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DEMOCRATIZATION OF THE TEACHING OF MORPHOLOGICAL SCIENCES PROJECT: PROMOTING ACESSIBILITY FOR VISUALLY IMPAIRED PEOPLE

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Abstract
In Brazil, although access to education is guaranteed by law, the inclusion of disabled people in the educational system is not occurring at the necessary speed, either due to lack of educational resources or lack of adequate training of educators. The extension project Democratization of the teaching of morphological sciences: promoting accessibility for visually impaired people aims to research and develop adequate didactic material, low of cost, and easy to reproduce, for the teaching of cellular biology and histology to the visually impaired. The tactile matrices, forms of representing structures with the use of materials with different textures and reliefs, were the didactic tools chosen. At present, tactile matrices of various cells of biological tissues are being made and tested. The results obtained will be published with the confection of an atlas of morphology and the creation of the electronic website of the project.
Keywords: Inclusive education. Didactic tools. Visual impairment. Cell biology. Histology.

PROJETO DEMOCRATIZAÇÃO DO ENSINO DE CIÊNCIAS MORFOLÓGICAS: PROMOVENDO ACESSIBILIDADE A PESSOAS COM DEFICIÊNCIAS VISUAIS

Resumo
No Brasil, apesar do acesso ao ensino ser um direito garantido em Lei, a inclusão de pessoas com deficiências no sistema educacional não está ocorrendo na velocidade necessária, seja por falta de recursos didáticos ou por falta de formação adequada dos educadores. O projeto de Extensão Democratização do ensino de ciências morfológicas: promovendo a acessibilidade a deficientes visuais visa pesquisar e desenvolver material didático adequado, de baixo custo e fácil reprodução, para o ensino de Biologia Celular e Histologia a pessoas com deficiências visuais. As matrizes táteis, formas de representar estruturas com a utilização de materiais com diferentes texturas e relevos, foram as ferramentas didáticas escolhidas. Atualmente, matrizes táteis de várias células dos tecidos biológicos estão sendo confeccionadas e testadas. Os resultados obtidos serão divulgados com a publicação de um atlas de morfologia e a criação do sítio eletrônico do projeto.
Palavras-chave: Educação inclusiva. Ferramentas didáticas. Deficiência visual. Biologia celular. Histologia.

PROYECTO DEMOCRATIZACIÓN DEL ENSINO DE CIÊNCIAS MORFOLÓGICAS: LA PROMOCIÓN DE ACCESIBILIDAD A LAS PERSONAS CON DEFICIENCIAS VISUALES

Resumen
En Brasil, el acesso a lo ensino es um derecho garantizado por la lei, la inclusión de persona con deficiencia en el sistema educacional no ocurre con la misma velocidad que se necessita, debido a la falta de recursos didácticos o por falta de adecuada formación delos educadores. El proyecto de extensión Democratización del ensino de ciências morfológicas: la promoción de la accesibilidad a las personas con deficiencias visuales busca investigar e desarollar materiales didácticos adecuados, de bajo costo y fácil reproducción, para el ensino de biología celular y histología a los deficientes visuales. Las matrizes táctiles, las representaciones de estructuras utilizando materiales de diferentes texturas y relieves, son las herramientas didácticas elegidas. Actualmente, matrizes táctiles de variadas células de los tejidos biológicos están sendo producidas y testadas. Los resultados obtenidos se convertirán públicos como un atlas de morfologia y la criación de lo sitio electrónico del proyecto.
Palabras clave: Educación Inclusiva. Herramientas Didácticas. Deficiencia Visual. Biología Celular. Histología.

INTRODUCTION

In this paper, the trajectory of the development of this project will be described: its beginning, the carried out activities, the obstacles overcome and the next challenges.

Contextualization

According to the IBGE (2010) 18,8% of the population of Brazil is affected by some type of visual impairment, with 17% declaring severe visual impairment, with great difficulty or not being able to see at all. Data from the Ministry of Education and Culture indicate that in 2007 there were 654.606 students enrolled in basic education, amidst these only 1,2% were considered impaired, but only 4 out of 10 impaired students were attending school.

