Preprint of: Harms, J., Kratky, M., Wimmer, C., Kappel, K., Grechenig, T.: Navigation in long forms on smartphones: Scrolling worse than tabs, menus, and collapsible fieldsets. In: Abascal, J., Barbosa, S.D.J., Fetter, M., Gross, T., Palanque, P., Winckler, M. (eds.) Proceedings of the 15th IFIP TC 13 International Conference Human-Computer Interaction – INTERACT 2015, Lecture Notes in Computer Science, vol. 9296. Springer (2015)

Navigation in Long Forms on Smartphones: Scrolling worse than Tabs, Menus, and Collapsible Fieldsets

Johannes Harms, Martina Kratky, Christoph Wimmer, Karin Kappel, Thomas Grechenig

INSO Research Group, Vienna Univ. of Technology, Austria.
`[firstname].[lastname]@inso.tuwien.ac.at`

Abstract. Mobile applications provide increasingly complex functionality through form-based user interfaces, which requires effective solutions for navigation on small-screen devices. This paper contributes a comparative usability evaluation of four navigation design patterns: Scrolling, Tabs, Menus, and Collapsible Fieldsets. These patterns were evaluated in a case study on social network profile pages. Results show that memorability, usability, overview, and subjective preference were worse in Scrolling than in the other patterns. This indicates that designers of form-based user interfaces on small-screen devices should not rely on Scrolling to support navigation, but use other design patterns instead.

Keywords. Navigation; Mobile; Smartphone; Form Design; Evaluation

1 Introduction

Forms are widely employed as user interfaces (UIs) for data entry and subsequent editing [15, 17, 22]. Long forms are often considered a bad design practice – e.g., an empirical study [22, p. 294] and recent guidelines [3] recommend against long forms and unnecessary questions. But they cannot always be avoided due to complex application requirements [16]. This also holds for forms on small-screen, mobile devices such as smartphones. Examples of mobile apps with long form-based UIs include editing a contact in the iOS address book (43 form fields), Facebook's mobile profile page (11 collapsible fieldsets for 88 form fields), and the Samsung Galaxy system settings (4 tabs for about 380 form fields). The length of these UIs clearly indicates a need for effective navigation. This can be supported through a variety of navigation design patterns (NDPs). Popular NDPs – also employed in the above-mentioned apps – include Scrolling, Tabs, Menus, and Collapsible Fieldsets. It is the goal of this work to compare and evaluate these four NDPs in a case study on social network profile page editing, see Fig. 1 for screenshots of the evaluated prototypes. The remainder of this work is structured as follows. Section 0 discusses related work with a focus on navigation within mobile UIs. Section 3 describes the case study and the empirical study design. A comparative, lab-based usability test was conducted with N=24 participants. Evaluation results are presented in Sections 4 and 5.

