Designing and evaluating OAsearch:

A crowdsourced search engine for scholarly OA publications, gamified to enhance user motivation

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Abstract

Ensuring access and findability of research is crucial to allow for scientific knowledge to be spread and built upon, and this is the primary motivator behind this thesis. A crowdsourced online search engine for Open Access publications has been developed, meaning that the application relies on users to add and curate the collection of indexed publications. Gamification, which is the use of game design elements in non-game contexts, has been applied to the system to increase users’ motivation to contribute.

The research questions of this thesis concerns how to provide findability of open access publications, as well as how users can be motivated to add, quality assure and curate publications. The process of designing the application has been conducted as a user centered process. The empirical methods applied throughout the phases of establishing requirements, prototyping and evaluating the final design, includes a review of excising products, a domain expert interview, a heuristic evaluation, observation and thinking aloud, user interviews and questionnaires.

A summative evaluation showed that the implemented game design elements moderately increased users’ motivation to add, quality assure and curate publications. The evaluation showed that all users agree or strongly agree that the system is easy and pleasant to use, and the search interface was proved to be quite adequate. This indicates that the system does to some extent achieve the goal of providing findability of OA publications at the time of the summative evaluation. Substantial improvements to the application were made subsequently of this evaluation, but the impact of these improvements remains to be investigated.
Foreword

The idea of creating a crowdsourced open access search engine for this thesis was introduced by my supervisor Gisle Hannemyr. I am very grateful for the highly valuable input and indispensable guidance Gisle has provided during the work of this thesis.

In the spirit of openness and free sharing that surrounds the domain of this thesis, the source code of the developed application is open source and available under an MIT license at https://bitbucket.org/espeandr/open-access-search-engine. I genuinely believe in the potential of the developed application, and will proceed to develop it further subsequently of this thesis.
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1 Introduction

1.1 Research questions

This thesis has resulted in a web application which, put simply, is an online search engine for scholarly open access publications, where users themselves are enabled to curate and populate the collection of indexed publications. At the core of OAsearch lies two important features: firstly, it enables users to add publications they believe should be included to the collection, which is subsequently quality assured by a separate user before accepted. Secondly, it enables users to edit metadata on publications. The application developed is named OAsearch, and is available at www.oasearch.com. A more extensive description of the application will be given in section 1.3 – Short description of the developed application.

The research questions which constitutes the basis of this thesis are:

- **RQ 1:** How can OAsearch be designed to make open access publications findable?
- **RQ 2:** How can OAsearch be designed to motivate users to add, quality assure and curate publications?

In order to contextualize the thesis, a brief introduction to the background and domain of the thesis will be given in the next section of this chapter. In section 1.3, the motivational factors which poses the need for OAsearch will be outlined. Lastly, a brief description of the implemented application will be presented.

1.2 Background

A study published by the Research Information Network aimed to assess the nature and scale of difficulties researchers faced when gaining access to licensed content (Brine, 2010). The study, which was conducted in the UK, showed that two-thirds reported being unable to readily access licensed content at least least monthly, and 40% at least weakly. 80% reported that these difficulties had an impact on their research, and nearly a fifth reported it to have an significant impact on their research (Brine, 2010). The report states that two of the key difficulties researchers encounter when accessing publications are the fact that they do not have a licensed way of accessing the content, and that “licenses for
online content are seen as complex and sometimes restrictive of access for non-members of institutions” (Brine, 2010, p. 23).

Open access publications, in the context of academic publishing, is referring to online publications which can be unrestrictedly accessed without meeting any intended barriers. Gold open access is OA content that is made accessible through a publisher, and are normally made available on a journal’s website. Such journals usually charge an article processing charge. Green open access is OA content that is made accessible by the author himself by uploading his works on an open repository (Suber, 2012).

A study titled Anatomy of green open access published in 2013 concluded that “The overall uptake of green OA [...] we estimate to be around 12%, based on a synthesis of a number of previous studies” (Björk et al., 2014, p. 23). Suber states that the majority of the traditional toll barrier journals allow researchers to self archive their publication as green OA alongside the traditional journal (Suber, 2012). However, he described this possibility as “one of the best-kept secrets of scholarly publishing” (Suber, 2012, p. 54). This is supported by other studies, namely a study conducted in 2013 which found that 81% of the publications examined would be allowed to be distributed in the form of the accepted manuscript sent to the publisher (Laakso, 2014).

If the possibility of self archiving alongside the traditional journal were to be fully utilized, most publications would be accessible through OA repositories, and the difficulties researchers faced when gaining access to licensed content, as described in the report by the Information Research Network, would be likely to diminish. The resulting application of this thesis is a search engine which encourages users to self archive such green OA versions, and which makes both green and gold OA versions findable by providing a centralized index of such publications.

Open access publishing is not without drawbacks. Jeffrey Beall is a man known for his critique of what he has coined as predatory publishing (Beall, 2013, p. 79). He describes predatory open-access publishers as “those that unprofessionally exploit the gold open-access model for their own profit. That is to say, they operate as scholarly vanity presses and publish articles in exchange for the author fee”¹. Such publishers may use tactics such

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as purposefully obscure their identity, location and financial workings (Bohannon, 2013, p. 60), and often employ no peer review even if they state so.

An experiment conducted 2013, raised alarming questions about peer review practices in the world of the open access. A paper crafted as a “credible but mundane scientific paper, one with such grave errors that a competent peer reviewer should easily identify it as flawed and unpublishable” was sent to a large number of open access journals (Bohannon, 2013). 70% of the journals that seemingly performed any actual review ultimately accepted the paper (Bohannon, 2013, p. 64). The article does note that the same result would may have have been shown if traditional subscription based journals where targeted instead.

1.3 Motivation

There are two main motivational factors behind this thesis: the promotion of OA in general, and to build an application which addresses the shortcomings found in the current applications which provides findability for OA publications.

1.3.1 Promotion of open access

In his book, Open Access, Peter Suber states that in 2009 Harvard University subscribed to 90800 serials, and the best funded research institute in India subscribed to 10600 (Suber, 2012, 30). It may be argued that researchers affiliated with the less fortunate institutes throughout the world, might report that difficulties in accessing publications would have an even more significant impact on their research than what was reported by the Research Information Network in their UK study, as previously mentioned. Corrado states in one of his publications: “One of the great benefits to open access is that libraries in smaller institutions or in economically disadvantaged areas around the world can have greater access to these scholarly resources” (Corrado, 2005, p. 197).

The literature presented shows that researchers report that difficulties in accessing content significantly impacts their research, and even more so for people not affiliated with the right institutions. The application developed as a part of this thesis hopes to promote the publication form of OA, contributing to making research more readily accessible to a larger population. It intends to make green OA versions more findable by both enabling users to
easily publish a OA version alongside publishing in a traditional journal, as well as simply link to green OA versions already available online

1.3.2 Shortcomings in current services

After conducting an expert interview, and researching applications in the domain of enabling findability of OA publications, four main shortcomings were found to be present: a less than optimal inclusion process, an inefficient quality control on included publications, erroneous metadata on publications and inclusion of non-OA versions of publications. These shortcoming will be further discussed in section 3.1.3 – Summarizing review of current services.

1.4 Short description of the developed application

Based on the findings of the research conducted as a part of this thesis, a web application which enables users to curate and search in a collection of open access publications has been developed. By utilizing the concept of crowdsourcing, the curation is done by user collaboration. Crowdsourcing is defined by the one of the authors originally coining the term as “the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call”\(^2\). Crowdsourcing will be further discussed in section 2.1 – Crowdsourcing. Effort has been put into ensuring that only scholarly OA publications are indexed, and to keep out publications of predatory publishing. Predatory open acces publishing

The core features of OAsearch are presented in the below bulletin:

- Users are provided a search interface connected to an index of approximately 900,000 OA publications. The service utilizes available data on citations and other forms of publicity.
- Users are enabled to add publications to the service, both publications they have authored themselves, and those of others. After a publication has been added/nominated, a separate user will verify / reject it for inclusion.
- Users can flag publications for moderation, and an interface for viewing all flagged publications has been developed. Papers with a publisher appearing on Bealls list of predatory publishers will be flagged for moderation.

• Users can add alternative sources to a publication, and are able to vote on which of the possible versions / sources they find to be the best alternative. The best alternative is displayed and linked to by default.

• Users can add missing metadata to publications and correct previous erroneous metadata.

• Users can comment and discuss both the content of the publications, and aspects of the inclusion of the publications.

Providing users with motivation to undertake these activities is central to the success of the application. Some researchers might be incentivized to add their research in the purpose of reaching more readers, some might be motivated to contribute by utilitarian motives. To further motivate users, the application has been gamified by adding game design elements. Gamification will be further discussed in section 2.2 - Gamification.

1.5 Structure of the thesis

This thesis counts 7 chapters including the current one. Chapter 2 - Applied theory, presents the underlying theoretical basis for the design and evaluation of OAsearch. Chapter 3 - Design, concerns the design process of establishing requirements, specifying the system, describing the finished interface and the technical implementations. The planning, execution and results of the evaluations that has been conducted are presented in Chapter 4 – Evaluations. The findings from the summative evaluation presented in Chapter 4 constitutes the basis for the discussion presented in Chapter 5 – Discussion, which also contains critical reflections on the results that have been obtained. In Chapter 6 - Conclusion, the thesis is summarized and it is concluded to what extent the requirements of the research questions have been achieved. Finally, in Chapter 7 - Future work and Final Remarks, my own reflections are presented, as well as the potential future work that may be relevant in the extension of this thesis.
Chapter 2 - Applied theory

2 Applied theory

This section provides an insight into what background and theory is applied in order to discuss and achieve what the research question of this thesis requires. As previously outlined, the concept of crowdsourcing is applied to facilitate the undertaking of the curation in the developed application, and previous research on this concept is the first subject explored in this chapter in section 2.1. When crowdsourcing a system, it is highly vital to ensure that the users which are to undertake the crowdsourced tasks are motivated to do so. The concept of gamification is applied to achieve this, and section 2.2 in this chapter explores gamification and the underlying theory of motivation. Section 2.3 to 2.5 addresses the theory on interaction design, methods and architectural software patterns respectively.

2.1 Crowdsourcing

2.1.1 Defining crowdsourcing

The term crowdsourcing was first coined in an article published in WIRED magazine in 2006\(^3\). The author of this article defines crowdsourcing on his personal blog as “the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call”, as previously quoted\(^2\).

In the article Toward an integrated crowdsourcing definition published in 2012, it is stated that crowdsourcing “may be identified [with] virtually any internet-based collaborative activity”, and that there is an abundance of definitions used (Estellés-Arolas and González-Ladrón-de-Guevara, 2012, p. 189). The same article points out that there are oppositions in the scientific community about what should be defined as a crowdsourced system, pointing to separate articles referring to YouTube and Wikipedia described as both. The objective of the article is stated to be to “form an exhaustive and global definition to describe any given crowdsourcing activity” (Estellés-Arolas and González-Ladrón-de-Guevara, 2012, p. 189).

\(^3\) [http://www.wired.com/2006/06/crowds/](http://www.wired.com/2006/06/crowds/) [last accessed 19.05.16]
To achieve this, a systematical analysis of previous literature on the subject of crowdsourcing was done, and the following definition was formed:

Crowdsourcing is a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task, of variable complexity and modularity, and in which the crowd should participate bringing their work, money, knowledge and/or experience, always entails mutual benefit. (Estellés-Arolas and González-Ladrón-de-Guevara, 2012, p. 197)

The definition further specifies that the user will receive some sort of reward, be it economic, social recognition, increased self-esteem or the development of individual skills. The crowdsourcer will benefit of whatever the user has contributed with, which will depend on the type of activity which was undertaken (Estellés-Arolas and González-Ladrón-de-Guevara, 2012).

The definition of crowdsourcing just presented will be the applied definition throughout this thesis. For future references, the term crowdsourcer is referring to individuals, institutions, non-profit organizations or companies that proposes the undertaking of the tasks that is to be crowdsourced. Throughout the literature within the context of crowdsourcing referenced in this thesis, the terms contributor, crowd and user are all used as terms referring to the entities that is to undertake crowdsourced tasks.

### 2.1.2 Examples of crowdsourced systems

To exemplify the notion of the diversity found in crowdsourced applications, as expressed by Estellés-Arolas and González-Ladrón-de-Guevara (2012), and for the purpose of exemplifying theory on crowdsourcing processes and tasks in later sections, a few systems implementing crowdsourcing will be briefly presented in the coming paragraphs.

**Wikipedia**

Wikipedia is an online encyclopedia which has crowdsourced the task of writing and curating the included articles. According to Wikipedia themselves, the community is self organized and the community applies structures that enforces meritocracy and communal
Meritocracy is defined by the Oxford Dictionaries as “Government or the holding of power by people selected according to merit”, and can be exemplified in the context of Wikipedia by the process of deciding on giving users additional responsibility by voting amongst community members. When deciding on the vote, the merits and previous contributions of the user that is to be given increased rights is arguably the most central consideration.

**InnoCentive**

InnoCentive is a platform which enables companies to crowdsourced the solving of scientific challenges they may have. Such challenges are registered on the website, and thus communicated as an open call for solving to any user browsing the website for challenges. Should a user be able to solve such a challenge, they will be given what is often a substantial monetary award.

**iStockphoto**

iStockphoto is an application that enables users to upload their images, thus crowdsourcing the gathering of stock photos, and which makes these images findable and purchasable. iStockphoto sells these images as royalty free material, and the contributors are given a portion of the earnings if one of their images is sold.

**Amazon Mechanical Turk**

This service enables individuals or businesses to crowdsourced almost any task they may have to a crowd of users doing these tasks in return for money. Task creators posts crowdsourcable tasks which normally require human effort, such as transcription of audio recordings and receipts, completing surveys and identifying objects in photos. The

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5 [http://www.oxforddictionaries.com/definition/english/meritocracy](http://www.oxforddictionaries.com/definition/english/meritocracy) [last accessed 10.06.16]
6 [https://www.innocentive.com/about-us/](https://www.innocentive.com/about-us/) [last accessed 10.06.16]
7 [http://www.istockphoto.com/faq.php](http://www.istockphoto.com/faq.php) [last accessed 10.06.16]
9 [https://www.mturk.com/mturk/help?helpPage=overview](https://www.mturk.com/mturk/help?helpPage=overview) [last accessed 10.06.16]
contributors, in the sense of task completers, are able to browse and undertake these tasks and are given a predefined payment when their task completion is verified.

### 2.1.3 Characteristics of crowdsourcing processes

In the context of crowdsourcing, Geiger et al. (2011, p. 1) state that the organization striving to achieve a specific goal should be able to evaluate the mechanisms that impact the processes used to source and aggregate the contributions from the users. In the article *Managing the Crowd: Towards a Taxonomy of Crowdsourcing Processes*, Geiger et al. (2011, p. 5-8) identifies four dimensions in which crowdsourcing processes differ; Preselection of contributors, Accessibility of peer contributions, Aggregation of contributions and Remuneration for contributions. These dimensions will be further discussed in the paragraphs below.

#### Preselection of contributors

This dimension is concerning the limitations the crowdsourcer set on who should be allowed to undertake the crowdsourced tasks. Geiger et al. (2011, p. 6) state that in most cases, the crowdsourcer wishes to benefit from as many and diverse users as possible, and therefore does not apply any preselections on the contributors. Geiger et al. (2011) defines two types of preselections which where found to be applied in crowdsourced systems; *qualification-based* preselections, and *context-specific* preselections.

In systems where a qualification-based preselection is applied, the systems require the contributors to demonstrate a certain knowledge or skill before they can undertake a task (Geiger et al., 2011). For instance, some of the tasks found on Amazon Mechanical Turk requires users to possess *Master Qualification*, which is given to users demonstrating a high level of accuracy on different types of tasks given by separate requesters over some period of time. If a crowdsourcer requires users to possess Master Qualification, they are imposing a qualification-based preselection which is done in an effort to ensure a higher level of quality on the crowdsourced work.

Systems applying context-specific preselections are systems that require the users which are to undertake the tasks to belong in some kind of group of context. For instance, online
stores might require users which are to evaluate customer service or write product reviews, to be actual customers.

**Accessibility of peer contributions**

This dimension of the crowdsourcing process concerns to which extent the users which are solving or contributing on the crowdsourced tasks, are able to view or interact with the work or contribution of other users. Geiger et al. (2011, p. 7) define four levels of accessibility that crowdsourced systems implement on peer contribution; *none, view, assess* and *modify*.

Systems classified with *none* on the dimension of accessibility of peer contributions, refers to systems where the users can not view each other’s work or contributions at all (Geiger et al., 2011). This level of accessibility could be selected for multiple reasons such as out of privacy, based on a wish to ensure diversity on contributions, or simply because it does not make sense to let contributors view each other’s contributions. In the context of crowdsourcing questionnaires for scientific use, hiding fellow user’s answers make sense both out of privacy considerations, and also out of the consideration of ensuring diversity in the answers in the sense of making sure users are not affected by other user’s responses.

Systems which can be characterized as having a *low* level of accessibility on peer contributions, are systems where the users can view each others contributions, but are not able to comment or rate the contributions (Geiger et al., 2011).

When the classification of *assess* is given on the accessibility level of peer contributions, the system we are referring to enables fellow contributors to express their opinion on individual contributions by rating or commenting on the contributions (Geiger et al., 2011). Examples of such systems are YouTube (users comment and rate user-uploaded videos) and Google Play (users rate and comment user-uploaded apps).

The final classification that the accessibility of user generated content can be given, is *modify* (Geiger et al., 2011). Systems with such an accessibility level implemented, provides a means for users to modify or even delete fellow contributors’ contributions. Wikipedia could be classified identified with an attribute of modify on the dimension of accessibility on peer contributions.


**Aggregation of contributions**

This dimension of the crowdsourcing process concerns how the crowdsourced work that has been contributed is aggregated and used by the crowdsourcer. Geiger et al. (2011, p. 7) uses the terms *Integrative Crowdsourcing* and *Selective Crowdsourcing* as introduced by Schenk and Guittard (2011), to describe two ways to aggregate the collected contributions.

*Integrative Crowdsourcing* is applied when the crowdsourcer desires a complementary pool of contributions (Schenk and Guittard, 2011), where all contributions meeting some requirement is reused in the final outcome (Geiger et al., 2011). The process of aggregating user contributions in Wikipedia can be classified as integrative, as all contributions are included, granted that they meet the requirements set by the community. Application stores such as Apple’s *App Store* and Google’s *Google Play* can also be classified as such, as they pool all user-contributed applications meeting a set of requirements in an online store.

As Integrative Crowdsourcing is applied when all contributions are included in the final outcome, *Selective Crowdsourcing* is applied when the crowdsourcer chooses an input from the pool of contributions (Schenk and Guittard, 2011). Schenk and Guittard (2011) state that “Selective CS generally implies a winner-takes-all mechanism where only the finder of the ‘winning’ solution is rewarded” (Schenk and Guittard, 2011, p. 98). This resonates with the aggregation of contributions found to be applied in the challenges in InnoCentive, where the crowdsourcer selects the contribution of a single user as the winning contribution. A crowdsourced way of finding a business logo in the form of a tendering process, could also arguably be considered as selective crowdsourcing.

**Remuneration for contributions**

This dimension concerns in what way the contributors are awarded or compensated for their efforts. Geiger et al. (2011, p. 7-8) defines three classes of remuneration: fixed, success based and no remuneration.

*Fixed remuneration* is applied when the contributors are given a fixed payment regardless of the value they contribute to the final outcome. For instance, users answering crowdsourced surveys are in some cases given such fixed remuneration, and all
contributions qualifying as serious are paid (e.g. e-rewards\textsuperscript{10}). Fixed enumeration is seemingly only applied in cases of integrative crowdsourcing (Geiger et al., 2011).

*Success-based remuneration* is applied when the contributors are given payment on the basis of their individual contribution to the goal of the crowdsourcing (Geiger et al., 2011). This type of remuneration is found in both ways of aggregating crowdsourced contributions. Success-based remuneration in selective aggregation of contributions is applied by InnoCentive in the way that they are paying only the winners of the posted challenges. Success-based remuneration in the case of integrative crowdsourcing can be exemplified by systems paying contributors based on the revenue they acquire through the crowdsourced system, such as iStockphoto.

Geiger et al. (2011) also mentions what he calls *no remuneration* crowdsourced systems, which are systems not rewarding contributors efforts with monetary value. Geiger et al. (2011) states that such such systems rely on other mechanisms to attract contributors, but the authors does not venture into describing such mechanisms. The system developed as a part of this thesis is a system with no remuneration, and therefore such mechanisms are a vital part of this thesis, and will be further discussed in *section 3.2.3 Crowdsourcing the application*.

### 2.1.4 Classifying crowdsourced tasks

Gadiraju et al. (2014, p. 218) state that understanding the dynamics of the tasks that is to be crowdsourced, and the users which are to do these tasks, is vital for ensuring an efficient work flow. In this section I will firstly present a scheme used for classifying crowdsourced tasks, then I will further describe the classes that is relevant in the context of OAsearch. Lastly I will classify the tasks that is to be crowdsourced in OAsearch according to the presented scheme.

Gadiraju et al. (2014, p. 218) state that “*existing works fall short when it comes to classifying typically crowdsourced tasks*”, and the authors proposes a classification scheme for tasks based on an extensive study with an initial 1000 participants. The scheme consists of 6 higher level classes based on the goals of a task, with some corresponding sub classes

\textsuperscript{10} \url{http://www.e-rewards.com/learnmore.do} [last accessed 04.04.16]
based on the workflow of the higher level tasks. The scheme proposed by Gadiraju et al. (2014, p. 222) is reproduced in table 1 below.

