Effects of Culturally Tailored User Interface Design

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Abstract. In recent years there has been tremendous development in user interface, the way by which people interact with computer systems. A key feature that needs to be considered in user interface design is culture. Research has shown that adopting a culturally-tailored approach in user interface design is a better approach than the "One size fits all" methods, and results in increased user satisfaction and engagement. This paper examines and highlights the implications of incorporating unique cultural components, such as values, diet and perception, into the interface. A pilot study was conducted with 30 participants to examine the usability impact of a culturally tailored interface design application using two West African user groups, specifically Ghanaian and Nigerian communities living in Maryland, United State as a case study.

Keywords: Cross-cultural design · User interface · Usability

1 Introduction

West African communities have seen increases in the use of mobile phones over the past decade [1]. Mobile health (mHealth) has gained popularity in recent years in developing countries, as governments realize the potential benefits of incorporating the technology to meet the needs of health system targets, such as sustainable development goals (SDGs) [2].

Culture plays a significant role in user interface design and usability [3] and cultural differences are unique in terms of values, beliefs, and customs. The role of culture is an essential aspect in interface acceptance. Poorly designed interfaces that are not personalized to meet the needs of the local culture can possibly result in low adoption and/or rejection of mobile applications by users [4]. As result, there is a need to be knowledgeable of the cultural inclinations of the end user in the design of the user interface in order to meet the needs of the local community [5]. The aim of this pilot study is to examine the impact of user interactions and interface design features that will provide useful data in the form of user requirements to enable the development of a culturally-tailored mobile health application for West African users.

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2 Background Study

To address the effects of cultural user interface design, attention was given to the condition for high blood pressure (BP) which is a major concern within Ghanaian and Nigerian communities in recent times. High blood pressure, also known as hypertension (HTN), is increasing at different rates in different countries. In sub-Saharan Africa, the number of individuals with this condition is estimated to increase to 68% (125.5 million) by 2025 [6]. Likewise, individuals with Western African heritage have the highest burden of HTN among adults aged 25 years or older [7].

mHealth applications are promising tools that can be harnessed to address health-related needs in the healthcare field [8]. mHealth is a commonly used mechanism to access health care and has the potential to provide consumers with health information to control and improve health outcomes through mobile or wireless devices [9]. In the United States, mobile phone and tablet ownership have significantly increased due to low cost, flexibility and convenience, creating a platform for mHealth interventions to manage chronic diseases [10]. In spite of the above prospects of mHealth, a study conducted by Langford et al., 2019, indicated that in the US people with self-reported history of hypertension are less likely to have health-related apps on their smartphone or tablets as compared to those without a history of hypertension [10]. Research has indicated that this is especially true among West Africans. This is quite alarming and there is a need to examine what can be done to enhance uptake.

To examine the effects of a usability impact of a tailored user interface design, we conducted a pilot study of a culturally tailored application developed on a smartphone to monitor blood pressure called AfriBP. Specifically, we examined two interactive factors: perceived usefulness and perceived ease of use.

2.1 User Interface

The user interface of a device is that part of a system that users can see, hear and feel [11]. Ideally, the interaction takes place through the user interface. An effective interface is one that enables users to concentrate on the information and complete the task at hand [12]. Alsswey and Al-Samarraie (2020) investigated elderly Arab users' acceptance of mHealth User Interface (UI) design-based culture and indicated that perceived ease of use and attitude towards use had a significant positive influence on users' behavioral intention to use mHealth UI design-based culture signifying its effectiveness [3].

As measured by the ISO 9241 standard definition, effectiveness is the extent of accuracy in which users' complete specific tasks. By examining the cultural factors in relation to ease of use and perceived usefulness the objective is to increase subjective user satisfaction among the Ghanaian and Nigerians community.

2.2 Intercultural Interface Design

Significant research has been conducted on intercultural interface design, many of which address different cross-cultural elements in interface design [13]. It is significant that when designing products for universal users, mobile application developers and

researchers should consider the values, attitudes, and behavioral patterns of cultures [15]. Two approaches should be considered in designing products for different countries and cultures: Internalization and localization. According to Russo and Boor (1993), internalization refers to the "process of isolating the culturally specific elements from a product; for example, the isolation of French text from a program developed in France" [14]. Taylor [16] asserts that localization refers "to the process of infusing a specific cultural context into a previously internationalized product; for instance, translating French text and message files into Spanish for Spanish users".

