Digital booklet for learning radiographic cephalometry: experience report

Manohelen Vasconcelos Melo Parente[1]
iD 0009-0003-9246-4397

Isadora Maria Paiva Simplício[1]
iD 0000-0001-9325-1754

Maria Clara Lima Barbosa Cardoso[1]
iD 0000-0003-4416-0375

Lucio Mitsuo Kurita[2]
iD 0000-0002-9676-4376

Catarina Chaves Machado[1]
iD 0000-0001-8745-8839

Paulo Leonardo Ponte Marques[1]
iD 0000-0001-8349-9772

[1]Universidade de Fortaleza (UNIFOR), Fortaleza, Ceará, Brasil.
[2]Universidade Federal do Ceará (UFC), Fortaleza, Ceará, Brasil.

Correspondence:
Paulo Leonardo Ponte Marques
E-mail: paulomarques@unifor.br

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Abstract
The use of new methods in the teaching process may enable better learning of more complex content. In Orthodontics, cephalometric analysis demands time and a high student/professor ratio in undergraduate Dentistry. Digital tools facilitate this process, providing autonomy for students over their own learning. This paper reports the development of a digital booklet for knowledge in cephalometry in an undergraduate Dentistry course. The setting was the discipline of Pediatric Clinic III in the Dentistry course of a private university, where printed material on the subject was used. Using information and communication technologies available for education, the material was developed as part of a Professional Master of Science program in Dentistry in partnership with the Center for Application in Information Technology and in association with a public university. The process was designed in five stages: analysis of scientific material for scripting; work drafting; design construction; interactivity; and publication/availability. Typographic elements with text and images, color and interactivity were included to facilitate quick viewing and browsing, as well as a formatting layout for access mainly using smartphones. This digital tool, as a collaborative resource for in-person and distance learning, will contribute to the teaching-learning process in a more playful and innovative manner, thereby favoring increasing the students' protagonism over their own learning.
Descriptors: Mobile Applications. Cephalometry. Education, Dental.

Folleto digital para el aprendizaje de la cefalometría radiográfica: relato de experiencia
Resumen
El uso de nuevos métodos en el proceso de enseñanza puede permitir un mayor aprendizaje de contenidos más complejos. En Ortodoncia, el análisis cefalométrico requiere tiempo y una alta proporción alumnos/profesor en la carrera de Odontología. Las herramientas digitales facilitan este proceso, proporcionando a los estudiantes autonomía sobre su propio aprendizaje. Este artículo se propuso relatar la elaboración de una cartilla digital para el conocimiento en cefalometría en una carrera de Odontología, tomando como telón de fondo la disciplina Clínica Infantil III de la carrera de Odontología de una universidad privada, donde se usaba material sobre el tema en formato impreso. Utilizando las tecnologías de la información y la comunicación disponibles para la educación, el material fue desarrollado en el ámbito de una Maestría Profesional en Odontología en colaboración con el Centro de Aplicación de Tecnologías de la Información y asociación con una universidad pública. El proceso se planteó en cinco etapas: análisis del material científico para el guion; esquema del trabajo; diseño de construcción; interactividad; y publicación/disponibilidad. Se incorporaron elementos tipográficos con texto e imágenes, color e interactividad para facilitar la visualización y navegación rápida, así como un diseño de formato para acceso principalmente a través de teléfono inteligente. Esta herramienta digital, como recurso colaborativo para la enseñanza presencial y a distancia, contribuirá al proceso de enseñanza-aprendizaje de una forma más lúdica e innovadora, favoreciendo una mayor implicación del estudiante en su propio aprendizaje.
Descriptores: Aplicaciones Móviles. Cefalometría. Educación en Odontología.

