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IN SEARCH OF DESIGN FOR ALL: THE INCLUSION OF BLIND STUDENTS' OPINIONS FOR FIELD RESEARCH IN SCHOOLS

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Abstract: This article discusses the design of data collection instruments that include the opinions of blind students, in accordance with the principles of Universal Design (UD). The aim of this study is to understand the importance of adapting data collection instruments for the inclusion of disabled persons in field research in Architecture and Design, among other fields. The data collection instruments developed were a play interview with a tactile map and a 3D survey with the use of tactile models. These instruments sought to assess the school environment experienced by blind students. The study involved students from the early years of a school for the blind who had not yet mastered the Braille system. The participation of these students was evaluated. A multidisciplinary team consisting of architects, designers, educators, and psychologists lent support to the study. The results showed that the data collection instruments adapted to blind students were successful in making the group of authors examine questions regarding UD. An analysis of the participatory phase showed that the limitations resulting from blindness determine the specificities in the adaptation and implementation process of the instruments in schools. Practical recommendations for future studies related to instruments in the UD thematic are presented. This approach is in line with the global trend of including disabled persons in society based on these users' opinions concerning what was designed by architects and designers.

Keywords: Universal Design (UD), Data Collection Instruments, Tactile Maps, Visual Impairment.

Introduction

In 2006, the General Assembly of the United Nations adopted the Convention on the Rights of Persons with Disabilities (CRPD). According to Article 7 - Children with disabilities:

1. States Parties shall take all necessary measures to ensure the full enjoyment by children with disabilities of all human rights and fundamental freedoms on an equal basis with other children.

The CRPD is regarded as having finally empowered the world's largest minority to claim their rights and to participate in international and national affairs on an equal basis with others who have achieved specific treaty recognition and protection (Kayess & French, 2008). Many countries have taken initiatives to promote and regulate accessibility in schools and to ensure compliance with the relevant legislation, according to the principle of 'Design for All'. Ron Mace, creator of the term 'Universal Design (UD)', was an architect and advocate who influenced international thinking about design. For most of his life, he used a wheelchair and understood what it was to attempt to participate in a world that was not designed to include him. Mace influenced the paradigm shift in the development of urban Architecture and Design (graphic, product, and interior) and others projects (Connell et al., 1997). UD is concerned with providing design with features that facilitate use by most people, including the elderly, children, pregnant women, and people with permanent or temporary impairments, among other segments of the population. Due to its importance as a mechanism of social inclusion, the school building must fully incorporate the principles of UD (Kowaltowski 2011, p. 200).

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Accessibility is the possibility and condition to reach, perceive, and understand the use of transport, space, equipment, furniture, objects, software, information, and communication, among other things, with safety and autonomy. Disabled persons have the right to participate in education, employment, and social life, reducing isolation and dependence. Autonomy in movement is fundamental for the integral development of the human being because movement is how individuals interact directly with the physical space and the elements present in it. When a disabled person is immersed in an environment with UD principles, their activities are preserved, and their disability does not affect their functions. Accessibility is a guiding concept in current pedagogies that support the social inclusion of persons with different abilities.

Blindness denotes the inability of living beings to visually capture the images projected from surrounding objects. Blindness is a visual impairment sign, but from a human perspective, it may be a distinctive sign of the ability that certain blind creatures have to interact with the world in a different, admirable, and perhaps more creative way than those who possess vision. To the visually impaired person, tactile perception is very important because it allows contact, knowledge of objects, and even reading by means of the Braille system. For orientation and mobility, hearing is one of the most important senses because it allows establishing spatial relationships. The vestibular or labyrinthine sense provides information on the vertical position of the body and the rotary and linear components of movement. Smell is a sense that may provide clues for orientation and the location of environments such as the kitchen, bathrooms, gardens, and other places. Kinaesthesia is the sensitivity to perceive muscle or joint movements. This capability alerts us to the position and movement of the body when raising an arm, for example, or when going up or down a slope. Muscle memory (repetition of movements in a fixed sequence), one of the kinaesthetic sense functions, is used to go up and down stairs or for short routes without needing to count steps. In this context, Wayfinding Design, which involves elements in a system that helps the user to find the route (to orient him/herself), stands out. Among these elements, emphasis is given to the design of environments that favour circulation and clearly present entries, exits, vertical access points, and path locations (the positioning of lookouts in urban pedestrian routes, among other references); the design of tactile maps; the design of models; the design of printed maps; the design of signs (ceiling, floor, or conventional); the design of information desks; the design of signallers and information lights; the design of smart phones (including those for the deaf); the design of intercoms; and the design of video and global positioning system (GPS) displays, among others. For persons with visual impairments, wayfinding system elements, such as walls, baseboards, tactile warnings, handrails, and ramps, in addition to tactile ground surface indicators, smell (such as landscaping) and noise (such as water fountains) sources, wind and sun positions (natural elements), and white cane use, among others, are important (Arthur & Passini, 1992; Gibson, 2009; Golledge, 1999; Meuser & Pogade, 2010; Passini, 1984).