Fernandes [13] emphasized that designers should address the cultural issues that vary from culture to culture when designing user interfaces: nationalism, language, social context, time (date and time formats), currency, units of measure, cultural values, body positions, symbols, and esthetics. Omitting or making deviations from these cultural issues could possibly frustrate the user. In designing an interface, user interface designers need to focus on cross-cultural elements such as typeface; number, date and time formats; images; symbols; colors; flow; and functionality [14] to avoid misunderstanding and usability problems.

3 Research Method and Design

To investigate the cultural effects among Ghanaians and Nigerians, a culturally specific mobile health application with emphasis on BP recommendations, was designed to measure the interaction factors 'perceived usefulness' and 'ease of use'. Based on research of BP health applications, user requirements focused on the following needs were determined: date; the system determines the time a user logs in and time zones; the system accepts systolic and diastolic BP reading input; the system accepts pulse input; the system determines the formula and calculations for BMI and allows for data export; the system accepts health history and the system accepts geolocation (zip code); the system accepts health reminders; the system accepts the users profile; the system is infused with West African cultural elements; and the system accepts data storage. The functional requirements are focused on the following needs:

- As a user, I want culturally tailored recommended features in the design
- As a user, I want the AfriBP to be effective in improving my health outcomes
- As a user, I want culturally tailored recommendations
- As a user, I want culturally tailored dietary recommendations
- As a user, I want an AfriBP that is useful in gaining understanding of blood pressure information
- As a user, I want the AfriBP to be easy to learn

The AfriBP application usability and design features includes:

Health-Related Features: This includes the ability of the AfriBP to register an account: the demographic, nutritional diet, and geolocation (zip code) recommendation based on where the user lives. Other health features include the manual entry of BP measurements allowing the system to calculate the body mass index (BMI), health history, bar chart and the cultural elements, export health data and BMI in pdf and printable format, notification reminder, and profile.

Cultural Features: The culturally recommended features are options provided to the user to improve health and lifestyle management. The exercise fitness and eat healthy diet recommendations are based on the BP category, readings, and BMI for: normal, elevated, high blood pressure on (hypertension) stage 1 and 2 options for the users. Exercise fitness: pick-up soccer, basketball league, volleyball league, soccer league, tennis; Africa Dance Fitness; Healthy Diet, Nigerian and Ghanaian foods recommended to enhance and improve health management of BP is displayed. The system allows users to find the nearest grocery stores that carries the dietary recommendations based on where the user lives (geolocation). The system allows users to find the nearest pick-up soccer leagues and the nearest African dance fitness recommendations based on where the user lives (geolocation).

Cultural Elements: This includes navigation and data presentation and icons such as the home, add data, history, reminder, and profile. The date and time zones in the United States and in West Africa are determined by users' login. The font sizes of the UI which ranges from 12 and 24 points. The Google font style was used to display the text and the icons in the design of the AfriBP.

The system uses the BMI measurement unit in kilograms and centimeters for the West African culture and the US units. The cultural food images of the Nigerian and Ghanaian users were also incorporated to the design of the AfriBP. Other recommended features provided included Spas which were based on the zip code to provide recommendations to improve stress management.

3.1 Prototype Design and Specification

A wireframe was designed using an adobe XD to display the main requirements of the users. The Flutter framework was developed by Google for cross-platform apps (iOS and Android) and uses Dart programming language to create the application, AfriBP. AfriBP is deployed on an Android platform using a Samsung Galaxy Tab A 10.1' 64 GB Tablet and on a mobile emulator for the usability testing experiment. User data of the application AfriBP was securely stored in the Google Firebase system, Cloud Firestore. Below are screenshots captured from the application (see Figs. 1 and 2).