Apostila digital para aprendizagem em cefalometria radiográfica: relato de experiência
Resumo O uso de novos métodos no processo de ensino pode possibilitar maior

aprendizagem de conteúdos mais complexos. Em Ortodontia, a análise cefalométrica demanda tempo e elevada razão aluno/professor na graduação em Odontologia. As ferramentas digitais facilitam esse processo, proporcionando autonomia aos alunos sobre sua própria aprendizagem. Esse artigo propôs relatar o desenvolvimento de uma apostila digital para conhecimento em cefalometria em um curso de graduação em Odontologia, tendo como cenário a disciplina de Clínica Infantil III do curso de Odontologia de uma universidade privada, onde se utilizava material sobre a temática em formato impresso. Valendo-se das tecnologias da informação e da comunicação à disposição da educação, o material foi desenvolvido no âmbito de um programa de Mestrado Profissional em Odontologia em parceria com o Núcleo de Aplicação em Tecnologia da Informação e associação com uma universidade pública. O processo foi delineado em cinco etapas: análise do material científico para roteirização; esboço do trabalho; construção do *design*; interatividade; e publicação/disponibilização. Foram incorporados elementos tipográficos com texto e imagens, cor e interatividade para facilitar a visualização e navegação de forma rápida, assim como *layout* de formatação para acesso principalmente via *smartphone*. Essa ferramenta digital, como recurso colaborativo ao ensino presencial e à distância, contribuirá no processo de ensino-aprendizagem de forma mais lúdica e inovadora, favorecendo o aumento do protagonismo dos alunos sobre sua própria aprendizagem.

Descritores: Aplicativos Móveis. Cefalometria. Educação em Odontologia.

INTRODUCTION

The study of cephalometry contributes to a better diagnosis, planning and follow-up of the progress of orthodontic treatment[1]. Several cephalometric analyses are currently used, and the teaching institutions usually have their own customized analyses[2,3]. However, locating the anatomical landmarks can be challenging, especially for beginners.

The description of anatomical landmarks and cephalometric points used may not be consistent in the literature and can be difficult to understand. The responsibility for radiographic interpretation evidence that dental professionals should be able to identify normal anatomical structures and distinguish them from signs of pathological disorders[3]. For that purpose, it is necessary to seek more resources to further disseminate this knowledge.

Technological developments have been rapidly incorporated in the routine life of individuals, significantly changing their way to relate and interact. In this scenario, the transition from analog to digital and from in-person to virtual also occurred in the formal education process[4,5]. Since 1996, guidelines have indicated that virtualization can be used as an adjunct to in-person training, aiming at providing students with a better understanding of the content explained in lectures, strengthening the teaching-learning process[6,7].

The advent of information and communication technologies (ICTs) has encouraged a revolution in teaching-learning, disseminating information by virtual means. Their implementation by professor enhances the teaching flexibility, allows greater interactivity among students and enhances the quality in teaching-learning[8].

However, it is known that it is not enough to ensure the inclusion of ICTs in the specialized education. It is fundamental to use them intentionally and meeting the specific needs of each student. In education in general, the technologies, especially those with online support, have presented great possibilities to support professors in their educational actions to promote student learning and development[9-11].

Therefore, higher education institutions, professors and students are facing a new reality within the classroom: combining traditional teaching, with expository lectures with explanations on the content by the professor, with the use of new methodologies and resources[12,13].

In this scenario, in which students are already familiar with information resources, one solution to overcome the shortcomings of traditional didactic methods is to incorporate computer-assisted learning (e-learning), which allows the

students to work in their own manner, at their own time and pace[8]. Also, this method can optimize classroom time and increase the student engagement with the learning content. E-learning is growing rapidly worldwide and has been increasingly popular among students and tutors[2,14,15].

Evidence supports the use of gamification and games in dental schools to promote a positive learning environment with increased student motivation and interest[3,16]. In this scenario, the following guiding question emerged: how is it possible to achieve greater interest, student involvement and enable greater effectiveness in the teaching-learning process, in person and/or remotely, of radiographic cephalometry in the diagnosis of dentofacial abnormalities?

This paper reports the experience of developing a digital booklet for teaching cephalometry in undergraduate dentistry courses.

EXPERIENCE REPORT

This experience was conducted at the University of Fortaleza (UNIFOR). Committed to educating for the future, in 2020 the institution adopted a virtualization tool to support the teaching-learning process and the dissemination of knowledge, using a virtual learning environment (VLE). Combined with in-person theoretical and practical classes, the environment allows students to complement their learning by interacting with professors and classmates, encouraging the debate and exchange of knowledge, besides facilitating the access to teaching materials, available from any location and at any time.

Radiographic cephalometry is taught by in-person theoretical and practical classes. The program content includes diagnosis and treatment planning in Orthodontics.

