

Research Report

Correlation between the number of mouse clicks and the rating of user experience in task-oriented navigation of desktop web pages for higher education institutions in the capital region of Helsinki

A?

Aalto University
School of Arts, Design
and Architecture

Ulrika Ura
Elena Shemyak
Inka Mattila

Design major
Department of Design
17.04.2020

Abstract

This study determines the correlation between the number of mouse clicks and the rating of user experience in task-oriented navigation of desktop web pages for higher education institutions in the capital region of Helsinki. The study is a response to a previous publication on the topic, presented by a team of researchers at the User Interface Engineering web publication portal. This study addresses the inconsistencies with previous research.

The research was conducted by collecting two data sets, one for the number of clicks and one with the scores of the users' navigation experience. The result was finding a correlation between the two sets of data, which shows that a navigation journey with more clicks leads to a more negative user experience, regardless of whether the user completes the tasks without errors. These findings can be applied in the development of websites as is, or with further research investigation.

FOREWORD

When choosing the topic of our research we found out that our group had much in common interest-wise. We soon agreed that our research topic should definitely be related to statistics and user experiences. All of us were excited to conduct research that would provide something useful, informative and truly interesting, in spite of having to work from home during the COVID-19 pandemic.

After a few meetings we decided to go for our current research topic, which we ended up being very satisfied with. Our approach, which was challenging a much cited study about the role of clicks in user experience, was an interesting take on an otherwise plain experience data analysis. We were also inspired by our fellow students, who struggle with finding the information they need on education websites. During our two years at Aalto University we have heard plenty of complaints from our peers. Information on exchange studies and even finding help for a students' day-to-day problems has often been the topic of discussion. We as students have had our share of these difficulties, so one could say that this research was close to our hearts.

Table of Contents

<i>Abstract</i>	<i>1</i>
<i>Foreword</i>	<i>2</i>
<i>Table of Contents</i>	<i>3</i>
<i>Introduction</i>	<i>4</i>
<i>Methods</i>	<i>6</i>
<i>Results</i>	<i>8</i>
<i>Discussion</i>	<i>10</i>
<i>Conclusion</i>	<i>12</i>
<i>References</i>	<i>13</i>
<i>Attachments</i>	<i>14</i>

Introduction

Website navigation is a field lacking sufficient published scientific research, despite the fact that it is essential in the design of every user-oriented website. Developers go by the theoretical writing and practices promoted by professionals, even though the origin of these practices is often outdated studies and anecdotal evidence. After researching the stance of writers and field professionals we have noticed limitations to their statements, as well as inconsistencies with our own experience. We set out to conduct our own study in order to test out a hypothesis that supported our experience.

The inspiration for our study came from using university websites and feeling dissatisfied with the navigation. When we started researching possible explanations for which elements could be responsible we came across the “three-click rule”. The three-click rule is an unofficial web design heuristic which claims that a navigation journey consisting of more than three clicks will leave the user unsatisfied and cause them to quit. It is sometimes attributed to author Jeffrey Zeldman, who endorsed the rule in his 2001 book *Taking Your Talent to the Web*. Despite having no scientific basis to it, the rule was widely cited, although usually in a more figurative sense, as in “less clicks = user is more satisfied”. This heuristic has since then been challenged by writers and practitioners. However, the counter evidence left us equally bemused, because the counter arguments seemed to all reference the same study, which does not hold up to scientific scrutiny either.

This widely quoted study is a 2003 web publication by UIE (User Interface Engineering), a publication outlet of the UX education program “Center Centre”. In the article, research consultant and contributor Joshua Porter presents the study titled “Testing the Three-Click Rule”. In the conclusion the study states that

“The number of clicks isn’t what is important to users, but whether or not they’re successful at finding what they’re seeking.”

Existing studies, even those focusing on UX, ironically do not take into account the actual experience of the user. The original “three-click rule” and the later publications challenging it focus

on whether the user will give up navigating after a certain number of clicks, even though in real life quitting is not always an option. A conclusion made by the UIE team after disproving the original three-click rule was that a navigation journey can be long, but users will not quit unless they experience errors or fails in their clicks. However from a UX point of view the actual user satisfaction in correlation to task-oriented clicking journeys of different length can provide important statistical insight. The UIE study also calculated the percentages of satisfied users for each number of clicks, and came to the conclusion that less clicks do not make more users rate their experience as satisfying. This research disagreed with our perception of task-based navigation on websites.

