Enhancing Webpage Navigation with a Novel Scrollbar Design

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Abstract. In this paper, we introduce a novel type of navigation bar especially designed to provide users with additional information as they navigate long web pages that consist of several different sections and a large amount of content. In addition to facilitating scrolling, the proposed navigation bar enables users to quickly traverse the page without needing to manually scroll. Moreover, we present the results of a comparative study that analyzed the effectiveness of our proposed system with respect to traditional approaches. From the findings of our research, which includes an evaluation of individuals' likelihood to use the proposed navigation bar, we can conclude that users have a strong preference for our system; also we found that it increases accuracy in information finding tasks. Consequently, we believe the proposed navigation bar design could enhance web usability and improve user satisfaction.

Keywords: User Interface · Scrolling · Usability

1 Introduction

In the recent years, vertical scrolling has been increasingly utilized in web design, though users were initially reluctant to use it and user interface experts advised against it [1]. Indeed, eye-tracking studies have repeatedly demonstrated a preference for above-the-fold viewing (i.e., absence of scrolling) [1, 2, 3, 4] and several studies have pointed out the drawbacks of scrolling [5, 6, 7, 8]. Nevertheless, the vertical layout of Social Media websites has acquainted users with long web pages and scrolling. Although modern devices have made scrolling more intuitive and effortless, there are still major drawbacks to it: the longer webpages become, the more difficult it is to find information on them quickly [7, 8]; also, without scrolling through content there is often no way to know what information is laid out on a page and in what order it is,

which, in turn, may make it difficult to mentally conceptualize the order and location of the information once a user has passed it.

2 Related Work

An early study comparing pagination with scrolling found the former to be superior for text sorting tasks and reading continuous text [5]. The authors conclude that the advantage of pagination over scrolling is the result of having an absolute spatial orientation: when paging, an item of information will always be located at the same location on the screen, which allows it to be located more easily. Conversely, when users scroll, any individual item of information could at some time be located anywhere on the screen. As a result, the users can rely on relative spatial orientation, only.

Another study compared presentation of text in page and scroll modes when reading and revising in a word processor to determine how individuals' mental representations of information were influenced by the two modes and which one would allow people to be more productive. The authors found readers using the paginated mode were able to build a more accurate mental spatial representation of the text and were able to move through the text faster and perform more revision actions on the text in a given time [6]. A study comparing pagination to scrolling for Search Engine Result Pages (SERPs) found that medium page length is more effective than long pages requiring scrolling and shorter pages requiring the user to click several times to see the entire content [7]. On the contrary, a more recent study [9] found that users preferred scrolling over pagination though no statistically significant difference was found in terms of time it took them to locate each type of information. Although most studies indicate that paging has performance benefits and enables users to develop a better mental model of where information is located, nowadays, scrolling has become ubiquitous, with several websites (e.g., Facebook and Instagram) implementing "infinite scrolling" features. In addition, it is possible users prefer scrolling over pagination regardless of any performance benefits that may be realized with pagination.

3 System design

In this paper, we propose a novel design for a navigation bar which attempts to incorporate the advantages of pagination in web pages that require scrolling while reducing the drawbacks associated with scrolling. This new navigation bar is intended to provide users with an absolute spatial orientation, which may help them find information on long web pages and increase the usability of websites. The mobile and desktop versions can be seen in Fig. 1. The correct version is displayed automatically based on device type.

The navigation bar is constructed similarly to a horizontal scrollbar with extra features. An indicator bar is programmed to display on the navigation bar whose width is calculated as the proportion of the page visible. The entire width of the navigation bar acts as a map of the page and is divided into sections which match the sections of the page in both order and relative size. The indicator bar moves as a user scrolls, so the

area of the page visible at any given time is apparent from the size and location of the bar.

Once a user begins scrolling down the navigation bar becomes fixed at the top of the screen, so it is always visible. In this way, the extra navigation bar acts like an interactive map of a page that also shows users their current position and what portion of the page they are viewing. Clicking a section on the navigation bar will also automatically scroll a user to that section on the page.

It is hoped that this system can help users find information more easily by narrowing the amount of the page that must be searched and by clearly dividing the page into smaller, more manageably sized parts. This navigation bar can also guide a user's scrolling so they know how far to scroll to reach a specific section without having to carefully read the text on the page.

For example, if a user is browsing a page for a hard drive and they want to know the storage capacity, they may simply click or scroll to technical specifications. The novel navigation bar provides a spatial target area that they can easily see within which to search for that information. Without this navigation bar users must scroll down while scanning for the information they are looking for, without know how far away it is from their current location. They may even miss what they were looking for, reach the end of the page, and be forced to scroll back up. This new navigation bar is designed to prevent this.