In terms of the methodological contributions of Architecture and Design applied to school settings, with regard to behavioural aspects and user satisfaction, emphasis is given to the studies conducted Baker and Mednick (1990); Bechtel, Marans, and Michelson (1987); Bishop, Adams, and Kean (1992); Groning (1986); Preiser and Smith (2010); Sanoff (1992); Sanoff, Pasalar, and Hashas (2001); Sebba and Churchman (1986); Sheat and Beer (1989); and Zeisel (2005), among others.

This article discusses the design of data collection instruments that include the opinions of blind students, in accordance with UD principles. The aim is to recommend procedures for the application of the 3-dimensional (3D) data collection techniques - play interview with tactile map and survey with use of tactile models - with blind students to evaluate the school environment.

Methodology

A public school in the municipality of São Paulo, Brazil, that provides services to students with visual impairments was adopted as a case study. A special education school was chosen because of the large number of students with visual impairment at this site, enabling the application of instruments, and the school's wide-ranging administrative experience with blindness,

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experienced in everyday life, providing greater support for the study. A total of 10 blind students in the early years and who had not yet learned the Braille system participated in this study.

In general, the development of data collection instruments for children is a challenging task because it requires a consideration of aspects related to cognitive abilities, the researcher's experience in addressing the issue, and the available resources. Regarding data collection instruments such as interviews and surveys, even defining the questions and their order raises ethical concerns because the formulation may induce answers, distorting the final results of the work.

In addition to meeting the research policy of the involved entity, this study relied on the collaboration of researchers with experience and was conducted with the support of a multidisciplinary team of architects, designers, educators, and psychologists. Unstructured observations of the students and interviews with the aforementioned team were conducted, in addition to the pre-testing of the instruments.

The application procedures adopted were discussed in advance with the teachers of the institution in an interview. The application site was an unused room located near the classrooms (to avoid disrupting the school routine). The application was performed by one of the authors with the support of 2 other individuals not employed by the school who provided assistance to the student (locomotion - assistant 1) and with instrument application (recording the students' responses and taking photographs - assistant 2). Instrument application was performed individually.

Play interview with the tactile map

Yates and Smith (1989) propose the interview as a method for obtaining data on phenomena that are only slightly susceptible to direct observation or with the aim of investigating the child's perceptions or conceptions. This technique has great potential and has been employed in qualitative studies as a solution for the study of meanings that are subjective or too complex to be investigated by closed-ended and standardised instruments (Banister, Burman, Parker, Taylor, & Tindall, 1994). As one of the most important sources of information for a case study, interviews allow the asking of questions and provide guidance and in-depth understanding on issues and specific topics.

The visually impaired person uses the remaining senses to gain understanding of the tactile map and the model, making use of the tactile, auditory (when the instrument emits sound), and kinaesthetic senses. According to Bernardi and Kowaltowski (2006), it is important to differentiate the terms *map* and *model*. The word map refers to the 2D representation of something described and/or portrayed with the clarity of a conventional geographic map, and the word model refers to a 3D representation on a reduced scale.

The tactile map of the representation of reality is critical to the spatial knowledge of the blind individual, both in education and in mobility. The map allows identifying and locating places and areas; identifying directions; calculating distances; identifying, locating, and analysing the distribution of territorial, physical, populational, and socioeconomic data; and making inferences through comparison with other maps, among other things.