We set out to challenge the conclusions of “Testing the Three-Click Rule”. Our research question was **“is there correlation between the number of successful clicks and the user’s rating of the navigation experience?”**. The null hypothesis that we address is formulated by the conclusion of the UIE study: **“The number of clicks isn’t what is important to users, but whether or not they’re successful at finding what they’re seeking”**. This hypothesis means that since the number of clicks should not matter as long as the results are successful, users should report success after following long successful journeys. The user experience of successful tasks should not correlate with the number of clicks, while with the unsuccessful journeys the length would be reflected in the emotional feedback. To challenge the null hypothesis we constructed the following research hypothesis: **“For successful journeys, user satisfaction will decrease as the number of navigation journey clicks increases”**. This relationship would be seen in a linear correlation.

We analysed the UIE article and noted the limitations of the study, which could explain the results. The limitations of the UIE study include

- Research setup and method are not defined: what kind of tasks did the test users attempt and what type of websites did they browse?
- The study does not take into account the user’s emotional experience and only determines whether users stay persistent, which in a simulated environment gives limited insight.

Our research method was to collect data on the relationship between the number of clicks and the emotional experience of the user during navigation journey tasks. We noted the limitations of the existing studies, took them into account and constructed an improved experimental setup.

An important influence on the planning of our study was understanding the difference between search-based and navigation-based browsing. In 2014 the consultancy firm Nielsen Norman Group published an article by Director of Research Raluca Budiu, titled “Search Is Not Enough: Synergy Between Navigation and Search”. The article explores the author’s five main points:

1. Search Requires Knowledge of the Search Space
2. Search Increases Memory Load
3. Search Has Higher Interaction Cost than Browsing
4. Site Search Often Works Poorly
5. Users Have Poor Search Skills and Don’t Know How Search Works

Raluca Budiu’s writing gave us guidance in assessing our own user behaviour in websites for education institutions, and helped reveal all the effort we subconsciously undertook to work around unsatisfying websites. Many of the navigation experiences can be commented on by Badiu’s words in the conclusion: “Navigation serves important functions: it shows people what they can find on the site, and teaches them about the structure of the search space.”

This led us to plan our study to consider navigation tasks only, in order to eliminate shortcuts and workarounds, such as relying on the results of an external search engine.

Methods

For our research setup we had test users complete navigation journeys.

For websites we used the websites of eight higher education institutions in the capital region of Helsinki. Choosing all websites with a shared purpose and having the browsing to be task-oriented was crucial for the setup: for example, the number of clicks would be perceived wildly differently with browsing an online store for leisure or scrolling down a photo feed, as opposed to having a specific task such as finding information about accessibility on campus. Our navigation tasks were user motivations of a hypothetical user of the websites, and we asked the test user to use the websites to find the information fulfilling the hypothetical user's need. These needs were realistic scenarios such as looking for university staff contacts. To read the precise wording of the tasks please see Attachment 1.

From each journey we collected:

- The total number of clicks
- The success category of the journey
- The satisfaction score given to the navigation experience by the user.

The research assignment is performed by the test User and the Scorekeeper with the following steps:

1. User prepares for the assignment:
 - User settles in a calm space with a computer.
 - User reads the task carefully. Scorekeeper can answer questions.
 - User opens the front page of the website to be tested.
 - Scorekeeper prepares the score table and gives a signal to start the task.
2. The User's goal is to find the information from the task by navigating the website using only mouse clicking and scrolling. It is allowed to click on any link even if it leads to another site. It is not allowed to leave the website by changing the address outside of

the website, e.g. clicking on a search engine shortcut in the browser bar.