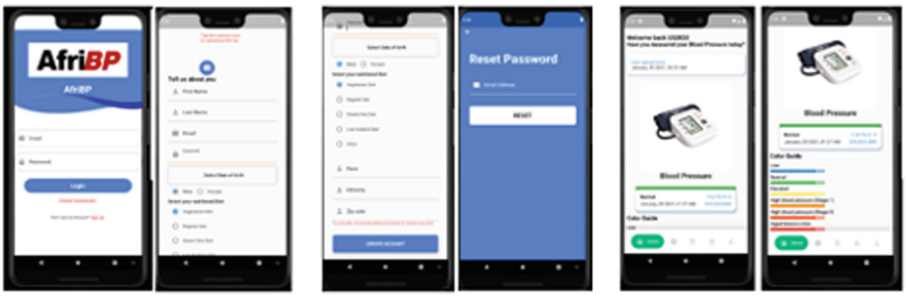

Fig. 1. Home screens

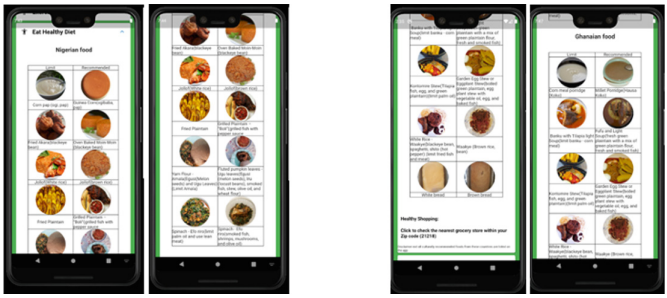

Fig. 2. Ghanaian and Nigerian diet recommendation screens

3.2 Data Collection

An Institutional Review Board permission received to conduct a mixed method data collection study. Zoom platform and the Qualtrics Survey software were used to conduct an online usability testing experiment. A random sampling approach was used in the recruitment process. Participants were selected by word of mouth, recommendations through local churches in Maryland, USA.

3.3 Procedure

An email was sent inviting participants to join in by the zoom platform. Upon joining and completing the consent form, the purpose of the pilot study was explained to all participants. After participants have agreed to have their blood pressure measurement recorded in the AfriBP application tool, each participant was asked to sign-in using a pre-provisioned credentials identifier on an Excel Spreadsheet.

During the usability testing, the participants were first asked to complete the pre-test questionnaire about their demographics and use of smartphone health apps. They then navigated briefly through the user interface of the AfriBP home icon, add data icon, history icon, reminder icon, and the profile icon before the actual tasks. Participants then proceeded to navigate through the user interface and the functionality to complete a series of tasks using the AfriBP application. The online usability testing experiment was observed and recorded using Microsoft Excel Spreadsheet.

The post-test questionnaires: the perceived ease of use and perceived usefulness were measured using a 5-point Likert type scale (e.g. 1 = Strongly disagree, 5 = Strongly agree) and the three open-ended questions. Interviews were conducted to inquire from some of the users about the AfriBP mHealth application, cultural features, interaction designs, cultural elements, and health-related features to find out what they like or don't like about the design of the AfriBP application. The entire procedure took approximately 30 min to complete. Data collections were cleaned and coded using Excel and analyzed using SPSS software. The pilot study was conducted within 12 months period.

4 Results

4.1 Respondents' Socio-demographic Characteristics

The ages of the respondents ranged from 18 to 69 years and more (30.0%) of them were within the age of 20–29 years. There was an equal number of male and female participants (50.0%). Many (53.3%) of respondents were Nigerian. Among the respondents, 43.3% who had Master Degree topped the list of the educational qualification.

All (100.0%) participants reported that they have and are using smartphone 66.7% of them were using iPhone. Half (50.0%) of respondents could not ascertained the comfortability of smartphone usage while 46.7% agreed that smartphone health app is comfortable to use.

Report on health status of the African community showed that many (56.7%) of respondents admitted that their BP reading was normal and those who had normal BMI was 46.7%. in the same vein, 46.7% recorded that they owned BP machine using to measure their BP.

50.0% of respondents reported that they were using smartphone for general things, 20.0% used it for health app and followed by those who were using it for measuring BP. Above three-quarter (76.7%) of respondents declared that they were on regular diet.

All respondents (100.0%) accepted that AfriBP is effective in improving their health and 93.4% agreed that interacting with the AfriBP with more recommendations will increase usefulness. Majority (63.3%) of respondents agreed that AfriBP is a safe interactive system that provides easy recovery in case of errors. Those who concluded that AfriBP is useful in gaining understanding of blood pressure information were 80.0% and 70.0% agreed that in overall, as users they were satisfied with the AfriBP (see Table 1).

Table 1. Age and gender will have no effect on perceived usefulness to adopt the AfriBP

Socio-demographic variable	Perceived usefulness			Chi-square (χ^2)
	Not useful (n = 12)	Useful (n = 18)	Total (N = 30)	
Age in year				
18–19	0(0.0)	2(12.5)	2(6.7)	$\chi^2 = 5.174^F$
20–29	5(35.7)	4(25.0)	9(30.0)	p = 0.410
30–39	4(28.6)	4(25.0)	8(26.7)	
40–49	3(21.4)	4(25.0)	7(23.3)	
50–59	2(14.3)	0(0.0)	4(13.3)	
60–69	0(0.0)	2(12.5)	2(6.7)	
Sex				
Male	6(42.9)	9(56.3)	15(50.0)	$\chi^2 = 0.000^F$
Female	8(57.1)	7(43.8)	15(50.0)	p = 0.715

* Significant at 0.05; F Fisher's exact test

4.2 Perceived Usefulness

Perceived usefulness of the application in the study was accessed through a 15-point perceived usefulness question and the mean score was 18.5 ± 5.4 and 53.3% of them had good perception of usefulness of AfriBP as effective in improving health (see Tables 2 and 3).

