

NEUROEDUCATION APPLIED TO TEACHING AND LEARNING IN ARCHITECTURE AND DESIGN: PEDAGOGICAL PRACTICES WITH USING REPERTORY CONSTRUCTION

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Abstract

The repertory presents itself as an essential element for the understanding, application, and communication of the process of creating and elaborating a project, being a relevant theme in the teaching of Architecture and Design. The repertoire that the student brings from his personal experiences is related to his life story, to his social, cultural, and emotional relationships, and is being built and expanded based on a joint intertwining, between what he brings from this life trajectory and the stimuli received of the school. This process of building the repertory is closely related to the cognitive process. Recent research in the cognitive field has shown that project teaching and pedagogical practices in architecture can be rethought and restructured with the application of neuroscience-based principles, which are presented through neuroeducation. Neurosciences allow the understanding of how the brain processes and retains information, being able to contribute to the cognitive processes involved in the project design, through stimuli that enhance the use of the repertory. This article aims to establish an approximation with the field of cognitive neuroscience from the analysis of empirical pedagogical experiences carried out in design disciplines of the early years of Architecture and Urbanism and Interior Design courses, focusing on the study of the project repertory. Such experiences were analyzed in the light of theoretical references in the field of cognitive sciences, especially the neurosciences applied to teaching and learning, with a focus on the principles of neuroeducation. To this end, a cut was made of the teaching methodologies in subjects of the courses of Architecture and Urbanism at the University of Taubaté - UNITAU, and in the Higher Course in Technology in Interior Design at the Federal Institute of São Paulo, both in the state of São Paulo, Brazil, in the years 2018 and 2019. With the results it was possible to weave relationships between the teaching methodologies used and the principles of neuroeducation, understanding how the brain captures, stores, and transforms the information collected into knowledge, thus activating the student's repertory in the project design. This process resulted in significant apprenticeship, showing that it is possible to contribute transdisciplinary with the teaching practice in Architecture and Design.

Keywords: Architecture, Design, Neuroscience, Neuroeducation, teaching and learning process, teaching methodologies, repertory.

1 INTRODUCTION

The beginning of an architectural or interior project is always a task fraught with uncertainty, as it tends to consider the creative process as something like the act of artistic creation. Between art and technique, science and creativity, the project allows for multiple approaches and answers very subjective questions. Because of this artistic nature, creativity is often seen as an inherent gift or talent of the designer, considered something that appears unexpectedly in the designer's mind, and not a skill that can be taught and learned. It is known, however, that this aura of mystery that involves the creation of a project is a mistake, and therefore the idea that being able to "create" a project is a gift must be discarded.

The realization that a project is not born from a blank slate and reflections around the studies of project references are common in the various researches and publications on the subject, and there seems to be an agreement between the authors that to start a new project and design the project. first stroke on a blank sheet, there is a prior intention that comes from an existing framework, as demonstrated by several authors and scholars such as [1], [2], [3], [4] and [5], among others found in the literature.

Such works strengthen the role of the repertoire and its importance as an essential element for the understanding, application, and communication of the process of creation and elaboration of the project in Architecture and Design. This belief about the use and importance of the repertoire in the design process

is not new. Traditionally, in teaching architecture, the repertoire has been used as a practice since the days of classical antiquity, when project precedents were adapted to create new possibilities [3].

Precedents of projects, adaptations, prior knowledge, baggage of knowledge, study of references, memories, and project memories, among other countless denominations, contemplate what is intended here to approach the concept of repertoire, and contribute to provide information and instrumentalize the student in Architecture and Design areas. Such information and instruments bring possibilities for critical reflection to make the pertinent connections between the various information contained in the reference projects and so that one can reflect on the project that is being created.

The formation process of the individual's repertoire is composed of several variants that go far beyond the knowledge that is built in the classroom. The student, when entering the educational space, already carries with him a vast bag of cultural references, formed by his traditions, customs, styles, tastes, beliefs, and life stories, as already demonstrated in previous reflections, as in Barbosa [6]. When we speak of this repertoire that the student brings from his personal experience archives, we speak of a person's life, that is, of what he brings and carries as a socio-historical subject, of his construction as an individual, in the emotional and sentimental relations with his life's history. In this way, this collection is being built and expanded based on a joint intertwining between what it brings from this life trajectory, and the stimuli received within the school [6].

