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A Toolkit for the Usability Evaluation of Digital Health Technologies

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Abstract

Introduction: NHS digital applications are often assessed against the NHS Digital Technology Assessment Criteria (DTAC). However, Small to Medium Enterprise (SME) developers often find DTAC itself 'heavy going'. One criterion of DTAC is usability and SME developers need guidance on how to meet this criterion. My PhD is a four-part study to develop such guidance.

Methods: (i) a scoping review of the methods of usability testing, (ii) development of a novel way of employing a usability scale, dividing it into discrete chunks to prevent "questionnaire fatigue", (iii) development of a toolkit, (iv) application of the toolkit with SMEs.

Results: (i) The scoping review identified 133 papers. (ii) The simpler way of administering the usability scale gave comparable results. (iii) I developed a toolkit that gives guidance on which testing method to employ, the number of participants, and the types of output. (iv) I have used the toolkit to guide three SMEs (two more in progress) in testing digital health technologies.

Conclusions: The toolkit will aid SMEs in meeting DTAC criterion for usability. Further research is needed to refine and validate the toolkit and develop methods for evaluating new types of digital health applications such as virtual reality and voice interfaces.

Keywords: Usability, digital health, mhealth. evaluation.

1. INTRODUCTION

I am a part-time PhD student and I am also currently working as a Research Associate in the Ehealth Productivity and Innovation in Cornwall and the Isles of Scilly (EPIC) project. The EPIC project aims to grow the digital health ecosystem in Cornwall and the Isles of Scilly by assisting Cornish Small and Medium Enterprises (SMEs) in developing digital health applications (EPIC, 2017). This is done by providing academic support, innovation funding, knowledge exchange and business support. Both my work and PhD research involve usability testing of digital health applications. As part of my work I am supporting SMEs by providing guidance on usability testing. To provide the best possible guidance, I conducted a scoping review on the methods of usability testing in the development of digital health applications. I have completed and published the scoping review (Maramba et al, 2019).

I am now using the results of the scoping review to inform the usability testing being done by SMEs receiving support from the EPIC project. One example is the usability testing I performed of the

MyPreOp web-based preoperative assessment system. Based on this and other experiences guiding SMEs in conducting usability testing, I have started designing a toolkit to guide the process of usability testing of digital health applications. I am using the toolkit together with SMEs to plan and conduct their usability testing and refining the toolkit collaboratively. The aim is for the toolkit to be an easy to use guide for digital health application developers to meet the criterion for evidence of usability, as set by the NHS Digital Technology Assessment Criteria (DTAC).

2. BACKGROUND

Digital health technologies are being promoted by the National Health Service (NHS) in England as part of the new Long Term Plan. As stated in section 5 of the plan, the aim is for digitally-enabled care to go mainstream across the NHS. To support this, the plan proposes to "work with the wider NHS, the voluntary sector, developers, and individuals in creating a range of apps to support particular conditions" (NHS, 2019).

This aim acknowledges the phenomenal growth in the eHealth sector, with an estimated 325,000 mobile health apps available for download in 2017 (Pohl, 2017).

In line with this, the Long Term Plan states the need to work with the wider NHS, the voluntary sector, developers, and individuals in creating a range of digital health apps to support particular conditions.

2.1 DTAC usability requirements

Existing guidance for usability evaluation activities for digital health technologies include the NHS DTAC (DTAC, 2022) and the National Institute for Health and Care Excellence (NICE) Evidence Standards Framework for Digital Health Technologies (NICE, 2019).

The requirements of DTAC for usability are the following:

- Does the developer engage users in the development of the product?
- Are all key user journeys mapped to ensure that the whole user problem is solved, or is it clear to users how it fits into their pathway or journey?
- Does the developer undertake user acceptance testing to validate usability of the system?

2.2 Problem Statement

SMEs developing digital health applications need to generate evidence that will satisfy the DTAC with regards to usability. However, in their present form, the criteria do not adequately describe how to generate this evidence. And whilst larger developers may have in-house expertise in usability evaluation, the smaller developers may not.

2.3 Research Purpose and Questions

The purpose of this research is to investigate how best to provide guidance in the practice of robust user experience evaluation amongst developers of digital health technologies. The following research questions were developed:

1. What are the current methods for usability evaluation of digital health applications as found in the published literature?
2. What are the enablers and barriers to embedding meaningful user experience evaluation activities amongst developers?
3. How can developers be guided in conducting meaningful user experience evaluation activities in the development of their applications?

3. RESEARCH AND WORK

3.1 Completed research

3.1.1 Scoping review

In the scoping review of 133 papers, I was able to identify the following methods of usability testing, and the number of studies using them (a number of studies used multiple methods): questionnaires (n=105), task completion (n=57), 'Think-Aloud' (n=45), interviews (n=37), heuristic testing (n=18), focus groups (n=13). (Maramba, 2019)

3.1.2 Usability testing of digital health applications.

I used the results of the scoping review to guide usability testing of digital health technologies. I also developed a novel way of employing a usability scale, dividing it into discrete chunks to prevent "questionnaire fatigue". This method was employed in the usability testing of a computerised preoperative assessment system. The use of this method did not affect preoperative assessment completion times and gave satisfactory results (n=1400 responses).

3.1.3 Barriers and Enablers Identified

The following barriers and enablers were identified from the literature and from qualitative work done with the SMEs:

Barriers: SMEs having little knowledge of user experience and usability testing methods.

Little or no access to patient groups for co-design and user testing.

Enablers: Support from academic institutions providing knowledge transfer about methodologies. Formation of networks of stakeholders in digital health through projects like EPIC.