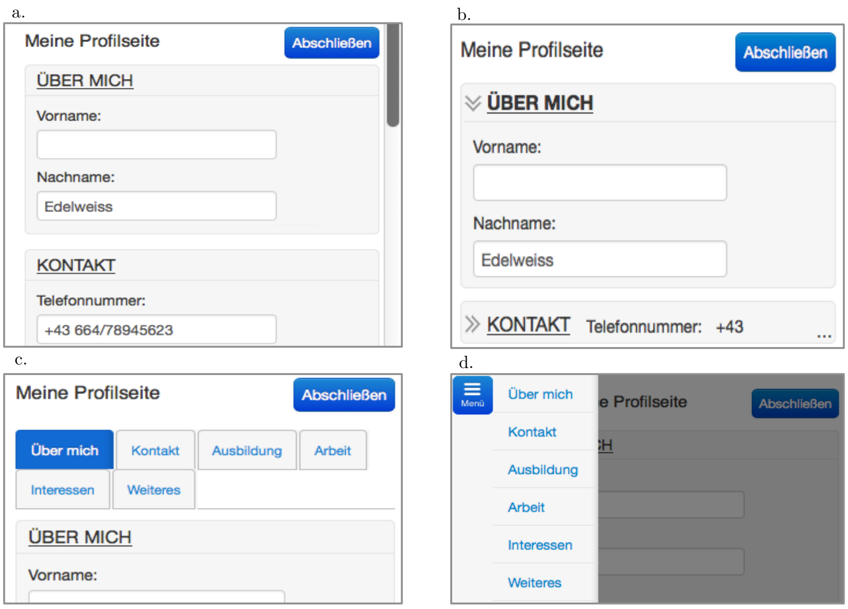

Fig. 1. Screenshots of the four navigation design patterns (NDPs) evaluated in this work: Scrolling (a) shows the entire form in a single, static view. Tabs (b) and Menus (c) provide an overview of the form schema and show details (for the selected tab or menu entry) in a spatially separated view. Collapsible Fieldsets (d) were designed as described in [16]; they employ the Focus+Context principle by surrounding detailed information at the user's focus of interest with a contextual overview.

2 Related Work

A recent overview of navigation research in HCI in mobile, wearable, embedded, 3D, and desktop information systems is provided in [20]. One branch of research has examined navigation between documents, e.g., in hypertext environments [8] and websites [21]. In contrast, research on within-document navigation investigates topics such as reading long documents [1, 2, 13], navigation in lists [12], and navigation in long form-based UIs [11, 16], as examined in this paper. Mobile UIs require special solutions for navigation – techniques for desktop computers may not be directly applicable [23]. Challenges specific to mobile navigation include smaller screen sizes, limited input devices and changing external environment [9].

Related work has presented recommendations for websites on smartphones, suggesting to keep navigation on a minimal scale to avoid using up too much screen space [18]. Existing navigation design patterns (NDPs) can be classified through concepts from information visualization [10]. Accordingly, Tabs, Menus, and Tables-of-Contents offer a spatially separated overview and detailed view. Zooming (not examined in this work) uses a temporal separation. Collapsible Fieldsets employ the Focus+Context principle, seeking to minimize the separation by combining overview and detail in a single, dynamic view. In contrast, Scrolling uses a single, static view.

Related evaluations of NDPs have compared the following usability measures: effectiveness and efficiency, errors, simplicity, comprehensibility, learnability, memorability, and user satisfaction; albeit with conflicting results, see [23] for a literature review. Scrolling is a popular NDP, but has delivered bad results for long mobile UIs [14]. Tabs are a common way to organize navigation in both desktop and mobile interfaces. They have been suggested for splitting heterogeneous content [19, p.448], but also recommended against due to poor performance in very long forms [17, p.111] [19, p.357]. Collapsible Fieldsets and Fisheye distortions employ the Focus+Context principle, which has been shown to reduce task completion time when navigating websites on small-screen devices [14]. The Fisheye distortion that is often – but not necessarily [10] – used in Focus+Context UIs has been shown to decrease targeting performance [10, 14]. Hence related work has recommended to investigate new, non-traditional, possibly non-distorted Focus+Context interaction techniques [4]. Within this direction, recent work has proposed a non-distorted, adaptive form design featuring Collapsible Fieldsets [16]; one such design is evaluated in this work with regard to small-screen devices. Menus and Tables-of-Contents are employed in many mobile apps to provide overview and detail for the primary navigation. Despite the popularity of these patterns, related research has mostly investigated Overview+Detail in a different context, namely navigation in two-dimensional map views. One study reported benefits [6], another pointed out the drawback of reduced screen size [7]. In summary, the above conflicting results indicate a need for further evaluation.

3 Case Study: Social Network Profile Forms

Social network profile pages were chosen as a case study. Many popular social networks allow users to edit their profile using a mobile app installed on their smartphone. These profile pages employ long form-based user interfaces (e.g., Facebook's profile page with 88 form fields, LinkedIn's with 43 fields) to help users provide details about themselves. Tasks comprise both initial filling and subsequent revising. In this respect profile pages are similar to forms in productivity applications and different from, e.g., registration forms and questionnaires. The forms are sparsely filled because not all fields are relevant, the frequency of use is rather low, and information is shared voluntarily at the users' discretion. Navigation is non-linear, not strictly goal-directed (compare [13] for more on goal directedness), and to some degree explorative. In contrast to other domains, no special knowledge is required to answer the questions of a profile page, making the case study suited for evaluation without interference by varying domain-specific knowledge.