3. Every time something is clicked, the User informs the Scorekeeper by saying “click”. The Scorekeeper marks down every click in the score table.
4. If an error occurs, the User informs the Scorekeeper by saying “Error”. An Error means that an “undo” of some sort has been done. Examples of an undo are clicking the “previous page” button in the browser, or having to return to the front page when the search has come to a dead end and it is otherwise impossible to continue the navigation. Every error is added to the scoretable by the scorekeeper. As an error click is also a click, Errors are added to the number of clicks after the task is finished.
5. The User navigates until one of the following happens:
 - they find the information they are looking for
 - The task is discontinued after the time limit is reached
 - the User quits the task.
 - The User may quit the task whenever they feel like it, e.g. if they don’t know where to look anymore or if the task gets too frustrating. The time limit for one task is 10 minutes. The Scorekeeper keeps time and informs the User when the time has passed.
6. The Scorekeeper categorises the User’s result. The categories are:
 - Task Failed
 - Task completed successfully, with errors along the way
 - Task completed successfully
7. After finishing the task the User scores their experience on the scale below, and informs the Scorekeeper about their score.
 - 1: Satisfied**, The experience was positive, I did not feel negative emotions.
 - 2: Neutral**, I did not feel negative or positive emotions / I have difficulty grading-my experience.
 - 3: Unsatisfied**, I was not entirely satisfied and I felt some negative emotions.
 - 4: Frustrated**, I felt frustration, my experience was considerably negative.
 - 5: Totally frustrated**, I felt intense frustration, my experience was absolutely negative.
8. In this way the User performs all the tasks for all institutions’ websites from the list. All the results are recorded on an Excel sheet (**Fig.1**)

In case of unexpected events, such as a browser crashing, an internet outage, or the mouse battery dying, the task is to be resumed from the same point.

From this data we create two graphs:

1. Graph displaying all the collected data to illustrate our findings. X is the number of clicks, Y is the score. The data is colour coded in the three categories of “success / success with errors / failure”.
2. Graph displaying only the data for successful clicks to illustrate our result

From the data for successful clicks we calculate the correlation coefficient to determine what the relationship between the two sets of data is.

For our study we had three different test users, eight websites and seven tasks. Some tasks were discarded after information could not be found, and eventually the number of valid collected navigation journeys was:

$$\begin{aligned} & 3 \cdot 8 \cdot 7 - 11 \cdot 3 \\ & = 135 \text{ results total.} \end{aligned}$$

Results

As planned, the result of our test series was the correlation coefficient for the data points of successful navigation journeys and charts illustrating the data.

Subject	Assignment	Esteettömyys				Valitton				IT-palvelut				Tapahtumat				Opiskelijayhteisöt				Yhteishaku				Kampuksen kartat			
		Clicks	Errors	Result	Score	Clicks	Errors	Result	Score	Clicks	Errors	Result	Score	Clicks	Errors	Result	Score	Clicks	Errors	Result	Score	Clicks	Errors	Result	Score	Clicks	Errors	Result	Score
Higher education institutions	Starting page	16	4	F**	4	2	0	S	2	3	0	S	1	1	0	S	3	3	0	S	3	2	0	S	3	1	0	S	2
Aalto-yliopisto	www.aalto.fi	-	-	-	-	3	0	S	1	4	0	S	1	1	0	S	1	5	0	S	1	3	0	S	1	1	0	S	1
Helsingin Yliopisto	www.helsinki.fi	7	1	F**	4	4	1	F	4	9	2	F	4	2	0	S	1	4	1	F	4	2	0	S	1	3	0	S	3
Taideyliopisto	www.universi.fi	-	-	-	-	11	0	S	3	19	0	F	5	2	0	S	2	14	0	S	4	3	0	S	3	6	0	S	3
Haaga-Helia	www.haaga-helia.fi	2	0	S	1	7	1	F	3	1	0	S	2	1	0	S	1	2	0	S	2	1	0	S	1	3	0	S	2
Metropolia	www.metropolia.fi	5	1	SwE	3	5	1	SwE	1	1	0	S	1	1	0	S	1	3	0	S	2	1	0	S	1	13	0	S	4
Laurea	www.laurea.fi	2	0	X	3	13	0	F	5	3	0	F*	5	1	0	S	3	14	0	S	4	2	0	S	1	2	0	S	1
Arcada	www.arcada.fi	4	0	S	1	6	0	S	3	8	1	SwE	3	3	0	S	3	2	0	S	2	3	0	S	3	4	0	S	1
Humanistinen ammattikorkeakoulu	www.humak.fi	4	0	S	1	10	1	SwE	4	2	0	S	1	3	0	S	1	4	0	S	2	3	0	S	1	3	0	S	1
		2	0	S	3	2	0	S	1	5	0	F	4	1	0	S	3	7	0	F*	4	1	0	S	1	11	2	SwE	5
		4	0	S	4	12	2	SwE	3	8	0	F	5	11	1	SwE	3	12	2	F	5	3	0	S	1	4	0	S	2
		2	0	S	1	22	1	F	5	11	0	S	4	2	0	S	2	-	-	-	-	3	0	S	3	3	0	S	3
		3	0	X	3	4	0	F	4	3	0	S	3	1	0	S	3	2	0	S	1	2	0	S	1	2	0	S	2
		-	-	-	-	12	0	F	5	15	1	F	5	3	0	S	3	3	0	S	1	2	0	S	1	6	0	F	5
		-	-	-	-	5	0	S	1	10	0	S	4	4	0	S	2	6	2	F	5	5	0	S	2	11	1	SwE	4

