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TOOLS TO INCLUDE BLIND STUDENTS IN SCHOOL BUILDING PERFORMANCE ASSESSMENTS

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Abstract: This article discusses the design of data collection instruments or tools that can facilitate the inclusion of blind students in school building evaluations. Principles of Universal Design (UD) are the basis of the development of these tools. The goal of this study is to enable the inclusion of disabled persons in field research in Architecture and Design through the application of appropriate investigation tools. The data collection instruments developed were a tactile map to support interviews with blind children and a 3D questionnaire as tactile models. The study involved students from the pre-school program of a school for the blind who had not yet mastered the Braille system. The ease of understanding the test questions and the use of tools 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 testing the design of the tools and the understanding by the participants of the questions asked. Assessment of school environments as experienced by blind students was made possible through these tools. An analysis of the participatory phase showed that the limitations imposed by blindness determine the specificities in the adaptation and implementation process of tools for Post Occupancy Evaluations of school buildings. Practical recommendations for future studies are presented. The study presented here is in line with the global trends to include disabled persons in society and

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base design decisions on diverse users' experience, opinions, satisfaction rates, desires and needs.

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 (United Nations, 2006). According to article seven of this convention: all 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 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' or Universal Design (UD). UD is about design that facilitates the use of space or objects by most people, including the elderly, children, pregnant women and people with permanent or temporary impairments. Due to its importance as a mechanism for social inclusion, school buildings must fully incorporate the principles of UD (Kowaltowski, 2011).

The concept of UD includes accessibility, which 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 (ABNT, 2004). Disabled persons have the right to participate in education, employment and social life. Autonomy in mobility is fundamental for human beings because through movement individuals can interact directly with their physical space.

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People with visual impairments have specific and special difficulties and needs. Blindness denotes the inability of a person to visually capture the images projected from surrounding objects. To a visually impaired person tactile perception is very important because it allows contact, knowledge of objects and reading by means of the Braille system. For orientation and mobility, hearing is another important sense for the user with visual impairment, because it allows spatial relationships to be perceived. Smell may provide clues for orientation and the location of environments such as the kitchen and gardens, for instance. Kinaesthesia is the sensitivity to perceive muscle or joint movements. This capability alerts humans to the position and movement of the body when raising an arm, for example, or when going up or down a slope, thus it is perceived without sight as well.

In this context, Wayfinding Design, is an important concept. It involves elements in a system that helps spatial orientation of users. The design of environments with Wayfinding in mind must be based on clear circulation routes with well-marked entries, exits and vertical access points. Tactile maps, models, printed maps, indication signs, the location of the information desks, among others, are important elements for Wayfinding design. For persons with visual impairments, Wayfinding systems must include special attention to physical elements, such as: layout and wall configurations, baseboards and tactile warnings. The design of handrails, ramps and the correct placement of tactile ground surface indicators must be carefully considered in design for all. Wind and sun are natural elements that may help orientation and sensorial elements such as smell from flowers and sound from water can be explored as well (Arthur & Passini, 1992; Gibson, 2009; Golledge, 1999; Meuser & Pogade, 2010; Passini, 1984).

For schools buildings Wayfinding design must be based on the analysis of special needs of children, including those with visual impairments. A participatory design process is recommended so that proposals incorporate needs and desires of users. This type of design process should have an analytical, a decision-making and a creative or propositional phase. The analytical phase involves data collection, often as Post-Occupancy Evaluations – POE of existing buildings. The development of data collection

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instruments for studies that involve the participation of children is however a challenging task. This becomes even more challenging when these participants are blind.

This article discusses the design of data collection instruments or tools for building performance assessments – BPA that include the opinions of blind students, in accordance with the principles of UD. The goal of this study is to demonstrate the importance of adapting data collection instruments for the inclusion of disabled persons in field research in Architecture and Design. The limitations imposed by blindness on users determine the specificities in the adaptation and implementation process of the tools to evaluate school buildings. The development of such instruments to allow the full participation of blind children in school building assessments is described and these are tested.