Cephalometric analysis comprises morphological analysis of the craniofacial complex and is considered a valuable tool for diagnosing malocclusions and planning orthodontic treatments. The learning of this topic, with a workload of 10 hours, is based on angular and linear measurements recommended by classical authors and addresses the understanding of dentofacial disharmonies.

In the context of this report, the experience of graphical design of an existing cephalometric booklet that had been validated in printed format will be described, in a study awaiting approval for publication in a specialized journal.

From an academic standpoint, this type of study can be classified as methodological[15]. The methodological procedures aimed at applying an educational tool that proposes to transform the study of cephalometric analysis and the diagnosis of malocclusions with the use of a virtual and interactive tool hosted on the institutional AVA.

The booklet consists of eight chapters including the history of radiographic cephalometry, the method for achievement of radiographs, learning on anatomical aspects of the craniofacial complex, identification of reference points and interpretation of cephalometric measurements in a digital and interactive manner. It included the main topics for cephalometric tracing: (i) introduction; (ii) summary of the history of radiographic cephalometry; (iii) objectives of cephalometry; (iv) lateral cephalogram; (v) cephalogram; (vi) cephalometric measurements and their interpretations; (vii) standard cephalometric analysis; and (viii) bibliographic references.

The methodology for creating the digital booklet consisted of five stages: (i) analysis of scientific material for scripting; (ii) drafting; (iii) design; (iv) interactivity; and (v) publication. The stages are described below with the respective screenshots of the final version of the booklet sections.

The first stage involved assessing the existing scientific material and the printed booklet, without changes to the content. This provided a reference base for scripting and planning the booklet transformation. The second stage consisted of drafting the digital booklet. It was outlined using a draft on physical paper, including description of the essential elements in each booklet section. Here, it was necessary to think about and design all aspects of browsing and interaction between user and product. The design was based on the need to simulate a complete handling experience, from start to finish.

The third stage comprised the onset of design. The visual part considered some elements that, when addressed together and in harmony, create the visual identity of the product. This stage was developed in collaboration with professionals from the Information Technology Application Center (NATI) at UNIFOR.

The elements discussed with information technology professionals and adapted for the digital booklet include design elements related to typography, color, format, icons and interactivity. Concerning the typography, the Myriad sans serif font was chosen, since this typeface is recommended for digital publications due to its good readability on screens. The color palette has dark blue as the main color. Lighter blue was the secondary color, as well as its tone variations. Blue is a color that allows good visibility and assigns seriousness to the proposed subject. The format, with 416-pixels width, was developed to facilitate the access for smartphone users. Concerning the interactivity, it has icons to signal actions for interaction and content navigation, including page advance (>>); return to the previous page (<<); chapter menu (=); access more content (+); and close content (x). Each of them was strategically positioned to stimulate the reader, aiming at providing easy browsing and access to the available subtopics.

The descriptions of explanations allow the user to choose between viewing the entire text by selecting continuous scrolling. This classification in the topics presentation aims at enhancing the access of users to different topics and speed up their learning process.

Therefore, when the student is using the booklet, it is important to do so in an established sequential order, i.e., starting from the most basic knowledge to the most complex, within a step-by-step process for constructing a cephalogram and understanding it to properly diagnose the malocclusions.

The digital booklet was designed and developed using dedicated software proposed by information technology professionals. The tool was constructed using Adobe InDesign (Adobe InDesign 2020 (version 15.0), Adobe Inc, San Jose, California, UUSA). The software In5 (version 4.0.17., Ajar Productions, Seattle, Washington, USA) was used to promote interactivity and generate the HTML5 (HTML5.3, World Wide Web Consortium (W3C), Cambridge, Massachusetts, USA). The drawing vectors were designed on the Adobe Illustrator (Adobe Illustrator 2024 (version 28.0), Adobe Inc., San Jose California, USA), and the images were prepared in Adobe Photoshop (Adobe Photoshop 2021 version 22.0, Adobe Inc., San Jose, California, USA).

Since the booklet was designed to be divided, each chapter is listed below and presented with a screenshot of the booklet in its current stage. Figure 1 shows the main screen of the digital booklet.

The first chapter presents the introduction and justifies the construction of the digital booklet as teaching material for undergraduate courses. Besides the target audience of students, the material can also be used as an update and reference tool for professionals willing to continue the studies on this subject.

