Reading Support: development of a prototype for aiding people with low vision – preliminary tests

EXPERIENCE REPORT

Suporte de Leitura: desenvolvimento de um protótipo para auxílio a pessoas com baixa visão – testes preliminares

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ABSTRACT: Low vision is an intermediate condition between normal vision and blindness, secondary to an irreversible impairment of the visual system, causing losses in performance and achievement of certain activities. To minimize these problems, it is recommended the use of Assistive Technology resources. The objective of this paper was to report the development of a Reading Support (RS) prototype and describe the results of the preliminary tests. For the methodological aspect, a survey of different assistive devices available for individuals with low vision was conducted and it was decided to build a Reading Support prototype that considers the ergonomic needs of the user, with low cost, easy access and within the concept of universal design. The results were: reading support comprised of a support base, a reclining top facilitating the portability and rails to drive the lens holder. It was concluded that the equipment developed has positive aspects such as better maintenance of posture, good usability, considerable portability and good ergonomic viability, but it will be essential to continue the equipment testing with the target population to ensure the actual usability and applicability of the device.

KEYWORDS: Educational technology; Low vision; Equipment design; Low cost technology.

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RESUMO: A baixa visão é uma condição intermediária entre a visão normal e a cegueira, secundária a um acometimento irreversível do sistema visual, acarretando prejuízos no desempenho e na realização de determinadas atividades. Para minimizar esses problemas, é recomendada a utilização dos recursos de Tecnologia Assistiva. O objetivo deste trabalho foi fazer um relato do desenvolvimento de um protótipo de Suporte de Leitura (SL) e descrever os resultados dos testes preliminares. Quanto ao aspecto metodológico, foi feito um levantamento dos diferentes dispositivos de auxílio para indivíduos com baixa visão disponíveis no mercado e decidiu-se pela construção de um protótipo do Suporte de Leitura que contemplasse as necessidades ergonômicas do usuário, com baixo custo, de fácil acesso e dentro do conceito de design universal. Os resultados obtidos foram: suporte de leitura composto por uma base de sustentação, um tampo reclinável facilitando a portabilidade e trilhos para movimentação do suporte da lente. Concluiu-se que

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o equipamento desenvolvido possui aspectos positivos como melhor manutenção da postura, boa usabilidade, portabilidade considerável e boa viabilidade ergonômica, contudo será fundamental dar continuidade aos testes do equipamento com a população-alvo para garantir a usabilidade e aplicabilidade reais do dispositivo.

DESCRITORES: Tecnologia educacional; Baixa visão; Desenho de equipamento; Tecnologia de baixo custo.

INTRODUCTION

The vision is one of the senses that has an important role in promoting communication, performance of the actions and interaction of the individual with the world[1]. According to data from the World Health Organization[2], it is estimated that there are 285 million visually impaired people worldwide, with 39 million blind people (14%) and 246 million people with low vision (86%). According to data from the Demographic Census (IBGE)[3], the most common type of deficiency on the Brazilian population is visual impairment, which affects approximately 35.8 million people, being declared by 18.8% of the population, of which 506 million are blind, 6 million have great visual difficulty and other 29 million have "some difficulty" to see. The estimate of the prevalence of blindness in Brazil suffers variations according to the different socioeconomic levels of the country: 0.25% at sites similar to developed countries and 0.75% in economically poorer areas[4].

Low vision or subnormal vision is an intermediate condition between normal vision and blindness, secondary to an irreversible involvement of the visual system, compromising visual functions even with the use of optical correction, leading to harms in performance and accomplishment of certain activities[5]. Low vision can occur by trauma, disease or imperfections in the organ or in the visual system, and the causes can be classified as congenital or acquired. The congenital occur at birth, and many are of genetic origin, such as: central chorioretinitis; congenital cataracts; congenital glaucoma; retinopathy of prematurity, retina degenerative diseases, retinal dystrophies. Those acquired occur by trauma, alcoholism, drugs in general, radiation, and infections (syphilis, rubella, toxoplasmosis), or derived from other diseases such as retinopathy; choroiditis; glaucoma; senile macular degeneration[6]. One of the main traits of these manifestations is the diversity of visual problems that they can generate. People with low vision may have low visual acuity, difficulty to see close and/or far, reduced visual field, changes of contrast sensitivity, change in the vision of colors and in the adaptation to brightness[7,8,9]. These involvements feature serious repercussions on the life of the individual, in any age group, causing limitations in daily activities, such as: to identify colors and pieces of clothing, to check the clock, to identify phone calls, to cook, to have independent mobility, to read, to work, and to write, greatly affecting their occupational performance and quality of life[10].

Low vision also has an impact on education, constituting an important cause of limitation in school age, in view of the teaching-learning process, compromising besides writing and reading, social interaction and, consequently, scholar inclusion[11]. Children with low vision, since they have some limitations regarding the possibilities of locomotion and objects exploration, are often considered unable to perform certain activities, to participate, to decide for themselves, and to contribute in group activities and free games. Their capabilities and capacities are understimated, thus interfering in the participation and integration with other classmates and teachers, hindering scholar inclusion[12].