<table>
<thead>
<tr>
<th>Information Finding</th>
<th>Verification &amp; Validation</th>
<th>Interpretation &amp; Analysis</th>
<th>Content Creation</th>
<th>Surveys</th>
<th>Content Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metadata finding</td>
<td>Content Verification</td>
<td>Classification</td>
<td>Media Transcription</td>
<td>Feedback/Opinions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content Validation</td>
<td>Categorization</td>
<td>Data Enhancement</td>
<td>Demographics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spam detection</td>
<td>Media Transcription</td>
<td>Translation</td>
<td>Promoting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data matching</td>
<td>Ranking</td>
<td>Tagging</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data Selection</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Sentiment Analysis</td>
<td></td>
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<td></td>
<td></td>
<td>Content Moderation</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Quality Assessment</td>
<td></td>
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</tr>
</tbody>
</table>
| Table 1: Sub-classes of the proposed categorization for typically crowdsourced tasks

The relevant classes in the context of OAsearch is Information Finding, Verification & Validation, Interpretation & Analysis and Content Creation. The class of Information Finding concerns tasks where the users are asked to gather information on a given entity as asked by the crowdsourcer. This could be to gather prices from online stores, or finding business’s contact information.

Verification & Validation concerns tasks where the user is asked to confirm the validity or to verify various types of content. For instance, this could be to verify data that has been auto gathered by a system.

Interpretation and Analysis is a class that concerns tasks that ask users to make decisions using their interpretational and analytical skills. This could be to moderate discussion fields for inappropriate responses, or rate content on quality.

Content Creation is the classification concerning tasks that require users to create new content for the crowdsourcer. This could be to write a product review, or to upload a video of an event to a crowdsourced video community.

2.2 Gamification

Ensuring user participation and providing motivation to ensure engagement, is crucial to the success of crowdsourced systems (Brito et al., 2015, p. 446). The application developed as a part of this thesis is what Geiger et al. (2011) likely would classify as a crowdsourced
system with no remuneration, thus the system relies on other mechanisms than payment for motivating users to contribute and participate. Gamification has been shown capable of promoting user motivation (Hamari et al., 2014), and has been applied to OAsearch as a means to do so.

Gamification requires a great deal of thought about the entire design of the system, including understanding the nature of your users, thinking about what you’d like them to do and how best to make them do it, considering the best technology platform to do that, and examining the specific game elements you’re going to employ to get them to do things—among many other considerations. (Werbach and Hunter, 2012)

Fostering motivation through gamification is not as simple as just applying the common game elements of points, badges and leaderboards, as will be shown throughout the coming sections. The first and second section will define gamification and the distinction between zero-sum and positive-sum games. The third and fourth section presents the motivational theory of STD and the findings of STD which were considered in the design of OAsearch. The fifth section identifies common player types and what kind of activities and goals that motivate them. Section 2.2.6 presents a categorization of the numerous possibilities of game elements which can be applied when gamifying. Finally, the framework applied to assemble the various elements presented throughout this section into a design will be presented.

2.2.1 Defining gamification

In the 2011 article From Game Design Elements to Gamefulness: Defining ‘Gamification’, Deterding et al. (2011, p. 9) states that there has been a rapid proliferation of mass-market products that takes inspiration from videogames, and that this trend is usually summarized as gamification. The article also states that this term is connected with a sizeable body of existing concepts and research, origins from various industries, charged connotations and debates about the practice, and hopes to clarify discourse on the meaning of the the term and related concepts. By investigating the term and the historical origins of it in relation to precursors and similar concepts, the following definition of gamification was proposed: “Gamification is the use of game design elements in non-game contexts” (Deterding et al.,
2011, p. 10). This is the definition that will be assigned the term crowdsourcing throughout this thesis.

In the article, Deterding et al. (2011) further elaborates on the definition by discussing the constituent terms of the definition explicitly. These terms are game, element, design and non-game contexts, and a brief summary of what Deterding et al. (2011) attribute these terms will be presented below.

**Game**

The term game, in the context of the definition proposed, is referring to playing that is structured, rule-bound and that is goal-oriented, rather than playing that is expressive, improvisational and more free-form (Deterding et al., 2011, p. 11). Deterding et al. (2011) denotes the experiential and behavioral qualities of such structured goal-orientated playing as gamefulness, and further proposes the terms gameful interaction and gameful design. Gameful interaction are artifacts that promotes the qualities that gamefulness denotes, and gameful design concerns designing for gamefulness (typically by using game design elements) (Deterding et al., 2011).

Deterding et al. (2011) states that the terms gamification and gameful design will usually coincide, and suggest to use the term gameful design for future references to gamification as this term has less baggage. In this thesis, gamification will be the applied term, as the later research applied in this thesis uses this term rather than gameful design.

**Element**

In the context of the definition proposed, Deterding et al. (2011, p. 11) state that the term element is referring to elements that are characteristic to games, found in most of them (but not necessarily all), readily associated with them and found to play a significant role in the gameplay. Ranks, levels, self-representation with avatars and time pressure are some of the examples Deterding et al. (2011) brings about when exemplifying such elements. Deterding et al. (2011) points to the fact that many of such elements in themselves are not necessarily considered a game element, but when put together they form constituents of a game.

It is also stated that it can sometimes be hard to distinguish a game from a gamified application. Deterding et al. (2011) describes serious games as the design of full-fledged
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games for non-entertainment purposes, where as gamified applications include a more limited set of game elements. As it may be hard to conclude on whether instances of real life applications are such full-fledged games or merely an application incorporating game elements, Deterding et al. (2011) states that one also has to consider social elements of the application. Peoples focus, perceptions and enactments to the application should also be acknowledged when determining the matter (Deterding et al., 2011).

**Design**

In the context of the proposed definition, design is referring the use of game design elements, rather than the use of game-based technologies or practices such as game controllers or graphics engines (Deterding et al., 2011, p. 12). The authors of the article states that game design elements can be groped into 5 levels of abstraction from least abstract to most: game interface design patterns, game design patterns and mechanics, game design principles and heuristics, game models and game design methods. To exemplify, game interface design patterns refers to design components and design solutions such as badges, levels and leaderboards. The most abstract level of game design elements, named game design methods, concerns practices and processes specific to game design, such as playtesting (quality control of unfinished games).

In the same way that gamified applications includes a more limited set of game elements than serious games, a designer of a gamified application intends to use merely some game design elements. A gamified application also differs from full-fledged games in the way that they can “flicker” between modes of user experiences, such as being playful, gameful, instrumental or otherwise.

**Non-game contexts**

The final constituent of the proposed definition reads non-game contexts, and is referring to the use of game elements for purposes other than their expected normal use in a game. Deterding et al. (2011, p. 12) further states that entertainment is the prevailing purpose of games, and can be claimed to be the normal use of game elements. It is also stated that the

11 [https://www.techopedia.com/definition/27197/playtesting](https://www.techopedia.com/definition/27197/playtesting) [last accessed 10.06.16]
predominant use of gamification is to improve user experience by increasing qualities such as joy of use and engagement (Deterding et al., 2011).

2.2.2 Zero-sum and positive-sum games

Robson et al. (2015, p. 415) describe zero-sum games as games where some lose, and some win. Positive-sum games are described as games where overall, the rewards are above zero. At the end of a zero-sum game, the overall gains and loss of the utility that is played for are zero. If one player does well and gains some value, this means that this gain must somehow be retracted from the score of other players. A game where success is measured on a leaderboard can exemplify this: for a player to climb a leaderboard, others must fall.

In positive-sum games the end score is above zero, which means that all players may gain some utility in the game, and no one has to make up for it. A game where players are given points, badges and unlocks, is a positive-sum game as such rewards are given from an inexhaustible pool rather than a fixed. Adjunct Game Design professor Amy Jo King sums up the notion of such games by stating that non-zero-sum experiences are experiences where you win by building relationships and partnerships, and succeed by working together towards a larger goal or cause12. She further states that “These games have scoring systems – but the score isn’t the main point; it’s more about the group effort, and the relationships built by playing together”13.

As the purpose of OAsearch is in the interest of the common, gamifying the application as a positive-sum game may further enhance the users’ motivation through facilitating a sense of fellowship, collaboration and joint effort for the common. Applying competitive zero-sum game elements such as player vs player competitions and leaderboards may take away from this notion of joint effort for the common good.

12 http://amyjokim.com/blog/2013/01/18/coop-gaming-on-the-rise/ [last accessed 10.06.16]
2.2.3 Self Determination Theory

Zichermann and Cunningham (2011, p. 15) state that “In any system, the player’s motivation ultimately drives the outcome. Therefore, understanding player motivation is paramount to building a successful gamified system”. Self Determination Theory (STD) is a highly influential empirical theory on human motivation, development and wellness (Deci and Ryan, 2008, p. 182).

STD uses the concepts of intrinsic and extrinsic motivation, which will be discussed in the next section. How intrinsic motivation can vary in its nature is discussed in the second subsection. STD proposes that we have some basic psychological needs, and that how these needs are supported or thwarted affect our motivation. This will be discussed further in third and final subsection. Findings and implications from research done within the context of STD which can be drawn upon when designing for crowdsourcing and gamification, are presented in Section 2.2.4 Findings from STD which can be utilized.

Intrinsic and extrinsic motivation

To be motivated means to be moved to do something, and thus can a person which has no inspiration to do something be characterized as unmotivated (Ryan and Deci, 2000, p. 54). They also state that motivation is not a unitary phenomenon as it varies not only in amount of motivation, but also in orientation. In other words, motivation can vary in how much of it we experience, but also in the type of motivation we experience. Two central central terms used when describing the orientation of motivation is intrinsic motivation and extrinsic motivation.

Gagné and Deci (2005, p. 331) defines intrinsic motivation with the following words: “Intrinsic motivation involves people doing an activity because they find it interesting and derive spontaneous satisfaction from the activity itself.” Such motivation typically arises when the activity is performed because it is found to be fun, or because of the excitement the challenge of the activity poses. To exemplify, we can say that a person using OAsearch to correct metadata because he finds it fulfilling and likes the challenge of the task is intrinsically motivated.
On the contrary of intrinsic motivation, we can define *extrinsic motivation* as motivation instrumented by a consequence of an activity, rather than the activity itself (Gagné and Deci, 2005, p. 331). Such consequences can be in the form of tangible rewards, such as money or prizes, but also intangible rewards such as status or positive verbal feedback.

In motivation theory, the term *tangible* is commonly used. Following the linguistic meaning of the term, virtual elements such as trophies and badges would not be tangible rewards. However, as the motivational effects of such elements are intuitively more congruent with those of tangible rewards also in the context of gamification, they are commonly referred to as such. Thus, we can say that a user which adds publications to OAsearch because he wishes to earn points and badges through the gamified system, is extrinsically motivated. Fear of negative feedback or punishment can also be regarded as extrinsic motivators.

**The autonomy continuum**

*Autonomy* concerns how we perceive the outcome of an event to be in our control. It “involves acting with a sense of volition and having the experience of choice” (Gagné and Deci, 2005, p. 333). A proposition of that extrinsic motivation can vary in the degree to which it is autonomous versus controlled, is central to SDT (Gagné and Deci, 2005, p. 334). It’s posited that extrinsic motivation can be described on a continuum ranging from controlled to autonomous, with *external regulation* as one extreme and *integrated regulation* at the other end. The process of shifting an activity towards being autonomously undertaken, STD refer to as internalization. The figure below has been formed on the basis of the theory and figure presented by Gagné and Deci (2005, p. 336)

![Figure 1: The motivational spectrum](https://community.lithium.com/t5/Science-of-Social-blog/Intrinsic-vs-Extrinsic-Rewards-and-Their-Differences-from/ba-p/128969 [last accessed 04.06.16])

14 https://community.lithium.com/t5/Science-of-Social-blog/Intrinsic-vs-Extrinsic-Rewards-and-Their-Differences-from/ba-p/128969 [last accessed 04.06.16]
Working only because the boss is watching would be an externally regulated behavior.

The second category of regulation is introjected regulation. Introjected regulation, is a regulation that has been taken in by a person, but has not been accepted as his or her own (Gagné and Deci, 2005, p. 334). Undertaking an activity to gain status, even though you may not like the activity itself, would be a case of introjected regulation of behavior.

In the case of identified regulation “people feel greater freedom and volition because the behavior is more congruent with their personal goals and identities” (Gagné and Deci, 2005, p. 334). Here, the persons would engage in an activity because it somehow aligns with their own goals. A student reading on a boring subject because he recognizes the importance of good grades would be example of this.

Finally, the most internal form of extrinsic motivation is integration. “With integrated regulation, people have a full sense that the behavior is an integral part of who they are, that it emanates from their sense of self and is thus self-determined” (Gagné and Deci, 2005, p. 335). An activity with an integrated motivation is still not done because the activity itself is interesting, but it is done because there is a strong coherence between the behavior and our goals and values. A person wanting to work out because he really wants to get fit or stay healthy, can be said to have an integrated extrinsic motivation to do so.

**How our basic underlying needs impact our motivation**

A the heart of SDT is the suggestion of that the extent to which our universal, innate and psychological needs for *autonomy, competence and relatedness* is supported or thwarted by an event or activity, will affect our motivation (Deci and Ryan, 2008, p. 182).

*Autonomy*, as previously stated, concerns how we perceive the outcome of an event to be in our control. Ryan et al. (2006) state that game designs may differ in the autonomy provided within the game itself, the flexibility and choices the application offers can be assumed to be influential on the perceived autonomy. More specifically, the flexibility in choices of tasks, sequences of actions and goals that can be undertaken is assumed to be influential to users’ perceived autonomy (Ryan et al., 2006).
Designing for introjectedly regulated behavior in the context of OAsearch could be done by implementing elements that supports gain of status, such as leaderboards and the ability of showing off earned trophies and badges. OAsearch may also provide identified regulation, as it enables researchers to spread their publications. Adding a publication is likely not perceived as intrinsically interesting to a researcher, but as spreading his work is of personal interest, the activity might coincide with identified regulation.

The suggestion of that we have innate needs for feelings of Competence, means that socio-contextual factors that would promote such feelings of competence will positively affect our intrinsic motivation (Gagné and Deci, 2005, p. 338). For example, a feedback stating that you successfully added a publication which met the criteria, is likely to enhance the users’ feelings of competence, and thus also their intrinsic motivation. By implementing various game elements (e.g. points, badges, levels), OAsearch can potentially facilitate feelings of improvement, success and progression and thus enhance users’ perceived competence.

The innate need for relatedness refers to our need for being connected with others and to be effective in the social world (Gagné and Deci, 2005, p. 337), and is an interesting psychological need in the context of OAsearch. As OAsearch is a crowdsourced application where users collaborate and contribute for the common good, the system possesses a potential for supporting users’ need for relatedness. Hopefully, the application will provide a way of nurturing this need by facilitating social interactions, collaboration and a sense of helping others.

### 2.2.4 Findings from STD which can be utilized

Within the context of SDT, there has been done a lot of research investigating the effects extrinsic motivators have on intrinsic motivation. According to Gagné and Deci (2005), in the earlier stages of the model on intrinsic and extrinsic motivation, it was thought that intrinsic and extrinsic motivation are additive. This means that the total motivation is the sum of both types of motivation. A later study examining the effects of external rewards on intrinsic motivation conducted by Deci (1971, p. 105) state that “The results indicate that when money was used as an external reward, intrinsic motivation tended to decrease”. This implied that motivation is in fact not additive, as it proved that extrinsic rewards will in
some cases undermine intrinsic motivation. Thus, it can be said that extrinsic and intrinsic motivators are interactive rather than purely additive (Gagné and Deci, 2005).

This interactivity relates to Motivation Crowding Theory which suggests that external incentives (e.g., awards) may undermine intrinsic motivation (Frey and Jegen, 2001). Motivation crowding theory refers to this effect as the *crowding-out effect* or *crowd-out problem* (Frey and Jegen, 2001, Werbach and Hunter, 2012). A meta-analysis of 128 laboratory experiments by Deci et al. (1999) examined the effects extrinsic rewards were found to have on intrinsic motivation, and used measures of free-choice and self-reported interest when determining such effects.

The meta-analysis examines what effect extrinsic rewards have when they are tangible/verbal, expected/unexpected and when they have various forms of contingencies. As stated in section 2.2.3, in the context of gamification, we perceive game elements such as points and badges to be tangible, and thus are the results of this study applicable. The figure below outlines the hierarchical structure these attributes have as they were tested and presented in the meta-analysis by Deci et al. (1999).

Figure 2: Structure of extrinsic rewards examined in meta-analysis
Effect of verbal rewards on intrinsic motivation

Verbal rewards, or positive feedback as it may also be referred as, most often contains explicit positive performance feedback (Deci et al., 2001). The meta-analysis showed that verbal rewards did tend to enhance intrinsic motivation (Deci et al., 1999).

However, Deci et al. (2001) state that studies in the meta-analysis showed that if the verbal rewards were administered in a controlling interpersonal style, it can in fact have a negative effect on intrinsic motivation. Such a controlling interpersonal style could be that the system of OAsearch displays a feedback message upon completing the process of adding a publication, but the message is perceived to be controlling and given only to further promote such actions. It can also be hypothesized that an online community of OAsearch giving users feedback may be perceived as instructional in a controlling rather than an informative interpersonal style, and may thus undermine intrinsic motivation. In contrast, verbal feedback given in an informative interpersonal style, meaning that it is not perceived as controlling, was proved to enhance intrinsic motivation (Deci et al., 2001). STD explains this, as the controlling interpersonal style undermines the perceived autonomy of the students and thus also the intrinsic motivation.

Effect of tangible rewards on intrinsic motivation

The meta-analysis by Deci et al. (1999) showed that on average, tangible extrinsic rewards significantly decrease intrinsic motivation regardless of being administered with contingencies on task engagement, completion or performance (Deci et al., 1999), with the exception of unexpected tangible rewards. Such rewards are rewards that are are given subsequent of an activity, and which are unexpected by the person conducting the activity at the time it is given. Such an unexpected reward in the context of OAsearch may be a badge or points given at random when logging in, or unexpected to the user when adding a publication.

Effects on intrinsic motivation when target task is dull

The primary meta-analysis of the Deci et al. (1999) publication included only studies where activities which were to be undertaken were initially interesting to the participants. To examine the effect of extrinsic rewards on intrinsic motivation when the target activity was initially deemed dull, a supplemental analysis was conducted.
Deci et al. (2001, p. 14) summarizes this analysis: “In summary, it is clear that rewards do not undermine people’s intrinsic motivation for dull tasks because there is little or no intrinsic motivation to be undermined.” Deci et al. (1999) also state that rewards do not enhance intrinsic motivation for dull tasks either. It is hypothesized that in cases of dull tasks it is more relevant to enable people to understand the importance such activities may have for themselves, and thus facilitate internalization and self-motivation of the task, rather than to try to do so by using extrinsic rewards (Deci et al., 2001).

2.2.5 Player types

The more you know about the players which are to interact with your gamified application, the easier it is to design such an application in a way that drives users to behave in a desired way (Zichermann and Cunningham, 2011). Richard Bartle is one of the most referenced authors in literature involving player types (Hamari and Tuunanen, 2014).

Based on an analysis of a heated long-going online bulletin-board discussion concerning what people wanted out of a game, Bartle classified player types on a two-dimensional scale based on the source of the players’ interest in a game (Bartle, 1996). Bartle identified four archetypical player types at the outer corners of the scale: Achievers, Explorers, Socializers and Killers. Later literature state that player’s intentions and behavior may change depending on context, and that where a player is best identified on Bartle’s scale may with time and context. Zichermann and Cunningham (2011) state that these categories are mutually inclusive, meaning that a player can identify himself in various extent with even all of these archetypes at once. The scale Bartle used to present player types (Bartle, 1996), has been reproduced below:
Achievers

Kapp (2012) describe achievers as the archetype of players striving to achieve within the context of the game. They seek status through being at the top of the leaderboard and vigorously strives to accomplish the goals of the game. Their primary enjoyment is in the challenge of the game, and their primary goals are gathering points, ranking up and gaining awards. They engage only in activities if they fit their purpose of achieving their goals.

Explorers

Players located in the outmost extreme corner of the Explorer category on Bartle’s scale, are players that seeks to find out and explore all aspects and possibilities within the gamified context, also the unintentional bugs (Kapp, 2012). They find enjoyment of discovering and sharing possibilities of the game that others do not know of. They may behave as other player types, as achievements, socialization and disruption are necessary to explore the full width of the game.

Socializers

The stereotypical socializer is a player that is primarily interested socializing, and the game is merely an environment which enables a socializer to do so. These players enjoy organizing other players, communicating and building social networks within the context of the game. They may undertake activities typical of explorers or achievers, but this is primarily done with a motive of socializing further (Kapp, 2012).
**Killers**

Killers are similar to achievers in their desire to win, but they seek to be the top player not to win, but to beat others (Zichermann and Cunningham, 2011). They want to destroy other players, and for them to admire and respect them. They find enjoyment in imposing themselves through their ideas, opinions and will.

**Amy Jo King’s social action matrix**

As previously mentioned, the player types Bartle identifies were based on a 1989 bulletin board discussion on a particular game (Bartle, 1996). Inspired by Bartle’s player types, adjunct Game Design professor Amy Jo King identifies four key patterns of social actions players undertake. Though King’s work was not found to be applied in academia, they seem to resonate more with the context of OAsearch, as they are based on her more updated experiences and work with more casual games than that of Bartle’s. She proposes to classify player types according to the actions they tend to undertake: Explore, Collaborate, Compete and Create.

