

Universiteit Leiden Opleiding Informatica

A comparison of search engine user interfaces

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BACHELOR THESIS

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1 Introduction

Over the course of many years we have been using search engines to search for information on the internet. These search engines have changed significantly during this period. For an example how search engine user interfaces have changed look at Figure 1, where you can see an example of Google's changing design from 1997 to 2014. As you can see the design became more minimalistic. The sidebars have appeared and disappeared again and now Google is using a drop down menu for the search options. Advertisement became a common sight in the interface, but they have changed from an advertisment that sticks out to an advertisement that blends in with the results. Also Google has started showing results from different kinds of searches like image search, news articles and Google maps, depending on the search query. The place of most of these additional results changed from between the search results to the sidebar. Furthermore Google started showing (summarized) content from other websites like Wikipedia in the sidebar or showing what other people searched for in the sidebar. But the most interesting change is the way a search result is represented. As you can see the explanation why a search results is returned became more elaborate in 2005.

We all grew accustomed to the user interfaces of the search engines we know today and specificly to the interface of Google which is used for 70.3% of all the search queries in 2014[1]. But how satisfied are we with these interfaces? Is the effort Google or Yahoo or any of the other search engines put in redesigning the user interface worth the effort or is it just a waste of time? Search engines have focussed their efforts at explaining why a result is returned. But does this explanation have any influence on the satisfaction of their users? This leads to the following research question:

"Is the rate of satisfaction higher when a search engine explains why the engine returns the results and with which user interface is the satisfaction the highest?"

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(j) Google in 2012	(k) Google in 2013	(l) Google in 2014

Figure 1: Interface of Google from 1997 to 2014

The answer to this question in not yet researched in a quantifiable and qualitive way. To answer this question a survey is created, because these proved to be quantifiable and qualitive[2]. We will research this question for text based queries looking for websites and images and for image based queries looking for visually similar images. In order to do this we will create a survey that shows several examples of search engine user interfaces with the question how satisfied the respondent is. This will be done for several categories so any bias because of prior knowledge of a topic can be reduced. To aswer the research question we will divide the research question into three questions.

- 1. Is the rate of satisfaction higher when a search engine explains why the search engine returns the values for a text based search for websites?
- 2. Is the rate of satisfaction higher when a search engine explains why the search engine returns the values for a search for images ?
- 3. With which user interface is the satisfaction the highest for a text based search for websites?

The remainder of this thesis is organized as follows. Section 2 describes the background of the thesis. First we will discuss an assessment of the current search engines. After that a review of a literature research is given. In this review we discuss the theories presented in the literature and use them to support our decisions. In section 3 we will present the survey and all the associated aspects. Section 4 will present the results and these will be discussed in Section 6. In section 5 we will conclude our findings.

2 Background

Because neither of us had any prior experience with conducting online surveys, we have done an extensive literature research. In this section we will present a review of our research and explain some of the decisions we have made concerning all the factors that needs to be taken into account when designing a survey.

2.1 Assessment

At the start of our research we made an assessment of the top 5 most used search engines in 2014: Google (70.3%), Baidu (16.37%), Yahoo (6.16%), Bing (6.09%) and AOL (0.26%)[1]. Because of the big market share of Google we expected that their interface was different from the other search engines. However it turned out that all the search engines are doing more or less the same when searching for a website as you can see in Figure 2. All the search engines show a short bit of the website of the result with the keywords in bold font. Only Baidu deviated from the bold font and used a red font for highlighting.

Except for an explanation why a result was returned most search engines also give additional information related to the query. For example a summary of Wikipedia when searching for persons. Also related searches were given at the bottom of the pages. However for the survey the additional information and related searches are not taken into account. We choose to only analyse the level of satisfaction with the (explained) results because we found this to be the main task of a search engine. And we needed to make sure that the survey wouldn't take to long cause this may discourage people from participating [3], [2], [4], [5], [6], [7], [8], [9], [10]. Taking all factors into account would probably lead to a very long survey with bad response rates. Also we would like to do some research on image search. A comparison of the search engines showed that they don't show an explanation directly in the results, except for Google who shows them after one click. And when searning for similar images with the use of an image query no explanation on why the results were shown was given. So we will also be researching if showing a explanation immediately will affect the level of satifaction. This strengthens our argument not to include all factors, because this will lead to even more questions.



(a) Google (b) Baidu (c) Yahoo



Figure 2: 2014 interfaces of the top 5 most used search engines

2.2 Choosing the type of survey

Having a idea which type of questions we are going to ask we need to make a decision about our type of survey. There are three alternative media which can be considered for distributing the survey: conventional mail, email and a web survey. A distinction is made between an opinion poll and an academic survey[3]. Your choice of survey type should depend on two criteria: your sample and the purpose of the survey[3]. Our survey focusses on the satisfaction of the users when using a search engine. So we focus on the interaction between a person and a service that has a user interface or you could also say the user experience[11]. In determing how many people like something a opinion poll is used[3], so we will conduct an opinion poll. However this leads to no decision in whether to use a conventional mail, email or web survey.

2.2.1 Paper vs Online

First we need to decide to use a conventional mail survey or an online survey through email or on the internet. We take the following criteria into account and will discuss them in this section: costs, response rate, data collection, response quality, time consumption, privacy of respondent, design options and sample control.

Cost The costs for the survey are one of the big factors influencing our decision. Because we have very limited funds available we need to conduct the survey as cheap as possible. Research shows that a survey conducted online is much cheaper compared to a survey on paper [12], [13], [2], [14], [15], [16], [17], [18], [19]. It even shows that the quality of a survey will not be comprimised by conducting it online at cheaper cost[12]. The costs are lower because data is collected faster, the collection of the data demands fewer people[13] and sending sollicitation emails is free[15].