This process of building the repertoire is closely related to cognition, and recent research in the field of cognitive-behavioral neurosciences applied to teaching and learning demonstrates that didactic strategies aimed at the design process can be rethought with the help of principles based on neuroeducation. Neuroeducation is a transdisciplinary field of knowledge that studies the relationship between mind, brain, and education from the understanding of brain mechanisms related to learning, and considers biological, cognitive, and behavioral factors, but also aspects related to emotions and feelings present in children. educational processes [6], [7]. In this sense, neuroeducation can contribute to the actions involved in project design through stimuli that enhance the use and expansion of the repertoire.

Neuroeducation helps to detect psychological and brain processes that can interfere with learning, bringing an understanding of how the brain captures, stores, and transforms the information collected into knowledge. With this, it contributes to direct the strategies that can be used in class to activate the brain processes of emotion, feelings and curiosity in order to awaken the mechanisms of learning and memory that the student brings from their life stories, and in this way, feed the repertoire in the project design [6], [8].

This article seeks to establish an approach with the field of neurosciences from the observation of empirical pedagogical experiences carried out in disciplines of the early years of Architecture and Design courses that developed approaches for building a repertoire in the teaching and learning of design. Such experiences were analyzed in the light of theoretical references in the field of cognitive sciences based on the principles of neuroeducation, with a focus on emotions and feelings present in the educational universe.

2 METHODOLOGY

To guide the analyzes and approximations of the pedagogical experiences with the field of cognitive sciences, an investigation of the adopted theoretical framework was carried out, based on the principles of neuroeducation from the concepts formulated by [8] in the work entitled "*Neuroeducación: Solo se puede aprender aquello que se ama*". For neuroeducation to happen, there are some elements that [8] all's "a set of neural ingredients", composed of brain processes and mental capacities such as memory, learning, attention, awareness and biological factors, and the psychological phenomena of emotion, feelings, and curiosity.

It is the latter, the affective components, that interest us in this approach, as stimuli to evoke curiosity and awaken students' involvement and feelings towards learning. In this sense, the pedagogical practices reported below are then analyzed based on the principles of neuroeducation, focusing especially on those related to emotion, feelings, and curiosity.

2.1 Pedagogical experiences in Architecture and Interior Design courses

To account for the intended approaches, the pedagogical practices of two disciplines in the creative-design field were observed, which occurred from empirical experiences in the first years of the

curriculum in the course of Architecture and Urbanism (AU) at the University of Taubaté (UNITAU), in the year 2014; and later in the Superior Technology (CST) course in Interior Design (DI) at the Federal Institute of São Paulo (IFSP) in the years 2018 and 2019, both institutions located in the state of São Paulo, Brazil.

In this way, it was possible to establish a look at the theoretical-practical approach to building a repertoire in the teaching of design from two different scales that complement each other: that of architectural design and its relationship with the city, during Architecture and Urbanism, and from the interior design and its relationship with the furniture, in the DI course. In both disciplines, reading and design analysis activities were proposed to present introductory notions about the project, to foster the construction of a design repertoire among incoming students and to evaluate the pre-existing concepts brought by them in relation to the understanding of space and of the design fundamentals. In addition, the objective was to awaken the creative and critical capacity to start the design process, bringing them closer to the universe of Architecture and Interior Design, to instrument for the project in the disciplines that precede them in the curriculum throughout the course.

2.2 Bachelor's Degree in Architecture and Urbanism from UNITAU. Discipline: Project I

The first pedagogical experience with the formation of a repertoire in the teaching of architectural design took place with the first-year class of the Architecture and Urbanism course at UNITAU, located in the municipality of Taubaté, in the interior of the state of São Paulo, Brazil, in 2014. An activity was called "analysis of architectural poetics", and aimed to introduce notions of concept, language and part of architectural design, spatial organization, needs program, access flows, materiality, and tectonics, among others, from the reading and analysis of residential projects of great architectural relevance.

In this strategy, the introduction of design thinking was adopted from the construction of a repertoire with cultural visits, studies of iconic references in architecture, and activities of reading and analysis of projects, eliminating the creative-design exercises at the beginning of the course, to develop them only at the end of the course, when the student has already matured in the area and does not need to leave a "blank slate". It was based on the understanding that the student arrives at the University without consistent project references, although it is known that he brings and carries with him the previous knowledge and life stories stored in his memories. Therefore, this repertoire is being fed and built collectively in the classroom from his personal experiences, either individually or in conjunction with what is provided to him at school.

