

## STUDY AND ANALYSIS OF INFORMATION TECHNOLOGY IN DENTISTRY IN LATIN AMERICAN COUNTRIES

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### ABSTRACT

Dentistry increasingly uses Information and Communication Technology (ICT), which has impact on teaching, research, the profession and dental care in general. However, there is a lack of valid information on ICT resources and use in Latin America. This was a descriptive, cross-sectional, multi-center, interdisciplinary study, the aim of which was to conduct a survey on how extensively ICT is used in Dentistry in Latin American countries by enquiring into two primary components: 1) use of ICT in student training and 2) use of ICT by professionals in consulting rooms and services. Two questionnaires on ICT were prepared: one for teachers/researchers and another for students/professionals. We received 94 answers from teachers/researchers at universities in the region providing information on ICT resources for teaching (type and implementation) and 221 answers from professionals (personal

use and use in healthcare). Data are presented as absolute relative frequencies and analyzed quantitatively as percentages. Results: 1) Teachers highlight ICT as an instrument for development, democratization and fairness in access to knowledge for higher education. 2) ICT supports collaborative learning and generates other innovative resources (e.g. simulators). 3) Innovations in telemedicine and experiences with electronic clinical history were identified in Brazil, Uruguay and Colombia. These results are a basis upon which to reach a consensus regarding a set of ICT indicators which are comparable at regional level and serve as input to unify the design and implementation of ICTs experiences in both teaching and dental care in Latin America.

**Key words:** Dental informatics, communication media, oral health, dental research.

## ESTUDIO Y ANÁLISIS DE LA INFORMÁTICA ODONTOLÓGICA EN PAÍSES DE LATINOAMÉRICA

### RESUMEN

La Odontología utiliza en forma creciente las Tecnologías de la Información y la Comunicación (TIC) impactando en la enseñanza, la investigación, la profesión y la atención odontológica en general. Sin embargo, no se cuenta con información válida sobre los recursos e utilización de las TIC en Latinoamérica. La investigación representó un estudio descriptivo, de corte transversal, multicéntrico e interdisciplinario, cuyo objetivo fue realizar un relevamiento del grado de informatización en Odontología en países latinoamericanos indagando dos componentes principales en el empleo de las TIC: 1) en la formación de estudiantes y 2) por parte de los profesionales en consultorios y servicios. Se realizaron cuestionarios a referentes TIC: uno para docentes/investigadores y otro para estudiantes/profesionales. Se recibieron 94 respuestas de docentes/investigadores de universidades de la región dando cuenta de los recursos TIC para la enseñanza (tipo e implementación) y 221 de profesionales

(personal y en la asistencia clínica). Los datos recogidos fueron analizados cuantitativamente con tabulación en porcentaje y se presentan en frecuencia relativa absoluta. Resultados: 1) Los docentes enfatizan a las TIC como instrumento de desarrollo, democratización y equidad en el acceso al conocimiento en educación superior. 2) Las TIC apoyan el aprendizaje colaborativo y generan otros recursos innovadores (ej: simuladores). 3) Se identificaron innovaciones en telemedicina y experiencias con historia clínica electrónica en Brasil, Uruguay y Colombia. Los resultados constituyen una base para consensuar un conjunto de indicadores TIC comparables a nivel regional y sirven como insumo para unificar el diseño e implementación de las experiencias TIC tanto en enseñanza como en la asistencia odontológica en Latinoamérica.

**Palabras clave:** Informática odontológica, Medios de comunicación, Salud oral, Investigación odontológica.

### INTRODUCTION

The rapid development of Information and Communication Technology (ICT) poses major challenges to the health sector in Latin America.