In Brazil, there are Laws, Ordinances and Decrees ensuring the access of all citizens to the educational system and establishing the duty of the State in promoting all forms of inclusion to the disabled. However, social inclusion of the disabled is not happening in the speed necessary for the integration of all in the educational system. It is also noted the lack of studies in the area of accessibility, for example, there is little official data about: Who are the disabled students? What do they do? What is the social and economic condition of their families? Why the majority of them are not attending school? What pedagogical tools are available in their schools?

The inclusion of all Brazilians in the educational system is an indispensable condition for the social, cultural and economic growth of the country. Besides the access to school being a right to the citizens, expressed in the Federal Constitution (Articles 205 and 208), the Law 9.394 of 1996 ensures the resources and educational techniques necessary to the education of the disabled (FERREIRA AND SILVA, 2012). However, there still are various big hurdles to overcome in order to promote accessibility for disabled people to the educational system. Such overcoming passes through the search of new strategies and technologies that make possible the development of courseware adequate to the process of teaching/learning and, consequently, promote the social inclusion of these students.

Conception

This extension project began to be idealized at the end of 2014, after the presentation of a PPCC (Pedagogical Practice as Curricular Component) of the subject MOR 7003-General Histology Applied to the Biological Sciences (PPCC 10h), ministered to the students of UFSC's Biological Sciences Course, as a proposal to teach the histology of the thyroid gland to visually impaired students. The students Caren L. da Rosa Pedroso and Larissa D. de Azevedo built a

model of the gland. Like this, came up the question: how to teach Histology to students affected with blindness?

Histology is a basic discipline, of the Morphological Sciences area, that studies the biological tissues, their formation, structure and function. The use of tools such as light microscopes, books and atlases with photomicrographs, strong obstacles in the teaching/learning process of blind students, is ordinary for the histological practice of sighted students.

The search for answers led us to find the accessibility sector of UFSC's library, where we had the first contact with the materials used by other areas of knowledge, mainly the geosciences, for the teaching of visually impaired students. Then, we went to visit LABTATE (Tactile and Scholastic Cartography Laboratory) of UFSC's Department of Geosciences, whereby we were welcomed by Professor Dr. Ruth Emília Nogueira that presented us her projects and agreed to work with us. This way our partnership with LABTATE began and in May 2015, the project was registered on the platform Notes, with the participations of Professor Ruth Emília Nogueira, her PhD student at the time, Léia de Andrade and Professors Dr. Kieiv R. S. de Moura, Dr. Eliane M. Goldfeder and Dr. Patricia de Souza Brocardo from the Department of Morphological Sciences (MOR), and UFSC's students, Caren L. Da Rosa Pedroso, Cleide dos Santos, Jade de Oliveira, Larissa D. de Azevedo, Matheus F. Haddad and Monique Piacentini.

Professor Ruth Emília Nogueira and Léia de Andrade ministered multiple workshops about their work at LABTATE and the tools and strategies used to teach Geography to blind students. There began our trajectory through an area of knowledge previously unknown in our pedagogical practice: the universe of inclusive education.

The initial challenge wasn't only to make the integration and adaptation of the knowledge received for the teaching of Histology, but to open our hearts and minds to new ways of seeing and perceiving the world, the world of visually impaired people. How do these people see and perceive the world? A possibility is through other senses such as hearing, touch and smell (SMITH, 2008; NOGUEIRA, 2009; SOLER, 2009), mainly the development of tactile perception, because the hands become the eyes of blind people (CARDINALI AND FERREIRA, 2010).

Other questions came up, for example: how to refer to the disabled person? And what is disability? Answering the first question – according to the Communication Manual from SECOM (Special Secretariat of Social Communication of the Federal Senate) – the best way to refer is "disabled person", while the term "deficient" must be used just to avoid repetition on phrases. In relation to visual disability, the best way is "visually impaired person", while "visually impaired and blind" also are accepted. As reported by World Health Organization (WHO, 2010),

there are two types of visually impaired persons: blind – when there is total or severe loss of vision and low or subnormal vision – when there is major functional impairment of the eye, even after treatment and repair.

To the second question – what is disability? – there isn't a simple answer, the concept being a complex one, that approaches the medical model, the social model and the feminist critic, broadly discussed by DINIZ (2007). The importance of the social model stands out, where the disability does not only stem from the injured body, but from the social barriers that trouble the impaired, that demands the application of affirmative policies, pushing for the inclusion of the aforementioned (DINIZ, 2007; SILVA, 2018).