The architectural poetics analysis exercise was proposed to be developed in small groups that should carry out research, interpretation and analysis of projects considered consistent references in the field of Architecture to foster repertoire and critical reflection among the class. The contents should be formatted and distributed on boards in A1 format, elaborated entirely freehand, to significantly incorporate the apprehensions of the analyzed work, using sketches, diagrams, texts, legends, and arrows that communicate the different design aspects. From then on, each group should make a short presentation and presentation of their work to the whole class, allowing the exchange and expansion of the collective repertory.

Among the design aspects proposed for analysis, it was requested: contextualization of the project and work, biographical data of the designer, insertion of the design place and relations with the surroundings and the landscape, analysis of conditions, implantation, characteristics of the surroundings, concept, party and architectural language, uses and functions of compartments, circulations, displacements and flows, distribution of the needs and environments program, layout, composition, materiality, tectonics, techniques used, in addition to the specifics of each project. Each of these concepts and elements was theoretically discussed throughout the practices and the development of the works in the studio.

2.2.1 IFSP CST Interior Design Course. Discipline: Reading project and repertory

The second pedagogical experience took place in the CST Interior Design course at IFSP, located in Jacareí, state of São Paulo, Brazil, in the years 2018 and 2019, with students from the first year of the course. As it is also an introductory discipline that precedes the design components, it is a space for discussion and construction of concept and repertoire, of presenting the great designers, the iconic furniture, to instrument for the interior design from of design readings. In addition, it is a space for recognition of the class that is arriving in the course, of their particularities, of the baggage and experiences brought.

Among the methodologies and activities worked in this discipline, we worked with the perception of space from cardboard boxes on the real scale, using the free spaces of the school, in a work of repertoire

of pre-dimensioning notions to understand the space and dimensions from the experience with the body, as can be seen in the images presented in the results, below (activity A). The work of readings and analysis of iconic design references was also carried out similarly to the activity of analysis of architectural poetics of the AU course, mentioned above, but here with a focus on the scale of interior design (activity B). This proposal resulted in a third activity of reading and analyzing designers and furniture, on the scale of the furniture project (activity C). The discipline also worked with visits and cultural trips, to arouse curiosity and emotionally involve the new students in this search to introduce him to the universe of Interior Design. The results and reflections on such experiences are presented below.

3 RESULTS

3.1 Course on Architecture and Urbanism at UNITAU. Discipline: Project I

The following images show some of the work done by the students and demonstrate their involvement with the proposed activity, bringing up issues regarding interpretation, apprehension, and ways of incorporating aspects of the analyzed projects. It is noteworthy that the purpose of bringing these images is to demonstrate the forms of expression and communication used by students to approach the experiences with the principles of neuroeducation, without the pretension that the texts and captions with the information and content of the boards are apprehended by the reader of this article.