School Building Performance Assessment

Preiser and Nasar (2014) in a recent review on assessing building performance - BPA, as Post-Occupancy Evaluation - POE is denominated today, have shown that these evaluations are important for a design process to be successful in providing users with buildings that respond to their needs and desires. These authors also showed that such assessments should employ participatory methods. A renewed interest in evaluation at the intersection of the physical and the social is therefore detected in the literature and this, represents a return to the origins of POE in environmental psychology. It also reinforces that building evaluation currently strongly favours 'bottom up' approaches to evaluation, which value the opinions of the user (Preiser & Nasar, 2008). Many studies have shown that in order to assess usability, one has to focus on the effect of the building on the user organization's fulfillment of goals, as well as the end users' satisfaction and experience (Blastad, 2010; Baker, 2011; Kowaltowski et al., 2013, 2014).

For better quality school buildings Dudek (2008) recommends a greater involvement of users in the design process. Attempting user involvement is not without its own difficulties. The participation of children in the design process is however strongly recommended by many in the field of school

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architecture including the schoolyard (Curtis, 2003; Addo-Atuah, 2012). In school building assessment one of the difficulties encountered is the fact that children of varying ages should participate in the design process. Children, before they have learned to read and write, should not be excluded. To overcome some of the hurdles of user participation in a school design process, and evaluate buildings against a "criteria of quality", Cleveland and Fischer (2014) recommend a mixed-method approach to data collection. Walkthroughs, questionnaires, interviews and focus groups are employed.

Within learning environment research, the investigation of learners' perceptions tends to rely on verbal skills of participants, and this could prioritise certain aspects. With children these verbal methods can be enhanced with story telling, gaming, mental maps and drawings that give young users the opportunity to express their preferences and desires. However, such methods need to be accompanied by a multidisciplinary team that includes educators and psychologists, and such processes will always need parent consent (Kowaltowski, 2011).

Woolner (2009) explored the pros. and cons. of participatory processes in school design. She detected enthusiasm within both education and architecture for the inclusion of students and other users of the school building in the design process. Such processes are seen as a way for architects to achieve a better understanding of the business of education and therefore supporting the design of more appropriate buildings and outdoor spaces. However, such involvement is not without difficulties, according to Woolner (2009). Within the educational context, examining previous waves of school building reveals that in the past consultation has tended to leave out certain users. Woolner (2009) recommends that, if participatory processes in school design are to aim to be genuinely inclusive, avoiding past experiences of narrow understanding, they must involve as wide a cross-section of the school community as possible. This should include teachers, support staff, technicians, administrators, cleaners, lunchtime supervisors, students of varying ages, parents and the local community. Involving such a diverse range of people produces many practical

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considerations, especially in the choice of research methods to be adopted to ensure a high quality participatory process, a process that results in school premises that offer a good fit to the needs and aspirations of the school's users.

Woolner et al. (2010) further argue that for both educationalists and social researchers visual methods are particularly appropriate for the investigation of people's experiences of the school environment. The authors have applied a range of visual methods, based on photographs and maps, to investigate the views of a diverse sample of school users. Methods which make more use of visual and spatial material are therefore seen as being able to widen participation to include all users, and are particularly appropriate for examining the contribution learning of the physical setting (Lodge, 2007; Prosser, 2007). It is vital to grapple with the issue of choices about research tools, because inevitably they affect research results, as Dewey put it in 1938: ''a tool is also a mode of language, for it says something to those that understand it: about the operations of use and their consequences'' (Woolner et al., 2010)

In her study on participatory school design processes Woolner (2009) does not include pupils with varying disabilities. How to assure an inclusive process is therefore still a challenge. Special difficulties arise when users, and particularly children, are visually impaired or blind. A further problem arises with the inclusion of blind children in a participatory design process when they have not yet mastered the Braille system. Visual methods are no longer appropriate and verbalization or articulation of preferences cannot be ascertained through normal written questionnaires. For the inclusion of such children to be made possible special tools and methods are paramount.