In relation to visual impairment, VYGOTSKY (1993, 1994 and 1997) discourses about blindness's social and psychological aspects, indicating that "blindness is not merely the lack of vision" and that this condition "by creating a peculiar formation of the personality, reanimates new sources, changes the normal directions of functioning and, in a creative and organic way, remakes and forms the psyche of the person". According to Vygotsky, if the impaired children are stimulated and inserted in an adequate educational environment, with favorable didactic material, their learning ability will improve.

In the educational context, various tools are utilized in the education of the visually impaired, like the tactile matrices, books in the Braille system and digital audiobooks. The tactile matrices are forms of representing structures with the utilization of materials that have different textures and reliefs, and are widely used in tactile cartography, representation of geographical phenomena and localization of places (LOCH, 2008; FERREIRA AND SILVA, 2012; FERREIRA AND SILVA, 2014).

In relation to the teaching of sciences, there are few studies about the use of didactic tools developed and available to the teaching of visually impaired students (CARDINALI AND FERREIRA, 2010; CODEN AND GARCIA, 2017; OLIVEIRA, 2018; COSTA, 2018). Between these, the work of OLIVEIRA (2018) about the use of tridimensional models stands out in the teaching of Cellular Biology to the visually impaired, which also highlights some of the challenges for Brazilian education to become more inclusive: the lack of preparation of the professor and the difficulty of accessing adequate didactic resources by students and professor. CARDINALI AND FERREIRA (2010) also demonstrated the importance of the utilization of tridimensional models of a cell and of cellular structures for teaching visually impaired students from the first year of high school.

It was found then that the use of tridimensional models is proven to be an effective didactic tool in the learning process of visually impaired students. However, in several papers, it is

noticeable that several of the models described and utilized were big, cumbersome and of difficult reproduction.

This project aims to study, develop and improve techniques and didactic tools, low of cost and easy to reproduce, for use in the teaching of morphology of cells and tissues to the visually impaired, both blind and low vision.

ACTIONS CARRIED OUT

The didactic tools chosen to be developed were tactile matrices.

Despite the discipline of Histology addresses the study of biological tissues, to learn Histology, the students need prior knowledge of Cellular Biology, morphological sciences area that studies the morphofunctional characteristics of cells. Thus, the construction of tactile matrices of different cells was started, representing the four basic tissues: epithelial, connective, muscular and nervous.

Construction and reproduction of tactile matrices

For the construction of low cost tactile matrices, materials with different sizes, reliefs and textures were used, like fabrics, sewing threads, strings, buttons, straw, beads and various materials used in the making of costume jewelry **(Fig. 1)**. It should be noted that said materials must be resistant to temperatures up to 70º C so that the matrix can be reproduced in acetate during the process of thermoforming.

Figure 1: Materials used in the construction of tactile matrices.
Source: NUNES (2018).

The first tactile matrix built wasn't tested by a visually impaired person due to having lots of mistakes. Among the problems identified by collaborator Léia de Andrade from LABTATE, can be highlighted the great amount of organelles and the tiny space between them **(Fig. 2).**

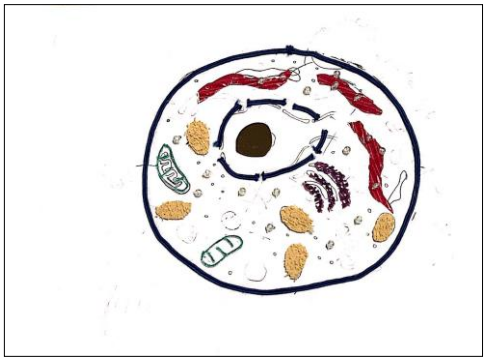

Figure 2: Tactile matrix of an animal cell.
Source: Authors.

In the construction of the following matrices, the cells were drawn utilizing the program INKscape 0.91 (Boston, MA, EUA), printed in A4 paper and evaluated by the Histology professors. Then, the detected mistakes were corrected and the drawings were reprinted in A4 paper with 180g/m^2. After, the matrices were built with the materials shown in **Fig. 1.** With these matrices the process of thermoforming was realized using the machine Termocop (LABTATE CMDV Braille copier) **(Fig. 3)**. Thermoforming is a process in which a sheet of acetate is heated up to 70ºC over the tactile matrix, in Termocop, thus making a copy similar to the matrix being used as a mold **(Fig. 4)**.

