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UNIVERSAL DESIGN EDUCATION: BRAZILIAN STUDENTS REFLECTIONS AND THEIR ENVIRONMENT

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ABSTRACT
The seven principles of universal design are based on equitable use, flexibility of use, simplicity and intuitive use, noticeable information, error tolerance, low physical effort and size and space for approximation and use, and can be applied to products, services, devices, buildings and urban furniture. In Brazil, there has been a change in the accessibility rule, including the principles of universal design, aiming to spread its concept and encourage its use. However, there is still no obligation to use and respect this regulation. Thus, this study aims to investigate how students identify and interact with products, devices, buildings and urban furniture, and how they solve the accessibility problems based on the principles of universal design. The method used was exploratory, following a qualitative approach and conducted through a survey of literature. A descriptive research was also carried out, observing and analyzing interactions with students of an Ergonomic and Product Design discipline in 2015 and in the same discipline in 2016. As results, interactions among students were identified, helping to use and seeking solutions to the obstacles encountered in the use of products, services, devices, buildings and urban furniture. Another aspect observed was the surprise with the lack of concern for accessibility by the people with disabilities or reduced mobility. The students identified points that made the use of products, devices, buildings and street furniture impossible by these people, but would be easy to solve if the principles of universal design were used in the project of these items.

Keywords: Universal design, design education, Brazilian environment.

1 INTRODUCTION

Brazil is a country with wide cultural diversity and huge social inequalities. In addition, many are the sociocultural and educational challenges to be overcome by Brazilians. Gradually, Brazilians are realizing the importance of education, and, over the years, there has been an increase in enrolment in undergraduate and postgraduate courses [1; 2]. However, the Brazilian society still lacks an understanding of socio-cultural issues increasingly present in their daily lives. Recently, the Brazilian Ministry of Education asked universities to include accessibility issues in undergraduate curriculum. In 2015, there was also an update on the Brazilian Standard for Accessibility, with the inclusion of the principles of universal design as guides of accessibility. There is an evolution, in the discussion on social issues in Brazilian education, and among them accessibility. Accessibility and universal design stay together and "from the perspective of more usable and supportive environments, the United States of America remains principally focused on accessibility: developing regulations, codes, standards, policies and procedures to provide societal inclusion to people with disabilities." [3].

1.1 Accessibility and Universal Design

In Brazil, there is a standard called NBR9050:2015 that deals with minimum requirements to provide accessibility for people. NBR9050:2015 standard was created to "establishes criteria and technical

parameters to be observed when designing, building, and proceeding installation and adjustment of urban buildings to the conditions of accessibility" [4]. A standard aims to "provide autonomous, independent and safe use of environment, buildings, furniture, equipment and urban elements to the greatest amount of people, regardless of age, height or limitation of mobility or perception." [4]. "Accessibility enables a person to fully utilize the entire space, whether they have failed vision, are pregnant or use a wheelchair." [5]. By 2015, NBR9050:2015 standard has been updated and among the modifications is the inclusion of the concept and principles of universal design. The universal design concept proposes criteria for projects of products, services, buildings, and interior and urban environments, which serve a great number of users, respecting a human-centred approach and diversity of the people. Universal design is the "design all of products, buildings and exterior spaces to be usable by all people, to the greatest extent possible" [6].

Elsewhere in the world, universal design is already part of accessibility parameters and is present in national laws. For example, in Norwegian, Duncan states, "universal design is already implemented in laws concerning the learning environment (buildings, equipment etc.) in universities, colleges, non-degree granting colleges, and in kindergartens." [3]. The author also affirm that "universal design extends beyond the confines of accessibility to include all persons and creates that inclusion by promoting integrated and mainstreamed products, environmental features, and services." [3].