Bartle’s player types of explorer roughly aligns with King’s actions of explore. King’s collaborators are attributed somewhat different underlying motivations than Bartle’s socializers. She states that collaborators “are motivated by working with others towards a greater goal [...] and measure success as collective impact”15. “They value teamwork, [...] and relationship-building via shared tasks”15. This is somewhat unaligned with Bartle’s comparable player type of socializers which seemingly only undertake tasks with an underlying social motive.

Bartle’s killers and achievers can be said to be distinguishable by their orientation of competition. While achievers simply enjoy success and winning, killers enjoy beating others and have more negative orientation of competition. King does not make such a distinction, and both achievers and killers are arguably classified as competitors in King’s social action matrix.

King identifies a player type that Bartle has not described in his matrix, namely creators. Such players are mainly motivated by features enabling self expression, making a mark and

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15 http://amyjokim.com/blog/2014/02/28/beyond-player-types-kims-social-action-matrix/ [last accessed 10.06.16]
“value original thought, creativity, hard work, and personal style. They seek status, recognition and influence through creative skill.”

2.2.6 Game elements

Hunicke et al. (2004) proposed what was called the MDA framework in order to provide a formal approach to understanding games, and to “clarify and strengthen the iterative processes of developers, scholars and researchers alike, making it easier for all parties to decompose, study and design a broad class of game designs and game artifacts.” The framework categorizes game elements into Mechanics, Dynamics, and Aesthetics from least to most abstract. Werbach and Hunter (2012) uses similar categories in their approach to classifying game elements of gamification: dynamics, mechanics and components, but the qualities attributed to these categories is somewhat different.

Werbach and Hunter (2012) states that putting game elements together is the central task of gamification design, and that the gamified application will suffer unless the designer has knowledge of the possibilities that the numerous elements offer. I will use the categories Werbach and Hunter (2012) applies, as they are coined in a perspective of designing gamified systems, in contrast to the categories proposed by Hunicke et al. (2004) which has a wider scope of uses in mind. The categories will be presented in a top-down manner, from abstract dynamics to concrete components.

Dynamics

Werbach and Hunter (2012) describes the dynamic game elements as the big picture aspects of the gamified application. These dynamics can be managed and designed, but when it
comes down to implementation it is done using more concrete elements such as game mechanics and components. Werbach and Hunter (2012) specifies five dynamic game elements they consider to be the most central: Constraints, Emotions, Narrative, Progression and Relationships.

Constraints are similar in nature to game rules. By limiting the users’ freedom through constraints, the designer can pose interesting problems and meaningful choices to the users (Werbach and Hunter, 2012). In the context of OAsearch, such a constraint is that only peer-reviewed publications may be entered into the application. This constraint could be enforced by users peer-reviewing the publications added by other users.

A gamified application can be designed to trigger various emotions. To trigger emotions such as those of cooperation, satisfaction, accomplishment and helpfulness are relevant in the context of OAsearch which can be a system where the crowdsourced tasks are done for the common good.

The narrative elements of gamification are referring to the consistent, ongoing storyline of the application (Werbach and Hunter, 2012). Such elements may also be implicit, which is arguably the most relevant form of such elements in the context of OAsearch. The elements that create a sense of end motive and goal of using the application, and which ties the activities that can be undertaken together are narrative elements. One could apply explicit storylines, for instance, by telling a story of scientist spreading knowledge, and using visual elements which further portrays this. More implicit concepts can also serve as narrative dynamics, such as expressing sharing of knowledge as the purpose and objective of the application though angling the activities as contributions to this purpose.

Dynamics which promotes users’ feeling of development and progression throughout using the application, are referred to as progressive elements by Werbach and Hunter (2012). These elements avoid people from feeling that they are doing the same activities again and again. Using points and levels are components that typically are used to instantiate such dynamics, and are relevant also in the context of OAsearch.

Relationships is the final dynamic game element proposed by Werbach and Hunter (2012), and is referring to the social dynamics of the gamified application. The dynamics of friends, teammates and opponents are instances of such game elements. Game elements such as friends lists, teams and competitions are enhancers of such dynamics.
Mechanics

Werbach and Hunter (2012) describes mechanics as the game elements that provides player engagement and drives the action forward. They further identifies 10 such game mechanics: Challenges, Chance, Competition, Cooperation, Feedback, Resource Acquisition, Rewards, Transaction and Turns. Werbach and Hunter (2012) states that such mechanics are ways of achieving the desired dynamics that were described in the previous section. For example, awarding a first time user of OAsearch a badge for creating a user, which would include game mechanics of chance (as it is unexpected by the user), rewards and feedback, can be seen as way of nurturing an emotional dynamic of curiosity.

“By matching Bartle’s user motivational state to game dynamics, we can develop experiences that target specific player behavior, resulting in greater engagement“ (Zichermann and Cunningham, 2011). Bartle’s game dynamics, as described in the previous section, does arguably resemble what Werbach and Hunter (2012) describe as gamification mechanics. The mechanics identified by Werbach and Hunter (2012) are quite self-explanatory by their name, but I will exemplify some of the mechanics I find to be relevant in the context of OAsearch bellow:

Challenges are tasks what require effort to solve (Werbach and Hunter, 2012). A challenge in OAsearch could be to add 5 publications that are all accepted into the database, or to verify 3 publications that other users have added.

Chance are mechanics that involve elements of randomness. I have previously exemplified instances of such mechanics as points given by chance when a user logs in or when he adds a publication to the system, in the paragraph on unexpected rewards in section 2.2.4 Findings from STD which can be utilized.

As OAsearch is a crowdsourced application, the system is arguably dependent on cooperation, and this is thus a central element. Allowing users to correct and enhance the quality of the metadata in the publications other users add, and verifying that the publications other users add are not already in the system and that they are meeting the inclusion requirements are some of the cooperative elements of OAsearch.

Feedback mechanics are elements that give the users information on how they are doing, namely their performance or their progression. Progress bars that displays users’ points and
progress towards the next level, or textual feedback stating whether a publication has been accepted into the system or not, are examples of feedback mechanics in the context of OAsearch.

**Components**

Werbach and Hunter (2012) describes *components* as instantiations of the higher level mechanics or dynamics, and are the basic processes that are the most concrete gamification elements (Werbach and Hunter, 2012). *Levels* is such a component, which can be said to instantiate the mechanics of *feedback* and *rewards*, which further offers the dynamics of *progression*. Werbach and Hunter (2012) identifies 15 such components: Achievements, Avatars, Badges, Boss Fights, Collection, Combat, Content Unlocking, Gifting, Leaderboards, Levels, Points, Quests, Social Graphs, Teams and Virtual Goods.

Giving users *badges* for completing a given challenge such as registering 5 publications is an example of an implementation of a component. Giving users more privileges such as allowing users to remove or downvote versions of publications would be an implementation of the game component *content unlocking*.

### 2.2.7 Design framework for gamified applications

As outlined throughout the sections found in this subchapter on gamification, successfully increasing player motivation is not done by simply applying random game elements. Kapp (2012, p. xxii) state that when designing a gamified system the designers should consider the engaging elements of why people play, and state that such elements are “the sense of engagement, immediate feedback, feeling of accomplishment, and success of striving against a challenge and overcoming it”.

Werbach and Hunter (2012) provides a design framework for gamified applications which consists of six steps, each of which starts with a *D*: Define business objectives, Delineate target behaviors, Describe your players, Devise activity cycles, Don’t forget the fun and Deploy the appropriate tools. This is the framework that has been used to incorporate the theory that has been explored throughout this subchapter.
Define business objectives

This step is meant to produce a list of the business objectives that one wishes to achieve from gamifying the application. This process is performed by first listing all possible goals of the gamification as precisely as possible, then remove the goals that are means rather than end goals and then prioritizing the resulting list. A final check on that the objectives on the list is appropriate can be done by ensuring that one would be satisfied with the gamification process if only a single goal out of all the goals would be successful. Werbach and Hunter (2012, Figure 5.1) presents a figure for visualizing this step, which has been reproduced below:

Figure 5: The objective definition process

Delineate target behaviors

This step is meant to produce a list of specific and concrete target behaviors you want users to do (e.g. register an account). These behaviors should promote the business objectives defined in the previous step, directly or indirectly.

Next after producing the list of target behaviors, one should also produce a list of metrics to measure these behaviors. How many points should a target behavior yield? The designer does not necessarily have to implement a scoring system, further not display such points to users, but they are a decent way of measuring and analyzing user behaviors. If game elements such as badges or winners are implemented, the triggers of these also has to be defined (e.g. a set of points required for awarding a badge).

Describe your players

The first step of this process is to produce a list of what might motivate and demotivate users. Next, Werbach and Hunter (2012) proposes segmenting these motivations into groups based on their relevance for various player types. Player types commonly found in games were identified in section 2.2.5, and will be applied in this step. Next, it is proposed that each player type is given an avatar and a story which resonates with plausible users of the system. This is meant to enhance the designer’s ability to visualize how different player
types will perceive and react to the game elements he is considering to implement. One should also consider the dimension of the player lifecycle of using the gamified application. The application should be interesting for both novices and experts, and elements giving both groups and those between a motivating experience is crucial.

**Devise activity cycles**

“Games always have a beginning and sometimes have an end, but along the way they operate through a series of loops and branching trees” (Werbach and Hunter, 2012). Activity cycles is a concept suited for modeling user actions, and is the method Werbach and Hunter (2012) applies. Werbach and Hunter (2012) present two types of activity cycles: Engagement Loops and Progression Stairs.

In Engagement Loops there are three elements, namely *motivation, action* and *feedback*. Engagement loops cycles as a user is motivated by some feedback that is given in response to an action. As the user receives feedback, he feels motivated and takes on an action, and so the cycle loops. Engagement loops should describe what players do, why they do it and what the system does in response.

*Progression Stairs* are the activity cycles which gives the players a sense of progression. By defining progressions stairs which give players increasingly difficult challenges and demands more effort in return for rewards and leveling up as the players progress, the experience of interacting with the application stays interesting.

**Don’t forget the fun**

This process is meant to ensure that the designer has not been to caught up in technicalities and details, and has lost focus on what gamification is actually meant to do. If the activities that the users are to undertake are in fact *not* fun, the rest of the application is rendered somewhat pointless. Werbach and Hunter (2012) state that one should ensure that the system offers activities that suits players looking for hardcore challenges, casual activates, socializing and all in-between.
Deploy the appropriate tools

The deployment phase is where all the work of defining, describing, delineating and devising comes together. By engaging in all these processes the designer should have a clearer picture of the purpose of the gamification, the players and a skeleton of the activities that is to be implemented. As designing a gamified application is process of uncertainty, doing testing, working iteratively and learning along the way is necessary.

2.3 Interaction design

Interaction Design is concerned with “interactive products to support the way people communicate and interact in their everyday and working lives” (Sharp et al., 2011, p. 9). Interaction design is commonly recognized as the umbrella term of interface design, software design, user-centered design, product design, web design, experience design, and interactive system design (Sharp et al., 2011). Sharp et al. (2011) view the scope of interaction design as even wider than that of Human Computer Interaction, as it is fundamental to all disciplines, fields, and approaches that are concerned with researching and designing computer-based systems for people.

The application developed as a part of this thesis has been design with the approach of interaction design and its commonly accompanying elements. An overview of the most central aspects and processes of interaction design will be presented in the next subsections.

2.3.1 The process of interaction design

In essence, interaction design is done by identifying users’ needs and the context of their activities, and further apply the gained knowledge for designing interactive products that users find to be easy, effective and pleasurable to use (Sharp et al., 2011). This process involves four basic activities: establishing requirements, designing alternatives, prototyping and evaluating.

A user centered design approach is commonly applied in the process of interaction design (Sharp et al., 2011). User centered design is defined by Mao et al. (2005, p. 105) as “a multidisciplinary design approach based on the active involvement of users to improve the understanding of user and task requirements, and the iteration of design and evaluation”.

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Sharp et al. (2011) identifies three principles that form the foundation for user centered design, namely *Early focus on user and tasks, empirical measurement* and *iterative design*.

The first principle constitutes the notion of users and their tasks and goals being the driving force of the development. The context of the users, their preferences, abilities and other characteristics are taken into consideration. Users are involved from the beginning to the end of the development. Following the principle of *empirical measurement*, a designer must clearly state usability and user experience goals, document them and measure them during the design process. Such goals will be further explained in the next subsection. The principle of *iterative design* means to allow designs to be refined based on feedback gathered at different stages of the development.

### 2.3.2 User experience and usability

As previously defined, the goal of interaction design is to design interactive products that users find to be easy, effective, and pleasurable to use. When designing for these main goals, Sharp et al. (2011) suggest classifying the more concrete objectives of the desired product into *experience goals* and *usability goals*.

Usability concerns the users’ ability to carry out a task successfully when using the product (Albert and Tullis, 2013), and can be measured by usability goals such as effectiveness, learnability and memorability (Sharp et al., 2011). User experience is a concept reaching wider as it concerns the overall experience the users has when using the product, including thoughts, feelings and perceptions that results from interacting with the product (Albert and Tullis, 2013). These concepts are somewhat overlapping, as providing usability is a necessity for providing a desirable user experience. Conversely, aspects of the user experience, such as how it feels and looks, will affect the usability of a product (Sharp et al., 2011).

**Usability goals**

The purpose of defining usability goals is to provide the designer with measurable attributes of the design when assessing various aspects of the designed product, such as the user experience. Sharp et al. (2011) suggest breaking usability down to 6 such measurable goals: effectiveness, efficiency, safety, utility, learnability and memorability. When measuring
these usability goals, couching them into them into more concrete questions can be useful. For instance, utility can be stated as the question: *Does the system provide the users with an appropriate set of tools and functionalities that the enable users to complete the activities in a desirable way?*

Sharp et al. (2011) explains *Effectiveness* as the concerns on whether or not the designed product is good in what is is supposed to do in general. *Efficiency* is referring to the products ability to enable and support the users in the tasks they are to undertake. A possible operationalization is to ask if the product increase the productivity of the users? *Safety* involves considerations on whether users might unintentionally conduct any kind of harmful actions when interacting with the product. The extent to which the product provides appropriate tools and functionalities, is, as previously mentioned, a concern of utility. *Learnability* is the extent to which the product is easy to learn how to use. Lastly, *Memorability* concerns how easy it is to recall how to use the system once it has been learned initially (Sharp et al., 2011).

These goals and questions can be further operationalized into quantifiably and measurable usability criteria. For instance, *Efficiency* can be operationalized into *time used to complete a task*. Such usability criteria can be used to quantifiably assess the performance on a usability goal, which can provide the designer with input on potential improvements and successes of specific aspects of the design (Sharp et al., 2011).

**User experience goals**

While usability criteria can be used to measure specific aspects of the product, user experience goals are used to measure the overall quality of the user experience (Sharp et al., 2011). User experience goals are commonly articulated as desirable emotions and felt experiences, such as *fun, helpful, motivating* and *entertaining*. Undesirable aspects of the user experience, such as *boring or frustrating*, are also important aspects to consider and capture when evaluating a design.

As previously stated, usability goals can be articulated as quantifiably measurable user criteria, and can therefore to a fuller extent be measured objectively by a researcher. In contrast, subjective emotions and felt experiences is what constitutes user experience, and is thus more likely to be subject to interpretive measuring by researchers.
As with usability goals, user experience goals are also more useful when transformed into questions (Sharp et al., 2011). When stating such questions, it can be useful to consider what elements contribute to the overall user experience the researcher is trying to measure. Elements of fun might be play, smiling, laughing, joy and excitement. Thus can the usability goal of fun be articulated as Does the user express feelings of fun by smiling, laughing, expressing joy, excitement or by any other forms of body language.

### 2.3.3 Usability testing

Lewis (2006) state that usability testing involves three key components: representative participants, representative tasks, and representative environments. The activities the participants undertake are monitored by one or more observers, and aim to assess usability as defined in section 2.3.2. Barnum (2010) further divides usability testing into formative testing and summative testing based on the points of the testing and at which point in the development cycle it is conducted.

*Formative testing* is testing done during development with the goal of diagnosing and fixing problems of an interface (Barnum, 2010). They can be applied as more informal tests early in the development, for instance when testing wireframes or other types of low-fidelity prototypes (Lazar et al., 2010). Such testing is often based on small studies and is normally repeated several times during development (Barnum, 2010). *Summative testing* is done after the completion of development, and is meant to verify that the application meets the established requirements, or to establish a baseline of metrics. For statistical validity of such testing, a larger number of participants is generally required (Barnum, 2010).

**User-based usability testing**

In the spirit of user centered design, user-based usability testing has been central in the development of OAsearch. Such user-based usability testing occurs when a group of representative users of an application undertaking a set of representative tasks in order to evaluate an interface (Lazar et al., 2010, p. 260). Despite investing time and effort in establishing requirements that match the needs of the users, designers can not be sure that their design actually match what the users actually want or need without testing prototypes with real users (Lazar et al., 2010, p. 260).
When measuring usability with a user-based evaluative approach, measurements can be both qualitative and quantitative. The most common quantitative measurements are *time performance* (how long it takes to complete a task), *task performance* (how many tasks were correctly completed) and *user satisfaction* (often measured by a standardized survey tool) (Lazar et al., 2010). More qualitative data, such as feelings and frustrations, can be gathered using for instance interviews or observation.

### 2.4 Methods

This sections presents a brief introduction to the empirical methods used to gather requirements and to perform a formative and summative evaluation.

#### 2.4.1 Researching similar products

Sharp et al. (2011) list *researching similar* products as a data gathering technique for establishing requirements. Although this is perhaps not a scientifically rigorous method, looking at the features and design of existing products is purposeful to form requirements and inspiration (Sharp et al., 2011, p. 386). This technique has been applied when establishing requirements for OAsearch.

#### 2.4.2 Interviews

“HCI researchers use interviews [...] to help build an understanding of the needs, practices, concerns, preferences, and attitudes of the people who might interact with a current or future computer system” (Lazar et al., 2010, p. 178). Interviews allows a researcher to investigate a subject in depth by asking a range of questions that stimulate the respondent to more freely reflect and discuss, and thus also capture valuable insights that are otherwise hard to obtain (Lazar et al., 2010).

Interviews can be a vital tool for initial exploration and gathering requirements for the design of new applications (Lazar et al., 2010). Lazar et al. (2010) mentions a hypothetical situation of a researcher having a hunch that the current tools offered are insufficient, and the researchers wishes to gather information on the use of current applications and what users actually desire. The possibility of doing *opportunistic interviewing*, that is to follow
up on topics the research subject brings up, is another beneficial aspect of doing interviews (Lazar et al., 2010).

Interviews can take form as structured, semi-structured or unstructured. Structured interviews are interviews where the researcher ask predetermined questions in a predetermined order, and allows minimal or no deviation from this plan (Crang and Cook, 2007). A questionnaire may be carried out as such a structured interview. Unstructured interviews are open-ended and are carried out more like a conversation around a particular topic (Sharp et al., 2011). Such interviews are exploratory in the sense that the researcher has no particular expectations in format or content of the answers, and that they allow for the interviewee to steer the direction of the topics discussed (Sharp et al., 2011). “Semi-structured interviews are interviews where the researcher has set some broad parameters on a discussion” (Crang and Cook, 2007, p. 60). Such interviews use both open ended and closed questions, and the interviewer has a basic preplan for the unfolding of the interview (Sharp et al., 2011).

A domain expert has been interviewed as part of the process of establishing requirements, and users have been interviewed as part of a summative evaluation of OAsearch.

2.4.3 Heuristic evaluations

“Heuristic evaluation is a usability engineering method for finding the usability problems in a user interface design so that they can be attended to as part of an iterative design process” (Nielsen, 1995). In an expert based heuristic evaluation, a small group of experts assesses the interface in question by comparing a set of heuristics (higher level design principles) to the interface (Lazar et al., 2010, p. 257).

Two such heuristics are visibility of system status (the system should keep the users informed about what is going on through feedback), and aesthetic and minimalist design (the system should not display information that is irrelevant or rarely needed). Jakob Nielsen has coined 10 such heuristics: visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalistic design.
Sharp et al. (2011, p. 508) state that for a quick evaluation of an early design, one or two experts can probably identify most of the potential flaws of the usability, but for more comprehensive evaluation of a fully working prototype, more evaluators are needed. Nielsen (1995) state that to improve effectiveness of the method, multiple evaluators should be used as different evaluators will find different problems. He further states that 3-5 evaluators are normally a good number as they will find most issues.

Heuristic evaluations are conducted by instructing the evaluators to firstly conduct the evaluation on their own, perhaps with an observer. “Only after all evaluations have been completed are the evaluators allowed to communicate and have their findings aggregated. This procedure is important in order to ensure independent and unbiased evaluations from each evaluator” (Nielsen, 1995).

A heuristic evaluation has been conducted as a formative evaluation of OAsearch.

### 2.4.4 Observations – thinking aloud

Observation is a data gathering technique applicable for both gathering requirements, as well as evaluating whether a prototype meat the established requirements (Sharp et al., 2011, p. 247). One such observational technique is the thinking aloud protocol, which is one of the most popular techniques for testing within HCI practice (Nielsen et al., 2002, p. 101). The thinking aloud protocol is conducted by allowing users to vocally express their thoughts while interacting with the interface so that their thought processes are externalized (Sharp et al., 2011, p. 256).

Nielsen et al. (2002, p. 102) points to various previous literature stating that this technique is purposeful for getting users’ inferences, intuitions, reasons and decisions while doing the tasks, and to detect users’ cognitive activities while interacting with a interface that otherwise would not have been captured.

