



## **DESIGN AND NEUROERGONOMICS IN IDENTIFYING ATTENTION RESTORATIVE ELEMENTS OF CHILDREN WITH ADHD IN EDUCATIONAL ENVIRONMENTS**

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**SUMMARY:** This work aimed to support a doctoral thesis under development whose theme is: the application of Design and Neuroergonomics in identifying elements that restore the attention of children with ADHD in educational environments. To this end, a Systematic Literature Review was carried out in order to search for studies that addressed children and/or adolescents with ADHD, in the learning/attention process in educational environments, in the light of Neuroergonomy and the Theory of Restorative Environments. The searches took place on the CAPES Periodicals Portal and the PRISMA method was used for this purpose. The filters used were only articles published in the last 5 years (2016 – 2021), peer-reviewed, in English and Portuguese. 166,419 articles were found, of which the first 100 of each combination were analyzed by title and abstract. After dynamic reading of the works, 14 articles remained divided into two groups: group A of greater relevance and B of less relevance. The articles in group A correlated the attention and learning of children with ADHD, suggesting and applying interventions of pedagogical and/or technological procedures to assist in the teaching and learning process for this audience. The work of group B addressed the experiences of professional educators and students with ADHD in the teaching environment. No works were found that correlated all the points sought, especially the 'Theory of Restorative Environments' to ADHD, thus proving the need to expand the search in future RSL works, and that there is a lot of room for new studies in this field.

**KEYWORDS:** Systematic Literature Review, Design, Neuroergonomics, Theory of Restorative Environments, ADHD.

### **INTRODUCTION**

Attention Deficit Hyperactivity Disorder (ADHD) is a neurobehavioral disorder with genetic causes that occurs in childhood and often accompanies the individual throughout their life. According to the Brazilian Attention Deficit Association (2020), ADHD affects 3% to 5% of children in various regions of the world, and in more than half of cases the disorder persists into adulthood.

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According to Arruda et al. (2015), approximately 912 thousand Brazilian children aged between 5 and 12 were diagnosed with ADHD, but without any type of clinical treatment. However, another 625 thousand minors, 2.3% of the total, do not even know the existence of the neurological disorder.

One of the main complications associated with ADHD is related to problems with concentration and consequently learning (ARRUDA ET AL., 2015, p.5). This fact highlights the need for specialists to focus attention on these individuals in educational environments, based on the child's right to go to school, participate, interact and develop.

Thus, the present study aims to contextualize Design in its multidisciplinary approach, establishing its connection with Neuroergonomics, ADHD and the Theory of Restorative Environments, with the aim of contributing both to these fields and to Design itself.

For the development of this research, a bibliographical survey was carried out, through a Systematic Literature Review, with the main objective of supporting the doctoral thesis being developed by the author herself, in the Postgraduate Program in Design at the Federal University of Pernambuco.

In the following topic, the theoretical foundations guiding this research will be explained.

## **DESIGN, ADHD, NEUROERGONOMICS AND RESTORATIVE ENVIRONMENTS**

To better understand the concepts of Design, Ergonomics, ADHD, Neuroscience and the Theory of Restorative Environments, this topic is divided into two parts. The first part, which follows, aims to establish a relationship between Design, Ergonomics and teaching environments, and the second part, later, sought to highlight the connection between ADHD, Neuroscience and the Theory of Restorative Environments.

### **Design, Ergonomics and Educational Environment**

Design is a word that has Latin origins, *designare*, which means to develop, conceive (BÜRDEK, 2010). The designer designs artifacts, environments and services. For Beat Schneider (2010):

Design is the creative and systematic visualization of interaction processes and messages from different social actors; it is the creative and systematic visualization of the different functions of objects of use and their adaptation to the needs of users or the effects on recipients (SCHNEIDER, 2010 p. 197).

Thus, Papanek (1995) highlights the importance of removing designers from the comfort of their offices and making them observe real social needs, considering that experiences are fundamental to training a design professional.

Therefore, Design comprises a multidisciplinary field that covers social, anthropological, psychological, marketing, ergonomic aspects, among others. As Ergonomics is one of its areas of study, the combination of Design and Ergonomics in social and educational intervention practices is understood as an essential process, since, according to Iida (2016), ergonomic requirements make it possible to maximize comfort, satisfaction, and user safety. According to ABERGO (2000):

Ergonomics is characterized as the study of people's interactions with technology, organization and the environment, aiming at interventions and

projects that aim to improve, in an integrated and non-separated way, safety, comfort, well-being and the effectiveness of activities. humanities (ABERGO, 2000).