The tactile map related to the implementation of the blind school (Figure 1) was adopted in this study to facilitate application by the authors (who have a background in Architecture) because it is an activity that focuses more on issues related to the school environment. The goal of the play interview with the tactile map was to promote interaction between the student and the interviewer (applicator) before and during the interview and to obtain information concerning preferences related to the school environment.

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Figure 1. Tactile map for the blind students.

3D survey using tactile models

According to Baird, Gray, Isaacs, Kernohan, and McIndoe (1995), surveys are very useful instruments for identifying issues related to the functional and technical factors of the environment from the user's perspective. The number of questions in a survey should be limited to avoid exhausting the individual and because the individual is not always available to the researcher for a long period of time. Generally, the use of closed-ended questions respects people's opinions more, allowing them to classify their responses as positive, negative, or neutral, with no influence from the researcher (Sommer & Sommer, 1997). In this study, the Likert scale was adopted because this measure is the most commonly used in the social sciences, especially in surveys on attitudes, opinions, and evaluations. The number of alternatives does not affect the reliability or the validity of the scale, and the respondent's discriminatory capacity must be taken into account (Cohen, Manion, & Morrison, 2000). In this scale, the respondent is asked to evaluate a phenomenon by typically choosing among 5 alternatives (in the case of this study, involving children, this number was reduced, and 3 alternatives were used).

The role of a common model is to represent a certain area or room in a smaller format but in its proper proportions. A person who sees can almost instantly acquire a global and synthetic understanding of the whole by looking at the model. The model enables the blind person to manipulate different data and information in a concrete manner, in 3D, and provides a perception and understanding of the data and information.

The objective of the 3D survey in this study was to identify issues related to the environmental comfort (thermal and acoustic) of the classroom based on the opinions of the blind students. The preparation and procedures for applying the 3D survey to the blind students were discussed with their teachers in interviews prior to the survey application. The authors developed 2 tactile models, adopting a tactile language and specific measures in the design, such as the use of coating materials that are pleasant to the touch, with no danger from sharp edges or burrs, and of the appropriate size. The dimensions adopted in the models took into account the anthropometric measurements of the hand, the frontal reach, and the sitting elbow to elbow breadth, among others, of the group of blind students (Panero & Zelnik, 1979). Models are inexpensive to produce and easy to make, which facilitates their replication. The application of the 3D survey to the blind students occurred following the application of the play interview with the tactile map in the same place, individually, with the support of the same 2 individuals brought by the authors. The 3D survey with models is described below.

3D survey with the tactile sound model

The tactile sound model (Figure 2) was used to apply the acoustic comfort question: **HOW IS THE NOISE DURING CLASS?**

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Figure 2. Tactile sound model designed for blind students.

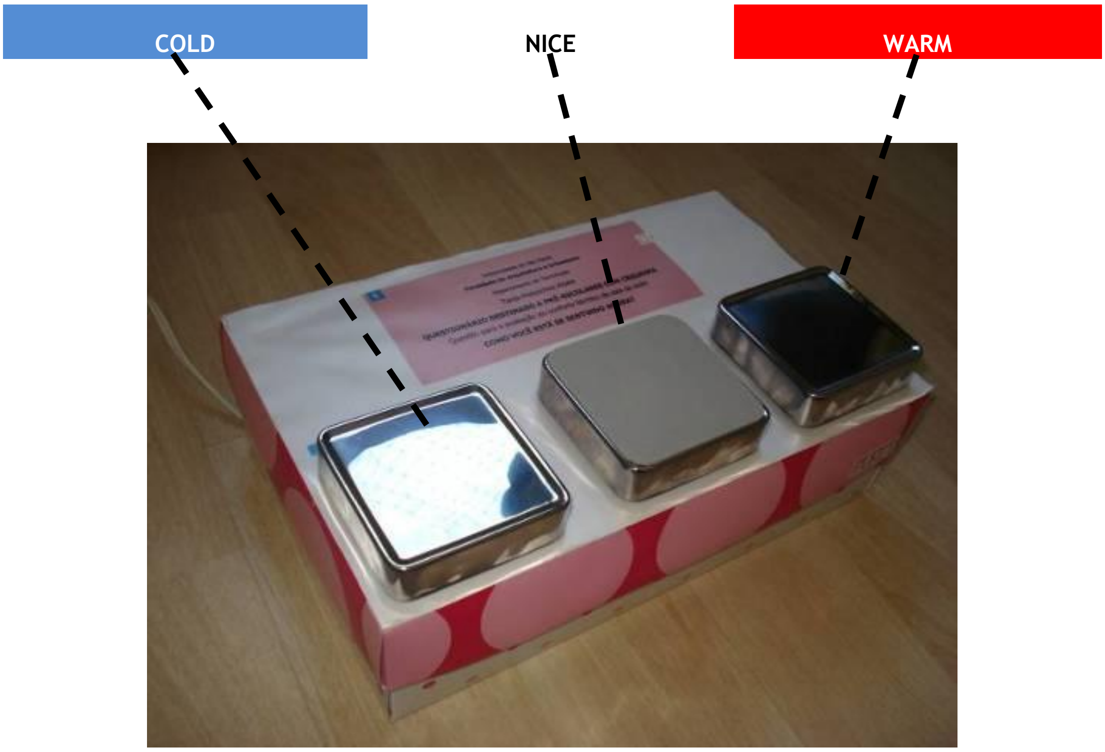
The features of the model are described below:

- Dimensions: Width: 18 cm / Length: 29 cm / Height: 0.5 cm
- Configuration: Formed by the representation of 3 alternatives for the question related to acoustic comfort. At the top of the model, there are 3 buttons (sound players) that, when pressed, reproduce recordings made by the applicator, corresponding, within the context of the alternatives for the question, to 3 noise levels. At the bottom of the base, there is a prosthesis of a child's ear made from plaster.
- Material used: Styrofoam board coated with bond paper, 3 sound reproducers (called buttons), child's ear prosthesis in plaster, hot glue, double-sided tape, contact paper, fine sandpaper.
- Procedure for construction: The vertical positioning of the recorders on the Styrofoam base covered with bond paper was measured. The ear prosthesis was glued down with hot glue, and the recorders were attached with double-sided tape.

3D survey with the tactile thermal model

The tactile thermal model (Figure 3) was used to apply the question related to thermal comfort: **HOW ARE YOU FEELING NOW**? Its features are described below.

Figure 3. Tactile thermal model designed for blind students.



- Dimensions: Width: 18.5 cm / Length: 29.5 cm / Height: 8.5 cm

- Configuration: Formed by the representation of 3 response alternatives for the question related to thermal comfort. At the bottom of the model, there are 3 stainless steel plates. One plate is coated with insulating material (corresponding to the alternative *nice*), another is heated by an apparatus (corresponding to the alternative *warm*), and another is at room temperature (corresponding to the alternative *cold*). When touched, the plates emit different temperatures corresponding, within the context of the alternatives for the question, to 3 temperature levels. The alternatives are printed above the boards for the applicator's visualisation.

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- Material used: Cardboard box, bond paper, 3 stainless steel plates, insulating material, hot glue, double-sided tape, contact paper, fine sandpaper, portable infrared light device with 110 V lamp.
- Procedure for construction: The positioning of the stainless steel plates on the printed sheet at the top of the model and the distance between the plates were measured. The insulating material was glued to one of the plates with hot glue. The box cover was perforated at the site corresponding to the plate that would be heated by the infrared light device, which was placed inside the model.

Results

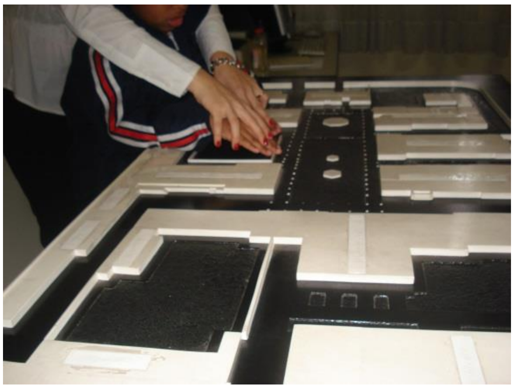
The individual application of the play interview with the tactile map and the 3D survey using the tactile models in a quiet environment favoured student concentration during the application process. Two external individuals provided assistance to the student (mobility) and to the applicator (recording the students' responses and producing images of the application process).