This type of navigation bar can also be modified to fit the needs of a variety of websites. It is envisioned primarily to augment existing navigation features but for certain websites it could replace the standard navigation bar altogether.

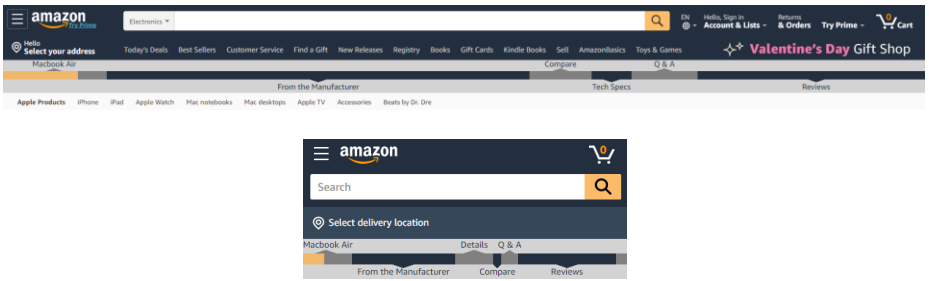

Fig. 1. The desktop (top) and mobile (bottom) versions of the proposed navigation bar, adjusted for the experiment. The grey portion becomes fixed to the top of the page when scrolling down. The orange colored bar moves to indicate position and visible area. Page sections are shown in alternating blue/dark grey. The mobile version functions just as the desktop version but is optimized for smaller screens.

4 Experimental Study

The purpose of our experimental study was to investigate the effectiveness of our approach compared to the standard design of long scrolling web pages, from quantitative and qualitative standpoints. To this end, we applied the design of our navigation bar to the Amazon webpages and we compared the performance of our novel naviga-

tion bar as applied to two product pages (product A and product B) selected at random and edited so that they included approximately the same amount of content.

Participants. A total of 55 participants (33 females, 21 males, 1 not specified) completed the study. Their average age was 29±15 years. 38 of them realized the study on a mobile device whereas 17 used a desktop computer. Most participants reported heavy Internet use (i.e., 4-8 hours per day) and were regular Amazon shoppers (none of them were unfamiliar with Amazon). Most participants (48) were from the USA, 2 were from Spain; Italy, Cambodia, Estonia, Saudi Arabia, and Honduras accounted for 1 participant each. The study was conducted entirely online and participants were recruited through social media. They were given a basic introduction to the novel navigation bar before the experiment began. Also, they were instructed on its function and specifically that the navigation bar could be clicked to move them to a specific location on the page.

Methods. All participants were shown product A and product B in random order: also, at random, one page would have the novel navigation feature and the other would show the standard scroll bar (control version). In order to have participants spend some time using the navigation bar and encourage them to scroll up and down the page frequently, participants were asked to find three different items of information on each page and to answer multiple-choice questions located at the bottom of each page. In order to quantitatively evaluate the performance of our proposed scroll-bar design, we acquired the time required for a participant to complete the tasks as well as the amount of upward and downward scrolling. Also, as the objective of our study was to evaluate participants' preferences, we adopted the Unified Theory of Acceptance and Use of Technology (UTAUT) in its second version (UTAUT2), which was developed as a model to predict the likelihood of consumers to adopt new technologies [10]. The original model was modified for this study and used to predict individuals' likelihood to use it, benefit from it, and enjoy it. Specifically, after the information retrieval task, participants were asked questions modeled on five out of the eight constructs of the UTAUT model (i.e., we included performance expectancy, effort expectancy, facilitating conditions, and hedonic motivation, and we disregarded habit, price-value, and social influence), presented in a random order. As in the UTAUT2 study, we also included a scale for behavioral intention in addition to the scales for each of the other constructs. Each scale consisted of three questions for a total of fifteen questions. Each item was measured using a seven-point Likert scale, with "strongly disagree" and "strongly agree" as the anchors. In addition, participants were asked to provide optional feedback on their experience with the proposed navigation bar in order to investigate their preferences from a qualitative standpoint.

5 Results and Discussion

Initially, we analyzed users' preference, to evaluate whether the proposed design introduced any benefits in terms of user experience. To this end, paired samples t-tests ($\alpha = 0.05$) were used to compare the novel navigation bar and the control version of the task using the 5 scales selected from UTAUT2 (i.e., performance expectancy,

effort expectancy, facilitating conditions, hedonic motivation, and behavioral intention). The scales indicated greater response scores for the novel navigation bar task in comparison to the control version on 4 of the scales measured. These included performance expectancy (P<0.001), effort expectancy (P<0.001), hedonic motivation (P=0.001), and behavioral intention (P=0.006). Descriptive statistics are shown in Table 1.