Response rate When conducting an online survey it is important to keep the response rate in mind. Low response rates may lead to biased results which treatens the quality of the research[13], [17], [20], [21]. Therefore the response rates should be kept in mind when choosing and desinging a survey. Research shows mixed result when comparing response rates of paper surveys and online surveys. Some researches state that online surveys offer the possibility of higher response rates [12], [2], [14], [22], [23]. Others state that their is no significance difference in response rates [24] or that the response rates are even lower [17], [18], [19], [21], [25]. A reason for a lower response rate could be that respondents don't have internet access^[17], ^[18], ^[19] so they can not be reached^[15] or the use of spam-blocking tools which blocks the invitations [10], [17], [26], [15]. However with a web survey the problem of distant becomes less of a problem so peoplo who are distant from the research site can be reached [27] and they reach the population with internet experience. When researching a population with internet experience, online surveys have proved to be usefull[28].

Data collection Data collection is a major part of a survey and can be very time consuming. Research shows however that online surveys provide an outcome. Data collection is faster[17], [18], [19], [29], [13], [14], [16], data evaluation is quicker[12], because this is done by the computer, the quality of the data is improved[16] and may lead to larger and more representative samples[14].

Response quality Also the quality of the responses should be taken into account because response of a bad quality might corrupt the result. Research states that questionnaires completed through email surveys result in more complete responses with a higher quality[24], [30] and less mistakes[30]. Also data collected through a web survey is likely to be less error prone[12].

Time consumption It is important for a survey to take as less time as possible because a survey that is too long will lead to lower response rates[3], [2], [4], [5], [6], [7], [8], [9], [10]. But also the consumption of time for the analyst should be taken into account. Time economy is offered for both the respondent and analyst by online surveys[2]. It dismisses the need of hours of data entry[14] because there is no need to enter the data manually into a database[29]. Another advantage of online surveys is that they can be taken at any time without the need of somebody to distribute and collect the survey, since this is done by the computer[31]. Because web surveys can be answered by a respondent when is suits them the survey may be more convenient[13]. Further online surveys are carried out quicker then paper surveys because of a shorter transmitting time [17], [18], [19]. Research shows that before conventional mail was processed, 95% of the responses from email surveys are already returned to the analyst[32].

Privacy of the respondent For sending a survey through mail, the physical address of a respondent is necessary. For an online survey only a email address is needed and this is likely to make a respondent feel less breached in his privacy[15].

Design options The options we have for desinging the survey is a vital factor for us. Because of the image query and image search part of our survey we need to be able to use images in our survey. Images are possible in both types of surveys, however web surveys have more design options than traditional paper surveys and multimedia can be used[13].

Sample control Sample control is enhanced by email surveys[33]. Because respondents keep their email private, the chance of the intended respondent to participate in the survey is bigger[34]. Also internet based surveys can produce bigger samples that are also more representative[14].

Conclusion In conclusion we can say that online surveys have a lot of advantages over traditional paper surveys. They cost less to perform, are easier to perform, provide higher response and data quality, take less time to perform and respondent can choose when to take the survey, respondents feel less infringed on their privacy, there are more design options and the sample is better controlled. Only about the response rate their isn't a conclusive answer. However we think that because of the wider use of internet this won't lead to big problems. Also we want to conduct the survey among people with internet experience, so the lack of response from people who don't use internet is not a problem. We therefore choose to conduct an online survey. But now we still need to decide between a email survey or a web survey.

2.2.2 Email vs Web

As stated before sample control is enhanced by email surveys[33] because respondents keep their email private, the change of the intended respondent to participate in the survey is bigger[34], and that questionnaires completed through email surveys result in more complete responses with a higher quality[24], [30] and less mistakes[30]. However an email survey would lead to a problem. For our survey we need to make use of images which leads to a higher chance of blocking by spam–blocking tools[15]. This could lead to lower response rates. Also web surveys have several advantages over email surveys. Respondents can answer the web survey whenever it suits them[13] and web surveys provide a greater flexibility concerning the order and layout of questions[10]. Because mail surveys have the risk to be blocked when using images, which are necessary in our research, and web survey have a greater flexibility in the layout of questions. We choose to use a web survey.

2.3 Make or buy survey software

After choosing for a online survey we need to decide whether to create our own software or buy software. Deciding on whether to buy or to create software depends on three primary issues: available funds, knowledge of web technology and computing resources that are available to the researchers[15]. As stated funds were lacking so buying software is not an option. However Mechanical Turk provides an outcome. This is online free survey software where participants are paid an incentive of a few dollar cents for completing the survey. However our application for membership is declined so this proves to be not an option. We now look further at other free software. But these have a few disadvantages. Although off-the-shelf software helps creating administering a web survey, they may also lead to a survey that look like every other survey and/or functions may be missing. Missing functions which limits usage leads to a percieved lack of control. This might cause the abscene of confidence in the possibility to create the desired survey. [15]. Because of the missing functionalities such as the ability to include images and because we have sufficient knowledge of web tecnology and sufficient computing resources available. We decide to create our own survey.