In this way, ergonomics is understood as an area that aims to transform and adapt, not only work, but space to the different needs of human beings, taking into account their limitations and characteristics.

Therefore, the combination of Design and Ergonomics can bring benefits to projects related to the educational environment, as according to the International Ergonomics Association (IEA, 2021), through data collection and ergonomic analysis, it is possible to identify physical factors - linked the anatomy, anthropometry, physiology, and biomechanics of the user and the activity analyzed; cognitive - such as mental processes, which use aspects of the user's perception, memory, reasoning and motor response in relation to the activity performed; and organizational - which assesses, in a holistic, systemic and integrated way, the activity environment, the relationship between the constituent parts of the organization, work flows and process schedules.

Furthermore, the National Guidelines for Special Education in Basic Education, presented by the Ministry of Education (MEC) (2001), states that it is not the student who molds himself or adapts to school, but it is the student who, aware of his role, it is available to the student, becoming an inclusive space (BRASIL, 2001).

In view of these considerations, Askina (2016) argues that the teaching environment must be effective to contribute to the successful adaptation of children with ADHD to the schooling process. Furthermore, Harrison et al. (2019), state that Design interventions in the educational environment can provide improvements in the quality of teaching and learning for these children.

A deeper understanding of ADHD, the concept of Neuroscience and the Theory of Restorative Environments will be covered in the following topic.

### **ADHD, Neuroscience and Restorative Environment Theory**

Arruda et al. (2015) define ADHD as a neurobiological disorder, generally genetic and hereditary, characterized by a dysfunction in the prefrontal cortex, the part of the brain responsible for decision-making, action planning and emotion control, which directly influences cognitive abilities. and behavioral aspects of children.

The spectrum of ADHD brings together cases with different variations of the neurological disorder, and the NeuroSaber institute (2016) states that all care offered during childhood may be able to minimize the complications associated with ADHD, as children with ADHD often present an index low performance in school environments (KUHLEN AND PUFF, 2014, p. 35). These complications, in turn, may be related to behavior and mood (aggressiveness, excitability, anxiety, hyperactivity, restlessness, irritability or lack of moderation) and cognition (problems with difficulty concentrating, forgetfulness, lack of attention and learning difficulties). ) of child.

Furthermore, there are several multidisciplinary areas that are interested in studying human thought and behavior, such as Environmental Psychology, Cognitive Psychology, and Neuroscience. According to Paiva (2018), the last two added to Ergonomics, result in Neuroergonomics.

According to Parasuraman and Rizzo (2007), Neuroergonomy converges concepts from the disciplines of Neuroscience and Ergonomics, and aims to study the brain and human behavior when carrying out activities, highlighting the context of cognition and behavior of individuals in work environments. daily. That is, the Neuroergonomics approach invests in

studies of neural structures to, through brain functioning, affirm or refute the prediction of tasks performed (PAIVA, 2018, p. 120).

According to Paiva (2018), human activities carried out in physical spaces are mediated by human cognition and perception in relation to these spaces, in order to optimize the physical, psychological and emotional needs required by users for these environments. Therefore, Design, when combined with Neuroergonomy, can be understood as a factor that constitutes a device that aims at physical and psycho-emotional well-being, capable of expanding human capabilities and potential.

For Bins Ely (2003), the influence of the built environment on the individual's behavior is related both to the demands of the task to be performed in the environment and to the characteristics and needs of the user. This is justified when the physical environment responds to users' needs, both in functional (physical and cognitive) and formal (psychological) terms, resulting in a positive impact on the performance of activities. Given this, the environment can provide a restorative space that helps the behavior, conduct and performance of its user.

Thus, the concept of restorative environment, an original term from Environmental Psychology, is used to describe the process of feelings awakened by the environment, which can have a positive influence on the health and well-being of the individual (ALTMAN & WOHLWILL, 1983; KAPLAN & KAPLAN, 1982; KORPELA, 1989).

Thus, Oliveira et al. (2019) emphasize that a welcoming/restorative educational space must promote the health of students, and constitutes an important public health issue, with personal, environmental, social and institutional impact. And Kuhnen and Puff (2014), in their studies with children with ADHD, state that the school environment should promote participation and learning, since the role of the environment is integration, attention and learning.

Therefore, in order to better support the study and identify other, more recent works in the literature that better addressed the topic in question, bibliographic searches were carried out in the databases of the Periodicals portal of the Coordination for the Improvement of Higher Education Personnel (CAPES). ).

The methodological procedure adopted for data collection was the Systematic Literature Review (RSL). The search method will be described in the following topic.