In the second chapter, the user accesses a historical summary of radiographic cephalometry, including the cycle from craniometry to the introduction of computers. The summary presents authors, studies and techniques developed since 1780, which have become references in the field.

The third chapter presents the definition and objectives of cephalometry, including general analysis of craniofacial anatomical structures; analysis of the soft tissue profile; definition of facial morphological pattern; definition of the predominant tendency of mandibular growth; auxiliary means for orthodontic diagnosis; auxiliary means for treatment planning; orthodontic treatment follow-up; analysis of changes produced by orthodontic treatment; auxiliary means in the planning of orthognathic surgeries; and means of interdisciplinary communication.

The fourth chapter defines lateral cephalogram and the radiographic technique used to achieve it (Figure 2). The fifth chapter defines the cephalogram, describes the structures involved in anatomical outline and how tracing is performed (cephalometric points and lines/planes). The sixth chapter describes the cephalometric measurements and their interpretations, such as determining the skeletal pattern in anteroposterior direction, facial growth pattern, predominant

mandibular growth tendency, analysis of dental pattern and soft tissue profile.

Figure 1. Main screen and introductory screen of the digital booklet.
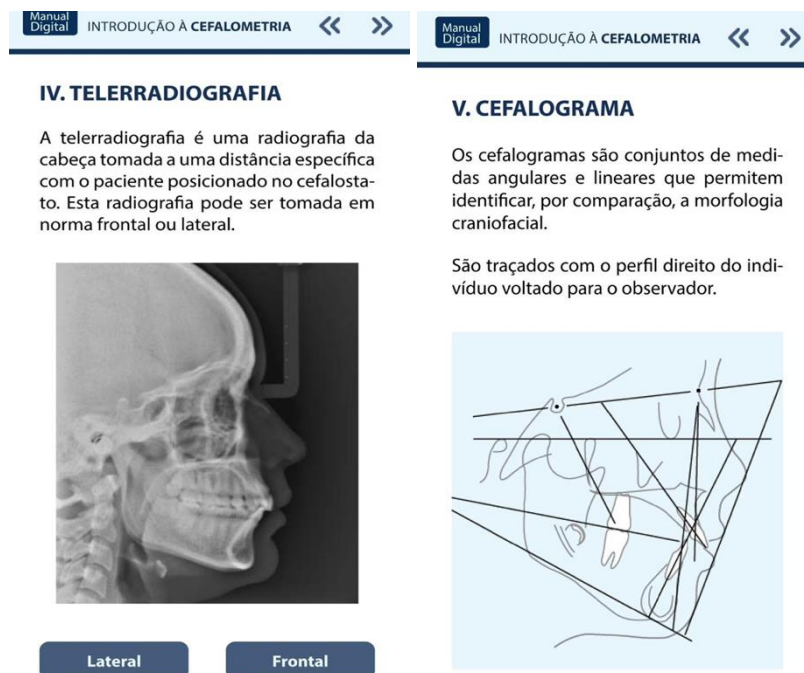

Figure 2. Screenshot of the lateral cephalogram and tracing.

Chapter seven describes the cephalometric analysis proper, following the standard adopted as reference by the institution. This chapter contains a table of angular and linear measurements and their values, as well as the different interpretations of cephalometric data, and finalizes describing how to summarize this analysis.

Finally, after completion of its development, the publication stage was initiated. The booklet is hosted on a server that

can be accessed preferably by smartphone, yet it can also be accessed on a computer with any system with internet access, at http://deadesigneditorial.site/Manual-cefalometria.

FINAL CONSIDERATIONS

An interactive digital booklet was developed for the study and diagnosis of radiographic cephalometry, using information and communication technologies and in collaboration with professors, students and computer science specialists.

Digitization offers the potential to revolutionize the entire field of dental education. More interactive and intuitive e-learning possibilities will emerge to encourage the students and provide a stimulating, pleasant and meaningful educational experience with permanent access to the content.

The successful transformation of this printed booklet into a digital format illustrates the potential of this method, which can be applied to several fields. Digitizing the content makes information more accessible and also provides possibilities for the modernization of processes in different contexts, benefiting several sectors.

With the availability of new technologies for teaching, it will be possible to perform the educational planning for undergraduate students that may significantly advance the student/professor interaction process, thus enabling a qualitative gain in the teaching-learning method.

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