Towards the Development of Usability Heuristics for Native Smartphone Mobile Applications

Ger Joyce and Mariana Lilley

School of Computer Science, University of Hertfordshire, Hatfield, Hertfordshire, AL10 9AB, United Kingdom
gerjoyce@outlook.com, m.lilley@herts.ac.uk

Abstract. This paper reports on initial work in the identification of heuristics that may be most usefully applied in the heuristic evaluation of native smartphone applications. Given the prevalence of such applications, this work seems pertinent, particularly as it also seems under-represented in the literature. Once defined, the heuristics were developed further based on the quantitative and qualitative feedback received from sixty Human-Computer Interaction experts in eighteen countries. The resulting heuristics could be beneficial to HCI researchers and educators, and could also potentially expedite and cut the cost of smartphone application usability evaluations for HCI practitioners.

Keywords: Usability, Heuristic Evaluation, Smartphone, Mobile Application.

1 Introduction

The ability to quickly learn, use and be satisfied with native smartphone applications is vital to users [1]. To meet this goal, a usability evaluation should be employed during the development phase of the mobile application. Otherwise, design considerations specific to native smartphone applications may not be taken into account, which in turn could lead to difficult-to-use applications, frustrated users and lost revenue [2]. Detailed platform-specific guidelines are available from Apple, Google, Microsoft and BlackBerry, yet their focus tends to be on style and design issues, not on usability issues. Furthermore, some of these guidelines can be too extensive, especially for enterprise-class native smartphone mobile applications built across iOS, Android, Blackberry and Windows mobile operating systems.

Research has also shown that traditional usability methods cannot be readily applied to the usability evaluation of native smartphone applications as traditional usability methods does not, among other issues, consider applications built for small screens nor environments far less constant than desktop applications. These types of issues present significant challenges for usability experts [3]. Consequently, when considering our options for defining usability methods for native smartphone applications, we were faced with two options:

A. Marcus (Ed.): DUXU 2014, Part I, LNCS 8517, pp. 465–474, 2014.

1. To create completely new usability evaluation paradigms for native smartphone applications;
2. To modify well-known, tried-and-tested usability methods, proven over many years of research.

Maintaining the benefits of a low-cost, effective, relatively fast usability inspection method, such as a Heuristic Evaluation [4], would seem to be an interesting idea to adapt for the mobile panorama. While existing heuristics may be used for evaluations of native smartphone applications, these tend to be too generic and their applicability to the domain may be limited which, in turn, may impair any evaluation that uses them. To this end, the applicability of each of traditional heuristics to the mobile panorama was considered, and then tailored to the usability inspection of native smartphone mobile applications. Furthermore, where gaps were identified, new heuristics were created.

The Heuristic Evaluation method, created by Nielsen and Molich and later modified for the web by Nielsen in 1994, offers the potential for a relatively inexpensive, effective method of usability inspection. This method became popular after studies revealed that the method found more usability problems when compared to other methods [5]. Indeed, the technique has since been applied in a range of domains, albeit with changes to the heuristics used; the heuristics were originally created for desktop interfaces, not native smartphone mobile applications which tend to be task-driven, are displayed on small screens with different methods of user input, and are typically used within constantly changing contexts and environments. As new products develop the need for the development of heuristics tailored to these new products becomes apparent [1].

2 Literature Review

To understand how a Heuristic Evaluation may be applied to the mobile panorama, an analysis of one hundred and five peer-reviewed papers in the field of usability evaluation was conducted. The literature review found that heuristics tailored to native smartphone mobile applications were under-represented in the literature. Indeed, much of the work does not fully target native smartphone mobile applications.

Initially, the history of the field of usability was researched from the time it first became considered. Papers such as “Designing for usability: key principles and what designers think” [6] were written to examine the issue of usability with desktop-based applications. Other studies defined sets of usability principles, including those in “Cognitive engineering principles for enhancing human-computer performance” [7] and “Heuristic Evaluation of user interfaces” [4].

