An Investigation into Monitoring Usage Data and Usability Testing for mHealth Applications

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ABSTRACT

Technology-based interventions can help greatly in supporting individuals and communities with their specific needs and issues. Mobile health (MHealth) solutions leverage available technology to provide communities and individuals with healthcare services through mobile applications.The You and Your Baby Android application is a MHealth application that was developed and deployed by Computer Science Honours students at the University of Cape Town in 2023. This application was developed in conjunction with the Bhabhisana Baby Project, a Western Cape initiative aimed at supporting parents of children born with developmental difficulties through the first few years of their lives. This literature review will explore the current methods of analysing whether a technology has been succcessful in serving its target audience, usability testing methods and how the resulting data should be analysed.

Author Keywords

Human-Computer Interaction; Application Usage Monitoring; Technology Acceptance; Participatory Design

INTRODUCTION

The You and Your Baby MHealth application serves a content delivery application service for the Bhabhisana Baby Project to disemminate articles, videos and other content relating to childcare and their child's health. The main focus of this application is to support the parents of children with developmental difficulties throughout their key years of development.

This educational content attempts to help inform parents about common issues and provide them with resources to help them through their parenting journey. Bhabhisana Baby Project administrators are able to assign specific content to parents, allowing them to ensure that parents are given the information relavent to them.

Early Childhood Development (ECD) refers to the vital development stage of young children roughly up until their third year of life.

This project builds on earlier work done by the Co-designing for Maternal and Child Health (CoMaCH) project to better understand the needs and wants of community members and how development of digital maternal and child health tools can better use these insights to develop useful solutions.

Mobile health application (MHealth) solutions are often proposed as a good means by which information can be disseminated. However, several usability issues can occur- especially in bandwidth constrained communities. These applications' usage data can be examined to uncover the application's popularity within the target community and invites the possibility of further usability testing to uncover possible improvements to the application.

The You and Your Baby application has been deployed in the communities of Oceanview, Western

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Cape and Sweetwaters, Kwa-Zulu Natal through the Google Play Store.

This literature review will focus on how monitoring of the current application's deployment can be done and how these insights can be used, alongside community engagement, to improve the application.

TECHNOLOGY ACCEPTANCE

Quantifying how well-received a technology is with its target audience has proven to be a historically difficult task. While usage data garnered from application downloads and interviews with target users can provide valuable qualitative and quantitative data surrounding the application's popularity, further insights into the users' motivations behind their acceptance or non-acceptance of the technology are vital. Developing these kinds of insights improving the application's reach. Research into this field has been ongoing and has produced many models of technology acceptance. These theories all aim to explain and predict an application's acceptance by its target audience by considering various factors and differ from each other from the factors considered.

Theories of Technology Acceptance

The field of consumer acceptance of new and emerging technologies has produced several theories and frameworks which are used as guidelines to measure the adoption of the technology within the target audience.

The Technology Acceptance Model (TAM) is perhaps the first model to predict and explain factors affecting a technology or software's acceptance by a community [6]. The TAM endeavours to predict and explain the adoption of given technologies through examination of the technology's perceived usefulness, the perceived ease of use and the users' attitude towards the technology. These factors were proposed as influencing the users' behavourial intention. In other words, the TAM seeks to understand users' intention to perform the behaviour of using the technology.

The TAM emphasises the need to consider the users' perception of the application in question in predicting its acceptance.

Limitations of the Technology Acceptance Model

The TAM has been criticised for being an insufficient framework to fully understand how consumers learn and adopt new technologies. It was developed in the early 1980s and struggles to accurately predict and explain consumer behaviour during the current rapid rate of technological development[3]. This is one of many popular concerns regarding the generalisability of the TAM to modern-day conditions.

Similarly, the TAM has been noted as not including the influence of outside factors such as organisational culture on consumers' acceptance of a technology[9].

Overall, the TAM is recognised as a useful method of measuring and explaining technology acceptance but it has been noted that there are several individual-level and contextual factors that should be taken into account [20]. These factors can help to better explain and predict consumer behaviour as they will provide researchers with a more nuanced understanding of how the application can be modified to encourage wider usage.

