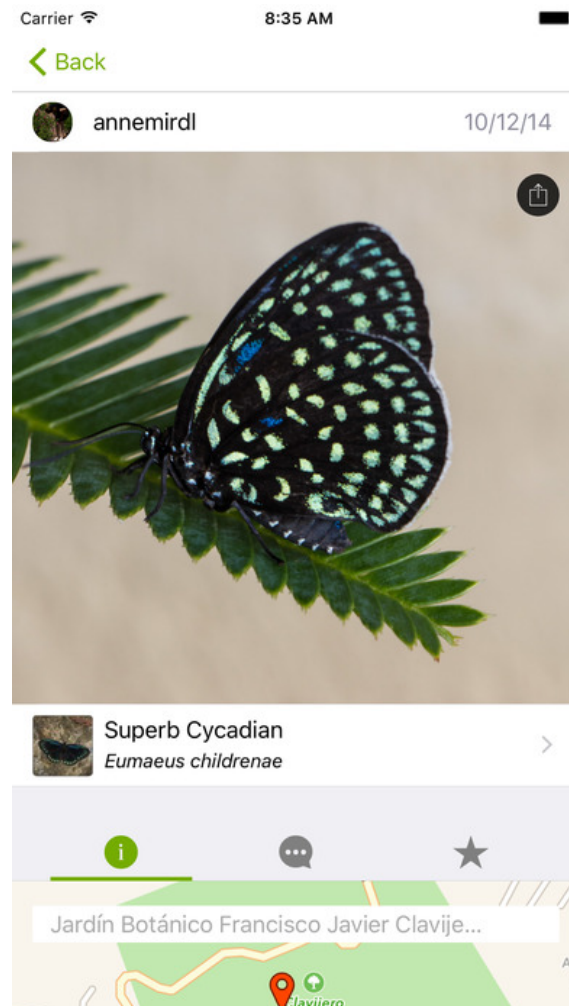


Figure 2.2: iNaturalist screen

Keywords: Collaborative identification, Map, Projects, Leaderboard

Google link: <https://play.google.com/store/apps/details?id=org.inaturalist.android>

Apple link: <https://itunes.apple.com/app/inaturalist/id421397028?mt=8>

NatureNet[10]: Encouraging design ideas and design challenges. Geographical map with sightings marked. Add photo. Gallery. Comment and like photos. Projects. A lot of dead links and unfinished interaction. Complicated process for joining.

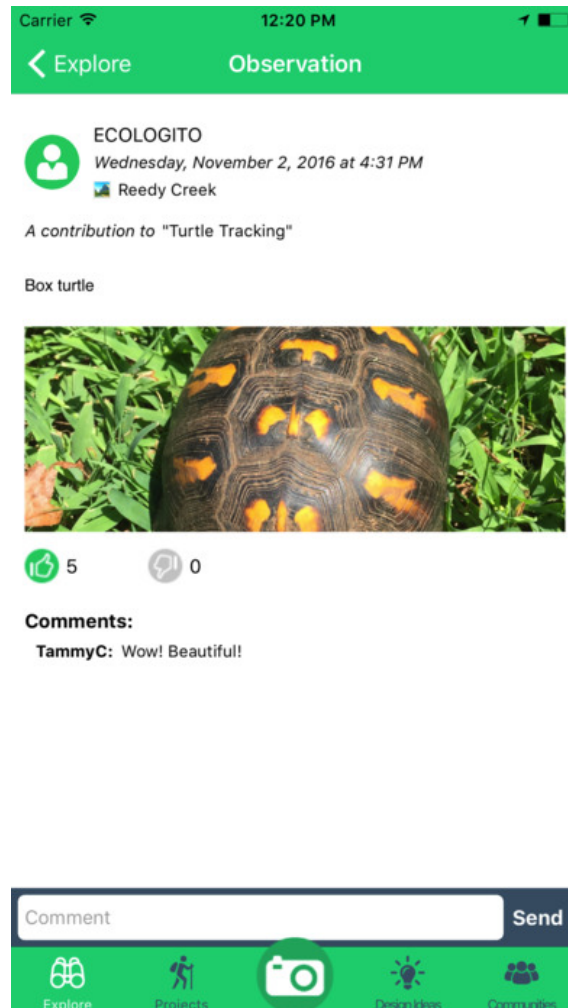


Figure 2.3: NatureNet screen

Keywords: Crowdsourced design, map, social media

Google link: <https://play.google.com/store/apps/details?id=org.naturenet>

Apple link: <https://itunes.apple.com/us/app/naturenet/id1104382694?mt=8>

2. Background: Crowdsourced Species Identification

eBird[11]: Free or paying account. Complicated process for joining. Create checklists with birds you want to see on a trip and then tick them off. Comments. Number of each species. Mode of identification. How many identifiers. Tracking of what I have sighted in trip summaries. No help identifying. Choose to see either the species' common or scientific name.

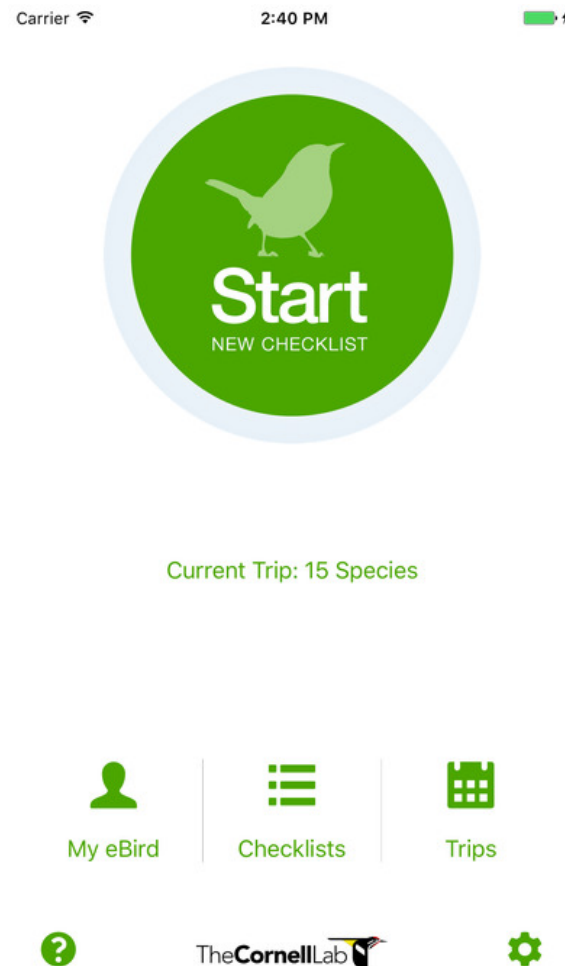


Figure 2.4: eBird screen

Keywords: Bird watching, trip checklists, tracking of sightings

Google link: <https://play.google.com/store/apps/details?id=edu.cornell.birds.ebird>

Apple link: <https://itunes.apple.com/se/app/ebird-by-cornell-lab-of-ornithology/id988799279?mt=8>

Naturtjek[12]: Front page with the possibility to register sighting or register all species in a certain area. Goal number of registered sightings for the entire community. Number of community sightings so far. Number of sightings the logged-in user has made. Animals, mushrooms and plants. Predefined species in an unsearchable list. Can click for info about each; how to identify them, size and where they live. Log in as late as possible; right before posting. Feedback after an interaction. Share post to facebook etc. FAQ and info about why they do this. Leaderboard. Quiz. Users do not have profiles.

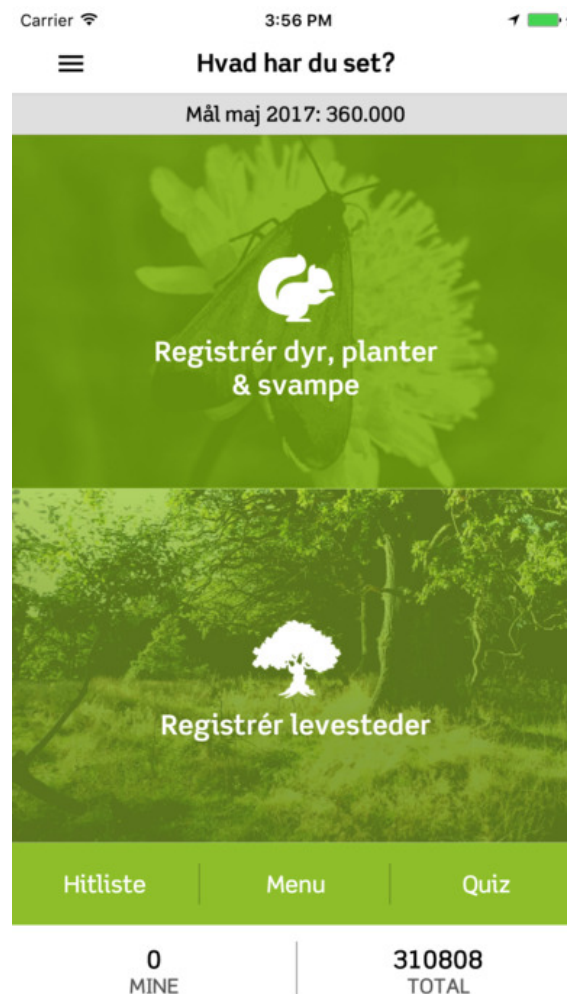


Figure 2.5: Naturtjek screen

Keywords: Collaborative game, species identification, logging, leaderboard

Google link: <https://play.google.com/store/apps/details?id=dk.dn.naturtjek&hl=da>

Apple link: <https://itunes.apple.com/se/app/naturtjek/id981559504?mt=8>

2. Background: Crowdsourced Species Identification

Fishbrain[14]: Following certain fish, locations and people. A feed with posts about locations, species and people that the user follows. Track catches. Profile with vanity stats. Like, comment and share posts. Share posts to Facebook when adding them. Add post about a catch with photo/video and meta-data. Notifications about interesting catches nearby. Forecasts about when and where to fish. Map with catches, baits, forecast and species. Badges for catching species.

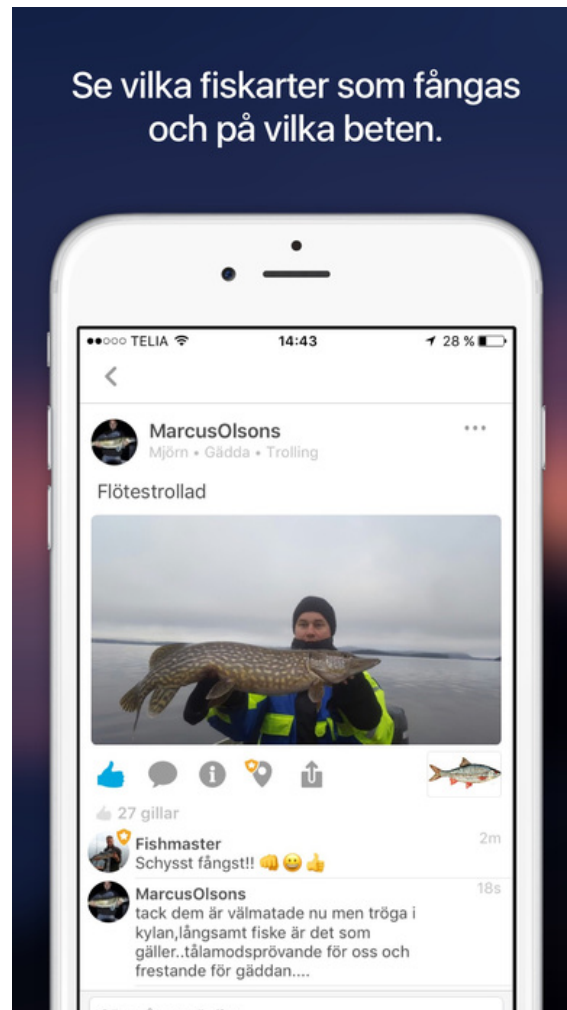


Figure 2.6: Fishbrain screen

Keywords: Fishing, following, predictions, social media, gamification

Google link: <https://play.google.com/store/apps/details?id=com.fishbrain.app&hl=sv>

Apple link: <https://itunes.apple.com/se/app/fishbrain-sportfiske-app/id477967747?mt=8>

GardenAnswers[15]: Choose area, upload photo, choose organ (organ is roughly a group of species). Photo recognition. If no species is recognized they can be searched for manually.

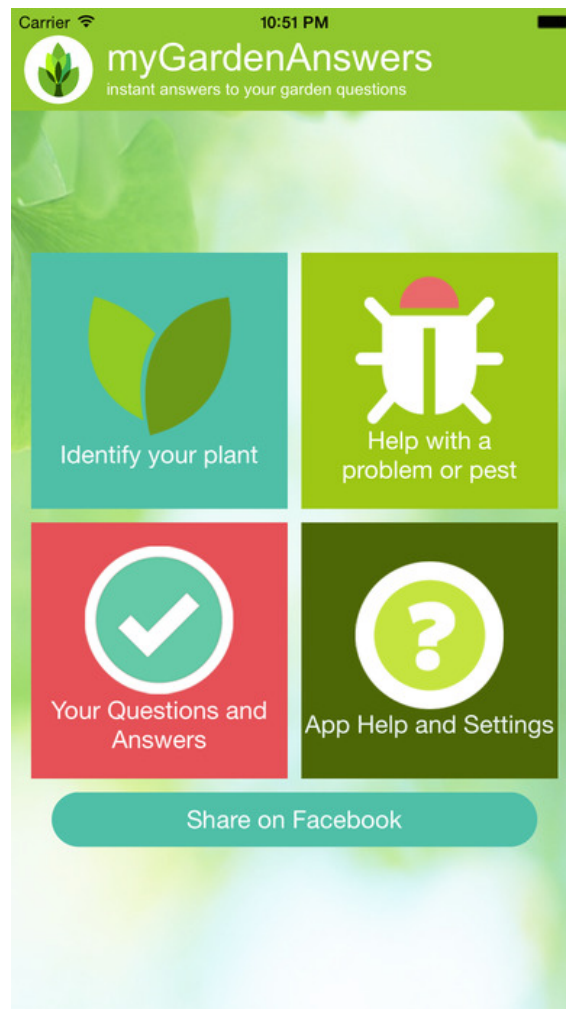


Figure 2.7: GardenAnswers Plant Identifier screen

Keywords: Machine learning, machine generated identification

Google link: <https://play.google.com/store/apps/details?id=com.teamsoa.gardenanswers&hl=sv>

Apple link: <https://itunes.apple.com/us/app/garden-answers-plant-identification/id605855033?mt=8>

2. Background: Crowdsourced Species Identification

Garden Tags[16]: Starts by asking experience level, interests. Following gardeners in feed. The app suggests people to follow. Posts that can be liked, favorited, commented. Hashtags. On profile: number following and followed and plants added. Feed, garden, plants, wishlist. Early/mid/late spring/summer/fall/winter.

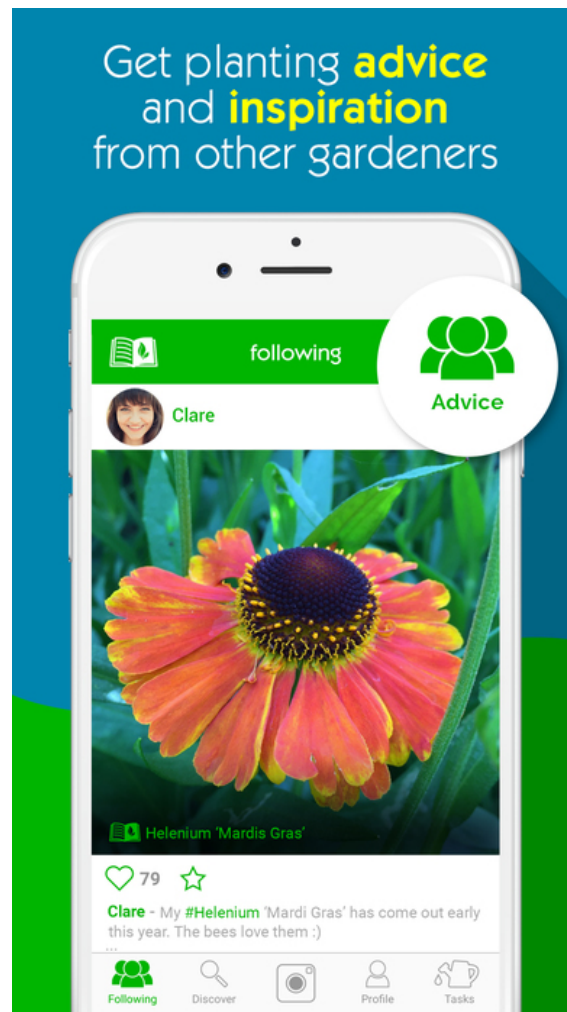


Figure 2.8: Garden Tags screen

Keywords: Gardening, community, social media, species tracking

Google link: <https://play.google.com/store/apps/details?id=com.gardentags&hl=sv>

Apple link: <https://itunes.apple.com/gb/app/garden-tags-plant-identification-and/id852472656?mt=8>

PlantNet[17]: Onboarding instructions. Feed named "Useful plants". Posts with image, organ, common and scientific name, username, date. Images of flower, fruit, leaf, habit and bark respectively. Link to wikipedia. Change feed content by switching project (different projects are basically different locations). Register to upload. Profile with number of requests vs contributions and uploaded images. Photo recognition. Explore sightings on a geographical map.

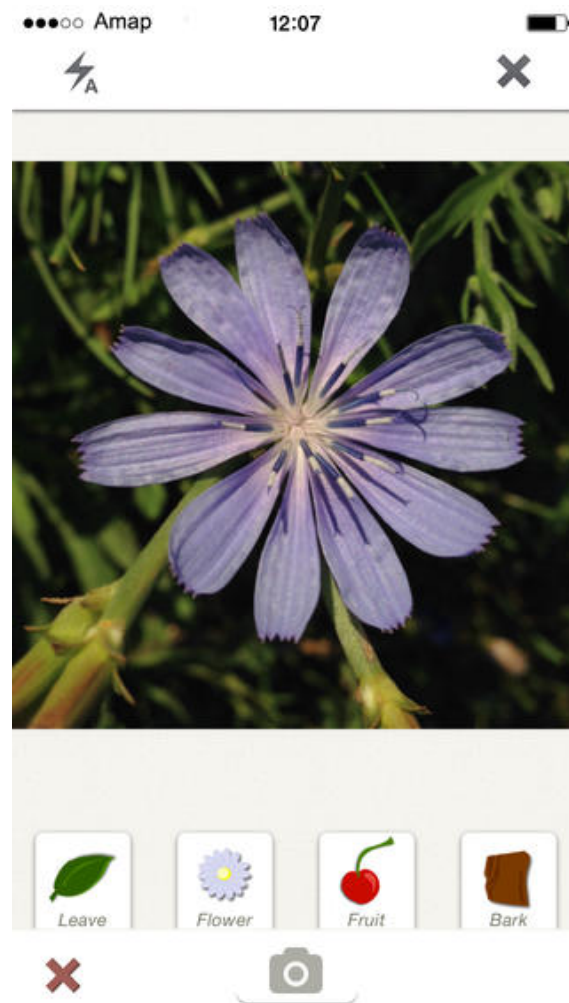


Figure 2.9: PlantNet screen

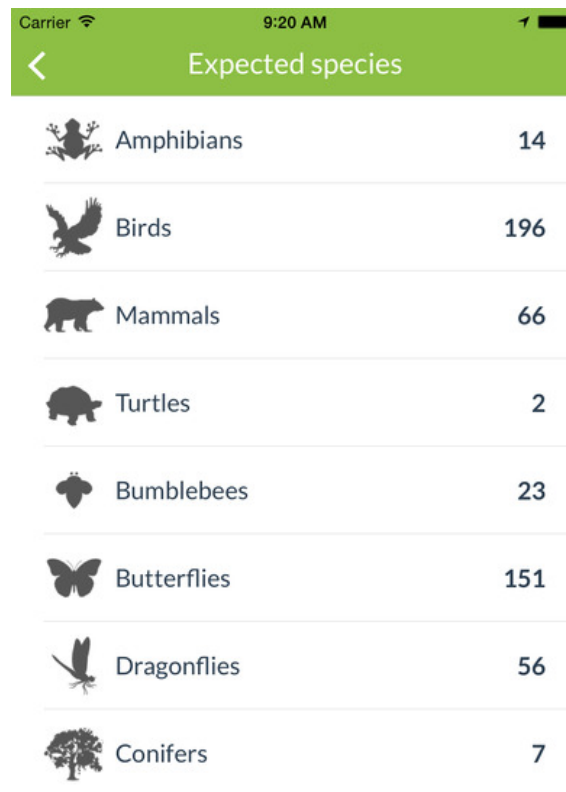
Keywords: Projects, machine generated identification, uploading images

Google link: <https://play.google.com/store/apps/details?id=org.plantnet&hl=sv>

Apple link: <https://itunes.apple.com/se/app/plantnet/id600547573?mt=8>

2. Background: Crowdsourced Species Identification

Map of Life[18]: Search area for expected species: names, description, range and concern. Vote on images. Can submit records from species page found/not found, no comments, own image etc. My records.