The four NDPs of Scrolling, Tabs, Menu, and Collapsible Fieldsets served as test conditions, see Fig. 1a-d for screenshots. We measured efficiency, errors, memorability, perceived usability, and subjective rankings of difficulty, overview, and preference. Participants started working with one randomly assigned NDP. A subsequent first questionnaire assessed memorability (between-subject test design). They then performed three more test runs with the remaining three NDPs. The order in which NDPs were assigned was randomized to level out learning effects. This provided measures regarding efficiency and errors (within-subject test design). Lastly, participants ranked and qualitatively described the NDPs in a second post-test questionnaire and in a short, semi-structured interview (between-subject). All tests took place in a home/office usage context. Users were allowed to sit or stand and used their own smartphones to access a website running the profile page. The tasks required entry, retrieval, editing, and deletion of fictitious form data. Screen recordings and log files supported further analysis.

4 Results

This section presents quantitative and qualitative results, as assessed through a comparative usability test with N=24 participants (f=14, m=10). The significance of observed differences was tested using two-sided Kruskal-Wallis H-Tests with a significance level of $p<0.05$. We used an Exact-Methods implementation of Kruskal-Wallis when computationally possible, otherwise Monte-Carlo with 10.000 samples. Post-hoc pairwise comparisons between groups were tested using Exact Mann-Whitney U-Tests. These test methods are well-suited for the lack of normality and the heteroscedasticity present in much of the data.

Efficiency: We measured the time needed for navigation by analyzing screen recordings, thus splitting total task completion time into navigation, data entry, and task comprehension. There were no significant influences of NDP on the time needed for navigation ($p=0.170$), data entry ($p=0.994$), and task comprehension ($p=0.377$), see Table 1. To assert that these results are not biased by learning effects, we additionally conducted separate statistical tests for each one of the test runs 1-4, but found no significant differences. This indicates that our randomized study design worked well for eliminating learning effects.

Navigation Errors: Screen recordings were further analyzed in order to count navigation errors. This included Scrolling in the wrong direction as well as selecting the wrong Tab, Menu entry or Fieldset. We found no significant influence ($p=0.094$) of NDP on the number of errors, see Table 2.

Memorability. The first questionnaire allowed to measure three memorability scores. Mem1 (number of correctly remembered form sections) and Mem2 (number of correctly ordered form sections) relate to how well participants remembered an overview of the form schema, whereas Mem3 (number of correct labels from the "hobbies" section) measures how well they remembered details. Test results show a significant influence of NDP on Mem1 ($p=0.001$), but not on Mem2 ($p=0.128$) and Mem3 ($p=0.813$), see Table 3. Pairwise comparisons for Mem1 revealed that Menu worked significantly better than both Collapsible Fieldsets ($p=0.009$) and Scrolling ($p=0.002$), the latter of which performed worse than Tabs ($p=0.041$); all other differences were insignificant.

Table 1. Efficiency (measured as time needed for navigation, data entry, and task comprehension) was insignificantly different depending on NDP.

Time needed for:	*Navigation*	*Data Entry*	*Task comprehension*
Scrolling	00:59.37 ± 00:18.56	01:25.63 ± 00:38.03	00:41.79 ± 00:15.28
Tabs	00:53.74 ± 00:30.14	01:18.93 ± 00:25.27	00:49.26 ± 00:17.77
Menu	01:05.50 ± 00:27.80	01:22.92 ± 00:32.79	00:45.04 ± 00:15.39
Collapsible Fieldsets	00:59.15 ± 00:25.00	01:18.40 ± 00:20.62	00:41.05 ± 00:13.23
H-Value, p-Value	H(3)=4.967, p=0.170	H(3)=0.83, p=0.994	H(3)=3.144, p=0.377

Table 2. Navigation errors were not significantly different depending on NDP.

Navigation Errors	*Scrolling*	*Tabs*	*Menu*	*Collapsible Fieldsets*	*H-Value, p-Value*
	2.50 ± 1.719	1.75 ± 2.541	1.79 ± 2.553	2.00 ± 2.377	H(3)=6.333, p=0.094

Table 3. Memorability scores depending on NDP. Mem1 (number of correctly remembered form sections) was significantly better for Menu, followed by Tabs, Collapsible Fieldsets and Scrolling. Mem2 (correctly ordered form sections) and Mem3 (correctly remembered labels in the "hobbies" section) showed no significant differences.

