USAMED Learning Object - Usability in Digital Educational Materials for Seniors

Planning, Development and Implementation

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Abstract— **The aim of this paper is to present the planning, development and implementation of USAMED learning object - Usability in Digital Educational Materials for Seniors. The object was developed in 2015 and has the purpose of discussing how to develop materials for mobile devices following usability guidelines that consider the needs of older people. The USAMED was planned and developed from the methodology suggested by Amante and Morgado (2001): a) Project Design; b) Planning; c) Implementation; d) Evaluation. During the development process, we observed the lack of information about the importance of the design of pre-planning to meet the need for responsiveness of the material and the pedagogical suitability to entice users to use it in practice. It was observed that the USAMED object may help different professionals in the planning and development of Digital Educational Materials (DEM) for seniors who use mobile devices on a day-to-day basis.**

Keywords—learning object; elderly; mobile devices; usability.

I. Introduction

Every year, digital technologies have been increasingly becoming an integral part of people's daily lives. In recent years, the number of mobile devices being marketed and acquired by the public (such as smartphones and tablets) has significantly increased. A research by the Getúlio Vargas Foundation University [1] of São Paulo indicated that, in 2015, there were 306 million devices connected to the Internet, 154 million of which were smartphones. At the same time, the number of elderly people has increased. According to the data of Brazilian's Institute of Geography and Statistics (IBGE), life expectancy in 2015 was 75.2 years, highlighting that Brazil's population life expectancy has been increasing [1].

Therefore, like younger people, the elderly are also acquiring or receiving mobile devices, especially smartphones, from their family members. However, older people have difficulty in handling such devices, both because of a lack of experience as well as other difficulties that such technologies present to the elderly, like the need for sensibility in the fingers to handle the touch screens, the small size of the screens, and so on. These obstacles can develop frustration and anguish for the elderly public, becoming necessary to develop actions that include them and enable them to use the technologies, in addition to theoretical discussions on possible strategies that can aid the elderly with the use of these resources or even the development of materials by different professionals for these public.

Based on this scenario, many questions arise, specially in the educational field: how to enable digital inclusion for the use of mobile devices by the elderly?; Which pedagogical strategies can be adopted for the use of mobile devices by the elderly?; Are there adequate materials to enable the elderly to learn how to use smartphones and/or tablet devices?; How to develop materials that may suit the older public in the use of mobile devices?

Starting with these questions, it is necessry to think more about possible guidelines for the development of digital educational materials (DEMs) that may be suitable for the elderly regarding the use of mobile devices. DEMs are educational materials composed of digital resources in their elaboration [3]. This type of material is used with the purpose of approaching with the use of technologies, being an advance of the analog material. Some examples of DEMs are websites, web pages and learning objects (LO). Therefore, in this article, the term Learning Object (LO) will be used as a synonym of Digital Educational Material (DEM). The usability of DEMs plays an important role, as it can influence its increasing use by students, instigating and motivating them to become an active participant. Therefore, the development of LOs may be an option to present educational content in a more dynamic and interactive way.

Therefore, this article aims to introduce the planning, development and implementation of the USAMED Learning Object - Usability in Digital Educational Materials for Seniors. The acronym for the learning object was chosen from its full name in Portuguese. The purpose of this object was to present and discuss, with/for different professionals, how to appropriately develop educational materials for the older public, proposing materials, explanatory texts, evaluation forms and activities in the form of challenges. This object was developed in the first semester of 2015 in order to help teachers and professionals from different areas

plan and implement educational materials for mobile devices for the elderlypublic.

Next, we will discuss the use of mobile devices by the elderly, followed by the concepts of digital educational materials. After that, the methodology adopted for the development of this material will be presented, culminating with the presentation and implementation of the USAMED´s learning object.

II.   EDUCATION, AGING AND MOBILE DEVICES

The constant changes in the world, especially concerning mobile technologies, impact different sectors of society. Some portions of the population are being digitally excluded because of lack of information or lack of training in the use of mobile devices. Thus, education comes as a way to support the elderly in their search for staying current in different areas, such as technology.