Another point that draws attention to the Brazilian reality is the number of disability people. Worldwide, around 15% of the world's population lives with a disability [7]. However, in Brazil, it is estimated that around 24% of the population present some type of visual, auditory, motor or mental disability [8]. These people need an inclusive society, a society that respects and meets their needs. The World Report on Disability lists challenges for governments, civil society organizations and disabled people's organizations, such as "create enabling environments, develop rehabilitation and support services, ensure adequate social protection, create inclusive policies and programs, and enforce new and existing standards and legislation, to the benefit of disability people and the wider community." [7]. Mazuch emphasized, in his study about design for older people, that designing socially inclusive urban spaces are "a great deal of emphasis on mobility and accessibility" [9].

But the target of universal design is not only at people with disabilities. Universal design focuses on all people. According to Duncan, "universal design still remains a strategy that has been implemented by different sectors of the private and public domains, selectively and for fairly narrowly framed purposes", and it is "now being used in new areas where accessibility issues have formerly not been observed." [3]. To support the conception and evaluation of products, devices, buildings and urban furniture, seven principles of universal design were developed in 1997. The principles deal with: equitable use, flexibility in use, simple and intuitive, perceptible information, tolerance for error, low physical effort, size and space for approach and use. Thus, this study aims to investigate how Brazilian students identify and interact with products, devices, buildings and urban furniture, and how they solve the accessibility problems based on the principles of universal design.

2 METHODOLOGY

In the first moment, a literature review was applied, whose goals of exploratory character were developed. Secondary sources were used for the research to gather previous information about the topic in question and thereby increase understanding of the problem. [10]. In the second moment, a descriptive research was carried out, observing and analyzing interactions with thirteen students of an Ergonomic and Product Design discipline in 2015 and sixteen students of the same discipline in 2016. These disciplines belong to the Ergonomic postgraduate course, at Engineering Production Department of a Federal University of Rio Grande do Sul (UFRGS), located in southern Brazil.

The students of the first group had various degrees, such as doctors, engineers, designers, therapists and business administrators. Students ranged in age from 28 to 55 years old. Six students are male and seven students are female. The professions of the students of the second group were: doctors, engineers, nurses, business administrators, physiotherapists and physical educators. Students ranged in age from 30 to 52 years old. Eight students are male and eight students are female.

The classes were organized to take place in two stages. The first stage was expositive, presenting the theoretical contents. The second stage was organized with dynamic groups where students experienced products and/or services and then analyzed the usability of the product/service and the principles of universal design. Three practical activities (PA1, PA, 2, and PA3) were developed. The first and second activities (PA1 and PA2) were developed only in the group that occurred in 2016, and the third

activity (PA3) was developed both in the group that attended the course in 2015 and in 2016. After the lecture, the students received activities in which they were asked to put themselves in the user's place to try a product, service and / or environment. IDEO [11] reinforces that if the designer puts himself in the user's place can provide a deeply understand the people they're looking to serve.

3 RESULTS

From the collected results, this study aimed to investigate how students identify and interact with products, devices, buildings and urban furniture, and how they solve accessibility problems based on the principles of universal design. In the first activity developed in class (PA1), an expositive class was held on the concept and principles of universal design. A lesson on usability concept and goals was also given. After the lecture, the case of a mineral water bottle of 300 millilitres was presented. This bottle had the proposition to the consumer, after drinking all the liquid inside the bottle, proceed with the discard of the packing twisting and flattening the bottle. The proposal for this product is that, before disposing of the packaging, the consumer can twist it, thus reducing the volume it occupies by 37%, which facilitates transport and recycling (Figure 1). Students were encouraged to put themselves in the user's shoes and carry out the entire process, from initial product contact, consumption, until disposal. Fifteen other 300-milliliter bottles of mineral water were also displayed to compare the products from their packaging. Also presented was a case study of Coca-Cola brand packaging, designed by Andrew Kim, emphasizing product usability requirements.