Memorability Scores:	*Mem1*	*Mem2*	*Mem3*
Scrolling	1.00 ± 1.265	3.17 ± 0.753	1.50 ± 0.548
Tabs	3.67 ± 1.966	3.67 ± 2.338	1.50 ± 0.837
Menu	4.50 ± 0.548	4.67 ± 1.633	1.83 ± 0.753
Collapsible Fieldsets	2.50 ± 1.225	4.83 ± 0.983	1.83 ± 1.169
H-Value, p-Value	H(3)=13.071, **p=0.001**	H(3)=5.616, p=0.128	H(3)=1.072, p=0.813

Perceived Usability. Participants comparatively rated the usability of the four NDPs by answering System Usability Scale (SUS) [5] questions in the second post-test questionnaire (handed out upon completion of all test runs 1-4). Overall SUS scores significantly differed (p=0.019) depending on NDP, see Table 4. Pairwise comparisons showed that Scrolling scored significantly worse than both Tabs (p=0.007) and Menu (p=0.024). We also evaluated each SUS question individually, revealing significant influences of NDP on three out of ten questions: SUS1 (p=0.001, "I think that I would like to use this design frequently"), SUS5 (p=0.015, "I found the various functions in this design were well integrated"), and SUS8 (p=0.004, "I found the design very cumbersome to use"), see Table 4. In every one of these questions, pairwise comparisons showed that Scrolling performed significantly worse than all other NDPs (p-Values between 0.000 and 0.026); all other pairwise differences were insignificant.

Subjective Rankings. Users ranked clarity of overview, perceived difficulty, and their individual preference of the four NDPs in the second post-test questionnaire. Results show a significant influence of NDP on overview ($p<0.001$) and preference (p=0.001), but not on difficulty (p=0.143), see Table 5. Pairwise comparisons for both preference and overview revealed that Scrolling worked significantly worse than all of the other NDPs (all p-Values ≤ 0.001); there were no significant differences in all other pairwise comparisons.

Qualitative feedback. Semi-structured post-test interviews asked participants to describe their experience and whether they had difficulties using the NDPs. The interviews were recorded, transcribed and analyzed using empirical codes, see Table 6. Scrolling garnered more negative comments than any other NDP. Users criticized a lack of usability in Scrolling (N=17 comments), stating they found it disorienting and cumbersome. In the same way, they criticized a lack of overview (N=7). In contrast, the other three NDPs received mostly positive comments regarding these topics. Tabs (N=2) and Menu (N=4) were criticized for hidden UI elements, i.e., the tab bar or menu button was hidden when users scrolled down. The visual design was only commented upon with regard to Collapsible Fieldsets (N=6); some users mentioned a lack of color; others were unable to articulate more specifically what they did not like. Users also complained that Collapsible Fieldsets (N=2) and Menu (N=3) lacked familiarity.

Table 4. Perceived usability. Overall SUS (System Usability Scale) scores ranging from 0 to 100, the higher the better. Three individual SUS questions (ranging from 1 to 5, the higher the more agreement) showed significant differences: SUS1 (“would like to use this frequently”), SUS5 (“well integrated”), and SUS8 (“cumbersome to use”).

SUS Scores:	*Overall*	*SUS1*	*SUS5*	*SUS8*
Scrolling	66.35 ± 23.751	2.33 ± 1.579	3.17 ± 1.551	3.08 ± 1.863
Tabs	83.13 ± 19.157	3.87 ± 1.191	4.29 ± 1.042	1.71 ± 1.197
Menu	80.94 ± 20.494	3.83 ± 1.167	4.25 ± 1.189	1.58 ± 1.213
Collapsible Fieldsets	78.75 ± 15.429	3.29 ± 1.429	4.17 ± 0.917	1.75 ± 0.897
H-Value, p-Value	H(3)=9.544, **p=0.019**	H(3)=15.24, **p=0.001**	H(3)=10.378, **p=0.015**	H(3)=12.751, **p=0.004**

Table 5. Subjective Rankings. Scores ranging from 1 to 4, with lower scores indicating a better overview, higher difficulty, stronger preference.