Figure 1. The full table of collected data on all navigation journeys. See the full sized figure in the attachments (attachment 1)

Abbreviations:

S	Task completed successfully
SwE	Task completed successfully, with errors along the way
F	Task failed
F*	Fail, info is available but it is in the subdomain and/or it can not be navigated to from the main domain
F**	Fail, information is not relevant
X	Info is not available
-	Task cancelled because F*, F**, or X

Scores:

1	Satisfied: The experience was positive, I did not feel negative emotions.
2	Neutral: I did not feel negative or positive emotions / I have difficulty grading my experience.
3	Unsatisfied: I was not entirely satisfied and I felt some negative emotions.
4	Frustrated: I felt frustration, my experience was considerably negative.
5	Totally frustrated: I felt intense frustration, my experience was absolutely negative.

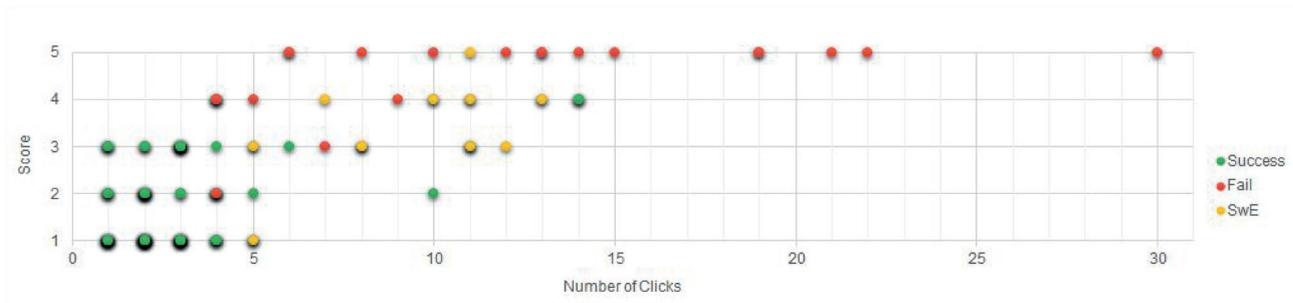


Figure 2. Collected data on all navigation journeys, presented in a graph. The darker circles indicate multiple dots placed on the same coordinates. See the full sized figure in the attachments (attachment 2)