Methodology

A case study is described. A special education school for visual impaired pupils was chosen for the development of the assessment tools described. This school is located in São Paulo, the largest city in Brazil. The school provides primary education for around one hundred students. 15 children are

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attended in the preschool program, which was used in this case study. Various ages were represented, from 5 to 15 years, because children are grouped according to their cognitive abilities. In the final test 10 pupils were included, because 5 students had additional intellectual disabilities and were unable to participate. All students were considered totally blind but verbally competent. Although various ages were represented all participants had academic competence only at the preschool level and did no master the Braille system.

In general, the development of data collection instruments for children is a challenging task because it requires the consideration of aspects relating to cognitive abilities, the researcher's experience in addressing the issues, and the available resources. Regarding data collection instruments such as interviews and questionnaires, even defining the questions and their order can raise ethical concerns as well, because specific formulations may induce answers, distorting the final analysis results.

In addition to meeting the research policy of the school involved, this study relied on the collaboration 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.

Three types of tools were developed for this case study: a tactile map and tactile and audible models as 3D questionnaires. A visually impaired person uses the remaining senses to gain understanding of a tactile map and model, making use of the tactile, auditory (sound) and kinaesthetic senses. According to Bernardi and Kowaltowski (2006), it is important to differentiate the terms *map* and *model*. A map is a 2D representation of something described and/or portrayed with the clarity of a conventional geographic map, and a model refers to a 3D representation of a concept or object at a reduced scale.

The application procedures adopted, or protocols, in this case study were discussed in advance with the teachers of the institution in an interview. The actual application and testing of the tools took place in a spare classroom of

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the school, located near the normal classroom block. The test was performed by one of the researchers of this study with the support of two assistants, not employed by the school, who guided students movements (assistant 1) and with documentation of observations (photographs) and verbalization results (assistant 2). The tools were tested with children individually.

Interviews with a tactile map

Participatory design processes are mostly based on an analytical phase. Users and members of the design and execution team analyse or assess the present building situation or a building of the type planned. Sanoff (2012) adopts a multi-method process for this phase in the school context. This includes interviews; annotated walkthroughs; wish poems and evaluation of images representing design choices. Yates and Smith (1989) propose interviews as a method for obtaining data on phenomena that are only slightly susceptible to direct observation or with the aim of investigating a child's perceptions or conceptions. This technique has great potential and has been employed in qualitative studies to elucidate meanings that are subjective or too complex to be investigated by closed-ended and standardised instruments (Banister, et al., 1994). Thus, interviews allow the asking of questions and provide guidance and in-depth understanding on specific issues and topics.

Walkthroughs are a type of interview and are particularly important in building performance assessments, because being in a specific place will stimulate more accurate responses to questions. However, in a participatory design process, involving users with visual impairments, the application of this method yields few analytical briefing data. Thus "walking through" a building needs special support. In this case study a tactile map (Figure 1) was introduced representing the actual school building in 2D.

Tactile maps, representing a specific reality, can enhance spatial knowledge of blind individuals, giving critical information and increasing mobility. Maps allow the identification and location of places and spaces, show directions and enable the calculation of distances. Rich and varying information

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(physical and socioeconomic) can be gained and users may make inferences through comparisons with other tactile map experiences.

The tactile map (Figure 1) used in this case study was developed to support interviews with the 10 children of the test. The main reason for introducing a tactile map was to promote interaction between students and the interviewer (applicator), substituting a walkthrough POE method.

The interview was in the form of a play-interview. Special care when interviewing children must be taken. Interview methods need to match children's developing cognitive, linguistic, social and psychological competencies (Gibson, 2012). Children often have a limited attention span and for this reason lengthy interviews should be avoided. Story telling and playing or gaming technics should be employed to ensure a child's response to the topics of the interview. The language the interviewer uses should be appropriate to the vocabulary of the group of children being studied.

Figure 1. Tactile map as support for the play-interview with blind students.

