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COMPUTATIONAL
AND STRUCTURAL
BIOTECHNOLOGY
JOURNAL

journal homepage: www.elsevier.com/locate/csbj

Developing a mobile application to better inform patients and enable effective consultation in implant dentistry

Erokan Canbazoglu^a, Yucel Batu Salman^{b,*}, Mustafa Eren Yildirim^c, Burak Merdenyan^d, Ibrahim Furkan Ince^e

^a Vocational School of Technical Sciences, Akdeniz University, 07058, Antalya, Turkey

^b Software Engineering Dept., Bahcesehir University, 34353 Besiktas, Istanbul, Turkey

^c Electrical and Electronics Engineering Dept., Bahcesehir University, Besiktas, Istanbul, Turkey

^d Department of Computer Science, University of York, United Kingdom

^e Computer Engineering Department, Gediz University, Izmir, Turkey

ARTICLE INFO

Article history:

Received 10 January 2016

Received in revised form 16 June 2016

Accepted 23 June 2016

Available online 29 June 2016

Keywords:

Implant procedures

Patient education

Interface design

Dental applications

Mobile devices

ABSTRACT

The field of dentistry lacks satisfactory tools to help visualize planned procedures and their potential results to patients. Dentists struggle to provide an effective image in their patient's mind of the end results of the planned treatment only through verbal explanations. Thus, verbal explanations alone often cannot adequately help the patients make a treatment decision. Inadequate attempts are frequently made by dentists to sketch the procedure for the patient in an effort to depict the treatment. These attempts however require an artistic ability not all dentists have. Real case photographs are sometimes of help in explaining and illustrating treatments. However, particularly in implant cases, real case photographs are often ineffective and inadequate. The purpose of this study is to develop a mobile application with an effective user interface design to support the dentist–patient interaction by providing the patient with illustrative descriptions of the procedures and the end result. Sketching, paper prototyping, and wire framing were carried out with the actual user's participation. Hard and soft dental tissues were modeled using three dimensional (3D) modeling programs and real cases. The application enhances the presentation to the patients of potential implants and implant supported prosthetic treatments with rich 3D illustrative content. The application was evaluated in terms of perceived ease of use and perceived usefulness through an online survey. The application helps improve the information sharing behavior of dentists to enhance the patients' right to make informed decisions. The paper clearly demonstrates the relevance of interactive communication technologies for dentist–patient communication.

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1. Introduction

The interaction between dentists and patients has become an important concern in making appropriate treatment decisions [1,2]. The primary components of dentist–patient communication are information exchange, treatment decision and interpersonal relations [3]. In order to make a favorable decision towards treatment it is vital that the patient clearly understands the treatment plan [4,5]. One of the important ways of gaining patients' trust and providing the patient with a sense of security is through effective patient-centered communication [6]. However, due to dentists' scheduled workload this crucial information exchange process can be overlooked and undervalued. In such cases, the information needs to be transferred

fast and effectively to ensure that the patient has gained full understanding of the procedures. Improving communication skills along with a display of sympathy to the patient in a professional manner by a dentist can certainly make the patient feel more at ease and relaxed [7].

Dentists experience difficulties in explaining the treatment plan to their patients only through verbal or pictorial presentations. Often dentists make desperate attempts, through sketching, to present the procedure to the patient, who is frequently unfamiliar with the subject. These attempts however, require an artistic ability that is not a precondition of becoming a dentist. Real case photographs are sometimes helpful to explain and illustrate procedures. However, particularly in implant cases, real case photographs are frequently ineffective and inadequate. Effective dentist–patient communication cannot be established merely based on using paper-based presentations.

Briskly progressing technological improvements have allowed for more powerful, graphics-oriented applications to be created and

* Corresponding author.

E-mail addresses: erokan@akdeniz.edu.tr (E. Canbazoglu),

batu.salman@eng.bahcesehir.edu.tr (Y.B. Salman), mustafaeren.yildirim@eng.bau.edu.tr (M.E. Yildirim), bm815@york.ac.uk (B. Merdenyan), furkan.ince@gediz.edu.tr (I.F. Ince).

utilized for patient presentations. The decision to develop an application compatible with tablet devices was made because of their portability and high performance. Currently, these devices can perform anything a standard PC can, just in a more portable format. These portable tablet devices eliminate the need for a standing PC in every room and allow dentists to gain flexibility. An efficient communication environment, supported by interactive systems with visual presentations should be implemented for better explanation of further treatment plans. Information technology developed for dentistry is relatively more limited than systems available for the wider medical industry. Thus, there is a need for a mobile application with rich graphical content to help inform patients about alternative methods of treatment, reduce confusion, improve the service quality, and enable correct use of medication [8].

