Assistive technologies for people with autism spectrum disorder

Tecnologias assistivas direcionadas às pessoas com transtorno espectro do autista

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1 INTRODUCTION

Assistive Technology is the term used to identify all the craft of resources and services that contribute to providing or expanding functional abilities of people with disorders and consequently promote independent living and inclusion (SARTORETTO and BERSCH, 2022).

According to Son (2009, p. 116) Assistive technology is the best way to neutralize the barriers caused by the disorder and insert these people in social environments for the improvement of the learning process and psychosocial and intellectual development.

In Brazil, the extinct Technical Aids Committee - CAT, established by ORDINANCE No. 142, OF NOVEMBER 16, 2006 (BRASIL, 2006) proposed the following concept for assistive technology: "Assistive Technology is an area of knowledge, of interdisciplinary characteristic, which encompasses products, resources, methodologies, strategies, practices and services that aim to promote functionality, related to the activity and participation of people with disabilities, disabilities or reduced mobility, aiming at their autonomy, independence, quality of life and social inclusion" (ATA VII - Technical Aids Committee (CAT) - National Coordination for the Integration of People with Disabilities (CORDE) - Special Secretariat for Human Rights - Presidency of the Republic apud SARTORETTO and BERSCH, 2022).

According to Sartoretto and Bersch (2022) resources are any and all items, equipment or parts thereof, mass-produced or custom-made products or systems used to increase, maintain or improve the functional capabilities of persons with disabilities.

Bersch (2017) highlights that assistive technologies can be classified into twelve categories:

1) Aids for daily living,
2) Augmentative and Alternative Communication,
3) Computer accessibility resources,
4) Environment control systems,
5) Architectural designs for accessibility,
6) Orthotics and prosthetics,
7) Postural adjustment,
8) Mobility aids,
9) Aids for the blind or partially sighted,
10) Aids for the deaf or hard of hearing,
11) Vehicle adaptations
12) Sport and Leisure.

The category in which the project was developed was "aid for daily living". The target audience was people with autism spectrum disorder. Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by atypical development, behavioral manifestations, deficits in communication and social interaction, patterns of repetitive and stereotyped behaviors, and may present a restricted repertoire of interests and activities (BRASIL, 2021).

For Vieira and Baldin (2017, p.2) people with autism spectrum disorder is defined as a syndrome, characterized by early changes in the development of communication and social interaction.

Oliveira, et.al., (2016) point out that autism spectrum disorder (ASD) has very peculiar characteristics, which can be noticed even in early childhood, which allows better monitoring so that the child can develop and become more independent. However, the delay of the family in diagnosing the autistic child, already in the first years of life, may cause significant losses for his future life. Considering that some behaviors of the autistic spectrum are common and similar to all people, but no autistic is equal to the other and there are three levels of classification regarding severity and needs are distinct (OLIVEIRA, et. al., 2016).

Such characteristics are important to detect the diagnosis of the syndrome that is found in all people who have the disorder to a greater or lesser degree. According to Bandeira (2022) for all legal purposes, autistic people are considered people with disabilities. And this understanding is also valid when talking about the use of assistive technology for their development.

According to the author, assistive technology for autistic people can assist in several fields, such as: It favors the literacy process; stimulates speech; awakens attention and concentration; motivates participation and social integration; provides support for the accomplishment of daily tasks; promotes the understanding of the functioning of the surrounding environment; provides the expression of emotions. Given this scenario, it is considered the hypothesis that assistive technology improves learning, work and life of these people with autism spectrum disorder. In view of the above, the following research question can be formulated: How can the IFSC community (teachers and students) help those with autism spectrum?

As a practical justification for the present work, it is estimated that Brazil, with its 200 million inhabitants, has about 2 million autistic people and once diagnosed autistic, the patient and his family face barriers such as the search for treatment. The difficulties lie mainly in the lack of professionals prepared to deal with the disorder, especially in the public network (SOUZA, et.al., 2019).

> "Educational practices for students with autism spectrum disorder are dependent on quality teacher training and continuing education truly willing for the teacher to overcome the limiting difficulties of teaching work with autistic students in favor of providing means and possibilities for an inclusive and not only integrative practice" (Oliveira, et.al., p.7, 2016).

Thus, this work is justified by addressing an important issue for the community and also for IFSC students because in addition to training professionals with technical skills necessary for their personal and professional growth, enabling them to work in industries, they will also be aware citizens and it is expected to awaken the students' affinity for the ASD public, since today, research shows that one in a hundred children (some research indicates that the disorder is even more frequent) can be diagnosed with some degree of the spectrum (BRUNA, 2021).

In order to solve this research problem, products that enable the stimulation of functional skills in people with autism will be developed in this research project, as presented in this document.

2 OBJECTIVE

This research project aimed to develop low-tech assistive products that provide and/or expand functional skills with people on the autism spectrum. To achieve this objective, the following specific objectives are outlined: to identify the needs of the target audience (autistic people) to assist them in routine tasks for daily life; design products in order to meet these identified needs; build prototypes with the designed characteristics in order to test their functionality; disseminate the knowledge acquired during the product development process to the IFSC community and consolidate a partnership between the mechanical and health areas of IFSC - Câmpus Joinville.

