Technology Design and Routes for Tool Appropriation in Medical Practices

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INTRODUCTION

Nowadays it is recognized that the developments and use of digital technologies are changing the way in which people communicate, get access to a variety of information, solve problems, and discuss solutions. These technologies open up novel avenues for people to share practical and specialized knowledge from a variety of domains, and interest or goals. Tools can be physical or virtual artifacts and they influence human cognition and act as mediators between the phenomenological and conceptual world (Santos-Trigo, et al. 2016). In health areas, experts or professionals such as physicians, nurses or physiotherapists rely on social media (YouTube channels, blogs, wikis, or specialized webs) to share knowledge and practical experiences. Similarly, patients look for information on diseases and health advice and they often interact, via Internet, with experts to monitor their health and to interpret lab results. An important feature of the Web or an online platform is that it allows the participation of experts and users with a variety of experience or knowledge to build a source of accumulated knowledge in constant scrutiny. Denecke (2015) identifies three main groups as users of medical social media with different aims and purposes: patients, healthcare professionals and researchers. Thus, through the medical web, patients interact with health professionals and other patients to get information on diseases, treatments, prevention or ways for operating tools for diseases. Healthcare professionals interact with other colleagues and patients to discuss latest results or to identify and share experiences and best practices. Researchers interact with other researchers to discuss treatment results and information on treatment outcomes and information of disease development and progression. How is a medical web system constructed? What criteria are used to select the information to be included in the online system? ¿How do patients process and use the information they consult? Available medical data in online platforms might vary and increase in volume and themes, then data visualization becomes important for physicians and patients to overview and interpret changes in health status. Likewise, physical tools designed by engineers and other professionals (magnetic resonance imaging, catheters, etc.) are also transforming medical practices such as surgeries and disease detection and treatments. Thus, it is important to analyze the extent to which users of both physical and virtual artifacts get engaged in activities to transform those artifacts into an instrument to solve problems. To this end, we focus on the importance for users to develop cognitive schemata that shape their appropriation of the tool affordances in problem solving environments (Santos-Trigo, et al, 2015).

The design and use of technological artifacts in medical practices involve the participation of

several experts' communities including engineers, scientists, and medical doctors. Thus, to delve into what happens to artifacts (designed by engineers) when they enter into medical practices implies not only to uncover what engineering and medical practices entail, but also to address how both agendas could converge or incorporate common goals. Regarding the engineering as a discipline, the National Research Council (NRC) (2009) pointed out its problem solving approach to design and create human-made products under certain conditions or constraints. Some of those constraints involve taking into account principles that encompass science and scientific laws, budget restrictions, available materials, sustainability, ergonomics, and ethical issues.

Progress in science and engineering goes hand in hand, science advances often depend on tools developed by engineers and reciprocally scientific knowledge guides and permeates engineering designs. Nowadays, it is not unusual to find engineers working with medical doctors and researchers in the design of artifacts that aim to improve human health.

Engineering design is a purposeful activity bound by specifications and constraints and an eminently collaborative enterprise. It involves an interactive process in which the design is tested and modified and it often offers several solutions to a particular problem (NRC, 2009). In general, the design and the construction of artifacts are tasks that require an expertise in science of materials, control, ergonomics and biomedicine. And there is set of standards that any medical artifact needs to fulfill in order to be used within the medical community. However, as Béguin (2003) pointed out the design of artifacts does not finish when the tool or object fulfills material and technical requirements; it should include how users transform the artifact into an instrument. Then, how does the medical community develop the needed expertise to use those artifacts efficiently in medical practice? This question becomes important to identify and delve into a research area that examines ways in which medical doctors transform

and artifact (physical device) into an instrument to solve problems. Then, what information and actions are important to characterize the process to transform an artifact into an instrument? Hadolt, Hörbst & Müller- Rockstroh (2012) cited a four-phase model (Hahn, 2004) that includes appropriation, objectification, incorporation, and conversion activities. The authors stress that the incorporation of artifacts into practices depends on social, cultural, and economic conditions.

It is important to analyze the extent to which medical doctors construct cognitive schemata that explain what we called their appropriation process of an artifact. In this process, it is recognized that tools shape and are shaped by the users' actions. Trouche (2004) pointed out the importance of considering the instrument as an extension of the body that becomes an organ formed by the artifact itself and by a psychological part that helps the user to mobilize the artifact to carry out activities and solve problems. Béguin (2003) emphasizes the difference between an artifact and an instrument or a problem- solving tool. The latter is made up by the artifact and the user' social and private cognitive schemata. The artifact characteristics that include ergonomics and constraints and the cognitive schemata developed by the user during the activities are important for the transformation of the artifact into a problem-solving tool or instrument to solve problems.

Artigue (2002) pointed out that users need to get involved in an appropriation process to transform an artifact or physical device into an instrument for specific use. This process leads users to gradually construct personal schemata or to appropriate pre-existing social schemata to appreciate its potentialities and use them in problem solving situations. Thus, relations between users and objects are shaped by ways in which a community of practice acts in problem solving environments. Trouche (2004) also mentioned that the development of the user's psychological component could be categorized in terms of three related functions: A *pragmatic* function where the subject achieves a particular goal, a *heuristic* func-

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