2.4 Sampling and incentives

There are two categories of web surveys: probability and nonprobability surveys [17]. In probability surveys, some element of randomization is included in sampling: the survey is displayed to random visitors of a website or database. Nonprobability surveys can be divided in three categories: unrestricted, self-selection; restricted, self selection or recruited opt-in panels [35] Although self-selection bias is a possible disadvantage of nonprobability surveys, purposive sampling can be achieved. With purposive sampling the results can be generalized to a subset of the population[36]. The context of the research is the main issue when making a choice between probability and nonprobability[15]. Random sampling is preferred by most of the researchers, but this proves to be a difficult task [28]. Mainly because there isn't a central repository available for random sampling[36]. It is possible to choose multiple sollicitation techniques which adds to the comlexity of choosing[15]. Because of the lack of a central repository we choose to use a convenience sample, which is for example used in psychology [14]. Where we invite people who are available from a personal network. They can be asked to share the survey with their personal network. This is called snowball sampling, it leads to low cost per respondents but is doesn't lead to a diverse sample [37]. However it can provide a sample in which different ages and professions are represented [14]. Another advantage is that the use of snowball sampling dismisses the need of incentives because the potential respondents are friends, family and colleagues who are motivated to help[14]. However if we use incentives this may even not lead to an increase in response rate because research shows mixed results [15].

2.5 The test set

A test set needs to be created to conduct a survey. During the creation of the test test the topics should be taken into consideration. The topic is a factor which influences the response rate significantly[10]. One of the problems is that the topics are assigned by the researcher and might not mean much to a respondent[38]. In order to decrease the influence of this problem we selected 3 categories, that should be publicly known or straightforward: Movie stars, education and news. We choose for Natalie Portman, Leiden University and the Oscar winners of 2014 to be our topics. We choose multiple topics in order to prevent any bias because of prior knowledgde of one of the topics. This will hopefully lead to a survey of higher quality although this will lead to a more elaborate survey.

2.6 Designing the survey

Key to the performance of a web survey is the design and usability. Reducing measurement error and non-response errors are important in regard to the design of the web survey[16]. In order to reduce the non-response errors factors who are unique to a web survey should be paid attention. The factors which influence the response rates are: topics(discussed in the previous section), length, ordering of the questions and formatting[10]. But other factors also have an influence on the response rate of an web survey and will be discussed in this section.

However first some general notes on survey design. Respondents should be presented with as little information as possible to prevent bias[39]. But the respondents should be informed about the study and in what way the results will be used, also the credibility of the researcher should be ensured[40]. Be sure that your survey is a professional instrument. If possible get approval from the faculty staff[3].

Techniques Popular techniques for creating web surveys are PHP with MySQL as the database[15]. We are using PHP with SQLite as the back– end database combined with HTML and CSS for the layout. Next to these techniques to create the design of the survey we alloo use MD5 hashes. It is important to prevent double responses because double responses could invalidate study result[15]. However storing email addresses and using them to prevent double responses could lead to an infringment of the respondent's privacy. However using the MD5 hash on the email addresses and using the results of this hash to prevent double responses proves to be succesfull while maintaining the respondents' privacy[15]. So we will use these techniques.

Layout Research has resulted in a few suggestions for the layout of a survey. The font size should be ten or twelve points, a standard font should be used and it is strongly suggested to avoid the use of many colors[15]. These suggestions have been taken into account when designing the survey.

Length Research states that the length of a survey has a negative linear relation with the response rates. However the effects ranges from strong to very weak[4], [5], [6], [7], [8], [9], [3], [10]. A lower response rate can have two reasons. The survey is not deemed important enough by the respondent[3] or the apparent length when opening the survey can discourage the respondent to participate in the survey[2]. To counter the effect of the apparent length it is important to inform respondents up front[10]. The ammount of time it should take at most to complete a survey differs between researches. One research states that between ten and 35 minutes is a good length[2]. While others state that is should not take more than thirteen minutes to complete a survey[41], [42]. However while designing the survey the researcher won't know exactly how long a survey will take to complete. But while designing the researcher should keep it in mind. A survey should be tested after the implementation is completed because this will lead to quick feedback about the length[3].

Questions In order to produce a valid survey, the interpretation of questions needs to be unambiguously[3]. The principles in writing questions for mail surveys (e.g. keeping questions simple, avoiding biased and vague questions) are also applicable to web surveys [43], [44]. Using the words satisfied and dissatisfied will prevent bias from the respondents interpretation of the words[22].

The method for evaluating satisfaction are Likert scales[38]. Research shows that respondents are most consistent and happiest with a five to ten point scale[45]. However a few problems arise with this methods. The anchors on the scale are assigned by the desinger and therefore don't mean a lot to the respondents[38]. Therefore it is preferable that some guidance is offered about what was meant by the designers[2]. Also the use of Likert scales could lead to possitive and very similar ratings for each question[38].

Ordering of questions One of the main concerns is the ordering of questions. Are the responses influenced by the order of the questions? This phenomenon is called the context effect. To counter this affect designers can questions from different constructs[15].Although mix up in computer-assisted interviewing the randomization of questions has proved to improve the validity of the data[46], it has not been empirically estimated for web survey design [10]. We think that we can counter the effect by mixing up the topics and also the website searches and image searches.

Multiple vs Single page Web surveys can be a single page survey or a multiple page survey. Each type has his own advantages and disadvantages. Research shows that there is no difference in response rates when a single page or multiple page design is used [47], [16], although it takes longer to complete a multiple page design [16]. However when an extreme version of multiple page design is used it increases the chances of abandoning the survey. In this design each page shows only one question. [16]. This design increases the response time [16] and a longer response time leads to abbandoning the survey [4], [5], [6], [7], [8], [9], [3], [10]. Nevertheless, multiple page design looks a lot like other websites and may be more intuitive [48]. Another advantage is that multiple page design offers control for item nonresponse, so item nonresponse should be lower [16], [47]. In comparison one page survey have a higher item nonrespone. Respondents seemed to skip questions when all the questions were in a single HTML page[16]. Also time measuring is available when using multiple page design [16]. A big advantage of multiple page design is that the designer can make sure the user follows a sequence of questions while answering the survey [49], [15]. This is also desirable in the context of the context effect. On the other side, single page design requires less computing time and resources because only a single submission is need to send the responses and it provides a context for the respondent when all the questions are on one page [43]. We choose to use the multiple page design. We want to do as much as possible to prevent the context effect and we want to be sure the respondent follow the intended sequence of questions and answer all of them. Also because we are going to show examples of user interfaces, we want each question and example to have his own page so no miscomprehension could occur about which question belongs to which example. And if all the different interfaces are shown one a single page, bias may occur because they can already see if a result is relevant or not. So by giving each interface his own page we can counter this effect. Although this may lead to some respondents abandoning the survey.