According to the survey "TIC Domiciles and Users 2013", 61% of Brazilians with ages 60 or over have a mobile phone device, referring to a sample of 168.3 million people. In 2006, this rate was 18.9%. The main reasons for the increase were the portability, lightness, discretion and size of mobile devices.

As a consequence, questions arise regarding the needs that come with age, especially in the use of mobile technologies: what educational practices to adopt to include the elderly in the use of digital technologies? How to develop educational materials for mobile devices that addresses the needs of the elderly? Therefore, usability issues have been the subject of new studies that also address the role of usability in the development of digital educational materials for mobile devices.

A.   Education and Aging

According to IBGE data [2], the elderly population has been growing significantly in Brazil. From 2000 to 2016, the growth went from 2.56%, going to 5.61% and to 8.17%. IBGE projects [2] that the senior public will be 13.44% of the country's population by 2030.

The elderly population's growth can be attributed to several factors, such as improvement in Brazilians' quality of life, development of medicines and diseases treatments, as well as the reduction in child mortality and fertility rates [4].

Osório [4] affirms that social and cultural aspects are strongly linked to the process of aging, therefore, this is not restricted only to psychological and physiological factors. Aging "is also seen as an event of changes in attitudes and mentality, resulting from the relationships established between age groups and their living conditions" [4].

A portion of the senior population seeks to adapt to the changes that are happening in society, especially in what refers to technological advancements. They seek to stay autonomous and active within their aging process [4]. However, there are still preconceived ideas that link the elderly to concepts like dependence, illness and little capacity, which can result in distancing of this public from other individuals.

According to gerontology researches, having a social role is essential for the elderly to achieve a promising aging. The quality of life of the elderly is strongly related to active aging, regarding the improvement of their physical, social or mental potential. According to Both and Portella [5], a relevant alternative that serves as support to keep the elderly active are educational interventions that take into account the interests of the target public, and may be through permanent education. Thus, it is opportune that these interventions take place in order to encourage the elderly in the search for knowledge of the aging process, considering their social environment, their experiences and their uncertainties, respecting their personal needs.

The importance of a permanent education is referenced by Doll [6] and Osório [4]. According to the authors, there is no specific age group for learning. According to Zimerman [8] and Pasqualotti [9], it is necessary to instigate the reasoning of the elderly, fomenting the reflection, communication and interactions, intending to soften the effects of aging. In this context, digital technologies are presented as an alternative to assist in the process of self-knowledge of the elderly. Some elderly have already discovered digital technologies and seek to explore them. Therefore, it is important to be aware of which characteristics of this technology and its use, or not, are significant to the elderly.

This public interest in learning how to use new technologies can be associated with the fact that the technology presents itself as an alternative to promote the interaction with other generations. That is, they can maintain an active communication with friends and family, staying socially active [7]. At the same time, Machado [10] mentions that education, together with digital technologies, can offer cognitive maintenance's alternatives to the elderly, good use of free time and more social contact.

Another factor considered important today, besides the fast access to the Internet, is portability. These are some of the attributes of a digital technology called mobile device. This technology has increasingly influenced the senior public to take and use these resources in their daily life, as they simplify communication and the search for information. Such topics will be discussed next.

B.   The Elderly and Mobile Devices

There are different types of mobile devices, the most popular ones being tablets and smartphones. The elderly are increasingly seeking to stay current about digital technologies and are motivated to learn how to use more economically accessible mobile technologies. In this sense, teaching about the use of these technologies by this public is important. At the same time, accessible materials for mobile devices are needed, both in interface and in educational aspects.

The main characteristics of mobile devices are the mobility and the possibility of connecting to the Internet, boosting the use of these technologies for different means and environments. Customization also makes mobile devices more attractive as it can be organized to meet each individual's personal needs.

Currently, there is a wide variety of applications for different areas, such as leisure: games, movies, books, travel;

for the job: bank transactions, office tools, information on professions; for health: information on sports, with diet and exercise tips; for education and culture: several study materials, knowledge tests and video lessons, among others. The use of applications for communication purposes is one of the most versatile ones, since there are apps with features that go beyond the voice, it can be for text messages, videos, image, music, text files as well as video conferences.