Expected species		
	Amphibians	14
	Birds	196
	Mammals	66
	Turtles	2
	Bumblebees	23
	Butterflies	151
	Dragonflies	56
	Conifers	7

Figure 2.10: Map of Life screen

Keywords: Expected species, map, image quality vote, add observation

Google link: <https://play.google.com/store/apps/details?id=org.mol.android&hl=sv>

Apple link: <https://itunes.apple.com/se/app/map-of-life/id983715827?mt=8>

iRecord[19]: Add a species from list. Add metadata: location, time, number, stage, comment, identifiers, picture. Then the added records appear in a list.

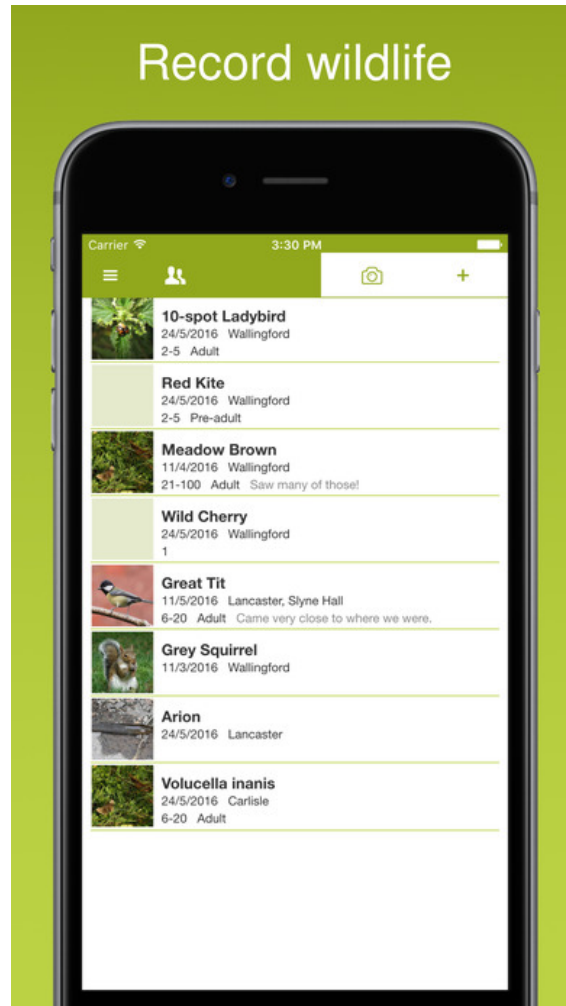


Figure 2.11: iRecord screen

Keywords: Add observation

Google link: <https://play.google.com/store/apps/details?id=uk.ac.ceb.irecord&hl=sv>

Apple link: <https://itunes.apple.com/gb/app/irecord-app/id1094633183?mt=8>

3

Theory: Motivation

This chapter aims to briefly describe the contemporary theoretical framework for understanding motivation which I have used in this thesis. Human motivation in general is explored, mainly through Maslow's hierarchy of needs, as well as motivation in citizen science and motivation in interaction design.

Abraham H. Maslow's hierarchy of needs[20] from 1943 is the most cited academic work in the theory of human motivation. See the hierarchy depicted below in Figure 3.1. It is both widely used and widely critiqued. The critique stems from a lack of empirical validity. Empirical experiments have been made that stand in contrast to the claims of the theory [21]. Moreover the theory has been critiqued for being too general, so that specific empirical studies are difficult to conduct [21]. Also critics say it does not contain spiritual needs (which some believe are manufactured needs), and it does not take social circumstances in consideration. The theory groups human needs, which are also called motivators, into five levels: physiological needs, safety needs, love/belonging needs, esteem needs and self-actualization needs [20]. The theory encompasses the concept that lower needs need to be fulfilled in order for higher-level needs to emerge [14]. The lower levels relate to deficiency needs which demand continuous refilling while the higher levels relate to growth needs [20].

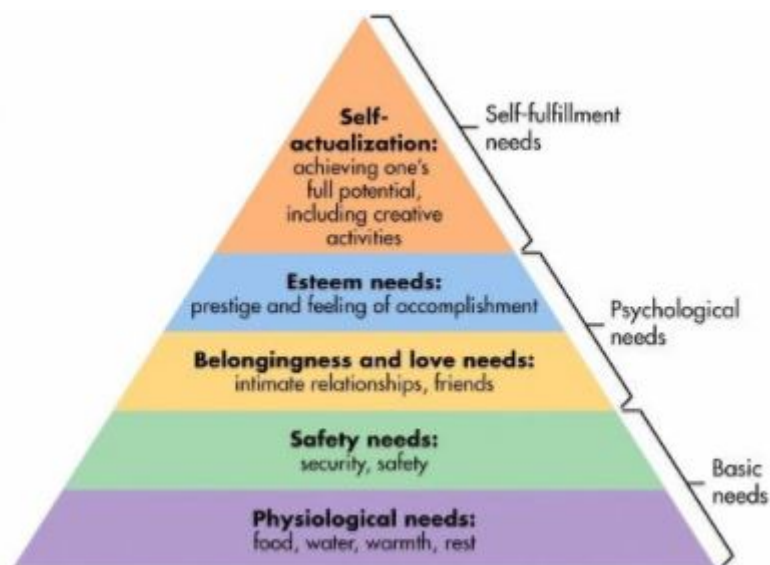


Figure 3.1: Triangle visualization of Maslow's hierarchy of needs [22].

Maslow himself states in *A Theory of Human Motivation* that it is far easier to criticize the less optimal aspects of his theory than to remedy them [20], which might be why we as of today do not have a broadly accepted better alternative. Maslow's hierarchy of needs can be used for reference while researching relevant factors that motivate people to contribute in citizen science for species identification.

In the last decade, scientists moved away from the idea of human motivations as buttons one can press to get a certain behavior. The prevailing view now is of humans as little scientists who detect how their own behaviors affect them and explore behaviors accordingly to find more suitable ones. There is also a lot of recent study on goal-setting and which behaviors and habits allow a person to set goals and achieve them, as well as how the whole pursuit affects a person's well-being. Self-efficacy is a currently popular term [23]. It means having the ability to achieve a specific result. It is similar to self-confidence but instead of having general confidence in oneself it means having confidence in oneself to have the ability to achieve a specific result or complete a specific task.

Motivation is only one of many factors that cause behavior [23], but such other factors as for example physiological structure of the organism have little relevance in the pursuit of factors that can be used to design a mobile application.

An important distinction in the contemporary scientific community researching motivation is that between extrinsic and intrinsic motivation. Extrinsic incentives are rewards and punishment, such as grades, praise and grounding, while intrinsic motivation comes from within an individual. Examples of intrinsic motives are curiosity, meaning and mastery. Intrinsic motivation has been found to be more resilient. While external incentives might produce the desired results in the short-term, in the long-term external incentives such as rewards have been found to impact intrinsic motivation negatively [24, 25].

3.1 Motivation of Citizen Scientists

The study of citizen science possibilities and success factors is currently popular in the HCI community, as suggested by it being a topic discussed at some of the largest HCI conferences every year since 2012. Motivation for participation has been studied as well since participation is critical. High levels of participation correlate with more data and faster accumulation of data, greater public exposure, more funding and project resources, and enhanced ability to meet more ambitious scientific goals [3].

In one study Jennett identified curiosity, interest in science and a desire to contribute to science as primary factors for initial participation [1]. Jennett's findings are somewhat congruent with Rotman's. Rotman's theory is described below in section 3.1.1 Rotman's Motivational Framework and is the one being especially built upon in this thesis. The research question of this thesis and the decision to use Rotman's theory were developed simultaneously. While researching the area of participant motivation in crowdsourced science we thought it would be interesting to build on

Rotman’s research by applying it and by using it in the field of mobile application design.

Nov et. al found that intrinsic factors were more important while rewards were less relevant. They also found that intrinsic and norm-related motives were most strongly associated with participation intentions, and that participation intentions in turn were associated with participation effort. [26]

3.1.1 Rotman’s Motivational Framework

Dana Rotman performed an intercultural investigation of factors that motivate people to contribute biodiversity data in citizen science projects. It was conducted in the United States, India and Costa Rica for optimal cultural diversity. In accordance with other research she states that participants tend to initially be motivated to join by their own intrinsic interests but concludes that for participants to continue to contribute, relationship factors become more relevant, such as feedback about their contribution, acknowledgement from scientists and peers and a sense of belonging to a community. The concluded initial and long-term motivational factors can be found in Table 3.2 along with descriptions of potential participants mapped to each factor as well as in which countries the particular factor was found to be of significance. [27]

The most important hindrances that Rotman found for contribution was time and problems with technology [1].

Theme	Related concepts	Potential participants	Countries
INITIAL PARTICIPATION			
Personal interest	Enjoyment, interest, ancillary hobbies, leisure, interest in nature	Individuals with ample time to spare or a very specific interest in nature; families, all ages	United States, India, Costa Rica
Self-promotion	Reputation building, social advancement, future employment	Individuals wanting to advance themselves (e.g., students, young adults)	United States, India, Costa Rica
Self-efficacy	Affecting scientific work, belonging to the scientific community	Educated individuals; relatively older adults	United States, Costa Rica
Social responsibility	Conservation, pride, national and local dependency	Individuals affected by the local culture and education system; relatively young adults	Costa Rica
LONG-TERM PARTICIPATION			
Within-project relationships			
Trust	Data quality, skills, value, time, leadership roles	Experienced citizen scientists looking for close relationships with scientists	United States, Costa Rica
Common goals	Communication, updates, structured protocols	Citizen scientists looking to deepen their relationships with scientists	Costa Rica
Acknowledgement	Recognition, attribution, value	All citizen scientists	United States, India, Costa Rica
Mentorship	Training, closeness, empowerment	Citizen scientists who want to become deeply involved in the project	United States, India
External relationships			
Education and outreach	Mediation, empowerment, local populations, knowledge	Long-standing citizen scientists who interact with locals	United States, India, Costa Rica
Policy and activism	Accountability, government, institutions, community	Long-standing citizen scientists who interact with locals	United States, Costa Rica

Figure 3.2: Rotman’s motivational framework

Citizen science projects often incorporate a hierarchy between citizen participants and leading scientists. There is room to play with this hierarchy and the relation-

ship between organizers and participants when designing a new mobile application. One of Rotman's conclusions is that participants remain in ecology citizen science projects largely depending on the quality of the relationships formed, both between participants but more importantly between participants and the leading scientists. Rotman's relationship-oriented retention factors were less prioritized in the beginning of the design phase. In part because we didn't want to constrain ourselves to the existing relationship model, and in part because we needed to focus on something. The exception was acknowledgement, which was still prioritized because it is so fitting for mobile application design and applies to all participant segments. The initially prioritized factors were personal interest, self-promotion and acknowledgement. These were the factors that Rotman had found important for all participants in all researched countries and I made the assumption that these three would translate well to mobile application design. In a mobile application the design has potential to implicitly convey a lot of the communication that would traditionally be explicit between scientists and users. There is potential to put more interaction between the user and the application, and less explicit interaction between the project administrators and recruited participants. The design process and design decisions are further presented in 5 Implementation: Design Process.

3.2 Motivation in Interaction Design

I have described general theory on motivation and motivation of citizen science participants. This chapter concerns motivation in the field of Interaction Design.

Interaction designers often seek to, in Zimmermann's words, design the right thing [30] or an ultimate particular [29]. The motivation for use is interesting because it can provide insight enabling designers to design something that more accurately responds to the need, or it can help them to allocate new needs. Understanding needs is a keystone in human-centered design [31]. Investigating the motivation behind the need is an important aspect to understanding the need [32].

Goals and motivation are sometimes used interchangeably in the interaction design community. However there is a difference between the two that can affect design. Cooper describes motivation as the "why" of a goal. Goals are "whats"; they are a state the user wants to attain. A goal is what they want to achieve, do, become or feel. Examples of goals are feeling hip, getting to work or saving money. Motivation sustains action towards a goal. [32]

If goals are "whats" motivations are "whys", according to Cooper. If you take a goal and ask why long enough, you will arrive at the core motivation. Two people can have the same goal, for example saving money, but have entirely different core motivations for wanting to do so. [32]

In interaction design practice interviewers seldom have the time to ask and interviewees seldom have the patience to answer enough questions to identify the core underlying motivations. However, knowing the underlying motivations of a goal

allows a design to more specifically address a need. It can determine which functions to focus on. And when functions are decided, the knowledge of the motivation behind the goal can allow the design of the function to be more fulfilling. [32]

When studying motivation in interaction design the topic of gamification is prevailing. Gamification is the use of game design elements in nongaming contexts to engage and motivate users to reach their goals [28]. The research on gamification of digital applications such as online learning falls under the category of Human-Computer Interaction and behavioural sciences. Gamification can provide the same state of flow and addiction that games provide, but in more traditionally serious or demanding domains [28]. Game elements can for example be highscores and leaderboards. Gamification is often described in terms of extrinsic and intrinsic motivation. Most studies argue that incentivizing users through extrinsic motivation is effective in the short-term, but in the long-term harms intrinsic motivation and overall results.

4

Methodology: Research Through Design

A common methodology in interaction design research is Research Through Design (RtD). It uses the processes and methods of design to generate new knowledge. RtD is most fit for problem spaces that are wicked and messy. [33]

Wicked problems are problems to which there is no one single and most optimal solution. Furthermore it is impossible to prove that a solution to a wicked problem is the most optimal that could be thought of. Wicked problems involve incomplete, contradictory and changing requirements, and the requirements are often difficult to recognize. Problems in social sciences are often wicked, while problems in mathematical sciences often are not.

Design challenges are typical examples of wicked problems. Contradictory requirements are coming from multiple stakeholders and users, and the requirements are often not known up front but need to be explored and prioritized. The objective of design is usually to create an ultimate particular [33], however it is close to impossible to prove that the final design is the most ultimate or optimal that could ever be created.

One might say that research through design is applying design thinking to research. Design thinking is a means of dealing with wicked problems, and so it is applied to wicked research problems. The core of design thinking is to explore needs and desires and to create solutions that fulfill them. Design thinking is an iterative process in which assumptions about needs are researched, prototypes corresponding to these needs are created, and these prototypes are then evaluated and improved by another cycle of research, prototyping and evaluation.

There is an array of methodologies established under the paradigm of design thinking. Some of them are Human-Centered Design (HCD), User-Centered Design (UCD), Activity-Centered Design (ACD) and Goal-Directed Design (GDD). These methodologies have a lot in common, and the differences are often shifts in focus.

HCD, UCD and ACD are explained and compared in section 4.1. Thereafter GDD is described in little more detail and with individual methods. Many of the methods described in GDD such as interviews, observations, personas, prototyping and evaluation are essential parts of HCD, UCD and ACD as well, but in order not to repeat them they are described only through the lense of GDD.

4.1 HCD, UCD, ACD

Human-Centred Design (HCD), User-Centred Design (UCD) and Activity-Centred Design (ACD) are different approaches with the same design thinking roots. I view HCD as the overarching methodology while UCD is a narrower version[34] and ACD an alternative version addressing some of HCD's drawbacks[35].

All three aim to bridge the gap between needs, desires and motivations of people and what is technologically feasible. All of them do this through an iterative process. The presence of users throughout the design effort is an essential cornerstone of all three approaches. They all investigate user groups and needs, create prototypes and evaluate.

The HCD process is normally divided into three phases. IDEO calls them Inspiration, Ideation and Implementation [36]. LUMA calls them Looking, Understanding and Making [37]. I like to call them Inspiration, Ideation and Prototyping. In the first phase knowledge about the intended users, the domain and the activity is gathered. In the second phase problems and potential solutions are identified. In the third phase solutions are prototyped and tested. The learnings are then input to the next iteration.

The difference between HCD and UCD can be sensed by their names: “Human” vs. “User”. UCD is more constrained to the specific relationship “use”. A user is something which strictly speaking only exists in the act of usage. Humans are not users. I become a user of my phone when I interact with it. Redström argues that the term “user” can be problematic for example when the artifact does not yet exist, and when an object is used in non-intended ways. UCD often acts to constrain a human into interacting with an artifact in a certain way. (If I crack an egg with my phone, do I use it?) [34]

One might say that HCD takes a broader perspective and incorporates more context exploration than UCD. UCD on the other hand can be more efficient when there is already an existing product with users to iterate upon. If the design objective is very constrained the narrower UCD can be more effective than going deep and trying to find underlying motivations with HCD. HCD searches more broadly and deeply and might find more unexpected and innovative solutions. Nonetheless, the two terms are often used interchangeably in common industry settings. They emerged when designers began to put more focus on the humans in the human-artifact relationship [34].

ACD puts less focus on the humans in the human-artifact relationship. It has its roots in HCD, but gives more importance to the activity and the artifact to be designed. ACD is not as concerned with making the artifact intuitive or adapting the artifact to the people, because people adapt to technology. The people performing the activities are still considered - they are an important part of the activity - and so a lot of the methods and principles of HCD carry over. In practice ACD often means spending less time modeling detailed personas and scenarios because this can be wasteful. [35]

4.2 Goal-Directed Design

Goal-directed Design (GDD) shares many characteristics with HCD, UCD and ACD and also belongs to the design thinking paradigm. Both ACD and GDD continue to, as in HCD, give humans and the needs of potential users importance, but put more emphasis on the artifact and the activity which is to be accomplished with it. GDD especially emphasizes the creation of actionable requirements from the understanding of user needs, in order to bridge the gap between understanding of needs and actual design [38].

The GDD process is divided into six phases: Research, Modeling, Requirements Definition, Framework Definition, Refinement and Support. These and their individual methods are described in the sub-chapters, see below.

4.2.1 Research

In goal-directed design terms the research phase is all about accumulating knowledge and an understanding of the problem and its aspects. These aspects are the people to design for, the task to design for, the constraints of the problem, and the organizational and business goals that are driving the design. The methods of the research phase are powerful because they give insight into the problem and context, which can greatly save resources that would be spent designing and developing something that is built on false assumptions about the market. [38]

The methods in the research phase are of both qualitative and quantitative form. However Cooper emphasizes that quantitative methods alone are not enough to understand design problems since they are complex and involve humans with mood swings and complex preferences and behaviours. We are dealing with wicked problems without clear requirements and solutions. Many of the methods in the research phase come from the social sciences. [38]

Kick-Off Meeting with Stakeholders

As a first step, both GDD's Cooper and HCD's Maguire recommend a kick-off meeting with stakeholders. The theme of the meeting should be answering questions about the purpose of the system that is to be built, objectives, how it will be judged as a success, who the target users and tasks are and why people would use the system, what other stakeholders might there be, are there any environmental and technical constraints, and what key functionality is needed. Answering these questions will show which areas need more investigation. [39, 38]

Literature Review

In a GDD literature review literature on the product to be designed and its domain are reviewed. It could be internal company documents on e.g. marketing, strategy, branding, customer data and relevant previous work. It could be literature on certain technology, relevant behaviours and targeted activities. The literature can

be academic or industry reports, internet forums, social media, competitor products or web searches for relevant topics. The main objective of the literature review is to create questions to ask stakeholders, subject matter experts and even potential or existing users. [38]

Similar Solutions Analysis

Examining any existing product or prototype and its main competitors is useful, and GDD recommends doing it before stakeholder, subject matter expert and user interviews. It provides a sense of the state of the art and often inspires good interview questions. A good way to achieve this is usually to perform a heuristic evaluation of the current design and/or competitor products. It could also help gain a sense of the functional scope of the product to be designed. [38]

Interviews

As a part of GDD, four types of interviews are common: stakeholder interviews, subject matter expert interviews, customer interviews and user interviews. It is recommended to begin with stakeholder interviews since business objectives should constrain further activities. A stakeholder is in general terms anyone who has authority over or responsibility for the artifact to be designed. It is often a good idea to interview each stakeholder individually. That way views are not lost in a crowd and the extent to which stakeholders hold a shared view and common goals can be seen. Interview content especially useful in stakeholder interviews is preliminary product vision, budget and schedule, technical constraints and opportunities, business drivers and the stakeholder's perception of the user. Discussing these topics is useful to create a common language between all different roles in the team around the product. [38]

Another group of people to interview are subject matter experts, experts in the domain in which the product is meant to operate. It is especially useful in complex domains, often either technically complex or where there are a lot of legal considerations. The subject matter experts' deep knowledge in the domain, product and users can be of great help, but it is also important to keep an open mind since subject matter experts are very invested in the current state of the domain and product, which often limits creativity and the ideas that are possible. The knowledge subject matter experts hold can be of great value, but they are not designers. [38]

The people who buy the product are in many situations not the ones that will use it. Cooper differentiates between customers and users. Customer interviews are often made by marketing people but can be useful for designers as well. Topics to uncover are what made them buy this product, what goals did they have with the purchase, frustrations with current solution, their decision-making process when purchasing, their role in installation, maintenance etcetera, and domain-related issues and vocabulary. [38]

Last but not least: user interviews. Users of the product should be the priority in the design effort. Both current users and potential future users should be interviewed.