Hosting Although the hosting doesn't seem very important, it may lead to several advantages. Research shows that surveys affiliated to academics or government have better rates of response than survey affiliated with commercial agencies[50], [51], [6], [25], [8]. So hosting on a university's web server where an affiliation with a university is shown in the web address helps develop the trust in scientific use instead of commercial use[15]. Also hosting within the researchers' own organisation proves to be usefull because is gives designers control in developing and administering the survey. This is especially usefull when many iterations are needed before the final survey is created[15]. So we will be hosting the survey on our personal website affiliated with the university.

Progress bars Research does not show any use for progress bar for increasing the response rates[20], [52]. However the use of a progress bar helps respondents estimating how close they are to the end of a survey and this reduces the anxiety level of the respondents[15]. Therefore we find is usefull to incorporate a progress bar.

2.7 Testing

Before sending out the survey it is important that a researcer tests the survey. This should be done one different computers with different operating systems, browsers and screen resolution[15]. Also testing is a quick way to get feedback about the length of a survey[3]. The group who pretest the survey should be representative of the group of responders and pretesting should be done in an environment that is similar to the environment in which the survey will be conducted[3].

2.8 Sollicitation

Sollicitation can be done with different types of contact. Pre-notificatons, invitations and reminders[53]. We will discuss the problem that arise when designing invitations, sending invitation and sending reminders.

2.8.1 Designing the invitation

The design of the invitation influences the response rate[10] and should therefore be considered important. It is not important that respondents receive a survey invitation but that they can easily find the survey website and open the survey [10]. A few factors are important when designing the mail: A catchy subject line that does not appear commercial, avoid exclamation marks because messages with exclamation marks are blocked or marked as spam, also researchers should refrain from using images cause this may lead to messages being blocked or marked as spam[15]. Research states that at least the following should be included in the invitation: Clear tasks and purpose, time estimation for finishing the survey, contact information and a notification on how the respondents' email address was acquired [54], [55], [56], [47], [57], [15]. The purpose of the invitation is for the respondents to be able to make a well-informed decision if they are willing to participate in the survey [15]. However respondents should be presented with as little information as possible about the intent of the survey to avoid bias [39]. Also the survey should not be overselled by researchers but kept simple and non-threatening[36]. Because we will be sending the invitation to family, friends and colleagues the notification on how the email address was acquired will be left out.

2.8.2 Sending the invitation

Contacting potential respondents through email is quick and easy[58] but also other methods can be used such as online forums[15]. Sending solicitations through email comes with a few problems. Spamfilters may block the email[15], [17], [26], because of the fast growth of unsolicited emails[10]. Access to relevant respondents can be found when solliciting through online forums such as Facebook[15]. Taking this in consideration we choose to send invitations both through email and Facebook.

2.8.3 Reminders

Reminders have proven to be usefull in increasing the response rate. Multiple contacts with potential respondents reminds them of the survey and increases the legitimacy of the survey. Sending reminders increases the response rate by seven to eleven percent[53]. Reminders have a more positive effect if the first reminder is sent a few days after the initial invitation rather than a week later[54]. The reminders should be send to nonrespondents to the initial invitation[15].

3 Methodology

In this section we will discuss and show our test set, survey design, the invitations and the reminders. The literature research as shown in Chapter 2 is used during the creation and design of our test set, survey, invitation and reminders.

3.1 The test set

For our survey we have created our own test set. Our test set has undergone a number of iterations. Each week we discussed the iterations with our supervisor. We started with text based searches for internet. At first we created a test set for a single topic, which are mentioned in the next paragraph, to design the interfaces. One of the remarks during this fase was that the result were all highly relevant so we incorporated less relevant results until the balance between relevant and irrelevant was satisfying. Once this is done we expand to the other topics and started working on the image based searches. After some problems on what to use as explanation for the image based searches we concluded that we needed to think of our own explanations. Also we concluded that it was interesting to do some research at text based image searches so we incorporated this into the thesis and survey. Our test set can be divided into three categories as listed below.

- Text based search for websites
- Text based search for images
- Images based search for similar images

The text based categories consisted of three topics: Natalie Portman(movie star), Leiden University(educational) and The Oscar winners of 2014(news). We choose these topics to limit the problem that the topics might not mean a lot to subjects[38]. We deem these topics to be generally known or clear enough to mean something to the subjects and therefore limit the aforementioned problem. To further limit this problem we chose for three topics, so that any bias of prior knowledge about a topic can be kept as low as possible. For each topic we create a set of result which will be shown in different interfaces during the survey. For each topic we create a set of ten websites and a set of ten images. For the websites we make sure that four or five are extremely relevant results, one or two extremely irrelevant results and the rest is somewhat relevant. With this setup we are trying to be sure that not every interface will lead to a high rate of satisfaction. We also make sure that in each topic at least one result seems irrelevant without explanation but with explanation could lead to a higher satisfaction.

We have created several interfaces. Each interface differes from each other. Examples of interfaces we create are shown in Figure 3.