3D questionnaire using tactile models

For building performance assessments - BPA important topics of investigation with users are: functional aspects (the ability to perform desired activities adequately), aesthetic impacts (visual impact), environmental comfort (thermal, acoustic and lighting conditions), psychological aspects (densities,

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privacy, territoriality, personal space, safety and security) and technical or very specific factors. To investigate these variables most BPA studies compare technical measurements and observations with user responses to questionnaires, including indications of satisfaction rates. For the last twenty years BPA or POE studies have used questionnaires to assess functional and technical aspect of the built environment from the user's perspective (Baird et al., 1995). The number of questions should however be limited to avoid exhausting the individual and allow research to be completed in available time.

Generally, the use of closed-ended questions is more appropriate for questionnaire design. Classification of results is made easier and the induction influence of the researcher is reduced (Sommer & Sommer, 1997). In this study, the Likert scale was adopted, being most appropriate in questionnaires on attitudes, opinions, evaluations and satisfaction levels. The number of alternatives should take into account the respondent's discriminatory capacity (Cohen, Manion, & Morrison, 2000). In this case study with children, the usual five levels of this scale was reduced, and only three alternatives were used.

The role of models is to represent an object in a smaller than full-scale format but in its proper proportions to help in the understanding of a project or building by users or observers. Blind persons can manipulate different data and information in a concrete manner in 3D, and models may provide a perception and understanding of a place or object.

A 3D questionnaire was developed in this study. The main goal of this instrument was to assess issues relating to the environmental comfort levels (thermal and acoustic) of classrooms by blind users in the school of this case study. Thus, the opinions of blind students on the comfort conditions could be registered. Teachers participated in the development of these specific 3D questionnaires and prior to application the interview procedure was discussed.

For this test case study two tactile models were developed. A tactile language was used. Special care was taken in the choice of materials and

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finishing of these models to make the tactile experience pleasant to the touch and avoid possible accidents from sharp edges. The dimensions adopted in the models took into account the anthropometric measurements of hands, the frontal reach and the distance between elbow to elbow when sitting of participants of the test (Panero & Zelnik, 1979). The type of model was inexpensive to produce and fairly easy to make, which should facilitate its replication. The application of the 3D questionnaire to the blind students occurred following the play interview with the tactile map of the school complex in the same place, individually, with the support of the same two assistants as outlined above.

The first tactile model (Figure 2) was designed to measure acoustic comfort levels. Blind students were asked about noise levels in their classrooms and indicated their answers through the specific tactile model, which emits sounds in three different noise levels as a Likert scale. The sounds were classroom noises recorded in the school itself, so that the test survey would represent the reality of the student's daily experiences.

Figure 2. Tactile sound model designed for questionnaires in environmental comfort surveys with blind children.

This model had the following characteristics:

- Dimensions: Width: 18 cm / Length: 29 cm / Height: 0.5 cm

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- Configuration: Pressing one of the three buttons on the model emits three alternative sound levels, which were previously recorded by the research team in the classrooms of the school. At the bottom of the base a small 3D representation of a child's ear was attached. This was made from plaster to indicate that sound or acoustic conditions (hearing) are being evaluated.

- Materials: Styrofoam board coated with bond paper, three sound reproducers (called buttons), a model of a child's ear in plaster, hot glue, double-sided tape, contact paper, fine sandpaper were used.

- Construction: The Styrofoam base was covered with bond paper. The ear model was glued on the board with hot glue, and the recorders were attached with double-sided tape.

The second model, part of the 3D tactile questionnaire, measured thermal satisfaction levels (Figure 3). In this case blind students were asked about thermal conditions in their classrooms and indicated their answers through the specific tactile model, with three metal boxes that when touch gave three different temperatures sensations. Again the different thermal sensation levels represented the Likert scale satisfaction levels of typical questionnaires investigations on environmental comfort conditions.