Seeing both the perspective of current users of the product and people who have similar needs but who do not use the product (yet), can give insight into how the use of the current product affects the user. The objective of user interviews are often in GDD to learn about the context of the product and the workflow it is used within, why and how it will be used, domain knowledge from a user perspective, current tasks and activities that the current product does and does not support, problems and frustrations with current product or workflow, and the overall mental model of the user concerning the product and its context. [38]

Cooper believes that one-on-one interviews with users in combination with observations is the best way to gather qualitative data about users and their behaviours. The method used is called contextual inquiry and is a form of ethnographic interviewing. The basic idea is that the user interviewee is the expert and the designer interviewer is a new apprentice wanting to learn. [38]

In contextual inquiry interviews, it is important that the setting of the interview is the user's natural environment. It should be set where they would normally perform the tasks that the interviewer wants to learn about. The tone of the interview should be of collaborative sort where observation of work is combined with discussion and questions. A critical part is reading between the lines and interpreting in order to discover underlying problems, aggregating information and forming design implications. It is important to balance own interpretation with what is actually being said and done. The interview should also not really feel like an interview with strict questions on a paper to be filled in, but to the user it should be like a casual conversation about their work. The interviewer needs to subtly direct the conversation. Avoid making the user a designer, discussing technology and asking leading questions. Encourage storytelling and show-and-tell. [38]

Observations

While interviews can give great insight, most people are incapable of correctly assessing their own behaviours. It is therefore useful to observe their behaviours, as they may differ from how they would describe them. The interview situation also incorporates social pressures regarding what is correct to say. Many people would refrain from saying things in interviews that they think might make them seem incompetent or which might be considered inappropriate. It is common that they manipulate their answers in order for them to be well-received by the interviewer. Cooper recommends combining observation and interviewing, that way clarifying questions can be asked in real-time while observing the behaviours. If audio or video recording is used, they should not be too obtrusive as to alter the situation that is to be investigated. If possible, the most unbiased way to observe behaviours is to observe them in their natural setting without the subject knowing he or she is being watched. Of course this way of performing observations arises questions of consent. [38]

4.2.2 Modeling

In the modeling phase the field research and interviews are analyzed and synthesized into models of the domain and of users. Models are an abstract representation of complex phenomena. The volume and form of the gathered conversations and research is easier to work with, to communicate and to incorporate in the design when abstracted into models. [38]

Personas

Personas are abstract models of users. They should be based on people that have been interviewed and observed. Personas make it clearer to think about and talk about the different user groups and their behaviours, preferences, goals and motivations throughout the design process. Getting the persona's goals right is especially important since goals translates into requirements for the prototype. [38]

Different people in the design project tend to have a different perceptions of the user. This can make it difficult to talk about users and decisions. The word "user" would mean different things depending on who is talking. Personas are more specific. If there is a persona for each user group, it is easier to discuss features from these different viewpoints, to empathize with these viewpoints and to have more precise discussions. If there are no personas, similar abstractions might be made for the sake of discussion anyway, but these abstractions might not be congruent with the research or with the reality of the domain and actual users. Basing decisions on such false "personas" is dangerous. Similarly, if there are no personas present in design decisions and discussions, it is easy for designers and stakeholders to just use their own goals, skills and mental models when designing and making decisions, which is equally dangerous because they might be inaccurate. [38]

Another pitfall that personas can help avoid is designing for edge cases. Edge cases are cases that can happen but usually don't. They are important to consider but should not be the focus of the design. Personas help put edge cases into perspective. [38]

Personas are made by analyzing material primarily from user interviews and observations and synthesizing into personas. Cooper proposes the following steps:

1. Group interview subjects by role.
2. Identify behavioral variables.
3. Map interview subjects to behavioral variables.
4. Identify significant behavior patterns.
5. Synthesize characteristics and define goals.
6. Check for completeness and redundancy.
7. Designate persona types.
8. Expand the description of attributes and behaviors. [38]

Goals

According to GDD, user goals are the perspective from which a designer should consider a product and its functions. These goals are typically addressed via tasks

as means to an end. Goals are what motivate people, personas or users to perform tasks and behave as they do. [38]

Usually goals can't be asked for directly, but have to be skillfully interpreted from observations, interviews and other research. If you ask for a person's goals it is likely that they are unable to articulate them, or they don't really know their own goals and so the answer is inaccurate, or the answer is a bit embarrassing so the answer is a modification or a lie. [38]

GDD groups goals into three kinds: reflective life goals, behavioral end goals and visceral experience goals, according to Norman's three-level theory of human cognitive processing [40]. Visceral experience goals are the most simple and universal and involve feeling smart or cool, having fun, feeling secure etcetera. Behavioural end goals are a little more concrete, such as clearing the todo-list, staying connected with friends and family and getting the best deal when buying tickets. Reflective life goals represent personal goals connected to identity. As such they typically go beyond the use of a single product. Examples of life goals are: mastery in a certain area, being a creative person or to be someone that people look up to. [38]

Workflow

Workflow models or user journeys model the flow of an action or process. For example a cinema visit with all its phases such as choosing a movie, buying a ticket, getting snacks, going to the bathroom, finding the chairs, watching the movie and leaving, or a decision-making process within a company with its people, discussions, digital elements and bureaucracy. [38]

4.2.3 Requirements Definition

The requirement definition phase is where the bridge between the research output and the corresponding prototype is built, while considering business objectives and technical constraints. It could be called the unique selling point (USP) or main novel process contribution of the GDD methodology. [38]

Context Scenarios

Scenarios are created through storytelling in order to explore and decide upon ideal user-artifact interactions. The personas are the characters of these stories, and their goals are being met in the scenarios. Scenarios can be verbal and text-based, other common options are storyboarding and sketching. Usually a variation between these is good. [38]

Design Requirements

A requirement is a statement which specifies what an intended product should be, do and how. It is important to make sure that the requirements are defined as clear as possible and that they are written in a way so that it is possible to understand when they have been fulfilled. Design requirements make the problem less wicked.

Requirements can be defined from context scenarios where the goals of the personas are fulfilled by the product. GDD provides the following step-by-step approach:

1. Create problem and vision statements
2. Explore/brainstorm
3. Identify persona expectations
4. Construct context scenarios
5. Identify design requirements [38]

There are different types of requirements that represent what the product needs to incorporate in order to meet persona goals. Data requirements concerns which information has to be presented. Functional requirements regard actions and operations that need to be possible to perform. Contextual requirements describe relationships and dependencies between parts of the system. Data, functional and contextual requirements are based on personas and users, but business requirements from stakeholders, brand requirements, technical requirements and customer requirements are important to establish in this phase as well. [38]

4.2.4 Designing the Product

When contextual scenarios and design requirements are created it is time to create the product prototype off of these. [38]

Framework Definition

The design framework defines the overall structure of the prototype. This involves screens, the arrangement of elements on these screens and navigation between screens. The user experience is wireframed. [38]

The GDD step-by-step framework definition process:

1. Define form factor, posture, and input methods.
2. Define functional and data elements.
3. Determine functional groups and hierarchy.
4. Sketch the interaction framework.
5. Construct key path scenarios.
6. Check designs with validation scenarios. [38]

Step 3 to 5 are often conducted iteratively and in differing order based in the designer's preferences. [38]

Design Refinement

When a solid framework is reached, in addition to key paths and validation scenarios, it is time to design for less common paths and challenge the design by scenarios which try to make the design fail in reaching the requirements and fulfilling the intended user experience. [38]

Testing the Design

The design should be tested soon so that there is time and resources to improve found flaws, but not too soon because the prototype needs to be in a representative state. The design can be tested by heuristic expert methods such as cognitive walkthroughs, or by bringing in users and perform user testing. User testing can be performed either in a lab or in the field, depending on which aspects are deemed important. [38]

5

Implementation: Design Process

The design process predominantly followed the theory on Goal-Directed Design (GDD), influenced by my experience with Human-Centred Design (HCD). The design process I adopted was flexible and responded to the interim results. In favor of such flexibility Wadworth states that "...a good research retains the capacity to respond flexibly as the inquiry unfolds" [5].

The activities performed are described in this chapter chronologically, starting with a summary of observations, workshops and involved people.

5.1 List of Observations, Workshops and People

During the process numerous observations with and without interviews were made, and numerous people were involved. There was also a large workshop with citizen science practitioners. I here give an overview of these observations, workshops and people before continuing to describe the process in more detail chronologically. The observations and workshops are summarized in Table 5.1. Involved people are listed.

The people who were involved in my pursuits in the observations, interviews and workshops mentioned in Figure 5.1 are in total a bit more than 100 individuals. The largest groups were the 36 participants of the ECSA workshop, and the 40 participants of the guided hike around S  ve  n which I observed. The people behind the posts and comments I observed online are also numerous. The ECSA workshop included many experts in citizen science, biology and mobile application design for citizen science (See 5.6 ECSA Workshop on UX for Citizen scientists). Of these two evaluated my second prototype (See 5.4.3 Prototyping, in Iteration 2). The first prototype was evaluated by an industrial design student, an industrial economy student, an entrepreneurship student and an associate professor at the institute of Interaction Design, all from Chalmers University of Technology. Below I list the collaborators at BioNote and the experts at the ECSA workshop.

Collaborators at BioNote:

- Erik Thorelli, CEO and Design Lead
- Johannes Klein, PhD in Biology and Mobile Developer
- Sara Lindgren, Designer
- Daniel Edler, Software Engineer

The workshop participants together with their associated university:

Figure 5.1: Overview of observations and workshops

	What	Who/Where	When
1	Informal interviews	5 convenient friends and colleagues who could belong to the target audience	Iteration 1 (See 5.3.1.4)
2	Online observation	Facebook, Twitter, Google, Flickr, Instagram	Iteration 1 (See 5.3.1.5)
3	Observation and interviews	The Museum of Natural History in Gothenburg. Six visitors were interviewed.	Iteration 2 (See 5.4.1.1)
4	Observation	The Botanical Garden in Gothenburg	Iteration 2 (See 5.4.1.2)
5	Workshop	Held by the European Citizen Science Association, 36 participants connected to digital application design for citizen science	Between Iteration 2 & 3 (See 5.5)
6	Case Study	Held by the European Citizen Science Association, around 20 participants connected to digital application design for citizen science	Between Iteration 2 & 3 (See 5.5)
7	Observation	Guided group hike around S��ve��n organized by V��stkuststiftelsen	Iteration 3 (See 5.6.1.1)
8	Expert interviews	The design lead and CEO of BioNote	Throughout (See e.g. 5.6.1.2)
9	Observations and informal interview	The lunchroom of the Institute for Biology and Environmental Sciences at University of Gothenburg	Iteration 3 (See 5.6.1.3)

- Adam McMaster, Zooniverse, University of Oxford
- Agnes Mair, National History Museum Vienna
- Alda Terracciano, UCL / University of Gothenburg
- Alexandra Albert, University of Manchester
-   sa M  kitalo, University of Gothenburg
- Candan Eyl  l Kilsedar, PhD Student, Politecnico di Milano
- Cecilia Lindh  , University of Gothenburg
- Chris Phethean, University of Southampton
- Christopher Kullenberg, University of Gothenburg
- Dick Kasperowski, University of Gothenburg
- Dilek Sahin, TEMA Foundation (The Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats)
- Ella Vogel, National Biodiversity Network (UK), and representing GBIF
- Erik Thorelli, BioNote, University of Gothenburg
- Flavia Bartoccioni, University of Rome Tor Vergata

- Giannis Haralabopoulos, University of Southampton
- Guilherme KODJA Tebecherani, IPM - Iniciativa Pro Mar, Brazil
- Gunilla Ullman
- Jakub Trojan, Tomas Bata University in Zlin, Czech Republic
- Janice Ansine, The Open University, iSpotnature.org
- Jari Silander, Ymparisto, Finland
- Jaume Piera, Institute of Marine Sciences (ICM-CSIC)
- Jonathan Brier, University of Maryland
- Lars Kristensen, University of Aarhus
- Lina Andersson, Royal Institute of Technology, Sweden
- Luigi Ceccaroni, 1000001 Labs
- Marisa Ponti, University of Gothenburg
- Niclas Hagen, University of Gothenburg
- Ola Langvall, Swedish University of Agricultural Sciences/Swedish National Phenology Network
- Patricia Paulsson, BioNote, Chalmers University of Technology
- Philipp Hummer, SPOTTERON
- Sean Lynch, University College Cork
- Soledad Luna, ECSA
- Sven Schade, European Commission, Joint Research Centre (JRC)
- Ulrike Sturm, Museum für Naturkunde Berlin
- Vanessa Lemos Campos, independent

5.2 Initiation

The first two weeks were dedicated to defining a research question, defining the scope of the design pursuit and planning the work. The goal was to find good questions to ask and answer in the intersection between crowdsourced species identification, motivation and interaction design. The answers to these questions should be of value to interaction designers and others. The main methods for scoping were literature reviews and researching existing digital solutions. The literature reviews were mostly academic.

In the initial phase contact was also initiated with the team behind one of the relevant applications: BioNote. As we decided to collaborate, conversations (or interviews) were held with them which further explored the domain and its potential questions. From all these initial research activities I decided to research motivations for using applications such as BioNote. After more literature reviews, it appeared that there was already a sufficient body of motivation research to draw from, at least motivations for participating in crowdsourced species identification in general. Motivations concerning mobile application usage in this field was less explored. I decided to accept the existing motivational frameworks and that it would be valuable to build on it by pursuing the question of how to design for it on smartphones. I also decided to scope the pursuit towards photo-sharing applications such as BioNote.

The problem of how to design mobile applications in a way that supports motivations for collaborative species identification meets the criteria of a wicked problem. It does not have one single solution, it can never be answered exhaustively, there are contradictory agendas and requirements, and requirements are not clear. Therefore the design research approach of RtD seemed appropriate. Of the three RtD approaches discussed by Zimmermann et. al: Lab, Field and Showroom, the Field approach was decided upon since the output of this approach is often a commercial product, and user-centered methods are used [28]. This type of RtD is used to produce knowledge about solutions to the design problem and about the methods that are used in doing so.

To implement RtD it was decided to work in a design thinking fashion with iterations loosely parted into inspiration, ideation and prototyping cycles. Since HCD is good at exploring underlying reasons and motivations, it seemed reasonable to work in an HCD fashion. Since I had good experiences with GDD in similar projects, I decided to use GDD methods and make my own mix of GDD and HCD. A GDD methodology was followed, but of course not every method was needed in every iteration. The iterations were not planned in detail - the results of the previous iteration would lead the way for the next. The iterations follow the phases Research, Modeling, Requirements Definition, Framework Definition and Refinement, but I grouped Framework Definition and Refinement into Prototyping. Also every iteration includes evaluation of produced prototypes and design artifacts in terms of Rotman's motivational framework [10].

5.3 Iteration 1

The first iteration followed a GDD cycle of research, modeling, requirements definition, framework definition and refinement. It resulted in a set of possible goals and a click-through prototype which was evaluated informally by colleagues and evaluated with the lense of the motivational framework described in 3.1.1 Rotman's Motivational Framework.

5.3.1 Research

The research phase of the first iteration consisted of a literary study on user motivation in similar citizen science projects, stakeholder interviews with the lead of BioNote, and five informal open interviews with ordinary people that might be or know potential users. The current BioNote system and similar applications were also taken into consideration. After establishing a target audience I researched where they hang out online and which Facebook and other social media groups there are in the domain and what they talk about.

In accordance with GDD and HCD recommendations, there were kick-off meetings with stakeholders. These stakeholders were mainly representatives at BioNote. In the meetings with BioNote topics included vision for the project, the purpose of the mobile application to be designed, knowledge about users and user groups, existing

personas, previous work and current prototype, current knowledge about goals and motivations as well as some long-term and short-term business objectives.

Literature Review

I reviewed literature on different citizen science projects using digital technology and which questions the community seems concerned about. I read about participant engagement in these projects and about motivation in general. I focused especially on studies regarding biodiversity citizen science projects and projects involving species identification. I also reviewed the relationship between crowdsourced species identification and species identification made by machines, as well as the state of the art of species identification made by machines. Some of the results of this review can be read in the Background and Theory sections of this thesis.

Solutions Review

The current BioNote prototype as well as similar solutions were reviewed. They were reviewed in terms of factors such as functionality, purpose, target audience and usability. I reviewed both web-based and mobile solutions. The current BioNote prototype was web-based so I reviewed it by looking at its screens and asking the BioNote team about its current and envisioned functionality and design.

The applications similar to BioNote ranged from citizen science applications purely concerned with collecting high-quality sighting data to general photo-sharing applications such as Instagram[40]. When reviewing mobile applications I downloaded the applications and looked at their screens. I mostly reviewed iOS versions since it is the operating system of my phone. For web-based applications I created accounts online in order to see their screens. For some applications with both a web and a mobile version such as iNaturalist[9], I looked at the screens of both.

Stakeholder Interviews

I had several conversations/interviews with members of the BioNote team where the current web-based prototype and visions for the to-be-designed mobile version were discussed. These interviews also tried to gain access to the learnings BioNotes had accumulated over the past two years concerning the domain, users, prototypes and business models. Topics included current user groups, current personas and their goals as well as user groups and goals envisioned for the mobile version. Furthermore these interviews were used to decipher business requirements and other non-user requirements.

The interviews with BioNote consisted of an initial meeting with all team members present for about an hour and later of unscheduled conversations at the office in between other activities.

User Interviews

I held six informal, open conversations/interviews with convenience-sampled friends and co-workers. They were sampled not only by convenience but also because I

knew that they had some interest in nature, but that they were not biology experts and had not, that I knew of, participated actively in species identification activities. These characteristics coincided with the target group that I through interviews with BioNote had learned that they thought the mobile version would make it easier to reach.

The interviews were held spontaneously when I met the person and they had the time. They were never longer than 20 minutes and I did not record them. Since time was often limited I did not risk the disruption of conversation flow that asking to record the conversation can have.

Interview topics included activities and preferences in nature, interest in species, nature photo sharing and photo sharing in general. Often if appropriate after they had answered a question I also asked what they thought people they know would have answered in order to get a bigger scope or at least gain insight into their view of the domain.

The interviews included storytelling about what they and people they know do in nature. By follow-up questions I probed for possible scenarios in which they or people they know would use an application similar to BioNote. I focused more on the purpose of getting an identification than the purpose of contributing with identifications because the interviewees had limited knowledge in species names. I tried to ask questions that could uncover underlying goals and motivations in the possible usage scenarios.

Online Groups Investigation

Complementing the real-life interviews about activities in nature I wanted to get an idea of what people do online in the area. For this purpose I did a small online ethnography study and looked through relevant Facebook-groups and relevant tags on Twitter, Instagram and Flickr. The tags reviewed were *whatisthisspecies* and variations of this. I investigated what kind of questions were asked and what kind of answers were given, and what the conversations looked like. I also looked at what kind of pictures people uploaded. On Facebook I joined a hiking group since I thought that people who go on hiking trips have an interest in nature but that their biology and species naming skills might vary from none to expert, with more people on the lower side of the scale. I looked at what kind of people do hiking and talk about it online, and what they talk about and what kind of pictures they share. I also investigated *Naturskyddsföreningen* and other environmental associations to get an overview of their posts and concerns, their events and members. The goal was both to get an overview of people's behaviours, but also to learn about communities in which I could do further research activities such as interviews and observations, should it be needed.

In Figure 5.2 an example of an online conversation involving collaborative species identification is shown. This example is from Facebook [41]. The to-be-designed application aims to optimize these kinds of requests. The reviewed conversations were both international and specific to the Gothenburg area.

Figure 5.2: An example online conversation involving collaborative species identification from Facebook [41].



5.3.2 Modeling and Requirement Definition

In the modeling phase the knowledge gathered from the preceding research phase was analyzed and synthesized into goals. In order to ground the design in Rotman's motivational framework this framework was the starting point of the analysis. A subset of the factors in her findings were given priority and were used as a basis for brainstorming. A set of possible goals were derived/created from the research material, using provisional personas/user segments. These goals were then again evaluated in the light of Rotman's motivational framework.

Motivation Prioritization

The motivational framework of Dana Rotman was the starting point of the design. From her ten themes three were prioritized in order to have a more manageable starting point to generate ideas from. The framework is described in 3.1.1 Rotman's

Motivational Framework, but for convenience the ten themes can be reviewed in Table 5.3.