The Unified Theory of Accceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology has been widely accepted as a unified theory that takes inspiration from the TAM and similar theories that can be applied to various scenarios and software [16]. The UTAUT attempts to combine the approaches of eight popular TAMs of determining user acceptance and succeeds in being applicable to varied contexts [17]. This model was further improved upon by the original researchers to add three constructs- hedonic motivation, price value and habit [17]. This model proposed to be more effective at encapsulating more of the nuance regarding the prediction and explanation of a software's acceptance into a certain community.

Although the TAM has been iterated upon many times, some studies within recent years have made use of a modified version of the TAM to explain and evaluate the adoption of technologies. A modified version of the TAM was used in 2013 to evaluate the adoption of financial technology services in South Africa[19]. This modified TAM took into account

levels of trust, social aspects, hedonistic motivators, tasks and self-efficacy to evaluate the adoption of a new bank that made use of increased technology-based channels to interact with their customers. The model, with its proposed additional factors, was found to explain the acceptance of the technology well. This modification of the TAM and other studies opens up the possibility that the original models for understanding technology acceptance can be modified to match certain specific contexts.

A vanilla TAM has been used to understand the relationship between perceived usefulness and perceived ease of use of technologies amongst Cape Town General Practitioners [10]. This study, however, investigated only the correlation between these two variables and did not extend to exploring possible methods of deploying more technology-based medical interventions and their benefits. Moreover, very little attention was given to the specifics of the South African context in the study.

This suggests that in order for analysis surrounding technology deployment to be done, a modified version of the TAM or UTAUT is necessary in order to draw comprehensive conclusions surrounding a technology's popularity amongst its target user base.This is largely done to expand the influencing factors to include additional details about the users' contexts.

USABILITY EVALUATION

A mobile application such as You and Your Baby can be evaluated on the basis of many factors, the most pertinent of which is the usability of the application as it relates to the parents. Of interest to us are those who use the application and those who do not. Investigating the motivations of the latter group can offer important insights into how the application can be improved to appeal to a wider audience.

Participatory design is a practice of involving the end user within the development process [14] in order to develop a solution with the direct input of those most impacted by its deployment. This approach to application design ensures that users are treated as experts rather than as if they are ignorant of their own wants and needs.

Mixed method usability studies have also been used within mobile health application development to great success. Mixed method studies result in qualitative and quantitative data, leading to the ability to conduct more nuanced analysis [1].

Content Prototyping

Low-technology prototyping options can be explored to engage with potential users with low technical experience, mainly Content Prototyping, an approach that been shown to be effective in explaining technology-based interventions to those with low levels of digital literacy [11].

Discount Usability Testing

Discount usability testing is a form of usability testing that involves using relatively smaller sample size and low resources for usability tests. This approach was first popularised by Jakob Nielsen in 1989 with his paper, 'Usability Engineering at a Discount'. Nielsen proposed using small, think-aloud studies, heuristic evaluation and rapid iteration during the development cycle as a cost- and time-effective method of conducting useful usability testing[12].

Since then, discount usability testing has become a popular methodology to iterate upon and improve on technologies without the need for investing time and money into implementing extensive, costly usability testing with large sample sizes. This allows developers to reap the benefits of usability testing while negating the intimidating effect of textbook usability testing methods [**?**].

Co-Design

Co-design is a software development methodology that is based on human-centred design, which focuses on ensuring that the end user is fully involved in the development process. This methodology can be effective when finding solutions for complex societal problems and driving public sector innovation [2].

When applied to six public service design projects surrounding topics from under-aged youths' alcohol abuse to the development of a weight management program, the usage of co-design was found to be useful in developing user-driven ideas [15]. The

authors of this study stressed that the development of any software needs to be an iterative process, with researchers enabling participants to engage in the ideation process through workshops.

Previous research with nursing mothers as participants has lent some key insights into how to better develop evaluation and co-design workshops for parents of young children. The participatory design approach lends itself to solutions such as one-handed prototypes that mothers can use while carrying their child and surveys that mothers can complete in their own time rather than in-person [18].

Participation of the end user in the development process is consistent with feminist HCI methodology. This allows for increased empathy-building with the participants, creating a sense of mutual aid and assistance amongst researchers and vulnerable groups such as nursing mothers [7].