Sharp et al. (2011, p. 258) states that one of the biggest problems when using this technique, is the occurrences of silent periods. The user may have several reasons for muting, such as simply forgetting to do the thinking aloud, because of being highly concentrated, or because of feeling embarrassed over the current thoughts. Reminding or urging the user to think aloud may be intrusive, or break a current line of thought which may effect the process being evaluated (Sharp et al., 2011, p. 258).
Thinking aloud has been used in a summative evaluation of OAsearch.

2.4.5 Questionnaires

“Questionnaires are a well-established technique for collecting demographic data and users’ opinions” (Sharp et al., 2011, p. 238). In addition to being efficient at gathering data from a larger sample, questionnaires are suitable for getting answers to specific questions and for corroborating findings obtained through other methods.

As questionnaires are answered without a moderator to explain or clarify, ensuring precise and well thought through questions and suitable response formats is of the essence. Questions can take several forms, such as open text fields, multiple choice or Likert scales. “Likert scales are used for measuring opinions, attitudes, and beliefs, and consequently they are widely used for evaluating user satisfactions with products” (Sharp et al., 2011, p. 241). On Likert scales, users are often presented with a statement, and asked to place their opinion on a scale ranging from strongly disagree to strongly agree, using either words or numbers. Sharp et al. (2011, p. 241) suggests using a five-point scale when asking participants to agree or disagree with statements.

Questionnaires has been used in a summative evaluation of OAsearch.

2.5 Architectural software patterns

Software architecture concerns the fundamental structural organization of software systems. Applying architectural patterns is useful when developing software (Leff and Rayfield, 2001, p. 118), as they offer well-established solutions to common architectural problems (Avgeriou and Zdun, 2005, p. 1). The Model-View-Controller pattern is such an architectural pattern, and has been applied in the development of OAsearch. The next section offers a high-level description of this pattern, and the benefits of applying it.

2.5.1 Model-View-Controller Pattern

The Model-View-Controller (MVC) pattern, or some variant or derivation of it, is frequently used in web applications, and has been applied in on the client side of OAsearch. The pattern was first described by Trygve Reenskaug while he acted as a visiting scientist
in the research center Xerox PARC in 1979\textsuperscript{16}, and “the key idea is to separate user interfaces from the underlying data represented by the user interface” (Leff and Rayfield, 2001, p. 118).

This pattern is useful for separating logical units and concerns when developing applications. As the name suggests, it divides an application into three distinct modular parts, namely Model, View and Controller, which each has its own responsibility. Put simply, a model contains the application data and the logic that manipulates data. A view manages the visual display of a model, and a controller interprets user inputs and prompts the model to change appropriately (Avgeriou and Zdun, 2005, p. 23). By applying such an separation of concerns, the code is more maintainable, modular and reusable (Seshadri and Green, 2014, p. 2).

\textsuperscript{16} \url{http://heim.ifi.uio.no/~trygver/themes/mvc/mvc-index.html} [last accessed 19.07.16]
Chapter 3 - *Design*

3 Design

This chapter concerns the entire design process from gathering requirements, to describing the finished design and the technical implementation. As previously stated, the evaluations that have been conducted are presented separately in chapter 4.

Section 3.1 presents the process of establishing requirements, and the second section concerns how the core features implemented intend to cater for these. Section 3.3 presents the implementation of gamification, and specifies how users will interact with the core features. While section 3.4 presents early prototypes in the form of wireframes, section 3.5 describes the actual design through screenshots with associated descriptions. Finally, section 3.6 describes the technical implementation of OAsearch.

3.1 Gathering and establishing requirements

Two methods were utilized when requirements for OAsearch were to be formed, namely an expert interview and a research of similar products which currently exists. The data that these methods yielded will be presented in their respective subsections below, and a review of the current services will act as a summary of the findings of these methods.

3.1.1 Expert Interview

An interview was conducted with a researcher with a strong technical background, with experience in the processes of publishing academic papers, with a special interest in Open Access and with a solid understanding of the current services in this thesis’ domain. The interview was conducted as an initial exploration of the domain area and the current services, to gain an understanding of how the current services are used, what works well in them and what does not. This understanding was further utilized to form requirements for OAsearch.

The interview was conducted as a semi-structured interview, with a set of broad topics formulated as open-ended questions. The opinions, experiences and thoughts that the expert expressed was quite determinative on what was the main topics of discussion, thus the interview had characteristics of being conducted as an opportunistic interview. The full write-up of the interview can be found in *Appendix 2: Expert interview – Write up.*
Chapter 3 - Design

The interview

- The services the interviewee most uses for finding academic publications, and how they are used:

The interviewee identifies three different use cases in relation to searching for publications: firstly, when he knows the title and author of a specific publication, and simply wishes to access it. In these instances, he often finds himself doing a regular google search as “this is an excellent service when searching for title combined with the primary author”.

A second use case that he identifies is when he is looking for non-academic texts such as can be found on blogs, news articles or technical manuals. As Google Scholar intends to only include peer-reviewed publications, it is not fitting for this purpose and the regular Google is used instead.

The last use case the interviewee expresses is when he is interested in a wider scope of publications and inputs key words related to a field of interest or a new phenomenon, rather than specific titles and authors. He states that for this use, he primarily uses Google Scholar, as the regular Google search engine yields to much irrelevant and low quality results.

- Experiences regarding making his own research findable

The critiques the interviewee has on the service is primarily as a researcher interested in making his own publications findable through the service, “primarily because they seem to ignore metadata unless they have an arrangement with the provider”.

The interviewee state that he thinks the inclusion guidelines Google Scholar has published are ignored, unless the repository in question has an agreement with them. He states to have meticulously followed the guidelines Scholar provides as he published his own research in his own repository, but that the metadata he provided was still ignored by Google Scholar. Instead, the interviewee finds that the metadata Scholar uses is clearly generated by scraping the PDF’s and that as a result the metadata “are often erroneous and incomplete”.

- Have you encountered any issues when trying to access publications?

When questioned on whether he has encountered any issues or problems when accessing publications, he says “no, not lately”. He further states that he will almost always find a publication either through legitimate sources, such as green or gold OA repositories, or through more illegitimate sources, such as compendiums violating the copyright.
The interviewee adds that based on his own experiences, he sees that clearly not everyone is able to find the publications they are looking for, even though they are published online. He exemplifies this with the fact that he has some publications made available on OA repositories and are included in Google Scholar, but he still gets requests from users of a service called academia.edu to publish them.

- **Other services than google scholar, and how they are used**

When questioned on experiences on other services than those of Google, the interviewee highlights a service called arxiv.org. This is a green OA repository which allows users to upload their own publications. Unfortunately, the service suffers from insufficient quality control. They have a staff of moderators doing their best to keep out spam, and are “by all means doing an admirable job, but they are likely too few”. This results in that “there is too much content that should not be findable through an academic search engine”.

The interview subject state that he uses other services for self promotion, making his publications findable and socializing in an academic context as well. He mentions Academia.edu and Mendley.com, and state that such services is good for these purposes, but not for finding specific publications as the search interfaces are lacking. The interviewee state that “Academia is Facebook for academics”, as they provide features such as friend lists, they can send you an email when a friend publishes something and you can “like” content of your choice. They also discover publications you may have published, but not linked to your profile, and ask you to verify that you are the author of the suggested publications.

### 3.1.2 Researching similar products

Sharp et al. (2011) proposes the technique of researching similar products in order to gather requirements by looking at what features and interactions similar products offer, and for inspiration when generating a design. The purpose of applying this method was also to identify points of improvement.

There are several green OA repositories, search engines and products offering functionalities that are relevant for OAsearch. A few of these has been selected for a closer examination based on popularity, and on their distinctive features which could be relevant to OAsearch. The expressed frustrations and apparent shortcomings the interview subject
stated to have encountered when using these, has been further investigated as a part of this process. A short description of the most relevant services investigated will be presented in the coming paragraphs.

**Academia.edu**

“*Academics use Academia.edu to share their research, monitor deep analytics around the impact of their research, and track the research of academics they follow*”\(^1^7\). This website allows researchers to upload or post links to their research, connect with fellow researchers, and add interest fields amongst other. The site’s search feature does not allow users to search for specific papers, but rather people, research interests and universities.

The service’s primarily focus seems to be on connecting users with their selected research interest and researchers, which facilitates more random publication discoveries based on interests rather than the search for specific publications. Seemingly, the service has implemented several mechanics which would resonate with the player type of *explorers* which is relevant also in the context of OAsearch. The service separates from OAsearch by the fact that it only allows users to upload their own research.

**Researchgate.net**

ResearchGate is similar to academia.edu in that it can be said to be an academic network, as it allows users to “*Connect and collaborate with colleagues, peers, co-authors, and specialists*”\(^1^8\). The service also allows users to share and publish their works, get stats and “*find out who's been reading and citing your work*”\(^1^8\). The service asks users to input research affiliations, interest fields, skills and connect with other researchers. The service has two additional main features, namely *questions* and *jobs*. *Jobs* is in essence a service where the users are given suggestions of jobs based on the information in their user profiles. *Questions* is a service which enables users to ask the community questions related to their research. Users are shown questions which the service think that they may be able to answer, based on the information in their user profiles.

\(^1^7\) [https://www.academia.edu/about](https://www.academia.edu/about) [last accessed 06.06.16]

\(^1^8\) [https://www.researchgate.net/about](https://www.researchgate.net/about) [last accessed 06.06.16]
Both academia.edu and ResearchGate does provides social functionalities as described, and especially ResearchGate which allows for discussions and helping others though their questions functionality. These are interesting features in the context of OAsearch, as they are likely to nurture users need for relatedness, which is likely to resonate with the player type of socializers.

**Arxiv.org**

Arxiv.org is a repository owned and operated by Cornell University, which provides “Open access to 1,133,670 e-prints in Physics, Mathematics, Computer Science, Quantitative Biology, Quantitative Finance and Statistics”\[^{19}\]. Registered users can upload their publications, and they will be findable through the website’s search functionality. This site does not provide archiving for other than these specific research fields, but is highly used by researchers within these fields.

OAsearch is dependent on users adding publications to the service. With more than 9700 new monthly submissions by the end of march 2016\[^{20}\], arxiv.org serves as a proof for the demand for such repositories, and for the presence of researchers motivation to promote findability of their publications.

**Openaccessbutton.org**

“The Open Access Button is an app that helps researchers, patients, students and the public get access to scholarly research and to report when they’re denied access”\[^{21}\]. The idea of this service is that when users encounters a pay wall when trying to access a publication, they can press a button and the application will try to find an available OA version by “effectively search on Google Scholar and CORE”, and then presenting the result to the user\[^{22}\]. The user is also asked to give a short description of with what purpose he wished to read the publication. This description, along with an inquiry for the researcher to publish in an OA format, will be attempted to be sent to the author of the publication.

\[^{19}\] [http://arxiv.org/](http://arxiv.org/) [last accessed 06.06.16]  
\[^{21}\] [https://www.openaccessbutton.org/about - landing](https://www.openaccessbutton.org/about - landing)  
\[^{22}\] [https://www.openaccessbutton.org/blog/launch-roundup](https://www.openaccessbutton.org/blog/launch-roundup) [last accessed 12.04.16]
descriptions the application gathers are also used to further advocate green OA through the website of openaccessbutton.org.

**Google Scholar**

When describing Google Scholar, Google states: “*From one place, you can search across many disciplines and sources: articles, theses, books, abstracts and court opinions, from academic publishers, professional societies, online repositories, universities and other web sites*”\(^{23}\), and can thus be described as a search engine. By reading Google Scholars inclusion guidelines, it becomes evident that they wish to only include scholarly articles. The indexed content is gathered by web-crawling robots, which decides what is likely to be of scholarly origin based on predefined algorithms\(^{24}\).

Metadata of publications is stated to be gathered by utilizing meta-tags that web-masters are asked to configure in the HTML sources of the pages where the publications are to be found. If no such tags are found, Scholar will instead scrape the PDFs to generate metadata\(^{25}\). However, the expert interviewed in section 3.1.1 stated that scholar apparently does not utilize such meta-tags unless the provider has an agreement with Scholar.

### 3.1.3 Summarizing review of current services

After conducting the expert interview and researching products in the same domain as OAsearch, I would argue there are several shortcomings in the current services.

**Inefficient quality control**

Arxiv.org is a green OA repository which allows users to upload their publications. However, there is apparently no quality assurance of the content that is added, other than a group of moderators doing their best to remove unwanted content. This site does not provide archiving for other than a few specific research fields, but it is highly used by researchers within these specific fields. The application developed as a part of this thesis

\(^{24}\) https://scholar.google.no/intl/no/scholar/inclusion.html - crawl [last accessed 12.04.16]  
\(^{25}\) https://scholar.google.no/intl/no/scholar/inclusion.html - indexing [last accessed 12.04.16]
Chapter 3 - Design

aims to solve the problem of the insufficient quality control by crowdsourcing this process, as well as the process of adding publications to the database. OAsearch will serve as a search engine for all research fields.

**Less than optimal inclusion process**

Google Scholar does not provide users with an option of self-archiving, and relies instead on web-crawlers to harvest publications. As the process of harvesting publications into the database is an automated process, Google relies on publications being published in a manner that makes them findable to their crawlers. The Criteria for being findable by Google’s crawlers are not documented anywhere in a manner that is consistent with the actual behavior of Google’s crawlers.

Because this is a completely automated process, those who fail to meet the criteria for inclusion are left out even though the scholarly content of the publications in question might be eligible for inclusion. Because OAsearch allows for manual adding of publications, those who are in possession of eligible scholarly content will be able to add their content to the service.

**Erroneous metadata**

The expert interviewed stated that he believes that even though Google Scholar guidelines for publishers request that metadata is made available in HTML-files, they do not utilize such data unless they have an agreement with the publisher. Instead, they scrape PDFs, and as a result there are misinterpretations. OAsearch will enable users to curate metadata by providing an interface for adding and modifying metadata. This is intended to facilitate higher quality data.

**Encountering toll-barriers**

In an article aiming to review Google Scholar, published in *The Journal of the Medical Library Association* in 2006, the author stated “most users will discover that clicking on a link in Google Scholar's search results may reveal only an abstract—not full text—accompanied by a pay-per-view option” (Vine, 2006, p. 98). Evidently, Google Scholar does not limit their indexing to OA records, which is another point which separates Google
Scholar and the application formed in this thesis. Thus, all the publications returned when searching in OAsearch are supposed to be barrier free, and readily accessible.

3.2 Description of core features

The application developed as part of this thesis is intended to resolve the shortcomings in existing products that were found and presented in the last section. This section presents the designs that has been implemented specifically to achieve this.

3.2.1 Quality assurance and inclusion process

All registered users will be able to add publications to the service, regardless of them being the author of the publication. In order to build a database of only peer-reviewed scholarly OA publications, several measures have been taken.

A set of about 900,000 scholarly peer-reviewed publications has been harvested using DOAJ’s API\(^2\) (allowed by DOAJ\(^7\)), which makes OAsearch somewhat useful even before any users have registered. “The Directory of Open Access Journals is a service that indexes high quality, peer reviewed Open Access research journals, periodicals and their articles’ metadata”. However, after doing some manual inspection of the gathered publications, it became apparent that there were a substantial portion of dubious publications included. To heighten the quality of the indexed collection, a script utilizing Jeffrey Beall’s list of predatory publishers\(^8\) was created. The list consists of more than 900 predatory publishers, and more than 7500 publications was removed from OAsearch’s database when the script checked for publications with a publisher on Beall’s list. The script can also be executed to simply flag such publications as predatory, allowing for a subsequent manual inspection before removal.

Users may not understand what type of publications are actually eligible for inclusion, or predatory publishers may try to push their publications into the service. In order to ensure that only eligible publications are indexed, all publications added by a user are reviewed

\(^{26}\) https://doaj.org/api/v1/docs#!/CRUD_Articles/get_api_v1_articles_article_id [last accessed 22.06.16]
\(^{27}\) https://doaj.org/faq#metadata [last accessed 22.06.16]
\(^{28}\) https://scholarlyoa.com/publishers/ [last accessed 28.06.16]
for inclusion by a separate user before indexed in the searchable database. Also, a set of guidelines stating what type of publications that are eligible for inclusion is clearly presented in the user interface.

Users are also provided with a tool for flagging and finding flagged publications. This is useful for making sure publications that have unrightfully ended up in the collection are identified. As deleting publications requires users to have a high rank, lower rank users may flag publications for authorized users to take appropriate action.

### 3.2.2 Ensuring correct metadata and accessibility of publications

The feature of flagging is also useful for ensuring quality metadata, as publications with erroneous metadata may be flagged. Users are provided with an interface for editing metadata on publications.

As many users may be turned away if forced to fill out a large set of metadata fields when adding publications, only the title and a link to the publication is mandatory. This may come at the expense of having publications with extensive metadata. To counter for this, users are given the option of having OAsearch automatically fill in metadata fields if they provide the system with the DOI (Digital Object Identifier) of the publication. The system will then access publication metadata through crossref.org’s API\footnote{https://github.com/CrossRef/rest-api-doc/blob/master/rest_api.md [last accessed 28.07.16]}, and this is likely far easier than manually inputting fields.

As previously stated, many publishers allow researchers to publish a preprint version in a green OA repository alongside the main journal, and perhaps a postprint after some quarantine period. OAsearch allows for users to register multiple versions / sources of a publication, and are tied to the same publication entity in the database. This means that if a user finds a better online source of a publication than currently registered (perhaps a higher quality PDF or a postprint version), this can be added to the publication. Users are given an interface for voting on the registered sources / versions, and the one that at any time has the most votes, is utilized.
3.2.3 Crowdsourcing the application

In the heart of the application lies the concept of crowdsourcing. As there is no money to be spent on this project, the application has to rely on users voluntarily contributing to the system. As previously stated, this means that the system can be classified as a system with no remuneration, and gamification has been introduced to enhance user motivation. Wikipedia is a crowdsourced system with no remuneration, which indicate that such systems do have potential. Towards the end of the previously presented definition of crowdsourcing, it reads “The undertaking of the task [...] always entails mutual benefit” (Estellés-Arolas and González-Ladrón-de-Guevara, 2012, p. 197). The mutual benefit in the case of OAsearch is arguably that while OAsearch’s collection of publications evolve with the number of contributions, the users themselves gains value in that the system becomes more useful.

In addition to the dimension of remuneration, Geiger et al. (2011) also applies the dimensions of accessibility of peer contributions, preselections of contributors and aggregation of contributions when describing characteristics of crowdsourced systems, as presented in Section 2.1.3 - Characteristics of crowdsourcing processes. The system will implement integrative crowdsourcing, as all publications that are added will be included given that they meet the requirements for inclusion.

On the dimension of accessibility of peer contributions, OAsearch will wary depending on the types of contributions, and the users’ previous efforts. All users will be able to view publications, but in order to be able to assess other users’ contributions by flagging, voting, and commenting, they have to be registered and potentially reached a higher level of qualification. Contributions can also be modified, as the metadata on publications are editable.

OAsearch does apply preselection of contributors. All users will have the same opportunity to unlock the highest accessibility of peers’ contributions, but as the system provides tools for intrusive actions such as modifying and deleting publications, some precautions are necessary to avoid user errors or vandalism. Therefore, users are required to prove themselves by conducting simpler and less critical interactions before unlocking more intrusive ones. Adding a paper requires the lowest level of authorization, and deleting them requires users to have reached the top levels. In this sense, OAsearch employs qualification-
based preselection. By only allowing researchers to curate the collection of publications, context-based preselection would have been applied. This was omitted as it would be hard to enforce and would drastically reduce the potential user base.

### 3.3 Specifications and Gamification

By applying the design framework for gamified applications proposed by Werbach and Hunter (2012) as presented in section 2.2.7 Design framework for gamified applications, the below specifications were delineated.

#### 3.3.1 Business objectives

The research questions of this thesis impose that the purpose of the application is to make publications findable, as well as motivating users to add, quality assure and curate the collection of publications. The business objectives below are the more concrete end goals for the design of OAsearch:

- Gathering a comprehensive collection of scholarly OA publications
- Making the publications findable through a search interface
- Quality assure the collection of publications
- Improving metadata on publications
- Growing a user base
3.3.2 Target behaviors and activity cycles

Points will be used as a *metric* for measuring the contributions and their relative value towards the business objectives. The table below summarizes the target behaviors of the system, and the implemented progression stairs through points, levels and content unlocking.

<table>
<thead>
<tr>
<th>Level required</th>
<th>Activity</th>
<th>Points awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unregistered</td>
<td>Register</td>
<td>10 points</td>
</tr>
<tr>
<td>Level 1 (0 points required)</td>
<td>Sign in</td>
<td>1 point (once each day)</td>
</tr>
<tr>
<td></td>
<td>Add a paper to OAsearch</td>
<td>10 points for adding, additional 40 if verified</td>
</tr>
<tr>
<td></td>
<td>Vote on the best version / source of a paper</td>
<td>1 point for each version voted up/down</td>
</tr>
<tr>
<td>Level 2 (25 points required)</td>
<td>Add a previously empty metadata field to a paper</td>
<td>2 points</td>
</tr>
<tr>
<td></td>
<td>Add a alternative version / source to a paper</td>
<td>25 points</td>
</tr>
<tr>
<td>Level 3 (50 points required)</td>
<td>Flag a paper for moderation</td>
<td>2 points</td>
</tr>
<tr>
<td>Level 4 (100 points required)</td>
<td>Verify a submitted paper</td>
<td>10 points</td>
</tr>
<tr>
<td></td>
<td>Reject a submitted paper</td>
<td>10 points</td>
</tr>
<tr>
<td>Level 5 (150 points required)</td>
<td>Edit existing metadata fields</td>
<td>2 points</td>
</tr>
<tr>
<td>Level 6 (250 points required)</td>
<td>View all flagged publications</td>
<td>2 points</td>
</tr>
<tr>
<td></td>
<td>Remove flags for moderation</td>
<td>2 points</td>
</tr>
<tr>
<td>Level 7 (1000 points required)</td>
<td>Delete a paper</td>
<td>10 points</td>
</tr>
</tbody>
</table>

Table 2: Gamification metrics and progression stair

Points can be described as tangible extrinsic rewards, which has been shown to potentially undermine intrinsic motivation in section 2.2.4 – *Findings from STD which can be utilized*. In the same section it was showed that extrinsic motivators have little or no effect on intrinsic motivation when the target activity is initially deemed dull by participants, and that in these cases it might be more relevant to facilitate for internalization of extrinsic motivation. Many of tasks that are to be undertaken in OAsearch are somewhat likely to be
perceived as dull and not intrinsically motivating to many users. This, combined with the fact that points will be used primarily as a metric for progression rather than as awards in themselves, will supposedly lessen the potential undermining-effect on the intrinsic motivation that points may have.