Therefore, all these characteristics from mobile devices end up increasing its use from different people, including the elderly, especially in regards to communication with family and friends.

However, older people who are interested in using these technologies end up having to adjust to the barriers that arise. After all, technologies are not usually projected considering motor and cognitive difficulties that come up with age [11].

Consequently, different studies have been done regarding usability and accessibility in these devices and in the construction of digital educational materials for them, taking into account the different needs of users.

III. DEMs AND THE ELDERLY

As technology advances, society has been through important transformations in all areas, especially in education. The main catalyst for those changes is the insertion of digital technologies into educational institutions. This makes the development of digital educational materials (DEMs) increasingly evident as a possibility to meet the new demands. In this article, the term Learning Object (LO) will be used as synonym of digital educational material (DEM).

DEM is understood to mean "all educational material that incorporates digital resources in its elaboration" [3]. Therefore, DEMs can be considered an evolution of the analogical material, being used with the intention of approaching technologies.

Some examples of DEMs are learning objects (LO), web pages and, with the advent of mobile devices, applications. Applications, also considered digital educational materials, since they are "[...] programs with few features that run on the operational systems created for these mobile devices, they have proprietary license and closed source license and are only available in repositories known as stores [...]" [12].

Learning objects are materials composed of several medias, such as texts, animations, presentations and videos [13][14]. Some of the benefits that justify the use of LOs in the educational context are flexibility, updating ease, customization, interoperability, increasing the value of knowledge, and ultimately indexing and searching [15].

Learning objects developed by institutions and research groups from different fields are available online through repositories, allowing anyone to access their contents. There are also websites and web pages where users can access their content at any time.

When searching for technologies related information, the elderly end up having contact with materials developed in several courses, such as digital inclusion. This public tends to search for information regarding technological resources, such as computers, notebooks and, increasingly, mobile devices. This way, developers of DEMs need to think over

and analyze possible ways of designing these materials to understand the specifications of new technologies, such as mobile devices, which is increasing in space among users.

According to Machado [10] the first LOs developed for the senior public was only done in 2013. Before that, there were not even LOs aimed to gerontology and education professionals with adequate contents and considering the needs of this public.

When designing a DEM for the elderly, it is important to look at this audience's specific demands, especially regarding mobile devices, as they have different properties than computers. The main differences between them are screen size, touchscreen, and movements, among others. Therefore, it is necessary to analyze these elements and their peculiarities to the development of DEMs [16].

In this perspective, the usability of DEMs aimed at the elderly is essential for the construction, since it facilitates its use. Usability is quoted by some authors as a point that should be considered in the development of digital materials to mobile devices regarding different needs of the public that use them [11]. Nielsen and Budiu [16] pointed out that web usability issues are for mobile devices, but for the latter they are indispensable.

According to the Brazilian Association of Technical Standards ABNT (NBR ISO 9241 - Ergonomic Requirements for Working with Computer Offices) usability is "[...] defined as the capacity that an interactive system offers its user in a given context of operation, for the accomplishment of tasks, in an effective, efficient and pleasant way ".

According to Preece, Rogers and Sharp [17], "usability is usually considered as the factor that ensures that products are easy to use, efficient and enjoyable from the user's perspective." These authors also highlight usability goals for materials, such as having security, both for fear of use issues and for security of technologies; being efficient and effective. The same authors state that the material should be easy to learn how to use, easy to remember and have good utility. They emphasize that it is important to take into account User Experience issues. Therefore, the evaluation of a material usability is essential in its planning, development and improvement.

Therefore, it is important to think which usability indicators would be significant to the development of mobile devices, taking into consideration the target audience, the material purpose and technology type.

The World Wide Web Consortium - W3C [18] highlights some guidelines for mobile websites, such as simple navigation; short URLs; different mobile devices must be taken into account; one must use Web standards in marking, formatting and making content available; avoid using mapped images, frames, nested tables, and pop-ups; do not measure in pixels or absolute units; avoid text entry; label all form controls appropriately; and avoid the use of pop-up windows that cause certain insecurity and confusion in the elderly.