To minimize these problems and to improve learning conditions, the visual performance and overall efficiency of school-age children with low vision, the use of resources of Assistive Technology (AT) is recommended[13]. According to Gasparetto[14], assistive technology is the area of knowledge, of interdisciplinary quality, that comprises products, resources, methodologies, strategies, practices and services that aim to promote functionality related to activity and participation of people with deficiencies, disabilities or reduced mobility, aiming at their autonomy, independence, quality of life and social inclusion.

Currently, the market offers specific AT resources that enhance the visual functioning of individuals in their daily activities, classified as optical aid (magnifying glasses, telescopic systems, read rules and special glasses), non-optical aid (luminaires, book support and reading boards), electronic aids (electronic magnifier, colored color detector, sound calculator) and computer aids (extended keyboard, tactile communication: Braille and ink, magnified printing)[15,16]. In parallel to this offering of resources, there is a growing demand for devices that enhance the visual functioning of the visually impaired associated with ergonomic aspects, since they constitute

an increasingly population of readers, who are demanding, active and numerous nowadays, comprising from young people to older adults[17]. However, a lack of investments and studies in this area can de noticed, as well as high cost of equipments, optical or not, available on the market nowadays, problems related to ergonomic aspect of the device, which often requires the maintenance of inadequate postures by the user in performing the tasks, resulting in muscle fatigue; and the difficulty to write when using manual or support magnifying glasses[6]. It can be noted, therefore, the need to develop new assistive technology strategies and equipments that advance in the accomplishment regarding ergonomic, economic and accessibility issues.

In this context, this study aims to describe the development of the Reading Support (RS) prototype and the results of the preliminary tests.

METHODOLOGY

The assistive technology device (RS) was development by PARAMEC, a multidisciplinary working group composed of professors and undergraduate students from the Federal University of Minas Gerais (UFMG), whose mission is to design low-cost solutions that meet the demands of people with disabilities who have difficulties to perform their daily activities.

The stages of the project are presented in Figure 1.

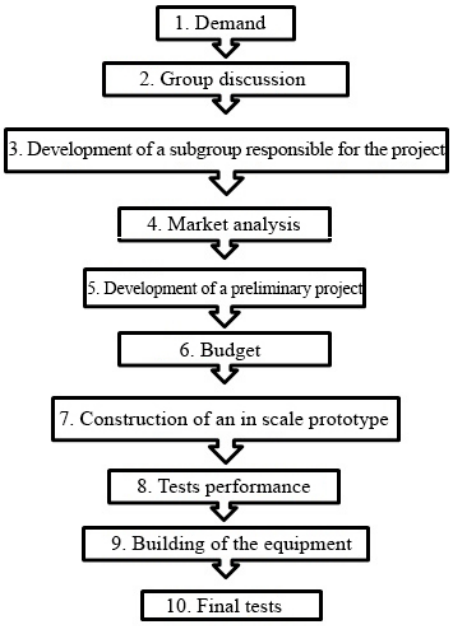

Figure 1 – Development stages of the project

The definition of the construction of a low vision equipment came from a request from an Elementary School to PARAMEC. From this demand, the group visited the school to know their physical, human and organizational reality, and to detect the specificity of the DTA. From the *in loco* observation, the group defined the type of DTA (RS) to be held, as well as the subgroup responsible for its development.

A bibliographic survey about DTAs for low vision was carried out, specifically to enhance reading, as well as a survey of market and resellers that commercialize these devices to subsidize their aesthetic and functional evaluation. From the bibliographical review and market information, a draft of the proposed DTA (RS) was elaborated, as well as a survey of the appropriate material to its construction and budget.

In possession of the materials and construction projects, the PARAMEC group has established a partnership with the UFMG Technical School (Coltec) for the manufacture of the first prototype of the support. Using Coltec's infrastructure, the construction steps were carried out, involving cutting, welding and final assembly of the equipment. The 3D CAD Design SolidWorks software was used for the design of the parts of the project and the technical drawing. The prototype was produced in scale and subjected to preliminary tests, such as top inclination suitable for a correct posture, mechanical functionalities, and positioning of the lens and their movement.

Weekly meetings were schedule by the PARAMEC group, in which adaptations, improvements and new approaches were proposed to solve the problems that appeared during the development of the prototype, in order to improve their conditions of use, and to reduce manufacturing costs, as well as the costs of the materials used. After the production of the prototype, the equipment was used by team members to assess the proper inclination for the reading material, security, and the RS usability.

RESULTS

The Reading Support (RS) was developed in order to facilitate the access to routine readings and the learning of students in the school environment, providing greater inclusion and better educational achievement. It was developed to meet the needs of students with low vision, comprising the majority of the Brazilian population, within the concept of a universal design, with the possibility to be employed in various institutions, with free and low-cost access.