There is a need to evaluate how adopting ICT and using it efficiently can contribute to responding to those challenges. Within the field of health, dentistry has been using ICT increasingly in

teaching, research, extension, the profession and dental care in general. However, there is a lack of valid information on ICT resources and use in Latin America enabling the establishment of groups and networks that could contribute to responding to the challenges of teaching, research and dental care in the region. Guillén and Monteagudo<sup>1</sup> claim that health researchers need to have at least a minimum level of knowledge of new technologies in order to carry out their activity. Peña<sup>2</sup> believes that research in biomedicine and health ultimately depends on researchers' ability to include and use technological developments in their daily work. Including ITC in Dentistry calls for changes in management, teaching and professional work, or, in more general terms, in lifestyle. Computers, networks and in particular the Internet, have had great influence on the ways in which information and knowledge are generated, managed and made known. Worldwide, ICT has changed training processes, whether in distance learning or as support for face-to-face learning. As centers of knowledge production and transmission, Institutions of Higher Education cannot ignore the enormous potential of ICT as a resource for graduate and post-graduate training, leading to substantial renovation or transformation of the ends, means and organization of the educational system<sup>3</sup>.

In 1999, Ehrmann S.C.<sup>4</sup> foresaw that there would be major transformations in upcoming years regarding the conception and practice of university teaching, suggesting that they would lead to a veritable pedagogical revolution. Axt M.<sup>5</sup> suggests that this passage to an information and communication society is similar what happened during the transition to literate societies with printing, recognizing four comparable features: (a) although technological progress is quantitative, it is especially qualitative (in terms of new cognitive demands); (b) once the process of technological diffusion begins, it appears to be irreversible; (c) a given development appears as a process of continuous extension and sophistication and (d) advantages and disadvantages go together, creating situations that require control by societies. It should be noted that there are certain features in the conceptions held by knowledge societies that go beyond those held by information societies. Although both types of society consider that ICT provides a qualitative leap, knowledge societies have an egalitarian background which respects

cultural diversity, and aim to reduce the digital divide between different countries. Both conceptions are based on the assumption that knowledge is key to the development of societies; thus, today, more than ever before, educational systems face previously unimaginable transformations. While information societies are based on technological progress, knowledge societies hold notions that include social, ethical and political dimensions.

Higher Education in Latin America is undergoing changes caused the widespread growth of teaching and the range of dynamics imposed by globalization. In this context, new communication and information technologies and increasing demand for access to education have major roles. Quality assurance, new post-graduate programs and virtual education are some of the tools created by a university system seeking to respond to new demands imposed by the international context<sup>6</sup>. The challenge is for universities to innovate, not only in technology, but also in their pedagogical conceptions and practices, which would involve changing the global university teaching model: changes in organization, ways of working, human interaction, the role of the teacher, learning activities and processes, forms of classroom organization and modes of access to knowledge. This requires universities to establish new organizational models and resources (combination of virtual and face-to-face learning). M. Silva<sup>7</sup> says, "... it should be noted that the distinction between "face-to-face" and "distance" will become less and less relevant as digital technologies become more widespread. Both modalities will coexist: use of the internet, multimedia supports and the traditional classroom with teacher and students face-to-face. The student will have a classroom at school or university, and also a website for the subject with exercises and new proposals, which will be the virtual classroom". Maraschin C. and Axt M.<sup>8</sup> analyze how teacher-student practices and their relationship to knowledge are changed by new devices. They enquire into how relationships, learning and knowledge can be affected by coexisting with technology, and emphasize an intricate, dynamic relationship between knowledge and technology. Information technology is not perceived simply as a means for learning or knowing something, but as an intrinsic, constitutive part of the way of knowing itself.

In recent years, the dental profession has included ICT in healthcare activities. ICT is increasingly

used for administrative activities at offices, clinics and healthcare services, as well as for activities for promoting health and health education, for marketing and for continuing education in dentistry. The aim of this study was to survey the degrees of computerization in the field of dentistry in Latin American countries by enquiring into two primary components (domains) in the use of ICT: (1) use for training students (graduate and postgraduate) and (2) use by professionals at dentists' offices and healthcare services. As a hypothesis, it was considered that input from local reference persons for countries in the Latin American Region (LAR) of the International Association for Dental Research (IADR) would provide valid information regarding ICT use in Latin America from a previously unexplored perspective, which would enable a consensus to be reached on a set of comparable ICT indicators in the region. Two questionnaires were prepared on ICT: one for teachers/researchers and another for students/professionals.

