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Interactive Digital Artifacts Embedded in Information Systems: a case study applied to Teledentistry

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Abstract

This paper aims to study how to embed interactive digital artifacts (such as blogs, wikis, videos, images, etc.) in information systems. These artifacts are unstable and in constant change challenging the traditional approaches to the management of information systems to which they are integrated. Institutions can no longer be seen as closed systems, but shall be construed as environments that expand in information networks and interaction and collaboration spaces for groups and society. Consequently, they become subject to interference from their cultural, behavioral, social and political environment. This research will focus on a case of a nation-wide information system for education, sharing of knowledge and assistance to dental professionals within government health teams. The expected contribution is a better understanding of the changes brought about in organizations and in information systems management processes resulting from the incorporation of interactive digital artifacts to those systems.

Keywords

Interactive Digital artifacts, Information Systems Management, Ubiquitous Systems, e-Health, Teledentistry.

1. Introduction

Organizations increasingly depend on collaborative work enabled by information technology, allowing professionals to work in shared projects and increased relationships with society regardless of their geographical location.

The rapid spread of digital technologies during the last decades gave rise to a new generation: the digital natives, a term coined by Prensky (2001) to designate a generation who grew up in a world surrounded by informational technologies, having easy access to Internet-connected computers, video games, cell phones and other information and communication technologies.

According to Prensky (2001), the environment in which this generation lives and the constant interaction with that environment changed the way they think and process information. This new generation is used to acquiring knowledge through collaboration and interaction, as well as to produce information and not just receive it, to find the information that interests them and make it available on a network. However, most

corporate systems are still designed without tools that allow easy interaction and collaboration and without the flexibility and communication resources offered by digital artifacts present in social networks.

The new information systems that enable the collaborative construction of knowledge and the possibility of sharing information, besides being ubiquitous, should, therefore, be designed differently from the systems developed in the past.

The provision of dental health services, requiring continuous education of their professionals, the sharing of knowledge and support to health professionals working in remote or difficult to access locations, but with increasing access to and digital competencies, offers a special opportunity for these new systems.

Our research focuses on the embedding of digital artifacts in information systems developed for teaching, sharing knowledge and supporting professional health teams that are part of the National integrated dental health system. This embedding could result in a greater integration among geographically dispersed teams and members and offering them more flexibility for sharing knowledge and collaboration.

2. Theoretical Framework

Digital artifacts are intentionally incomplete and are constantly changing (Garud et al. 2008). According to Kallinikos et al. (2013), the fact of being incomplete represents both an opportunity and a problem. It is an opportunity by not limiting the set of tasks and operational links that an artifact can accommodate, but it is also a problem if one considers the reduction of control over the device and its use. According to Kallinikos et al. (2013), digital artifacts are ontologically ambivalent. They are objects, although lacking the amplitude and stability exhibited by traditional items and devices.

According to Ekbia (2009), digital artifacts (such as blogs, wikis and personal profiles on social networks) lack an identity defined, a condition resulting from continuous change through which they pass. The author also describes them as being capable of fomenting social relationships, rather than just representing something fixed and immutable. Digital artifacts such as files, images, movies and videos are considered by Kallinikos and Mariategui (2011) as fluid and editable, often immersed in complex, distributed and constantly changing environments.

Other authors such as Yoo and Gothenburg (2010) and Yoo et al. (2010) describe digital artifacts as reprogrammable and self-referencing entities whose constitution allows the decomposition, adaptation, tracking, and interoperability. As these artifacts are diffused, these properties allow them to be embedded into digital infrastructures and become independent services or devices.

Authors like Yoo and Gothenburg (2010) proposed frameworks that include artifacts, actors, space and time. The space and time elements define "where" and "when" (the context) the actors interact with the artifacts. Vodanovich et al. (2010) proposed a framework composed of four dimensions. It encompasses the relationship of digital natives and digital immigrants with: IS (traditional IS versus Ubiquitous IS); activities (professional versus personal) and context (work versus social life). Figure 1 represents the relationships between these dimensions:
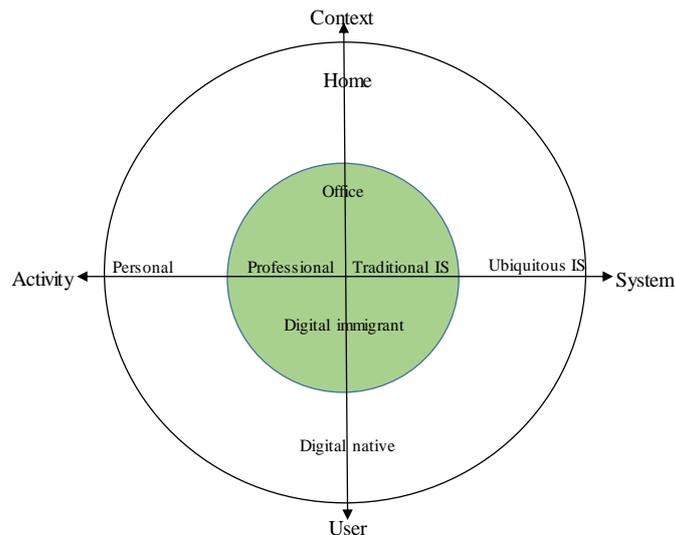
Figure 1 – Dimensions for Understanding the Digital Natives in the Context of
Ubiquitous Information Systems.
Source: (Vodanovich et al. 2010)

