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CARTOGRAPHIC LITERACY FOR VISUALLY IMPAIRED PEOPLE

Educação Cartográfica de Pessoas com Deficiência Visual

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ABSTRACT

Without maps blind people are limited to receive information about the geographic space through words and/or need to memorize long descriptive information in order to have access to places. Maps may offer access to spatial information for this group of users to organize their internal spatial images (estimating distances, locating places and objects). As a consequence, this might revert in a greater independence and autonomy in the orientation, mobility and self-assurance of these people. Such facts demonstrate the importance of cartographic education of people with visual impairment (VI), a theme that has been the object of study of the authors of this article. The first part of the text demonstrates how the tactile maps were standardized in the Laboratory of Tactile and School Cartography of Federal University of Santa Catarina and how they are produced. The following section describes the Tactile Model System - /Mapavox developed in partnership with São Paulo State University - UNESP, |Rio Claro Campus and Tércio Pacitti Institute of Computer Applications and Research of Federal University of Rio de Janeiro (UFRJ). One last item is dedicated to demonstrate experiences of the authors in the cartographic initiation of blind students, where the importance of pedagogic mediation of tactile pedagogical material in this process is discussed.

Keywords: Models of Tactile Maps, Mapavox, Tactile Perception.

RESUMO

Sem mapas as pessoas cegas ficam limitadas a receber informações do espaço geográfico através de palavras e/ou precisam memorizar longas informações descritivas para acessar lugares. Os mapas podem proporcionar acesso à informação espacial para esse grupo de usuários organizar suas imagens espaciais internas (estimar distâncias, localizar lugares e objetos), o que, consequentemente, pode reverter em maior independência e autonomia na orientação, mobilidade e segurança dessas pessoas. Tais fatos mostram a importância da educação cartográfica de pessoas com deficiência visual, temática esta que vem sendo objeto de estudos das autoras desse artigo. Desta forma, na primeira parte do texto mostra-se como os mapas táteis foram padronizados no Laboratório de Cartografia Tátil e Escolar da Universidade Federal de Santa Catarina e como eles são produzidos. Na sequência é descrito o Sistema Maquete Tátil/Mapavox desenvolvido em parceria pela Universidade Estadual Paulista, Campus de Rio Claro e o Instituto Tércio Pacitti de Aplicações e Pesquisas Computacionais da Universidade Federal do Rio de Janeiro. Um item é dedicado a mostrar experiências das autoras na iniciação cartográfica de estudantes cegos, onde se discute a importância da mediação pedagógica e dos materiais didáticos táteis nesse processo.

Palavras Chave: Modelos de mapas táteis, Mapavox, Percepção tátil.

1. INTRODUCTION

Conventional maps need to be adapted for people with visual impairment (VI) or total blindness, since they are not able to read a printed map, or map displayed on the screen of a video monitor or television screen. Such task does not simply consist in substituting colors in textures, producing contours in relief or inserting information in Braille or in broadened conventional writing. It is necessary to consider that hands do not substitute eyes in order to acquire information and that their absence will provoke specific strategies in order for the brain to be able to offer meaning to whatever is discriminated by touch.

While conventional maps try to reduce the world by shortening the distances, the adapted map for tactile reading (tactile map) promotes the expansion of the universe of a blind person because it can illustrate concepts of difficult comprehension for a visually impaired person such as those of a state, country or planet. To show to this person that she is part of a planet, that this planet is a sphere divided in continents and oceans, that the continents are subdivided in countries and in other territorial units up to the point reaching where the person lives can be a quite complicated task. However, all of this can be facilitated if the person has in hands a tactile map. With the map, the localization, the distances and the spatial relations can be observed and therefore, easier to be comprehended by the visually impaired.

Despite this fact, it is observed that the majority of the visually impaired does not know maps or how to read them. This occurs due to the lack of adapted maps for the public whether in school, on the streets or in any other place. However, it is not sufficient to have adapted maps for the visually impaired; the pedagogical mediation of the process of reading a map is a determinant factor for the understanding of what was represented and for its meaning in reality. If the visually impaired are not taught to use maps they will not be able to apprehend the information transmitted – and this does not happen in a single moment – it is a long process of spatial development of the individual (Almeida; Passini, 2010). However, if he/she did not have access to maps and is already an adult, he/she needs to be taught to use this resource, because a literate citizen should be capable of reading maps to access information in order to be able to make decisions about space.