This model had the following characteristics:

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

- Configuration: Touching one of the three boxes on the model three different temperatures can be felt by touch to indicate that thermal conditions are being investigated. One box is coated with insulating material, which was considered to correspond to a satisfactory or "nice" thermal room temperature condition. Another box is heated by a heating device and represents a "warm" sensation setting on a Likert scale. Finally the third box is made of stainless steel and touch would represent a "cold" temperature sensation. The three alternative thermal comfort levels are printed above the boxes for the researchers visualisation.

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Figure 3. Tactile thermal model designed for questionnaires in environmental comfort surveys with blind children.

- Materials: Cardboard box, bond paper, three stainless steel plates or boxes, insulation material, hot glue, double-sided tape, contact paper, fine sandpaper, portable infrared light device with a 110 V lamp.

- Construction: The positioning of the stainless steel boxes on the printed sheet at the top of the model and the distance between the boxes were measured to ensure that participants distinguish the three boxes. The insulating material was glued to one of the stainless steel boxes with hot glue. One of the boxes was perforated on one of the sides, because underneath an infrared light device was installed and lit when the model is in use and the box is heated to a warm temperature.

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Results

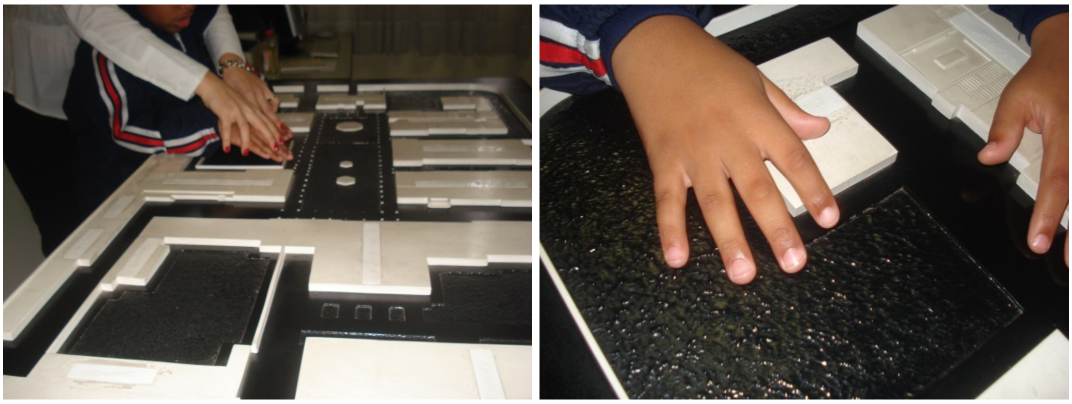
The location of the case study test, as a quiet room, favoured the play interview with the use of the tactile map and also the test of the 3D questionnaire on issues of environmental comfort aspects (acoustics and thermal). Students were able to concentrate on tasks and reflect on their responses. The two assistants were of vital important to guide students in their tactile tasks. These assistants also acted as observers, documenting the event.

Play interview with the tactile map

For this test each student was individually invited to the test room. Along the way, between the normal classroom and the test room, the assistant talked to the student, so that he or she would become familiar with the assistant's voice. The student was guided towards the front of the tactile map (Figure 4), representing the school building lay-out. An initial recognition of the map occurred so that each participant would understand the model and its purpose. While exploring, through touch, the tactile map the assistant would provide verbal descriptions of shapes that represent physical spaces of the school (Figure 4).

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

(a) *(b)*



After this initial guided warm-up open-ended questions relating to the preferences of the school environment were asked. A pause was introduced

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after each question to permit reflection and answers as well as their recoding on the researchers questionnaire. The questions were:

- What is the place you like the most in the school?
- Why did you choose this place?
- What is the place you like the least in the school?
- Why did you choose this place?

All students answered the questions readily and without difficulty. The test lasted 15 minutes for each of the ten students. Although the 3D map was large all participants could reach the entire map with their hands. The second assistant acted as an observer and recorded the responses verbalised by the students, while the researcher asked the questions and the first assistant helped in guiding the tactile experience.

3D questionnaire tests

The 3D questionnaire application test took place in the same room shortly after the play interview. Each student was seated at a table where the tactile models were located.