Figure 3: Termocop – LABTATE.
Source: LABTATE Website: http://www.labtate.ufsc.br/ct_como_se_faz_reproducao_termocop.html

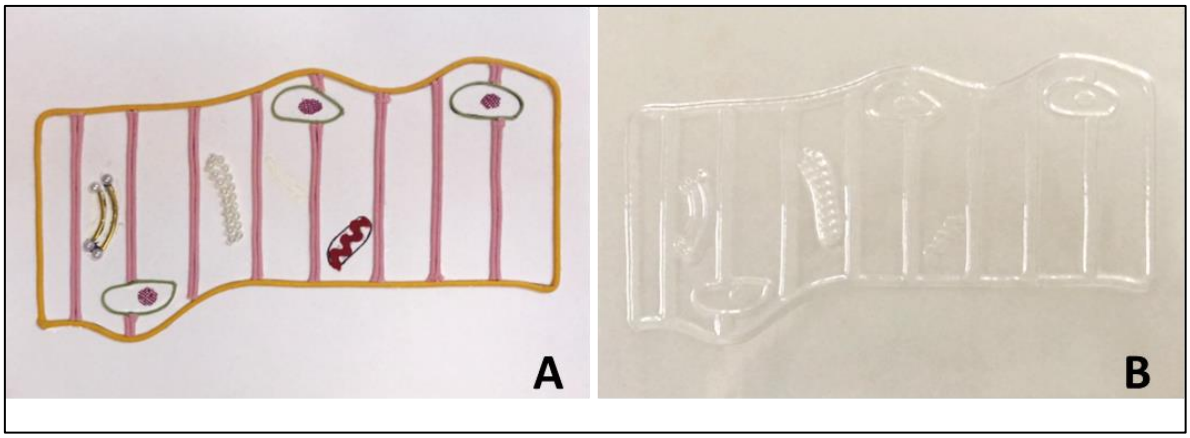

Figure 4: A- tactile matrix of a skeletal striated muscle cell. **B-** copy in acetate of the matrix shown A.
Source: Authors.

Afterwards, several tactile matrices and their acetate copies were tested by the visually impaired student, Sabrina M. de Assunção, from LABTATE **(Fig. 5)**.

Figure 5: Test of the matrices at LABTATE.
Source: Authors.

In the beginning of 2017, the project's team changed with the leaving of some students and the entrance of some new ones. In this moment, the professor Dr. Juliano A. Miyake from the Department of Morphological Sciences (MOR/CCB) also became a collaborator. In the end of 2017, Professor Dr. Ruth Emília Nogueira retired and Professor Dr. Rosemy da Silva Nascimento from LABTATE joined this project's team, providing the continuation of our partnership. Besides that, at the beginning of 2018, we were contemplated with a scholarship in the edict PROBOLSA 2018 and the scholarship student Matheus H. M. Grisoski became a collaborator in our project.

At this new stage, with new perspectives and after several tests carried out by Sabrina, some changes in the construction of the tactile matrices were made, such as the use of A3 paper and the addition of subtitles in each matrix (**Fig. 6**).

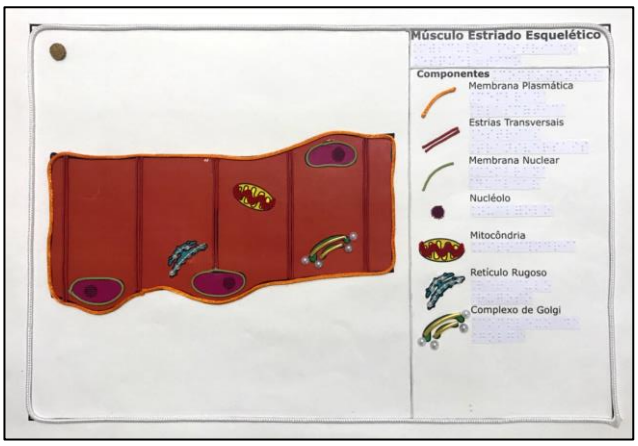

Figure 6: tactile matrix of a skeletal striated muscle cell.
Source: authors.