Efforts have been being made in the Laboratory of Tactile and School Cartography of UFSC (LabTATE) as well as in other universities of Brazil with the objective of reducing the difficulties encountered by these individuals for the educational and social inclusion. Standardized models of tactile maps were created in LabTATE, constructed with technical rigor, with the consideration of tactile perception. These models are available at the www.labtate.ufsc.br website and maybe sought for the production of this type of map by any person that accesses the website, including the blind.

This article demonstrates one of the ways of elaborating the tactile maps of the LabTATE. We also present the Tactile Model System - Mapavox and the paths to a cartographic education of the visually impaired.

2.THE STANDARDIZATION OF MAPS IN LABTATE

Despite of the variation in the way that the tactile maps are produced, it is highlighted that, besides the costs that make the maps accessible to the visually impaired, the sophisticated technology may not be the most appropriate if the maps are not easy in terms of cognition. The elaboration of tactile maps can be totally handmade, from the design of the maps to make up the model to the making of the model itself, which is manually constructed by sticking different materials, such as cork, rubbers, strings, and junk jewelry materials. It is also possible to use graphic design software to transform the conventional map (in ink) into a reference for the tactile map. The advantage of creating maps on the computer lies in the possibility of standardization of forms, sizes, themes, and layouts of maps which will be stored in digital formats and that will be able to be printed anytime that one wants to design the model of a tactile map.

Another way to produce the tactile maps is to use a microcapsule paper as a means of map representation. After digital elaboration, the map is printed on microcapsule paper (brands: Zy-tex, Flexipaper, or Piaf) by a DeskJet printer. This special paper contains on its surface some alcohol microcapsules that may create textures when heated. Thus, lines, points, polygons, and texts in Braille printed over it in black or dark-grey are heated by a special machine (*Tactile Image Enhancer*) until the explosion of microcapsules that elevate and construct relief textures, that is, the tactile map. In this method of elaboration, the map does not need a model. After the digitalization, it can be stored in a digital file in any interchange format (LOCH, 2008).

In LabTATE one research was proposed to define what could be standardized in terms of good tactile maps in Brazil both for education and orientation/mobility. We had the direct participation of the visually impaired, who were volunteers from two organizations: Associação Catarinense para a Integração do Cego (ACIC) (Association for the Integration of the Blind of Santa Catarina) and Fundação Catarinense de Educação Especial (FCEE) (Association of Special Education of Santa Catarina).

In this sense, the standards proposed for Brazil, exhaustedly studied in LabTATE concern the methodology of production and reproduction, the layout, and the symbolisms used in tactile maps for education. For instance, Figure 1 shows a standard layout and some patterns signs for educational maps.

It is possible to observe in Figure 1 that the map and its components are contained in a frame that limits the point where the tactile map user will find information to read it. The North, standardized as a punctual element and composed by a point and a line, also assumes a standardized position on the upper-left corner to facilitate the positioning of the map. Right below the North, in the same box, it is possible to perceive the scale in graphic form that represents only a part of it, which is enough to understand the reduction that was made.

The title of the map in Braille is placed in the other box, on the left. All of these components will always be on the upper part of the sheet. Therefore, the user will position the map for the reading using the North, recognizes the scale, learns about the theme or topic of the map and then is able to explore the map. The legend follows a similar pattern, but it is made separately, on a separate sheet, and in the place of the scale, the word "Legend" will be written in Braille, as it is shown in Figure 1. In some cases, if the legend and the title are small, they might be placed together in the same box.