## METHOD

A descriptive, cross-sectional, multi-center, interdisciplinary study was conducted, based on questionnaires on two domains with relation to ICT (approved by the Ethics Committee, UFRGS, Brazil-CAAE: 12381613.7.0000.5347). The study began in February 2012 according to defined guidelines and preliminary agreements on different components of the research process, professional activities and dental care in particular. Permanent online exchanges were maintained among members of the research team, and four face-to-face meetings were held in Montevideo (Uruguay) and Porto Alegre (Brazil) (April and September 2012; August 2013 and April 2014). Relevant university actors and professionals from Latin American countries were defined as "key informers". They were asked about demographic data (population, number of dentists, number of dental schools and reference persons on the subject in their countries). Inclusion criterion was to be a country in the Latin American Region (LAR) of the International Association for Dental Research (IADR): Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Paraguay, Peru, Uruguay and Venezuela, which answered the questionnaires (Paraguay was excluded because it did not meet this criterion). Two questionnaires were prepared in Spanish and Portuguese containing

multiple choice and open-ended questions about what, how and why ICT was used. Questionnaires were e-mailed to the reference persons for ICT identified by the key informers for each country: one questionnaire for teachers and researchers (A) and another for students and healthcare professionals (B):

A. Questionnaire in Spanish and Portuguese for teachers, researchers and undergraduate and graduate students

(<https://docs.google.com/forms/d/12MFIFHXSy5tO9PGR-ErGs3PgwnHlzBqCFErwlcDXLY/viewform>)

and

[https://docs.google.com/forms/d/1o5g0WFBRAp237SkH0RUnl\\_cPbLYRNKIw6jRku-QwCf/viewform](https://docs.google.com/forms/d/1o5g0WFBRAp237SkH0RUnl_cPbLYRNKIw6jRku-QwCf/viewform))

B. Questionnaire in Spanish and Portuguese for ICT users at dental offices, clinics and/or services

(<https://docs.google.com/forms/d/1Ndn4CF3ZxRCuekABQfpiLaHPDIOrcLHKEFeTUswZhYg/viewform>)

and

<https://docs.google.com/forms/d/1FvDAPNzpdI4vLAzqLxB6bXk3sEdUZ3W-RbvLU9fzrGE/viewform>)

Data collected were analyzed quantitatively by percentage. They are presented in relative and/or absolute frequencies.

## RESULTS

Table 1 shows the number of key reporters, ICT reference persons and total number of answers to questionnaires, distributed by country.

Total number was considered as having answered the questionnaire; thus, as some reference persons did not answer all the questions, there are a few situations in which the sum of answers to a specific question does not match 100% of questionnaires answered.

### A) TEACHERS/RESEARCHERS

We received 94 answers from teachers and researchers at universities in the region: Argentina 18, Brazil 32, Chile 6, Colombia 3, Costa Rica 8, Ecuador 2, Paraguay 0, Peru 10, Uruguay 9, Venezuela 6. Teacher and researcher profile was: (a) age: 36 were younger than 40 years, 30 were 40 to 50 years old and 28 were over 51 years old; (b)

**Table 1: Frequency distribution in absolute values for number of answers from key informers and ICT reference persons to questionnaires per country.**

COUNTRY	KEY REPORTERS	ICT REFERENCE PERSONS	TOTAL ANSWERS
ARGENTINA	20	26	27
BRAZIL	25	63	221
CHILE	10	7	6
COLOMBIA	6	6	3
COSTA RICA	3	7	7
ECUADOR	3	7	3
PARAGUAY	6	1	-
PERU	3	11	14
URUGUAY	9	20	15
VENEZUELA	2	19	9

graduation year: 36 graduated before 1990, 32 graduated between 1990 and 2000 and 25 graduated after 2001; postgraduate degree: 82 have a postgraduate degree and 12 do not. With regard to specific ICT knowledge: 43 consider it is sufficient and 51 consider it insufficient; 60 took training courses within the past 5 years and 34 did not. Some general results on university resources and activities are shown in Table 3, e.g. number of computers, virtual classroom, distance education courses (DE). For number of computers at the educational institution, the answers were: 27 had 1 to 10 computers, 34 had 11 to 50 computers, 31 had 51 to 100 computers and 11 had over 100 computers. With regard to the question of whether distance education (DE) was used as an educational methodology, 47 answered yes, accounting for 50%.

Tables 2, 3, 4 and 5 show the answers from reference university teachers about use of ICT resources for teaching: type, implementation and difficulties in use.