Figure 5.3: Dana Rotman’s conclusion of motivational factors in biology citizen science projects. [21]

Theme	Related concepts	Potential participants	Countries
INITIAL PARTICIPATION			
Personal interest	Enjoyment, interest, ancillary hobbies, leisure, interest in nature	Individuals with ample time to spare or a very specific interest in nature; families, all ages	United States, India, Costa Rica
Self-promotion	Reputation building, social advancement, future employment	Individuals wanting to advance themselves (e.g., students, young adults)	United States, India, Costa Rica
Self-efficacy	Affecting scientific work, belonging to the scientific community	Educated individuals; relatively older adults	United States, Costa Rica
Social responsibility	Conservation, pride, national and local dependency	Individuals affected by the local culture and education system; relatively young adults	Costa Rica
LONG-TERM PARTICIPATION			
Within-project relationships			
Trust	Data quality, skills, value, time, leadership roles	Experienced citizen scientists looking for close relationships with scientists	United States, Costa Rica
Common goals	Communication, updates, structured protocols	Citizen scientists looking to deepen their relationships with scientists	Costa Rica
Acknowledgement	Recognition, attribution, value	All citizen scientists	United States, India, Costa Rica
Mentorship	Training, closeness, empowerment	Citizen scientists who want to become deeply involved in the project	United States, India
External relationships			
Education and outreach	Mediation, empowerment, local populations, knowledge	Long-standing citizen scientists who interact with locals	United States, India, Costa Rica
Policy and activism	Accountability, government, institutions, community	Long-standing citizen scientists who interact with locals	United States, Costa Rica

Since Rotman’s results concern multiple types of biology citizen science projects, with and without technology, a criterion for the subset of her motivational factors was that they should be possible and meaningful to design for in the context of mobile application design. Another criterion was that the chosen factors should hypothetically be the ones most relevant to our target group of potential users who have some interest in nature but who are not used to the activity of taking nature photos and identifying species in them. This target group was established during kick-off meetings with stakeholders, see arguments in the next section: Personas.

The chosen factors were: personal interest, self-promotion and acknowledgement. Personal interest and acknowledgement were the most universal factors since they applied to almost all types of citizen science participant segments [rotman]. Self-promotion was assumed to go well with the concept of photo sharing social media. Furthermore these factors were not as focused on the relationship between leading scientists and participating crowd as some of the other factors, which I thought would help to not be too constrained by the existing relationship models in citizen science.

Constraining the factors to design for was a decision taken with the objective to make the design work more manageable. However the other factors, such as the ones concerning relationships and communication, would still be highly important and taken into consideration. Mentorship, training, empowerment, and clearly communicated common goals could be important as well although they were not chosen

as the starting point in the first iteration. The rest of Rotman's found factors such as social responsibility and self-efficacy were not forgotten either.

Personas

In the beginning of this project, BioNote had created three personas that were used while working on the web product. These personas were all academics in the field of biology, but with ranging experience. It is common for startups to initially design for extreme users invested in the niche, so called early-adopters. One of the three personas was a stressed-out thesis writer, one was a laid-back biologist who enjoys hikes and field trips, and one was a highly experienced professor with almost no spare time who organizes field trips and bioblitzes. These three personas had differing goals with the interaction. The first stressed out student needed some distraction, the laid-back biologist wanted to immerse themselves in their interest, and the professor wanted a convenient way to organize bioblitzes and make use of the data.

In stakeholder conversations we had agreed on trying to reach a not so biology invested group with the mobile application prototype. While people experienced with species identification and taking photographs of species in nature might have an established workflow as described in 2.2 BioNote, people who are less experienced were assumed to more readily use their mobile phones. We assumed that the quality of their mobile phone cameras in most cases would suffice. We also assumed that since the people of the target group would have their phones with them almost all the time it would be easy for them to engage with the community in the field or from anywhere. The internet connectivity issue would need to be taken into account.

New personas for this new group of people could have been created, but instead I just envisioned three segments based on species identification skill and niche investment rate. I did not want to make a too long and detailed iteration; I wanted to generate a prototype rather quickly in order to through evaluation of it maybe reach some new conclusions. Therefore no detailed personas were created in this iteration, but I figured it would be a good thing in future iterations. Instead the provisional user segments were:

1. Basic: Very limited knowledge in species names. Enjoys nature but is moderately invested.
2. Advanced: Has a bit more advanced nature interest or ancillary hobby investment.
3. Expert: Biology professional with species identification interest and skill.

The segments were interpreted from the research but since the analysis and synthesis method had not been as systematic as recommended by Cooper I used them in the design activities but was aware that they might be flawed.

Non-User Requirements

As described in 4.3 Goal-Directed Design, in addition to the user-centered data, functional and contextual requirements, there are often other important require-

ments to be considered such as business requirements, brand requirements, technical requirements and customer requirements. These requirements often serve as constraints for the user-centered requirements, and can often symbolize the purpose of the application from the perspective of its financiers, initiators and/or visionaries. These additional requirements were mainly formulated by interpreting stakeholder conversations with BioNote and literature about typical crowdsourced species identification citizen science projects. GDD recommends giving business and stakeholder requirements priority [28], and so they were formulated first. They represent core qualities and functionality of the design.

An important cluster of requirements are requirements concerning quality of data. These can be viewed in the perspective of scientists and societies who want to benefit from the data and in business perspectives aimed at selling the data. A potential scenario in which scientists and societies would like to benefit from the data is in construction. For example if a new highway is to be built, the data could be used in order to find the optimal route for it, so that it does not kill important ecosystems. An associated business objective would be to benefit from sharing this data. Another scenario might be usage of the data in the scientific (and industrial) advancements of machine learning technology. The following base-line requirements were constructed:

- The application should generate data consisting of photographs mapped to names of the species in them.
- This data should be created through content uploaded by users.
- The data should, in long-term, be of high enough quality to be used in theoretical and applied biodiversity research.
- The data should, in long-term, be of high enough quality to train an algorithm to identify species in photographs. The application should, in long-term, be able to produce machine generated identification from uploaded photographs.

The above last requirement, to in long-term be able to produce machine generated identifications, and the associated requirement that the user-uploaded content should help make this possible, could also be seen from a user perspective. From a user perspective being able to get a high-quality identification from the software would be more effective than relying on the community. From a business perspective this technology would be valuable.

A certain non-functional requirement, rather strategy, was formulated:

- In the startup phase of the application, user engagement is prioritized over data quality in order to build a user base. The value of the community lies in it being populated with engaged people. However sufficient data quality should be achieved in the long-term.

Some requirements constraining the purpose of the application:

- The application should be photograph centric.
- The application should foster a community around the uploaded images and species identification.

Related experience-oriented requirements were expressed. Although they are user-centered and could have been interpreted from the user research, they came from stakeholders:

- The application should enhance the user's nature experiences.
- The application should contribute to the user's ability to appreciate nature.

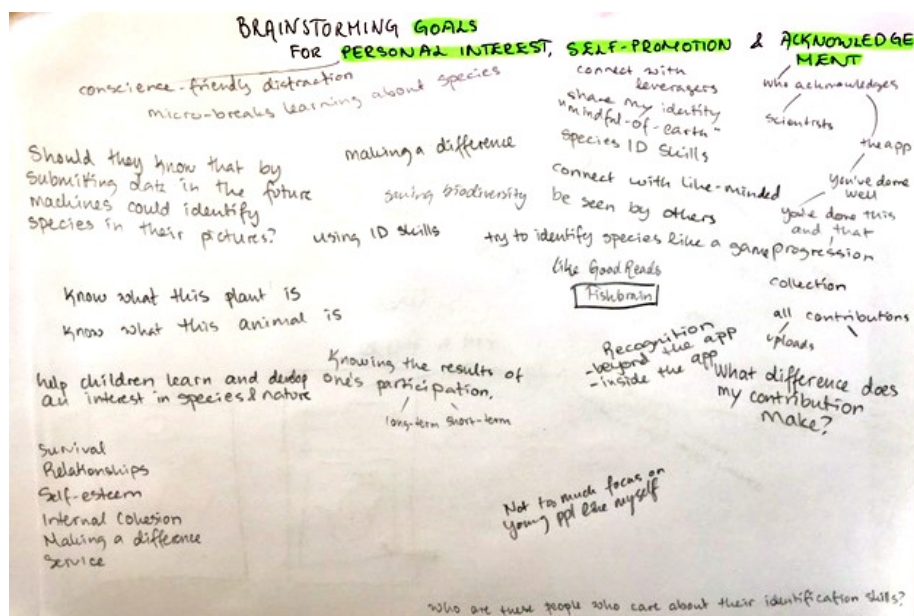
This last requirement built on the assumption that nature is inherently appreciable. Nature was likened to art, where several studies have shown that the more a person knows about the artwork and the artist, the more they will appreciate the art experience. Similarly it was thought to be possible, or at least worth investigating, if the to-be-designed application could have similar effect on users' nature experiences.

The above presented requirements painted a more constrained picture of what the design should be able to do.

Brainstorming Goals and Scenarios

From the motivational factors personal interest, self-promotion and acknowledgement I performed a brainstorming session where I gave myself ten minutes to write down goals I could think of relating to the three motivations. The BioNote personas and provisional user segments described above were also kept in mind. Figure 5.4 is a picture from this session. The requirements were not explicitly considered in the brainstorming in order to explore a broader range of ideas.

Figure 5.4: Brainstorming goals.



While brainstorming I decided to go along with the BioNote concept of photo-centered, community and sharing experiences.

Goals

From the brainstorming combined with the previous knowledge from the research phase I zoomed in on the three following goals:

- Conscience-friendly distraction
- Share mindful-of-earth identity with others
- Connect with leveragers

Other goals in mind were “Get something I have seen identified” and “Show off something rare I have seen”, since these were viewed as the core of the concept. The core of the concept was a social media community in which pictures of species were shared and collaboratively classified. These were more behavioral goals (see the section Goals in 4.3.2 on goals in GDD) concerning a step in the interaction, while the brainstormed goals were more overarching concerning the whole interaction.

Conscience-friendly distraction is a goal that is intended to match the prevailing habit that a lot of people have of distracting themselves with their phones by checking social media. A lot of people feel bad about doing this in a way that makes the behaviour not conscience-friendly. Our to-be-designed social media around species identification would however allow the user to engage in the habit of distracting oneself with social media on a smartphone conscience-free since the social media would have the good cause of preserving biodiversity and learning about and increase societal awareness of nature, as well as aiding in the advancements of photo recognition software. This goal was primarily thought to match users of segment 1: “Very limited knowledge in species names, enjoys nature but is moderately invested”. This goal also matches the already in-use persona created by BioNote: the stressed-out thesis writer. However it could apply to anyone who feels guilty about checking social media too often or who needs distraction throughout the day.

The goal of sharing one’s mindful-of-earth identity with others adheres to the human need of identity and the social movement which works to and seems to somewhat succeed in making caring about nature and being mindful of the state of the earth the norm. The goal would be of Norman’s life-goal type on the reflective level (see the section Goals in 4.3.2 on goals in GDD). The goal is to be a person who is mindful of the Earth and who has a positive impact on the Earth, but especially to be recognized as such a person through interaction and belonging in the to-be.designed social media community.

The third goal: connecting with leveragers, is explicitly connected with Rotman’s theme of self-promotion. People with this goal would use the to-be-designed application in order to connect with people who could help them reach the next step in their professional or private pursuits. A leverager here means a person who implicitly or explicitly helps another person to advance themselves. This is thought to be made possible through profiles describing the members and their contributions so that they can get a sense of each other, as well as through the ability for members to communicate with one-another and possibly by integrating the application with other existing social media platforms.

Goal-Motivation Mapping

The three goals presented above were mapped to motivational themes in Rotman's framework. See a review of the goals and motivational themes in Table 5.1

Table 5.1: Iteration 1 Goals and Motivations

Goals	Motivational Themes
Conscience-friendly distraction	Personal interest
Share mindful-of-earth identity with others	Self-promotion
Connect with leveragers	Self-efficacy
	Social responsibility
	Trust
	Common goals
	Acknowledgement
	Mentorship

Conscience-friendly distraction relates to the social responsibility factor and the personal interest factor. It is a goal that was also mentioned in the expert interview. BioNote expressed that they think it has potential. It would apply to the broad target audience and the form of a mobile application. From this a scenario was storyboarded about a person who waits for the bus and distracts themselves with a photo-centric application for collaborative species identification. Depending on the individual different motivational themes would be more important. For example one person would be motivated by personal interest in seeing species and another person would be motivated by social responsibility or self-efficacy, or a mix.

The goal Share mindful-of-earth identity relates to the Rotman motivational factor of self-promotion. It also relates to human needs such as self-expression and identity creation and expression. It also relates to acknowledgement.

Connect with leveragers relates to self-promotion as well and human needs such as survival, connection and growth.

Contextual Scenarios

Contextual scenarios were derived from the user interviews, brainstorming and the total insights from all previous activities. Different alternatives were explored but the following three scenarios were developed further and storyboarded:

- Waiting on the bus
- Mushroom picking in the forest
- Showing off a rare flower

Waiting on the bus shows a person using the application on the go while waiting on the bus and connects heavily to the conscience-free distraction goal. The persona could be BioNote's stressed out thesis worker, or would fit in all three provisional user segments: basic, advanced and expert.

Mushroom picking involved sketches of a person who uploads a picture of a mushroom after coming back from picking mushrooms, because they did not have internet connection at the picking spot, wanting to share their nature experience with the community, but primarily in order to be soothed that the mushrooms are not poisonous. In terms of Rotman's motivational framework it especially connected to personal interest. The scenarios grew more and more into sketches and there was an overlap with the prototyping and framework definition phase. Contextual scenarios are usually less detailed but they grew more and more detailed and started resembling a design framework. The showing off a rare flower scenario similarly consisted of sketches including screens where a person shows off a cool flower they have seen and enjoys acknowledgement.

5.3.3 Prototyping

The prototyping phase included framework definition and refinement inspired by GDD. When the prototype was refined enough but not too much it was shown to colleagues in an informal evaluation.

Framework Definition and Refinement

In the framework creation phase I did paper-sketching and scenario-writing simultaneously, iteratively. I took inspiration from similar apps such as BioNote and Fishbrain. When a flow was established on paper I created a higher fidelity version with Invision. Invision is an online tool in which image files of screens can be ordered into an interactive prototype where clicking on different parts of a screen can lead to desired actions such as navigating to another screen. The Invision version would make it easier to communicate the prototype more similar to an actual app with potential users. The prototype was successively refined and became more detailed. The prototype was wireframe-like and was mostly intended to test the functionality and flow and catch issues related to these. Screenshots of it are shown below. First an overview of the main screens is shown, followed by an image of my environment during the prototyping showing both paper-sketches and Invision prototyping.

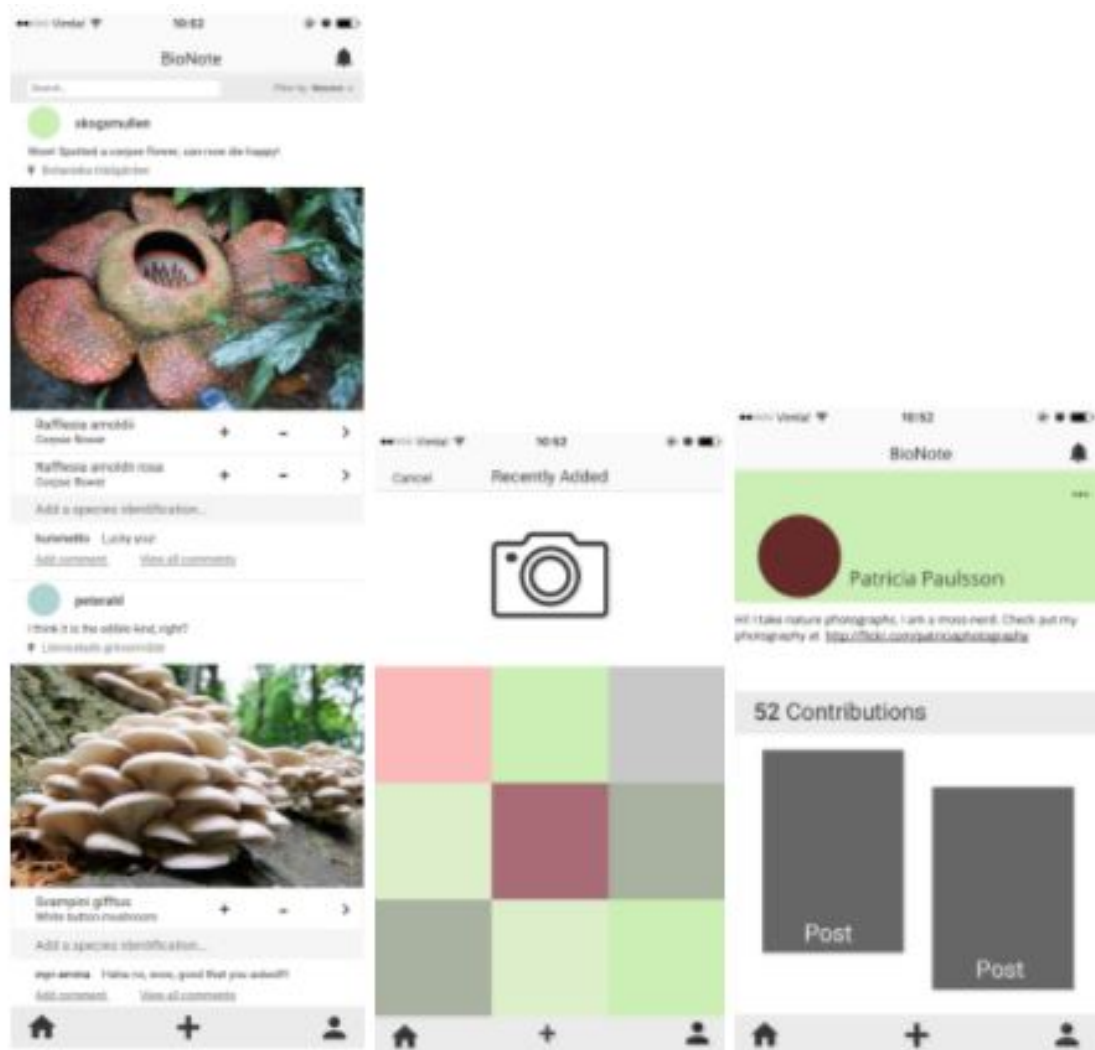


Figure 5.5: Prototype 1 Feed, Add sighting and Profile



Figure 5.6: Prototype 1 working environment

The prototype was created around a scenario which would be asked of people to perform while testing the prototype. This scenario tested the main structure and core functionality as shown in Figure 5.5. The scenario consisted of scrolling through a feed of user uploaded nature posts, then adding a post (including several sub-steps), and finally seeing the posted post in the feed and looking at one's profile. The screens for this scenario are presented below in steps.

Step 1: Scrolling through feed.

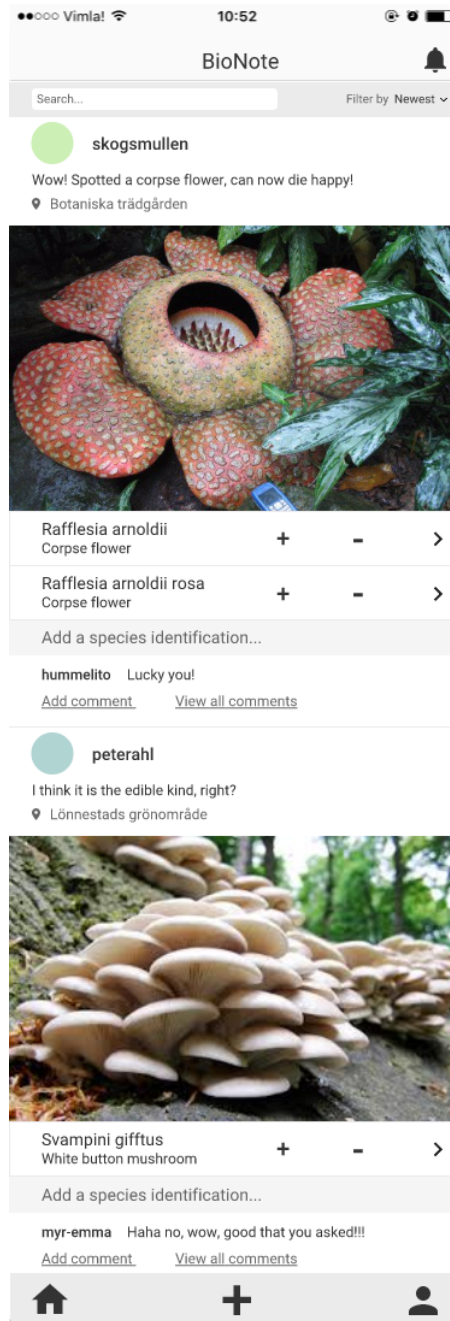


Figure 5.7: Prototype 1 Feed

Step 2: Adding a post.