## **METHOD**

The Systematic Review was developed based on the PRISMA method - Preferred Reporting Items for Systematic Reviews and Meta-Analyses (SALAMEH ET AL., 2020).

The study comprised a systematic review of a qualitative and analytical nature, as it deeply evaluated the information collected, in an attempt to explain the selected works that addressed the theme of: children and/or adolescents with ADHD, in the learning/attention process in educational environments, teaching strategies and Design interventions in classrooms, in the light of Neuroergonomics and the Theory of Restorative Environments.

As a source of consultation, the CAPES journal database was used, selected due to the considerable inclusion of journals in carrying out its searches: Scopus (Elsevier), SciELO (CrossRef), MEDLINE, PubMed (NLM), among others.

To this end, the following keywords in the Portuguese language were used as descriptors: “Neuroscience, Ergonomics, Neuroergonomy, educational environments, schools, learning process, learning, teaching, classrooms, Design, Interior Design and Restorative Environments, combined with the terms ADHD and Attention Deficit Hyperactivity Disorder”, and in some cases with the terms “NOT Treatment” and “NOT Medication”. In English the terms were used: “Neuroscience, Ergonomics, Human Factors, Neuroergonomics, educational

environments, school, learning process, learning, teaching, classroom, Design, Interior Design, Restorative Environment, combined with the terms ADHD and Attention Deficit Hyperactivity Disorder ” and in some particulars with the terms “NOT Treatment, NOT Medicine and NOT Drug”.

The search filtered only articles published in the last 5 years (2016 – 2021), reviewed by peers, that is, only for articles evaluated by at least two evaluators, in English and Portuguese. The Inclusion and Exclusion criteria for the works analyzed were:

- *inclusion* – articles that addressed the topic of children and/or adolescents with ADHD in the teaching environment; studies focusing on the learning of children and/or adolescents with ADHD; studies that addressed teaching strategies and design interventions in classrooms for children and/or adolescents with ADHD, in the light of neuroergonomics and/or the theory of restorative environments;
- *exclusion* – research that samples adults with ADHD; works that only address clinical pathologies and/or use drugs in analysis and treatment; studies that deal with other conditions in addition to and/or combined with ADHD, such as Autism Spectrum Disorder (ASD).

The searches took place in four stages, as illustrated in Fig. 1.

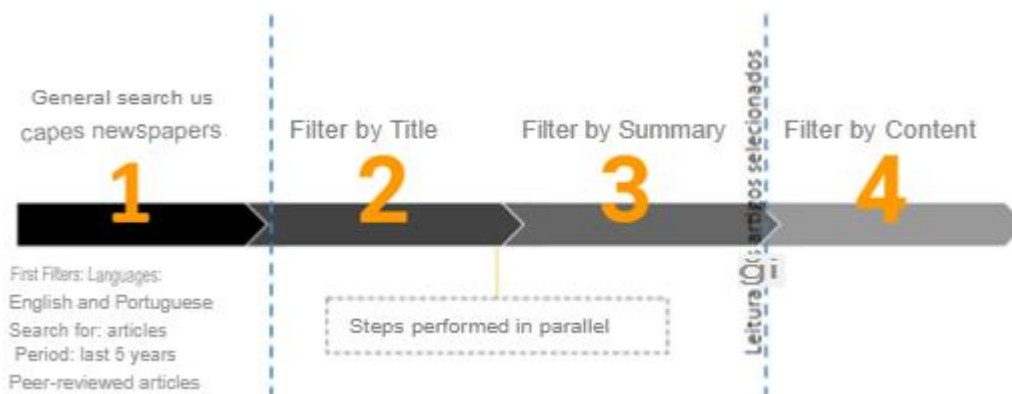


Figure 1. RSL steps based on the PRISMA method. Source: author (2021)

The first stage comprised a general search for articles on the CAPES Journal Portal, using pre-defined filters. The search returned a grand total of 166,419 articles in Portuguese and English. To carry out the searches, the Any – Any categories were chosen, which brings together all the other categories offered by the platform: Title search, Author search and Subject search.

The Boolean operators selected for the searches were 'and' and 'not' since the use of the Boolean 'or' did not generate results targeted to the study. Furthermore, the search for keywords was carried out in pairs, since the attempted combination in trio, using the Boolean 'and' returned very few results.

Thus, to form the combinations, the descriptors were always combined with the terms ADHD or Attention Deficit Hyperactivity Disorder, and in some particularities accompanied with the Boolean 'not', aiming to exclude articles that only addressed drug treatments and drug use. . The combinations of keywords used in the searches can be seen in tables 1 in Portuguese and 2 in English, respectively.