Following general research into the initial interest in usability, research for this work began to funnel toward native smartphone application usability with the reading of papers such as “Three Facets of Usability in Mobile Handsets” [8], which recognized that the standard usability methods in use then and now did not work well within the mobile domain. Following this observation, papers such as “Heuristic Evaluation and Mobile Usability: Bridging the Realism Gap” by Po et al. [9] started to call for future research into adapting traditional usability methods, specifically

Nielsen's heuristics, for the mobile domain. Two notable works emerged from the call by Po et al., namely "Appropriating and Assessing Heuristics for Mobile Computing" by Bertini et al. [10] and more recently "Usability Heuristics for Touchscreen-based Mobile Devices" by Inostroza et al. [11]. The teams of researchers led by Enrico Bertini and Rodolfo Inostroza produced noteworthy papers in their quest to adapt Nielsen's heuristics for the mobile domain.

However, the heuristics defined within each paper are not directly applicable to the usability evaluation of native smartphone applications. This is because the heuristics from Bertini et al. tend to concentrate on the operating system, the loss of the mobile device, and the ergonomics of the mobile device. This resulted in just several of the nine heuristics aimed at the mobile software, resulting in important areas not being included. On the other hand, while the paper from Inostroza et al. concentrates fully on smartphone application heuristics, not the device. Yet, the authors changed only one heuristic and added another based on Nielsen's traditional heuristics. While, the author's mention that the definitions of the heuristics differed from Nielsen's even if the heuristics had the same titles, this approach could potentially be ambiguous to HCI experts that have worked with Nielsen's heuristics. The author's subsequently report that the number of usability problems found in an experimental study was not significant in comparison to those found using Nielsen's heuristics. Consequently, the evidence would appear to suggest that native smartphone mobile application heuristics:

- Should be more applicable than Nielsen's heuristics to the mobile domain;
- Should not have the same heuristic title as Nielsen's heuristics.

3 Approach

Based on this research and using Nielsen's heuristics as a point of reference, a set of eleven heuristics applicable to the evaluation of native smartphone mobile applications was devised. An important aspect of this work was to subject the set of eleven heuristics developed to a review by HCI experts and researchers.

We sent emails to one hundred and twenty HCI experts requesting their participation in a review of the newly-defined heuristics. The emails addresses were those of authors of papers read during the literature review. This allowed the experts to rate the heuristics through the use of a five-point Likert scale displayed under each heuristic on a custom-built survey. An area for free text comments was also included. We then analyzed the quantitative and qualitative feedback received from the HCI experts that took part in the review, refining the heuristics based on the feedback.

4 Initial Set of Native Smartphone Mobile Application Heuristics

The initial set of heuristics based on the literature, prior to the application of HCI expert feedback follow. We refer to these as **S**martphone **M**obile **A**pplication heu**R**is**T**ics ("SMART") for purposes of differentiation from other sets of heuristics:

SMART1: Provide immediate notification of application status – Ensure the mobile application user is informed of the application status immediately and as long as is necessary.

SMART2: Use a theme and consistent terms, as well as conventions and standards familiar to the user – Use a theme for the mobile application to ensure different screens look alike. Also create a style guide from which words, phrases and concepts familiar to the user will be applied consistently throughout the interface, using a natural and logical order. Use platform conventions and standards that users have come to expect in a mobile application such as the same effects when gestures are used.

SMART3: Prevent errors where possible; Assist users should an error occur – Ensure the mobile application is error-proofed as much as is possible. Should an error occur, let the user know what the error is in a way they will understand, and offer advice in how they might fix the error or otherwise proceed.

SMART4: Use a welcome mat for first-time users – A welcome mat displaying the main features and how to interact with the application allows first-time users to get up-and-running quickly, after which they can explore the mobile application at their leisure.

SMART5: Employ a simplistic, focused, glanceable, visually pleasing, intuitive interface – Main interfaces should be easy-to-learn whereby next steps are obvious, focused on one task, be simple to the point of only having the absolute necessary elements to complete that task which will allow access to vital information while users are interrupted frequently and are themselves mobile, yet the interface should still be attractive and memorable.

SMART6: Design a clear navigable path to task completion – Users should be able to see right away how they can interact with the application and navigate their way to task completion.

SMART7: Allow configuration options and shortcuts – The mobile application should allow configuration options and shortcuts to the most important information and frequent tasks, including the ability to configure according to contextual needs.