When it comes to mobile devices, these issues need to be reinforced, as they have some different characteristics, such as having less space for writing and reading, since the main

way of entry are practically the human fingers, which requires space for action [16]. The authors also reinforce the importance of avoiding unnecessary information, or, if needed, place it in the background, otherwise it may discourage users.

IV. METHODOLOGY

The development of learning objects requires planning, communication and technical, pedagogical and design knowledge. Tarouco et al. [14] point out that, for the construction of objects, it is necessary to consider "both inherent aspects of learning theories and to combine the knowledge of areas such as ergonomics, systems engineering, besides taking into consideration the potentialities and limitations of the technology involved". Therefore, the complexity required for the development of learning objects is evident, as well as the need for an interdisciplinary team to be involved.

For the development of the learning object USAMED - Usability in Digital Educational Materials for Seniors, a specific methodology presented by Amante and Morgado [19] was adopted. These authors point out that "Designing, planning and developing educational applications requires, however, the passage through a set of phases that together determine the quality of the final product" [19].

The steps suggested by Amante and Morgado [19] are: a) Project Conception: what, for whom and in what way is the object to be developed; b) Planning: put into practice the first phase of what was designed, the so-called storyboard-model of what will be created; c) Implementation: all points planned during project development and planning will be put into practice; d) Evaluation: set of evaluated procedures and validation of the product.

Thus, these steps were the base for developing the USAMED object, as detailed next:

Step 1 - Project Design: The project objective was initially outlined, specifying the final user profile, as well as emerging needs to meet the material objectives. The variables responsiveness, usability and accessibility were considered, as well as the user profile diversity.

Step 2 - Planning: After the initial design of the object, the operating storyboard was made, on which the possible links, modules and technological resources that could be used in the object were listed. Also, wireframes of the screens to adjust the screen layout (location of the elements that will compose the interface) were developed. The navigation was readjusted during the process to suit the needs that arose (for example, use of such object in mobile devices and usability to meet this need), as well as accessibility issues.

Step 3 - Implementation: In this step, the planning and design of the storyboard were put into practice. For that matter, a survey was made on possible metaphors that could be adopted for the interface of the object, considering three areas: mobile devices, seniors and usability. A selection of the materials and contents was also made.

Step 4 - Evaluation: For the accomplishment of this step, it was used the evaluation form of usability developed in a master's dissertation work [20]. After analyzing the object,

we intend to apply it in an extension course that will be offered at the University in 2018, where the improvement of professionals who wish to develop a DEM for mobile devices for the older public is sought.

It should be noted that the object's team, composed of pedagogues, gerontologists and designers, accomplished all stages. For the planning and development process, bi-weekly meetings were held where the individual and collective tasks of the team members were divided.

This methodology was used because it is the recurrent one for the construction of learning objects in Brazil. The team developed a new methodology called ConstruMED [22]. However, this new methodology was developed after the construction of the object and is based on competencies, the focus not being adopted on the Object.

V. RESULTS

The purpose of USAMEDs - Usability in DEMs for Senior is to discuss and deepen usability issues regarding Digital Educational Materials (DEM) for the elderly, focusing primarily on new frameworks to meet the needs of mobile devices. The object is available in the University's repository (http://www.lume.ufrgs.br/), as well as through the website: http://nuted.ufrgs.br/oa/usamed. The USAMED learning object was developed and published in Portuguese language in Brazil. This LO was developed by an interdisciplinary team of the Nucleus of Digital Technology Applied to Education (NUTED), and has as target audience professionals from different areas: teachers, designers, programmers, gerontologists etc. Therefore, the object can be used as a subsidy to create educational materials on mobile devices aimed at the elderly, with four modules available:

1)   DEMs for the elderly: this module deals with the concepts of DEMs, repositories and developed examples specifically for the older public;

2)   Usability in DEMs: discussion on what is usability, its theoretical application in digital educational materials and analysis tests;

3)   Usability recommendation: here, specific usability parameters for the elderly public are pointed out, responsiveness issues (in order to meet the demand of mobile technologies) and application examples;

4)   Online tools: possible digital tools for building DEMs are presented in order to apply usability recommendations to the older audience.

