User-Centric Mobile Application for Long-Term Data Collection: Design and Strategy

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Abstract— **This paper presents a work in progress on the design and development of a user-centered mobile application intended for data collection in Randomized Controlled Trials (RCTs) and longitudinal studies. Focusing on the future implementation of gamification and other engagement strategies, this project aims to mitigate survey fatigue—a significant challenge in sustained data collection efforts. The proposed application will incorporate user involvement throughout its design and development to ensure features that promote consistent and reliable data submission, thereby aiming to reduce the necessity for data imputation and minimize attrition bias. The paper outlines anticipated elements critical to the success of the application, including questionnaire design, strategic incentive usage, and adaptation of surveys to align with user preferences and technological interfaces. Through a planned iterative design and testing process, involving A/B testing and focus group evaluations, the study will seek to determine effective methods for user involvement and develop a mobile tool that closely meets the needs of both researchers and participants.**

Keywords-Survey Fatigue; Gamification; Data Collection; Mobile Application Design and Development; User-Centered Design

I. INTRODUCTION

This paper explores theory and concepts to consider into the planning stages of the development of a mobile application centered around user involvement, aimed at enhancing the quality and consistency of data collection for research purposes, particularly where standardized questionnaires are used to collect quantitative data over a longer period. The essence of our approach lies in the hypothesis that incorporating user feedback and involvement throughout the development process will significantly boost the frequency and reliability of data submission from study participants. By doing so, we anticipate a reduction in the need for data imputation, a decrease in attrition bias, and the maintenance of statistical power, thereby preserving the integrity and longitudinal insight of the study.

Randomized Controlled Trials (RCTs) and longitudinal studies rely on participants to complete and return questionnaires over extended periods. This fundamental requirement remains unchanged whether the data collection is via traditional pen-and-paper methods or through digital forms. Inadequate compliance and incomplete surveys lead to several challenges, including missing data, necessitated data imputation, attrition bias, diminished statistical power, and potentially, an increase in project costs and resource utilization [1][2].

There are numerous web and mobile application solutions available for data collection, catering to various user groups including domain experts and general users, such as healthcare apps. The purpose of these solutions varies based on the technology employed and the involvement of stakeholders. For instance, health apps are commonly utilized for self-assessment. Enabling users to monitor diverse health metrics like heart rate, stress levels, sleep patterns, activity levels, and food and water consumption [3]. Much of this data is seamlessly collected through wearables such as smartwatches, activity trackers, and the latest addition, activity rings [4]. Meaning that collecting data through wearables eliminates the need for manual input from the user. However, the potential of wearables as a data collection tool in research can be restricted by privacy regulations like General Data Protection Regulation GDPR [5], and the high costs associated with providing participants with devices like smartwatches.

This paper aims to explore different methodologies for designing a user-centric mobile application tailored for data collection in research settings. We aim to investigate different strategies for involving users in the development process and how to motivate and encourage to regularly and timely submit data, which is crucial for the success of longitudinal studies and RCTs.

This paper is structured as follows: Section II delves into the theoretical framework, focusing on gamification and questionnaire design, and explores how these elements can enhance user engagement and reduce survey fatigue. Section III discusses practical strategies for involving users in the research process and addresses the challenges encountered in survey design to engage users effectively. Finally, Section IV provides an overview of future work, detailing further research on questionnaire design and the use of gamification to improve response rates and data integrity.

II. THEORY

This section explores the theoretical foundations focusing on gamification and questionnaire design, which are central to the development of our mobile application for data

collection in controlled studies. This insight aims to deepen our understanding of how gamification can enhance user engagement and how effectively designed questionnaires can mitigate survey fatigue, thereby improving data quality and participant retention in RCTs and longitudinal studies. By analyzing existing literature and outcomes from previous research, we seek to identify and integrate the most effective practices and innovative approaches from these areas. Emphasizing gamification, we will examine how game-like elements can motivate and maintain participant interest over time. In terms of questionnaire design, we will consider various strategies to ensure clarity, reduce bias, and enhance the overall user experience, thereby ensuring high-quality data collection tailored to our research needs.