We create an interface where just the link to a website is shown and a similar interface where just the title of the webpage is shown. For a little more elabore interface we create interfaces where below the links or title the number of keywords found is shown. And we create four interfaces with a piece of text below the title and link, just like the five biggest search engines, where the highlighting of the keywords change. There is no highlighting, italic highlighting, red highlighting and bold highlighting.



(a) Interface with just links

Keywords found Leiden: 4 times University: 6 times http://http://portal.leiden.nl Keywords found Leiden: 16 times University: 1 times http://en.wikipedia.org/wiki/Leider Keywords found Leiden: 109 times University: 18 times http://en.wikipedia.org/wiki/Leiden_Uni Keywords found Leiden: 107 times University: 98 times https://www.lumc.nl/ Keywords found Leiden: 1 time University: 1 time

(c) Interface with links and number of keywords found

outstanding international ment with high academic

historic city will captivate you with its charm, its elegance, filiness and its hidden treasures. A visit to Leiden can be an 'ience; it will ...

en - Wikipedia, the free encyclopedia //en.wikipedia.org/wiki/Leiden en (in English and archaic Dutch also Leyden) is a city and icipality in the Dutch province of South Holland.

den University - Wikipedia, the free encyclopedia wikipedia.org/wiki/Leiden, University fen University (Datch: Universiteit Leiden), located in the city of fen, is the oldest university in the Netherlands. The university was uled in 1575 by ...

ne i LUMO Home LUMC https://www.lumc.nl/home/?setlanguage=english The Graduate School of the Leiden University Medical Center offers PhD students a highly reputed research environment, excellent infrastructure and

(e) Interface with a piece of text



(g) Interface with a piece of text and keywords shown in red font

(b) Interface with just titles



(d) Interface with titles and number of keywords found



Homepage - EN - Leiden http://portal.leiden.ni/en/homepage This historic city will captivate you with its charm, its elegance, itt friendliness and its hidden treasures. A visit to Leiden can be an er experience; it will ...

Leiden - Wikipedia, the free encyclopedia http://en.wikipedia.org/wiki/Leiden Leiden (in English and archaic Dutch also Leyden) is a city and municipality in the Dutch province of South Holland.

Leiden University - Wikipedia, the free encyclopedia en.wikipedia.org/wiki/Leiden_University Leiden University (Duch: Universitet Leiden), located in the city of Leiden, is the oldest university in the Netherlands. The university was founded in 1575 by ...

Home LCONC. https://www.lumc.nl/home/?setlanguage=english The Graduate School of the Leiden University Medical Center offers PhD students a highly reputed research environment, excellent infrastructure and

(h) Interface with a piece of text and keywords shown in **bold** font

Figure 3: User interfaces created for the text based searches for websites

During our assessment we noticed that with image search the explanation was not (directly) shown. So we are interested if showing an explanation directly would lead to a higher satisfaction. Therefore we create an image result set consisting of ten images for each topic where five images are relevant and five images seem to be irrelevant. Although five of the image seem irrelevant, they all are in somehow connected to the query. This connection will be shown in the explanation so the rate of satisfaction can be increased because of the explanation.

For our image based search we selecte two different images. The first image is a computer generated image of two flowers with a sunset and grass fields in the background. The second image is a picture of Nathalie Portman at the red carpet of the Golden Globe awards. Because there is not yet a search engine that shows why visually similar images are given as a result, we need to think of our own explanation. We decide to use properties of the images to explain the results. We use the following properties: color, composition, background and textures. For both searches we create a set of ten results. Each with five relevant results and five less relevant results. We make sure that some of the properties off the less relevant images were the same as some properties of the query image so that an explanation could increase the satisfaction. Examples of the image search interfaces are shown in Figure 4.

At the top of each interface was a search bar shown with the query as shown in Figure 5.



Figure 4: User interfaces created for the image searches



(a) Search bar for text based searches

Search



(b) Search bar for image based searches

Figure 5: The search bars

3.2 The survey

Our survey consists of 34 questions. After the test set was completed we started ordering the questions. We divide the text based website searches into several categories. No explanation, keyword explanation and text eplanation. To minimize the context effect[15] the three topics were put after each other. We started with as less explanation as possible and increased the amount of explanation during the survey. This is done to prevent a bias which can occur if a subject first sees a lot of explanation about a result and afterwards needs to answer a question without explanation while knowing that the result is very relevant. So the questions for text based searches are ordered as shown in Figure 3 with alternating topics. Between each category of questions a text based image search is shown. First the searches without explanation and afterwards the searches with explanation. At the end of the survey the image based searches are shown. So the ordering of the questions looks like this.

- 1) Natalie Portman, just links
- 2) Natalie Portman, just titles
- **3**) Leiden University, just links
- 4) Leiden University, just titles
- **5**) Oscar winners 2014, just links
- **6**) Oscar winners 2014, just titles
- 7) Natalie Portman images, no explanation
- 8) Natalie Portman, links and keyword explanation
- 9) Natalie Portman, titles and keyword explanation
- **10**) Leiden University, links and keyword explanation
- 11) Leiden University, titles and keyword explanation
- **12**) Oscar winners 2014, links and keyword explanation
- **13**) Oscar winners 2014, titles and keyword explanation

- 14) Leiden University images, no explanation
- 15) Natalie Portman, text explanation
- 16) Leiden University, text explanation
- 17) Oscar winners 2014, text explanation
- 18) Oscar winners 2014 images, no explanation
- **19**) Natalie Portman, text explanation with italic highlighting
- **20**) Leiden University, text explanation with italic highlighting
- 21) Oscar winners 2014, text explanation with italic highlighting
- 22) Natalie Portman images, explanation
- 23) Natalie Portman, text explanation with red highlighting
- **24**) Leiden University, text explanation with red highlighting
- 25) Oscar winners 2014, text explanation with red highlighting
- **26**) Leiden university images, explanation
- 27) Natalie Portman, text explanation with bold highlighting
- 28) Leiden University, text explanation with bold highlighting
- 29) Oscar winners 2014, text explanation with bold highlighting
- **30**) Oscar winners 2014 images, explanation
- **31**) Flower image, no explanation
- **32**) Flower image, explanation
- **33**) Natalie Portman image, no explanation
- 34) Natalie Portman image, explanation