SMART8: Cater for diverse mobile environments – Diverse environments consist of different types of context of use such as poor lighting conditions and high ambient noise are common ailments mobile users have to face every day. Cater for these potential issues, for example by allowing users to change interface brightness and sound settings.

SMART9: Facilitate effortlessness input – Mobile devices are difficult to use from a content input perspective. Ensure users can input content accurately by displaying keyboard buttons that are as large as possible, as well as allowing multimodal input.

SMART10: Make good use of sensors – Utilize the complex sensors available as much as possible to provide users with a more interesting and stimulating experience.

SMART11: Create an aesthetic and identifiable icon – An icon for a mobile application should be aesthetic and identifiable as this is what a user sees when searching the device interface for the application they wish to launch and when scanning through app stores it will be the first item they see before the application title, description and screenshots.

5 HCI Expert Survey

The review of the heuristics was held through the use of a custom-built online survey (see Figure 1). Prior to the survey, the participants were informed of the gap identified in the literature that prompted the research and subsequent creation of the heuristics.

Fig. 1. HCI expert survey

The participants were asked to rate each of the eleven heuristics developed using a five-point Likert Scale from 1 (Not Useful) to 5 (Very Useful). Sixty HCI experts from eighteen countries took part in the review; forty-six of the reviewers were HCI researchers, with the remainder being primarily HCI practitioners and HCI educators.

6 HCI Expert Survey Results

The heuristics were well-received by the reviewers. The free text comments received were also very insightful. The modes received in the survey for each heuristic were:

Table 1. Modes for each heuristic

Heuristic	Mode (1 – Not Useful to 5-Very Useful)
SMART1	5
SMART2	5
SMART3	5
SMART4	3
SMART5	5
SMART6	5
SMART7	4
SMART8	4
SMART9	4
SMART10	3
SMART11	5

We used a centered stacked bar chart to display the review results as a standard stacked bar chart does not have a common baseline [12] (see Figure 2). By removing Likert scale responses equal to 3 (Neutral) a central line is created. This separates positive and negative responses, allowing the results to be clearly visualized [13].

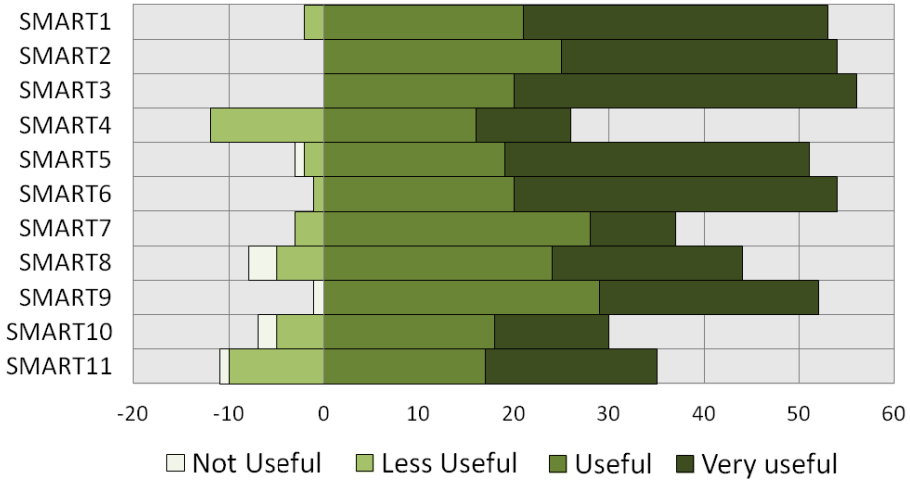

Fig. 2. HCI expert survey quantitative results

As can be seen in Figure 2, the vast majority of HCI experts rated the SMART heuristics either "Useful" or "Very Useful". However, the results also clearly show that a number of HCI experts deemed SMART heuristics 4, 8, 10 and 11 less useful without modification. Based on their comments, modifications were made to the heuristics.

7 Modifications to Initial Set of Heuristics

Changes to SMART4 were to use the term *overlay* which is more commonplace than *welcome mat*, as well as an addition to the definition as a HCI expert mentioned that overlays should be available also for later use. This certainly makes sense where a power user has discovered a lot of the features they wish to use, and would like to see the overlay to learn more features.