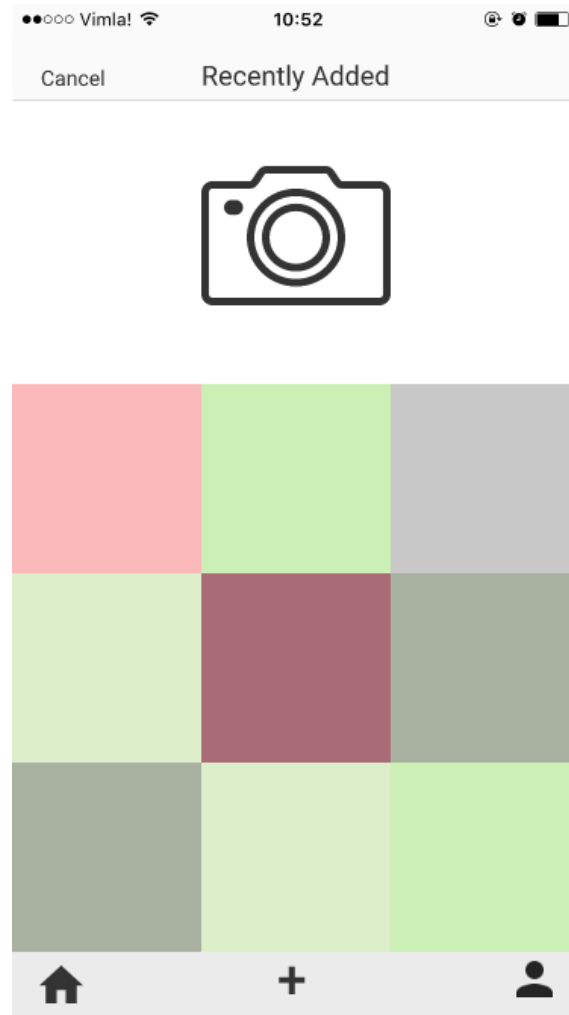


Figure 5.8: Prototype 1 Add post



Figure 5.9: Prototype 1 Add post attributes

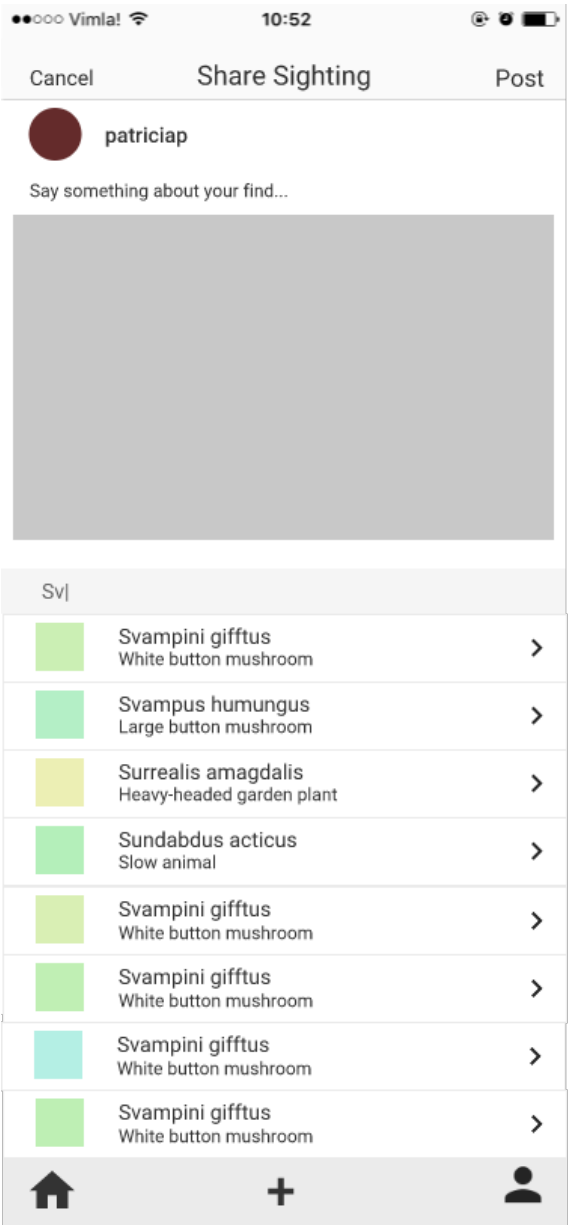


Figure 5.10: Prototype 1 Add identification to post, search species



Figure 5.11: Prototype 1 Add identification to post, species chosen

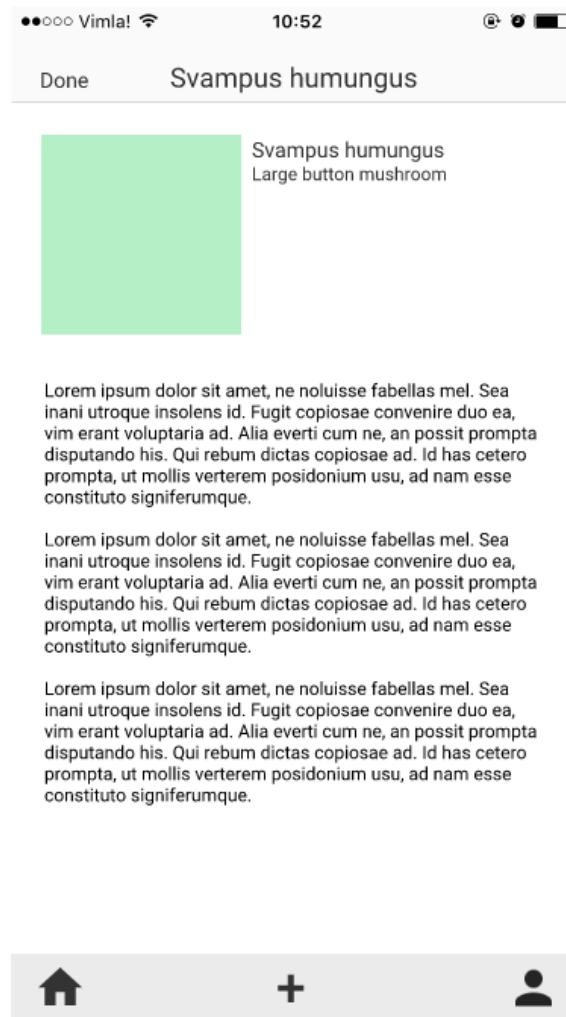


Figure 5.12: Prototype 1 Add identification to post, info about species

Step 3: Seeing the post in the feed and viewing one's own and others' profiles. The same feed image was used. It can be seen above in Figure 5.7. The profile mockup can be seen in Figure 5.13.



Figure 5.13: Prototype 1 Profile

The Invision click-through prototype was evaluated in two ways: informally and generally by fellow students, and with regard to Rotman's motivations.

Informal Evaluation

The informal evaluation was performed in the refinement phase when it was still not too defined but I thought it was refined enough to get the point across. I showed the prototype to three fellow students; one studying industrial economy, one studying industrial design and one studying entrepreneurship. They clicked through the prototype and we had a conversation about it. Some feedback was elicited but mostly I received recommendations about my process. For example they recommended me to do a simpler prototype and to test with the actual target audience since they

felt they were themselves not in this target audience and that they would not use something like this. An associate professor at the Interaction Design department had some opinions on the design and functionality such as making the location and time of the posts more protruding.

The prototype was also shown to the tech and design lead at BioNote. He advised me to create a prototype which has clearer mappings to the motivational aspects in order to be able to make more significant conclusions. For example when a user has have posted an image they could either get to know they have reached level 1 or that they have contributed to the greater good of our planet. Then we would test which incentive seems to engage them the most. It would also be possible to see who engages more with which incentive and thereby group the audience into different target groups which could be used to create personas.

Prototype-Motivation Mapping

I evaluated the prototype with regard to Rotman's motivations. I especially focused on personal interest, self-promotion and acknowledgement since these were the three motivational factors I had chosen to zoom in on in the beginning of this iteration. My motive for choosing these three can be found in 5.3.2 Modeling and Requirements Definition of Iteration 1.

The prototype can be viewed as having three main functionality areas:

- adding a photo post,
- viewing the feed and interacting with feed posts by
- identifying species and commenting, and that everybody has a profile.

Personal interest is present in all these three functional areas. Evaluating the prototype with regard to personal interest is not an exact evaluation since it concerns potential user's personal interests, which I do not have direct access to. The evaluation is therefore accomplished using empathy, imagination and insights and assumptions from previous background and user research. The following functionality in this first prototype is thought to be able to support individual user's personal interests, grouped by functionality area:

Adding a post

- Take a picture and share it
- Write something about the picture (can be used to guide the purpose of posting it)
- Identify species in own post

Viewing the feed and interacting with feed posts

- Look at sightings in feed
- Filter feed
- Identify species in other people's feed posts
- See other people's species identifications
- See up- and downvotes
- Read about species

- Comment on posts and engage in discussions
- See location of feed posts

Profiles

- Personalize profile
- Possibility to add link and contact info in profile
- See other people's profile

I conclude that the design does have potential to support personal interests since the listed functionality above might support it. However a lot can be done to enhance the experience. The most important next improvements that were suggested included to incorporate a map of sightings and including the time of the sighting.

With regard to self-promotion the profile is the most obvious example. It should be possible for users to personalize their profiles and to provide links. The profile also shows a user's amount of contributions and the posts they have contributed with. Commenting on posts is another way to promote oneself. The prototype does support some basic ways of self-promotion, however there is potential to support it more. In the evaluated prototype the user does not get credit for the identifications they make in photos. There should be a way to see who is the author of a species identification. Follow-functionality could be another way of self-promotion, acquiring a follower base can increase the possibility that one's posts are being seen and that they are seen by the right people.

The prototype has a lot of room left for supporting acknowledgement, but the ways that it does it is by enabling the user to show off cool things they have seen in nature and gain comments. Likes could be a way to further give acknowledgement, as well as getting points or a little satisfying animation after uploading a post. The contribution count in the profile is a way of giving acknowledgement for participating but acknowledgement should be explored further. Upvotes are a way of getting acknowledgement for species identifications. The conclusion is that the potential for supporting acknowledgement and gamification should be further explored.

How the other motivational factors are supported by the prototype was only evaluated superficially:

Self-efficacy

By uploading images or by providing species identifications the user is affecting the scientific community. This is not explicitly explained or hinted at by the prototype, but this motivation could be supported inexplicitly. To further support self-efficacy motivations it could be beneficial to show the effects of the user's contributions. Another way in which the prototype supports self-efficacy is by enabling a feeling of belonging to the scientific community and to a nature-positive community.

Social responsibility

Uploading images and providing species identification has the potential to support a user's motivation based in social responsibility because in doing so they contribute to

awareness of nature, maybe appreciation of nature, and to biodiversity conservation. These effects are not highlighted in the prototype.

Trust

Up- and downvoting can be seen as a way to support trust in data quality. The profiles can also have a function in supporting trust.

Common goals

This is not really facilitated. An idea is to support the creation of groups and exclusive challenges.

Mentorship

Mentorship is not really facilitated.

5.4 Iteration 2

In the second iteration I took the advice from my evaluators in iteration one to get a better understanding of the target audience and to do prototype testing with people who are active in the target domain. It was a small iteration where some changes to the prototype were paper-prototyped.

5.4.1 Research

I performed observations at the Gothenburg Museum of Natural History and at the Botanical Garden.

Observations at the Museum of Natural History

I did an observation with incorporated spontaneous interviews at the Museum of Natural History in Gothenburg after lunchtime on a workday. I chose the Museum of Natural History because I thought that people who go there would fit in the target audience. I assumed they would have some sort of interest in nature. This assumption was later refuted. I also assumed that they would have ranging biology expertise but that the majority would fit the basic category: “Very limited knowledge in species names, enjoys nature but is moderately invested”. The main objective was to find people in the target group whom I could ask questions about what they do in nature, if they enjoy taking photographs of nature and sense their attitude in general and their interest in learning to classify organisms. I wanted to find a place where I could find such people and the Museum of Natural History seemed like a good start. I took the ethical considerations which can be found in Appendix B into consideration.

I walked around the museum and got to interview six different people. There weren't so many people so I just chose the ones that were there and seemed approachable. My assumption that the visitors of the Museum of Natural History would have some interest in nature was a little bit too optimistic. When I asked the personnel about their typical visitors she answered that it was mostly school classes, parents with

their children and tourists. She said that sometimes university students in fields related to biology would come in, and at special lectures and occasions people with special nature interests or people from Naturskyddsföreningen would come. She said that normally visitors don't have to be particularly interested in nature in order to enjoy watching the animals. For me enjoying to watch the animals would count as nature-interest. I saw many parents and grandparents with children and tourists, but it was quite mixed. It could be that because I went on a weekday after lunch it was mostly older people and children. The rest of this chapter summarizes each spontaneous interview. Overall I learned that people are more willing to talk and share when I could articulate a clear purpose for approaching them.

The first person I got to interview was an older lady who had a special interest in funky animals who live undersea. She especially liked see-through underwater creatures and nice photographs. Her reason for coming to the museum and for having this interest seemed to be fascination. "There are species that nobody has seen!", she said and showed me a picture of a seahorse that she liked. She does not take pictures due to personal reasons she said, it seemed she did not feel comfortable with camera technology, but her grandchildren photograph a lot. She uses binoculars in the large park, maybe to look at birds or other species.

The second interview was with an older couple. I asked them if they like species and they said "it's the reason we're here!". They were there with their grandchild who asks a thousand questions. They were fascinated with the biological diversity. They expressed that they enjoy "being out there" in nature, surrounded by nature and one with it, and that they feel like one is drawn back to nature as one gets older. They really like the aesthetics of nature and described it somewhat spiritual. They live on the countryside. The male of the hetero couple was a hunter, but he said that usually a hunting trip just becomes a nature experience since they do not often find anything to shoot. He used to take nature photographs and show them to friends, but not anymore. He photographs periodically, but usually not species but landscapes. He is not sure that his friends appreciated the photographs as much as he did. They like seals in the Gothenburg archipelago.

Next was another old couple, their child and grandchild was with them. They were playing a kind of quiz game where the grandchild had to name the species that they were seeing in the museum. They all seemed to enjoy it and the grandchild of approximately ten years seemed keen on getting the right answers. They live on the countryside and have a hurt Canada goose. When I brought up the photosharing application Instagram [Instagram] they ended the conversation in order to go back to watching the exhibition by expressing that they do not use Instagram. They did not seem to like Instagram.

Then I talked to a young man. He was Australian and came to the museum because he had some spare time. He said he enjoys birdwatching and koalas are his favourite species. He said he does not have a habit of taking photographs and sharing them. He also answered "No" when I asked him he had ever spontaneously wondered what species it was that he was seeing, although he added "maybe sometimes with birds".

The fifth guerilla interview was with a mother and her little girl of approximately five years. The mother said they go to the local big park once in a while. The mother expressed a little pride in that she could recognize a satisfying amount of plants, but also stated she is not so good with birds.

The last conversation was with two tourist men who said that nature is interesting because it is disappearing.

Observations at Botanical Garden

At the Botanical Garden I walked around and observed people and their behaviour in nature and around plant species. I don't know what kind of insights this gave, at least that people like to be in the Botanical Garden outside when it's sunny. They also seemed leisurely, so they might have time to engage with an application. Many looked at the plants to check what species it was on the name tags, so there could be some interest to get an identification via a mobile application. But this observation was just to get a feeling and some ideas and assumptions.

5.4.2 Modeling and Requirement Definition

The second iteration was small and so was the modeling and requirement definition phase. It consisted of iterating on the set of goals to design for.

Goals

I iterated on the goals of the last iteration by incorporating new learnings. Strictly speaking one could argue that the items are more “things the user can do or accomplish with the application”, than goals. The following list emerged:

1. Show something cool I have seen.
2. Get an identification of something I have sighted.
3. See where specific species have been sighted.
4. See in which time periods specific species have been sighted.
5. Identify species in my expert field because it is a fun challenge.
6. Identify species in my expert field because it helps biodiversity.
7. Identify species in my expert field to gain reputation and acknowledgement.
8. Better species identification skills.

The goals were tested by discussing the goals with the tech and design lead at BioNote after which the list was updated again. Social interaction was considered crucial. They became:

1. Show something cool I have seen.
2. See nice nature photos.
3. See how everyone else acts on this platform and in nature and what they have seen.
4. Connect with like-interested.
5. Better species identification skills and learn about the species around me.
6. Get an identification of something I have sighted.

7. See where specific species have been sighted and what is around me.
8. See in which time periods specific species have been sighted.
9. Identify species in my expert field because it is a fun challenge.
10. Identify species in my expert field because it helps biodiversity.
11. Identify species in my expert field to gain reputation and acknowledgement.

The goals can be used to group the target user pool into three segments. The mainstream (basic) would mostly apply to goal 1-7, 1-8 would be for more nature enthusiastic people (advanced) and 9-11 would be mostly for people with species expertise (expert).

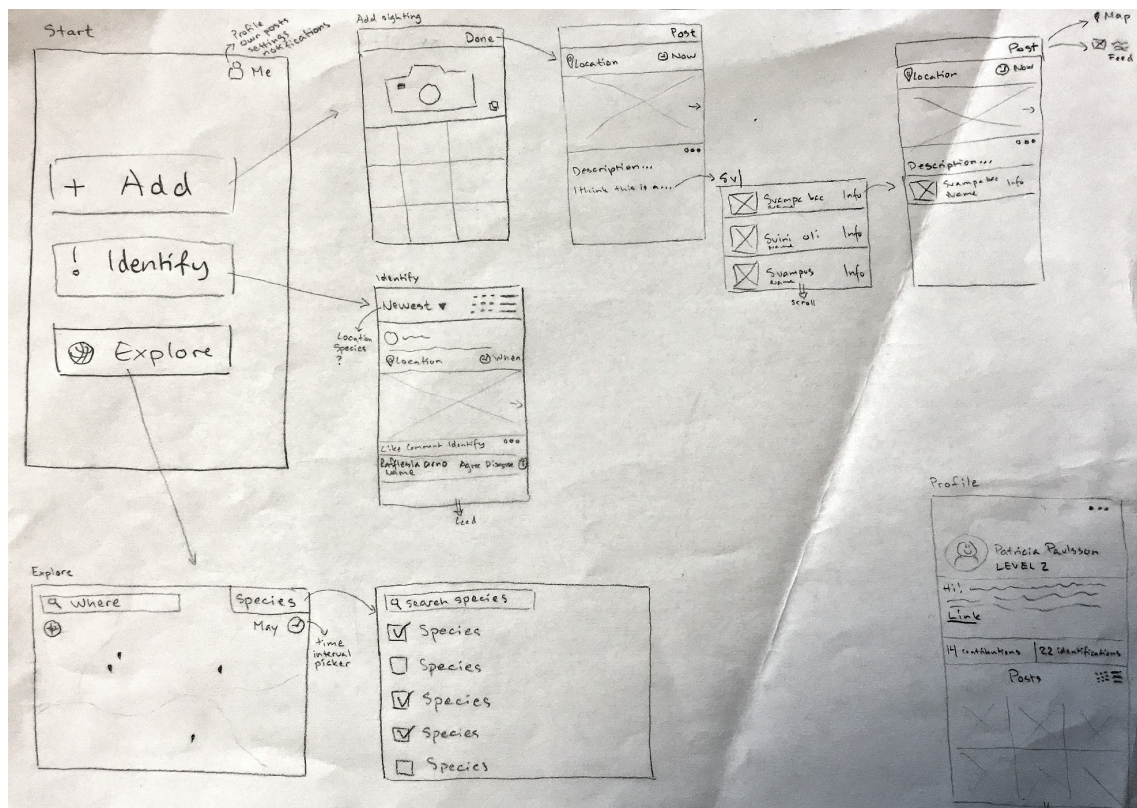
5.4.3 Prototyping

The prototyping phase involved redefinition of the structure of the prototype from the previous iteration and adding functionality which had come up as ideas that could enhance the ability of the application to support user motivation.

Prototype Update

I went over the prototype and mainly added the explore-functionality with a map. See the paper-prototype in Figure 5.14 below. It also had three clear entry points: add, identify and explore.

Figure 5.14: Prototype 2



The form of the prototype is less high-fidelity than the prototype in the first iteration. It is very similar to the first prototype but other than being of paper some functionality has been added and three clear entry points have been defined. There is map functionality and a little acknowledgement after posting. Contributions and identifications have been splitted in the profile and a level has been added in the profile. Time metadata has also been added. When the sighting was sighted can be seen in posts and the map can be filtered for a specific timeframe in the year or it can be filtered for a time of day. A post can be liked in addition to commented on and identified for species.