After testing the product, an exercise was proposed to the students. The task asked them to develop the usability goals for the bottle in question, to analyze the strengths and weaknesses of the bottle as well as the strengths and weaknesses of the packaging of competing products. Usability goals were: efficiency, satisfaction, safety, ease of learning and ease of storage [12].

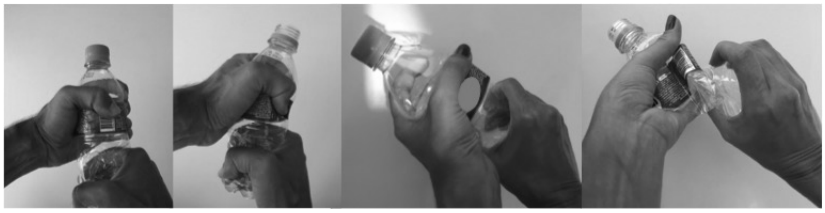

Figure 1. First activity with students

In the second activity (PA2), the students were presented with five products: scissors, screwdriver, nail clipper, can opener, and measuring tape. The students organized themselves in groups and each group chose a product. Students were challenged to use the products with both hands (right and left), verifying how the usability requirements were being addressed (Figure 2). It was also proposed that they tie their thumbs in one hand, and the index finger at another time, trying to perform the same movement and use. From this experimentation, students were asked to apply the principles of usability in the re-design of a product. The first part consisted of analysis of the product and use. The students analyzed the goals of usability and defined the objectives regarding: ergonomics, safety, use, and aesthetics of the product chosen by the group. They were also asked to collect data on the user and the product, that is the ergonomic analysis of the task, photographic records, task verification, and analysis of product systems and subsystems. Students also defined the requirements and parameters (dimensions, material, structure, safety, mechanics, comfort, shape, strength, and weight).

The second part consisted of rapid design of the project, where students defined attributes, characteristics and requirements that the product should present so that the deficiencies were corrected and the positive aspects were maintained. The students were also asked to make a quick outline of the new product and make the presentation to the other colleagues. Due to the short time of the class, no other steps of product development were made. After each presentation, there was discussion of the cases between the students and professor.

Figure 2. Second activity with students

In the third and final activity (PA3), the students attended an expositive lecture on accessibility and the presentation of the Brazilian Standard NBR9050:2015. Only in this standard edition, the universal design principles were inserted as guides in the project of products, services and environments. After the lecture, a proposal was made for an activity to be carried out in groups of students, where each one would be responsible for a disability and would test the use of a product, a service, and the accessibility of a building. Students were given a map with a path that they should go through, and the request to evaluate the positives, negatives and identify suggestions for possible improvements to be proposed in the product, the service and the building. The students were invited to organize groups of four students each, where two students in the group would be responsible for recording the observations, a student would be in charge of experiencing a disability (physical or visual) and a student would be a companion of the student who would be experiencing the disability. The first group (G1) was responsible for the physical disability with the use of the wheelchair. The second group (G2) had the physical disability but as the use of crutches. And two groups (G3A and G3B) were responsible for visual impairment with the use of a cane and a blindfold. The groups of the discipline that occurred in 2015 were called G1/2015, G2/2015, and G3/2015. The groups of the discipline that occurred in 2016 were called G1/2016, G2/2016, G3A/2016 and G3B/2016.

Year 2015	Year 2016	Disability	Users	Objects
G1/2015	G1/2016	Physical disability or reduced mobility	Physically Handicapped or persons with reduced mobility	Wheelchair
G2/2015	G2/2016			Crutches
G3/2015	G3A/2016	Visual disability	Visual impaired	Cane and blindfold
	G3B/2016			