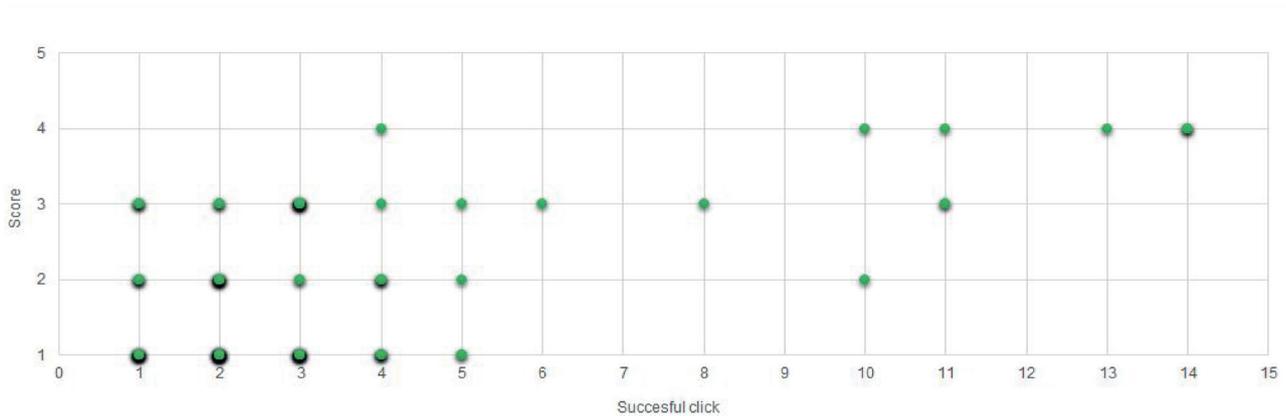


Figure 3. The data for errorless successful navigation journeys presented on a graph. The darker circles indicate multiple dots placed on the same coordinates. See the full sized figure in the attachments (attachment 3)

We can observe that after more than five clicks only one result got a grade lower than three (neutral grade, no negative feelings). Even though not a single errorless successful journey got the worst grade (5), the most negative grade is regardless a “four” (frustrated). We can estimate visually that the grades do get worse with more clicks. However, besides a visual estimate it is important to get the correlation result in numbers.

In order to calculate the correlation coefficient we placed the X and Y values in adjacent columns in Excel and used the CORREL function. The calculated result was

$$r=0.571785\dots$$

Which rounds up to

$$r=0.57$$

In calculating correlation coefficients the result of zero means no correlation, and 1 means perfect positive correlation. To place our result in a worded category we used the categories of statistician Deborah Rumsey, according to whom our result means that our correlation coefficient indicates *a moderate uphill positive relationship*.

Discussion

The visual analysis of Fig.3 and the positive correlation of 0.57 indicate that in the context of this study our hypothesis “For successful journeys, user satisfaction will decrease as the number of navigation journey clicks increases” has been confirmed, and that the null hypothesis of the UIE study has been disproved. Our research question “is there correlation between the number of successful clicks and the user’s rating of the navigation experience?” has been answered by the result of the data analysis. The correlation between our two data sets is the moderate uphill positive relationship of $r=0.57$, indicating that there is a statistical connection between the two. However it needs to be stated that correlation does not equal causation.

The results of our study are easily generalised because every user-oriented web page has a navigation structure, and website developers can take the study results into account in their work in order to have web development aided by scientific data.

The findings of our study are restricted by a number of limitations. Since we only focused on the number of clicks, our correlation shows exactly that, and other factors have not been measured. This means that the experience of the test users could have been influenced by many other factors such as excessive scrolling, buttons that don’t work, drop down menus that can not be scrolled, or slow internet connection. Clumsy UI design played a role with the amount of clicks performed, meaning that the number of clicks was not necessarily caused by the navigation structure alone. With this in mind we did test a large sample of websites with the same purpose, although we did not measure the performance of a computer.

All research participants were 20-25 years old students, meaning that the sample group had relatively similar technical skills. Because we did our research during the COVID-19 pandemic it was challenging to organize a larger research group. Even making these results was excessively time consuming since we worked from home through Zoom video conferencing. There was a benefit to this however, for example the Scorekeeper would turn off their video so that their facial

expressions would not influence the grade and performance of the test User.

A larger research group would allow us to have a separate research manager, who could have checked if the info needed to complete the task actually exists and if certain tasks should be done or cancelled, and could have served as a permanent Scorekeeper. Since we served as Scorekeepers to one another, the first test user had to keep score for themselves and afterwards research the availability of the results, so as not to spoil the navigation journey for the test subject. This means that not all test users followed the same exact method described in the instructions.

The value of our study comes much due to how it addressed UIE's existing but incomplete investigation on the topic. We could not replicate the study because the study's methods were not reported in sufficient detail, so we constructed our own methodology to challenge the conclusions of the original UIE study. Our research setup is improved compared to the existing studies, our reporting of the process is detailed, and our conclusions are based entirely on the results of the study.