## **B) PROFESSIONALS AND/OR CLINICIANS**

We received 211 answers from professionals in the region. Their profile was: (a) age: 179 were younger than 40 years, 20 were 40 to 50 years old and 12 were over 51 years old; (b) graduation year: 11 graduated before 1990, 17 graduated from 1990 to 2000 and 182 graduated after 2001; postgraduate degree: 82 have a postgraduate degree and 129 do not; 79 work in public service and 132 work in private dental offices. With regard to frequency of ICT use: 32.22% answered always, 54.44% often, 6.77% occasionally and 6.67% never. With regard

to type of Internet used: 10% use 3G (cell phone), 78.89% use broadband, 0.37% use dial-up, 10% none and 0.74% does not know. With regard to connection between health centers/clinics: 15.93% respond they have, 79.63% do not and 4.44% do not know.

Tables 6 and 7 show the answers from university professional reference persons about use of ICT resources for personal and clinical use.

## **How does ICT help the teaching and learning process?**

Answers highlight that ICT is an instrument for development, democratization and fairness in access to knowledge in Higher Education, enabling knowledge to be conveyed in different ways which are more dynamic and encourage association and teamwork. ICT supports collaborative learning, i.e. participation of two or more persons in performing a task, with the aim of the participants constructing knowledge by exploring, discussing, negotiating and debating. Here, the teacher acts as guide and facilitator, introducing the subject, and students discuss, create and modify content by using resources available online. It has been found that virtual settings facilitate exploration and individual search for information and knowledge, and that collaborative learning increases student participation and motivates student learning; the student is no longer a passive receiver, but becomes the protagonist of his/her own learning. Moreover, research skills and construction of student's own learning are reinforced, competition is left aside,

**Table 2: Frequency distribution in absolute values for answers on use of ICT resources at Latin American Schools of Dentistry.**

Enrolment, courses, exams	Access to didactic material	Results of exams and evaluations	Group work	Training	Institutional communications
69	73	55	53	64	67

**Table 3: Frequency distribution in absolute values for answers on type of ICT resources for teaching Dentistry.**

PC	Projector	Interaction device	Video conference	Digital board	Moodle	CDs, Dropbox	Virtual classroom
84	88	9	7	20	2	4	80

**Table 4: Frequency distribution in absolute values for answers on communication media used by Latin American university teachers.**

Telephone	E-mail	Virtual platform	Paper	Chat	Other
23	77	14	11	4	5

**Table 5: Frequency distribution in absolute values for answers on difficulties in implementing ICT by university teachers.**

Lack of resources	Lack of training	Lack of student interest	Lack of teacher incentive	No access	Lack of time	Preconception with ICT	No difficulty
25	40	9	7	5	6	15	4

**Table 6: Percentage of personal ICT equipment.**

Smart phone	PC	Web cam	Scanner	Tablet	Printer	Screen in reception	Digital biometry	At least one resource
54.07	96.19	58.51	60	30.74	83.70	7.04	4.44	96.30

**Table 7: Percentage of clinical ICT equipment.**

Laser	Intraoral camera	Digital camera	Digital photopolymerizer	Tablet	Printer	Screen in reception	Ultra sound/prophylaxis	Dental equipment monitor	Implant digital motor
90.3	87.41	58.51	60	30.7	83.70	7.04	63.33	15.19	18.15

and students listen to each other and cooperate actively to complete the final project. ICT generates new learning contexts and in addition, can be used to represent phenomena by means of models and simulations that enable the abstract to be visualized<sup>9</sup>.

#### **Relevant experiences at the institution with ICT use (teaching and/or research)**

Answers refer to a series of resources and methods which can be grouped into: (a) Electronic clinical history (for healthcare, research, extension); (b)



Institutional repositories: teaching materials, news, documents (e.g. Universidad Mayor, Chile <sup>10</sup>); (c) Management support: enrolment, formation of student groups, evaluation results; (d) Teaching support: questionnaires, tests, videos, photographs, google doc, webquest, moodle platform, youtube, live clinical procedures transmitted in real time, virtual training classrooms with teacher forums; postgraduate distance courses; (e) Communication: chat, forums, e-mails, social networking, blogs, tutoring, presenting theses by videoconference; (f) Groups: telehealth, teleconsultation (second opinion), web conferences for discussing clinical cases (teachers and students), video conferences among several universities; projects with researchers from different cities; virtual professorship (international relations and regional integration).