Each module has explanatory texts on the presented subjects, including links to videos, online pages, images, and so on. Support materials built by the team itself in a dynamic way that allows a greater understanding of the issues addressed; Challenges, in the form of activity, that intend to problematize the questions presented during the modules. Some of the texts wording that may be difficult to understand were conceptualized, in order to facilitate the usability and to enable a better understanding of it.

The object also includes, in addition to the modules, a user guide page about the object itself for the user-student, as well as a user guide with possible strategies that the user-

teacher can adopt for the use of the objects in their practices. Credits are also available presenting the developer team (both the pedagogical and design group).

For a better understanding, in the next section, we will analyze and point out the results found in the developed object and two categories: Design and Educational Gerontology.

A.   Design

The user interaction with the interface can directly influence the learning process, and may or may not motivate the user to continue to explore the material [3]. Thus, a design of easy navigation and exploration was adopted in the LO, not relying on depth or specific knowledge on the computer resources for its manipulation.

The object followed the standards of the World Wide Web Consortium (W3C) accessibility [18]. For usability issues we considered the studies of Nilsen and Budiu [16], mainly the 10 heuristics suggested by the author, which are: 1) Visibility of system status; 2) Link between the system interface and the real world; 3) User freedom and control; 4) Consistency and standards; 4) Error prevention; 5) Recognition rather than recall; 6) Flexibility and efficiency of use; 7) Aesthetics and minimalist design; 8) Support for users to recognize, diagnose and recover from errors; 9) Help and documentation.

In this sense, the interface was thought from its users, professionals from different areas who wish to work with the elderly. In view of the target audience and objectives of the object, it was possible to delimit the general requirements of the interface such as the indispensability of working fully on mobile devices. It was also necessary to exercise caution with users who did not have technical knowledge about digital technologies, considering users' needs and mobile devices' uses. Thus, it was determined the use of a grid on the home page and a simple layout of columns on the internal pages. The grid on the page and the simpler layout on the inside pages make it easier to transition between LO on your mobile device and your computer (Figure 1).
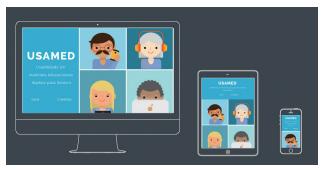

Figure 1.   USAMED Responsibility.

After the initial research in which the initial requirements of the users and the objectives of the object were exposed, we set out to generate alternatives that could meet these demands. For such, the brainstorming method was applied first, where the objective was the definition of the main problems and the creation of initial concepts at the beginning

of a project. After that, during meetings with the pedagogical team, a sketch of the initial layout concepts based on the content already created was designed. From these sketches, associations of the main layout schemes were created (Figure 2).
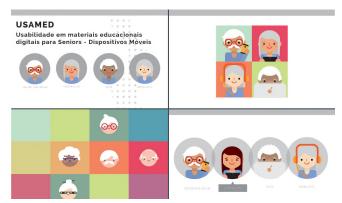

Figure 2.   Initial Home Sketches.

Since the object was to aid users who would teach seniors, it was decided to use a color palette that was pleasing to this public. Several texts refer to the use of pastel colors when mentioning the older population, to pass a tranquility and serenity notion. For this reason, less saturated colors and pastels were used in the first schemes. In the next interactions of the color palette, the spectrum has decreased, tending to more monochromatic or analogous situations to exalt the concept of set to all the modules. For the implementation it was decided to use a monochromatic set of blues, tending to the less saturated ones. According to Heller [21] in her book Psychology of Color, blue is the favorite color of 46% of men and 44% of women, being also acknowledged as the color of sympathy, harmony and trust. Pink has been defined to serve as an accent on buttons to add interest and force to the layout.