For SMART8 "Cater for diverse mobile environments", the HCI experts pointed out that there are too many contexts to be able to cater for them all. While this is true, much can be done to cater for the most common mobile contexts. Other HCI experts pointed out that it was the responsibility of the operating system to adjust screen and sound settings to the environment.

Moving onto SMART10, several HCI experts pointed out that sensors and other smartphone features such as the camera and sensors may not be needed for standard applications and may only be needed for certain applications such as context-aware applications and that the heuristic title sounded as if sensors must be used. This would mean that evaluators would need to highlight the lack of sensor use as a problem even if the application did not require their use. However, rather than remove this heuristic, it was instead modified as a call-to-action to consider using the camera and sensors to lessen users' workloads where possible.

There were no comments specifically about creating an aesthetic and identifiable icon, yet it can be seen from the results that some HCI experts did not deem SMART11 as important. As the majority of HCI experts felt this heuristic was either useful or very useful, it was decided to leave the heuristic as is.

Finally, while SMART5 was deemed 'Useful' / 'Very Useful' by most HCI Experts, several experts commented on the need to create separate heuristics from this single heuristic. To this end, SMART5 was broken up into:

- SMART5: Each interface should focus on one task;
- SMART6: Design a visually pleasing interface;
- SMART7: Intuitive interfaces make for easier user journeys.

The initial heuristics SMART6 to 11 were therefore re-numbered SMART8 to 13.

8 Final Native Smartphone Mobile Application Heuristics

Following the aggregation, analysis and implementation of quantitative and qualitative feedback received during the HCI expert survey, the final set of SMART heuristics for the usability evaluation of smartphone-deployed mobile applications were defined as:

SMART1: Provide immediate notification of application status – Ensure the mobile application user is informed of the application status immediately and as long as is necessary. Where appropriate do this non-intrusively, such as displaying notifications within the status bar.

SMART2: Use a theme and consistent terms, as well as conventions and standards familiar to the user – Use a theme for the mobile application to ensure different screens look alike. Also create a style guide from which words, phrases and concepts familiar to the user will be applied consistently throughout the interface, using a natural and logical order. Use platform conventions and standards that users have come to expect in a mobile application such as the same effects when gestures are used.

SMART3: Prevent errors where possible; Assist users should an error occur – Ensure the mobile application is error-proofed as much as is possible. Should an error occur, let the user know what the error is in a way they will understand, and offer advice in how they might fix the error or otherwise proceed.

SMART4: Display an overlay pointing out the main features when appropriate or requested – An overlay pointing out the main features and how to interact with the application allows first-time users to get up-and-running quickly, after which they can explore the mobile application at their leisure. This overlay or a form of help system should also be displayed when requested.

SMART5: Each interface should focus on one task – Being focusing on one task ensures that mobile interfaces are less cluttered and simple to the point of only having the absolute necessary elements onscreen to complete that task. This also allows the interface to be glanceable to users that are interrupted frequently.

SMART6: Design a visually pleasing interface – Mobile interfaces that are attractive are far more memorable and are therefore used more often. Users are also more forgiving of attractive interfaces.

SMART7: Intuitive interfaces make for easier user journeys – Mobile interfaces should be easy-to-learn whereby next steps are obvious. This allows users to more easily complete their tasks.

SMART8: Design a clear navigable path to task completion – Users should be able to see right away how they can interact with the application and navigate their way to task completion.

SMART9: Allow configuration options and shortcuts – Depending on the target user, the mobile application might allow configuration options and shortcuts to the most important information and frequent tasks, including the ability to configure according to contextual needs.

SMART10: Cater for diverse mobile environments – Diverse environments consist of different types of context of use such as poor lighting conditions and high ambient noise are common ailments mobile users have to face every day. While the operating system should allow the user to change the interface brightness and sound settings,

developers can assist users even more for example by allowing them to display larger buttons and allowing multimodal input and output options.

SMART11: Facilitate easier input – Mobile devices are difficult to use from a content input perspective. Ensure users can input content more easily and accurately by, for instance displaying keyboard buttons that are as large as possible, as well as allowing multimodal input and by keeping form fields to a minimum.