First, the acoustic model was tested. The student was asked to feel the bottom of the model (Figure 5a) where the plaster model of a child's ear was located and the activity plan was explained. This was considered a warm-up phase to familiarize the participant with the model and its purpose.

The student's hands were then guided to the top of the model, where the three buttons with recorded sounds that emit different noise levels, are located (Figure 5b). The student haptically recognised the buttons and tested each one, as instructed by the assistant.

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Figure 5.3D questionnaire 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' classroom noise. After the warm-up phase the acoustic comfort question was asked:

- Which of these sounds represents the noise level in your classroom?

The student was asked to indicate, by touching one of the three buttons, the perception of the classroom noise level. The assistant recorded the response provided by the student. Most students indicated that the noise level is high in their classroom.

Next, the tactile thermal model was tested. An initial warm-up phase gave each student the opportunity to get familiar with the 3D questionnaire, in this case the three stainless steel boxes and the perception of different temperatures, through touch. During this phase the researcher explained that the exercise related to thermal comfort conditions in the normal classroom of the school. Students haptically explored the 3D questionnaire (Figure 6), first with one hand and then with both, to get a sense of comparison between the temperatures perceived. After this, a question relating to thermal comfort was asked verbally:

- How would you evaluate the temperature of your classroom?

The student then indicated one of three boxes or alternatives as his or her answer. All students, using both hands, were easily able to indicate their

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chosen alternative. The assistant recorded the response provided by the student. Most students considered their classrooms thermal conditions warm.

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

(a) *(b)*

Discussion and Recommendations

The tests of the data collection instruments were evaluated through observations of ease of application, length of familiarization phases, complexity of proposed tasks and the physical and mental efforts required by participant blind school children to use these. All participant students had good motor coordination and managed to perform all the tasks requested of them (answering the four questions of the simulated walk-through on the tactile map and indicating the perception of acoustic and thermal comfort conditions in their classrooms on the 3D Likert scale using tactile models). Thus the students understood the questions and were able to express their opinions adequately. The length of the exercise was considered adequate.

The tactile map was shown to be an important instrument to engage the participants in their physical environment when participating in a POE survey. The interview method was also considered adequate to promote interaction between student and interviewer (researcher).

The 3D questionnaires using the tactile models were found to be effective tools for expanding students' knowledge about an unfamiliar topic, environmental comfort conditions in the school environment. Participants

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were able to indicate their own perceptions on a three level 3D Likert scale for two important aspects of environmental comfort: acoustics and thermal sensations. Thus the aim of this study (the development of POE data collection instruments and the inclusion of visually impaired user participants) was fully achieved. Although questions on environmental comfort could be directly asked to participant pupils in a typical POE survey, the tools can allow participants to respond with autonomy in a ludic context. The tools also showed that students became interested in the experiment and asked questions on environmental comfort.

The challenge for the study was the design of instruments, which take into account the specific disability of participants and the extent to which POE data can be collected with blind children. Testing showed that the design of the instruments described is in accordance with UD principle.

Some lessons learned:

- Testing and research with children with disabilities can present stressful situations. The research team should be experienced and the support of teachers and caretakers of the school to be evaluated is important. Specific questions may arise when developing instruments and their method of application. To obtain productive answers the support of other professionals such as psychologists, speech therapist, physical therapists, and educators is imperative.

- The limitations and specificities of the disability have to be studied first. Interviews with the administration and teachers of a school should be conducted. Also researchers should conduct non-structured observations of the place and its users to familiarize themselves with the scope of a POE study. The main aspects to be investigated should be identified to focus the design of data collection instruments clearly on essential issues.

- The tests and or POE survey should be thoroughly prepared with the administration and teaching staff of a school. The scope of the study and all the instruments and their application methods must be presented. The stronger the bond of confidence between researchers

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and staff the easier the preparation and application of the instruments will be. Pre-testing is also extremely important to avoid problems during final evaluations. Pre-testing should occur in the same place as the final test.