Heuristic Evaluation

The prototype was tested through heuristic evaluation with a gamification expert and game developer, Lars Kroll, who creates citizen science games at ScenceAtHome.org, and a biodiversity scientist, Ola Langvall, who has been part of creating and managing the citizen science web platform vårkollen.se. The test gave ideas about how to add game elements and about what scientists and expert users would like in this kind of application.

Prototype-Motivation Mapping

In addition to testing with these two experts I reviewed the prototype with regard to Rotman's motivational framework like in the previous iteration. The functionality that is new was stated in the description of the prototype. For each new element the following text describes how they correspond to Rotman's motivations. The rest of the elements have already been evaluated in iteration 1.

Map

The map supports personal interest in species distributions, interest in spending time in nature and interest in one's surroundings. The filter functionality further supports personal interest in certain species and in certain timeframes. It could indirectly contribute to self-promotion because it teaches the user species distributions. It could also give a sense of acknowledgement to see one's own contributions on the map. This visual feedback could also somewhat support self-efficacy and social responsibility motivations.

Time in maps and posts

As described above in the map section being able to see the time of a sighting corresponds primarily to personal interest. It could also perhaps strengthen trust in data quality and value.

Acknowledgement after posting

This mainly supports acknowledgement.

Contributions and identifications splitted

This gives a better idea of which actions are the most valuable and give more detailed acknowledgement. It could also enhance self-promotion because it says more

about what kinds of contributions one has made and whether one has made many identifications or posted many images.

Levels in profile

Primarily self-promotion and acknowledgement.

5.5 Iteration 3

The third and last iteration involved further observation and interviews, design artifacts such as low-fidelity personas, goals requirements and a medium-fidelity prototype. The prototype is presented in 6.3 Prototype in the Results-chapter.

5.5.1 Research

I went on a guided hike with 35 nature enthusiasts and interviewed BioNote's lead on wished-for functionality. I also talked to some more potential users.

Observations at Guided Group Hike

I observed a group of 35 people who participated in a guided walk along S  ve  n. It was held by Naturskyddsf  reningen [?] and V  stkuststiftelsen [?]. The guide was a biologist. She pointed out interesting species and habitats and told us stories about the things we were seeing. I observed the other walkers, what they seemed interested in, how they acted during the guiding, what they talked to each other about and what they seemed to observe in nature. I also gave attention to whether they took pictures and whether they used their phones and if then what did they do with their phones. At the end of the walk I asked one walker and the guide some questions.

Expert/Stakeholder Interview on Desired Functionality

I interviewed the lead at BioNote on which functionality they would like to implement based on their learnings. I got to know which species groups categories could be appropriate from a domain expert position with consideration of the knowledge level of the target group: Plants, Insects, Mammals, Reptiles, Fish, Amphibians, Molluscs, Birds, Fungi, Ferns, Microbes, and Fossils.

User Interviews

I had two user interviews this iteration with focus on goals, activities and desires. One with a friend who enjoys spending time in nature and one with a biologist parent who is new in Sweden and eager to learn the species in her new environment. The main findings from the nature-enjoying person was that he would like to get notifications for interesting sightings in real-time. He would also like to see where stuff has been sighted and also would like to be able to get an identification for things he sees. I created a persona around the biologist, because it was very concrete and seemed to match other people. I incorporated findings from other user research sources, but it was a creative way of creating a persona rather than a strictly scientific

or recommended way. The persona was only used to get a feeling of understanding and to mentally connect with potential users.

5.5.2 Modeling and Requirement Definition

I did a persona from one of the user interviews. From the iterated on user goals a text was written about the imagined usage of the app. From this text verbs were then made into functional requirements.

Personas

I created the persona "Ottilia" from a user interview. See Figure 5.15. I also wanted to do a more laid-back persona who is a beginner in the activity but who enjoys nature since I have been stating that this is the target group. Even if I did not have time to fully build this second persona my general awareness of it had effect on my further design activities. Although it was not fleshed out and documented in text it resided in my mind along with Ottilia. I did have design activities together with other people, and fleshing out a persona on paper does make it more concrete even if the design team is only one person, but since I was often alone it was less detrimental to have incomplete personas than if we had been more people. However it is true that a persona can be used to communicate with other stakeholders as well and with people who are going to test the artifacts, but there was not time.

Figure 5.15: Ottilia persona

Ottilia, biologist

Primary goal: Learning the flora and fauna surrounding her.
Why: Biologist identity, biodiversity fascination, "should know" but also intrinsically interested
Skills: Average tech user. Understanding of taxonomy and systematics. Knows some species, primarily flowers and trees.
Biodiversity understanding: Understands its worth but not overly passionate.
Secondary goals: Providing useful identifications. Community belonging.
Tags: Learning, pride, knowledge, identity
Also of interest: Learns together with her 6 year-old son.

Scenario: Wants to learn flora and fauna. Has a huge book at home. Mostly plants and flowers. Learned fall leaves with her son who is in kindergarten. Now they have to learn the spring ones. They are new in Sweden so there are a lot of new species. When she walks around she feels she wants to know what the plants around her are. For example she doesn't even know the yellow and the white flowers that come here in spring. She hasn't looked it up in her book because it is so big and it feels daunting, so to her it would be perfect to have an app where she can look it up. Since she is a biologist (and just in general) she feels she should have knowledge about the living things around her. She is annoyed by her ignorance and the general ignorance. Recently she has noticed and become fascinated with the different patterns of bark on trees.

The creation of this persona led to further questions such as: How does she view getting identifications from others? Would it hurt her biology ego? Would it be nice being part of a community? Would she trust the identifications?

Scenarios

How the system would accommodate these goals was described in a scenario per goal. The verbs used to draw functional requirements from are in italics. The results of this process can be seen below:

1. Show something cool I have seen.

The user will *snap a photo*, *add some text to describe the photo*, and *share the post with others*. They will *share it to the feed* and have the option to *share the post to Facebook* as well. Should they be able to *share the post to Twitter* and *share the post to Instagram*, and is there some other medium they would share it to?

The user will be able to *enhance the photo* and *draw on the photo* in order to highlight sighting.

There will also be the possibility to *provide a species identification* for what is in the photograph. They will either *identify kingdom*, *identify family*, or *identify species*. In order to do so they will either *search or browse*. The user will *search for the common name* or *search for the scientific name* they think they have captured in the photograph. Before deciding they will be able to *read some information about the species* and *see similar species that it might be*.

They will also *browse species*; they will do so by starting with kingdom and from there get an overview of families sorted by likeliness and if choosing a family they will from a list of species sorted by likeliness be able to choose a species. In kingdom, family or species mode they will be able to search for a particular species.

2. See nice nature photos.

The user will *scroll through a feed of photos* that people have posted to the app. They will *filter the feed* for what the user is interested in seeing. They will *filter the feed for people they follow*, *filter the feed for species they follow* and/or *filter the feed for locations they follow*. In order to filter the feed for these objects they are following they will *follow people*, *follow species* and *follow locations*. They will *get recommendations for people, species and locations to follow*.

They will also *filter the feed for a kingdom, a family or a species, or filter the feed for a location*. This can be any species or location. They will also *filter the feed for posts from nearby* and *filter the feed for recent posts* and *filter the feed for popular posts*. Maybe they could even *get recommended posts based on previous viewing and following behaviour*.

3. See how everyone else acts on this platform and in nature and what they have seen.

The user will be able to *scroll through a feed of photos* and *explore the feed by filtering the feed*.

The user will be able to *see a map* with what people have seen and *filter the map for species, location and time*.

The user will *see comments, likes and identifications*.

4. Connect with like-interested.

The user will *follow others* and *be followed*. They will *like a post* and *comment a post* and *identify species in a post*. The user will *view other people's profile* and *have a profile* to be viewed by others. The user will *edit their profile picture*, *add and edit a bio* and *provide a link to any page they want to link to*.

The user will be able to *join a challenge*. The user will be able to *create a challenge*. The user will be able to *post text and images to a challenge they are part of* and *comment and like challenge posts* of others. They will be able to *set challenge description for challenges they are admin for*. The user which created the challenge automatically admin and can *add others to be admins*. Any admin can *add or remove other admins*. An admin can *add or edit challenge image* and *add or edit challenge header*.

Will they be able to *comment an identification* as well? Will they be able to *send messages to each other within the app*?

5. Better species identification skills and learn about the species around me.

The user will *see identifications* that others have provided. They will *provide identifications by searching or browsing*. The searching and browsing will lead to enhanced knowledge.

6. Get an identification of something I have sighted.

The user will *post an image* which ends up in the feed for others to identify. The user will *be encouraged to add at least the kingdom* so that others can filter for this and *see posts to identify*.

7. See where specific species have been sighted and what is around me.

The user will be able to *see a map with what people have seen* and *filter the map for species, location and time*.

8. See in which time periods specific species have been sighted.

The user will be able to *see a map with what people have seen* and *filter the map for species, location and time*.

9. Identify species in my expert field because it is a fun challenge.

The user will be able to *filter the feed* and *identify species in posts*.

10. Identify species in my expert field because it helps biodiversity.

The user will be able to *filter the feed* and *identify species in posts*.

11. Identify species in my expert field to gain reputation and acknowledgement.

The user will be able to *filter the feed* and *identify species in posts*.

User Requirements

From this the following functional requirements emerged:

Add sighting post

- snap a photo
- describe the photo
- share the post with others
- share post to the feed
- share the post to Facebook
- share post to Twitter
- share post to Instagram

Enhance photo

- enhance the photo
- draw on the photo

Identify species

- provide a species identification for what is in the photograph
- identify kingdom
- identify family
- identify species
- search for the common name
- search for the scientific name
- browse species
- read some information about the species
- see similar species

Follow

- provide a species identification for what is in the photograph
- follow people
- follow species
- follow locations
- get recommendations for people, species and locations to follow

Feed

- scroll through a feed of photos
- provide a species identification for what is in the photograph
- see comments, likes
- see identifications on photos
- like a post
- comment a post

Filter feed

- filter the feed
- filter the feed for people they follow
- filter the feed for species they follow
- filter the feed for locations they follow

- filter the feed for a kingdom, a family or a species
- filter the feed for a location
- filter the feed for posts from nearby
- filter the feed for recent posts
- filter the feed for popular posts

Map

- see a map with what people have seen
- filter the map for species
- filter the map for location
- filter the map for time

Profile

- have a profile
- view other people's profile
- edit own picture

Challenges

- join a challenge
- create a challenge
- post text and images to a challenge they are part of
- comment and like challenge posts of others in a challenge they are part of
- set challenge description for challenges they are admin for
- add or remove other admins
- add or edit challenge image
- add or edit challenge header

5.6 ECSA Workshop on UX for Citizen scientists

I participated in a workshop held by the European Citizen Science Association (ECSA) in Gothenburg on Defining principles for mobile apps and platforms development in citizen science: Interaction, Interoperability, Innovation. Citizen scientists, researchers and app developers from all over Europe and two from the United States came together to address the complexity of application and platform development in citizen science. The workshop was held the 25-27th of April at the University of Gothenburg. The goal for my participation in this event was to incorporate the design principles conceived in the workshop into the creation of the design principles that would be the final outcome of this thesis. The workshop included presentations by scientists on their research about how to use technology in citizen science projects, workgroup discussions, a case study of a mobile app for collaborative species identification called Naturest, and a smaller workgroup on topics that had arisen during the previous workgroups. Since it was the second workshop in the series there had already been one workshop in which a first draft of design principles had been conceived. A report was written about the workshop [39].



Figure 5.16: Workshop attendees.

The workshop participants together with their associated university:

- Adam McMaster, Zooniverse, University of Oxford
- Agnes Mair, National History Museum Vienna
- Alda Terracciano, UCL / University of Gothenburg
- Alexandra Albert, University of Manchester
- Åsa Mäkitalo, University of Gothenburg
- Candan Eylül Kilsedar, PhD Student, Politecnico di Milano
- Cecilia Lindhé, University of Gothenburg
- Chris Phethean, University of Southampton
- Christopher Kullenberg, University of Gothenburg
- Dick Kasperowski, University of Gothenburg
- Dilek Sahin, TEMA Foundation (The Turkish Foundation for
- Combating Soil Erosion, for
- Reforestation and the Protection of Natural Habitats)
- Ella Vogel, National Biodiversity Network (UK), and representing GBIF
- Erik Thorelli, BioNote, University of Gothenburg
- Flavia Bartoccioni, University of Rome Tor Vergata
- Giannis Haralabopoulos, University of Southampton
- Guilherme KODJA Tebecherani, IPM - Iniciativa Pro Mar, Brazil
- Gunilla Ullman

- Jakub Trojan, Tomas Bata University in Zlin, Czech Republic
- Janice Ansine, The Open University
- Jari Silander, Ymparisto, Finland
- Jaume Piera, Institute of Marine Sciences (ICM-CSIC)
- Jonathan Brier, University of Maryland
- Lars Kristensen, University of Aarhus
- Lina Andersson, Royal Institute of Technology, Sweden
- Luigi Ceccaroni, 1000001 Labs
- Marisa Ponti, University of Gothenburg
- Niclas Hagen, University of Gothenburg
- Ola Langvall, Swedish University of Agricultural Sciences/Swedish National Phenology Network
- Patricia Paulsson, BioNote, Chalmers University of Technology
- Philipp Hummer, SPOTTERON
- Sean Lynch, University College Cork
- Soledad Luna, ECSA
- Sven Schade, European Commission, Joint Research Centre (JRC)
- Ulrike Sturm, Museum für Naturkunde Berlin
- Vanessa Lemos Campos, independent

The workshop was during three days and started with a session of presentations by scientists on their recent research. The topics were: whether there is a contrast between games and science, lessons learned on reusability and how success is defined within a citizen science project, lessons learned from the building of the Zooniverse platform for online citizen science games, lessons learned from the SciStarter online platform for citizen science projects, and open data structures and relevant licensing laws throughout Europe.

The second and main part of the workshop gathering was that we parted into three groups. The three groups were tasked with conceiving and discussing principles for a topic each. These topics were :

- Principles for Interoperability: Data Standardization & Data Quality
- Principles for User Interface and User Experience Design: Interaction, Mechanisms to Support Motivation
- Principles for Outreach, Learning and Education, and other rewards of Participation.

I participated in the workgroup around Principles for User Interface and User Experience Design: Interaction, Mechanisms to Support Motivation. At the end there was a group discussion where all groups presented their work. The workshop was moderated by two facilitators and the participants were:

- Chris Phethean (Uni of Southampton)
- Ulrike Sturm (Museum für Naturkunde Berlin)
- Marisa Ponti (University of Gothenburg)
- Alda Terracciano (UCL) - morning session
- Flavia Bartoccioni (University of Rome Tor Vergata) - morning session
- Lars Kroll (ScienceAtHome) - morning session

- Ola Langvall (Swedish University of Agricultural Sciences)
- Patricia Paulsson (Master Thesis Interaction Design, Chalmers University of Technology)
- Vanessa Lemos Campos (Uppsala University) - morning session

We had a moderated group discussion about the principles that were conceived in the first workshop and proposed adaptations and new principles. While we searched for principles many relating guidelines were conceived as well. In the second session we compared our results to the ten citizen science principles [x] and found both matchings and conflicts. Our results and recommendations were at the end of the day shared with the other groups and they shared their results with us.

The main resulting principles from the user experience workgroup was “It is not all about data, it is also about the citizen scientists” and “Communication is essential in citizen science”.

This workshop gave me an immersive insight into the citizen science community and their paradigm. I learned that it is a very top-down community where there is often a researcher leader who recruits participants to do, often tedious, work for free. When citizen science projects and technology is designed a science-centered and data-quality-centered approach is often taken primarily and the experience of the participants is secondary. The workshop also made clear that there might be a paradigm shift in action where more user-centered and democratic approaches are winning land. It seemed the citizen science community is beginning to notice the impact human-computer interaction competence could have in their field, which is also expressed by Preece [1] and other citizen science researchers explicitly.

5.6.1 Design Values

The workshop made me reflect on the values which the design is based on. Design always expresses some values, priorities and biases. It is important that a researcher is aware of their own values and biases [Wadsworth].

In the workshop it became apparent that the usual organization of citizen science biodiversity data collection projects involves a leading biology scientist team and recruited volunteers performing the collection following the leader’s instructions. The main goals of these projects is to produce high quality data. I could here see a tension between this approach and an approach focusing on user engagement, and decided to more explicitly prioritize user engagement. It was thought that in doing so and following user centered design methodologies, user engagement and an active community would in the long-term also enable more and better data. It should also be noted that science quality could be important for user engagement.

In accordance with the priority of user experience over science outcomes the starting point was user focussed. The prototypes were also more often evaluated from a user view although they were evaluated by scientists as well.

5.7 BioNote Activity Observation

The activity of taking pictures of species in nature was tested with two grade five classes at Fiskebäcksskolan in Gothenburg. One class tried the activity before lunch and the other after lunch. The sessions were one hour long and in a small forest area near the school and the archipelago. The children were instructed to use their iPads to take pictures of plants and animals they saw. Since they were below the age of 13 they were not allowed to use the BioNote application due to the Swedish law which restricts social media use. Instead the pictures were then sent to the teacher who uploaded them to BioNote. The children were grouped into groups of three. We explored the forest one hour and then we gathered again in the classroom where they got to answer some questions about the experience collectively. The test was planned and scheduled by BioNote.

Just like our target group the children were not used to the particular activity of species identification, and one might assume that many of them did have a basic interest in nature. This assumption is mainly based on their behaviour, their engagement and that they seemed curious and stimulated. These behaviours varied in the group and there were some that did not express them. There was a clear difference in engagement between grade five children and grade eight children. The grade eight individuals were not as engaged. This comparison could be made because a similar test had been performed with grade eight learners a couple of weeks earlier.

From user research we had found that some people like to learn species identification and about nature together with their children which also might be an argument for why this test group was relevant. Also, they are people and so the findings might say something about people's relationship with the tested activity. Because they were two different classes who tested separately we could get a sense of similarities and differences between the groups which probably enhanced the quality of our conclusions.

The greatest finding was that they were engaged and overall enjoyed the activity. They seemed to enjoy spending time in nature, exploring, and they seemed to enjoy taking pictures. It was also a highly social activity, they played a lot with each other and liked to show each other things they had seen and competed for taking pictures of the coolest things. When asking them afterwards what would have made the experience better, a majority of the children answered it would be fun with more competition. Although, since the questions were asked openly to the class, the most assertive children were the ones whose opinions were heard. They said they would like to compete before we had given it as an alternative. Examples of competitions were suggested by the children such as finding the most rare thing, finding dangerous things, finding all things on a list or competing on who could find the most things. The idea that was perhaps most well-received was to compete as a school against other schools. This was an idea proposed by us, the team leading the experiment. Competition between schools would incorporate cooperation, belonging and a sense of us-against-them and is a quite clear case of gamification.

In the context of my prototype this testing could mean that the challenge functionality and some gamification would be of high value in order to engage. In the next chapter, the final prototype along with other final design artifacts are presented.

6

Results

The results are design artifacts mapped against Rotman’s motivational framework. The artifacts and mapping is meant to give insight to the research question: ”What mobile application design can support motivations for collaborative species identification?”. The design artifacts consist of user goals, requirements, and a medium fidelity prototype demonstrating one way to create screens for these goals and requirements.

The results chapter consists of three sub-chapters: user goals, requirements and prototype. In these the respective design artifacts are mapped to the themes in the motivational framework. Each motivational theme has been given a color and an abbreviation. See the color coding in Figure 6.14. The goals and requirements have then been mapped in tables to the themes that were deemed to correspond. The theme is indicated with its color and abbreviation. For example if a goal or requirement is marked with pink and “PI” it means it is deemed to correspond to the motivational theme of “Personal interest”. The two last “external relationships” themes are not included since they were not used in the design work.

The reason for mapping the artifacts to the motivational themes is in order to answer the question of how to design for the motivations. The relevance is discussed more in 7.2 Reflection on the Results. The mapping could be used to get ideas about how to design for motivation in crowdsourced species identification, or in a domain which is similar.

Table 6.1: Color coding key

Personal interest	PI
Self-promotion	SP
Self-efficacy	SE
Social responsibility	SR
Trust	T
Common goals	CG
Acknowledgement	Ack
Mentorship	M

6.1 User Goals

A list of user goals was iterated upon. The final list includes eleven goals and is presented here:

1. Show something cool I have seen.
2. See nice nature photos.
3. See how everyone else acts on this platform and in nature and what they have seen.
4. Connect with like-interested.
5. Better my species identification skills and learn about the species around me.
6. Get an identification of something I have sighted.
7. See where specific species have been sighted and what is around me.
8. See in which time periods specific species have been sighted.
9. Identify species in my expert field because it is a fun challenge.
10. Identify species in my expert field because it helps biodiversity.
11. Identify species in my expert field to gain reputation and acknowledgement.

