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Mobile Health Applications: Engineering User-Centric Designs

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ABSTRACT

Mobile health applications (MHAs) are becoming an integral component of modern healthcare, offering users accessible and convenient tools for managing health. This paper examines the importance of user-centric design principles in developing effective and engaging MHAs, emphasizing intuitive usability, personalization, and inclusivity. This review examined the role of technology, including artificial intelligence, wearable integrations, and regulatory compliance, in ensuring a seamless user experience. By analyzing case studies, we highlight best practices and challenges in designing MHAs tailored to diverse populations, demonstrating their potential to influence health behaviors positively. This study aims to provide a comprehensive framework for engineers and developers to innovate in the m-Health sector, ensuring their designs meet both technical and human-centric demands.

Keywords: Mobile Health Applications (MHAs), User-Centric Design, Healthcare Technology, Human-Centered Engineering, e-Health and m-Health, Digital Health Usability.

INTRODUCTION

Nowadays, there is a notable emphasis on e-Health and m-Health applications. Mobile health applications are the fastest growing market for ordinary people to use and are an essential domain for engineers to advance in the delivery of primary care. Today, the healthcare trend is rapidly shifting towards extending healthcare beyond traditional clinical settings. Thanks to the development of ultra-portable enzymatic instruments, smartphones have gone from being simple fashion accessories to real-life companions for people who want to be informed about their health and have access to increasingly advanced services. Although it is only a small number of people who seek to experience having a diagnosis through the use of a mobile application, a segment that grows 5% per year, the development of new healthcare information technologies oriented to the desires and needs of individual users is the market niche that promises the highest growth and value [1, 2]. There are about 318,000 applications in the Apple Store, 346,000 of which are designed to help users manage their health. The number of Android applications to manage health is much higher: in fact, 15% of the 187,000 available on Google Play provide some form of assistance to countless customers, with an average of over 10 billion app downloads per year. Currently, the creation of new health apps is based primarily on design. Although the use of health apps is currently marginal, significantly below 10% of the world's total applications, the e-health sector is growing. With increasing frequency, health phone apps focus on user satisfaction and healthcare. Usually, there is a difference in experience between the two applications: one is more well-liked because it is simpler, visually attractive, and more intuitive than the others. There are other applications available, but they are used little because they are poorly designed. In this regard, we want to reflect on industry developers to build technical tools that are handy and attractive to customers who opt to employ technological applications in healthcare [3, 4].

The Importance of User-Centric Design in Mobile Health Applications

Mobile health applications must attract diverse end users and induce them to maintain app usage for optimal behavior change results. Research has shown that end users are more amenable to choosing and using mobile health applications that present a user-centric approach to application development. User-centric design includes understanding who the users are and what they aim to achieve with application use. Iterative design processes help the end user feel understood and choose to use the health application.

Successful user-centric applications can make engaging with an application a regular and desirable interaction. This is significant because a correlation has been established between regular app use and the level of individual health improvement. However, the choice of a non-user-centric approach in the app design process may lead to frustration or limited app use [5, 6]. Consideration of physical and cognitive behavioral patterns, individual motivational drives, and the end users' stresses are important during the design of mobile health applications. Application designers are also encouraged to adopt a robust approach to mobile health application design that considers barriers to app usage and health literacy, as well as approaches to encourage the disabled to engage in the mobile health process. Successful user-centric health application designs can also strengthen user trust in technology and keep them using selection strategies with systems to match. In mobile health, this trust relationship involves a patient's ability to form a level of confidence in various technological components [7, 8].

Key Principles of User-Centric Design

1. Intuitive and Simple 2. Test Towards Perfection 3. Results: Insights on Design 4. Empathy is Key 5. Flexible and Personal 6. Clear, Comfortable, and Cognitive Despite the disagreement on specific principles, common ground can be found in combining and expanding various opinions, resulting in these 6 key principles for user-centric design. We design interfaces guided by these principles and think that successful user-centric designs comply with a combination of these principles. An example would be a user interface that visually prioritizes the content from a next of kin of a patient, uses simple language in correspondence with the result of a readability test but refrains from exclusively using orthographic or grammatical tools to express very strong emotions to avoid confusion with emotionally oppressive situations and uses a cognitive tool to express the extent of advice the patient or next of kin can make use of from a list of possible follow-up actions for a chosen treatment. Those interfaces will most likely be both effective but also more engaging than interfaces that are based on only one user-centric principle. The principles are interrelated and partially overlapping; they function as a framework for the evaluation of the designs. Firstly, an interface is designed in a way that is intuitive and simple. It could be said that the higher the degree of intuitive design, the higher the usability of the application. Secondly, the designs are tested on potential users to investigate how intuitive the design is and how the users interact with it. The crux of the usability tests in the user studies is the iterative cycle of design-implement-repeat. It's important to remember that though based on these principles, user-centric design adds usability to these principles. User testing upheld against these principles may suggest that from a usability perspective a design is flawed in one area, but users feel very strongly that it is very important. If we were to take the users' feelings on board, we may need to explore design possibilities that seem at odds with the principles that make this aspect of design unusable or unfit according to the analysis [9, 10].