A. *Gamification*

Gamification is a method that has become popular across various domains, including education at both primary and tertiary levels [6][7], as well as in self-assessment and health applications [8]. Additionally, gamification elements have even been integrated into various gaming platforms to motivate and encourage users to engage in gameplay. Examples of this is awarding players with trophies for different playing styles or for in-game achievements [9].

Gamification is frequently employed in subjects that demand logical thinking and problem-solving skills, particularly within STEM disciplines, such as mathematics and programming [10][11]. This approach has been shown to motivate students by presenting challenging and abstract concepts through mediums they are more familiar with, such as games [12] [13]. The incorporation of game-like elements, including rewards, points, trophies and badges, leverages the concept of "positive reinforcement," thereby enhancing student motivation. This strategy capitalizes on the inherent human response to rewards, as detailed in psychological research on positive reinforcement [14]. By rewarding students for their achievements, gamification in educational contexts encourages engagement and persistence in learning, making difficult subjects more accessible and enjoyable.

Gamification elements have increasingly been integrated into health and self-assessment mobile applications [15], creating engaging and motivational aspects found in different game elements. Acknowledging the inherent challenges of maintaining a healthy lifestyle and engaging in regular exercise these apps utilize gamification strategies to make the process more appealing and rewarding. Through challenges and reward systems, like being awarded stars and badges for completing specific tasks or reaching goals, users find it more motivating to reach their health objectives [16]. Leveling systems which reward users with various benefits as they progress to higher levels are also a familiar element in health apps, ranging from step counters to water consumption trackers.

Level and bonus systems isn't limited to health applications but also extends to other sectors, including booking platforms and numerous other service-oriented applications, demonstrating the broad applicability of gamification strategies. Furthermore, these apps often employ mechanisms of loss aversion, a psychological principle suggesting that the fear of losing is more compelling than the prospect of gaining [17]. By "punishing" users through the removal of benefits, level down-grade or the breaking of "streaks," apps tap into this aversion to loss, compelling users to stick to the app's requirements to maintain or enhance their status, levels, points, or other forms of rewards [18][19]. Indicating that the use of both positive reinforcement and negative reinforcement creates a powerful motivator for users to engage regularly with the apps.

B. *Questionnaire design*

Crafting a questionnaire or survey that yields reliable and unbiased responses is a nuanced psychological science [20]. The formulation, presentation, context, and language of questions can significantly influence how participants respond [21]. How questions are phrased and their placement within the survey can also impact how participants respond to other previous or later questions, called “order-effect bias” [22]. Research on survey methodology shows that small changes in question formulation can lead to significantly different answers [21].

UserGuiding identifies five types of survey fatigue: 1) Questionnaire fatigue, 2) Frequency fatigue, 3) Repetition fatigue, 4) Design fatigue, and 5) Incentive fatigue. These factors, including lengthy and complex questionnaires, survey frequency, repetitive questions, poor design, and incentive-driven responses, can overwhelm users and affect the quality of survey responses, potentially leading to biased results [23].

Bias can be introduced into surveys through various means, including participant recruitment, questionnaire design, and the way questions are posed. Similar to how survey fatigue affects participants, different types of biases can impact data collection, such as sampling bias, non-response bias, acquiescence bias, social desirability bias, question order bias, and interview bias [24]. Effective measures to mitigate these biases include avoiding leading questions, using interview guides, maintaining respondent anonymity, and providing the option to skip questions. Being able to skip questions has been shown to prevent users from quitting mid-process.

Additionally, it's crucial to ensure that surveys are compatible with various browsers and systems to prevent non-response bias and facilitate comprehensive data collection. Inaccessible or unreadable surveys can lead to significant data loss. Therefore, conducting a test round where surveys are sent to different emails and opened in various apps and browsers can help identify and prevent potential issues before the actual dispatch.