The goals can be viewed in terms of three different user segments:

1. Basic: Very limited knowledge in species names, enjoys nature but is moderately invested.
2. Advanced: Has a bit more advanced nature interest or ancillary hobby investment.
3. Expert: Biology professional with species identification interest and skill.

The first category of users, "Basic", which consists of mainstream users with limited interest and biology expertise, are thought to mostly relate to goals 1-7. The second user category, "Advanced", consisting of more invested users are thought to relate mostly to goals 1-8. The third user category, "Expert", consisting of biology experts are thought to relate the most with goals 9-11. This assumption is based on the user research but has not been validated with users.

In Table 6.2 on page 81 the user goals are mapped to Rotman's motivations. The goals are referenced by their number in order to fit. The motivations are referenced by their abbreviations and color.

Table 6.2: User goals color coding

	PI	SP	SE	SR	T	CG	Ack	M
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								

Table 6.3: Color coding key

Personal interest	PI
Self-promotion	SP
Self-efficacy	SE
Social responsibility	SR
Trust	T
Common goals	CG
Acknowledgement	Ack
Mentorship	M

6.2 Requirements

In this section the requirements are presented. First business requirements from stakeholder interviews and then user requirements from the user research. The user requirements are grouped based on function and for each group they are mapped to Rotman's motivations in tables. Rotman's motivations are referenced by their color and abbreviation, see Table 6.14 on page 84 in chapter 6 Results.

The following base-line science and business requirements were constructed:

- The application should generate data consisting of photographs mapped to names of the species in them.
- The data should be created through content uploaded by users.
- The data should, in long-term, be of high enough quality to be used in theoretical and applied biodiversity research.
- The data should, in long-term, be of high enough quality to train an algorithm to identify species in photographs.
- The application should, in long-term, be able to produce machine generated identification from uploaded photographs.

Further business requirement:

- In the startup phase of the application, user engagement is prioritized over data quality in order to build a user base. However sufficient data quality should be achieved in the long-term.

Purpose/idea definition requirements:

- The application should be photograph-centred
- The application should foster a community around the uploaded images and species identification
- The application should enhance the user’s nature experiences.
- The application should contribute to the user’s ability to appreciate nature.

The user requirements that were interpreted from the scenarios based on the goals are presented in Table 6.5 to 6.13. For each requirements group there is a table indicating which of Rotman’s motivational themes could correspond to them. Rotman’s themes are referenced by their abbreviations and colors. For a review see Table 6.14 in section 6 Results.

Table 6.4: Color coding key

Personal interest	PI
Self-promotion	SP
Self-efficacy	SE
Social responsibility	SR
Trust	T
Common goals	CG
Acknowledgement	Ack
Mentorship	M

Table 6.5: Add sighting post color coding

	PI	SP	SE	SR	T	CG	Ack	M
Snap a photo								
Describe the photo								
Share post with others								
Share post to the feed								
Share post to Facebook								
Share post to Twitter								
Share post to Instagram								

Table 6.6: Enhance photo color coding

	PI	SP	SE	SR	T	CG	Ack	M
Enhance the photo								
Draw on the photo								

Table 6.7: Identify species color coding

	PI	SP	SE	SR	T	CG	Ack	M
Identify species in photo								
Identify kingdom								
Identify family								
Identify species								
Search by common name								
Search by scientific name								
Browse species								
Get information about the species								
See similar species								

Table 6.8: Follow color coding

	PI	SP	SE	SR	T	CG	Ack	M
Follow people								
Follow species								
Follow locations								
Get recommendations for who/what to follow								

Table 6.9: Feed color coding

	PI	SP	SE	SR	T	CG	Ack	M
Scroll through feed of photos								
See likes on posts								
See comments on posts								
See identifications on posts								
Like a post								
Receive likes								
Comment post								
Receive comments								

Table 6.10: Filter feed color coding

	PI	SP	SE	SR	T	CG	Ack	M
Filter the feed								
Filter feed for people they follow								
Filter feed for species they follow								
Filter feed for locations they follow								
Filter feed for a kingdom, family or species								
Filter feed for a location								
Filter feed for nearby location								
Filter feed for recent posts								
Filter feed for popular posts								

Table 6.11: Map color coding

	PI	SP	SE	SR	T	CG	Ack	M
See map with people’s sightings								
Filter map for species								
Filter map for location								
Filter map for time								

Table 6.12: Profile color coding

	PI	SP	SE	SR	T	CG	Ack	M
Have a profile								
View other’s profile								
Edit own profile								

Table 6.13: Challenges color coding

	PI	SP	SE	SR	T	CG	Ack	M
Join a challenge								
Create a challenge								
Post text and images to challenge								
Like challenge posts								
Comment challenge posts								
Edit challenge description when admin								
Edit challenge image when admin								
Add or remove admins when admin								

Table 6.14: Color coding key

Personal interest	PI
Self-promotion	SP
Self-efficacy	SE
Social responsibility	SR
Trust	T
Common goals	CG
Acknowledgement	Ack
Mentorship	M

6.3 Prototype

The final prototype was made in Adobe Xd and has five main screens. Adobe Xd is a prototyping software in which screens can be built and put together into click-through prototypes. Figure 6.1 shows an overview of the screens and how they are interconnected.



Figure 6.1: Prototype 3 overview

The five main screens in the tab layout are:

- Feed: A feed (similar to social media “walls”) and browsing environment where other people’s sighting posts are seen.
- Map: A filterable map of sightings.
- Add sighting: Uploading one’s own sighting in a sequence of screens.
- Challenges: A screen that shows challenges that are joinable and the ones one is part of and enables creation of challenges.
- Profile: A profile with information about the user and their contributions.

All screens include the bottom tab bar. Therefore all main screens can be accessed from all other main screens. The feed is the start screen. In the feed user uploaded photographs of species or nature can be scrolled through, searched and browsed. There is an extra screen dedicated to notifications for interactions. The main screens are discussed in a section each. The notification screen is also discussed in its own section: the last one. The notification screen is different from the others because it is not a tab and not considered a main screen.

6.3.1 Feed

The feed is the start screen. Posts can be scrolled-through in an infinitely scrollable list. The feed can be adapted in order to show the posts that the user is interested in. This is mainly accomplished by filtering and following. Figure 6.2 shows the feed and the filter options. Some of the requirements the filterable feed supports are:

- Scroll through a feed of photos
- Filter the feed
- Filter the feed for people they follow
- Filter the feed for species they follow
- Filter the feed for locations they follow
- Filter the feed for a kingdom, a family or a species
- Filter the feed for a location
- Filter the feed for posts from nearby
- Filter the feed for recent posts
- Filter the feed for popular posts

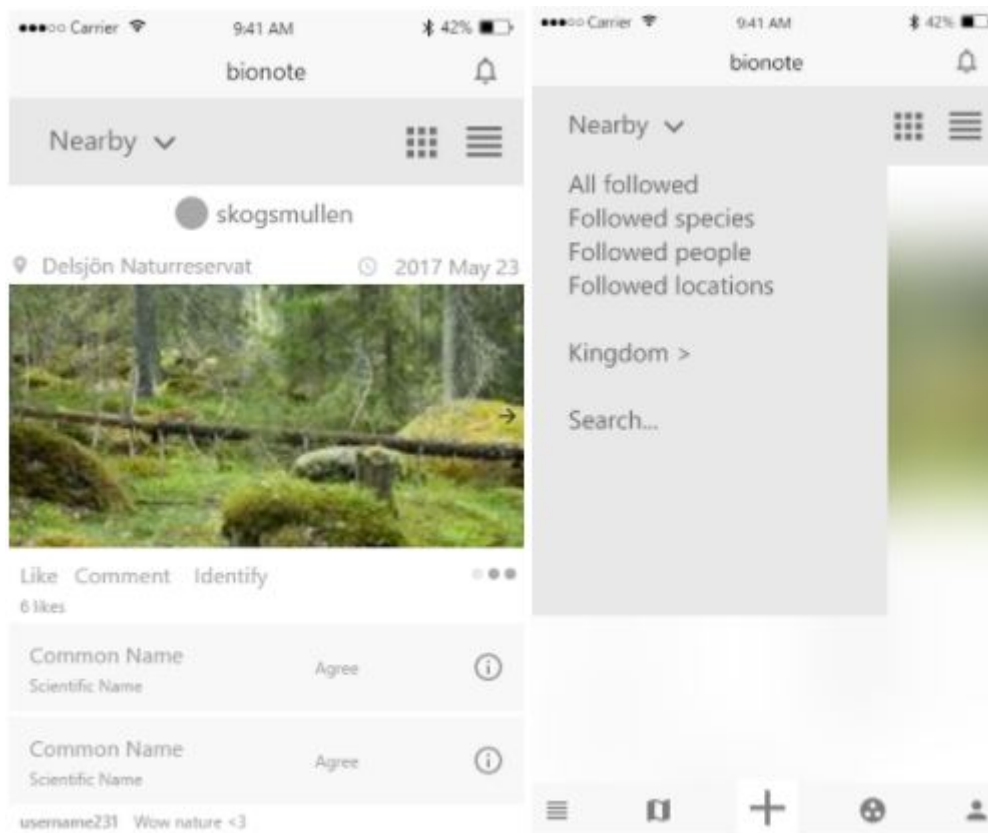


Figure 6.2: Prototype 3 feed and filter options

The feed is like a collection of all the posts. Since the application accepts all species, it can become a lot. Therefore filtering is introduced. The feed's filtering functionality is meant to allow the user to explore nature, species and locations according to their specific interests. Their interest can be long term or contextual. Experts can browse for their expert field. That way they can provide identifications and go through and correct the identifications that have already been made. In some cases this provides a paradox since before there is an identification associated with the photograph, it cannot be filtered for by using that id. A way that this paradox is approached is by encouraging all posters to at least choose a category of the following: Plants, Insects, Mammals, Reptiles, Fish, Amphibians, Molluscs, Birds, Fungi, Ferns, Microbes, and Fossils. This terminology was derived by BioNote through user research. It is easy to see to which one of these a species would belong, and so the quest would be narrowed down.

The follow functionality also restricts what the user sees, so that they are more likely to see posts that they care about. To follow somebody means that their posts will have higher priority in the feed and that their posts will appear when the user filters for posts they follow. One can follow people, species or locations. In order to only see posts from/about people, species and/or locations one follows one can

choose this in the filtering settings. The filter settings are used to browse the posts. There is also a search function in order to find what one looks for. Users, locations, species, kingdoms etcetera can be searched for.

The feed corresponds to many requirements. Firstly "Share the post with others" and "Share post to the feed". The feed is where posters and identifiers meet. Where photographs are posted by people needing an identification and where they can be viewed by people who possess the expertise needed to provide that identification. The feed is where everything is shown and can be seen. The feed therefore accommodates following requirements as well:

- Provide a species identification for what is in the photograph
- Identify kingdom
- Identify family
- Identify species
- Search for the common name
- Search for the scientific name
- Browse species
- Read some information about the species
- See similar species

The feed could support all of Rotman's motivational themes, in the following ways: Personal interest: The feed can let the user explore locations, species, people and nature that the user is interested in.

Self-promotion: Uploading something to the feed or connecting with somebody the user has seen on the feed can be an act of self-promotion.

Self-efficacy: Uploading a sighting for others to see or adding an identification can make the user feel that they are affecting the scientific community and that they are belonging to the scientific community or the application community.

Social responsibility: The feed is where sightings and identifications can meet so it can be felt as an act of social responsibility to do any of these activities on the feed. Promoting nature, adding sightings or identifications.

Trust: The feed could be used to convey data quality in the future.

Acknowledgement: Through likes, comments, identifications and agreeing on identifications acknowledgement can be experienced through posting to the feed.

6.3.2 Add a Sighting

In order to upload a sighting the middle tab icon is clicked. The user is guided through a sequence of steps, like a wizard, in order to fill in a post and at last share it, see Figures 6.3 to 6.5.

First the user gets to select which images to add to the post:

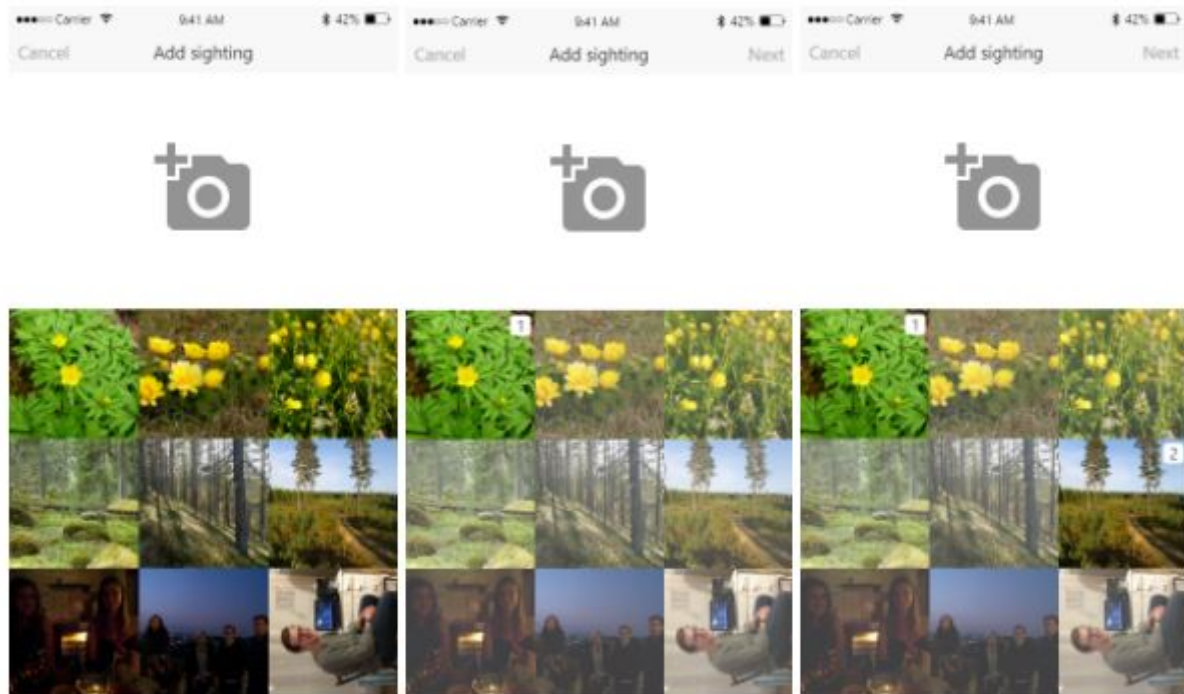


Figure 6.3: Prototype 3 Choose photo

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Then the user gets to preview their post, add a description, maybe an identification, and decide whether it should be shared to Facebook as well:

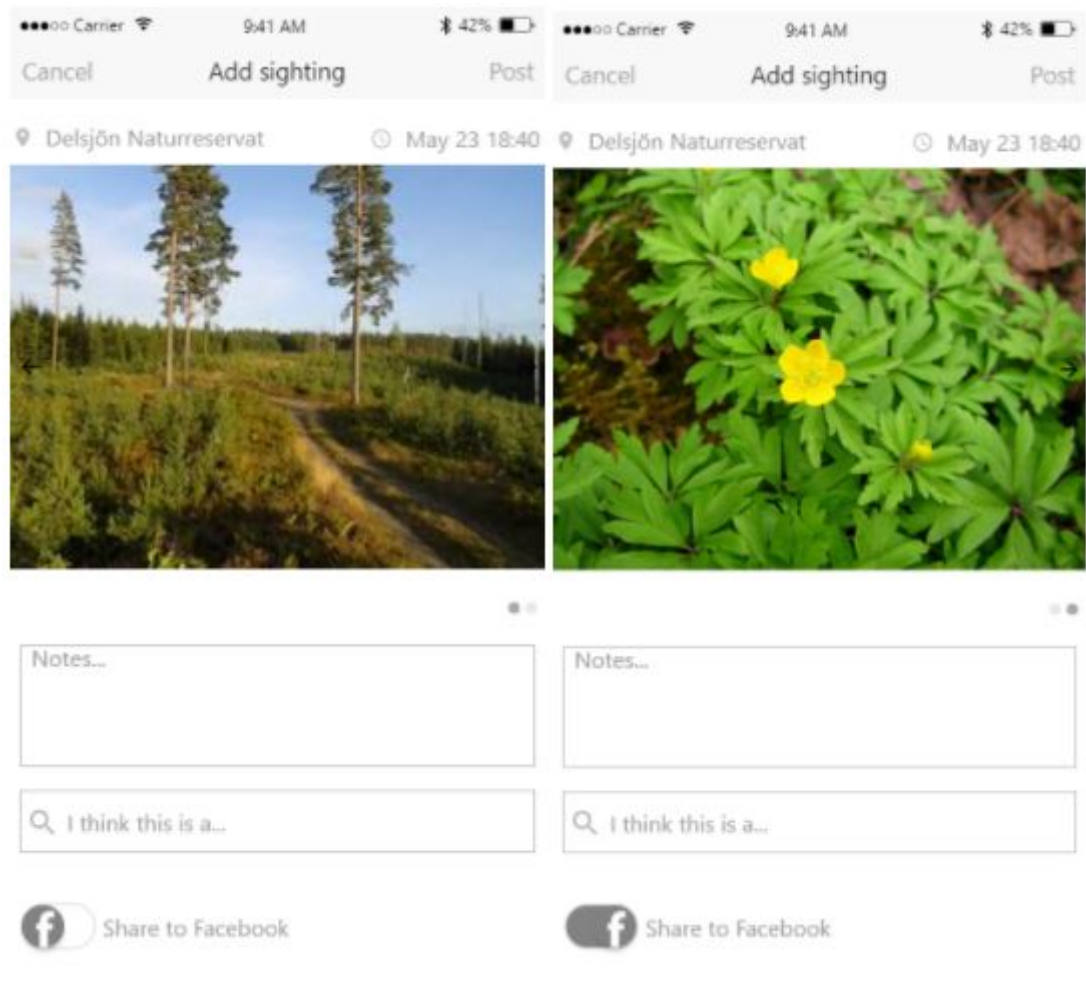


Figure 6.4: Prototype 3 Edit post

Finally when they have posted, they will receive a small but satisfying accomplishment:

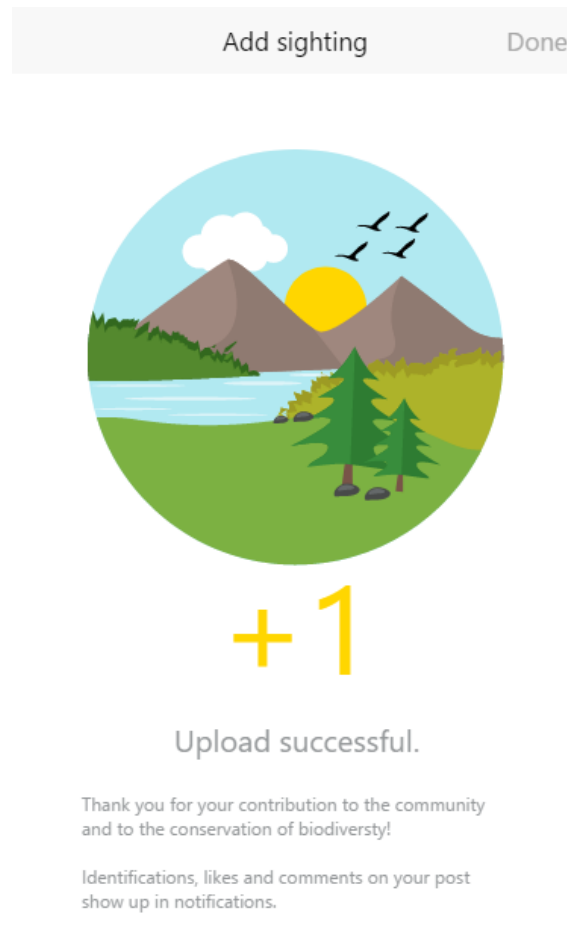


Figure 6.5: Prototype 3 Acknowledgement after posting

The screens for adding a sighting could support Rotman's motivational themes in the following ways

Personal interest

The user could have personal interest in getting identifications for what they are uploading or personal interest in contributing a sighting to science or sharing what they have seen with others.

Self-promotion

Uploading something to the feed and adding a description or/and an identification can help in self-promotion.

Self-efficacy

Uploading a sighting for others to see or adding an identification can make the user feel that they are affecting the scientific community and that they are belonging to the scientific community or the application community.

Social responsibility

The feed is where sightings and identifications can meet so it can be felt as an act of social responsibility to do any of these activities on the feed. Promoting nature, adding sightings or identifications.