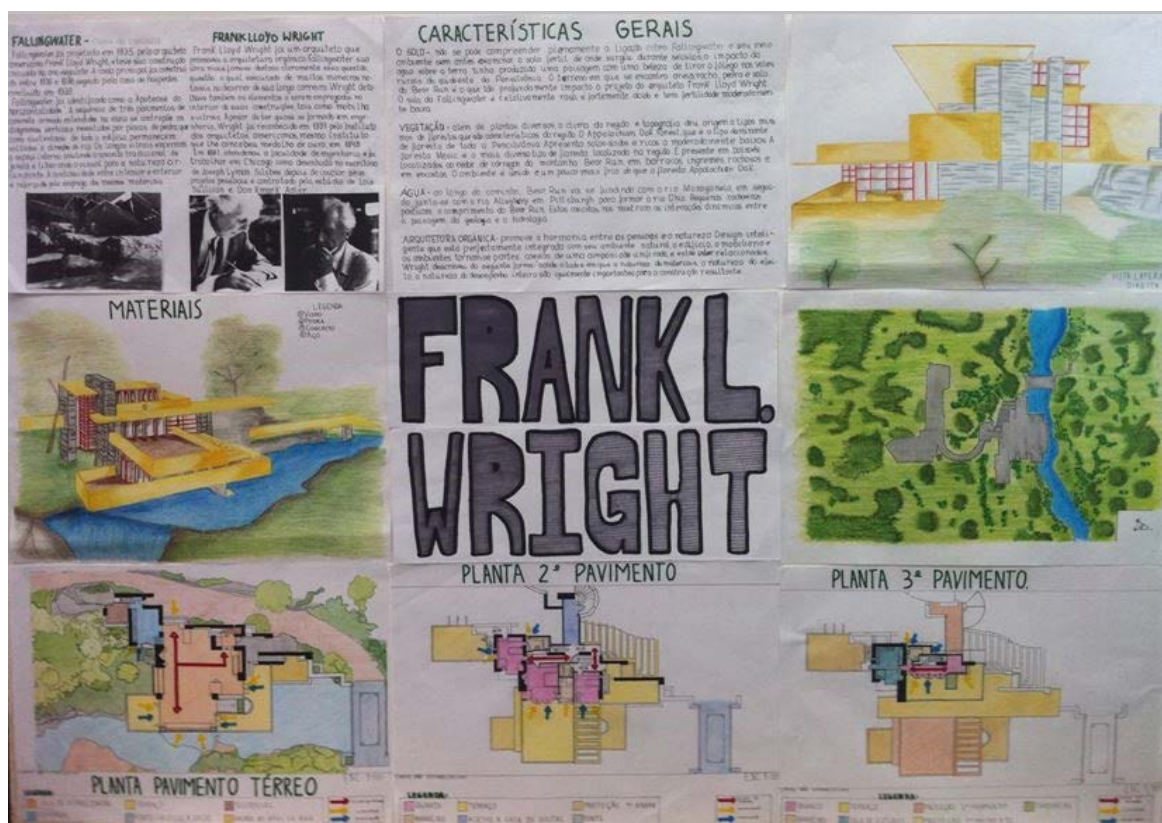


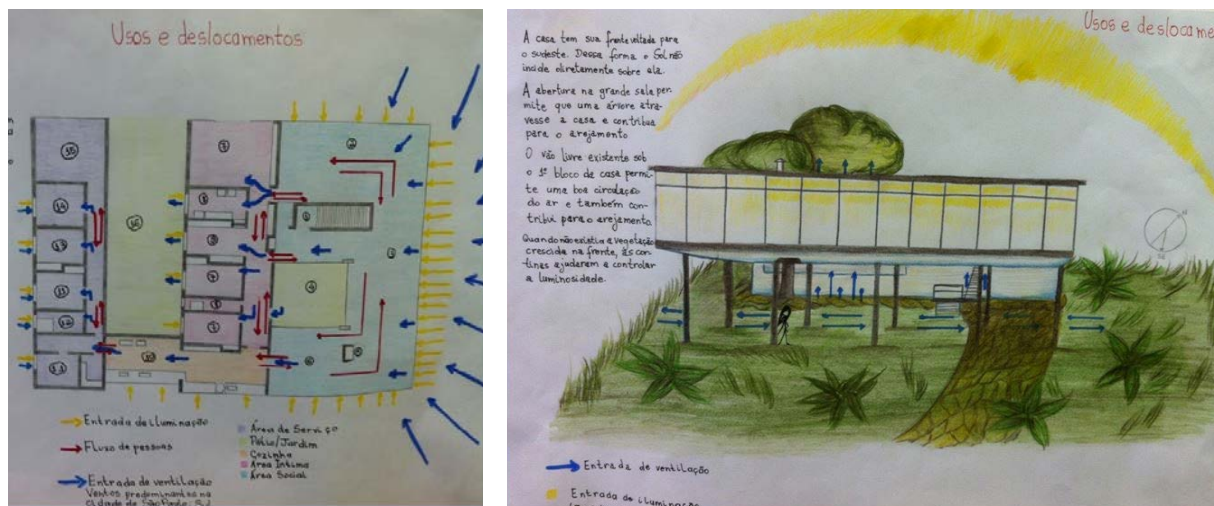
Figure 1. Work of projectual references for the formation of a repertoire. Cascade House. Frank L. Wright. Conducted by students of the first year of the AU course at Unitau, 2014.