Table 1. Searches on the Journal Portal, articles – CAPES – Terms in Portuguese

<b>Search category: Any – Any Keyword / Boolean / Keyword</b>	<b>Return (number of articles filtered by peers)</b>
Neurociência <i>and</i> TDAH	7
Neurociência <i>and</i> TDAH <i>not</i> Tratamento	6
Neurociência <i>and</i> TDAH <i>not</i> Medicamento	6
Neurociência <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	4
Neurociência <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade <i>not</i> Tratamento	0
Neurociência <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade <i>not</i> Medicamento	0
Ergonomia <i>and</i> TDAH	0
Ergonomia <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	0
Neuroergonomia <i>and</i> TDAH	0
Neuroergonomia <i>and</i> TDAH <i>not</i> Tratamento	0
Neuroergonomia <i>and</i> TDAH <i>not</i> Medicamento	0
Neuroergonomia <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	0
Neuroergonomia <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade <i>not</i> Tratamento	0
Neuroergonomia <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade <i>not</i> Medicamento	0
Ambientes Educacionais <i>and</i> TDAH	4
Ambientes Educacionais <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	0
Escolas <i>and</i> TDAH	18
Escolas <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	6
Processo de aprendizagem <i>and</i> TDAH	21
Processo de aprendizagem <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	12
Aprendizagem <i>and</i> TDAH	35
Aprendizagem <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	21
Ensino <i>and</i> TDAH	29
Ensino <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	14
Sala de aula <i>and</i> TDAH	13
Sala de aula <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	9
Design <i>and</i> TDAH	64
Design <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	3
Design de interiores <i>and</i> TDAH	0
Design de interiores <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	0
Ambientes Restauradores <i>and</i> TDAH	0
Ambientes Restauradores <i>and</i> Transtorno do Déficit de Atenção e Hiperatividade	0
Total	272

Table 2. Searches on the Journal Portal, articles – CAPES – Terms in English

<b>Search category: Any – Any Keyword / Boolean / Keyword</b>	<b>Return (number of articles filtered by peers)</b>
Neuroscience <i>and</i> ADHD	5.355
Neuroscience <i>and</i> ADHD <i>not</i> treatment	1.944
Neuroscience <i>and</i> ADHD <i>not</i> medicine	2.490
Neuroscience <i>and</i> ADHD <i>not</i> drug	3.322
Neuroscience <i>and</i> Attention deficit hyperactivity disorder	5.586
Neuroscience <i>and</i> Attention deficit hyperactivity disorder <i>not</i> treatment	1.710
Neuroscience <i>and</i> Attention deficit hyperactivity disorder <i>not</i> medicine	2.273
Neuroscience <i>and</i> Attention deficit hyperactivity disorder <i>not</i> drug	3.000
Ergonomics <i>and</i> ADHD	99
Ergonomics <i>and</i> Attention deficit hyperactivity disorder	118

Human Factors <i>and</i> ADHD	9.670
Human Factors <i>and</i> Attention deficit hyperactivity disorder	10.366
Neuroergonomics <i>and</i> ADHD	8
Neuroergonomics <i>and</i> ADHD <i>not</i> treatment	4
Neuroergonomics <i>and</i> ADHD <i>not</i> medicine	4
Neuroergonomics <i>and</i> ADHD <i>not</i> drug	7
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder	12
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder <i>not</i> treatment	8
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder <i>not</i> medicine	8
Neuroergonomics <i>and</i> Attention deficit hyperactivity disorder <i>not</i> drug	9
Educational environments <i>and</i> ADHD	1.836
Educational environments <i>and</i> Attention deficit hyperactivity disorder	1.740
School <i>and</i> ADHD	15.463
School <i>and</i> Attention deficit hyperactivity disorder	14.633
Learning Process <i>and</i> ADHD	7.811
Learning Process <i>and</i> Attention deficit hyperactivity disorder	7.959
Learning <i>and</i> ADHD	15.367
Learning <i>and</i> Attention deficit hyperactivity disorder	16.525
Teaching <i>and</i> ADHD	3.147
Teaching <i>and</i> Attention deficit hyperactivity disorder	2.980
Classroom <i>and</i> ADHD	3.308
Classroom <i>and</i> Attention deficit hyperactivity disorder	3.078
Design <i>and</i> ADHD	12.683
Design <i>and</i> Attention deficit hyperactivity disorder	13.093
Interior Design <i>and</i> ADHD	111
Interior Design <i>and</i> Attention deficit hyperactivity disorder	95
Restorative Environment <i>and</i> ADHD	151
Restorative Environment <i>and</i> Attention deficit hyperactivity disorder	174
Total	151.368

The second and third stages, filtering by title and summary, respectively, were carried out in parallel, since, often, just by analyzing the title of the work it is not possible to infer the content it covers. Thus, at this stage the titles and abstracts of the articles were analyzed in order to separate those of most relevance. To this end, the first 100 most relevant articles from each of the 70 groups of keyword combinations presented were evaluated, totaling 7,000 titles and abstracts analyzed.