DATA ANALYSIS

Deployment and iterative improvement of any technology brings with it the data produced through extensive interviews and research into users' opinions and experience whilst using the technology. This data can be qualitative, in the form of interview transcripts or field notes from focus groups or quantitative, in the form of responses to surveys or questionnaires [5]. Different types of data analysis have been proposed and have become popular for use with these two main types of data.

Thematic Analysis

Thematic analysis refers to a qualitative data analysis method for analysing data collected during interviews, workshops and other interactions with users. This method is popular in the social sciences, psychology and anthropology and involves naming themes and patterns in the data [4]. This is an effective method for understanding and exploring the findings from user interviews.

Thematic analysis is a flexible method for analysing qualitative data that can be easily applied to the observations and interviews done in a HCI context [5]. This method of data analysis can be adapted to suit every kind of project and the focus can be shifted depending on the participants, the project's goals and any external factors, helping researchers better understand certain topics and ideas as they relate to their specific research question.

Statistical Data Analysis

The use of statistical data methods- specifically hypothesis testing- has been common in most fields of research for as long as they have been popularised. Research in HCI makes use of statistical data analysis during usability testing to ensure that any conclusions drawn from the interviews can be validated through the data collected.

The methods most popular in the field of HCI include hypothesis testing using t-tests and ANOVA tables and regression analysis. These are standard statistical analysis tests that are run on various data types across the breadth and width of scientific research.

It has been noted that it is important that the right statistical method is selected to evaluate the given data types [13] to minimise the inclusion of any less useful statistical analysis.

However, the use of statistical analysis in HCI research has been criticised as being ineffective in explaining the data and drawing conclusions from the data. This arises from the use of statistical significance levels that are chosen arbitrarily and impair the reader's ability to draw their own conclusions from the data [8]. The estimate-based approach to statistical analysis provides a remediation for this discrepancy between the authors'

DISCUSSION

The You and Your Baby application's initial deployment presents a good opportunity for analysis into how well the communities have received the application. This should be achievable through the monitoring of Google Play Store downloads and monitoring the web page.

The usage of a theory of technology acceptance model is clearly a vital consideration when monitoring the acceptance of the You and Your Baby application. The models provide guidelines that will shape the way in which data surrounding the application's usage will be collected and will influence the types of interviews conducted. However, it is

not immediately clear which of the existing theories of technology acceptance is most suited to the You and Your Baby application. Given that the communities in Oceanview and Sweetwaters have their own differences, it is likely that slightly adjusted models will be used to explain the usage patterns in the different communities. Further inquiry into the factors of user behaviour in these communities will need to be done in order to establish which theory of technology acceptance will provide the best foundational model. It is important to consider external factors, such as network access, digital literacy, electricity outages and other contextual issues that will impact the usability of an application in the specific communities where it has been deployed. These, alongside other influencing factors, are vital in creating a nuanced understanding of why target users behave in the way that they do.

Creating a comprehensive technology model will not only assist in understanding what the users who consistently use the application find useful about the application, but also assist in determining what may deter continued usage by some target users and in other cases, what stops target users from downloading the application in the first place.

Although the You and Your Baby application was co-designed with the Bhabhisana Baby Project members and the resulting application includes most of the initial asks of the organisation, there is room for improvement to address any usability issues faced by the end users. In this case, due to funding and time constraints, traditional usability testing methods are not feasible. Discount usability testing methods will therefore can used to involve the end users in these communities in interviews and perhaps workshops that focus on their usage of the application. This would involve small focus groups of community members and focus on members of the target audience in these communities who do not use the application as well as those who do. the insights gained from why certain community members do not use the application can be instrumental in the iterative development of the application to eventually have it appeal to more users.

The opportunity also presents itself to monitor the effect of any improvements of the application. This can be done by deploying improved versions of the application and investigating the effects of the changed application on the communities' usage of the application.

CONCLUSION

The You and Your Baby application's initial deployment in two under-served communities around the country provides an opportunity to investigate the usability issues of the application and to investigate how the application can be improved to better served the parents in these communities. Well-researched HCI paradigms exist to evaluate the usability of an application and to explain the acceptance of a technology within its target user base and can be modified to suit the specific case of the You and Your Baby application.

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