**Implemented game design elements**

Mechanics are, as previously stated, a way of facilitating dynamic game elements. The table below outlines what mechanics have been implemented, and how.

<table>
<thead>
<tr>
<th>Game mechanic</th>
<th>Component or implementation of the game mechanic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges</td>
<td>• Content unlocks that are progressively harder to achieve</td>
</tr>
<tr>
<td>Chance</td>
<td>• Points, verbal feedback, levels and content unlocking will appear unexpectedly in several situations to the users.</td>
</tr>
</tbody>
</table>
| Cooperation   | • Users verifying each others publications  
• Users flagging and resolving the flags that other users have placed  
• Users are notified when other users interact with their contributions (reviewing, flagging, commenting)  
• The undertaking of most activities is in cooperation of reaching the collaborative goal of the application |
| Feedback      | • Progress towards reaching the next level is shown on a progress bar  
• Users are given feedback during and on completion of activity cycles in the form of verbal feedback regarding what rewards they have achieved, leveling up and unlocking content  
• Users have are shown an event feed notifying them on events related to their contributions |
| Resource acquisition | • Points and levels provides a means for users to collect items which may provide social status  
• Users have a profile page listing all their contributions. |
| Rewards       | • Points, levels and content unlocks |

Table 3: Implemented game mechanics and components

**Engagement loops**

The engagement loops presented in the tables below describe the activity flow of the core functionalities, and the motivational nature of these activities.
A: Register an account  

**Motivation**
Registering an account in itself is hardly a fun activity, but as this step is necessary for users to be able to undertake other activities they are more internally motivated to do, this activity can be believed to be subject of identified regulation. The points given will serve as an unexpected extrinsic tangible reward, as they are not anticipated.

**Case flow**
1. The system displays fields for inputting username and password and the criteria for these fields.
2. The user inputs his desired values to these fields and clicks “register”
3. The system validates that the username is not taken, and that the values meet the criteria

**Goal achieved** – Account created

**Alternative flow**
3.1: The username is already taken
   - The system displays a message stating that the username is already taken, and moves to step 1.

Table 4: Activity cycle – Register an account

---

B: Sign in  

**Motivation**
The motivational nature of this activity is likely to be very similar to the activity of A: Register an account. The points given will serve as an unexpected extrinsic tangible reward the first time it is given, and will hopefully motivate users to regularly use the system.

**Case flow**
1. The system displays fields for inputting username and password. An option of signing in with a Facebook account is also displayed.
2. The user inputs his username and password and clicks “sign in”
3. The system verifies that the username and password is registered and matches.

**Goal achieved** – User signed in

**Alternative flow**
3.1: Username or password is incorrect
   - The system displays a feedback message stating that username/password is incorrect.

Table 5: Activity cycle – Sign in

---

C: Find a publication  

**Motivation**
Users may perform searches for several reasons, depending on context. The explorer player type may find the activity of finding and reading on new phenomenon or research fields to be intrinsically motivating. Others may need to find a specific publication as a part of their job, and may have an externally regulated behavior.

**Case flow**
1. The system displays a search field with appropriate search options
2. The user inputs publication title and clicks “search”
3. A list with publications matching the user’s input is displayed
4. The user finds the publication he was looking for in the list and clicks on it

**Goal achieved** – Publication found

**Alternative flow**
3.1: There are no matches on the user input
   - The system displays a feedback message stating that there where no publications matching the given input

Table 6: Activity cycle – Find a publication
**Chapter 3 - Design**

### D: Add a publication

<table>
<thead>
<tr>
<th>Motivation</th>
<th>50 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td>It can be assumed that researchers in general have an inherently autonomous motivation or an internalized extrinsic motivation for expanding the reach of their research. Making publications findable is an essential part of this process, which adding a publication to OAsearch will facilitate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case flow</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The system displays the <em>registered user</em> with a link to a page for adding a publication</td>
<td></td>
</tr>
<tr>
<td>2. The <em>registered user</em> clicks this link</td>
<td></td>
</tr>
<tr>
<td>3. The system displays information about which fields are mandatory, and the requirements imposed when the publication is to be accepted. The system also gives the user the option of auto filling the form if user is able to provide a DOI.</td>
<td></td>
</tr>
<tr>
<td>4. The <em>registered user</em> inputs the publication data and clicks “add publication”</td>
<td></td>
</tr>
<tr>
<td>5. The system validates that the input in the mandatory fields are valid</td>
<td></td>
</tr>
</tbody>
</table>

**Goal achieved** – Publication added to system (awaiting peer-review)

### Alternative flow

**4.1 User provides DOI and clicks on button for auto filling the form**

- The system looks up the DOI in an external database, retrieves data on publications and fills out the form.
- The system asks the user to validate the data that has been provided, and fill out any missing fields before submitting.

The system displays a feedback message stating which requirements are not met

**5.1 A mandatory field is missing, or the data provided is invalid**

- The system displays a feedback message stating which requirements are not met

<table>
<thead>
<tr>
<th>Table 7: activity cycle – Add a publication</th>
</tr>
</thead>
</table>

### E: Verify/reject a publication

<table>
<thead>
<tr>
<th>Motivation</th>
<th>10 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td>This is one of several activities that might be harder to motivate users to undertake, as it is on its own not rewarding or beneficial on an individual level. However, by highlighting the common benefit achieved by having several users undertake such tasks, it can be believed that innate needs for relatedness are stimulated and that especially social player types will find this task motivating for this reason. In these tasks the gamification of the system is especially important, as it will hopefully further motivate the undertaking of such tasks.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case flow</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The system displays the <em>registered user</em> with a link to a page for verifying publications</td>
<td></td>
</tr>
<tr>
<td>2. The <em>registered user</em> clicks this link</td>
<td></td>
</tr>
<tr>
<td>3. The system displays a list of unverified publications</td>
<td></td>
</tr>
<tr>
<td>4. The <em>registered user</em> clicks on one of the publications</td>
<td></td>
</tr>
<tr>
<td>5. The system expands the publication clicked, and shows the metadata which was added to the publication when it was added. The system also displays buttons for opening the publication, editing the metadata of the publication, verifying the publication and for rejecting the publication.</td>
<td></td>
</tr>
<tr>
<td>6. The <em>registered user</em> examines the publication and decides that it is to be accepted into the index of OAsearch</td>
<td></td>
</tr>
<tr>
<td>7. The user clicks “accept publication”</td>
<td></td>
</tr>
</tbody>
</table>

**Goal achieved** – Publication added to system

### Alternative flow

**3.2: There are no publications awaiting verification**

- The system displays a feedback message stating that no publications are currently awaiting verification

**6.1: The publication does not meet the requirements for inclusion**

- The *user* clicks “reject publication”
- The *system* displays a text field where the user is asked to input the reason for rejection
• The registered user inputs the reason, and clicks save
• The system notifies the adder of the publication of the declination, and displays the reason given

Table 8: Activity cycle – Verify/reject a publication

<table>
<thead>
<tr>
<th>F: Add/correct/improve a metadata field on a publication</th>
<th>2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td></td>
</tr>
<tr>
<td>Ensuring correct and as exhaustive metadata as possible is important to ensure the findability of publications, thus can this task be imagined to be similar in the motivational nature for researchers editing their own publications as <strong>D: Add a publication.</strong> To users editing metadata of unfamiliar researchers publications, the activity is likely to be similar in its motivational nature as <strong>E: Verifying/rejecting a publication.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Case flow</strong></td>
<td></td>
</tr>
<tr>
<td>1. The system displays the registered user with a link to a page for modifying metadata of a publication</td>
<td></td>
</tr>
<tr>
<td>2. The registered user clicks this link</td>
<td></td>
</tr>
<tr>
<td>3. The system displays all fields of metadata in prefilled input field, and a save/update button that is clickable if the user changes the value in one of the fields.</td>
<td></td>
</tr>
<tr>
<td>4. The registered user inputs the metadata in the desired field and clicks “save”</td>
<td></td>
</tr>
<tr>
<td>5. The system displays a confirmation dialog where the user is presented with the changes he has made to the metadata value.</td>
<td></td>
</tr>
<tr>
<td>6. The user confirms the changes by clicking a button.</td>
<td></td>
</tr>
<tr>
<td><strong>Goal achieved</strong> – Metadata has been updated.</td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Activity cycle – Add/correct/improve a metadata field on a publication

<table>
<thead>
<tr>
<th>G: Flag a publication</th>
<th>2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td></td>
</tr>
<tr>
<td>This activity is likely very similar in its motivational nature as F – add/correct/improve a metadata field on a publication, as flags are likely to be used a tools for doing just this in addition to having unfitting publications removed. This functionality is useful for users that encounter a issue, but does not possess the right to resolve the problem.</td>
<td></td>
</tr>
<tr>
<td><strong>Case flow</strong></td>
<td></td>
</tr>
<tr>
<td>1. The system displays the registered user with a link to a page for flagging a publication</td>
<td></td>
</tr>
<tr>
<td>2. The registered user clicks this link</td>
<td></td>
</tr>
<tr>
<td>3. The system displays a modal and asks the user to classify the flag and write a short text telling why the flag was set.</td>
<td></td>
</tr>
<tr>
<td>4. The registered user fills out the fields and clicks to confirm.</td>
<td></td>
</tr>
<tr>
<td>5. The system registers the flag, and this flag is displayed to users who opens the publications, as well as in a dedicated page for viewing all flags.</td>
<td></td>
</tr>
<tr>
<td><strong>Goal achieved</strong>   – Publication is flagged</td>
<td></td>
</tr>
<tr>
<td><strong>Alternative flow</strong></td>
<td></td>
</tr>
<tr>
<td>4.1 Fields are missing</td>
<td></td>
</tr>
<tr>
<td>• The system displays a feedback message stating which requirements are not met</td>
<td></td>
</tr>
</tbody>
</table>

Table 10: Activity cycle – Flag a publication
Chapter 3 - Design

<table>
<thead>
<tr>
<th>H: Unflag a publication</th>
<th>2 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td>This activity is likely very similar in its motivational nature as F, and G. As users encountering a flagged publication may be turned away from reading it, the author of the flagged publications may be eager to resolve the reason behind the flag.</td>
</tr>
</tbody>
</table>

**Case flow**

1. The user navigates to a page where all flagged publications are displayed
2. The system displays all flagged publications, the classifications of the flags and the statement regarding the flags from the user who flagged it. A link for opening the publication internally is also displayed.
3. The user reads the reason behind the flag, clicks the link and is now on the internal page representing the publication.
4. The system displays the flag, any previous flags on the publication, and a button for removing the allocated flag.
5. The user then takes the necessary actions (e.g. editing metadata, or removing the publication altogether)
6. The user clicks the button for removing the flag

**Goal achieved** – Publication is unflagged

Table 11: Activity cycle - Unflag a publication

<table>
<thead>
<tr>
<th>I: Add an additional version of a publication</th>
<th>25 points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motivation</strong></td>
<td>Ensuring that the links that OAsearch provides are working and linking to the best possible OA version, is likely to be of importance to the authors of the publications. To users adding alternative versions of publications they have no direct association with, the activity is likely to be similar in its motivational nature as E: Verifying/rejecting a publication.</td>
</tr>
</tbody>
</table>

**Case flow**

1. The system displays the registered user with a link to a page for adding an additional source/version of a publication
2. The registered user clicks this link
3. The system displays input fields and information of what fields are mandatory.
4. The registered user inputs the data in the desired field and clicks “save”
5. The system validates that at minimum a link to the version has been given
6. The system displays the new version on the publication in question, with the possibility of upvoting it

**Goal achieved** – A new version/source of the publication was added.

**Alternative flow**

5.1 The link provided is invalid
   • The system displays a feedback message stating that the link is invalid
5.2 No link was provided
   • The system displays a feedback message stating that a link must be provided

Table 12: Add an additional version of a publication
**Table 13: Activity cycle – Vote on a version of a publication**

### 3.3.3 Player types

The users of OAsearch is likely to be mainly researchers and students, but would also include anyone with interest in scholarly publications. Researchers might have an interest in adding their own publications for the sake of making it findable to a larger population. However, there are no requirements saying that users can only add publications they have authored themselves, and thus everyone with an interest can contribute to the process of curation and quality assurance. Amy Jo King’s social action matrix has been utilized to describe how different player types are likely to relate to OAsearch in the sections bellow:

#### Collaborators

As OAsearch is a crowdsourced system designed for the common good, the strongest motivator for contributing might be the sense of collaborating and working together towards a greater goal. Collaborators are likely to be motivated by activities improving the collection of publications by adding publications and metadata, improving metadata and verifying publications, as this is beneficial for the common. Connecting and communicating with other users through discussion fields on publications is also a potential motivator for this player type.

#### Competitors

Competitors are likely to find motivation in the gamified aspects of the applications, and might be motivated by possibility of scoring points, gathering badges and ranking up. As
the basic activities that the application offer can be said to quite mundane in themselves, game elements will hopefully contribute to making these tasks more interesting.

**Explorers**

As OAsearch is an application developed as part of a master thesis and thus is somewhat limited on resources, explorers may not find the application to provide a large variety of functionalities to explore. Still, the offered game elements introduced as a result of the gamification should provide a somewhat extensive range of aspects to explore in addition to the core features. In addition, exploring the repository of publications in general can be assumed to be motivating to these users.

**Creators**

Functionalities such as the possibility of choosing badges to display to fellow users, the possibility of creating and selecting an avatar and the possibility of commenting and discussing may contribute to a feeling of self-expression. For a researcher to expand the reach of his research by making it findable for more people, might also give a sense of self-expression.
3.4 First prototype – Wireframes

The wireframes presented below are some the wireframes that were developed early in the design process of OAsearch, mostly to outline the design of the core features in order to be able to start the programming of the application. Game design elements were added to the wireframes as well, but these were though out before a substantial effort had been done to understand gamification theory, and served mostly as a layout of where these elements were to be placed. As the design process has been conducted in an iterative manner, the design which were first outlined in the wireframes has changed considerably throughout development. These templates have not been subjected to structured user testing, but was used in informal discussions with potential users.

Figure 6: Wireframe 1 shows how search results were thought to be displayed. Figure 7: Wireframe 2 – Metapage of a publication shows a page which gives an extensive view of the publication, with options to correct metadata, add and vote on versions and to comment. Finally, Figure 8: Wireframe 3 - Gamification elements shows how the game elements were initially pictured as well as the discussion functionality.
Figure 6: Wireframe 1 – Search results
Figure 7. Wireframe 2 – Metapage of a publication (alternative versions expanded)
Figure 8: Wireframe 3 – Gamification elements (social expanded)
3.5 Final design – Features with screenshots

3.5.1 Home page

Figure 9: Final design - Home page as signed in user
The top navbar contains two drop down-menus, which displays actions that are available to the users. Low ranking users will have fewer options in these drop-downs, than those who have unlocked all features. The modal below is displayed when user clicks info, and then “paper inclusion guidelines” option in the appearing drop-down. The inclusion guidelines are shown in the figure below.

![Requirements for inclusion:](image)

Figure 10: Final design - Paper inclusion guidelines

The home page contains information on what OAsearch is, why you should register as well as a link to a page listing all the main features of the service. A youtube-video explaining what OA is is also displayed\(^{30}\). The wording in the text fields are formulated in a way that emphasizes the collaborative aspects of the service. For instance, the slogan presented in the navbar on top reads “OAsearch.com – a crowdsourced collection of OA scholarly papers”. When clicking the “why register link” as seen in figure 9, the the text shown in the figure below is displayed.

![Register in the top right corner!](image)

Figure 11: Final design - "Why register"

\(^{30}\) [https://youtu.be/L5rVH1KGBCY](https://youtu.be/L5rVH1KGBCY) [last accessed 16.22.06]
The navbar at the top of the page, and the right side panel titled your progress, is static on the entire site. When not signed in, an alternative panel which encourages users to register is displayed in place of the “your progress” panel.

### 3.5.2 Search interface

![Search results page](image)

Figure 12: Final design - Search engine results page

Each match on a given query is represented on a separate panel, as seen on the above figure. The tile is black and is a clickable link which will take the users to the highest rated version of the publication. Journal, year of publication, authors and publisher is presented if these fields are present in the publication’s collection of metadata. By clicking “expand abstract” a text field with the abstract drop down directly under the appropriate panel. On the right side of the cards, information about number of alternative versions and metadata fields registered is presented. By clicking “View/edit publication”, the user is taken the publication meta page, as will be presented in section 3.5.3.

The blue “chip” displays the number of citations that Scopus provides, as previously stated. The embedded tag displaying a “Am-score” is retrieved from Altimetric.org[^31], and displays information on mentions in online sources such as Wikipedia articles, news outlets, tweets

and Facebook when hovered. The score is calculated based on the amount of such attention that a publication has received. The citation counts and AM-scores is retrieved by querying the respective services with a DOI, and thus no such information can be displayed on the publications that have no such metadata registered.

The database technology used in OAsearch, MongoDB, has some features and limitations which effects how OAsearch has been implemented. The titles of the publications have been full-text indexed, and can be searched using three types of inputs: keywords, phrases and negated terms (exclude publications with match on given term). Keywords are entered as standalone words (effect and placebo in the figure above), negated terms with hyphen in front (-cancer in the figure above), and phrases are entered by surrounding a series of words with quotation marks (“clinical trials”). All words in the index of titles are stemmed (meaning a search for “fishes” will match “fish), and the results of a query is sorted on number of hits on the keywords or phrases in the publication.

As a results of the limitations given by MongoDB, only the titles could be full-text indexed (only one full-text index in each collection). When searching other fields, only a simple regex match is being done which scans the chosen data field for the given string. As a results of limited time, it is not possible to combine several fields when searching. The search options can be seen on the figure below:

![Search options](image)

Figure 13: Final design - Search options
3.5.3 Publication meta page

"Alternative versions" tab

![Publication meta page](image)

Figure 14: Final design - Publication meta page: "Alternative versions"

When clicking “View/edit paper” on one of the search results, the page given in the above figure is presented. On the top, a panel displaying the most significant information about the publication is given, as well as buttons activating functionalities related to the publication. In the larger panel on the bottom side of the screen, a three-tab panel is displayed. The above screen shows the “alternative versions tab”. On this tab users can add different versions/sources to the publication, and vote amongst the versions. Two versions are listed in the screenshot above. The highest rated version/source, is utilized when users click the link of the publication.

Clicking “Edit metadata” will take users to a separate page for doing just this. Clicking “Add a version” opens a pop-up modal for doing so. The “Flag paper” button triggers a small drop down below with options for either adding a flag, or view any previous flags on the publication. The above screen is taken from a high ranking user, which has all
features available. A level 1 user will not see the functionality of editing metadata, flagging or adding versions to the publication.

Table 14: Final design - A flagged publication

Figure 15: Final design - Modal for adding a version

“All available metadata” tab

Figure 16: Final design – Publication meta page: "All available metadata"
In the previous screen, the “All available metadata” tab has been selected, and all registered metadata on the publication is shown. The button “Edit metadata” is displayed as the user is sufficiently ranked to do so.

“Discussion” tab

![Discussion Tab](image)

Figure 17: Final design - Publication meta page: "Discussion"

The last tab displays a discussion feature. Enabling some form of communication is important to support users’ sense of relatedness. As a result of limited time, the discussion service of the third party service named Disqus has been implemented\(^32\). Because of this, users are required to sign in with a separate account than that of OAsearch to be able to comment.

\(^32\) [https://disqus.com/](https://disqus.com/) [last accessed 22.06.16]
3.5.4 Edit metadata interface

Figure 18: Final design - Page for editing metadata

The above screen is from the page opened when clicking “Edit metadata” as seen in Figure 16. All possible metadata fields are displayed, those empty as well. The existing metadata is displayed in prefilled input fields, and is editable. The below modal is given when a user clicks the save icon seen on the right side of each input field:

Figure 19: Final design - Modal for saving edited metadata
3.5.5 Add publication interface

Add a paper

The only mandatory fields are title of paper and link, the rest are optional. However, the more data you add, the more findable the paper will be when searching!

Please read the requirements for inclusion before submitting.

