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Improving Assistive Technology in Practice: Contributions from Interdisciplinary Research and Development and Collaboration

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Abstract

This paper describes a collaborative strategy shared by a rehabilitation center and a public university with a goal to improve the knowledge on assistive technology and rehabilitation research and development in Brazil. Here, we focus on the contributions, challenges and investigations performed so far.

Keywords: assistive technologies; design; rehabilitation; interdisciplinary.

Introduction

Data from the World Health Organization (WHO, 2017) indicates that more than 1 billion people in the world experience disability. In Brazil, approximately 24% of the population has some type of disability (IBGE, 2010). Many people with disabilities do not have the necessary support in terms of health care, rehabilitation service, education, and employment opportunities, thus preventing them from actively participating in society (WHO, 2011). This is even more problematic in countries with a low gross domestic product (GDP) (Borg and Larsson, 2011), and scientific research and innovation on Assistive Technologies (AT) is therefore necessary to, ultimately, enhance users' independence, social participation, and quality of life.

In Brazil, AT is defined as an area of knowledge with an interdisciplinary character. This encompasses products, resources, methodologies, strategies, practices, and services that aim to promote the functionality related to the activity and participation of people with disabilities, incapacity, or reduced mobility. The goal is autonomy, independence, quality of life, and social inclusion (CAT, SEDH, 2007).

The International Classification of Functioning, Disability, and Health (ICF) developed by the World Health Organization (WHO, 2001) substitutes the negative focus of disability and incapacity for a more positive perspective, considering the activities that a person who presents changes of function and/or body structure can perform, as well as his/her social participation. In this context, the AT design and provision must consider not only the users' disability and needs, but also his/her potentialities and the activities and context in which the resource will be used.

Despite the growing demand for assistive technologies, Brazil still faces many challenges in terms of AT design and provision in a biopsychosocial model, which requires the focus on the user as the center of the AT actions, the integrated involvement of the professionals of different areas of knowledge, and the evaluation of such practices (CAT, CORDE, 2009). This scenario highlights the need to improve scientific evidence supporting technological innovation in this field, to provide products that best meet the users' needs and expectations.

AT prescription and provision require an interdisciplinary approach to effectively match the users' characteristics, meet the users' needs and their preferences. In Brazil, many people with disabilities depend on the public health system for access to assistive devices. Such products are provisioned by places that provide AT related services, that is, every service that directly supports a person with disability in the selection, acquisition, or use of a AT device (CAT, CORDE, 2009). Despite some recent advances in the public system for AT provisioning, still some users do not have access to a specialized AT prescription and provision system, which ultimately prevent them from having access to the device best suited to their characteristics, needs, and preferences (Medola, Elui and Santana., 2010). As a result, users' acceptance and

satisfaction with the device may be affected, which may lead to abandonment of the equipment (Phillips and Zhao, 1993). Users with disabilities are often quite conscious about how they and their assistive technologies are being perceived by others (Sandnes, 2016).

To prevent the abandonment of the equipment, it is important that the user participates in the AT process and that his/her characteristics, potentialities, and preferences are considered.

Many times, the resource used in rehabilitation therapies can turn into a more permanent assistive resource. This happens when a tool being trialed in therapy provides a desired outcome. At that point the rehabilitation team, along with the user, decide to acquire the resource so it can be used in daily life. From the moment the resource is used in the daily routine to benefit the users' functionality, it becomes an AT resource. Therefore, for the optimization of the users' functionality, it is important that the reha-bilitation and the resource complement each other.

Brazilian public universities are recognized institutions of high quality education and research. Complementarily, public universities are also committed to benefit the community by making the produced knowledge available, supporting evidence-based decisions, and addressing social issues. The actions of the universities are defined in three fundamental pillars: education, research, and outreach. Outreach refers to the actions performed outside the campus, that is, a variety of approaches developed in col-laboration – and benefit – with the community. This type of action provides a learning experience for students, professors, and researchers while having the opportunity to make their knowledge useful to solve/minimize social problems and increase general well-being.

This article reports on the collaboration between a university and a rehabilitation center, based on a strategy of exploring the contributions of the research on product design and ergonomics for the area of the AT and rehabilitation technology and how it may benefit the end users.

Target Audience and Relevance

This article may be of special interest for universities, research institutions, and rehabilitation centers from developing countries, as well as health professionals, researchers, designers, and engineers that work with AT design, prescription, and provision. Universities, research institutes, and rehabilitation centers may also benefit from this article as it describes a blueprint for collaborative research and development in AT.