At the top of each page we show the question: "Below you will see an example of a search engine user interface. How satisfied or dissatisfied are you with the results of the search?". The subject needs to answer this question using a five point Likert scale because our literature research states that this was the best way to do it. Each anchor has a number assigned to it from 1 to 5. Next to the number is an explantion what the number means so that this is clear to the subject. The anchors are placed one below the other so subjects can not mix up which anchor belongs to which value. Also a progress bar is shown at the top to make clear at which question of the 34 questions the subject is located. After pretesting we got the remarks that the search bar wasn't clear enough in explaining the query so we add a short explanation about the query. After this alteration the top of the page looks as shown in Figure 6

You're searching for websites about the university of Leiden

Question 3 of 34.

Below you will see an example of a search engine user interface. How satisfied of dissatisfied are you with the results of the search?

Satisfied: 1: Very dissatisfied 2: Dissatisfied 3: Average 4: Satisfied 5: Very satisfied

Submit

Figure 6: Top of the page

At the start of the survey the subjects are shown a short introduction and the number of questions. There is suppossed to be an estimate of time but we forgot to update the page after pretesting. But in the invitation a time estimate is mentioned so this is not a big problem. After testing we got the remarks that the link couldn't be clicked upon, although this is supposed to be so this was not clear to the subjects so a note about this is added. We also got the remark that subjects more looked at the layout of the reslt page than at the results so we also add to the note that the results should be treated like they would be treated in everyday life. At the bottom contact information is shown and subjects need to fill out their email address to prevent double responses. The introduction looks as shown in Figure 7. At the end of the survey subjects are thanked for their participation and contact information is shown again as shown in Figure 8.

Welcome to the online survey for my bachelorthesis. In this survey you will answer 34 questions about the user interface of an search engine for both text based searches and image based searches. The survey will take a maximum of # minutes. Please finish the survey before closing the window otherwise your progress will be lost
Note: the results are not clickable. Furthermore it's important that you treat the results like you would treat results in everyday life.
If you have any questions you can contact <u>rmeijer2@liacs.nl</u>
Please fill in your e-mail to prevent double results.
E-mail: Submit

Figure 7: Introduction of the survey

Thank you for participating. If you're interested in the results of this survey you can contact rmeijer2@liacs.nl

Figure 8: End of the survey

3.3 The invitation and reminders

After designing, testing and improving the survey. Invitations are send out to friends, family and colleagues through mail. As you can see in Figure 9 the invitation contained the following:

- Link to the survey
- Task to be carried out
- Purpose of the survey
- Information about the size of the survey and time it would take to complete the survey
- Contact information
- Credentials of the researcher to prove his credibility
- A deadline for filling out the survey
- The request to share the survey among friends, family and colleagues

The invitation is written in both Dutch and English. This is done so that everyone should be able to understand the message. This was important because of the snowball sampling. It might be possible that the invitation was shared abroad.

The invitation is also put on Facebook. This is done in multiple places. On the wall of the researcher and in several groups. The message that was placed on Facebook was the same as in the mail. The groups in which the invitation is posted are:

- Leiden university, all students of the University of Leiden
- De Leidsche Flesch, study association of Mathematics, Physics, Astronomy and Computer Science
- SSR-Leiden, a student associaton in Leiden
- Klikspaanweg campus, a group for the residents of Klikspaanweg
- Code 418, third year Computer Science students at Leiden University



Figure 9: Invitation to the survey

The invitations are send out on Friday so that all the potential respondents could use their time in the weekend to fill out the survey. After the weekend the first reminder is sent to everyone. Although it is advised to sent the reminder only to people who haven't responded yet, we still choose to send it to everyone. Because we want people also to be reminded that the survey may be shared among their personal network.

The first reminder contains the link to the survey, the deadline and the request to share the survey. Also the original message with more information can be found at the bottom of the reminder. Some people were forgotten while sending the invitation or email addresses proved to be expired and were replaced by updated ones. So there was also a brief reference to the invitation at the bottom in the first reminder sent through email. On Facebook the reminder was posted as a comment to the original message in the groups so the message would be back on top of the newsfeed of the group. Also the reminder is posted on the wall of the researchers so it would show again on the newsfeed of their Facebook friends. The first reminder is showed in Figure 10.

Ricardo Meijer <meijer.ricardo@gmail.com> Aan: meijer2@liaos.nl Reminder: Hulp met bachelorproject</meijer.ricardo@gmail.com>	19 mei 2014 14:05 Verberg details	
for english see below		
Geachte ontvanger,		
Vergeet u niet mijn enquete in te vullen op www.liaca.ni/~mmejer/2/hesis/ De deadline hiervoor is 25 mei. Zou u ook zo vriendelijk willen zijn dit bericht te delen.		
Met vriendelijke groet, Ricardo Mojer Student Informatract(Universiteit Leiden)		
ps. Als u dit bericht voor de eerste maal ontvangt staat onderaan meer informatie		
Dear recipient,		
Please don't forget to fill out my survey at www.liacs.nl/-rmeijer/2/hease/ fill the survey out before May 25th. Would you also be so kind to share this message.		
Regards, Ricardo Maijer Student Computer Science(Leiden University)		
ps. If you receive this message for the first time, more information can be found below this message		

Figure 10: First reminder to the survey

A day before the deadline of the survey a final reminder is sent out. This reminds the potential respondent of the upcoming deadline and again requests them to share the survey, as is shown in Figure 11. It is again send out through email with both the invitation and the first reminder. On Facebook the same routine is executed as with the first reminder.