6.3.3 Map

The map lets the user see where what has been sighted. See Figure 6.6. Apart for location the map can be filtered for certain species and for a certain time of year or time of day. Each post is shown with a marker and can be clicked in order to view more information about it. The map primarily corresponds to the goals 7 and 8: "See where specific species have been sighted and what is around" and "See in which time periods specific species have been sighted".

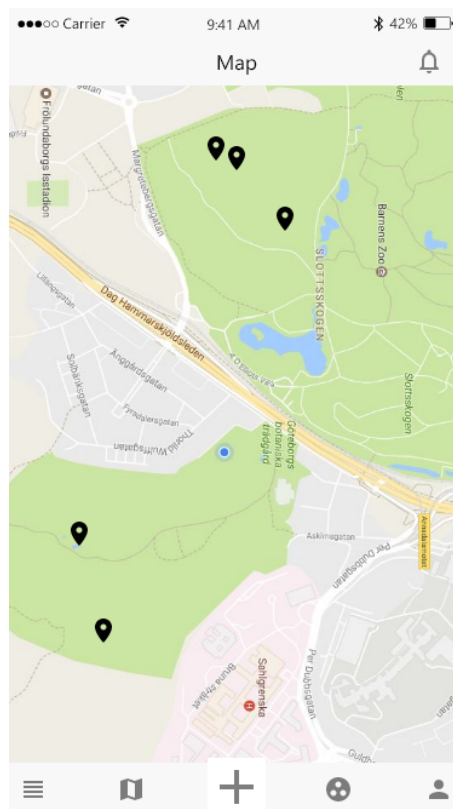


Figure 6.6: Prototype 3 Map

The map could also help accomplish goal 2 and 3: "See nice nature photos" and "See how everyone else acts on this platform and in nature and what they have seen".

The map also serves as a confirmation that one's own post has been shared and can be seen and used by others, goal 1: "Show something cool I have seen". It could also be used in order to fulfill goal 4, if deciding to connect with people who have posted thing one can see on the map: "Connect with like-interested". Generally it could also be used to support goal 5 if it is used in field or by looking at identifications of species at locations one often visits, for example: "Better my species identification skills and learn about the species around me".

Experts who are experts in a certain location, for example Swedish west coast plants, could look at this location on the map and use their expertise by giving and correcting identifications for images uploaded from their expert area. Then the following goals 9 to 11 would be supported: "Identify species in my expert field because it is a fun challenge", "Identify species in my expert field because it helps biodiversity" and "Identify species in my expert field to gain reputation and acknowledgement".

The map screens could support Rotman's motivational themes in the following ways:

Personal interest

To see different things either virtually on the map or IRL by following it while out. The species and time filters can support personal interest further.

Self-promotion

Uploading something to the feed will make it end up in the map as well and so it could be used self-promotionally.

Self-efficacy

Uploading a sighting for others to see or adding an identification can make the user feel that they are affecting the scientific community and that they are belonging to the scientific community or the application community. It ends up on both the map and the feed.

Social responsibility

Some people feel a responsibility to know what lives around them.

6.3.4 Challenges

A distinct screen has been planned for challenges. Here available challenges can be seen and joined. One can create a challenge and one can see and access challenges one has already joined. The interactions and design is not fully fleshed out. For example a challenge could be to identify everything in a certain area or to identify a certain species. The challenge could fit a certain scientific need. It could also just be fun or promote nature or learning.

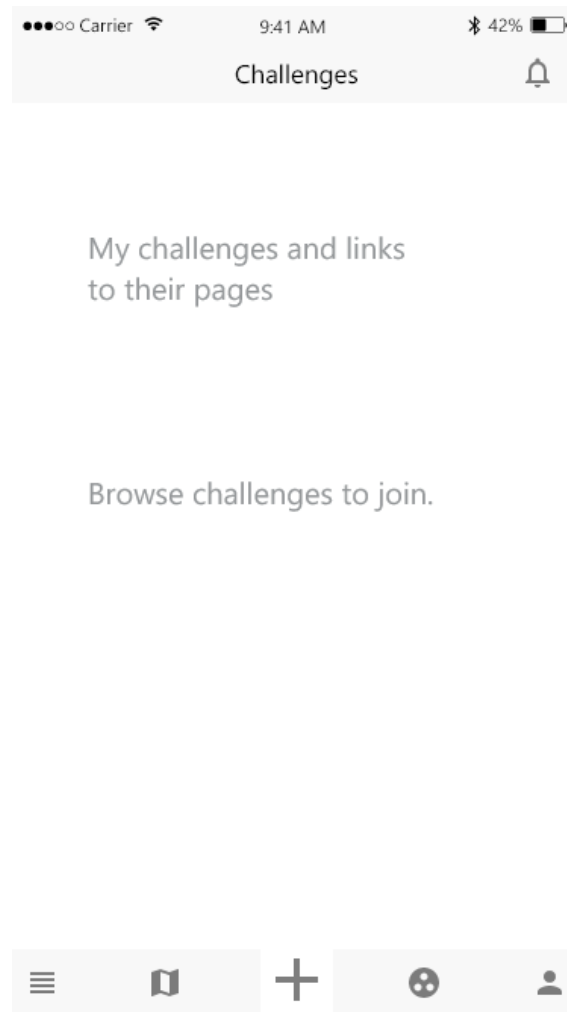


Figure 6.7: Prototype 3 Challenges

The screens for challenges could support Rotman’s motivational themes, in the following ways:

Personal interest

A challenge could be fun. Also the user could care about the specific challenge.

Self-promotion

The interactions within a challenge could be self-promotional. Depending on whether it is cooperational or competition different scores can be shown that could also be promotional.

Self-efficacy

Challenges could make the user feel that they are affecting the scientific community and/or that they are belonging to the scientific community or the application community.

Social responsibility

One can feel social responsibility to join a challenge.

Trust

Trust could be created in a challenge for the application that it is good or within the challenge. Trust could also be diminished. Trust in data quality and identification skills of the participants for example.

Common goals

Common goals can be communicated and experienced in a challenge.

Acknowledgement

Acknowledgement how well the challenge is going and acknowledgement by other challenge members.

Mentorship

Mentorship can be provided for example by challenge admins.

6.3.5 Profile

The profile is where the user is presented to others, and where they can access their own contributions, and their settings. It includes a profile picture, statistics showing how many posts one has uploaded (called sightings in order to be more nished), how many identifications one has contributed with and the amount of followers and followings. The name is also shown as well as space for a short biography or whatever the user chooses to write and it is possible to put in links, for example to one's associations, website or other social media profiles.

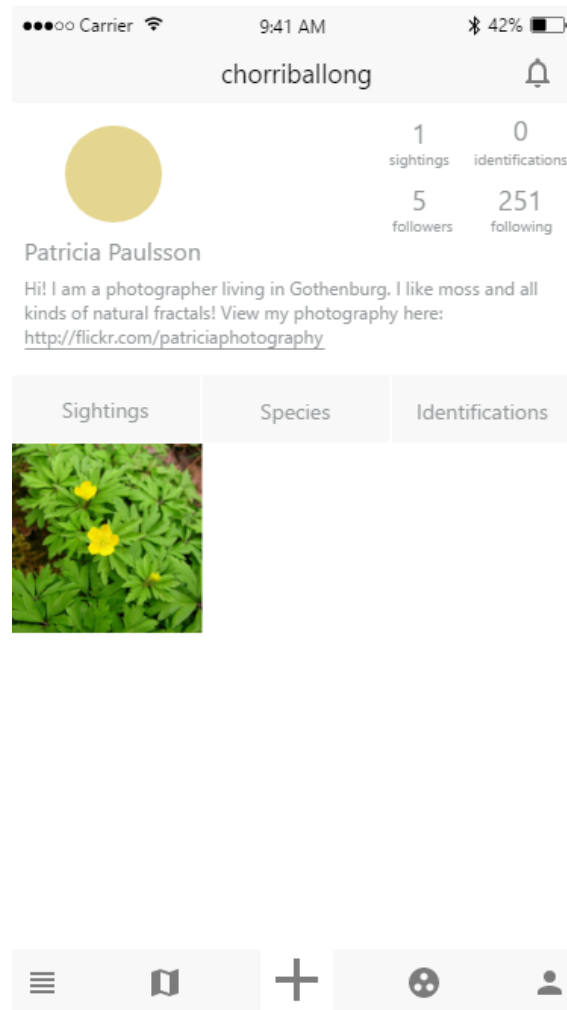


Figure 6.8: Prototype 3 Profile

The profile screen could support Rotman's motivational themes in the following ways:

Self-promotion

The content the user puts on their profile can be used for self-promotion as well as the statistics of their contributions.

Self-efficacy

A profile could make the user feel a part of the application and the community since there is a representation of them.

Trust

The people on the platform are presented which could enhance trust.

Common goals

Depending on what ends up on the users' profiles it could reflect some common goals.

Acknowledgement

The contribution statistics are a way of acknowledging the users' contributions.

6.3.6 Notifications

When somebody has interacted with a photograph, comment or identification that the user has made, the user receives a notification. These are then collected in the notification screen which is reached by clicking on the icon in the upper right corner of the feed screen. The screen is in low fidelity.

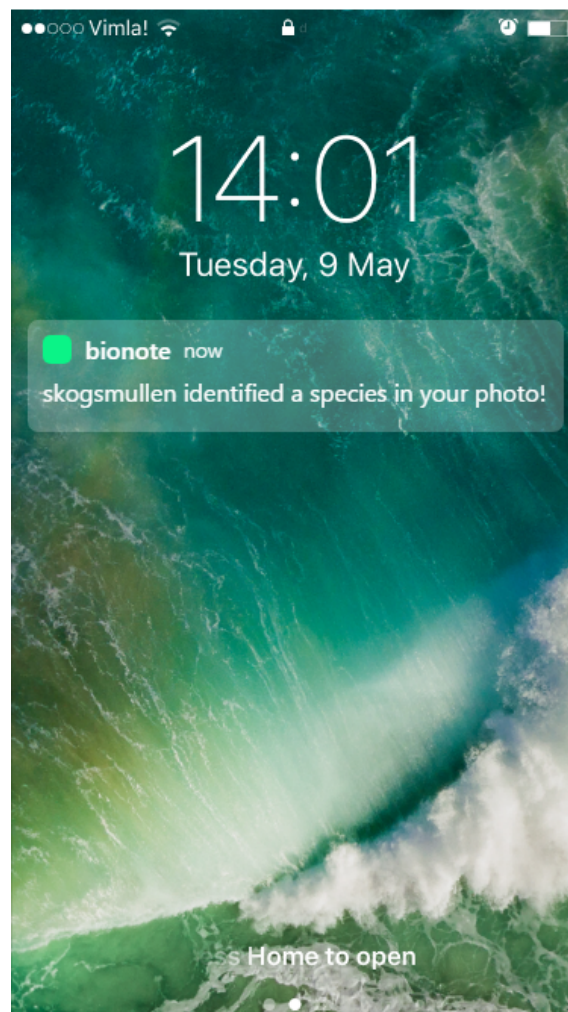


Figure 6.9: Prototype 3 Notification

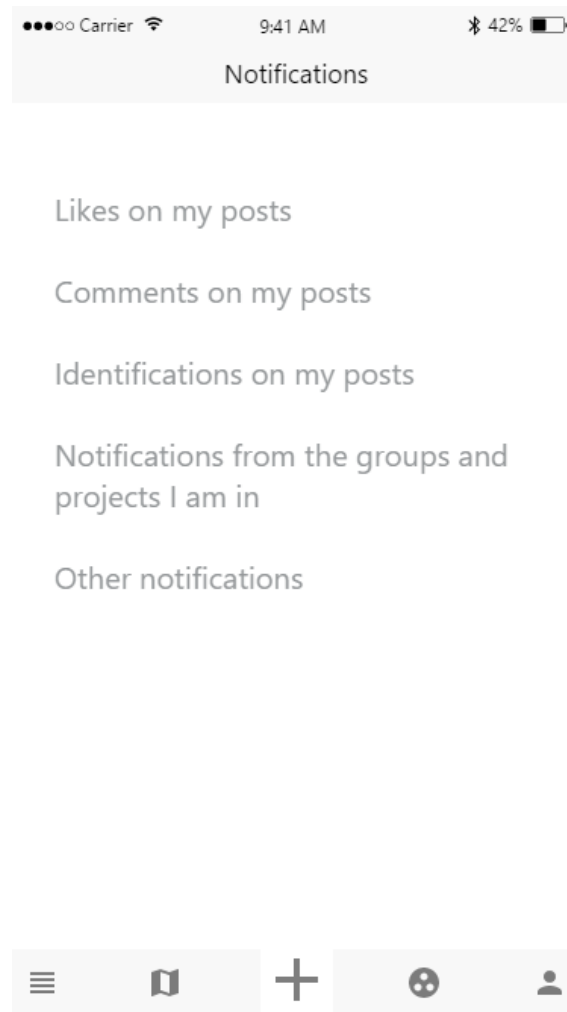


Figure 6.10: Prototype 3 Notifications

The screens for challenges could support Rotman's motivational themes, in the following ways:

Personal interest

Notifications can be sent that support the user's personal interest such as when a specific species has been sighted somewhere that they are interested in. Also it could be of personal interest to receive notifications that somebody has interacted with their post by either giving an identification, an agreement or disagreement to an identification, a comment or a like.

Common goals

Reminders could be sent. Although they have to be carefully designed so they are not annoying and repulsing.

Acknowledgement

A notification give acknowledgement that something has happened.

7

Discussion

The process and the results are reflected upon in this chapter. Strengths and weaknesses of the thesis and future work is addressed.

7.1 Reflection on the Process

There is a lot to say about the process. I have decided to specifically address:

- how I gathered actionable information about the domain,
- the decision to value user experience over data quality,
- if it made sense to so heavily use Rotman's motivational framework,
- the involvement of users and the way goals were used.

The work was a lot about getting access to the specific domain of crowdsourced species identification. An additional challenge in this project was that the target group was quite broad and fuzzy. We wanted to "go beyond biology enthusiasts". To meet these challenges, the knowledge that had already been created by BioNote was useful. It was also useful to work in the environment of biology specialists, sharing their lunchroom and work place and having casual chats. The BioNote team often took the role of what Cooper calls subject matter experts.

A decision was taken early on to prioritize a good user experience and to let scientific outcomes be less important for now. The aim was to build engagement and a crowd and to see what could engage mainstream people and not just biology experts. But it might very well be that data quality is very important for users as well. If they need an identification they would probably like some security that the identification given is actually accurate. The distinction between user experience and data quality is not that trivial. Furthermore data quality is deeply embedded within the stakeholder requirements and desired by the people financing the pursuit.

The process was grounded in Rotman's motivational themes which she has found in participants of biology related citizen science projects. The reason for this was not just to use Rotman's insights in the practical design work, but also to through the practical design research build on her previous research. The idea was to add the perspective of mobile technology design to her insights. This was somewhat accomplished, since the question of this thesis - "What mobile application design can support motivations for crowdsourced species identification?" - was answered by mapping elements in some design artifacts to her themes. However, while designing, the contextual user research work was more useful than Rotman's motivational

themes. The contextual user research gave actionable insights to base design decisions in a greater extent than Rotman's general themes. This said, her work was very valuable in order to understand the domain. I believe even more would have been found with proper user testing.

Rotman's themes are congruent with other models such as Maslow's hierarchy of needs. There are many alternative models that could be designed for. For example Maslow's hierarchy has been interpreted for design, see Figure 7.1. Maybe this would have been a complementary or alternative way to incorporate motivation theory.

Figure 7.1: Hierarchy of needs for design by Duhig



Levels of User Experience by Jon Duhig. Creative Commons Attribution 2.5 Australia License.

Although I meant to incorporate users in a user or human centered fashion, users were mostly involved as research subjects. They were less involved in prototyping and evaluation stages. Clearer results could have been created if the exposure of artifacts and prototypes to users would have been more controlled. I did expose the artifacts to people, but because this was mostly done informally, there is an absence of facts or concrete arguments for going in a certain direction or making certain conclusions. Intuition was gained, but hard convincing facts less so. Time ran out, however I think that testing is so important that it should have been better planned for.

The way in which goals were used and defined is a bit different from theoretical GDD. I did not make elaborate personas. However there are conflicting voices in the HCI community about the value of personas. In some cases they can be considered wasteful. In GDD the personas are the connection between research findings and goals to design for. Since this layer was not fleshed out the connection between potential users and the design is maybe less accurate. Furthermore the goals are exclusively behavioural goals that describe what a user should be able to do. They are more concrete than visceral and reflective goals. Often reflective goals and visceral goals are less concretely translatable into a prototype than the behavioural goals I worked with.

7.2 Reflection on the Results

The interactions of the prototype presented in section 6.3 are not fleshed out. More could be done with the amount of research that has been made. Unfortunately, the time has run out. One can always iterate further. An interesting phenomena about design is that it can always be improved. Therefore the method of “Defining Done” or defining at which point the project can be deemed a success can be important. The results presented in this thesis can be further iterated on. Maybe the goals and requirements, the process and the context descriptions in the earlier chapters, could aid someone who wishes to iterate upon this product. Neither the goals, requirements or prototype have been properly evaluated. It is hard to draw conclusions about them. To know how well the goals, the requirements and the prototype actually work, both in relation to the motivational themes and in relation to users’ and stakeholders’ intentions with the design, it would be necessary to perform user testing. This has already been discussed in the process discussion. Although the answers given in this thesis are not definitive, they can be used as hypotheses or inspiration and as a way for other designers to become immersed in the domain more quickly.

The second part of the results is the mapping to Rotman’s motivational themes. A reflection on the usage of this framework has already been given in the reflection on the process. The mapping between design artifacts and Rotman’s themes come from my judgement. It has not been tested how accurate my judgement is.

A lot of fun could be created in the application. The experience could be made more gamelike. For example quizzes could be involved, there could be a way to track the user’s learning process, or it could be a game similar to Pokemon Go[47] where species are collected instead of Pokemons. More help could also be given when identifying. Pedagogical guides could be incorporated. Another way would be to show similar species when the user is about to identify. More interactivity between users could be supported. The challenges could be elaborated upon and the way biodiversity goals are communicated within the app. These ideas have also been discussed within the BioNote context, and do not entirely come from me. In fact most of the knowledge presented in the thesis comes from asking an amount of other people and papers and interpreting the answers and bringing it together.

Towards the end of the thesis project BioNote hired a mobile developer and started implementing a mobile version of their web application. Their result is similar to my final prototype with roughly the same main screen functionality.

8

Conclusion

The design space of mobile applications for crowdsourced and collaborative species identification was explored with focus on motivation and how to design in order to support motivations in this field. The research question was "What mobile application design can support motivations for crowdsourced species identification?". Previous research on participant motivation in biology citizen science projects by Dana Rotman was used. A mobile application for collaborative species identification was designed with focus on photo sharing and social media. A human centered and goal directed design process was adopted. The process consisted of numerous observations and interviews and a workshop together with experts in citizen science. Three iterations were performed and three prototypes in varied fidelity levels were created.

The resulting artifacts of the design process was a set of eleven goals that users could have with the interaction, a set of 60+ requirements that could be translated into a visual prototype, and a simple click-through visual prototype. These final artifacts were mapped against Rotman's motivational themes in order to give ideas of how mobile applications could be designed to support the motivations in the framework. Future work consists of testing the resulting artifacts.

For anyone who wants to create a similar design I would advice to take the eleven goals created in this thesis into account. They base on research but are not solidly tested, so it is difficult to draw any further conclusions.

This project was grounded in a framework of what motivates people to contribute in biology citizen science projects. It was useful to use this framework as a reference, however evaluating the prototype with it in mind did not say much. Furthermore the framework was quite general, and did not provide as much actionable guidance for design decisions as the context-specific user research. It was useful as a starting point for understanding users, but context-specific user research is more effective.

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A

Appendix A: Ethical Considerations

When conducting interviews and user studies it is important to value the participants' time and effort.

An ethical concern that arises whenever users add content to an application or community, is that they might choose to add unethical or inappropriate content. This needs to be addressed when designing this type of application. Ungenuine content, offensive content and spam needs to be discouraged.

The privacy of users also needs to be considered, as they upload information about themselves. For example posting pictures with attached location data enables other parties to track the user's location history.

The domain of biodiversity conservation is under some controversy since it has been linked to increased local poverty, for example in areas where nature is restricted in nature preservation camps instead of being used [18]. This is a consideration to keep in mind to check whether the proposed designs have any, negative or positive, impacts on the biodiversity conservation driven aspects of poverty.

I take the approach of creating designs that correspond to users' desires, of researching motivations in order to design for them. The line can be quite thin between this approach and designing in order to motivate somebody to do something. In a sense that is what readers of this thesis, interaction designers and citizen science coordinators might want to do. They want people to collect data for them, so they want to know how to motivate them. This is all natural, however I believe that when you design in order to persuade somebody to do something, it is best if this something benefits the persuaded and does not harm them.