Because LO is composed mostly of texts, typography serves as an important tool for user comfort. For this project, the use of Roboto font in the text body and Raleway for titles was chosen. Google, developed especially for use on the web and open source nature, meaning that anyone can download, modify and use it for personal or commercial projects, authors both fonts. The fonts are offered in different weights and are available with Portuguese language accents. Font size, line spacing, and kerning were taken into account to ensure readability across devices.

From the definition of the elements previously mentioned, the wireframes of the LO pages were elaborated. The goal of this step is to design a page starting from the structural level. Typically, this method is used at the beginning of projects to establish the basic structure of a page before adding visual design and content. Afterwards, a prototype is produced, where colors and actual content are added before implementation begins. Then, the prototype implementation of the learning object was coded using HTML, CSS and Javascript/Jquery (Figure 3).

Figure 3.   USAMED interface.

B.   Educational-Gerontology

The content of the object was developed to attend to the needs of the elderly who will access educational materials on mobile devices. To meet this proposal, the pedagogical team, composed of undergraduates, graduates and postgraduates in education and/or gerontology, developed contents that can be accessed in the order in which it was presented or randomly, according to the user's needs.

The object also has, as reference, results of studies based on the needs of the elderly in the use of mobile technologies, as well as from experiences in digital inclusion courses [6][7]. In addition to these aspects, the physiological, psychological and cognitive changes of the elderly and their influence on the teaching and learning process were also considered in the construction of the learning object [5].

Explanatory texts: In order to attend to the needs and adapt to mobile devices, the texts of the modules were made in an objective way and with an informal language, in order to approach the user with the approached thematic. The texts were divided into small blocks so that reading on mobile devices is facilitated, and situations and examples that refer to the elderly public were also quoted. Illustrations were used as a complement to the text, in order to instigate the user to read the available material. The references of authors used in the text were listed below it and not in the body, so that there would not be a distruption in the reading. The pedagogical team developed all texts collectively.

Activities: In total, eight challenges were proposed, two on each module. They are presented as activities on which the user can perform in the learning object itself. This could ensure higher autonomy and interactivity in a playful and contextualizing way in the use of LO or combined with other digital resources. In order to achieve this, challenges were proposed that, besides being able to finish out of the

object, can also, in some cases, be finished by combining them with a virtual learning reality.

Complementary materials: The materials developed for the object had the purpose of helping the users to deepen their knowledge about the addressed topics. They were all developed by the pedagogical team, using different formats, such as explanatory flowcharts, animations, tables, questionnaires, etc. (Figure 4). These materials may serve as a complement to the text of the modules and may be used separately or in conjunction with the proposed challenges in the object.

Figure 4.   USAMED Tools Module Support Material Interface.

Therefore, from the construction of the modules by the pedagogical team and the layout by the designer, the USAMED learning object became available on the Web. This can be used by anyone who has an interest in it, as well as by using in training and training courses.

VI.   FINAL CONSIDERATIONS

The use of mobile devices by the elderly will increase even more in the coming years. Education, as well as other different fields, must be attentive to these changes, discussing and developing materials that can help the older public to handle these technologies. As presented in this article, there is a lot of research being done on usability and mobile devices. However, most of it is focused on the presentation of technologies (screen, layout of applications etc.), with digital education materials being deprived, especially the learning objects. Education has not yet begun a more in-depth reflection on issues concerning the importance and influence of design (usability and accessibility) in DEMS for mobile devices, especially for the elderly public.

Thus, this article's objective was to present the stages of development and implementation of the USAMED learning object that addresses this theme. It is observed that the USAMED object can help different professionals from

different fields, such as health, education, technology, etc. in the planning and development of DEMs for seniors who use smartphones and/or tablets on a daily basis.

During the development process, it was possible to observe the lack of information on the importance of design pre-planning to attend to the need for material responsiveness, as well as pedagogical suitability to instigate users to use the object in their practices.

One of the main contributions of the USAMED object is the updated materials on the subject, as well as examples and forms that present usability guidelines that users can use to evaluate their materials constructed or under construction. In this perspective, more research and more in-depth discussions on the subject should take place in order to enable the planning and implementation of new educational materials on mobile devices for the elderly.

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