The researches and production of material for low vision students have also been initiated, with the help of Kainara Ferreira de Souza from CAE/UFSC (Educational Accessibility Coordination/Federal University of Santa Catarina), that presented to us UFSC's employee and student William Steffan de Oliveira that began to test the material produced (**Fig. 7**).

Figure 7: examples of matrices of a smooth muscle cell for visually impaired people with poor vision.
Source: authors.

In July 2018, the student participant of this project, Pâmylla R. O. Nunes, developed her undergraduate thesis about the construction of tactile matrices, describing the obstacles overcome until that moment and detailing, step by step, the construction process of the matrices (**Fig. 8**).

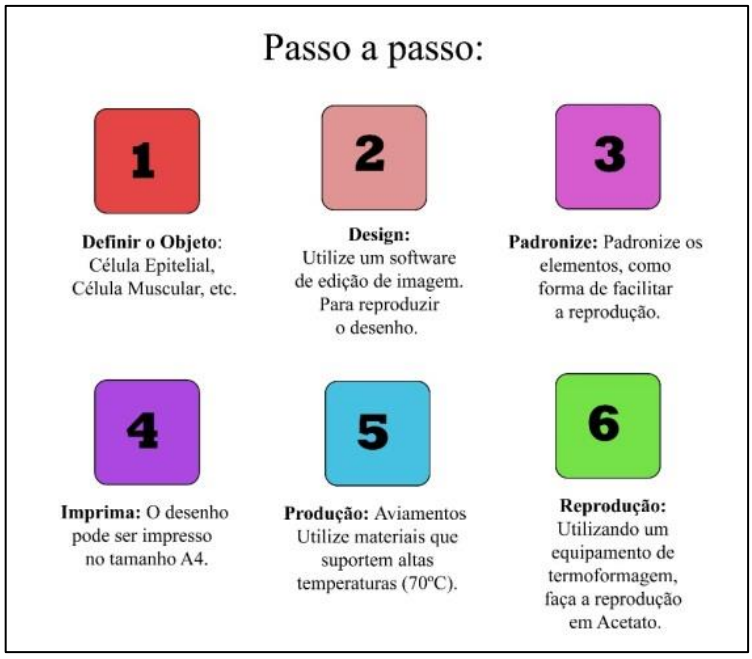

Figure 8: step by step construction of the tactile matrices.
Source: NUNES (2018).

Currently, the tests with the tactile matrices of cells, as well as for the material for the impaired with poor vision are being finalized, aiming at the publication of these results in a morphological atlas and at the electronic website of the project.

PARTICIPATION IN EVENTS

This project provided until the current moment participation in the following events:

- Presentation in "Bio in School" (BioPIBID/UFSC, 2016: Institutional Program of Teaching Initiation Scholarship/ Federal University of Santa Catarina);

- Presentation in stands at Teaching, Research and Outreach Week (SEPEX) of the Federal University of Santa Catarina in 2016 and 2017;

- Defense of the undergraduate thesis of student Pâmylla R. O. Nunes, in July 2018;

- Presentation in the round table "CCB Extension", from XIX Academic Biology Week at UFSC, in 2018;

- This project was approved and contemplated in PROBOLSA 2018 and in PROBOLSA 2019, and now in Edict 01/2019/PROEX (PRORECTOR'S OFFICE FOR OUTREACH AND EXTENSION) – SUPPORT POLICY FOR INCLUSION.

FINAL CONSIDERATIONS

Beginning from all that was experienced until here, it was found that this proposal presents broad and new possibilities of application in teaching and research aimed at the inclusion of people with visual impairment.

The investigation of the results obtained using the didactic material developed will permit, also, the generation of new knowledge that will provide a better advantage in the teaching-learning process of visually impaired people, as well as contribute to the academic formation of students and professors dedicated to this area of knowledge.

NEXT CHALLENGES

The future perspectives of this project include:

- Publishing an atlas with tactile matrices of cells;

- Obtain permission from the Ethics Committee on Human Research to test the matrices with low vision and blind students from ACIC (Catarinense Association for the Integration of the Blind) and/or middle and high schools. For this, the project was also registered as a research project, emphasizing the development of didactic tools for the teaching of students with visual impairment;

- Make the electronic website of the project together with UFSC's webpage. Divulge the results in social media such as Facebook and Instagram;

- Adapt the drawings to allow for 3D printing of the tactile matrices.

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