The way in which the design elements and analyzes were represented through sketches, diagrams, arrows, use of colors and hatches, went through a mental process of decoding and understanding of each team, showing different interpretations and forms of expression. It was necessary to understand and apprehend each aspect of the project, for its interpretation and registration in a creative way, which could communicate the idea.

Figure 1, on the previous page, shows the use of colors to sectorize spaces and demonstrate the distribution of uses and functions according to the program, the use of red arrows to indicate the main flows, arrows in orange to indicate the entry of natural lighting, blue arrows to indicate the prevailing

winds, among other forms of communication selected by the students to demonstrate the analysis of the various aspects and particularities of the famous project by Frank L. Wright. Such strategies used on the boards demonstrate that it was necessary for the group of students to understand the party adopted by the architect for implementation, the flows thought about the distribution of the house, the best implantation to receive natural light and air circulation, the choices of materials, among others, generating discussions and critical apprehensions about such concepts and design elements.

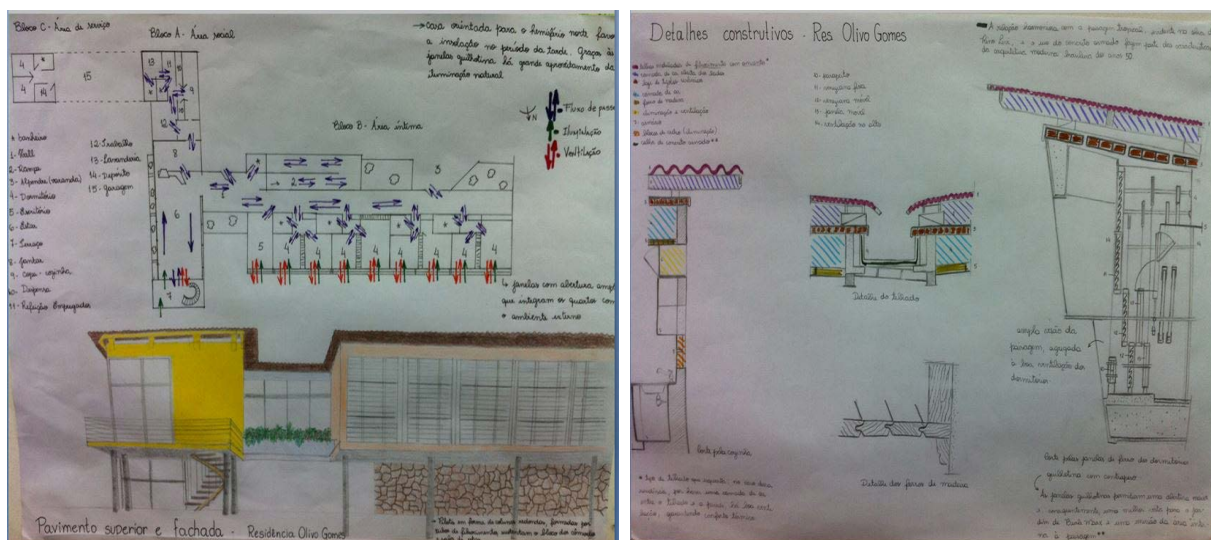
In the same way, it can be seen in figures 2 and 3, below, the concern to bring visual elements, colors, arrows, and hatches used in a creative way to demonstrate important points in the analysis of the glass house project, an important architectural reference of architect Lina Bo Bardi in the city of São Paulo. How to represent the board the entry of natural light and justify the implantation, or how to demonstrate the flows in the spatial organization? In the example of the images presented, the students used the yellow color to represent the entrance of natural light, showing with arrows the openings in which this illumination is directly present (figure 2), and “stained” the view of the tape window with yellow. (figure 3). Blue arrows were used to express air flows and ventilation, and the colors and hatches brought the sectorization and organization of spaces. It is noticed that the team of students learned the knowledge of the main elements that guided the design of the house project, and that this process of understanding the concepts and the party adopted by the architect turned into learning.



Figures 2 and 3. Work of iconic design references for the formation of a repertoire - Glass house. Lina Bo Bardi. Conducted by students of the first year of the AU course at Unitau, 2014.