Play interview with the tactile map

First, the teacher introduced the application team and explained that the students would perform an activity outside the classroom. One blind student at a time was removed from the classroom by assistant 1 (to avoid disrupting the school routine) and was led to the room intended for the application. Along the way, assistant 1 talked to the student so that he or she would become acquainted with her voice.

The applicator positioned the student standing in front of the tactile map of the school in question. The student was then invited to feel the map for an initial recognition of its shapes and was provided a concomitant verbal description of the shapes (Figure 4).

Figure 4. Application of the play interview with the tactile map designed for blind students (a-b).



(a)

(b)

After this initial phase of guided warmup and during the activity of feeling the map by the student, the following open-ended questions related to the preferences of the school environment were asked, with pauses: 1. What is the place you like the most in the school?; 2. Why did you choose this place?; 3. What is the place you like the least in the school?; and 4. Why did you choose this place? All students answered the questions readily and without difficulty. Applications lasted approximately 15 minutes each, and the students had enough frontal reach to feel the entire tactile map. Assistant 2 recorded the responses verbalised by the students.

3D survey with the tactile sound model

The survey application took place in the same room shortly after the play interview with the tactile map. The student was seated at the table where the tactile sound model (related to the acoustic comfort question) was located.

First, the student was asked to feel the bottom of the model (Figure 5a) where the plaster ear prosthesis was located (the student's hands were guided by the applicator), and the activity plan was explained (initial warmup phase). The student's hands were then guided to the top of the model where the 3 buttons (recorded sound players) that emitted the noise levels were located for their tactile and auditory recognition (Figure 5b). The student haptically recognised the elements (shapes) that were described by the applicator, who asked the student to press one button at a time for recognition of the noise levels emitted.

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Figure 5. 3D survey application using a tactile sound model designed for blind students (a-b).

(a) *(b)*

When pressed, each button reproduced the recorded sound of the students' class noise (previously recorded by the authors during a class at the school in question). The button located at the top emitted noise at a higher level, the button in the centre emitted noise at a middle level, and the button at the bottom emitted noise at a low level. After this phase of recognition by the student, the acoustic comfort question was asked verbally: *How is the noise during class?* The student was requested to indicate one of the 3 buttons or alternatives, without the applicator guiding his/her hands. Using both hands, the student easily indicated the chosen alternative (a lot of noise). The assistant recorded the response provided by the student.

3D survey with the tactile thermal model

Next, the tactile thermal model related to the thermal comfort question was positioned in front of the same blind student. The student was then asked to feel it, and his/her hands were guided by the applicator, who explained that the exercise was related to temperature (initial warmup phase). The applicator guided the student's hands for him/her to thermally and haptically recognise the elements, which were concurrently described by the applicator. The student's 2 hands were guided over the 3 stainless steel plates (one plate coated with insulating material) one by one (Figure 6), then in pairs, with one hand on each plate to compare the temperatures emitted. After this initial phase of tactile and thermal recognition by the student, the following question related to thermal comfort was asked verbally: *How are you feeling now?* The student was requested to indicate one of 3 boards or alternatives, without his/her hands being guided by the applicator. Using both hands, the student easily indicated the chosen alternative. The assistant recorded the response provided by the student.

Figure 6. 3D survey application using a tactile thermal model designed for blind students (a-b).

(a) *(b)*

Discussion and recommendations

The application process of the data collection instruments was evaluated through structured observations of their performance, taking into account the complexity levels of the proposed tasks and the physical and mental efforts required, in addition to the actual results produced by the instruments, which, although not shown in this article, were analysed.

All of the blind students who participated in the study had good motor coordination in the upper and lower limbs. All students managed to perform the play interview with the tactile map and the 3D survey using the tactile models and exhibited good understanding of the questions and discernment of thought, resulting in clear answers. The number of questions was found to be appropriate.

Regarding the play interview with the tactile map, the objectives of promoting interaction between the student and the interviewer (applicator) before and during the interview and obtaining information concerning preferences related to the school environment proposed by the instrument were achieved.

The surveys using the tactile models were found to be effective tools for expanding students' knowledge about the acoustic and thermal comfort

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conditions in the school environment because they made the response alternative concepts more concrete.

The objectives and the applicability of the proposed data collection instruments were fully achieved because they provided the blind students with accessibility to and usability of the instruments themselves and the consequent inclusion of their opinions about the school physical space, where the students stay for long periods of time.