This arrangement of elements follows the most ergonomic reading format – the reading of a text in western languages and also in Braille language is performed from left-right, up-down direction. Moreover, it facilitates the tactile exploration, once the VI first explores the whole map, that is, the contours of the mapped area; afterwards, with the help of the legend, the

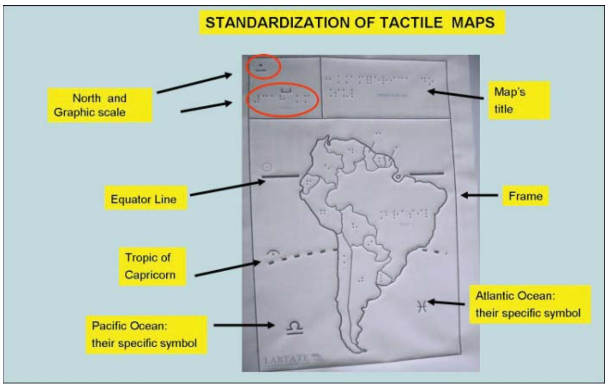

Fig. 1 – Standard layout for the small scale maps produced in microcapsule acetate paper and the example applied to South America in microcapsule paper (original size A4format).

user interprets the parts: the punctual elements, the internal limits that constitute areas and the linear elements, in case they are on the map. The VI needs help to understand how to position a map to read it and what this kind of graphic representation means; once the VI has learned, when faced with other maps with the same configuration of elements, he/she will be able to explore it by himself/herself, departing from the north position to start the reading.

In addition to the layout standardization, other patterns were created in relation to the elements, as shown in Figure 2.

3. ELABORATION OF PLASTIC TACTILE MAPS

The creation of any tactile map is always commenced based on a conventional map, or, in other words, one that can be seen by sighted individuals. After this there is a process that usually, according to Nogueira and Regis (2010) is common to the making of any tactile map elaborated in a handmade fashion, which is resumed below.

3.1 Conceptual and graphic generalization

In the graphic generalization, geometric transformations are applied to make the selection, softening, displacement, fusion and relieving of lines, points or areas of the map. This is not automated for tactile maps due to the necessity of doing much more than algorithms allow. The conceptual generalization continues to be totally a task of the human mind that affects especially the attributes (the classification) of the data represented. In the graphic generalization, transformations that do not affect the symbology of the map are applied, as where in the conceptual generalization the transformations may affect the symbology and reduce the number of classes. For example, if in a map the *eucalyptus* and *pinus* classes appear separated in the legend and they are small and contiguous on the map, in the process of generalization, when the map is reduced, they may be grouped in a single class with a new denomination, for example, Reforestation, and grouped in a single area. The graphic generalization maybe done with the help of a graphic design software or drawn with pencil over paper. The advantage of the drawing on the computer, even if it takes longer to be done, is to be able to store the image of the map in a file format to be used and re-used.

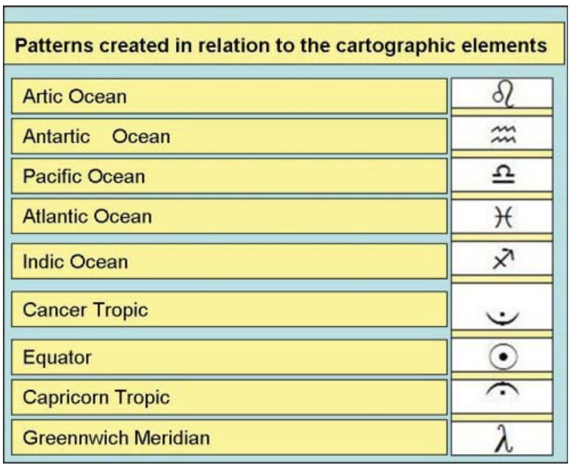

Fig. 2 – Some standard symbols for small scale tactile maps.

3.2 Making of the Model

The images of the generalized maps for the production of tactile maps - as well as those that are available through the LabTATE site, maybe printed over paper of adequate weight (cardboard in A4 or at the most A3 size) and the materials that offer relief to the contours, points, lines and other symbols of the map maybe glued over it.

On the handmade models elaborated in the LabTATE, two different sizes of lines are used, the thicker one to make the external contours of the continents and the thinner one for the internal contours and all of the other symbols. Other indicated materials are cork, beads and fabric and good quality white glue. All are very easy to acquire in stores anywhere, and, especially, are not abrasive to touch and have enough durability for a blind student to use and transport the model to school, in case he/she doesn't have the Termoform machine to produce the final map.