## DISCUSSION

Considering the exploratory character of this study, the results can be used as a basis to reach a consensus on a set of ICT indicators that would be comparable on a regional level and could be used as input to unify the design and implementation of ICT experiences, both in teaching and in dental care. ICT is a tool for learning and teaching, representing an opportunity as well as a challenge. We propose that ICT could be instrumental in improving the learning and teaching process, without intending to assign any intrinsic transformational capacity to ICT alone. Latin America and the Caribbean have been at the cutting edge in recent years, with the fastest growth rates in the world for incorporating technology and connectivity (IDB, 2012)<sup>11</sup>, even though there is still a long way to go to ensure fair, universal access. To date, it has not been easy to connect this huge investment and progress to better and fairer development, or, for educational systems, to better student learning outcomes. The ECLAC report Social Political Series, N° 171<sup>12</sup> states that the design and implementation of ICT policies in the different countries in the region vary widely. In general, it can be said that countries are better at designing policies than at implementing them. Outstanding countries are Mexico, Panama, Uruguay and Cuba, which have relatively high rates of ICT policy definition and implementation. In contrast, Bolivia, Colombia, Paraguay and Ecuador tend to have low policy definition and implementation rates. Finally,

Argentina, Chile, Costa Rica, El Salvador, Nicaragua, Peru and Dominican Republic have higher rates of definition than implementation. This reflects a scenario in which many countries have the necessary definitions but implementation is pending. According to the abovementioned report, although the most likely reason for this situation is lack of resources to invest in implementing policies, it could be assumed that in some cases this lack is added to the inherent difficulty in implementing these initiatives, i.e., lack of institutional capacity to put designs into practice. Various authors and international agencies <sup>13-15</sup> recognize the importance of certain conditions of ICT context, access and use for producing concrete impact.

In agreement with the above, the results of this study show that most universities in Latin America have made progress in ICT infrastructure and in providing Internet resources and access. However, there is a need to improve teacher training in order to increase the use of ICT in teaching, especially in graduate courses, where ICT is mainly used to store subject materials, and in interactive and/or distance teaching, which is currently limited to optional or postgraduate courses. Analysis of university curriculum and ICT implementation in different areas and/or subjects shows that there is a variety of resources. The field of pathology is outstanding in several universities in the region, with innovations in teaching method (microscopy) and services (exam results). There is also relevant use of equipment in the field of imaging, with results transforming clinical and paraclinical dentistry practice. Many teachers and researchers relate the difficulties in using ICT to "lack of resources" and "lack of training" (Table 5). The 2012 SITEAL report<sup>16</sup> (System of Educational Trends in Latin America) The Digital Divide in Latin America, says that despite the relevance of Internet use for accessing knowledge in a globalized world, Internet access in Latin America is not yet democratic and access opportunities are very uneven: in Bolivia, El Salvador, Guatemala, Honduras and Paraguay, less than 5% of the total population has Internet access, while in Costa Rica, Chile, Brazil and Uruguay, 19 to 30% has Internet access. Latin American student home Internet access varies considerably by country. Students in Guatemala, Honduras, Bolivia and Paraguay have the least home Internet access (2 to 4%). Uruguay has the best relative situation,

with approximately 4 out of 10 students having home Internet access. In Brazil, Chile and Costa Rica 1 out of 4 students has home Internet access. Thus, according to the country where they live, some students have a likelihood up to 17 times higher of Internet access at home than their peers in other countries. University student Internet skills are variable and seem to depend on public policies at primary and secondary school. The abovementioned document from the Regional Bureau for Education in Latin America and the Caribbean (OREALC/ UNESCO Santiago 2013) says that new generations experience the omnipresence of digital technology intensely, to the point that it might even be modifying their cognitive skills. Indeed, these are young people who have not known the world without Internet, and much of whose experience is mediated by digital technology. Some people claim that these youths are developing distinctive skills such as acquiring much information outside teaching centers, taking decisions rapidly and being used to receiving almost instantaneous responses to their actions, having surprising multitasking ability, being highly skilled in multimedia and apparently learning in a different way. Teaching centers thus face the need to innovate in pedagogical methods if they wish to attract and inspire new generations. Are current pedagogical methods useful for motivating them? Activities and pace need to be adapted to the attitudes and features of new students who are used to accessing digitalized information, not only information on paper; enjoying moving images and music, in addition to text; are comfortable multitasking; and learn by processing discontinuous rather than linear information.