3 METHODOLOGYIA

The methodology adopted for the realization of the project was based on the reference model of Rozenfeld et al (2005) and will follow the following main steps:

1) Informational design: the design problem, available and necessary technologies, research on standards, patents and legislation, research on similar products, life cycle detailing, identification of customer requirements (through interviews with family members and health professionals serving this public), definition of product requirements and definition of product specifications were analyzed.

2) Conceptual design: the product was functionally modeled through CAD (Computer Aided Design) software. The CAD software was SolidWorks available at Joinville campus.

3) Detailed design: the sizing of the components and final modeling of the product was carried out. SolidWorks software was also used at this stage.

4) Manufacturing of Prototypes: analysis of the drawings, manufacturing of the components was carried out. The products were manufactured through the additive manufacturing process using FDM (Fused Deposition Modeling) technology. At this stage, the 3D CAD file was converted to STL (Surface Tessellation Language) and the transfer of this STL file to the Graber I3 TEK3D and SLIM 3D printers (printers available at Câmpus Joinville).

5) Prototype Tests: testing of the prototype products was carried out with people with autism spectrum disorder (ASD).

6) Preparation of the final report: description of the activities carried out.

7) Dissemination of Results: Through the scientific event and/or in a scientific journal. All these steps were developed by the scholarship student of the project and also involved the students of the technical courses in: mechanics of the curricular units of Integrative Project and Nursing Technician; under the guidance of the teachers involved in this project (teachers of the mechanical manufacturing area and health area).

Through this project, it was intended that the scholarship student and students of the technical courses in Nursing and Mechanics develop the product design with characteristics favorable to applied research, that is, simulate variables of the product development process of the industrial environment and develop a product that could be used by the community of people with autism spectrum disorder (external community).

The technologies used in this project are 3D manufacturing, which is widely applied in today's industry in all areas of knowledge such as: cars, spacecraft, bones and organs. Thus, the students were responsible for the informational design stage, that is, they analyzed the existing and necessary technologies and standards, identified the needs of people with autism spectrum disorder (BRASIL, 2003) through interviews with this public and with health professionals, in order to define the requirements that this product should have.

In the following steps, students designed the product using CAD software and built the prototype using 3D printing technologies. There was great learning, since they transported the knowledge acquired in the classroom to the practical experience environment.

- **Step 1:** Informational Design: problem analysis, available and required technologies, research on standards/standards, patents and legislation, similar products and life cycle detailing. Who: scholarship student, under the supervision of the teachers. How: Capes journal portal, online libraries, internet were used. Results: texts with the bibliographic review were delivered and the teachers involved in the project will evaluate it. The results were also presented to the students of the technical course in mechanics (scholarship student for students of the curricular units of the Integrator Project).
- **Step 2:** Informational Project: identification of customer requirements - interviews with elderly people and health professionals (Aim to identify the needs of the target audience). Who: scholarship student and students of the Integrating Project curricular units under the supervision of the teachers. How: interviews with health professionals. Results: list of public needs.
- **Step 3:** Informational Project: definition of product requirements and definition of product specifications Who: scholarship student and students of the Integrating Project curricular units under the supervision of the teachers. How: Discussion in groups. Results: list of product specifications.
- **Step 4:** Conceptual Design: product modeling in CAD software. Who: scholarship student and students of the Integrative Project curricular units under the supervision of teachers. How: SolidWorks CAD (computer-aided design) software was used, available in the computer labs of IFSC Joinville campus. Results: Prototype designs and evaluation by the teachers involved in the project. At this stage the geometries were chosen to be manufactured by the additive manufacturing process (rapid prototyping).
- **Step 5:** Prototype Manufacturing: 3D printing of the prototypes Who: scholarship student and students of the Integrator Project curricular units under the supervision of the teachers. How: the prototypes were manufactured preferably during the integrative project classes. Results: Prototypes.
- **Step 6:** Prototype Test: with people with autism spectrum disorder (ASD) Who: scholarship student and students of the Integrator Project curricular units under the supervision of teachers. How: visit to the clinic that serves this public. Results: prototype test report.

- **Step 7:** Preparation of the final report. Who: Scholarship student under supervision of the teachers. How: group discussion on the report of the previous stage. Outcomes: report and final project.

As presented, the target audience of this project was people with autism spectrum disorder. Health professionals who work directly with this audience also actively participated in the project in the prototype development stage, through their experiences and needs assessment. They also contributed to the testing stage of the prototypes by evaluating them and suggesting improvements. The social groups involved expressed their needs regarding activities in motor development, memory strengthening, leisure and socialization demands, that is, what they have of demand and what can be done by the academic area to assist them.

4 DEVELOPMENT

In order to solve this research problem, it was developed in this research project prototypes of low-tech assistive products that would expand the functional abilities to people with autism spectrum, as presented in the methodology item of this document.