According to Kallinikos et al. (2010), the technical, behavioral and organizational implications arising from these properties of digital artifacts, the fluid nature of digital content and the architecture of relationships present in creation of these elements require itself a change in the research agenda. It is necessary to study the technical and organizational requirements of the digital artifacts in order to ensure interoperability and growth of these elements, because their use implies the possibility of combining the technology and social practices. Examples are the incorporation of Youtube, Wikipedia and Facebook into organizational systems. In addition, digital artifacts become important means of communication and expression for the new generation, the digital natives that expect to use the technology both in their personal life as for the performance of its tasks in an organizational context (Vodanovich et al. 2010). In other words, they expect to interact within a network and to be able to work in a collaborative way with their peers.

Information and communication technology (ICT) is very relevant for the health sector. Through its use it is possible to provide medical and dental attention to people living in remote areas. It is also possible to promote the e-learning and exchange of information among health professionals, as well as to deliver information targeted to specific audiences like children, teenagers, indigenous communities, etc.

The use of these resources in health gave rise to a new field of knowledge, the e-health, defined by the World Health Organization (WHO) as the use of ICTs in the health area for the treatment of patients, development of research, dissemination of knowledge, workforce education and monitoring of diseases and public health. Such systems are increasingly designed to use interactive digital artifacts. Therefore, they are subjected to constant changes posing new challenges to the development and management of them.

3. Research Problem
New ubiquitous digital technologies permit changes in the products and services offered by organizations to society. In turn, organizations are constantly under pressure to

execute changes in their communication models and management driven by the new workforce, the digital natives and by society. Therefore, new challenges are imposed to the design of these systems fostering the following research question:

What are the guidelines for the design of information systems in order to better integrate interactive digital artifacts to their structure?

4. Research Model

The widespread adoption and use of ICTs in contemporary organizations makes the relationship between information systems (IS) and the organization increasingly complex (Zammuto et al. 2007). As a result, the effectiveness of a single system is largely conditioned by an installed base of extant socio-technical arrangements (Henfridsson et al. 2013). For these systems the boundaries between intra and inter-organizational systems become blurred. In addition, IS can change over time due to embedment of new digital artifacts into these systems transforming them into digital infrastructures, as illustrated in figure 2. These digital infrastructure functionalities are the resources that enable the digital natives requirements as characterized in Figure 1 and are therefore essential to the success of the studied case.

According to Henfridsson et al. (2013), the term digital infrastructure has been adopted to define interconnected systems collectives. To Braa et al. (2007), a digital infrastructure is a collection of human and technological components, networks, systems and processes that contribute to the functioning of an IS, whose evolution comprises technical and social elements. Moreover, Lanzara (2009) adopts the term "assemblages" to define digital information infrastructure, adding to them the rules, practices and institutional and organizational values.
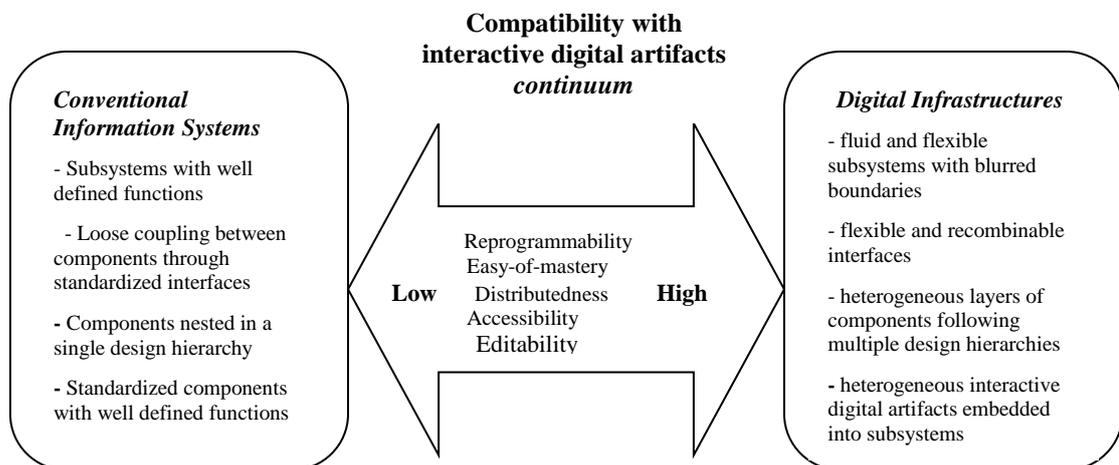

Figure 2 – Information architectures continuum
Source: (adapted from Yoo et al. 2010)

The present research will investigate the challenges tackled in the design of information systems due to the embedment of digital artifacts to their structure. This case study is based on a healthcare information system developed for teaching healthcare professionals and students. It is part of a larger project research of how universities can

make use of new technologies for the dissemination of knowledge to society by developing information systems with the embedment of digital artifacts.