At dental offices and clinics, use of ICT resources has provided various benefits for dentists in areas such as management, diagnosis and professional marketing. This study found that high percentage of respondents (96.19%) has a PC at the dental office or service, especially for administration and patient databases. Current technology is powerful enough to provide real benefits to dental practice, with increasing importance of high-tech equipment; digital cameras and video cameras, intraoral cameras, digital imaging equipment, scanners, 3D technology, digital printing and laser application are all relevant resources for diagnosis, planning and treatment evaluation. However, these ICT resources are used little at dentists' offices except for those who have a

postgraduate degree (Tables 6 and 7). In endodontics, apex locators have increased accuracy in measuring root length and perfected canal filling. In orthodontics and surgery, ICT enables prior analysis of the result of a therapeutic plan and improvement of patient communication and understanding. In periodontology, tissue bioengineering has impact on regenerative therapies by enabling reconstruction of tissues damaged or destroyed as a result of disease, and aims to develop tissues similar to tooth, bone, mucosa and skin by means of regenerative cells.

### ICT innovations highlighted in this study:

**1. Cyclops Group (Brazil)**<sup>17</sup>. Development of telemedicine technology for Public Health, especially applied to remote contexts where there is broadband communication. Thus in Santa Catarina Province (Brazil), this group set up a platform to support diagnosis in cooperation with the provincial government.

**2.** The Ministry of Health in Brazil, in the context of the Single Health System (Sistema Único de Saúde, SUS), is developing two projects using ICT:

**2.1. The Telehealth Program**<sup>18</sup> for distance learning for professionals in family healthcare teams. Healthcare centers are connected via Internet to university academic teams, which support local decision making through formative second opinions.

**2.2. Universidade Aberta (UNASUS)**<sup>19</sup> provides ongoing education and training for workers in the Single Health System by connecting family healthcare teams to specialists at universities through videoconferencing.

**3. Electronic clinical history.** Although 81.43% of professionals in the region answered they do not use electronic clinical history, there is nevertheless a positive trend among researchers in the region towards creating and executing projects using it in order to improve information and knowledge exchange among clinics, universities, basic healthcare units, etc. Three of them have a high degree of implementation:

**3.1. Project REDIENTE**<sup>20</sup>, **Uruguay.** Clinical record in an online-accessible database, with national vocation and local management by dentists at their individual offices or institutions. Patients keep a card with a copy of their clinical history, which connects all events in a coherent documentary thread. REDIENTE enables epidemiological studies, evaluation of dental

care quality, and follow-up, and respects laws on patient data privacy protection.

**3.2. Project DENTSIO<sup>21</sup>, Colombia.** An application designed exclusively for iPad, to enter and manage patients' clinical histories quickly, easily, economically and intuitively. DENTSIO administers dental practice using dental record data, images, X-rays, etc.

**3.3. Project mobile phones<sup>22</sup>, Brazil.** A multi-center research project conducted experimentally by a group of professionals from Healthcare Centers with the aim of improving the quality and efficiency of services provided by the Basic Healthcare Units. Cell phones store information as mobile electronic records. They serve as a tool to support dental care by accessing patient background or other information, and are also able to cross-check data.

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This study provides perspectives for various lines of action with the aim of increasing exchange of experience, knowledge and tools among universities, services and other institutions in the different countries in the IADR Latin American Region, supporting research, establishing a permanent communications network among LAR/IADR divisions and sections, and promoting networking opportunities among researchers with innovative works on similar subjects. With regard to support for teaching dentistry in the region, it shows the need for universities to invest in ICT resources and to train teachers, students and officials in ICT resources and methodologies. It also shows the need to promote distance education by perfecting extension services and healthcare team training in distant areas in order to improve the quality of dental care and thereby community health.

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