<table>
<thead>
<tr>
<th>Field</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOI</td>
<td>optional, but highly recommended</td>
<td></td>
</tr>
<tr>
<td>Link to the paper. e.g <a href="http://www.somedomain.com/a_paper">http://www.somedomain.com/a_paper</a></td>
<td>mandatory</td>
<td></td>
</tr>
<tr>
<td>Title of paper</td>
<td>mandatory</td>
<td></td>
</tr>
<tr>
<td>What kind of version is the link referring to?</td>
<td>optional</td>
<td></td>
</tr>
<tr>
<td>Authors - separate multiple authors by a semicolon and spaces ('Author X; Author Y')</td>
<td>optional</td>
<td></td>
</tr>
<tr>
<td>Abstract - you can use html tags in this input field</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 20: Final design – snippet of the “adding publications interface”

The above page is available when clicking “Contribute to OAsearch” in the top navbar, and then selecting “Add paper” on the emerging drop-down. The users are given some information on what fields are mandatory, which is validated before users can submit the publication. If a user fills the input field labeled “DOI”, the button named “Autofill form using DOI” is enabled. When this button is clicked, a query using crossref.org’s API is, and if a valid response is returned, the form is automatically filled. When a publication has been submitted, a modal informing on the subsequent process of verification is shown as bellow:
3.5.6 Verify/reject publications interface

In this interface the users are given a list of expandable elements of publications awaiting verification. When rejecting/deleting a submitted publication, a conformational modal is given and the user is asked to state why the publication is rejected. The reason stated will appear in the user interface of the users added the publication.
3.5.7 View flagged publications interface

An interface for viewing all flagged publications has been implemented. This page resembles the page for reviewing publications, but information on the category of the flag and the stated reason for flagging is displayed instead of metadata.

These are the papers that have been flagged for moderation. The categorization of the flag is displayed in the header alongside with the title of the paper.

- **Uncategorized flag**: Breast cancer patients with lobular cancer more commonly have a father than a mother diagnosed with cancer
- **Uncategorized flag**: Evidence for placebo effects on physical but not on biochemical outcome parameters: a review of clinical trials

Eapen, 2016-07-31 18:58:

The ISSN registered is wrong, and I am not able to edit metadata yet. The correct ISSN is 1741-7015.
3.5.8 Gamification elements

**Progress panel**

The figure given on the left side of this text, is fixed at the right hand side of the screen on all pages. This panel summarizes many of the implemented gamification elements. Points and levels are stated, and progressions is clearly visualized by using a progression bar and displaying points until next level is achieved. By stating what the next content unlock is, users are hopefully further motivated to contribute more.

The panel displays the last five events of the signed in user. By giving points for each day a user signs in, users are hopefully incentivized to somewhat consistently use the system. The destination of the two links at the bottom of the panel is shown in section 3.5.9

![Progress panel](image)

Figure 23: Final design - User's progression panel

**Feedback given to users**

Feedback is an essential part of activity cycles, as described in section 2.2.7 Design framework for gamification. The choice of words in feedback messages given is intended to promote users sense of contributing to the common good, enhancing users feeling of relatedness. The feedback is clearly stated and will likely be unexpected in a lot of cases. The feedback messages suggest either directly or indirectly that users may engage further in activities, but these suggestions are intended to be conveyed more informative than controlling, thus enhancing users’ sense of autonomy. Hopefully, the activity cycle of motivation, action and feedback will be realized in the system by adding these elements to the feedbacks. Below are some of the feedback messages given to the users:
3.5.9 User’s statistics page and All features page

When clicking link titled “View all stats” in the fixed right side progress panel presented in section 3.5.8, all events of the user is displayed as shown in the snippet below:

![Page with user's statistics](image)
In addition to the pages presented in the above sections, there is a page for viewing what levels are required to unlocks what features, and how many points that an activity awards. The picture below shows some of this screen.

![Image of level required, feature, and points awarded table]

**Figure 27: Final design - "All features" page**

### 3.6 Final design – Technical implementation

The application is built utilizing the so called MEAN stack, which consists of a series of technologies for building a full-stack web application. The stack consists of the *MongoDB* database, the *ExpressJS* web application framework, the *AngularJS* client side development framework, and the *NodeJS runtime environment*. All of these components are JavaScript based which advantageously means that developers only have to deal with one programming language.

#### 3.6.1 Front-end

The front-end of the applications has been built using the AngularJS framework, with a series of additional modules. The application has been implemented as a single page app, which means that all necessary HTML-files, CSS-files, JavaScript or other resource files are loaded once on page load, or dynamically retrieved from the server side of the application on request. Angular is arguably one of the main solutions for building such single-page applications.
One of the main features of Angular is that it extends the HTML syntax through a construct called *directives* and utilizes this by providing a library of services for common tasks\(^{33}\). Two-way data-binding, control structures for repeating, showing and hiding, form validation and grouping of HTML into reusable components are some of these additional HTML constructs offered. Angular also promote separation of concerns which makes the code more flexible, reusable and maintainable by implementing concepts such as dependency injection and the architectural pattern MVC or similar, as described in *Section 2.5.1 Model-View-Controller Pattern*.

### Non-angular core modules used

- **Materialize**
  - CSS framework used for generating visual components such as cards, panels, navbar, drop-downs, tables and lists.
    - [http://materializecss.com/](http://materializecss.com/)
- **Bower**
  - Packet manager used for installing angular modules.
    - [https://github.com/bower/bower](https://github.com/bower/bower)
- **JQuery**
  - A JavaScript library. Primarily utilized by the Materialize CSS framework.
    - [https://jquery.com/](https://jquery.com/)
- **ngSmoothScroll**
  - A JavaScript library and set of directives that makes it easy to smoothly scroll to an element in the DOM.
    - [https://github.com/d-oliveros/ngSmoothScroll](https://github.com/d-oliveros/ngSmoothScroll)
- **AngularUI-router**
  - Non-native router framework which provides more features. Used primarily for the strong-type linking between states based on state names, and other possibilities of the state concept.
    - [https://github.com/angular-ui/ui-router](https://github.com/angular-ui/ui-router)
- **Angular-loading-bar**
  - Automatically adds a loading bar at the top of the site whenever an XHR request goes out, and removes it once a response is received.
    - [https://github.com/chieffancypants/angular-loading-bar](https://github.com/chieffancypants/angular-loading-bar)
- **Angular tooltips**
  - An Angular directive which makes it easy to add tooltips to elements. Only used in a few places in OAsearch.
    - [https://github.com/720kb/angular-tooltips](https://github.com/720kb/angular-tooltips)
- **AngularUtilz-disqus**
  - A directive used to embed a Disqus comments widget on publications on OAsearch.

\(^{33}\) [https://docs.angularjs.org/guide/introduction](https://docs.angularjs.org/guide/introduction) [last accessed 16.06.24]
Back-end

NodeJS is an asynchronous event driven JavaScript runtime, and is designed to build scalable network applications by simplifying handling of concurrent connections\(^{34}\). ExpressJS is a NodeJS framework which, amongst other things, simplifies building a web server by providing an API with common back end-functionality such as routing. All CRUD (Create, Receive, Update, Delete) routes implemented on the server can be seen in the figure below:

```javascript
// Routes used for passport-local authentication.
app.route('/register').post(routes.register);
app.route('/login').post(routes.login);
app.route('/get_login').get(routes.getLogin);
app.route('/logout').post(routes.logout);

// All other routes: All responses returned in JSON format.
// Rewriting points and registering events handled in called functions.

// Used to fetch users' updated points and events | authenticated required
app.route('/api/user').get(routes.getUpdatedStats);

// Returns publications in JSON | no authentication required
app.route('/api/search/:query').get(api.search);

// Returns publications in JSON | authentication required
app.route('/api/verification_list').get(api.getVerificationList);
app.route('/api/flag_list').get(api.getFlagList);

// Returns single publication in JSON | no authentication required
app.route('/api/citation_count').post(api.citationCount); // Forwards a call to Scopus API
app.route('/api/publication/id/:id').get(api.getPublicationById);
app.route('/api/publication/title/:publication_title').get(api.findOnePublicationByTitle);
app.route('/api/hitcount/:query').get(api.hitcount); // Returns number of hits on query.

// Returns: 'success': boolean, '_id': string (when successful), 'message': string (when failing)
// Authentication required
app.route('/api/publication').post(api.createPublication);

// Returns: 'success': boolean, 'message': string | authentication required
app.route('/api/version').post(api.createVersion);
app.route('/api/vote').put(api.voteOnVersion);
app.route('/api/save_metadata').put(api.saveMetadata);
app.route('/api/flag').put(api.flagPublication);
app.route('/api/remove_flag').put(api.removeFlag);
app.route('/api/verify_publication').put(api.verifyPublication);
app.route('/api/delete_publication').delete(api.deletePublication);
```

Figure 28: Server’s routes

Mongoose, an object relational mapper (ORM), were used to gain some abstraction on the more primitive APIs exposed by using only the MongoDB driver. Mongoose is a schema-based solution, which provides out of the box validation and query building amongst other things. The schemas applied in OAsearch can be seen in Figure 29 and Figure 30.

\(^{34}\) [https://nodejs.org/en/about/] [last accessed 16.06.25]
An authentication module for NodeJS named *Passport* has been configured to handle authentication and establishing persistent login sessions. Two ways of authenticating through Passport and OAsearch has been implemented: delegated authentication using the OAuth service of Facebook, and by the conventional method of registering and signing in with username/password. Yet another module titled *passport-local-mongoose* has been configured to handle hashing and salting of passwords when creating users locally on OAsearch, as seen in Figure 31.

**Database and the workings of searching for publications**

MongoDB is a NoSQL database which stores records as documents consisting of field and value pairs stored in a binary encoded JSON format. The data structure of documents allows for embedded documents, arrays, and arrays of documents. As the schemas are dynamic, developers are able to add additional field-value pairs to individual documents without it affecting the rest of the records, making the database more flexible. MongoDB was chosen as the database technology primarily because of this flexibility, because it integrates well with the rest of the MEAN stack, and because it is well documented throughout the web.

MongoDB provides full-text indexation with a corresponding search and ranking of results functionality, which was highly relevant in the context of OAsearch. An attempt at making a full-text index of all fields in the publications were conducted, which would enable a “all field search”, but this greatly reduced the performance of the system, resulting in queries using more than a minute when returning results of only a single concurrent query. This is likely because of the amount of keywords which needs to be indexed in the abstracts of the large number of publications in the database.

Only a single full-text indexation per collection can be applied in MongoDB, and as a result, only the titles of the publications were full-text indexed. This means that functionality of word stemming, phrase and keyword searching, stop words, negated terms and ranking of results are only applied when searching in the titles of publications. Ranking is simply done by summing the number of matches between the query keywords or phrases and the publication titles. All other fields are searched with a simple regex pattern matching the input with an unlimited number of wildcard characters before or after the query given by the user. Only a single field can be searched at a time. There are multiple ways of improving
this, but as a result of limited time, the current search performance was deemed sufficient for the time being.

Four different collections have been implemented, namely *publication*, *version*, *flagEvent* and *account*. A *publication* document contains an array of embedded *version* and *flagEvent* documents, which can be seen on the figure below.

```javascript
var Version = new Schema({
  user: String,
  link: String,
  date_added: { type: String, default: getDateTime() },
  type: String,
  upvoting_users: [String],
  downvoting_users: [String],
});

var FlagEvent = new Schema({
  date: { type: String, default: getDateTime() },
  type: String,
  text: String,
  addedById: String,
  user: String,
  resolved: Boolean
});

var Publication = new Schema({
  verified: Boolean,
  date_added: { type: String, default: getDateTime },
  addedById: String,
  flagEvents: [FlagEvent],
  flagged: Boolean,
  publication_title: String,
  abstract: String,
  authors: String,
  publisher: String,
  journal_title: String,
  journal_number: String,
  journal_volume: String,
  year: String,
  pages: String,
  doi: String,
  ISSN: String,
  eISSN: String,
  versions: [Version]
});
```

Figure 29: Database model – Version, Flag and Publication schemas
The tables below show the Account schema, where user information and statistics are stored. The application had implemented authentication through Facebook, but this stopped working after some major changes were made in the applications routing structure, and this has not been reimplemented at the time being.

```javascript
var Account = new Schema({
  schemaId: String,
  accountNumber: SchemaType.
});
```

Figure 30: Database model – Account schema

```javascript
> db.accounts.find({username: '0AsearchDummy'}).pretty()

"_id": ObjectId("576dd3f57bb4830176d6dc2a9"),
"salt": "05995757de757b98778680831ae1a16c3921f29241b3f3e3e92c1847f28bba",
"hash": "7a9ed84f97ff5f58059f1fd298b2a5c3a887dcb0bdfc11a7a35fb5fb2b24ccdbb1848a212723e2b5f681f1da3e1880a6def4b973b17e313547ae07441fa3dbca0a8b3c4d0130f7a22824aa3c3fc92839
```

Figure 31: Sample of how a account is stored in the database.
4 Evaluations

4.1 Formative heuristic evaluation

After the core features of OAsearch was implemented as a high-fidelity prototype in the form of a working web application, a formative evaluation of the application was conducted. No form of gamification had been implemented, and the evaluation was done to discovery potential problems in an earlier stage of the development.

This evaluation was conducted to discovery usability problems in an earlier phase of the development, as they are easier to attend at this stage. It is also favorable to eliminate as much usability issues as possible before conducting user based usability tests, as these users are easier turned away when encountering bugs and issues than experts.

4.1.1 Execution

The evaluation was conducted as a heuristic evaluation with three participants. All three were master’s students in informatics with a specialization of design, use and interaction, and are arguably quite capable of understanding design. One of the three had previously conducted a heuristic evaluation. Before conducting the evaluation, all participants were given an explanation of the process of heuristic evaluation and how the process would go about.

The evaluators were given a copy of Jacob Nielsen’s 10 heuristics for interface design\textsuperscript{35}, with a brief explanation of each and an example of how to take notes on the issue they would discover. Each evaluator was given a set of tasks designed to emulate potentially common user scenarios. They were asked to perform each tasks multiple times in various ways, and to have an exploratory mindset when undertaking the tasks, in order to provoke potential issues.

The evaluation was split into two phases, an initial phase were the experts were asked to evaluate the design separately in order to ensure independent and unbiased evaluations. In

\textsuperscript{35} See Appendix 6: Heuristic evaluation – Heuristics
the second phase, the participants were gathered to discuss and elaborate on their findings, and compile a joint list of issues with suggestions for improvement.

4.1.2 Findings

A total of 14 unique issues were found, ranging from simple bugs to more intricate problems with understanding the navigation\textsuperscript{36}. The issues which were more than simple bugs and were found to be more substantial will be subject to a short description in the coming paragraphs.

Issues with navigation

The evaluators reported several issues with the navigation of the application. They found it somewhat difficult to find the functionality for editing metadata, stating that important functionality had too low of a visibility. It was suggested that the buttons for the features of adding versions and editing should be grouped into a side menu, or otherwise made more apparent. It was also commented that the “tab-layout” was not clear, and that it should be made more visible that there were several tabs of feature by either enlarging the headlines or to convert the design to a vertical collapsible list.

Issues with readability

The evaluators found some of the text displayed to be somewhat hard to read. It became apparent that this was a result of a somewhat bad contrast between text and background, and that the text was a bit too small.

Inconsistency in navigational elements

A particular element on the search results page was stated to be unintuitive, as it was a link comprising of several lines of text. In the rest of the interface, similar navigational elements where given a button rather than a link.

\textsuperscript{36} See appendix 7 for full the full table of issues which was found during the evaluation.
Unavailable features should not be shown or be disabled

The evaluators criticized that the application did not show users which are not signed in which functionalities they were unauthorized to access. The system did give a feedback message stating that they need to be registered to access these features when buttons for accessing them were clicked, but the evaluators argued that this should be apparent simply by looking at the buttons. One evaluator argued that the buttons should not be displayed at all, unless the users are signed in.

Performance issues

All evaluators noted that they found the response time when searching for publications to be far too slow. The database of publications counts more than 1.5 million, and when doing full text searches the response time is slow on a low performance VPS. The provider of the VPS where OAsearch is hosted provides easy scaling of resources, and this issue has been proven to be non existent when the performance was scaled up. As a slip, the performance was set to a low-cost configuration at the time of the evaluation.

4.1.3 Discussion

Sample and setting

The heuristic evaluation yielded several usability issues, but it is likely that there are more issues than the ones which were found. As previously stated, more evaluators find more issues. As only one in three had previous experience with conducting heuristic evaluations, evaluators with more expertise might have found additional issues. This was confirmed by the fact that the experienced evaluator found the deeper issues of the design, while the inexperienced evaluators found more superficial bugs. As both types of issues are important to discover, it would have arguably been useful with more evaluators.

Even though the task were meant to reflect natural use of the application, it should be noted that a usability test with actual users in a more natural setting might have yielded somewhat different results. As this evaluation was done in a controlled setting with users given a set of tasks, and a mindset of finding issues, the results are likely not congruent with what one might find if a study happening in a more natural environment. Still, as this evaluation was
a formative evaluation meant to find the most critical issues, I believe its results are quite valid for this purpose.

**Utilizing the results**

Conducting a formative evaluation proved to be highly useful, as it showed that the users did not find the interface as intuitive and easy to navigate as I as the developer expected. As some of the issues found were quite substantial, they would have had a negative impact on the usability and user experience of the application, and thus they would likely undermine users’ motivation. Discovering these issues somewhat early in the development process made the issues easier to attend to, and are likely to resolve in higher usability and a better user experience in the summative evaluation of the application.

As the developer of the application, I was aware of several bugs and had certain notions of possible usability issues. As the tasks the evaluators were given were meant to reflect actual use of the application, which of these bugs and issues the evaluators reported is useful information. Arguably, it says something about which issues users are likely to actually encounter in normal use, and thus also which issues should be prioritized.

All issues presented above has been catered for prior to the summative evaluation presented below.
### 4.2 Summative usability test

#### 4.2.1 Purpose

The primary purpose of the summative evaluation, was to collect data useful for answering the research questions posed in the introduction of the thesis. The below table summarizes the process of gathering data for this purpose.

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What is evaluated</strong></td>
<td><strong>What is evaluated</strong></td>
</tr>
<tr>
<td>RQ1</td>
<td>RQ2</td>
</tr>
<tr>
<td>OAsearch’s performance on finding specific publications</td>
<td>OAsearch’s performance on exploratory research on a subject</td>
</tr>
<tr>
<td>Task completion time, number of searches to find publication</td>
<td>Comparing results between services</td>
</tr>
<tr>
<td>Comparing results between services</td>
<td></td>
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</tbody>
</table>

Table 15: Overview of the summative evaluation

To discuss the first research question (RQ1: *How can OAsearch be designed to make publications findable?*), the performance of OAsearch on the two relevant use scenarios identified by the expert interviewed was tested, namely *finding a specific publication* and *exploratory research on a subject.*
As Google Scholar is one of the most used services for searching for scholarly content, the findability performance of this service was applied as a benchmark when testing OAsearch. Naturally, OAsearch can not be expected to have the rich database of publications, the advanced ranking algorithms, the extensiveness of the search interface or the response time of such a big-budget application. It is still interesting to see how far off OAsearch is, and whether the performance is adequate for most users and use cases.

In the second phase, the second research question (RQ2: How can OAsearch be designed to motivate users to add, quality assure and curate publications), was not subject to a comparative study. This phase utilized more qualitative methods to explore whether users actually find the system to be motivating, and the underlying reasons for why they did or did not. In addition, an anonymous qualitative questionnaire was applied to get more quantifiable data on the motivation. This methodical triangulation was also applied in an effort to reduce potential biases and thus enhance the reliability of the results.

4.2.2 Execution

Prior to engaging in the evaluation, all participants were given a consent form with information on what participation would involve, how the data gathered would be used and stored, and their right to withdraw from the study at any time (appendix 10). The sessions were audio recorded, and notes were taking during the full length of the sessions. The sessions were conducted in various places, but all tests were conducted on the same computer with more or less the same surroundings.

Phase 1

The first section of tasks was designed to measure the findability of the publications included. To measure performance on the scenario of finding a specific publication, participants were given three tasks with information about the title and authors of the publication, and one with the DOI and author of the publication. The participants were randomized into two groups which were asked to perform the tasks using either OAsearch or Google Scholar first. During these tasks, the participants were asked to not think aloud, as it could potentially lessen focus and have an effect on the performance. Two metrics were recorded: time spent from task were read and understood to full text of the publications was opened, and number of searches performed to find publication.
Chapter 4 - Evaluations

In the second part of phase 1, the participants were given the task of doing 3 searches on one or more research fields that they had an interest in. The participants were asked to repeat the same exact queries in both services, and the same randomization of which service was used first were applied also in this part of the evaluation. Before doing the searches, they were told to pay attention to the relevance and accuracy of the results the services gave on their queries, as they were to answer a questionnaire on this matter subsequently. The questionnaire is given below:

![Questionnaire](image)

Figure 32: Summative evaluation questionnaire - Findability

**Phase 2**

The subsequent task section where designed to explore the user experience that the system provides, and more specifically how the application affect users’ motivation to contribute to the system. The participants were asked to say out loud what they thought, felt, liked and disliked as they performed the tasks, as according to the thinking-aloud protocol. In an effort to making the testing situation more realistic, the tasks were formulated as scenarios contextualizing why such tasks might be undertaken. Two of the scenarios is presented bellow, and the rest are available in *Appendix 8: Summative evaluation - Tasks/scenarios.*

- You’re a researcher which has published a paper you think a lot of people will find to be interesting. Currently, it is not receiving much attention as it is only published on your research institutions repository. You are aware that OAsearch allows you to add
your publication to it’s database which makes it findable through the service’s search functionality.

- Add the following publication to the service:
  - Title: “A study on human motivation”
  - Link: http://www.dummyurl.com
  - Authors: Input your own name
  - Publisher: “OAsearch publishing”

- You navigate to the page of publications awaiting verification. You spot a publication which is clearly unfitting for OAsearch as it is not a peer-reviewed scholarly publication.