Figure 3. Groups of the third activity with students

The map with the path was drawn from a route to be done at the University of Engineering Faculty, where the course was realized. The path indicated that students should leave the classroom (located on the fifth floor), go up one floor (on stairs) and go to the bathroom (located on the sixth floor). After, enter inside the elevator and go into the library (located on the second floor) and pull out a book. Then, down one floor (on stairs) to the ground floor. At the end, walk out of the building, go through the reception and reach the sidewalk. An observation must be made: they were asked to go up and down a staircase so that the students would experience the difficulty and, in certain cases, the impossibility that some people suffer to use stairs. The groups of students left the classroom one at a time (in 5-minute spaces), not to cause turmoil and exchange of perceptions among groups at the time of task execution. After completing the path and returning to the classroom, the groups were asked to organize the information and present the results to other students. They were asked to evaluate products, services, equipment, and environments in accordance with the universal design principles. Students were given the freedom to use whatever forms they thought best to present their work.

4 DISCUSSION

It was observed that the class of students (the year of 2015) had more difficulty in applying the principles of universal design in the final proposed activity (PA3), because it was only developed this practical activity. From this observation, more practical exercises (PA1 and PA2) were prepared for the group of students that started in 2016. The students' class of 2016 showed more mastery of contents and evolution when applying the concepts in practice. This was noticed in the use of the contextual analysis and conception techniques used, and also throughout the work presentations. The G1/2016 group used the storyboard technique to report their experiences on the course of the third practice activity (figure 4). The group reported that through the storyboard drawing, it was possible to express some of the sensations they experienced along the way. According to Kumar, “stories have the fundamental ability to translate abstractions (…) stories can connect with audiences on emotional and experiential levels in a way that diagrams or charts simply cannot.” [13]

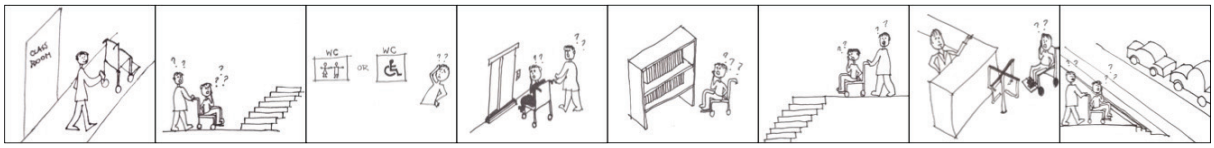

Figure 4. Results of the group G1/2016 about the third activity with students

In both classes, it was observed that students were very surprised by the lack of accessibility and respect for people with disabilities or with reduced mobility. Students also understood the importance of putting themselves in the user's place to identify needs and possible nonconformities in the use of products, services, environments, and systems. IDEO [11] affirms that experiencing the circumstances of the lives of people you're designing for give us the ability to really understand what people think and feel. One student commented, "professor, it is impressive how I had never thought about the needs of a disabled person. I never thought that simple and everyday tasks, such as crossing the street or opening a bottle, could involve so many devices and equipment in a way that all people could use it. Another student added: "We realize that it is not people who have disabilities. The society has deficiencies and does not provide access conditions for all people." These two students were part of the G3A/2016 group. In the third activity, this group collected some photos of the sidewalk with accessibility problems (Figure 5).

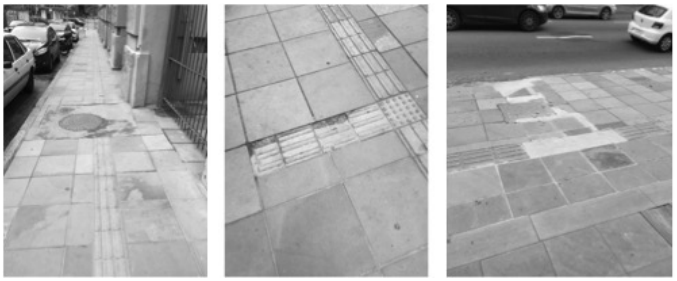

Figure 5. Part of the results of group G3A/2016 about accessibility problems on the sidewalks

The principles of universal design enabled the students would focus the look in solving routine and key issues in the lives of users. Students reported that the principles of universal design helped to evaluate products, services, equipment, and environments more clearly, highlighting nonconformities and possibilities for improvement from the analysis of each principle. One of the G3B/2016 students reported that: "By using the environment and perceiving barriers, these could be rethought and eliminated through studying the seven principles of universal design." Students realized the importance of updating the NBR9050: 2015 with Insertion of the principles of universal design as guiding principles.