The images in figures 4 and 5 on the following page illustrate an interesting experience with the team that studied and analyzed the Olivo Gomes residence, located in São José dos Campos, São Paulo, by modernist architect Rino Levi, as the involvement with the research grew from the on-site visit. It was possible to establish several relationships with modernist architecture, and students were able to experience the five points of modern architecture (free facade, tape windows, stilts, garden terrace and free floor plan) from observation in practice, in addition to knowing the Burle Marx gardens that surround the land. At the time, the group was very curious about the system of openings in the intimate part of the house, taking pictures and asking questions of the group of teachers. This curiosity motivated them to an intense research on the system of frames and frames used by the architect.

In the project studio, the group tried to communicate through the drawing on the boards all the sophisticated system of frames to present to the whole class, which made the involvement with the theme quite intense, as they wanted to be able to explain to colleagues how that system was built. It was observed the excitement with which they presented this work to the other students of the class, showing details of the frames, pointing out curiosities about Levi's work, and narrating all the paraphernalia that constitutes the frames of the residence. The new discoveries opened other possibilities of knowledge about the points of modern architecture, and the answers to these questions became challenges, stimulating curiosity and emotional involvement for learning, expressing itself through the feelings of the students.



Figures 4 and 5. Work of iconic design references for the formation of a repertoire - *Residência Olivo Gomes*. Rino Levi. Conducted by students of the first year of the AU course at Unitau, 2014.

The results of the work carried out show the particularities of the proposals, demonstrating that each group was involved in a peculiar way with the projects, bringing up what it considered most important and significant in the project, due to what it meant for him and his previous references. The process of reading the project, interpreting, analyzing, understanding, and then having to communicate the most important aspects and elements with drawings went through a brain exercise that stimulated the mental capacities of memory and attention, as it was necessary to understand each one in depth. one of the design aspects relating them to their own references, contributing to reflection and collective thinking. All this emotional involvement and the pride in having developed a good job to be presented to the class provided the experience of collaboration, dialogue, and acceptance of different points of view, demonstrating an intense deepening in research, which strengthened the appropriation of the analyzed and discussed, enabling reflection and the transformation of information into learning. Because the experiences meant something important and significant to them, arousing emotions, and feelings in the learning process, such as the joy of leading and raising critical discussions in the projects.

3.2 CST Course on Interior Design at IFSP. Discipline: Reading project and repertoire

3.2.1 Activity A - spatial perception with cardboard boxes

This activity enabled the spatial perception of what the student knows as “space”, from everyday dimensions, through his experience with the body and concrete execution using real elements (cardboard boxes), trying to make space explicit as an object of Design, and introducing the notion of the bi and three-dimensionality of shapes in space. The challenge enabled the construction of shapes and volumes using cardboard boxes in the open space of the schoolyard, in a sequence specified and guided by the teachers. The boxes functioned as a module for the construction of elements (“walls”, walls, and circulations). The students experienced these elements, these “spaces”, and gaps between created elements, and were able to perceive the dimensions in different ways, experiencing the spaces and circulations created between the boxes, making relationships with the heights and depths. The groups recorded the entire development process, listing the sensations and perceptions obtained throughout the sequence of activities. The first stage was collective, and the second stage was distributed in groups, who needed to create shapes and represent them through sketches.