  - Navigate to the page allowing you to verify/reject publications, and identify the publication titled My high school paper on bees.

  - Reject this publication, and state/input the reason for why it is rejected.

**Phase 2 – Questionnaire**

After finishing all the tasks, the participants were asked to fill out a questionnaire of 5 questions (Figure 33). The questionnaire posed statements, and the participants were asked to answer on a Likert scale ranging from strongly disagree to strongly agree. The participants were informed that their answers were anonymous, and that I would not oversee them as they filled out the form. This was done in an effort to reduce response bias.
Figure 33: Summative evaluation questionnaire - Motivation

### Phase 3 – Interviews

The interviews were conducted in a semi-structured manner, as some predefined topics were explored in each interview. In addition, some of the comments made during the thinking aloud sequence was reopened for further elaboration. As the evaluation was moderated by me as the student writing this thesis, effort was put into reducing research- and confirmation bias by consciously striving to remaining free of assumptions and in avoiding asking leading questions.

### Participants

The evaluation involved 7 participants with an age of 21 to 26. All participants have completed either a bachelor’s or a master’s degree within informatics, civil engineering, nursing, police studies, or business administration. 2 out of the 7 participants were female, 5 were male. All participants recruited where selected based on availability of the time of the evaluation, and can be said to be a convenience sample.
4.2.3 Findings

Comparison of performance on finding specific publications

The below figures and descriptions concerns the results of the objective qualitative measurements of OAsearch’s performance on the scenario of finding a specific publication compared to Google Scholar. Task 1 – 4 was applied to measure this, however, as the results on task 4 differed from the rest, they are presented in a separate figure. As previously expressed, the participants were asked not to think aloud during these tasks, and thus there is no qualitative verbal responses to add to the results in this section, for now. In the presentation of the findings of the interviews, users’ subjective opinions on the findability of specific publications will be revisited.

![Task completion time when searching for specific publication by title / author](image)

**Figure 34: Summative evaluation findings - Task completion time on task 1-3**

All participants conducted the tasks by copying and pasting the title of the publication into the search field, not using quotation marks and thus performing a key word search rather than a phrase search.

Participant 2, 6 and 7 in the evaluation used Google Scholar first, and the rest of the participants used OAsearch first. Across task 1-3, the difference in average time completing the tasks using the systems was 2.0 seconds in favor of Google Scholar. At a later point, I
timed the systems’ response times on the queries required by the tasks by utilizing the network tools found in Google Chrome’s developer tools. Two key word searches on the title found in each task were conducted, meaning that each service’s average number is based on 6 measurements. OAsearch averaged 2.26 seconds from request sent to response was received, Google Chrome averaged at 0.51 seconds from request sent to response received and DOM content was loaded (as OAsearch is a single page app, Chrome does not record the DOM update time). Response time in OAsearch varied from 0.7 seconds to 3.2 seconds. Scholar’s response time varied from 0.49 to 0.54 seconds.

Figure 35: Summative evaluation findings – Task completion time when searching for specific publication by DOI
The above figures visualize the time users spent finding a publication based on a DOI (Digital Object Identifier) and how many searches they did before finding correct publication. All but two users did not change their input type to “DOI” in the search options panel prior to searching with OAsearch, and were given a set of results unrelated to the actual intent of the searching. After some time, all participants realized that the interface required them to specify that they wish to search by DOI.

Figure 36: Summative evaluation - Queries used to find specific publication by DOI
Comparison of performance when doing exploratory searching

Figure 37: Summative evaluation - Responses on questionnaire regarding the system's performance on exploratory searching

All answers on the questionnaire were in either the neutral category, or the two agreeing categories. All participants used keyword searching on their queries. Most participants searched with keyword being used relatively limited to the topic that they were after, and were quite satisfied with the results based on their *thinking aloud*. One participant stated that “This article seems really relevant to my thesis, and it hasn’t shown up in scholar”. Participants inputting more generic and fewer key terms were, based on their reaction and their verbal response, less content with the results. One participant stated that “the results seems to only be linked to one of the keywords I gave”, when he assessed the results on one of his queries.
Quantitative measurements of the user experience

![Responses on questionnaire regarding the user experience of OAsearch (n = 7)]

Figure 38: Summative evaluation - Responses on questionnaire regarding the user experience of OAsearch

The above figure presents the participants subjective ratings of various aspects of the user experience of OAsearch, and how it would be influenced by adding some elements to the design.

Qualitative measurements of the user experience

In the paragraphs below, the users’ expressed opinions from the thinking aloud protocol and the interviews will be presented. The findings are categorized in the following topics: usability, how the gamified aspects of the service affected the user experience, users sense of the system being a collaborative effort, what additional elements they believe would further enhance motivation to contribute and lastly their overall assessment of the system and their motivation to use it.

When the participants were asked how they perceived the process of finding publications, the participants overall seemed to mostly find it easy and intuitive, but with two exceptions. The search panel seemed to be misplaced, as 5 out of seven participants spent some time figuring out that it was essential for solving task 4. One participant noted that when
inputting a DOI, the system should automatically recognize this and change the settings accordingly. However, the participants seemed to find the act of searching by other means than of authors and title to be an infrequent scenario, and did not express any significant dislikes towards the interface for this reason. One participant stated “The concept of using DOI and ISBN for finding research is really useful, but I can’t remember actually using it when looking up a publication I found in a list of references. I don’t think its that common to use them”. Three of the participants did not know what a DOI is.

The usability of the system appears to be good for all interactions done when contributing to the system, as all participants stated that they had no problems completing the scenario tasks, and encountered no significant issues. One participant stated that “things worked as I expected, and I think the usability was good”, another said that “there were some minor issues that ideally would be different, but these are not important in the big picture”. Users reported that the navigational structure of the site was good, and that “things was logically structured”.

Two participants struggled somewhat with finding the buttons for adding a publication and verify/reject publications, and stated that they found the placement in the top navigation bar to be somewhat strange. Another participant stated that it should be more clear in which order the versions of the publications were added. One participant noted that the gamification panel included too much information, and that she would prefer it to be possible to hide it or only display it on request.

When asked how the game elements of progression through levels, points and content unlock was experienced, the answers were somewhat ambiguous. The participants seemed to enjoy the feedback messages as they received them. Several of the participants expressed notions of joy as the feedback pop-ups were given, and it was stated that “being given points and leveling up ads something to the site which might otherwise have been quite boring”. One participant stated that “seeing the progression bar being almost complete makes me want to make it go all the way up, but its hard to say why”. Another participant expressed that he liked the idea of being able to do things in the system that others could not, and stated that “If someone requested in a comment on a publication that some metadata is wrong and I had the power to fix it, I would enjoy helping them out”. However, two participants gave the impression that as they didn’t see much personal gain in return for
contributing to the system, and that “being awarded more ways to add or fix things in the system isn’t really that tempting”.

When the participants were asked whether they sensed a notion of contributing to a common good when doing the tasks, all the responses were contingent on that there were actual users of the system. Being a quite prototypical answer, one participant stated that “If there actually was people using the system, and I could see that other people contributed as well, I think I would see the site as a group effort”. As one of the participants completing a task of adding a publication and a feedback message was shown, she stated that “I like how the system says ‘thank you’ when I do something good”. Another participant stated that “it feels like there is not much use in adding things as for now, as there are no other users of the system”.

When exploring how additional elements would affect the user experience, it became apparent that the participants desired more social elements rather than competitive. One participant stated that “too me, ranking up and having lots of points would matter much more if I could show it off to other users”, and this view seems to be prevalent among the participants. Three of the participants requested, on their own initiative, that there should be a way to discuss or talk more generally with other users. When asked if the discussion board on each publication served some of this purpose, one participant stated that “I’m not sure if anyone would see the comment if it is not displayed somewhere more general”. One participants argued that introducing discussions and particularly a chat feature were outside what he would expect to find in such an application, and pointed out that allowing one on one communication might compromise the reliability of the quality assurance process. Being able to see what friends had contributed with to the system was also suggested by two of the participants, implying a desire for friend lists and the possibility to track other users’ contributions.

When answering how implementing competitive elements such as scoreboards and competition would affect their motivation to use the system, the responses were two folded. Most of the participants expressed limited excitement on such elements. One participant stated that “having a scoreboard would be nice as a way of showing of your effort to other”, another participant stated that “scoreboards wouldn’t really make sense, because turning the system into too much of a competition would probably make people add bad content just to get points”. However, one participant stated that really really making it into a game
where he could compete with friends, show off their stats and do challenges would make
the tasks more fun. He also suggested that users having trouble finding a specific
publication should be able to give away a bounty on the task of finding the publication.
Users who were good at finding publications other people could not, should be awarded
some special symbols in their names as it is displayed in the system. This user had
experience with other systems implementing similar functionality, and found it to be
fulfilling to solve tasks that others had failed at.

When asked whether they found the application to be useful and whether they would like
to contribute to the system in the future, clear cut answers were hard to obtain. The users
expressed that they found it to be great for finding publications, and that they enjoyed using
the system as it was. A participant stated that “the scenario of me adding a publication that
I knew other people would like to have access to for free as well, might actually happen”.  
One of the participants stated that “If I were a researcher and had published something, I
would include it here so that it would be easier to find. I would also probably fix wrong
metadata on publications I knew if I spotted them”. Another participant stated that “I would
make sure my own publications were correct, and probably add missing information to my
own publications and of those I know”. However, the motivation to contribute with
publications and metadata on publications that they had no relation to themselves seemed
rather absent.
5 Discussion

In this chapter, the findings of the summative evaluation form the basis of a discussion on the research questions posed in the introduction.

5.1 Findability of publications

5.1.1 Finding specific publications

The first set of tasks were conducted to measure the usability of the system when finding specific publications by recording task completion time and number of searches needed to be performed to complete task. As stated in the findings section on the summative evaluation, on tasks where users where asked to find specific publications by title and author, the average difference between the system were 2.0 seconds, and all participants performed only one search for finding each publication. It can be argued that this difference is quite insignificant, as users are likely to perceive the system as fast enough for only doing one query. It could be argued that the increased response time would be more significant when doing more exploratory searching, as users are likely to perform multiple queries in these cases, but no users commented on this by the thinking aloud protocol or in the interview.

About 1.75 seconds of this difference was shown to come down to the response time from the server. The task completion times shows that the more tasks a participant completes, the faster the next task he completes will be. This is likely a result of the participants being trained at using the interfaces, but also a result of their gained experience with using an unfamiliar keyboard and trackpad as they complete more tasks. As there were 7 participants, and one more participant were in the group which used Scholar last, the training effect might have skewed the average task completion time somewhat in favor of Google Scholar. All in all, most of the additional task completion time using OAsearch can be explained by other factors than the usability of the interface for inputting queries, and the interface for which the results are presented. This is not that surprising, as the interactions required for searching and opening a publication are relatively simple. Still, in the heuristic evaluation, some errors in the results interface were highlighted by the evaluators, and fixing these may have contributed to the successful results.
Finding publications by DOI

As also seen in the findings section, the performance of OAsearch was far less optimal when searching by DOI. The data collected in the findings, namely the qualitative statements from the thinking aloud protocol and the interview, point to the fact that this was because the search option panel were not very visible in the interface. It can also be said that this issue would likely not exist if OAsearch was capable of full-text searching in all fields, as this would have been the standard search option.

It could be hypothesized that the nature of how the tasks were presented also affected the results of task 4. As the participants where asked to find a publication by title on the three first tasks, which does not require changing search settings, they might have accustomed themselves into the notion of that simply inputting the query and pressing enter is all there is to the interaction of searching. This effect can have been reinforced in the group which used OAsearch for last, as Google Scholar doesn’t require users to specify by which data field they are searching.

As previously stated, the participants’ overall impression on the usability of the search interface was seemingly not very affected by the issues just discussed, as it was not found to be a common scenario to search by DOI. It could also be argued that once the participants where aware of that they had to specify by which metadata they are searching, the usability would be fairly adequate, and the completion time on another task of finding publications by a DOI would likely be of similar performance as the other tasks.

Subsequently of the summative evaluation, a feature that automatically triggers a search for DOI when the user inputs such a field has been implemented.

5.1.2 Performing explorative searches

As previously described, the system has no logic implemented for ranking search results other than counting matches between the keywords of the queries and the publication titles. With this in mind, it is somewhat surprising that participants rated the performance of exploratory searching using OAsearch as accurate and relevant as they did. This can be explained by several things. Firstly, the ratings of the participants are likely more of an assessment on whether the database contains publications containing all the keywords that the user queried, rather than the systems ability to present the best publications within the
range of publications matching the query. If users had been given tasks to see if the system returned the most significant publications within a particular research field when inputting relevant keywords, the results would likely be rather different. Still, the results indicate that the functionalities of the full-text search implemented on the titles are quite adequate also for exploratory searching and that the current database of publications is extensive enough for this purpose as well. Though, services ranking results by more advanced algorithms considering citation counts and other statistics will be superior on this matter.

5.2 User experience and motivation

5.2.1 Overall user experience

The intention of the more extensive questionnaire was to explore the user experience that the system offers. A user experience is made up of numerous factors, but ensuring good usability is pivot in achieving a desired one. The data shows that all users agree or strongly agree that “the system is easy and pleasant to use”, which indicates that the system do have a sufficient degree of usability.

Among many desired user experiences, the one of a motivating system has been the primary pursued one. As seen in the findings of the summative evaluation: on the statement of that OAsearch is fun and motivating to use, the participants mostly placed themselves within the two agreeing categories, but two participants positioned themselves as neutral towards the statement. This do indicate that the design efforts of providing an overall motivating system has been moderately successful. The statements in the interviews and from the thinking aloud protocol provides a more nuanced view of this conception, which will be presented throughout this chapter.

5.2.2 Examining participants’ motivation

Statements from the interview indicated that the participants found the underlying activities of adding, quality assuring and curating publications to be somewhat dull in themselves, meaning that they were not intrinsically motivated to do the tasks. Still, as discussed, the participants did find the system to be motivating overall. As previously stated, the metastudy by (Deci, 1971) found that external rewards had no effect on the intrinsic motivation of tasks that were initially deemed dull. They further suggest that facilitating
internalization and self-motivation instead of relying on extrinsic rewards might be more relevant to facilitate increased motivation. With this in mind, it can be argued that the motivation that is seen among the participants to some extent is a result of internalization of the motives behind OAsearch, indicating what would be described as *identified regulation* according to SDT.

In addition to the internalization of goals, the evident motivation among the participants can be hypothesized to be a result of the implementation of gamification. Users pointed out that they liked to progress through levels, unlocking features and receive the affirming feedback messages, indicating that these game elements did enhance motivation. No users pointed out that earning points, or being awarded a new level in itself was perceived as fun or motivating. The questionnaire statement regarding whether game elements enhances the users’ motivation towards contributing yielded somewhat ambiguous results, but can overall be said to support the notion of that these elements did enhance motivation.

It can be argued that by implementing the low level game components of points, levels, content unlocking and achievements; the game mechanics of cooperation, chance, feedback and rewards has brought motivation particularly through realization of the dynamic game element of progression. By not implementing the application as a zero-sum game, and by verbalizing the notion of the application being a joint effort of the community of users, dynamic game elements of *emotions* and *relationships* was hopefully also attendant. It can be hypothesized that the dynamics of progression successfully support the participants underlying need for feelings of competence, and that the feelings of cooperation and realization of relationships supports the underlying need for relatedness likewise.

### 5.2.3 How can users’ motivation be enhanced further?

As previously stated, there are numerous possibilities and choices to be made with regards to the implementation of gamification. Far from all desired mechanics were implemented in OAsearch as a result of the limitations imposed by this being a master thesis rather than a cooperate initiative. The implemented game elements were a mere selection among the desired, and were chosen on the grounds of what elements were thought to have the most effect considering the amount of work required to implement them.
The data from the questionnaire strongly indicate that it is social elements which particularly would further enhance motivation. Several of the participants enthusiastically suggested friends lists and the ability to follow other friends’ contributions. It was also stated that earning levels and badges would be more worthwhile if users could show off their earnings. Implementing competitive elements where preferred by particularly one participant, which expressed enthusiasm for the idea of competing amongst friends or within research fields, establishing competitions and track stats and compete on leaderboards and challenges. The gathered input resonates with the motivational factors of the previously described player types. It seems that out of the pool of participants, most of them could be identified with a stronger affiliation towards the player types of collaborators as they desired social elements, and competitors as they wished for ways of showcasing their achievements.

It can be argued that the value and usefulness of OAsearch correlates with the extensiveness and quality of the collection of publications. Further, the quality and extensiveness is dependent on having a substantial user base adding and undertaking the curation of publications. And lastly, users’ willingness towards adopting OAsearch is likely to coincide with the extensiveness and quality of the collection, the size of the user base, the usefulness of the offered features and the general usability and user experience. As all these aspects are seemingly interconnected, facilitating one or several of these aspects are likely to enhance all.

5.3 Limitations

As three different methods was employed, both qualitative and quantitative, and the participants’ responses where consistent over the course of the three methods, the reliability of the results are arguably quite sufficient. The responses across the participants were also relatively clustered, but as the size of the selection of participants is limited, it can not be stated with certainty.

As a result of limited time and resources, the summative evaluation has some significant issues which reduces the validity of the evaluation. A somewhat unrepresentative sample, and an insufficient sample size are the major concerns. These, and other limitations are further discussed in the sections below.
5.3.1 Representativity

The participants have all completed a bachelor’s degree or more, and are in this sense academics and thus potential users. However, they do not make out a representative selection of the entire population of interest, as none of them are working as researchers and publishing peer-reviewed publications. Researchers with experience of publishing papers may experience the interface of adding publications differently than the participants in the evaluation, which does reduce the validity of the evaluation.

All participants are under the age of 26, and is there not representative of the age of the population of interest. Older user with less digital experience would maybe have rated the performance of OAsearch lower than the actual participants.

5.3.2 Sample size

The data collected in the questionaries’ can not be said to be more than moderately saturated, which means that the sample size of 7 participants only provide statistical power to do rather general conclusions on the performance of OAsearch. By collapsing the agreeing categories of the Likert scale and by utilizing the qualitative data from the observations and interviews, I believe that there is a sufficient foundation to the assumptions of the discussion and conclusions drawn in this thesis.

5.3.3 Respondent bias

The sample of participants where selected consists of people that know me personally, which introduces some potential biases. The respondents may exaggerate the performance of OAsearch in an effort to please me, or to avoid appearing critical or mean. Steps were taken to counter this effect. Firstly, it was stressed that I did not in any way wish or expect the participants to rate the application in an overly positive manner prior to the evaluations. In addition, the feedback in the questionnaire were anonymized in an effort to increase the honesty of the answers. By recruiting participants unfamiliar to me as the researcher, or more ideally by randomizing a sample of participants among the population of interest, such biases could have been countered.

Another potential bias emerges with the use of Likert scale questions on the questionnaire. In the questionnaire distributed, all the statements were formulated in a positive manner.
An acquiescence bias may have emerged, meaning that the tendency some people have towards agreeing rather than disagreeing may have reduced the validity of the evaluation. This effect could have been controlled by distributing two sets of questionnaires which only differed in whether the statements were expressed in a positive manner or not, and then randomizing which of the set each participant where distributed.

5.3.4 Researchers bias

As I as the researchers moderated the evaluation myself, a confirmation bias may have occurred. However, as a somewhat trained researcher I am aware of this potential bias during the evaluation, and consciously avoided asking leading questions and put effort in keeping myself free from presumptions. By having a moderator independent of the thesis moderating the evaluation, these biases could potentially be further reduced.

5.3.5 Sample of tasks

Several aspects of the user interface involved when searching for publications were not tested, and the system is likely to perform less optimal if it had been tested more extensively. Some additional likely use scenarios are:

- Users only know the authors of a specific publication. The system is likely to perform less optimal in these cases, as it is not possible to do full-text searches in other fields than than titles.
- Users may wish to combine fields of input, but this is not possible with the current system.
- Lack of significant metadata or erroneous metadata on the publication a user is looking for
- The system does not contain the publication that the user is looking for.

When doing exploratory searching, the evaluation the participants did of the results was quite shallow. By requiring the participants to do a more thorough evaluation of the resulting publications of a search, the performance of OAsearch would possibly have been different.
The tasks which were administered during the evaluation is not a complete set of the scenarios which may happen in a real life context, which reduces the validity of the evaluation. To capture the full extent of the usability of the system when searching for specific publications, implementing a naturalistic study where the participants are asked to use the system as their primary source of publications over some period of time, would have been useful for gaining a more extensive understanding of the current usability and motivation.

During the interviews, participants emphasized the importance of that there were other users utilizing the system in order for them to actually want to use the system. This indicates that the answers given in the questionnaire to some degree is a characterization of how the participants would perceive the system if it actually had a substantial user base, rather than how they experienced the system as it currently is.
6 Conclusion

Two areas of focus were established in the introduction through the research questions, namely how to make publications findable, as well as how to motivate users to add, quality assure and curate publications.

6.1 Are the publications in OAsearch findable?

By harvesting about 900,000 publications from DOAJ.org and implementing full-text search with a selection of search functionalities, a somewhat substantial search interface has been implemented to provide findability of publications. In the preliminary phase of the thesis, an expert was interviewed partly to explore how researchers use the current search engines for finding scholarly publications. Two main scenarios were identified, namely finding a particular publication based on title and perhaps authors, as well as doing more exploratory searching to learn more on a particular topic. A summative usability test showed that the interface implemented is completely adequate for the scenario of finding publications by title, but lacking when searching by other fields. Providing a system in line with the big budget established services when it comes to exploratory searching is unrealistic in the context of a master thesis, but the summative usability test proved that OAsearch is a surprisingly usable service for this purpose as well.