For example, during PA3, G3/2015 and G3A/2016 realized that when a visually impaired person walks into the elevator, they will have a good chance of pushing on many buttons because they are sensitive to touch and do not have Braille reading. By observing the principles of tolerance for error and perceptible information, it was possible to think of pushbuttons and Braille reading to avoid this error. The lack of noticeable information was also noted when groups G3/2015, G3A/2016, and G3B/2016 went to the bathroom. There was no signage for people with visual disability. The elevator also presented another non-compliant point: the door presence sensor, which prevents people from crushing, is located at the top of the door. There is no device that is sensitive to the passage of a person in a wheelchair, which consequently has a lower height than a person without a wheelchair. Observing the principle of equitable use, students suggested placing the sensor in the middle or bottom of the sides of the elevator door. During the discussion, these students identified that, observing the principle of tolerance for error, the action of changing the positioning of the sensor would also facilitate the use of the elevator by short children or dwarfs.

When students performed PA2, they noticed that the products such as scissors, can opener, and nail clippers (Figure 2) were designed for right-handed people. In proposing suggestions for improvement, they observed the principle of flexibility in use. When the G3/2015, G3A/2016, and G3B/2016 groups went to the library, they encountered equipment that was difficult to handle and understand to get a book. To propose improvement, they used the principle of simple and intuitive. This principle was also conceived for bathroom signalling by the groups G1/2015 and G2/2016. The low physical effort principle was used when groups G1/2015 and G1/2016 tried to enter inside elevator. There is a gap to enter inside elevator, a small step of 3 centimetres, which makes it difficult for wheelchair users to enter. There should be a levelling of the floor or a small ramp to eliminate the physical exertion that people in wheelchairs should do. The same thing was observed when using a ramp to access the building. There was a very inclined elevation at the ramp, so people in wheelchairs needed help from other people to go up or down the ramp. The principle of size and space for approach and use was

observed when the person in wheelchair of G1/2016 tried to pick up books from the library shelf. The library has narrow aisles and tall shelves. On the lower shelves, the books are at the bottom, which also makes it difficult to approach and use. All groups observed this principle when the bathroom use. From the students' contact with the concepts of user-centred design and accessibility, and universal design principles and usability, students were able to realize the importance of designing according to user needs, not according to the designer needs. User-centred design has helped students look at and design for those who will use these products, equipment, services, environments, and systems. Moreover, it was possible to perceive the behavioural change of the students, initiating a thought from the point of view of the collective and the inclusion of all people. In both classes, it was possible to perceive that the experience in the context of the user and the use and application of universal design principles to evaluate products, services, equipment and environments made possible reflection and behavioural change of the students. From these experiences, it has emerged that addressing the issue of accessibility in the classroom and using the universal design principles can bring gains for the education of Brazilians, both as students and citizens.

5 CONCLUSION

This article analyzed aspects related to accessibility and universal design in education, aiming to investigate how students identify and interact with products, devices, buildings and urban furniture, and how they solve accessibility problems based on the principles of universal design. Interactions among students were identified, helping to use and seeking solutions to the obstacles encountered in the use of products, services, devices, buildings and urban furniture. Another aspect observed was the surprise with the lack of concern for accessibility by the disability people or reduced mobility. The students identified points that made the use of products, devices, buildings and street furniture impossible by these people, but would be easy to solve if the principles of universal design were used in the project of these items. This lack of concern comes from the characteristics and local culture. Although there is a rule that includes the use of universal design principles, in Brazil there is no formal requirement for the use or punishment of non-compliance with this regulation.

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