For the development of this product (prototype) was used the methodology based on the reference model of Rozenfeld et al (2005). (Rozenfeld et al 2005) mentions that the Product Development Process (PDP) lies between the company and the market, and it is up to it to identify and even anticipate market needs and propose solutions (through product designs and related services) that meet such needs, i.e. it seeks to identify market and customer needs at all stages of the product life cycle; identify technological possibilities; develop a product that meets market expectations, in terms of total product quality; develop the product in the right time, i.e. faster than competitors and at a competitive price.

In addition, the manufacturability of the developed product was also ensured, that is, the ease of producing it, meeting the cost and quality constraints in production (Rozenfeld et al 2005). For Costa et al (2017) PDP is a business process within companies, based on market information, requirements and constraints, in which ideas and concepts are organized and generated, resulting in planning, design and manufacture of a product.

Volpato et al (2006) describes that PDP presents a multi and interdisciplinary nature where three-dimensional physical models (physical representations) are fundamental in this process. Three-dimensional physical models can be used for different purposes, among which learning, product improvement, error identification, usability and ergonomic studies, redesign, communication, integration, design gates, as well as advertising and aid in sales / market research (COSTA et al, 2017).

If a few years ago, the creation of a physical model (or prototype) was something very costly and time-consuming, because the main manufacturing techniques involved manual operations or machining, traditional and/or CNC (Computer Numerical Control/Computer Aided Manufacturing), today additive manufacturing (AM) allows an acceleration in the process of generating physical models, of the most diverse types, in any phases of the PDP, providing the fastest and most accurate convergence to the final solution, either in the initial phases or in the final phases, resulting in a reduction in development time and costs (COSTA et al, 2017).

In this sense, AM technology was used in this research project. According to Volpato and Carvalho (2017), additive manufacturing (AM) can be defined as a manufacturing process through the successive addition of material in the form of layers, with information obtained directly from a 3D computational geometric representation of the component. The advantages of using additive manufacturing are many, such as: it is possible to manufacture any geometry, even the most complex ones; little material waste and efficient use of energy, does not require fixing devices, no tool change is required during component manufacture; the component is manufactured in a single piece of equipment, from start to finish, that is, in a single step (VOLPATO and CARVALHO, 2017 and A VOZ DA INDÚSTRIA, 2017).

ISO/ASTM 52900:2015(E) proposes the classification of additive manufacturing technologies into seven categories or groups:

1) Photopolymerization in vat, extrusion of material,
2) Material blasting,
3) Binder jetting,
4) Powder bed fusion,
5) Material extrusion process,
6) Filament feeding.
7) Addition of blades and disposal with directed energy (VOLPATO and CARVALHO, 2017).

For the execution of this project, the material extrusion process was used, where the material is extruded through a nozzle or hole, being selectively deposited (VOLPATO and CARVALHO, 2017). Among the various technologies available on the market for the production of parts manufactured through material extrusion, are the low-cost technologies that have recently emerged and are based on the principle of material extrusion, especially in FDM (Fused Deposition Modeling) technology, that is, with filament feeding (VOLPATO, 2017), which was used in this project.

In this FDM process, the prototype was built by deposition of an extruded material. The extrusion head with movements in the X-Y axes, positioned on a table with movement in the Z axis, continuously receives the material in the form of a wire, heating it to the semi-liquid or pasty point (VOLPATO, 2006). Additive manufacturing technologies based on the principle of material extrusion are among the most widely used today, whether in industrial applications or in popular or domestic applications (VOLPATO, 2017), according to the author, this great popularization, observed recently, is strongly associated with the principle of material extrusion, since most low-cost and small 3D printers are based on this principle, in particular with filament feeding (VOLPATO, 2017).

5 FINAL CONSIDERATIONS

The proposed project was characterized as applied research and is part of one of the research lines of the GEFAMAC group. The teachers participating in the group have experience in the area of product development through 3D printing with several published works in the area.

As described above, a scholarship student from the health area and students from the technical course in mechanics (concomitant modality) participated in the project through the Integrating Project curricular units. The project also had the participation of health professors (IFSC research group - Management of Health Organizations).

With the realization of the project we obtained accurate information for the personal and intellectual growth of all members involved directly or indirectly in it.

Learning took place in the following areas:

1) Integration between teaching, research and extension insofar as it provided the institution and students with contact with society,

2) The involvement of students in the project was able to realize and develop the fixation of theoretical knowledge acquired in the classroom and practical use of the same and initiation of applied research;

3) Involvement and articulation of teachers in conducting studies and research aimed at contributing to the academic community, dissemination of IFSC in research and extension and,

4) Inclusion and social integration for people with autism spectrum disorder (ASD).

The project allowed to expand the interest of academics in producing a product, as well as the interaction between peers in the construction of knowledge, through the teaching-learning process. The creation of the product allowed to provide the improvement of functional skills stimuli in people with autism.

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