SMART12: Use the camera, microphone and sensors when appropriate to lessen the users' workload – Consider the use of the camera, microphone and sensors to lessen the users' workload. For instance, by using GPS so the user knows where they are and how to get there they need to go, or by using OCR and the camera to digitally capture the information the user needs to input, by allowing use of the microphone to input content which would save the user from having to type on the small keyboard.

SMART13: Create an aesthetic and identifiable icon – An icon for a mobile application should be aesthetic and identifiable as this is what a user sees when searching the device interface for the application they wish to launch and when scanning through app stores it will be the first item they see before the application title, description and screenshots.

9 Conclusion and Future Work

The traditional heuristic method is an inexpensive, highly effective and intuitive method of usability inspection. However, much of Nielsen's and Molich's traditional heuristics are too general for the evaluation of applications that have emerged after these heuristics were first created in 1990, such as native smartphone mobile applications.

In this work, Nielsen's and Molich's heuristics as well as findings from the HCI literature were used as a basis for the development of thirteen heuristics tailored to the inspection of native smartphone mobile applications. Initial results were very encouraging, as the heuristics developed as part of this work received positive reviews from a group of sixty HCI experts in eighteen countries.

Much of the literature has evolved based on expert reviews and empirical studies. The next stage of this work will be to empirically evaluate the usage of the heuristics. It is hoped that this work will contribute towards the development of a set of usability heuristics for native smartphone applications that can be applied widely by HCI researchers, educators and practitioners.

Acknowledgments. The authors are grateful to the sixty HCI experts that participated in the heuristics review and to the School of Computer Science, University of Hertfordshire for providing funding.

References

1. Rogers, Y., Sharp, H., Preece, J.: Interaction Design: Beyond Human - Computer Interaction. John Wiley & Sons (2011)
2. Coursaris, C.K., Kim, D.J.: A Meta-Analytical Review of Empirical Mobile Usability Studies. Journal of Usability Studies 6(3), 117–171 (2011)
3. Bernhaupt, R., Mihalic, K., Obrist, M.: Usability Evaluation Methods for Mobile Applications. In: Lumsden, J. (ed.) Handbook of Research on User Interface Design and Evaluation for Mobile Technology. IGI Global (2008)
4. Nielsen, J., Molich, R.: Heuristic evaluation of user interfaces. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 249–256 (1990)
5. Jeffries, R., Miller, J.R., Wharton, C., Uyeda, K.: User interface evaluation in the real world: a comparison of four techniques. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 119–124 (1991)
6. Gould, J.D., Lewis, C.: Designing for usability: key principles and what designers think. Communications of the ACM 28, 300–311 (1985)
7. Gerhardt-Powals, J.: Cognitive engineering principles for enhancing human-computer performance. International Journal of Human-Computer Interaction 8, 189–211 (1996)
8. Ketola, P., Röykkee, M.: The three facets of usability in mobile handsets. In: CHI 2001 Workshop: Mobile Communications: Understanding Users, Adoption & Design (2001)
9. Po, S., Howard, S., Vetere, F., Skov, M.B.: Heuristic evaluation and mobile usability: Bridging the realism gap. In: Brewster, S., Dunlop, M.D. (eds.) Mobile HCI 2004. LNCS, vol. 3160, pp. 49–60. Springer, Heidelberg (2004)
10. Bertini, E., Gabrielli, S., Kimani, S.: Appropriating and assessing heuristics for mobile computing. In: Proceedings of the Working Conference on Advanced Visual Interfaces, pp. 119–126 (2006)
11. Inostroza, R., Rusu, C., Roncagliolo, S., Jimenez, C., Rusu, V.: Usability Heuristics for Touchscreen-based Mobile Devices. In: Proceedings of the Ninth International Conference on Information Technology: New Generations (ITNG), pp. 662–667. IEEE, Las Vegas (2012)
12. Robbins, N.B.: Creating More Effective Graphs. John Wiley & Sons (2012)
13. Petrillo, F., Spritzer, A.S., Freitas, C.D.S., Pimenta, M.: Interactive analysis of Likert scale data using a multichart visualization tool. In: Proceedings of the 10th Brazilian Symposium on Human Factors in Computing Systems and the 5th Latin American Conference on Human-Computer Interaction, pp. 358–365 (2011)