Table 2. Perceived usefulness AfriBP

Item	Strongly Agree N (%)	Agree N (%)	Neutral N (%)	Disagree N (%)
The AfriBP is effective in improving my health	10(33.3)	20 (66.7)	0(0.0)	0(0.0)
Interacting with the AfriBP with more recommendations will increase usefulness	17(56.7)	11 (36.7)	2(6.7)	0(0.0)
The AfriBP is a safe interactive system that provides easy recovery in case of errors	9(30.0)	10 (33.3)	8(26.7)	3(10.0)
The AfriBP is useful in gaining understanding of blood pressure information	13(43.3)	11 (36.7)	5(16.7)	1(3.3)
Overall, as a user are you satisfied with the AfriBP	7(23.3)	14 (46.7)	7(23.3)	2(6.7)

Table 3. Aggregate score of perceived usefulness

Variable	No	%
Not useful	14	46.7
Useful	16	53.3
Total	30	100.0

Mean (±)18.5 ± 5.4

4.3 Perceived Ease of Use

Majority (80.0%) of respondents proposed that learning to operate the AfriBP will be easy to use and 70.0% admitted that the navigation on the home, add data, history, reminder and profile icons was easy to use. Most (93.4%) of respondents agreed that the culturally recommended features for exercise fitness (Pick-up soccer leagues, Basketball league, Volleyball league, Soccer league, Tennis, Africa Dance Fitness, and Eat Healthy Diet (Nigerian and Ghanaian Foods) on the AfriBP was easy to use and those who accepted that it was easy to recall the culturally recommended food images on the AfriBP were 93.4%. Participants' perception of easiness to use AfriBP was accessed through a 12-point perceived ease of use question and the mean score was 15.1 ± 4.0 and 60.0% of them perceived that AfriBP will be easy to operate.

Table 4. Aggregate score of perceived ease of use

Variable	No	%
Not easy to use	12	40.0
Easy to use	18	60.0
Total	30	100.0

Mean (±)18.5 ± 5.4

Table 5. Relationship between perceived ease of use and usefulness of using the features of the AfriBP

Perceived usefulness of AfriBP	Perceived ease to use AfriBP App			Chi-square (χ^2)
	Not easy to use (n = 12)	Easy to use (n = 18)	Total (N = 30)	
Not useful	11(91.7)	3(16.7)	14(46.7)	$\chi^2 = {}^{F}$ p = 0.000
Useful	1(8.3)	15(83.3)	16(53.3)	

5 Discussion

The implications of the results indicate that perceived ease of use has an effect on perceived usefulness in using the features of the AfriBP. The relationship between perceived ease of use and usefulness of using the features of the AfriBP (Table 4), indicates that, proportion of respondents who found AfriBP useful also found it easy to use (83.3%) in that category. Statistically, there was a significant effect between the tested variable ($p = 0.000$). Based on the results shown in Table 4, the null hypothesis, which stated that perceived ease of use will have no effect on perceived usefulness in using the features of the AfriBP was therefore rejected ($p < 0.05$). This finding highlights the significance of ensuring that navigation, display features, and the overall basic concepts of the application should be easy to use. For the purpose of this study the insight gained from this is to present the application in a culturally tailored way but to understand and from the above is apply the basic elements inherent to the different cultures in a simple easy to use platform. The aim is to optimize ease of use while offering maximum functionality (see Table 5).

The results on the relationship between perceived usefulness and attitude to using the features of the AfriBP revealed that respondents who reported that AfriBP is useful were willing to use the application. Although, significantly perceived usefulness has no effect on attitude to adopt the AfriBP ($p = 1.000$). Based on the result shown in Table 4, the null hypothesis, which stated that perceived usefulness will have no effect on attitude to adopt the AfriBP was not therefore rejected ($p > 0.05$).

6 Conclusion

By analyzing user interactions with culturally tailored interface applications, useful data is provided which helps in optimizing usability and increasing user adoption. Researchers and interface designers will also benefit from available data and understand requirements from users to enable them to develop culturally tailored mobile health applications for the West African populace in the United States.

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