Technological Considerations in Designing Mobile Health Applications

Selecting an optimal platform for a mobile health application is critical for supporting informed and seamless user interactions. Operating systems such as iOS and Android are the major mobile platforms, each of which has design guidelines that influence a multitude of usability components, such as design patterns, terminology, and navigation modes, as well as accessibility factors, including assistive technology compatibility. In addition, the operating system can influence software-inherent security. Mobile health applications are developed with a wide variety of programming languages and frameworks, so it is important to choose an application programming interface-compatible server and companion database application that is compatible with this programming language. Storing proprietary user or health information requires security features. If a mobile health application stores protected health information, then the database storage design must be compliant with regulatory laws [11, 12]. Artificial intelligence and machine learning can be used to improve usability and learnability by customizing content, data analysis recommendations, and functionality controls to match a user's learning style or compensatory capabilities. Responsive web design is an approach to web design that creates pages flexibly to accommodate multiple devices, screen sizes, or window sizes. A mobile health application with integration into wearable devices can be coupled with a broader system of data collection and analytics. The user may interface with the system through a variety of end-user devices, some of which may not offer the same level of data analytics or personalization that the application-origin wearable may enjoy. Disparities exist in internet access. Some urban poor, as well as residents of rural areas in high-income countries or even entire states or countries, may have insufficient or no internet access. Using the approach of developing a web-based mobile health application with companion software works around the internet divide for users who possess the latest-generation device. Technology selection has significant potential to influence the willingness of the intended user population to engage with technical tools and the environment.

Case Studies in User-Centric Design of Mobile Health Applications

In this paper, we provide case studies that exemplify the user-centric design of MHA and describe how the presented application is a result of our work grounded and heavily informed by users. Each case study includes the application focus and the health domain it covers, a broad overview of its user base, the strategies in designing the application and the rationale behind them, the successes in user engagement, the difficulties in implementation, and possible future work and lessons learned. Also, we present anonymized feedback from users. The outcomes and validity of the users' responses and improvement of health behavior and conditions are used to verify the benefits of the presented application on users. The case studies illustrate the following: how MHAs can leverage serious games for user engagement; how to provide rights of patients following charity guidelines; how an application is adapted to a new cultural context and to address users with lower computer literacy; and how to design a system with tight diagnostic criteria, reducing the likelihood users will self-diagnose or interpret inappropriately [13, 14]. The UK has seen a dramatic increase in the number of people diagnosed with type 2 diabetes and significant growth in the mobile app market. Our development brief was, based on these national patterns, to (1) focus on an app for people at high risk of diabetes who are encouraged to increase the amount of walking in their daily lives and (2) base the development on persons from 'at risk' communities in Sheffield. It is also of interest to examine if an app based on self-determination theory would be engaging to its users and how it can be improved. Feedback on usability and engagement based on app function from the target audience was obtained through involvement. Feedback on how to tailor the intervention app to make it engaging for these individuals was sought through a subsequent interview. Attendees of the outreach session were recruited via a flyer or after a direct invitation by a worker. Meetings were at the center, at various times, and on different days. Involvement in development meetings took place in the early stages to inform the design of the Walking Away from Diabetes app. A total of 68 members of the community attended the open-door activities during the twenty days that they were run. Participants of the development activity who had a BMI ≥ 25 ($n = 24$) and/or were at increased risk of diabetes ($n = 28$) completed a further baseline questionnaire allowing us to further characterize them and their willingness to engage with exacerbating questions. The completion of the baseline questionnaire served as consent to participate in the structured interview for the alteration review. These questionnaires were easy to do and had good visual appeal. Participants also attended a structured interview to discuss cultural aspects and perceived barriers to the mobile app. From these two recruitment activities, a total of 10 people had further contact about their willingness to collaborate on the development of the mobile app and were either turned down because they had no handheld device or did not meet the inclusion criteria [15, 16].

CONCLUSION

User-centric design is critical to the success of mobile health applications, bridging the gap between technical innovation and the user experience. By adhering to principles such as intuitive interfaces, personalization, and inclusivity, developers can create tools that foster long-term engagement and promote healthier behaviors. The integration of advanced technologies like AI and wearables, along with considerations for accessibility and cultural context, further strengthens these applications' impact. Case studies demonstrate the value of iterative development processes informed by user feedback. Moving forward, it is essential to align technological advancements with human needs, ensuring that mobile health applications continue to evolve as reliable companions in global health improvement.

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