Our research opens up directions of focus for subsequent studies. Possible directions include designing setups that address our limitations in order to assess the validity of our studies' correlation, and to gain insight into the possible causative factors for the correlation.

During the series of tests we had made a few casual observations with our research participants:

- As the participant's journey went on the participant became increasingly more careless. For example, going through a sitemap for the first time was quite precise, but when going through the second time the participant often scrolled past the necessary information.
- The experience of extreme frustration was often caused by accidentally returning to the same page multiple times. Going in circles often caused the participant to quit the task before the time limit was reached.
- On the other hand, if the participant felt that they were on the right track or had noticed some promising keywords, they stayed more persistent

This suggests that when someone persistently uses a lot of clicks and spends a lot of time doing this, it means that they still have hope in finding what they need. Quitting after just a few clicks on the other hand often means that the participant feels hopeless. Many sites could have prevented this kind of negative experience by adding a navigation menu with clearly labelled links. Having additional information about the contents before clicking (e.g. by hovering the mouse) should aid navigation. These user insights are valuable information for designers and developers, and can help them make websites more accessible also for frequent website users such as students, and not just for guests such as investors. We also figured out that we had actually become more accustomed to navigating the pages that were part of our study. This proposes the idea that these kinds of tasks could be part of an introductory course in education institutions.

Conclusion

Based on our data the research hypothesis “For successful journeys, user satisfaction will decrease as the number of navigation journey clicks increases” has been proven true, with the correlation between the two data sets being a moderate uphill positive relationship of $r=0.57$. Our data shows that a navigation journey with more clicks does lead to a more negative user experience, regardless of whether the user completes the tasks without errors.

This result has value for user-oriented website navigation development. The study can be reviewed and developed with future studies to create a scientific background for web development practices.

REFERENCES

Budiu, Raluca. "Search Is Not Enough: Synergy Between Navigation and Search." Nielsen Norman Group, Nielsen Norman Group, 7 Sept. 2014, www.nngroup.com/articles/search-not-enough/.

Porter, Joshua. "Testing the Three-Click Rule." UX Articles by UIE, Center Centre, 16 Apr. 2003, articles.uiem.com/three_click_rule/.

Rumsey, Deborah Jean. "How to Interpret a Correlation Coefficient r ." Dummies, www.dummies.com/education/math/statistics/how-to-interpret-a-correlation-coefficient-r/.

ATTACHMENTS

Attachment 1

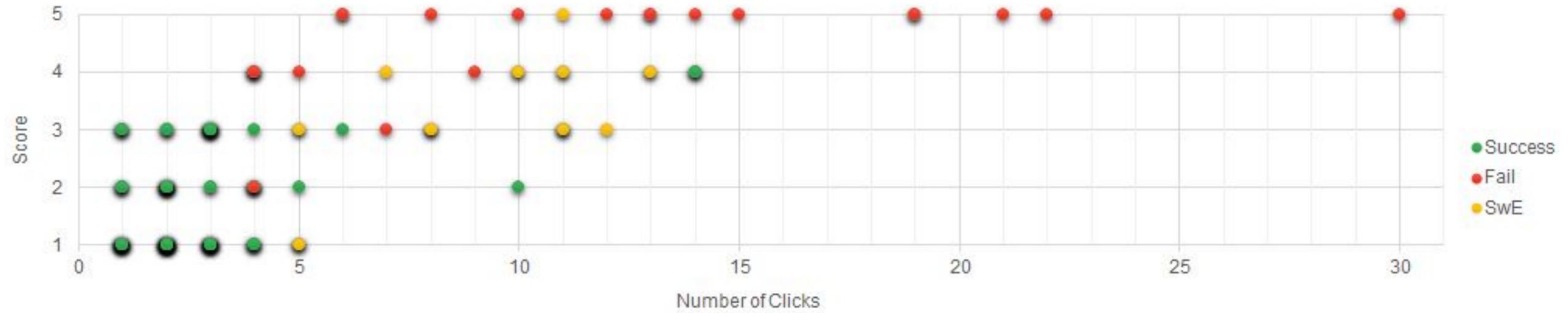
Scores:	
1	Satisfied: The experience was positive, I did not feel negative emotions.
2	Neutral: I did not feel negative or positive emotions / I have difficulty grading my experience.
3	Unsatisfied: I was not entirely satisfied and I felt some negative emotions.
4	Frustrated: I felt frustration, my experience was considerably negative.
5	Totally frustrated: I felt intense frustration, my experience was absolutely negative.