3.2 Ongoing and future work

Based upon the findings of the literature reviews, existing evaluation frameworks for other domains, and usability studies personally conducted, I developed a framework for usability testing of digital health applications. It specifies the kind of tests that would be suitable for various stages of development of the application, as well as the objectives, the number of participants needed, and the approximate time involved. A summary version of the proposed framework is included as Appendix 1.

4. CONCLUSION

The toolkit intends to guide a developer in gathering evidence to satisfy the requirements of DTAC in the areas of usability. Further research needs to be done on:

1. Validating the toolkit in successfully meeting the DTAC criteria on usability.
2. Further updating the toolkit to include new evaluation methods and new interfaces, for example, virtual reality and voice interfaces.
3. Creating an interactive, digital version of the framework, either as a web or mobile app.

5. REFERENCES

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Appendix 1: Usability Evaluation Framework

Introduction

The following is a framework for usability testing of digital health applications. It specifies the kind of tests that would be suitable for various stages of development of the application, as well as the objectives, the number of participants needed, and the approximate time involved. It is followed by an explanation of the test methods.

Framework

Development Stage	Type of testing / activity	Objectives	Output	Number of Participants	Time required	Meets which DTAC Criteria
Requirements Gathering and Analysis	Focus Group, Interview,	To gather all the information like what the customer wants to build, who will be the end-user, what is the purpose of the product.	Software Requirements Specification document	At least 2, 5 or more if possible	Focus group: 2 hours Interview: 1 hour	D1.1
Design:						
Proof of Concept	Focus Group, Interview, Card Sorting, Persona development	Used to validate the idea or the feasibility of the concept. To verify if a concept can be implemented on the technical capability and business model grounds.	Document showing proposed screens. Possible user journeys based on personas. Feature list and projected implementation.	At least 2, five or more if possible	Focus group: 2 hours Interview: 1 hour Card Sorting: 1 hour. Persona Development: 1 hour	D1.2
Prototyping: Low (Paper), Wire frames) and High Fidelity (Screens)	Focus Group, Interview, Think Aloud, Heuristic Evaluation, Questionnaires	General: To Show how an app will flow from one screen to another and how it would look to the end users. To identify usability issues from the prototype.	Usability test report. Qualitative analysis of Focus group / Interview. List of issues found together with rating of issue.	Think-Aloud: 8-10 Questionnaires:20 Heuristic: 4	Focus group: 2 hours Interview: 1 hour Think Aloud –1 hour Heuristic: 1 hour	D1.2 D1.3
Coding:						

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Minimum Viable Product	Think Aloud, Completion Times and Rates, Error Rates, Heuristic Evaluation, Questionnaires, Interview, Eye Tracking, Click Maps	General: To verify the app feasibility, teams' assumptions about the application, and its probable usability along with the market demand. To identify usability issues in the minimum viable product.	Usability test report. Qualitative analysis of think aloud. List of issues and rating. Questionnaire results, Completion times and error rates. Heat maps.	Think-Aloud: 8-10 Questionnaires: at least 20. Other Quanti: at least 20. Heat Maps: 39	Think Aloud –1 hour Heuristic: 1 hour Eye-tracking: 1 hour. Questionnaires: 0.5 hour.	D1.2 D1.3
Testing:						
Alpha	Think Aloud, Completion Times and Rates, Error Rates, Questionnaires, Eye Tracking, Click Maps, Log Analysis	Identify all possible issues and bugs before releasing the final product to the end users. Alpha testing is carried out by the testers who are internal employees of the organization.	Usability test report. Qualitative analysis of think aloud. List of issues and rating. Questionnaire results, Completion times and error rates. Heat maps.	Think-Aloud: 8-10 Questionnaires: at least 20. Other Quanti: at least 20. Heat Maps: 39	Think Aloud –1 hour Heuristic: 1 hour Eye-tracking: 1 hour. Questionnaires: 0.5 hour.	D1.2 D1.3
Beta	Completion Times and Rates, Error Rates, Questionnaires, Eye Tracking, Click Maps, Log Analysis	Beta Testing is performed by "real users" of the software application in "real environment" and it can be considered as a form of external User Acceptance Testing. It is the final test before shipping a product to the customers.	Usability test report. Questionnaire results, Completion times and error rates. Heat maps.	Questionnaires: at least 20. Other Quanti: at least 20. Heat Maps: 39	Eye-tracking: 1 hour. Questionnaires: 0.5 hour.	D1.2 D1.3

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Deployment: User Acceptance Testing	Completion Times and Rates, Error Rates, Questionnaires, Click Maps, Log Analysis	User Acceptance Testing (UAT) is a type of testing performed by the end user or the client to verify/accept the software system before moving the software application to the production environment. UAT is done in the final phase of testing after functional, integration and system testing is done.	Usability test report. Questionnaire results, Completion times and error rates. Heat maps.	Questionnaires: at least 20. Other Quanti: at least 20. Heat Maps: 39	Eye-tracking: 1 hour. Questionnaires: 0.5 hour.	D1.3
Maintenance: In Service Testing of new versions.	Completion Times and Rates, Error Rates, Questionnaires, Click_Maps_ Log Analysis	Maintenance testing is the type of software testing that refers to testing the changes to an operational system or the impact of a changed environment to an operational system.	Usability test report. Questionnaire results, Completion times and error rates. Heat maps.	Questionnaires: at least 20. Other Quanti: at least 20. Heat Maps: 39	Eye-tracking: 1 hour. Questionnaires: 0.5 hour.	D1.3