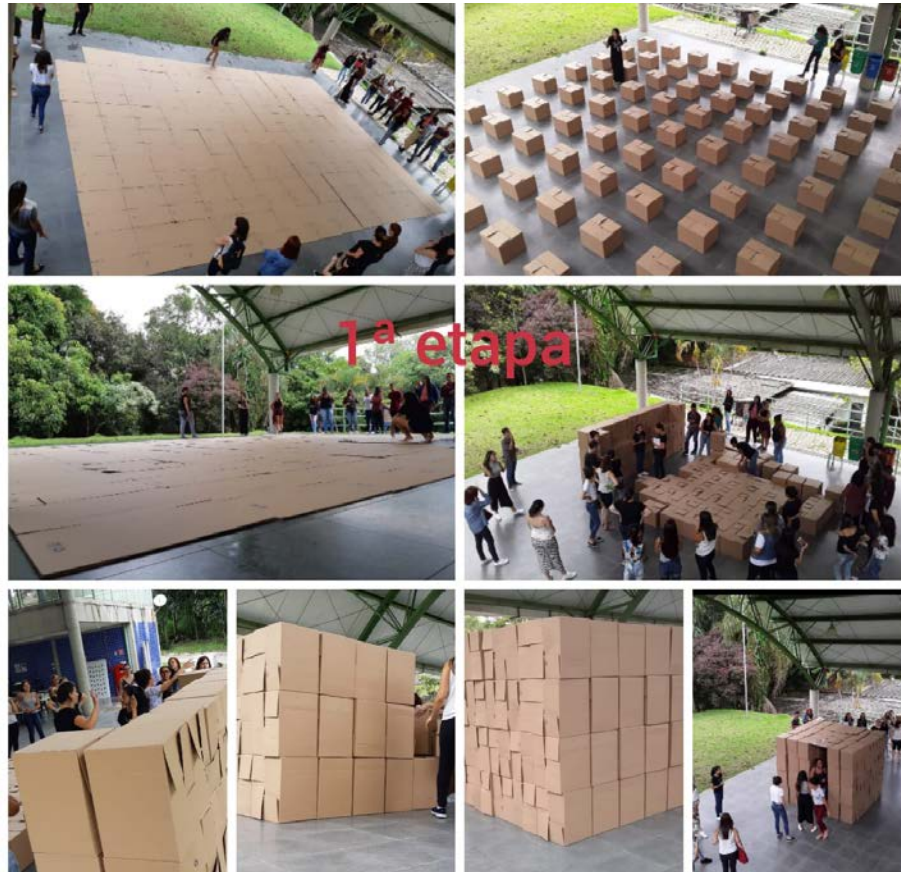


Figure 6. Work of repertoire: understanding of space and minimum dimensions from experience with the body and cardboard boxes. Project Reading Discipline and repertoire. Held by students of the first year of the Interior Design course, 2018.

3.2.2. Activity B - Readings and analysis of design references in Interior Design

The proposed activity of reading and analyzing project references of this discipline resulted in the investigation and development of works that are considered icons in the field of Interior Design, and the works were presented on freehand planks that highlighted the main aspects analyzed in the project, similarly to the activity carried out in the Architecture course. However, due to the specificity of the scale and scope of the DI, the proposal focused on internal environments, furniture, and artifacts. The following images demonstrate some specificities and interpretations brought by the teams, showing the compositions of plastic and aesthetic elements that make up the interior projects, such as materials, colors, textures, finishes, furniture, among others. Upon understanding the program's distribution in the environments, the details of the elements used and their meanings in the design composition, the intention of the colors and materials chosen, the teams began to scrutinize the concepts used, bringing meaning to each of the choices to justify the adoption of the party defined by the designer. Each new material verified in the projects of the environments enabled research on technologies and innovations in the field of design, further feeding the repertoire of references, expanding research possibilities.

This activity was interesting as a pedagogical practice because it positively stimulated the class, involving students with joy and enthusiasm for research, bringing the “ingredients” that neuroeducation proposes. It is like the euphoria of a child with a new toy, and as Mora points out [8] “emotion stimulates curiosity, attention and interest in discovering something new”. There was a feeling of belonging and bonding, and the students proposed an exhibition in the common areas of the school, allowing the visualization and contact of other colleagues and classes, stimulating curiosity and empathy between them. Emotion and empathy are essential for the teaching and learning of children and adults [8].



3.2.3 Activity C - Reading and analysis of furniture references and iconic designers

This exercise was an offshoot of the previous activity and consisted of the analysis on the furniture designers of the projects studied in activity B, with the use of digital platforms, instead of hand-made boards, and was done individually by each student. Each member of the teams selected a piece of furniture and / or artifact from the house previously studied to carry out a more in-depth investigation regarding the ergonomic, functional, material, technical and artistic aspects of the selected furniture or object. The research took place in the computer lab and the products presented were infographics prepared on digital platforms, such as Canva and Miro. The change in the proposed tool, which went from the freehand exercise to the one performed with innovative digital technologies, generated enthusiasm among the class, as it involved a new challenge and apprehension of new tools. This contributed to trigger brain stimuli that activated the curiosity generated by the challenge and the new possibilities. The use of the internet for research and investigation also provided moments of great involvement among students in the laboratory. As stated by Mora [8], the internet is a cultural revolution that can facilitate the processes of learning, memory, and acquisition of new knowledge and if used properly it can enhance and expand teaching and learning.