The text must be written in Braille using a Perkinson machine braillex regletee paper, or other type of paper that supports points in relief. After written, each text must be cut out and glued over the map matrix on the appropriate places. As an example Figure 3 demonstrates the model of the tactile map of South America with the models of the respective legend.

3.3 The production of the final map

A model maybe used to generate "n" tactile maps. It will serve as a mold of the map which is placed over a support of a machine of

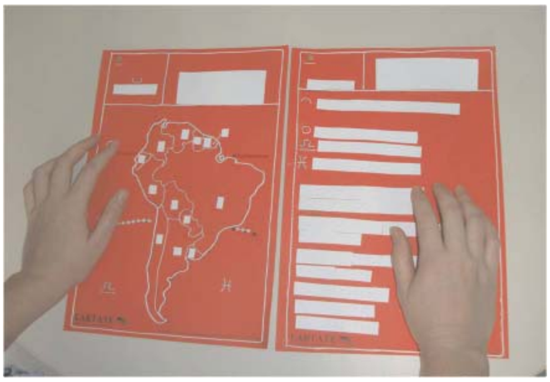

Fig. 3 – Map of South America.

molding plastic which is placed over a supporter of a molding plastic machine using heating and vacuum. The heated plastic is sucked by the supporter where the model is copying all of her relief, or in other words, reproducing the tactile map.

4. MAPAVOX/ TACTILE MODEL SYSTEM

The Mapavox/Tactile Model System was developed through partnership among researches of CEAPLA –Center of Analysis and Environmental Planning of Paulista State University –UNESP –Rio Claro Campus and Tércio Pacitti Institute of Computer Applications and Research (old Center of Electronic Computer Science – NCE)UFRJ. This System is composed by a set of micro-keys, a software called MAPAVOX and tactile pedagogical ensembles (VENTORINI, 2012, BORGES et al., 2011).

The MAPAVOX program is compatible with Windows 95 or superior and the insertion of serialized sound information, through the keyboard by typing of a phrase or text and reproduced by a voice synthesizer available in the System and/or through the recording of sounds using the Windows recorder as a resource. The recorded sounds may be the voice of the user and/or sounds available in different medias and internet. Figure 4 illustrates the opening screen and the main functions of the MAPAVOX program.

Some description icons and functions are presented in order to explain Figure 4. Authors: exhibits the credits of the creation of the system; Inhibits: sensors Inhibits or allows the use of a pedagogic model; Tests sensors: allows testing of the sensors of a pedagogic model connected to the computer; Edit map: allows editing a figure with sound information and associating

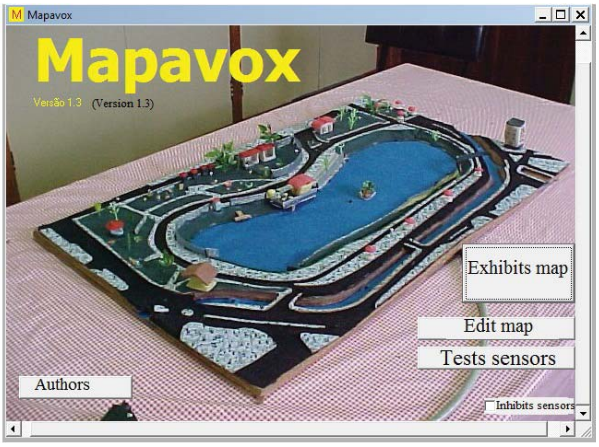

Fig. 4 - Opening Screen with Functions of the MAPAVOX.

this information to a specific micro-key; Exhibits map: exhibits an image connected to the information inserted by the user.

The program and the set of micro-keys allow the user to associate up to four types of sound information in a single micro-key. The maximum number of micro-keys with four types of information that can compose the set is 8. However, the set may have up to 32 micro-keys with one type of information in each one. Its process of elaboration, as well as the materials adopted were reformulated with the objective of making its construction accessible to Elementary School teachers, as well as facilitate its use in games and tactile maps.