The last three years have been marked by rapid adoption of mobile devices. In the United States, researchers predicted that 20% of the populations use touchscreens with natural user interfaces as their primary computing device by 2014 [9]. 37% of the populations own such devices for business purposes [10]. In December 2014 there were 49 million mobile subscribers supported with 3G connections in Turkey [11]. 945,254 tablet computers were purchased by Turkish users in the fourth quarter of 2014 [11]. The number of tablets sold in Western Europe is to be 47.6 million units in 2015 [12]. Approximately 83.7 million tablet pcs were sold in the USA in 2015 [12].

In this study, we designed a mobile application to be used to inform patients about treatment plans in office settings. The application was developed for dentists by implementing user centered development methodology followed by testing. User centered approaches are beneficial in gaining insights in the healthcare domain, and for identifying the knowledge and requirements of all stakeholders [13]. The integration of potential users in the software lifecycle reduces the number of iterative developments and the users' training costs [14]. Physicians believe that developers should be more interested in their preferences, and visit their practice environment in order to clearly identify the context. The collaboration between the development team and the dentists is improved by implementing this methodology [15]. Salman et al. proposed icon design guidelines and designed medical icons for a mobile emergency service application. It was found that the participatory icon design guidelines resulted in usable and clear icons, which improved the system usability and user success [16].

Soft and hard tissues were modeled in 3D computer aided design programs and the most frequently encountered implant cases were prepared for both dentists and patients. The system enables the presentation of implant supported prosthetic treatments to the patients with 3D rich illustrative content. It enables dentists to easily explain treatment plans to their patients when there is a need to describe surgical operations.

The treatment decision making should be managed together and the patient has the right to be informed in details. The portability of new generation devices provides flexibility to dentists in effectively communicating with the patients. The contribution of this research is in the designing of the application with the participation of actual users, implementing user-centered design methodology to remove the communication barriers between dentists and patients. Few researches focused on computerized systems in a dental environment, and these papers do not present a mobile application. However, our application was developed specifically for implant procedures. Additionally, we found encouraging outcome as dentists indicated that they are willing to continue using this application in the future.

1.1. Scientific background

Wingard describes patient education as the process of informing the patients by health professionals in altering patients' health behaviors, improving health status, and aiding in development of remedy treatment [17]. The aim of patient education is to assure that the patients

are informed of their treatment options, efficient use of medication, and the management of their healthcare needs [18]. It is also critical for improving self-advocacy in deciding to act independently from medical provider and increasing patient motivation.

In addition to the complexities involved with developing education programs that meet the needs of a highly diverse population, resources available to healthcare providers have come under significant financial pressures. This challenging environment has made it essential that healthcare providers take a more systematic, coordinated, and strategically planned approach that would facilitate the effective deployment of the resources allocated to patient education [19].

Mobile systems developed to support the interaction between physicians and patients are now replacing paper based methods [20]. The expanding use of portable devices in the education of physicians and students is a well-documented phenomenon [21]. Tablet devices have become useful for decision making purposes and are increasingly used in clinical settings as a reference tool [22]. The use of mobile applications has emerged as an educational method that may assist dentists in meeting financial and strategic challenges. These applications may provide a highly cost effective modality for delivering content [23]. Tablet devices have various multimedia capabilities such as CT images and drawing tools that are useful in increasing clinical efficacy, improving the patient experience, and optimizing patient satisfaction [24,25].

Various studies measure the effect of interactive education applications on users' overall satisfaction with their healthcare encounter [26–28]. The quality of patient education may also affect patients' health conditions. While some studies reported no benefits of using such applications in this context [29–33], others reported a positive impact of the use of interactive systems [34–40,28].

It is suggested that physicians' job satisfaction is a perception based reaction that results from a number of variables including the nature of relationships with patients [41–43]. The quality of doctor–patient interactions is consistently noted as an important driver of satisfaction [42]. Haas et al. found that more satisfied physicians are better communicators and more empathetic [43]. In turn, patients with higher satisfaction prompted physicians to feel better about the care they provided, which motivated physicians to spend more time meeting patients' needs. Physicians also believe that there is a brilliant future at hand where several clinical practices, such as lab work and CT images are carried out using a mobile device [44].

1.2. Rationale for the study

The portability of tablet devices provides efficient communication with patients not only in clinical settings, but also in eliminating the location barriers. To enhance patient education dentists need to be able to illustrate the benefits of treatment easily, show the consequences of untreated cases, and demonstrate dental concepts from simple fillings to complex implant procedures [45,46].

The primary function of our application is to inform patients by using the new generation of hardware and communication technologies in implant dentistry to support treatment decision making. The treatment plan is better explained to patients using 3D illustrations through a mobile device, which also helps improve the service quality in terms of time and effort spent, and enables better understanding of treatments. It was observed that prior to using our application our dentists were using real images from a book, and sketches, which have the potential to cause frustration and fear in the patients (Fig. 1). We witnessed several failed conversations between dentists and patients during our on-site visits.

It was crucial to get a quick understanding of the content preferences of the dentists in creating innovative ideas for our application. At the very beginning of the research, an online survey was given to potential users in order to identify the potential areas of implementation for our application. The aim was to identify the primary demands of dentists regarding the content to be included in the system. Sampling was

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