Ranking Scores:	*Overview*	*Difficulty*	*Preference*
Scrolling	3.63 ± 0.770	2.04 ± 1.334	3.29 ± 1.042
Tabs	1.96 ± 0.859	2.67 ± 0.917	2.29 ± 0.955
Menu	2.21 ± 1.021	2.58 ± 1.100	2.17 ± 1.049
Collapsible Fieldsets	2.21 ± 1.021	2.71 ± 1.042	2.25 ± 1.113
H-Value, p-Value	H(3)=32.854, **p< 0.001**	H(3)=5.476, p=0.143	H(3)=16.031, **p=0.001**

Table 6. Qualitative feedback from the post-test interviews. Transcriptions were coded into positive and negative statements and counted regarding the four NDPs.

Feedback:	*Scrolling*	*Tabs*	*Menu*	*Collapsible Fieldsets*
Positive	Usability (1)	Usability (11)	Usability (10)	Usability (10)
		Overview (8)	Overview (8)	Overview (9)
Negative	Lack of Usability (17)	Lack of Usability (2)	Hidden UI Elements (4)	Visual Design (6)
	Lack of Overview (7)	Hidden UI Elements (2)	Unfamiliar Design (3)	Lack of Usability (3)
				Unfamiliar Design (2)

5 Discussion

The four NDPs of Scrolling, Tabs, Menu, and Collapsible Fieldsets evaluated in this work differed regarding memorability, perceived usability (SUS), subjectively ranked overview, and user preference. There were no significant differences in measures of efficiency (time needed for task completion) and navigation errors.

Scrolling performed worse than all other NDPs in every measure with significant differences. Memorability was lower in Scrolling, indicating that users remembered the form schema less well. One possible explanation is that Scrolling required no direct interaction with form section titles, never showed all section titles at once, and thus provided less overview. This lack of overview is confirmed by qualitative results and subjective rankings. Perceived usability and user preference were also significantly worse for Scrolling. The other three NDPs performed equally well with regard to most measures, the only significant pairwise difference being higher memorability of Menu than Collapsible Fieldsets.

Results indicate that designers should not rely on Scrolling alone, but should provide an additional high-level overview of the form schema, possibly using Tabs, Menus, or Collapsible Fieldsets. We expect the results to be generalizable from our case study about social network profile pages to other scenarios with similar characteristics: Long, form-based UIs filled on small-screen devices where tasks include initial filling and subsequent revision of form data in a non-linear, not strictly goal-directed manner. Examples are forms in productivity applications, mobile app settings, and system preferences. Future work should investigate further scenarios and other, not just form-based UIs. Also, the memorability of the various NDPs should be further examined in long-term studies.

6 Conclusion

This paper set out to compare Scrolling, Tabs, Menus, and Collapsible Fieldsets with regard to navigation in long forms on small-screen devices. A usability evaluation was performed with 24 participants in a case study on social network profile pages. Results revealed no influence of navigation design pattern on efficiency and errors, but the following measures significantly differed: memorability, perceived usability, subjectively ranked overview, and user preference. Scrolling performed worst in all of these measures. The remaining three patterns worked equally well. Qualitative results and subjective rankings provided the explanation that the more interactive patterns (i.e., Tabs, Menus, and Collapsible Fieldsets) offer a better overview than Scrolling. We conclude that designers should avoid Scrolling in favor of the other patterns when designing navigation for long, form-based UIs that users fill and edit on small-screen devices.

References

1. Alexander, J., Cockburn, A.: An Empirical Characterisation of Electronic Document Navigation. In: Proceedings of Graphics Interface, GI '08, pp. 123–130. Canadian Information Processing Society, Toronto (2008)
2. Atterer, R., Lorenzi, P.: A Heatmap-Based Visualization for Navigation Within Large Web Pages. In: Proc. 5th Nordic conf. Human-computer interaction: building bridges, NordiCHI '08, pp. 407–410. ACM, New York (2008)