The set of micro-keys was developed by Diogo Fugio Takano of Tércio Pacitti Computer Science Applications and Research of (UFRJ) and, initially, the material used in its construction were wire-wraps, printer cables, DB25 for parallel doors and micro-keys (reference 095 and/or 125). Its assembly was done through the welding of the wires on the DB25 and on the micro-keys. This fact made its construction more difficult for the teacher and his/her students, during classes in Elementary School, because of the risks of the accident produced by the welding iron.

After several experiments, the micro-keys of reference 095 and/or 125 were substituted by small pieces of thin aluminum sheets. The procedure of its construction consists in: a) cutting three squares of approximately 2x2 cm of aluminum; b) cut out two small holes in the center of one of the squares; c) take off the wrap of the wire of a RCA connector and fix it on the piece of aluminum with the holes; d) place the piece of aluminum with the wire between the other two pieces, leaving one side with the unwrapped part of the wire exposed; e) weld the wires on the DB 25. Figure 5 illustrates the new micro-key set composed by 8 micro-keys.

The experience with the Tactile Model System - MAPAVOX/Tactile Model System indicates the viability of use of its technology in the production of low cost tactile pedagogic material: models, maps and games. It also indicates to be adequate for tactile use and for the limitations of sight, offering sound resources to broaden the perception and learning process of students with special educational needs. The changes in the System offer more conditions for teachers to develop their own tactile material, with adjustments for people with or without visual limitations.

However, it is pointed out the use of the MAPAVOX demands basic knowledge of cartographic language, necessary for the reading, analysis and interpretation of cartographic documents. The teachers may approach this knowledge with the support of tactile models and maps of the places where the students live, like we describe in item 5.

5. TEACHING VISUALLY IMPAIRED PEOPLE TO READ THE MAP

Teaching visually impaired people to read the map, as well as people without sight problems, should occur since the earliest years of school, passing through the process of cartographic literacy – with activities that develop the spatial abilities of the child, respecting each age group and the nearest concrete space of the student. Until the 5th school year, Simileli (2008) and Almeida and Passini (2010) recommend that the notions of laterality, references and orientation in space, proportion and scale, construction of the legend, the cartographic alphabet (point, line and area), oblique and vertical view, three-dimensional and two-dimensional image be developed.

Fig. 5 - Completed micro-key set Lace.

By analyzing these recommendations, it is verified that vision is present in almost all of the items to be developed. Hence the question, how to conduct this with blind students? Without longer explanations, because this would be the subject of a specific text, it is possible, based on the experiences and researchconducted by the authors, to recommend some procedures to be employed in the process of cartographic literacy of people with visual impairment.

Taking into consideration the fact that children with or without visual impairment acquire spatial notions through actions in familiar environments, cartographic initiation maybe conducted through activities with tactile models representing the place where the students live. Such models may be constructed with low cost materials (offscorings) and maintain the principle of representation of a small physical space within a greater one, which allows the teacher to work with the students the notion of continuity, connection and integration between the spaces proposed by Almeida and Passini (2010). The approach of cartographic concepts having tactile models as support material may start with the model of the classroom, followed by the representation of other environments of the school such as the neighborhood where the school is located and other places in the city.

The space of the classroom of common use of the students, allows them to reflect about the characteristics of the objects organized in this environment, such as the relation of size (proportion), shape, distance, directions, etc. Once this environment is common also to the teacher the mediation will be facilitated. Therefore, the approach of the contents and the development of the activities, using the classroom as the area of study, helps the child to broaden his/her spatial notions and to understand concepts of graphic language (ALMEIDA, 2010).

The tactile models may be used in integrated classes with the participation of blind, poor sighted and sighted students if these are elaborated with some criteria such as: a) the use of materials with pleasant textures to touch and with strong colors; b) by making available information in conventional writing and in Braille; c) by gluing the representation of the objects in order for them not to move when touched; c) by maintaining the relation of the proportion between the representation of the objects, exaggerating them when necessary, to be identified by touch.