Ricardo Meljer <meljer.ricardo@gmail.com> Aan: mreljer2@lacs.ni Last reminder: Hulp met bachelorproject</meljer.ricardo@gmail.com>	24 mei 2014 18:31 Verberg details	
"for english see below"		
Gechte ontvangen,		
Hierbij nog een laatste herinnering aan mijn enquete. U kunt hem nog t/m morgen invullen en/of doorsturen.		
Met virindalijke groet, Filorado Mejer Student Informatica(Universiteit Leiden)		
Dear recipient,		
This is a last reminder for my survey. Please fill it out and/or share it before monday,		
Regards, Ricardo Meijer Student Computer Science (Leiden University)		

Figure 11: Last reminder to the survey

4 Results

A total of 133 people participated in our survey. Of these 133 people 89 finished the survey. The number of responses per questions can be seen in Table 1. For our results we will only be using the completed surveys. Notable is the sudden increase of one response at questions 21 and 22. An inspection of the results showed that two respondents probably had to refresh the page because they had a double responses to these questions. After an inspection it showed that several respondents had the same kind of double responses, so all double responses were deleted. We also noticed that a respondents answered the first five questions and then went back to question two and started answering al over again. And alse a respondent had answered part of the survey and started over a few day later to deliver a complete survey. To prevent any bias we have deleted these complete responses. So our set of results consists of 87 responses.

For the processing of our results we combine the questions of different topics into categories. The categories for text based queries are the same as mentioned in Figure 3 on Page 21. The searches for images are divided into the categories without explanation and with explanation. We choose to combine the different topics into categories to prevent any bias because a respondent is (un)familiar with a topic. We will use these categories to answer the questions we have prepared on the basis of the research question.

We will compute the averages and we will also compute the standard deviation for each categorie. The average and standard deviation for each category is computed with the following formulas:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (x_i - \mu)^2}, \text{ where } \mu = \frac{1}{N} \sum_{i=1}^{N} x_i,$$

where μ is the average, N is the number of responses to a category and x_i is the response to a question.

The results of these computations are shown in Table 2. We put these results in graphs so we can have a quick overview. These graphs are shown in Figure 12.

Question	Number of	Question	Number of
	Responses		Responses
1	137	18	89
2	128	19	89
3	121	20	89
4	121	21	89
5	115	22	90
6	112	23	90
7	110	24	89
8	106	25	89
9	103	26	89
10	103	27	89
11	99	28	89
12	96	29	89
13	95	30	89
14	95	31	89
15	93	32	89
16	89	33	89
17	89	34	89

Table 1: Number of responses per question

Category	Average	Standard deviation
Links	2,666666666666666	1,02222209745677
Titles	3,36015325670498	0,919604608212335
Links with	2,70498084291188	1,13923248977037
Keywords		
Titles with	3,17624521072797	0,972386185832835
Keywords		
Text	3,94252873563218	0,980409576899196
Text with italic	3,7816091954023	1,03749163316573
Text with red	2,88122605363985	1,13286709539603
Text with bold	4,18007662835249	1,05299988299923
Search for images	2,93869731800766	1,08909571220741
Image based	3,63218390804598	0,919752818932285
searches		
Searches for images	3,39463601532567	1,08520578803631
with explanation		
Image based	3,7183908045977	0,956114586250423
searches with		
explanation		

Table 2: Averages and standard deviations for each category



(a) Rate of satisfaction of text based searches for websites in a graph Level of satisfaction

(b) Standard deviation of text based searches for websites in a graph



Figure 12: Results shown in graphs

In Table 3 we show the spread of the responses per category. When we take a look of the responses for each respondents it shows that none of the respondents showed an increase in the rate of satisfaction for text based searches for a website. In particular the text explanation with red highlighting leads to a lower rate of satisfacation. However it shows that for each respondent the rate of satisfaction increases when the explanation becomes more elaborate. It also shows that for a text based image search 16 out of 88 respondents did not care for an explanation and showed no change in rate of satisfaction. For 14 out of 88 respondents the explanation even leads to a lower rate of satisfaction. However for 58 respondents an explanation leads to a higher rate of satisfaction. When looking at image based searches 33 out of 88 respondents did not care for an explanation and showed no change in rate of satisfaction. For 22 out of 88 respondents the explanation even leads to a lower rate of satisfaction. 33 out of 88 respondents have a higher rate of satisfaction when an explanation is shown.

Category	1	2	3	4	5
Links	42	73	86	50	10
Titles	17	34	80	89	32
Links with Keywords	15	95	107	40	4
Titles with Keywords	8	53	95	95	10
Text	0	16	39	149	57
Text with italic	2	14	74	120	51
Text with red	34	69	76	58	24
Text with bold	1	6	41	110	103
Search for images	11	69	115	57	9
Image based searches	8	34	95	98	27
Searches for images with explanation	2	17	45	86	23
Image based searches with explanation	2	15	43	84	30

Table 3: Spread of the responses per category. 1: Very dissatisfied 2: Dissatisfied 3: Average 4: Satisfied 5: Very satisfied

5 Conclusion

5.1 Is the rate of satisfaction higher when a search engine explains why the search engine returns the values for a text based search for websites?

Figure 12a shows there is not a continuous increase in the rate of satisfaction. But we can see that the use of an explanation affects the rate of satisfaction. For example showing a title of the website leads to a higher rate of satisfaction compared to showing only a link to a website. Also showing text leads to a significant higher rate of satisfaction except for the red font. Showing keywords however leads to almost similar ratings when not showing keywords. We conclude that the rate of satisfaction is higher when a search engine explains why the search engine returns the results for a text based search for websites.