Abbreviations:	
S	Task completed successfully
SwE	Task completed successfully, with errors along the way
F	Task failed
F*	Fail, info is available but it is in the subdomain and/or it can not be navigated to from the main domain
F**	Fail, information is not relevant
X	Info is not available
-	Task cancelled because F*, F**, or X

Subject	Esteettömyys	Vaihtoon				IT-palvelut				Tapahtumat				Opiskelijayhteisöt				Yhteishaku				Kampuksen kartat							
		Clics	Errors	Result	Score	Clics	Errors	Result	Score	Clics	Errors	Result	Score	Clics	Errors	Result	Score	Clics	Errors	Result	Score	Clics	Errors	Result	Score				
	Assignment	Liikun pyörätuolilla. Tarvitsen tietoa esteettömyydestä kampuksella.				Haluan löytää informaatiota vaihtoon lähtemisestä.				Haluan löytää informaatiota mahdollisista IT-palveluista.				Haluan löytää sivun josta näkisi minkälaisia tapahtumia on tulossa yliopistoon.				Haluan löytää opiskelijaorganisaation, joka esim valvoo opiskelijoiden etuja ja järjestää toimintaa.				Etsin infosivua hakijalle. (Sivulta olisi hyvä löytää esim hakuajan ja hakuohjeet)				Tarvitsen kartan, jonka avulla tutustua kampuksen rakennuksiin tai alueeseen.			
Higher education institutions	Starting page																												
Aalto-yliopisto	www.aalto.fi	16	4	F**	4	2	0	S	2	3	0	S	1	1	0	S	3	3	0	S	3	2	0	S	3	1	0	S	2
		-	-	-	-	3	0	S	1	4	0	S	1	1	0	S	1	5	0	S	1	3	0	S	1	1	0	S	1
		-	-	-	-	3	0	S	1	2	0	S	3	2	0	S	1	4	0	S	2	2	0	S	1	2	0	S	1
Helsingin Yliopisto	www.helsinki.fi	7	1	F**	4	4	1	F	4	9	2	F	4	2	0	S	1	4	1	F	4	2	0	S	1	3	0	S	3
		-	-	-	-	21	2	F	5	10	0	S	2	1	0	S	2	13	2	F	5	2	0	S	1	19	1	F	5
		-	-	-	-	11	0	S	3	19	0	F	5	2	0	S	2	14	0	S	4	3	0	S	3	8	0	S	3
Taideyliopisto	www.uniarts.fi	3	0	X	5	4	0	F*	5	2	1	F*	5	2	0	S	2	2	0	X	5	2	0	S	2	3	0	F*	5
		-	-	-	-	13	1	F	5	-	-	-	-	1	0	S	1	-	-	-	-	3	0	S	1	-	-	-	-
		-	-	-	-	13	1	F	5	-	-	-	-	5	0	S	3	-	-	-	-	1	0	S	1	-	-	-	-
Haaga-Helia	www.haaga-helia.fi	2	0	S	1	7	1	F	3	1	0	S	2	1	0	S	1	2	0	S	2	1	0	S	1	3	0	S	2
		5	1	SwE	3	5	1	SwE	1	1	0	S	1	1	0	S	1	3	0	S	2	1	0	S	1	13	0	S	4
		2	0	S	1	14	1	F	5	1	0	S	2	1	0	S	1	10	1	F	5	2	0	S	2	7	1	SwE	4
Metropolia	www.metropolia.fi	2	0	X	3	13	0	F	5	3	0	F*	5	1	0	S	3	3	0	S	3	1	0	S	1	3	0	S	1
		-	-	-	-	30	4	F	5	-	-	-	-	2	0	S	2	14	0	S	4	2	0	S	1	2	0	S	2
		-	-	-	-	11	0	S	3	-	-	-	-	13	1	SwE	4	14	0	S	4	2	0	S	1	2	0	S	1
Laurea	www.laurea.fi	4	0	S	1	6	0	S	3	8	1	SwE	3	3	0	S	3	2	0	S	2	3	0	S	3	4	0	S	1
		4	0	S	3	8	1	SwE	3	3	0	S	1	3	0	S	1	4	0	S	2	2	0	S	1	3	0	S	1
		4	0	S	1	10	1	SwE	4	2	0	S	1	3	0	S	1	2	0	S	1	3	0	S	1	4	0	S	1
Arcada	www.arcada.fi	2	0	S	3	2	0	S	1	5	0	F	4	1	0	S	3	7	0	F*	4	1	0	S	1	11	2	SwE	5
		4	0	S	4	12	2	SwE	3	8	0	F	5	11	1	SwE	3	12	2	F	5	3	0	S	1	4	0	S	2
		2	0	S	1	22	1	F	5	11	0	S	4	2	0	S	2	-	-	-	-	3	0	S	3	3	0	S	3
Humanistinen ammattikorkeakoulu	www.humak.fi	3	0	X	3	4	0	F	4	3	0	S	3	1	0	S	3	2	0	S	1	2	0	S	2	4	1	F	2
		-	-	-	-	12	0	F	5	15	1	F	5	3	0	S	3	3	0	S	1	2	0	S	1	6	0	F	5
		-	-	-	-	5	0	S	1	10	0	S	4	4	0	S	2	6	2	F	5	5	0	S	2	11	1	SwE	4