All the dimensions of the UTAUT2 model included in our study showed significant and strong improvement for the novel navigation bar over the control except for the facilitating conditions construct. This demonstrates users believe the new navigation bar will enhance their performance when using the site, is easy to use, is enjoyable to use, and they would like to use it again in the future. The fact that there was not a significant difference in the facilitating conditions scale may be due to the fact that users did not have prior exposure to this navigation design and would not expect others to have either.

Table 1. Means and Std. Deviations for the novel navigation bar (NNB) and the control version of the task, as well as P values of the paired samples t-tests comparing versions for each of the five scales used in our tests. PE = performance expectancy, EE = effort expectancy, FC = facilitation conditions, HM = hedonic motivation, BI = behavioral intentions.

Scale	Mean	Std. Deviation	P
PE Control	12.852	4.350	.0000
PE NNB	16.241	4.023	
EE Control	13.704	4.363	.0000
EE NNB	17.037	3.529	
FC Control	15.630	3.200	.338
FC NNB	15.130	3.066	
HM Control	12.925	3.920	.001
HM NNB	15.302	3.964	
BI Control	13.763	4.150	.006
BI NNB	15.836	3.857	

Paired samples t-tests were also used to compare time spent completing the information search tasks, the amount of upward and downward scrolling, and the accuracy on the multiple choice questions during the information search tasks between the novel navigation bar and the control version of the task. No significant differences were found between the tasks when performed with the novel navigation bar in comparison to the control version for the total time to complete the task (P=0.733), or total distance scrolled up (P=0.328) or down (P=0.245). However, there was a significant difference between the versions for the accuracy of responses during the information search task (P=0.015), such that participants were 12.7% more likely to correctly identify and recall information on the novel navigation bar version in comparison to the control. Descriptive statistics for these variables are shown in Table 2.

The novel navigation bar design significantly improved participants' ability to find or recall information. This may be a very important factor in considering whether to implement such a navigation bar in a website. In all cases, the correct information was

available on the page if participants were willing to spend enough time looking for it. It may be that many participants simply gave up before finding the information in the control version.

The novel navigation bar did not significantly impact participant's overall time spent on the page or distance scrolled. However, this is not unexpected, because participants were using the novel navigation bar for the first time. It was expected that due to the novelty of the design participants may spend more time on the page with the navigation bar. A similar effect was anticipated for scrolling because clicking on the navigation bar causes an instant and large scroll across the page. Participants likely click this button much more often than necessary just for the enjoyment of doing so. Some users clicked the new navigation bar as many as 11 times. Despite this, the control and novel navigation bar designs were similar in terms of total time spent on the page, and the amount of upward and downward scrolling. It may be that any speed or scrolling advantage was offset by this effect.

Table 2. Means and Std. Deviations for the novel navigation bar (NNB) and the control version of the task, as well as P values of the paired samples t-tests comparing versions for the total time spent in the information search task, the total number of pixels scrolled up and down, and the accuracy of responses in the information search task.

Scale	Mean	Std. Deviation	P
Total Time Control	130095 ms	4.350	.733
Total Time NNB	135421 ms	4.023	
Scroll Up Control	20222 px	4.363	.328
Scroll Up NNB	17108 px	3.529	
Scroll Down Control	33209 px	3.200	.245
Scroll Down NNB	29036 px	3.066	
Accuracy Control	79.4%	3.920	.015
Accuracy NNB	66.7%	3.964	

6 Conclusion

Nowadays, scrolling is a ubiquitous design feature that, despite being criticized by many, has not changed much over time. While the introduction of scrollbars, smoother scrolling resulting from better graphics processing capabilities, and better interfaces for scrolling such as mouse wheels and touch screens have improved user experience, little has been done to assist users in conceptualizing information on pages with very large amount of content. Among several consequences, information is unknown before it enters the viewport, which makes it difficult for users to conceptualize after it has left the viewport.

In this paper, we introduced a novel navigation bar designed to give users a better mental conceptualization of the entire page, especially in the context of long vertical scrolling. Furthermore, we presented the results of a study that compared our design and traditional navigation: our findings clearly demonstrate participants' preference for the novel navigation bar, which also improved participants' ability to find and recall information. The results of our study suggest that including the proposed navi-

gation bar in websites may lead to meaningful improvements in usability and user satisfaction.

While some websites may prefer to force users to traverse all the information on a page, many types of websites and webpages may benefit from this technology such as reference sites, shopping sites, and news articles. It may be difficult to adapt this technology for certain sites such as those with a very large number of short sections. It may be possible to convey most of the benefits of this design however, by using a type of navigation bar design that magnifies the sections closest to the visible area.

In our future work we will investigate how the proposed navigation bar can impact a user's mental map of information, whether using the navigation bar can improve the speed with which as user can locate information, and whether more advanced navigation bar designs can better accommodate larger numbers of page sections.

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