Interdisciplinary Solutions

From a design perspective, daily life products can be analyzed under three different, yet complementary, aspects: practical, aesthetical, and symbolical (Lobach, 2001). The practical aspects are directly related to the performance and efficiency with the use of a product in a given

a task. The aesthetics and symbolic functions of a product refer to the appearance and significance, respectively. In AT products, the practical aspects are emphasized to provide the users the best condition to perform their daily life activities more effectively. However, aesthetics and symbolic aspects are equally relevant in AT devices, as they may influence users' acceptance and satisfaction.

In contrast to general products, many devices designed for people with disabilities have characteristics that may be associated with symbolic loads such as stigma (Gaffney, 2010). The wheelchair, one of the most representative AT products, has important symbolic representations, considering that the wheelchair itself is the symbol that represent disability and accessibility (Lenney and Sercombe, 2002). This symbolic load related to AT devices may be associated with problems of user's acceptance and satisfaction with the product. Therefore, it is important to investigate how the design of AT products can be optimized in its practical, aesthetical, and symbolical aspects. This knowledge can support innovative proposals on the design of AT devices focusing on empowering users' functionality, independence, and satisfaction.

To carry out research exploring the different perspectives of the interface between assistive device and the user, the investigation must be built up based on an interdisciplinary approach. Professionals from the area of Rehabilitation have a unique view on the users' characteristics, needs, functionality, and performance during functional tasks, which can mainly contribute to the analysis of the practical aspects of the product, while designers and engineers have skills to address the user-device interface from the perspective of the product, that is, investigating factors such as materials, shape, size, surface, constructive issues, colors (Sandnes, 2016), text (Berget, Mulvey and Sandnes, 2016), readability (Eika, 2016), among others. These features determine what the product says about the user, which may influence users' acceptance and satisfaction.

Outcomes and Benefits

The current manuscript presents an initiative of interdisciplinary approach in research and development on AT and rehabilitation. Although the practical contributions might be local, the idea on how to implement the knowledge gained from research carried out by universities in the rehabilitation process may serve as a simple and flexible model to improve the quality of the AT system. In the context of Brazil, we understand that public universities are high-skilled centers able to carry out research that can be directly applied and implemented by rehabilitation and AT services.

The collaboration between Sorri Bauru Rehabilitation Center and the Department of Design of the Sao Paulo State University (UNESP-Bauru) grew up from the need to improve the research and development in AT by means of an interdisciplinary approach. Sorri Bauru is a specialized

rehabilitation center accredited by the Ministry of Health, with competences on physical, intellectual, and auditory disabilities, as well as having an orthopedic workshop. Sorri Bauru was founded forty-one years ago and by 2017 it had handled more than 171,000 issues for 4,340 users, with 2,774 AT devices provided (Sorri Bauru, 2017).

There are numerous benefits from this collaboration: UNESP researchers and students have gained much and learned from the experience together with patients and the rehabilitation team. Sorri Bauru has been presented with new possibilities of addressing AT issues from a scientific perspective in the areas of design, ergonomics, and rapid prototyping. Since 2014, the collaboration between Sorri Bauru and UNESP has resulted in studies addressing the interface between users and their assistive technologies. In particular, the studies have addressed the significance of manual wheelchairs for their users (Lanutti, Medola, Goncalves, da Silva, Nicholl, and Paschoarelli, 2015), functional difficulties in wheelchair mobility (Silva, Boiani, Silva, Paschoarelli, and Medola, 2016), and problems experienced in computer usage by subjects with tetraplegia (Medola, Lanutti, Bentim, Sardella, Franchinni, and Paschoarelli, 2015). Manual wheelchair mobility is another topic that has been addressed as part of the collaboration between Sorri Bauru and UNESP, focusing on how changes in wheelchair design and configuration influences users' actions during manual wheelchair propulsion. Additionally, innovation in the design of walkers was reported (Nicholl et al., 2015), which is currently under evaluation to verify possible benefits in gait with the use of a walker with posterior support. These walkers were designed by Sorri Bauru as an alternative to conventional anterior-support walkers and aim to improve postural alignment and balance development in ambulation (See Figure 1).



Figure 1. SORRI Walker. Source: Sorri Bauru collection.

An important characteristic of the studies in collaboration with SORRI is that we have explored not only the practical aspects of product usage, but also the aesthetical and symbolic aspects of the design of AT devices. This is important considering that, many times, equipment

abandonment is related to problems with users' acceptance and satisfaction with the device. Ultimately, the research on the interface between user and assistive device, that is, how the design features of AT devices influence usability and meet the users' needs, preferences, and expectations, may provide additional knowledge and scientific evidence supporting decisions for the innovative design of assistive technologies.