The greatest challenge for this study was the issue of disability itself and especially the understanding of its actual limitations for the design of data collection instruments. The application of the data collection instruments (the play interview with the tactile map and the 3D survey with the tactile models) to blind students was experienced to observe the process of trial and error in the preparation of these instruments jointly with the respective teachers and school principal to adapt each data collection instrument to the capabilities of visual disability and to UD principles. It is believed that all difficulties were overcome and that knowledge of instruments designed in accordance with UD principle was gained.

Some practical recommendations for future studies related to instruments designed in accordance with UD principles and designed for children with disabilities in school are listed below:

- Involve researchers with experience who can tolerate stressful situations generated in field research as a consequence of students with severe disabilities who co-habit the space that is the research focus, despite the fact that they are not the direct research subjects. Considering these situations and the specific needs of children with disabilities, the support of other professionals such as psychologists, speech therapist, physical therapists, and educators is indispensable.

- Study in depth the limitations and specificities of the disability, conduct interviews with the administrators and teachers of the considered school, and conduct non-structured observations of the study participants to select the data collection instruments.

- Discuss in depth the process of the selection and development of the data collection instruments designed for students with their teachers through interviews. The stronger the bond of confidence between the researcher and the teacher is, the easier the process of preparing and applying the chosen data collection instruments. For this reason, pre-testing and the subsequent application of the instruments should be performed in the same school.

- Apply the instruments quickly and during class time. The application site should be an unused room located near the classroom to avoid disrupting the school routine. Application should be individual and performed in quiet surroundings that favour student concentration during the application process.

- Rely on the support of 2 external individuals (non-school employees) brought by the applicator to provide assistance to the students (locomotion – assistant 1) and to the applicator (recording the students' responses and taking photographs - assistant 2).

Regarding the preparation of the tactile map, the floor plan of the school building or institution that is the focus of the study is required. Caution is recommended in choosing the scale to be adopted because its size and height should be compatible with the manual frontal reach and height of children at the lowest anthropometric percentile in the group in question. All students must have enough frontal reach to feel the tactile map. The applicator should not lift students without sufficient reach or place them on chairs or pedestals because doing so could stress both the student and the applicator. Generally, blind children feel very insecure when they are lifted.

The dimensions adopted in the models should also take into consideration the anthropometry of the users. The 3D survey designed for blind students may be applied following the application of the play interview with the tactile map in the same place, individually, and should rely on the support of the same 2 people brought by the applicator.

In the case of blind students who use wheelchairs, the base supporting the instruments should allow the frontal approximation of the wheelchair.

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This article does not aim at immediate and total transformation in relation to the inclusion of the disabled person's opinion in field research in general. However, for the benefits of Design for All to be experienced, a gradual change in the evaluation of products, equipment, and built space is necessary. It is not believed that field research that considers the opinions of children with disabilities has the revolutionary force in school to the point of being decisive for their inclusion. There is a long way to go between producing inclusive data collection instruments and restructuring the design of these spaces and facilities to make them accessible. This study is part of a paradigm shift change process, where field research in schools should consider the opinions of students with disabilities through instruments that are adapted to them, where the systemic transdisciplinary and multi-method vision that characterises UD will effectively contribute to the future of school inclusion. This study seeks to provide guidance for an initial, not a definitive, model for the design of data collection instruments.

Conclusion

This study assessed the importance of data collection instruments designed for blind children to evaluate the school environment and found that their limitations determine the specificities in the adaptation and application process of these instruments. The instruments developed in this study were specific to the evaluation of the preferences for certain spaces and for environmental comfort in those spaces, but the application process may be replicated in other UD-related studies.

Future studies focusing on Design for All or other design principles can use the instruments and application processes developed in this study to improve and apply the instruments in research and adapt them to other spheres of human activity.

In general, children with disabilities play an important role for qualitative research in schools, enabling improvement in the design of products, equipment, and the built environment. The need for a multidisciplinary approach aimed at improving the quality of education in general is confirmed (Kowaltowski, 2011).

Worldwide, the future of school inclusion will depend on a collective effort that will require researchers, politicians, service providers, architects, designers, educators, teachers, and society as a whole to review their roles and to work together in ensuring an inclusive and better education for everyone.

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