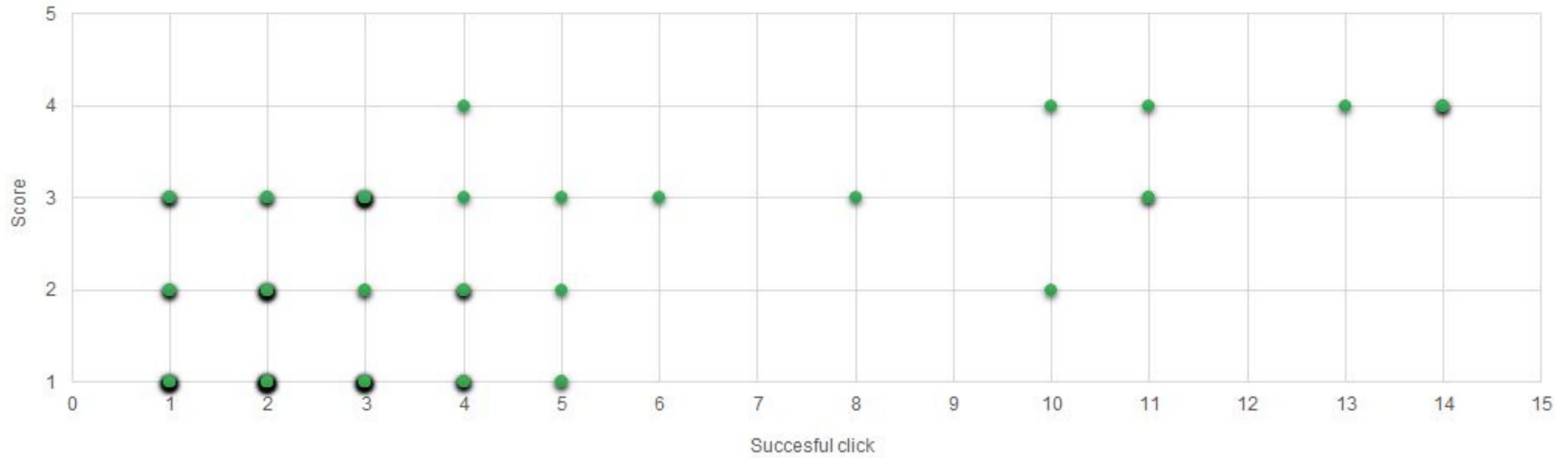
Attachment 2

Figure 2. Collected data on all navigation journeys, presented in a graph. The darker circles indicate multiple dots placed on the same coordinates.



Attachment 3

Figure 3. The data for errorless successful navigation journeys presented on a graph. The darker circles indicate multiple dots placed on the same coordinates.



A?

**Aalto University
School of Arts, Design
and Architecture**