Finally, an example of combining education, research, and development of assistive and rehabilitation technology is the platform of the course "Inclusive Design" of the bachelor program in design at UNESP-Bauru. During this semester course, the students developed projects based on practical demands raised by the Sorri Bauru rehabilitation team. After a theoretical introduction and the contact and lectures with a member of the Sorri Bauru rehabilitation team, the students were able to identify needs and potentialities of projects that can be developed and implemented in the rehabilitation practice. This resulted in objects to be used by the rehabilitation team during the therapy with patients, such as a tactile memory game, a domino game, an inclusive children's book, a tangram puzzle, and 3D pieces for interactive storytelling, all of them designed with inclusivity concepts (See Figures 2 and 3). Besides the actual rehabilitation benefits, such experience is also very positive for the students from UNESP as they develop empathy and learn to design for inclusion.



Figure 2: Inclusive tools designed by UNESP students in collaboration with SORRI. Source: the authors.

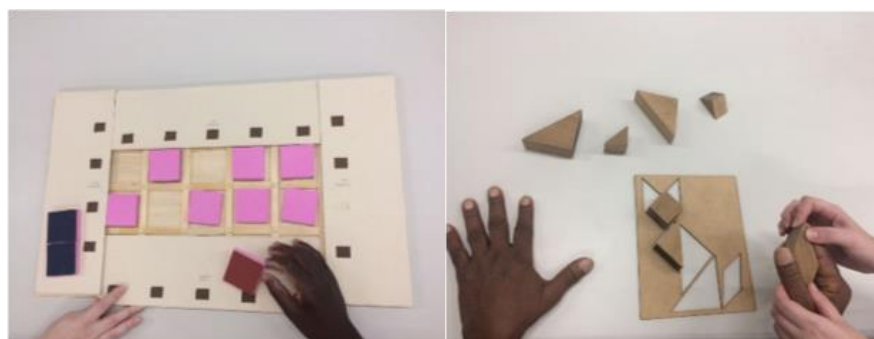


Figure 3: Inclusive tools designed by UNESP students used in real context of rehabilitation at SORRI BAURU. Source: SORRI collection.

Discussion/Conclusion

Optimizing AT design, prescription, and provision requires improving scientific knowledge to support decisions based on evidence and innovation. A collaborative interdisciplinary initiative integrating knowledge from health, social sciences, and product design can provide a wide scope that covers the many aspects that characterize the interface between user and assistive technologies. As the interaction between user and assistive device is not limited to practical aspects, but also semantic aspects, interdisciplinary research is necessary to understand the interface from a more complete perspective. This ultimately can contribute to the design of assistive devices that meet not only users' characteristics and functional needs, but also acceptance and satisfaction. Here, we reported on some integrated initiatives in research, product development, and education combining the areas of rehabilitation and product design, as a result of a collaboration between a public university and a rehabilitation center. Developing technological solutions valuing the users' knowledge about his/her needs, expectations, and the context that such technology is going to be applied, favors the user to be engaged and truly makes use of a technology that meets his/her expectations (CAT, CORDE, 2009).

It is also important to expand the understanding about AT beyond just equipment and products that help in functionality, but also services, strategies, practices and, above all, the application of the knowledge aimed to promote the independence and social participation of people with disabilities (CAT, CORDE, 2009).

There are still many questions that need to be explored to have a more complete understanding of the role of technology for people with disabilities. Some of these questions can be addressed by means of our university and rehabilitation center collaboration, and are listed below:

- To what extent are people with disabilities limited in social participation?
- To what extent can AT improve users' independence and social participation?
- How can we ensure that people with disabilities have access to the best product for their specific needs and characteristics? What are the consequences of using an AT device that is not the most appropriate for the user?
- What more do we need to know about the AT users' needs, characteristics, expectations, their interaction with the environment, and participation in society?
- Is there enough evidence available to improve the design, prescription, and provision of AT? How is evidence-based knowledge implemented in the AT system?

Having access to such, and more, information would benefit the entire AT community from a wider perspective, favoring designers, engineers, rehabilitation and health professionals, policy makers, companies, and stakeholders.

While the information presented here is a result of a collaboration between a public university and a rehabilitation center, the practical implications may have limited reach. To ensure this knowledge gets transmitted to the field in a wider and more effective way, it is important that AT companies participate and get integrated in research and development initiatives.

Declarations

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