6.2 Does OAsearch provide motivation to add, curate and quality assure publications?

Providing motivation to add, curate and quality assure publications has been found to require a highly substantial effort, and the main bulk of this thesis has revolved around the theory, the design and evaluations conducted in order to achieve this.

By researching similar products and gathering requirements through an expert interview, a set of desired functionalities for OAsearch was established. A substantial review of relevant theory on gamification and motivation more generally has been conducted, and a somewhat limited set of game design elements were implemented. A set of wireframes were developed, and later a high fidelity prototype of the service. A heuristic evaluation conducted to find usability issues in the design was performed, and the problems discovered
in this prototype were addressed through another development cycle. Finally, a summative evaluation which in addition to gathering quantitative data on usability, findability and motivation also explored these aspects deeper through by using the thinking aloud protocol, and by interviewing the participants.

Based on the collected data, I believe it can be concluded that the gamification has provided a moderate increase in users’ motivation towards adopting the system and contributing. Though, the limited set of game design elements are likely not reaching the full potential benefit of gamifying the application. Providing sufficient usability and a pleasant user experience is central in ensuring user motivation, and the summative evaluation indicate that this has been achieved. Overall, the data obtained from the summative evaluation indicate that the users where moderately motivated to add, curate and quality assure publications.
7 Future work and Final Remarks

7.1 Future work

As previously discussed, introducing social game elements and allowing users to show off their contributions and earnings were found to be the most favored game design elements to implement. A natural implementation of this might be to allow users to create a profile page where they can show off their contributions, and perhaps to display users’ scores next to usernames throughout the system, and making usernames a link to such a profile page.

As previously mentioned, the application has been given several new features and improvements since the summative evaluation. As the deadline for submission of this thesis were too close, yet another evaluation could not be performed in time. However, it would have been interesting to further develop the gamified aspects of the application, and subsequently evaluate whether the additional elements have actually increased user motivation further. In such an evaluation, I would include researchers as participants and increase the number of participants.

Much of this thesis has revolved around how users can be motivated to contribute in the context of OAsearch. OAsearch was decided to be designed as a non zero-sum game by avoiding competitive game elements, as this was hypothesized to be suitable in the context of the collaborative service that OAsearch is. I would find it interesting to further explore how different types of game design elements affect motivation in different kinds of applications. Perhaps competitive game design elements are more appropriate in crowdsourcing application with selective integration, where only a single or a few contributions are utilized. It would also have been interesting to investigate how different player types experience OAsearch, and perhaps see whether users which can be affiliated with the competitive player type is in fact less motivated to participate in OAsearch or other non zero-sum games.

There are numerous features I deem desirable for OAsearch. There should also be a system in place to view and revert users’ changes to publications, considering the possibility of vandalism and user error. Proving better search functionality would also be a top priority.
Chapter 7 - Future work and Final Remarks

It was planned to implement the open source search engine named Elasticsearch and syncing publications from the current database to this search engine, but there was no time. Elasticsearch would have simplified creating an interface that enables users to combine fields and do more advanced queries, as well as improving the search algorithm.

7.2 Final remarks

The process of technically developing OAsearch involves numerous processes, including setting up a VPS, acquiring a domain, harvesting publications into the database, writing database scripts, coding, bug fixing and testing. All these processes have proved to be highly time consuming, especially since my web development skills were limited to basic use of angular, PHP and SQL prior to engaging in the development of OAsearch. As a result, countless hours has gone into learning NodeJS, ExpressJS, MongoDB, AngularJS and the numerous additional modules and frameworks needed in the project, in addition to actually writing the code. My web development skills have increased tremendously during the work of this thesis, and this is perhaps the taking I value the most.

I have been thought many important lessons throughout the process of developing a concept into a fully working product. Two central takings from is process is the importance of user testing, and properly planning evaluations. Parts of the interface were proved to be less performing and intuitive to users than anticipated. After discovering many of these issues, the design could be further optimized. I have also been taught the importance of properly planning evaluations in order to obtain valid results. Even though substantial effort was put into planning the summative evaluation, there were some drawbacks to the design of it. The results suffered from a sample of participants being somewhat inadequate in terms of representativeness and size.

Through researching literature on gamification, it became evident that carelessly applying simple game components such as score and badges are unlikely to yield much user motivation. Instead, by thoughtfully considering business objectives, desirable behaviors, target users, and thoughtfully choosing game dynamics, mechanics and components you are far more likely to achieve increased user motivation.

37 https://www.elastic.co/products/elasticsearch


BEALL, J. 2013. Predatory publishing is just one of the consequences of gold open access. *Learned Publishing*, 26, 79-84.


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Appendix 1: Expert interview – Interview guide

- Which services do you use for finding academic publications online?
- Why do you use these services?
  - Good search functionality?
  - Quality control of publications included?
  - Good additional tools and features?
- Have you encountered any issues when accessing online publications?
  - Toll barriers?
  - Bad usability?
- Do you have any particular experiences with the process of adding publications to these services?
  - What works well?
  - Any issues?
- Do you have any particular impressions of the quality of metadata on publications in these services?
- Do you have any experiences or opinions on services for finding open access publications?
  - Quality control
  - Usability
- As a domain expert, do you have any thoughts or ideas on ways to solve the issues you are currently experiencing?
- Are there any other shortcomings in the current services, or any features that you wish would be included in the design of a new application for finding academic publications?
Appendices

Appendix 2: Expert interview – Write up

What services do you use to find academic publications? How do you use them?

The interviewee state that “I primarily use google Scholar when searching for publications”, but he later adds that the regular Google search engine is often used as well. He identifies three different use cases in relation to searching for publications: firstly, that he knows the title and author of a specific publication, and simply wishes to access it. In these cases, he often finds himself doing a regular google search as “this is an excellent service when searching for title combined with the primary author”. If this does not yield the desired result, he will then use Google Scholar which then often will find the desired publication.

A second use case that he identities is when he is looking for non-academic texts such as can be found on blogs, news articles or technical manuals. As Google Scholar intends to only include peer-reviewed publications, it is not fitting for this purpose and the regular Google is used instead.

The last use case the interviewee expresses is when he is interested in a wider scope of publications and inputs key words on an interest field or a new phenomenon, rather than specific titles and authors. He states that for this use, he primarily uses Google Scholar, as the regular Google search engine yields to much irrelevant and low quality results. He also states that “I sometimes use the library services, where qualified staff searches on my behalf in the databases that they can access”.

Experiences regarding making his own research findable

The interview subject state states that for finding publications he finds Google Scholar to be the best working service, although it is not perfect. The critiques he has on the service is primarily as a researcher interested in making his own publications findable through the service. “Even though I am satisfied with Google Scholar as a user, it is hard to get your own things in and make them findable through Google Scholar, primarily because they seem to ignore metadata unless they have an arrangement with the provider”.

He states that Google Scholar has published inclusion guidelines for publishers to follow, which requires that metadata should be made available in the HTML files where the publications are located. The interviewee state that he thinks the inclusion guidelines are overlooked by Google
Scholar, unless the repository in question has an agreement with them. Such a repository may belong to a university publisher. In these cases, Google relies on the metadata that the organizations provide in their repositories.

However, the interviewee believes that Google Scholar ignores the metadata when the provider of the repository is not a contracting party. He states to have meticulously followed the guidelines Scholar provides as he published his own research in his own repository, but that the metadata he provided was still ignored by Google Scholar. Instead, the interviewee finds that the metadata Scholar uses is clearly generated by scraping the PDF’s. As a result of using PDF-scraping rather than utilizing the metadata that publishers post, the metadata of his publications in Google Scholar “are often erroneous and incomplete”. He states to have encountered instances where title and the name of the author is switched, and things similar.

When questioned on whether he has encountered any issues or problems when accessing publications, he says “no, not lately”. He further states that he will almost always find a publication either through legitimate sources, such as green or gold OA repositories, or through more illegitimate sources. Such am illegitimate source he exemplifies by stating that there are teachers which include articles in compendiums for students. As these compendiums lie open on the internet, people can access articles not intended to be freely accessed, even though this is a clear violation of the copyright.

The interviewee adds that based on his own experiences, he sees that clearly not everyone is able to find the publications they are looking for, even though they are published online. He exemplifies this with the fact that he has some publications made available on OA repositories and are included in Google Scholar, but he still gets requests from users of a service called academia.edu to publish them. Evidently, they were not able to locate the published publications online.

The interview subject state that he uses other services as well for self promotion, making his publications findable and socializing in an academic context. He mentions Academia.edu and Mendeley.com, and state that such services is good for these purposes. The interview subject state that “Academia is Facebook for academics”, and exemplifies the features of Academia.edu by stating that they provide friend lists, they can send you an email when a friend publishes something and you can “like” content of your choice, in addition to enabling researchers to upload
their research. They also discover publications you may have published, but not linked to your profile, and ask you to verify that you are the author of the suggested publications.

The interviewee state that “Academia is good for keeping track of what your friend and colleagues publishes, but not finding publications of complete strangers.” He states that the search interface of this service is bad for finding specific publications.

When questioned on experiences on other services than those of Google, the interviewee highlights a service called arxiv.org. This is a green OA repository which allows users to upload their own publications. Unfortunately, the service suffers from insufficient quality control. They have a staff of moderators doing their best to keep out spam, and are “by all means doing an admirable job, but they are likely too few”. This results in that “there is too much content that should not be findable through an academic search engine”.

Appendencies
Appendix 3: Expert interview - Consent form

Background and purpose

This interview is conducted as a part of Espen Andreassen’s master thesis at the University of Oslo. The purpose of the thesis is to design an online application for curating Open Access publications and making them findable. This interview is intended to explore the thesis’s area of domain, explore the use and shortcomings in current services and to establish user needs for the application which is to be designed. The interview subjects can withdraw their contributions at any time while the project is ongoing without stating any reason. The researcher may be reached at: espeandr@ifi.uio.no

Participation

Participation involves being interviewed by Espen Andreassen. The interview will last approximately 30 minutes. Notes may be written during the interview, and an audio recording of the interview and subsequent dialogue will be made.

Handling of collected data

The interviewee will not be identified by name in the collected data or in the the published thesis. The notes and audio recording collected will be deleted after the submission of the thesis.

Participant’s signature, date, place: _____________________________________________

Researcher’s signature, date, place: _____________________________________________
Appendices

Appendix 4: Heuristic evaluation – Tasks

Repeat each task a reasonable amount of times: try to vary your input and sequence of actions.

1. Register an account on the service (your account will be deleted subsequent of this evaluation)

2. Find the abstract of the publication titled “Improving the effectiveness of developed heuristic evaluation method”

3. Find the name of the publisher of the same publication

4. Add you own name as an author of this publication

5. Add another alternative source to the publication
   a. Link to the source you wish to add: http://testurl.com/
   b. Specify the version to be “this is a test source”

6. Vote the version you just added up, and the current version down

7. Verify the publication named “Conducting a heuristic evaluation”

8. Reject the publication named “My high school paper on bees”

9. Sign out

10. Spend the rest of the time exploring the interface at will.
Appendices

Appendix 5: Heuristic evaluation – Consent form

Background and purpose

This evaluation is conducted as a part of Espen Andreassen’s master thesis at the University of Oslo. The purpose of the thesis is to design an online application for curating Open Access publications and making them findable. This evaluation is intended to discover usability problems of the current design of the applications, so they may be attended to. The participants can withdraw their contributions at any time while the project is ongoing without stating any reason. The researcher may be reached at: espeandr@ifi.uio.no

Participation

Participation involves performing a heuristic evaluation of a prototype web page, and will last approximately 1 hour. The participants are asked to evaluate the design following a set of heuristics, and subsequently discuss and compile the results with other evaluators. An audio recording of the compilation discussion will be made.

Handling of collected data

The participants will not be identified by name in the collected data or in the the published thesis. The audio recording collected will be deleted after the submission of the thesis.

Participant’s signature, date, place: ________________________________

Researcher’s signature, date, place: ________________________________
Appendix 6: Heuristic evaluation – Heuristics

Below you will find 10 heuristics\textsuperscript{38}, and an example at the end of the document on how to note potential issues you may encounter during the evaluation.

1: Visibility of system status

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

2: Match between system and the real world

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

3: User control and freedom

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

4: Consistency and standards

- Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

5: Error prevention

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

6: Recognition rather than recall

- Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another.

\textsuperscript{38} 10 Usability heuristics for user interface design, Jakob Neilsen 1995. Available at https://www.nngroup.com/articles/ten-usability-heuristics/
Instructions for use of the system should be visible or easily retrievable whenever appropriate.

7: Flexibility and efficiency of use

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

8: Aesthetic and minimalist design

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

9: Help users recognize, diagnose, and recover from errors

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

10: Help and documentation

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

Fill in the fields that are relevant to the issue you may find.

<table>
<thead>
<tr>
<th>Heuristic (number)</th>
<th>Task (number)</th>
<th>Severity (0-10)</th>
<th>Where?</th>
<th>What is the problem?</th>
<th>Suggested improvement?</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>7</td>
<td>Home screen</td>
<td>The search functionality does not work</td>
<td>Fix it</td>
</tr>
</tbody>
</table>
## Appendix 7: Heuristic evaluation – Compiled list of issues

<table>
<thead>
<tr>
<th>Heuristic (number)</th>
<th>Task (number)</th>
<th>Severity (0-10)</th>
<th>Where?</th>
<th>What is the problem?</th>
<th>Suggested improvement?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5</td>
<td>8</td>
<td>Add version</td>
<td>Article got added twice</td>
<td>Only add it 1 time</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>7</td>
<td>Publication page</td>
<td>It should be easier to find the main functionalities for adding versions and editing metadata.</td>
<td>Put the buttons for these two functionalities somewhere more visible, maybe both in a menu.</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>7</td>
<td>All functionalities requiring log in</td>
<td>Functionalities that require log in should be more visible that is disabled until user has logged in.</td>
<td>“grey out” or hide unavailable functionality.</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>7</td>
<td>Home screen</td>
<td>The extended search functionality does not work.</td>
<td>Fix it.</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>7</td>
<td>Home screen</td>
<td>Search is very slow.</td>
<td>Make it faster.</td>
</tr>
<tr>
<td>1, 3</td>
<td>Exploring</td>
<td>7</td>
<td>Various pages</td>
<td>Hard to figure out how to navigate back.</td>
<td>Add back buttons or breadcrumbs.</td>
</tr>
<tr>
<td>8</td>
<td>Exploring</td>
<td>7</td>
<td>Everywhere</td>
<td>Somewhat bad visibility as a result of small text and low contrast.</td>
<td>Make it more distinct.</td>
</tr>
<tr>
<td>3</td>
<td>Exploring</td>
<td>7</td>
<td>Search results</td>
<td>Somewhat difficult to see that the “more on this publication” is a button.</td>
<td>Make a button below the text instead of having the text as a clickable link.</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>Meta data view</td>
<td>The input field of new value should contain the current value so it is easier to remove/add things.</td>
<td>Add current value.</td>
</tr>
<tr>
<td>8</td>
<td>Exploring</td>
<td>3</td>
<td>Everywhere</td>
<td>Annoying icon from logo in lower</td>
<td>Remove it.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>3</td>
<td>Registering</td>
<td>When password is too short, the error feedback is hard to see.</td>
<td>Make the feedback bigger and in a more visible color.</td>
</tr>
<tr>
<td>10</td>
<td>Exploring</td>
<td>3</td>
<td>General</td>
<td>Hard to navigate.</td>
<td>Implement a tutorial after creating user to learn about how it works.</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
<td>Home screen</td>
<td>Would be nice with autocomplete when searching.</td>
<td>Implement auto complete.</td>
</tr>
<tr>
<td>3</td>
<td>Exploring</td>
<td>1</td>
<td>General</td>
<td>A lot of inputs to fill out to add publications manually.</td>
<td>Maybe add the ability to add articles from endnote/latex references (or at least extract most of the values from it).</td>
</tr>
</tbody>
</table>
Appendix 8: Summative evaluation - Tasks/scenarios

Set 1: Tasks of finding publications

1. Find and open the full text of the following publication

   **Title:** “Intrinsic and extrinsic motivations: Classic definitions and new directions”

   **Authors:** RM Ryan ; EL Deci

2. Find and open the full text of the following publication:

   **Title:** “Towards a characterization of crowdsourcing practices”

   **Authors:** Karen Robsona ; Kirk Planggerb ; Jan H. Kietzmanna ; Ian McCartheya ; Leyland Pitta

3. Find and open the full text of the following publication:

   **Title:** “Is it all a game? Understanding the principles of gamification”

   **Authors:** Hinely Mark ; Winter Jeff

4. Find and open the full-text of the following publication:

   **DOI:** “10.14419/ijans.v4i1.3726”

   **Author:** Yosria Hossein

Set 2: Tasks of searching for interest fields

Please conduct 3 searches for publications on topics that interests you or you wish to explore. After conducting the searches, you will be asked to rate the relevance and accuracy of the results that the services gave you on your queries.

Set 2: Scenarios

- “You’re a researcher which has published a paper you think a lot of people will find to be interesting. Currently, it is not receiving much attention as it is only published on your research institutions repository. You are aware that OAsearch allows you to your
publication to its database which makes it findable through the service’s search functionality.

- Add the following publication to the service:
  - Title: “A study on human motivation”
  - Link: http://www.dummyurl.com
  - Authors: Input your own name
  - Publisher: “OAsearch publishing”

- “You were told the title of a great publication on a matter that really interests you, unfortunately only easily findable version cost more than what you find reasonable to pay for it. After spending more than half an hour searching through the internet for an alternative version, you finally found a preprint of the publication available for free. You want to add it to OAsearch to make it easier for other people to find.

  - Add the following publication to OAsearch
    - Title: “The Stanford prison experiment”
    - Link: http://www.dummyurl.com
    - Version type: “preprint”

- You used OAsearch to find a publication, but the version of the publication which OAsearch gave was a bad quality scan of a printed document. You search the internet and successfully find a better quality version, and wish to add it as an alternative version of the publication in OAsearch. As you believe this version is better than the current top rated, you vote on the version you just added.

  - Add and then vote on the below version/source to the publication titled “Modern Computer Interface Designs for Most Flexible Human Computer Interactions”.
    - Link: http://www.dummyurl.com
- Version type: “Version of record”

- You navigate to the page of publications awaiting verification. You spot a publication named *My high school paper on bees*, which is clearly unfitting for OAsearch as it is not a peer-reviewed scholarly publication.
  
  o Reject this publication, and state the reason for why it is rejected.

- You navigate to the page of publications awaiting verification. You spot a publication titled *Examining Correlations in Usability Data to Effectivize Usability Testing*. After examining the publication, you find that it fulfills the inclusion guidelines of OAsearch.

  o Verify/accept this publication.

- You have published a paper, and do a search in OAsearch to see if it is included. You find that the publication is in the database, but that you are not listed as the author.

  o Add your own name as the author of the publication titled “Computer Vision Based Human Computer Interaction”.
Appendix 9: Summative evaluation – Interview guide

- How did you find the process of adding publications, editing metadata, adding versions, and voting to be? (asked separately)?
  
  o Did the easy of use or troubles you encounter impact your motivation to use the system? How?

- How did you experience the game elements?
  
  o Did they add to your motivation to contribute to the system? Why, why not?
  
  o Any specific elements having a negative or particular positive effect?

- Did you experience some sense of collaboration when doing the scenario tasks?

- Are there some aspects that you think might further motivate you or other users to contribute?
  
  o Would you be more motivated by competitive elements? How?
  
  o Would you be more motivated be collaborative and social elements? How?

- Is this service something that may be relevant for you to use in the future?

- Do you think other people than yourself would find this application to be useful and motivating? Why?
Appendix 10: Summative evaluation – Consent form

Background and purpose

This evaluation is conducted as a part of Espen Andreassen’s master thesis at the University of Oslo. The purpose of the thesis is to design an online application for curating Open Access publications and making them findable. This evaluation is intended to assess the service, more specifically the findability that it offers and its motivational impact. The participants can withdraw their contributions at any time while the project is ongoing without stating any reason. The researcher may be reached at: espeandr@ifi.uio.no

Participation

Participation involves performing a series of tasks such as searching for scientific publications, editing publications and adding publications to the service. Participation also involves filling out two short questionnaires, and subjecting themselves to a short interview. One of the questionnaires will be answered anonymously. The session will not last longer than 1 hour. An audio recording of the entire session will be made.

Handling of collected data

The participants will not be identified by name in the collected data or in the the published thesis. The audio recording collected will be deleted after the submission of the thesis.

Participant’s signature, date, place: ____________________________________________

Researcher’s signature, date, place: ____________________________________________
Appendix 11: Summative evaluation – Summary of qualitative assessments

- How did you experience the system when using it to find both specific publications, but also doing broader searches?

- How did you find the process of adding publications, editing metadata, adding versions, and voting to be? (asked separately)?
  
  o Did the easy of use or troubles you encounter impact your motivation to use the system? How?

- How did you experience the game elements?
  
  o Did they add to your motivation to contribute to the system? Why, why not?
  
  o Any specific elements having a negative or particular positive effect?

- Did you experience some sense of collaboration when doing the scenario tasks?

- Are there some aspects that you think might further motivate you or other users to contribute?
  
  o Would you be more motivated by competitive elements? How?
  
  o Would you be more motivated be collaborative and social elements? How?

- Is this service something that may be relevant for you to use in the future?

- Do you think other people than yourself would find this application to be useful and motivating? Why?