III. DISCUSSION

In this section of the paper, we will discuss and ideate around how users can be involved in the project, identifying specific stages where their input is crucial. The research indicates that survey fatigue could be a primary reason for reduced participant motivation. Therefore, it's essential to

strategically involve users where feasible. However, there are constraints, such as the formulation of questions, where user input is limited due to the standardized nature of the questionnaires planned for the study. The challenges associated with question frequency and repetition are significant, especially since the study aims to measure changes over an extended period, requiring participants to complete the same survey weekly. While the structure and frequency of the surveys are fixed to meet the study's objectives, this setup presents an excellent opportunity for user involvement in designing app features that could help mitigate typical survey fatigue issues. This involvement can enhance user engagement and potentially improve the quality and consistency of the data collected.

The list below presents some of the key elements and focus points we must consider and further research continuing the project before development:

- Question bias.
- Survey fatigue.
- Design layout and instructions.
- False participants, only there for gifts.

Working with the hypotheses that incorporating user feedback into the design and functionality of the tool is essential for enhancing participant engagement and mitigating survey fatigue. One effective strategy to keep participants motivated throughout the study is the integration of game-like elements. Previous research has demonstrated that gamification can significantly enhance motivation and engagement. In determining the specific game-like elements to incorporate the involvement of potential participants is key. Actively engaging them in this process allows for a design that is more effectively tailored to their preferences and needs, which in turn boosts their overall engagement with the mobile application [25]. Techniques such as loss aversion and positive reinforcements including leveling, rewards, and bonuses have been shown to be effective. Exploring the incorporation of these elements in the way incentives are given or achieved could be a valuable strategy to enhance participant interaction and satisfaction.

However, careful consideration should be given to the use of incentives, ensuring they are appropriate for the target group to avoid attracting participants who are not genuinely interested in the study or rushing participants to "just answer something". Sharing insights with participants about how their responses are used can also reinforce the value of their contributions, enhancing their engagement and willingness to participate [23].

Effective survey design is also essential. Surveys should have clear instructions, easy navigation, and a user-friendly layout. Conducting A/B testing on different survey designs can help identify the most effective elements that enhance user experience and response rates. Deciding when, how often, and where surveys are administered is another critical factor. Utilizing focus groups can provide insights into the preferences and aversions of potential participants, helping to plan survey delivery that minimizes disturbance and annoyance. This strategic involvement of users at various stages not only helps in tailoring the survey experience to their needs but also ensures that the tool developed is user-centered and effective.

IV. Conclusion and Future Work

This paper explores the preliminary planning for the design and development process for a mobile application aimed at enhancing data collection in controlled studies, specifically RCTs and longitudinal trials. The primary objective is to reduce data loss caused by participant dropout or response failure. By gathering insight into various theories and concepts, such as gamification we explored how we can better motivate participants to stay engaged and consistently report data. It is evident the theoretical frameworks that studies involving data collection through surveys are susceptible to survey fatigue. This paper examines the factors contributing to survey fatigue and discusses strategies for involving users in the design process to mitigate these risks.

Several key features and design elements require additional research before proceeding with development. Future plans involve further investigation and usability testing focused on questionnaire design, particularly how different biases can be minimized through strategic layout and question presentation. Preliminary research suggests that allowing participants to skip questions could prevent them from abandoning the survey midway. We intend to explore this aspect through A/B split testing and interviews to assess the potential impacts on data integrity when participants have the option to skip and return to questions.

Additionally, gamification has shown promise in enhancing user engagement across various platforms. Moving forward, we will investigate how to integrate gamification effectively into the research data collection application to encourage frequent and consistent participant responses. Another area of interest is the integration of incentives into reward and leveling systems, ensuring they do not inadvertently prompt participants to rush through responses, thereby compromising data quality.

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