The experiences of Almeida and Nogueira (2009) with blind students demonstrated that the identification of the objects of the environment where the students live, such as the bedroom, maybe used in the cartographic initiation of adults. Miniatures of the furniture of the bedroom may be arranged by them, in their correct localizations, in a cardboard box that will symbolize the bedroom (such as a shoebox). This model may be reconstructed several times and, afterwards, the individual maybe stimulated to choose symbols for each one of the objects and post them on a metal plate with magnets to reproduce the positions of each one, making a plant of the room.

To initiate the cartographic literacy of teenage students, Nogueira and Andrade (2009) proposed the following activities:

A) To challenge the student to explore three-dimensional objects with geometrical shapes and afterwards identify them in the drawings in relief which are presented to them.

B) To investigate how the student understands the space where he lives and encourage him to explore it.

C) To present the model of the room and verify what he recognizes; to ask him to draw the localization of the objects in the geometrical shape in which he recognizes each object.

D) To walk with the student through the school and identify the points of reference important to his/her locomotion and to construct the plant of the school with these points.

The observation of models associated with the observation of real environments allows the students, blind or not, to comprehend the projection of the objects of the place where they live in the space that is represented. The exploration and observation of the model and of the real environment together facilitate the process of comprehension in two dimensions by the child.

The experience of Ventorini (2012) indicates that blind students comprehend the meaning of the symbols in tactile maps with one hand on the classroom model and the other on a tactile map of the same environment, at the same time that the researcher, through speech, informs the meaning of each symbol of the map, for example, a line, representing a blackboard, squares representing desks, rectangles representing the teacher's table and the closet, among other things.

The model representing the school, neighborhood, town squares, public spaces such as parks, among others, allows the blind person to decentralize his body as a point of reference to perceive his/her location and move within the environment. The process used by a blind person during his movement consists in a) receiving a perceptive information through touch; b) to analyze and organize the received information based on his perceptions; c) to remember the data about the place, stored in his memory; d) to initiate the movement in the desired direction (VENTORINI, 2009).

The problem is that the perceptive information received during the movement is not always sufficient for the blind person to move about with safety (HUERTAS, OCHAÍTA, ESPINOSA, 1993).The ability to anticipate information for moving about safely through the senses of touch, hearing and smell is smaller related to the perceptive capacity of vision. Besides this, this capacity may be muffled by external noise of car traffic, for example. Objects that do not produce sound or smell are only perceived by the blind person when touched with parts of their body or with a cane. Even with the use of a cane during the movement the blind person only anticipates obstacles within a meter of distance of his position.

This way, the exploration of a model or map allows the blind person to anticipated the information about the presence of objects or the modifications in the localizations of objects in a specific environment, accelerating the process of anticipation of objects, as well as, the process of reorganization of information used in their movement, contributing to the acquisition of information that will help him/her to acquire information that will help him/her in daily movement.

6. FINAL CONSIDERATIONS

Maps are recognized by blind people as the main tool for the geographic comprehension of the world and for his/her orientation and mobility, despite the help of new technologies. This fact justifies that these people have adapted maps for their use and that they know how to use them.

It is necessary that the organisms responsible for the production of maps and teachers know how to make this kind of map and that they also may be responsible for the acquisition of cartographic literacy in blind and/or visually impaired people. The standardization of tactile maps, as proposed by LabTATE, facilitates both the production as well as use of these maps, while the Tactile Model System/MAPAVOX is a tool for visually impaired students with the use of models and maps.

In order to make tactile maps it is necessary to consider that the tactile discrimination is much less detailed that the visual one. Because of this, the fundamental is not to transform what is visual into tactile, but to try to reach an understanding of how this reading is done and how the cognitive process happens in visually impaired – only this way it is possible to make maps that they are able to read. Besides this, it is necessary to know how the spatial development of the blind person happens in order to conduct the process of cartographic literacy. In this case, the use of three-dimensional representations of the environment where the blind person lives is the most adequate manner to reach the map, which means that the map should be a model. In this text we present some experiences that show how to use models to help cartographic literacy.

Last and not least, the mediation of this process is a role of the teacher. He/she must be careful with the language used, because the geographical concepts involved are not always understood by the visually impaired in the same way as language of the visual world. For example, a river is represented by a blue line because it makes a path and water is blue. This is too vague and does not make sense to a person who has never seen or that has a limited capacity of vision.

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