The results of this activity contributed to feed the repertoire related to designers who are a reference in furniture and artifact projects in the field of Design, and made possible the curiosity and motivation to know and learn, because in several situations it was possible to find students in the computer labs outside class hours, involved in research on designers presented by other groups, or unfolding on new

projects. It was evident the students' affective and emotional involvement, perceived at different times during the practices.

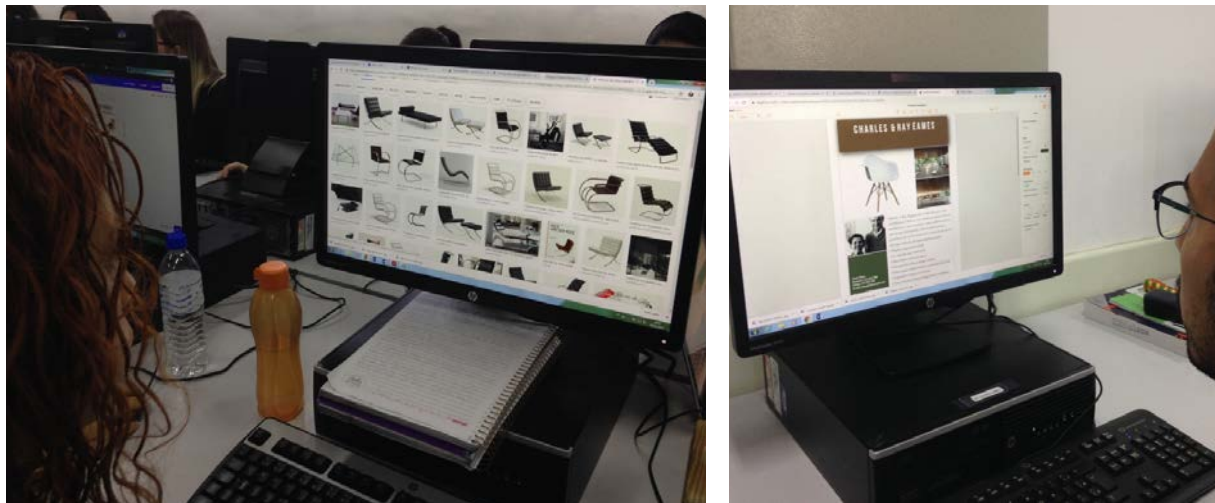


Figure 9. Work of furniture references for repertoire. Development of research in the laboratory by students of the first year of the Interior Design course, 2019.

It is noteworthy that according to the principles of neuroeducation proposed by Mora [8], the activation of curiosity is understood as one of the basic ingredients of emotion, and motivation is an essential condition for learning. The results of research motivated by the students' curiosity and emotional involvement generated infographics products that were brought together in an exhibition about the great designers of Brazil and the world, according to some examples illustrated below.



Figure 10. Reference work by designers and furniture to form a repertoire. Infographics developed on the Canva platform by students of the first year of the Interior Design course, 2019.

To place the observer's gaze in an analysis of the processes and methodologies used to build the project repertoire, a great approximation of the didactic strategies is envisaged with the concepts and principles proposed by the theoretical framework adopted for neuroeducation.

4 CONCLUSIONS

With the results it was possible to weave relationships and approximations between pedagogical experiences aimed at building a repertoire in the project design and the principles of neuroeducation, focusing on the emotions and feelings present in the educational universe. It became evident that strategies based on stimulating curiosity and motivation related to aspects that make sense to students, that relate to their life repertoire, and that arouse emotional involvement and empathy, promote feelings, and create links with information and content worked, translating into effective learning.

Such approaches are important to direct the didactic strategies on the processes involved in the conception of design in Architecture and Design, specifically in the steps that precede the first sketches of an idea, when working with the design repertoire. It is possible to activate brain mechanisms that refer to emotional relationships, feelings, experiences, and life stories, which were built, stored, and consolidated in a learning context provided by the involvement and bonds created; and subsequently evoke memories and references from this project repertoire to be used in a new project.

Relationships with neuroeducation can contribute to the understanding of brain mechanisms and mental constructions that constitute a repertoire based on the processes of activation and processing of information and memories constructed in the context of learning by the student designer, of what he brings and carries with him while socio-historical and cultural subject, who is fed into affective pedagogical experiences, in order to contribute to potentiate the construction and use of the repertoire in the design process.

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