From the literature review and market analysis, a survey of some ergonomic and mechanical aspects that

could be improved in the equipment currently available on the market was performed. This analysis showed two reading support equipment that served as the basis for this study. The first was the Reading Board made of PVC (polyvinyl chloride) and profiles of aluminum. It has magnifier lens and an attached bag for prototype storage. "The board presents, on its back, a support dovetail location to allow an inclination of 45°, if the user wishes, and an elevation at the bottom to support the reading and/or writing material, with the preestablished maximum thickness limit in 4 cm of spine"[6]. The second device was the reading board produced by Bonavision, a scientific company of the USP Innovative Technological Businesses and Enterprises Center (Cietec) that develops innovative equipment for image magnification. This equipment already has a consolidated national market. It has a magnifying glass of 22 positive degrees (dioptres), 5 cm of diameter, and 6x increase, with individualized focus adjustment. Attached to the board, the magnifier lens horizontally slides on rails to accompany the line of the text to be read. The inclined position of the board allows the user to look through the magnifier lens without tilting the neck too much[18].

The presented reading boards can be found on the market at a price that is inaccessible to users of low socioeconomic condition. Both have reduced inclination degrees, making difficult to maintain a proper posture while reading[19]. Considering these aspects, the preliminary project of the reading equipment (RS) sought to meet the following aspects: low cost, better posture condition for reading, weight and strength, portability, usability, adaptable to any environment, good functioning conditions in the area and the needs of the user.

The project resulted in the production of three prototypes, according to the diverse needs of adaptation. The 1.3 version of the RS is presented in Figure 2.

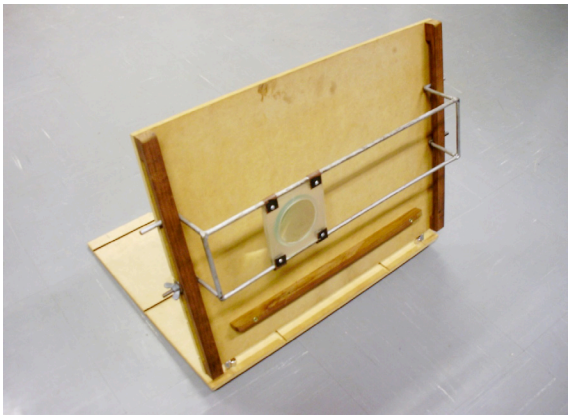

Figure 2 – RS 1.3 version

The RS is composed of a support base, a reclining top, and rails to move the lens support. The dimensions were adopted considering the length and the width of the reading materials used by the user, as notebooks, books and magazines.

The inclination of the device was obtained through a stem supported between the support top and base. On the back of the top were made three extrusions that provide the inclinations of 80º, 65º and 51º of the top in relation to the base of the support.

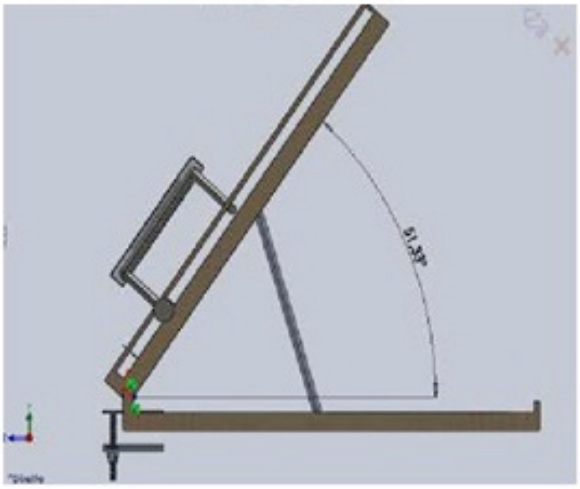

Figure 3 – Side view of the support with 51º inclination.

The material used for its construction (base) was Medium Density Fiberboard (MDF) for its facility of machining, weight, market cost, and dimensional stability due to moisture, which makes cleaning easier.

Concerning ergonomic issues, the preliminary tests carried out by the research team suggest the following advantages: the three inclinations favored the maintenance of a more adequate posture of the user (Figure 4). In addition, the size of the RS allowed the use of books of different brochures, including children's books, which are generally of larger sizes; the lens can be moved over the top in vertically and horizontally, and may fix the vertical direction, which prevents the line of reading from being harmed by adverse factors; the top can be fully reclined, facilitating portability.

These preliminary tests indicated very positive aspects of the device, such as better maintenance of posture, good usability, considerable and ergonomically feasible portability. However, new laboratory tests are required to assess the lighting attachment, development of

a universal dovetail for magnifier lens and a better study about the material. To ensure usability and applicability of this device, it should be tested by the target population, future steps of the project.

Figure 4 – Reading support in use

CONCLUSION

The making of the RS, having satisfactory results regarding the proposed objectives, was developed through reducing cost, aiming at a product that reaches the market without neglecting the user's safety and comfort. As the research developed, it showed viable use manners, emphasizing the importance of developing an equipment that has aesthetic qualities that may contribute to improve the acceptance state of the product by means of computational design tools and materials tests. The process of observation of the daily school life, in addition to maintaining a constant dialogue with the community and an interdisciplinary group, enabled the production of an object of access to routine reading and learning of students in the school environment, with practicality and comfort to the user. It will be essential to continue RS tests in order to ensure that the equipment meets the requirements proposed by the study.

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