3. Bargas-Avila, J., Brenzikofer, O., Roth, S., Tuch, A., Orsini, S., Opwis, K.: Simple but Crucial User Interfaces in the World Wide Web: Introducing 20 Guidelines for Usable Web Form Design. In: Matrai, R. (ed.) User Interfaces, ch. 1. InTech (2010)
4. Bjork, S., Redstrom, J.: Redefining the Focus and Context of Focus+Context Visualizations. In: IEEE Symp. Information Visualization, InfoVis 2000, pp. 85–89, IEEE (2000)
5. Brooke, J.: SUS-A quick and dirty usability scale. Usability evaluation in industry 189, 194 (1996)
6. Burigat, S., Chittaro, L.: On the effectiveness of Overview+Detail visualization on mobile devices. Pers. Ubiquit. Comput. 17(2), 371–385 (2013)
7. Büring, T., Gerken, J., Reiterer, H.: Usability of Overview-Supported Zooming on Small Screens with Regard to Individual Differences in Spatial Ability. In: Proc. Working Conf. Advanced Visual Interfaces, AVI '06, pp. 233–240. ACM, New York (2006)
8. Chen, C., Rada, R.: Interacting With Hypertext: A Meta-Analysis of Experimental Studies. Int. J. Hum.-Comput. Interact. 11(2), 125–156 (1996)
9. Chittaro, L.: Visualizing Information on Mobile Devices. Computer. 39(3), 40–45 (2006)
10. Cockburn, A., Karlson, A., Bederson, B.B.: A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. ACM Comput. Surv. 41(1), 2:1–2:31 (2009)
11. Couper, M.P., Baker, R., Mechling, J.: Placement and Design of Navigation Buttons in Web Surveys. Survey Practice. 4(1) (2013)
12. Furnas, G.: A Fisheye Follow-up: Further Reflections on Focus + Context. In: Grinter, R., Rodden, T., Aoki, P., Cutrell, E., Jeffries, R., Olson, G. (eds.) Proc. SIGCHI Conf. Human Factors in Computing Systems, CHI '06, pp. 999–1008. ACM, New York (2006)
13. Guiard, Y., Du, Y., Chapuis, O.: Quantifying Degree of Goal Directedness in Document Navigation: Application to the Evaluation of the Perspective-Drag Technique. In: Proc. SIGCHI Conf. Human Factors in Computing Systems, CHI '07, pp. 327–336. ACM, New York (2007)
14. Gutwin, C., Fedak, C.: Interacting with Big Interfaces on Small Screens: A Comparison of Fisheye, Zoom, and Panning Techniques. In: Proc. Graphics Interface, GI '04, pp. 145–152. Canadian Human-Computer Communications Society, Waterloo (2004)
15. Harms, J.: Research Goals for Evolving the 'Form' User Interface Metaphor towards More Interactivity. In: Holzinger, A., Ziefle, M., Hitz, M., Debevc, M. (eds.) Human Factors in Computing and Informatics, LNCS, vol. 7946, pp. 819–822. Springer Berlin Heidelberg (2013)
16. Harms, J., Wimmer, C., Kappel, K., Grechenig, T.: Design Space for Focus+Con- text Navigation in Web Forms. In: Proc. 2014 ACM SIGCHI Symp. Engineering Interactive Computing Systems, EICS '14, pp. 39-44. ACM, New York (2014)
17. Jarrett, C., Gaffney, G.: Forms that Work: Designing Web Forms for Usability. Morgan Kaufmann, San Francisco (2008)
18. Lobo, D., Kaskaloglu, K., Kim, C.Y., Herbert, S.: Web Usability Guidelines For Smartphones: A Synergic Approach. Int. J. Inf. Electron. Eng. 1(1), 33–37 (2011)
19. Tidwell, J.: Designing Interfaces. O'Reilly Media, Inc. (2010)
20. Vainio, T.: A Review of the Navigation HCI Research During the 2000's. Int. J. Interact. Mobile Technologies 4(3), 36–42 (2010)
21. Weinreich, H., Obendorf, H., Herder, E., Mayer, M.: Off the Beaten Tracks: Exploring Three Aspects of Web Navigation. In: Proc. 15th int. conf. World Wide Web, WWW '06, pp. 133–142. ACM, New York (2006)
22. Wroblewski, L.: Web Form Design. Filling the Blanks. Louis Rosenfeld (2008)
23. Zhang, D., Adipat, B.: Challenges, Methodologies, and Issues in the Usability Testing of Mobile Applications. Int. J. Hum.-Comput. Interact. 18(3), 293–308 (2005)