We intend to apply the design science research (DSR) for this case study. According to Adomavicius et al. (2008), DSR involves the construction and evaluation of IT artifacts, constructs, models, methods and instantiations by which important organizational IT problems can be addressed. Hevner et al. (2004) suggested seven evaluation methods. One of these is the observational approach, which will be reached by case study and interviewing methods. The results of semi-structured interviews with health personnel and health students that make use of this information system for learning purposes, digital designers, health specialists, strategists for Telemedicine, sponsors and project managers will help to understand the main weakness and limitations imposed by technology, cultural gaps, digital competency, etc in the project of an information system with the embedment of digital artifacts. It will be also important to understand how these limitations were tackled during the design of this information system.

5. Case Study

This case study will analyze ubiquitous information systems developed for dentistry students and professionals at the Teledentistry Center at the Faculty of Dentistry (NTO-FOUSP) of the University of Sao Paulo (USP). This center was created in 2007, in agreement with the Center of Telehealth of Sao Paulo, a part of the Brazilian Ministry of Health's Telehealth Program. This program is sponsored by the Ministry of Health (http: www.saude.gov.br) in collaboration with the Pan American Health Organization (PAHO). This national program intends to use information and communication technologies (ICTs) to implement teleconsulting and tele-education initiatives for health professionals working for the Unified Health System (SUS). As part of the effort for promoting tele-education and continuous education, the Center of Telehealth of Sao Paulo is developing educational information systems in partnership with NTO-FOUSP (more information about this project is available at http://projetohomemvirtual.com.br/downloads/Guia_HV_SerieOuro.pdf). Since the year 2000, dentists have joined the SUS family health teams. The Teledentistry Center at USP provides educational material for clinical consultations, teleconferences with discussion of clinical cases submitted to them and courses in order to provide support for dentistry professionals working at SUS. These educational systems are making use of interactive digital artifacts as interactive infographics, games, videos, etc, with the intention of improving learning. It is particularly relevant to understand the main challenges and limitations for embedding interactive digital artifacts in these educational systems. Based on this knowledge it will be possible to establish some useful guidelines for embedding interactive digital artifacts in information systems.

It is important to emphasize that in Brazil, broadband Internet is not widespread. In remote regions even the use of computers are uneven. Therefore, interactive learning environments must be designed to meet dissimilar digital competence and diverse professional skills. University students are almost all digital natives. Therefore, they are able to interact with digital interactive environments and make use of all available digital resources. In contrast, health professionals living in remote areas are still digital immigrants with little competency to work with interactive information systems.

In this case study the infrastructure responsible for supporting health work professionals develops through a process involving socio-technical relations, i.e., is resultant from the interaction of health work professionals, specialists, technicians, culture, governmental institutions, universities, knowledge (digital competency for making use of the available resources) and technology. Due to the actors' diversity and roles in the building of the digital infrastructure, it is difficult to establish rigid guidelines for its construction. It is important to point out that Ministry of Health has established partnership with other Brazilian universities. They are responsible for providing support to pre-determined groups of health professionals. This allocation takes into account their geographical location. Therefore, the university responsible for supporting a given region is capable of identifying regional problems, endemic diseases, etc, and developing tools compatible with digital competency of local health professionals. Consequently, their response to questions can address specific issues in a customized manner. The governmental Telehealth program only establishes some guidelines for evaluating the support provided by these centers, not imposing rigid rules trying to align support initiatives. Therefore, the evolution of this resulting digital infrastructure is dependent on actors, collaborative work, culture, sponsorship provided by other governmental organizations (state and municipal agents), digital competency and technology available in diverse geographical locations. Therefore, it can only be interpreted as a continuum between a conventional information system and a digital infrastructure.

5.1 Data Collection

The University of Sao Paulo, through its specialized institutes has a long tradition of disseminating knowledge and practices to society. This is also the case of the Teledentistry area. We intend to study how these educational systems are making use of interactive digital artifacts as interactive infographics, games, videos, etc, with the intention of improving learning. It is particularly relevant to understand the main challenges and limitations imposed by the embedment of interactive digital artifacts in this educational information system in order to establish some useful guidelines for integrating interactive digital artifacts in information systems. The building knowledge base about the embedment of interactive digital artifacts in IS will be resultant from analysis of these interactive learning environments and evaluation of their effectiveness following the design science research guidelines.

6. Expected Contributions

We expect this research to contribute with the proposition of guidelines for the building of ubiquitous information systems that can embed interactive digital artifacts into their structure.

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