- Preparation of tactile maps needs the support of documents belonging to the institution to be evaluated. Plans of the building are necessary, or measured drawings will have to be produced by the research team, which is a lengthy and laborious task. Time and resources must therefore be planned for far ahead.
- The scale of a tactile map is an important factor to be considered. The map cannot be too large that by touch a child will be unable to get an overview of the building and grounds. The scale cannot be too small either to prevent the user from understanding each space and important details that are part of the specific POE.
- The setup of a test and its instruments must consider the anthropometric data of the participants, in this case a large age span of children from five to fifteen ages. Children should be able to perform the haptic experience on their own, without having to be lifted to reach far corners of a tactile map. Generally, blind children feel very insecure when they are lifted. In the case of blind students who also use wheelchairs, the base supporting the instruments should allow frontal approximation of the wheelchair and be at the appropriate height of a wheelchair user's reach.
- Time is an important factor to be considered, especially with children. Their concentration span is mostly shorter and should be respected. Also, participants should not feel bored or over-taxed in taking them away from their main activities. Therefore, all details must be prepared prior to the tests to avoid time spent on installations and room and furniture layouts. Class-time should be used and not recreation or snack and lunchtime.

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- With children and especially with children with disabilities, individual tests are important to avoid distraction. A quiet environment is recommended for this reason as well.

- The support of assistants (non-school employees) as part of the research team is important. In this case two assistants were needed, one to guide each students in the right direction and place him or her in front of the instruments and one to record the observations and responses. The main researcher can then concentrate on the interview and questionnaires.

Conclusion

This study presented the development of data collection instruments to be applied with blind children in building environment assessments. Two types of tools were developed and tested. The specific results of these, such as the participants' opinions on spatial preferences and environmental comfort were only used to test the tools and their application protocols. The important result of the study is that specific tools are paramount when including the visually impaired and especially blind children in building assessment evaluations. The instruments developed in this study were specific to the evaluation of the preferences for certain spaces and for environmental comfort of those spaces. The results demonstrate that specific tools can be developed for the inclusion of blind children in POEs and the instruments can be expanded for wider UD related studies. Similar tools can also be developed for other POE variables such as: security for instance.

UD, the basis for an inclusive design, demands that the design of buildings respects and permits the participation of all potential users in the planning and design process as well as the use of the product of that process: the building, grounds and objects. For schools, children with disabilities should be part of this process. They play an important role in qualitative analytical research, enabling the introduction of improvements in proposals for the built environment and furniture and equipment design as well as stimulus for

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new ways of using space. A participatory process is also seen as an educational opportunity. In the case of school design, a specific group of users can reflect on traditional ways of doing things and propose innovations to improve the quality, not only of the built environment, but also of education in general (Kowaltowski, 2011).

The main aim of this study was to demonstrate that users with disabilities, in this case with visual impairment, can and should participate in building design processes. Also the research results showed that children from early ages of five years are able to participate in the analytical phase of a design process if appropriate tools are used with adequate methods of application. Building performance assessment is an important part of a quality architectural design process. Results from such evaluations are the basis of the briefing phase when needs are reflected upon and decisions are made on a detailed architectural programme. The inclusion of user opinions, perceptions and satisfaction rates enriches these two design process phases. For public buildings the inclusion of all types of users should be ensured. School building design is of prime importance to support teaching and learning activities and ensure a comfortable, secure and inspiring environment for pupils, teachers, staff, parents and the neighbourhood community. The school building design process therefore should also be participatory and inclusive. The extra challenge of a participatory process with children demands specific tools and protocols, as discussed here.

Although the study above showed positive results in relation to the inclusion of blind school children in BPA studies, the research also demonstrated that to introduce change in school building design with UD in mind is not an easy task and will not happen spontaneously. Efforts must be made on various fronts: attitudes, methods and protocols, instruments and tools, political and social will as well as technical developments. The contribution of this study is related to instruments and protocols of their application and serves as a stimulus to further efforts to impact positive change in school building design.

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