5.2 Is the rate of satisfaction higher when a search engine explains why the search engine returns the values for a search for images?

The graph in figure 12c shows that the satisfaction is higher when an explanation is given for each type of query. Text based queries lead to a higher rate of satification and image based queries lead to a higher rate of satisfaction although the difference is very slim. Also we can see in Figure 12d that for image based searches the standard deviation is higher when an explanation is given and for text based searches the standard deviation is lower. But both searches has a difference that can be neglected. For a text based image search 58 respondents had a higher rate of satisfaction and 15 respondents had an equal rate of satifaction. But only 32 respondents had a higher rate of satisfaction for an image based search and also 33 respondents who had a lower rate of satisfaction when using image based search. So giving an explanation probably leads to a beter understanding of the results. And therefore some respondents were less satisfied with the results. So an explanation alters the rate of satisfaction of the respondents. But it does not make a lot of difference for image based searches. An explanation for text based searches however leads to a higher rate of satisfaction.

5.3 With which user interface is the satisfaction the highest for a text based search for websites?

We have shown in the section 5.1 that an explanation leads to a higher rate of satisfaction for text based searches for websites. But we are also interested in which interface leads to the highest satisfaction. As we can see in the graph in Figure 12a explanations with text (and bold or italic highlighting) have the best averages and as we can see in the graph in Figure 12b these categories also have the lowest standard deviation. This means that the level of satisfaction at these categories was most equal between all the respondents. When comparing these three categories with each other we can see that a text explanation with italic highlighting has the lowest average and the highest standard deviation. So this category does not lead to the highest satisfaction. We see that a text explanation with bold highlighting has an average that is 0,237547892720307 higher then the average of a text explanation without highlighting. Also the difference of the standard deviaton is very small, namely 0.07259030610003663. When we take a look at the spread of these two interfaces we see that 103 questions are answered very satisfied with bold highlighting and 57 with no highlighting. This is an increase of 80%. 110 questions are answered satisfied with bold highlighting and 149 with no highlighting. This is a decrease of 26%. Because of the higher average and the big increase in questions which were answered with very satisfied, we conclude that the text explanation with bold highlighting leads to the highest satisfaction for most of our respondents.

5.4 General conclusion

Concluding from the results of our survey we state that giving an explanation raises the rate of satisfaction and as we can see in Figures 12a and 12c. Every interface where some kind of explanation was given leads to a higher rate of satisfaction in comparison to the interface where no explanation is shown(e.g. only a link when searching for a website). But also the standard deviation is lower for almost every interface.

For text based searches for websites we conclude that a text explanation with bold highlighting leads to the highest rate of satisfaction with a standard deviation that is slightly bigger than the standard deviation of text explanation without highlighting. But because the difference with the lowest standard deviation is so small the difference can be neglected. And because of bold highlighting 46 questions more are answered with very satisfied. So in general we conclude that the rate of satisfaction is higher when a search engine explains why the engine returns the results and with a user interface that explains the results with a short text from the website with search words highlighted with the bold font the satisfaction is the highest. However for image searches we can not state a conclusion regardings the best interface.

6 Discussion

As we state in our conclusion the text explanation with red highlighting leads to a significant lower rate of satisfaction and higher standard deviation. As the red highlighting is the only factor different in comparison with the other interfaces using a text explanation we can say that this influences the rate of satisfaction. However we are not sure why. In one of the researches on creating an online survey it is said that the use of too much color can create clutter[15]. It might be that this also applies to the user interface of a search engine. Since the interface already uses green, blue, grey and black the addition of the color red could have lead to clutter. Another possibility is that the use of the red color was too conspicuous, and thus distracted too much from the actual results. But to be sure this needs to be researched.

Although we did our very best to prevent bias, it can not completely be prevented since conducting an online survey leads to a higher probability of sample based bias[59]. However next to the sample based bias there is another possibility for bias which we can not prevent. Since one of our interfaces was exactly the same as the interface of Google it is possible that people were biased regarding this result. The respondent are used to using the user interface of Google so they might rate it higher because they are familiar with it. However since this is a bias emerging from everyday life we can not prevent it.

When discussing the survey afterwards with some of the respondents a remark that was made by some respondents is that the intent of the survey was not clear enough. They therefore asigned values to the first interfaces that were actually too high if they compared it with the other interfaces. However to prevent bias respondents should get as little information as possible[39]. So the respondents felt that they were not able to provide the correct rates of satisfaction. The difference in satisfaction between the first interfaces and the final interfaces is bigger than they can indicate. So in future research it might be better to use a Likert scale with more options so the difference in satisfaction can be better presented.

One of the parts our survey is missing are different interfaces for image searches. Because we focussed on searches for websites first when designing our test set we already were around the limit of the number of questions in regard to the length of the survey. So we needed to limit the number of question regarding searches for images because if a survey is too long, respondents will not complete it unless they are highly motivated[3]. However we have shown with our survey that using a explanation lead to a higher rate of satisfaction. So in future work this can be used to motivate a research into different user interfaces for image searches.

The results show that image based searches are slightly affected by explanations. Because searching with images is a new development people might not be used to it and don't know what to do with it so an explanation only slightly influences their rate of satisfaction. However we showed that 33 respondents had a lower rate of satisfaction so the explanation lowered their rate of satisfaction. It is possible that respondents disliked the way of explaining we designed. However as we stated above we could not incorporate more interfaces in the survey due to the length. So the question which interface leads to the highest rate of satisfaction for image based searches should be incorporated in future work.

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