After this analysis and selection of works, repeated articles were excluded at this stage, resulting in a total number of 91 articles, 10 articles in Portuguese and 81 in English to be analyzed in dynamic reading in order to verify whether the content of the works in question actually complied with the inclusion and exclusion criteria described previously.

Of these works, 1 study in Portuguese and 13 in English were selected, totaling 14 articles that best met the purposes of this research to be evaluated in full reading. In order to illustrate the review up to this stage, a graphical scheme presented in Fig. 2 was developed.



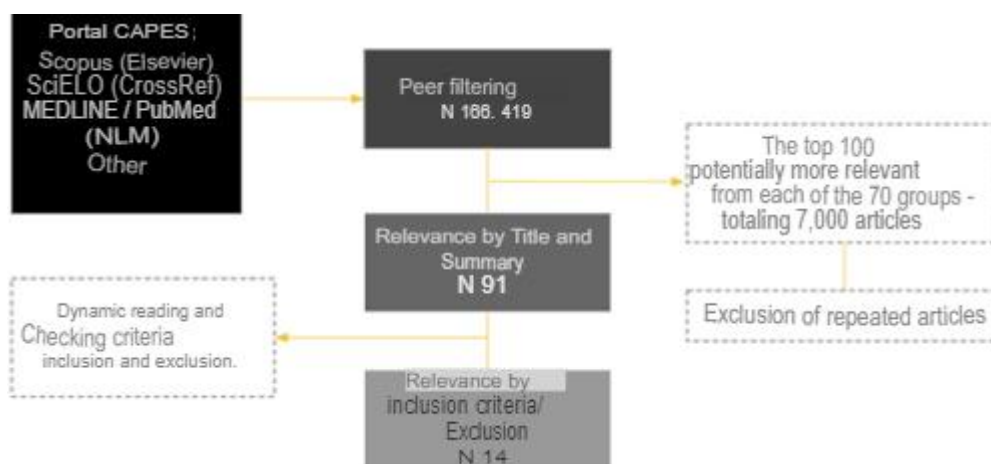


Figure 2. Steps 1, 2 and 3 of the RSL process. Source: author (2021)

In the fourth and final stage, a complete reading of the selected works was carried out with the aim of analytically exploring the material. Using the PRISMA method, the work information was systematized in an Excel spreadsheet with the following categories: title, author(s), reference, summary, country of origin, object of study, objectives, methods and tools, results, conclusion and classification of work relevance.

This method made it possible to divide the articles into two groups: A and B. The criteria for this division were based on the degree of relevance of the content of each article regarding the focus theme of this Systematic Review.

In group A are the works that showed greater relevance for the research, as they had a greater focus on the topic studied. In this group, the works addressed learning/attention processes of children with ADHD in classrooms, in the light of Design and Neuroscience interventions.

In group B are the works that were less relevant to the study. They discussed the teaching strategies adopted by teachers and early childhood educators in classrooms, and the experiences of students with ADHD. Each group will be detailed in the topic discussions below.

## RESULTS AND DISCUSSION

This topic will present the works belonging to each of the groups: A and B.

### Grup A

In this first group, considered as the group for most relevant work, 7 articles were analyzed that more specifically addressed the theme of this Systematic Review.

All seven works targeted children with ADHD. Of these studies, three carried out learning assessments on individuals through interventions using pedagogical and technological procedures (Mohammadhasani et al. (2018); Nazer (2017) and Barnett (2017)); two studies presented pedagogical teaching approaches and interventions in educational environments through literature reviews (Adaskina (2016) and Harrison et al. (2019)); and two studies had a technological approach, with a greater bias towards the application of Neuroscience (Garcia-Zapirain et al (2017) and Janssen et al. (2017)).

The results of the studies are better described, respectively, in the following subtopics.

#### *Pedagogical and Technological Approach*



Mohammadhasani et al. (2018) achieved positive results when investigating how a pedagogical agent can improve the learning of students with ADHD, applying a computer-assisted instruction (CAI) system: Koosha, with the aim of supporting children's learning by obtaining and guiding information. attention to relevant information in classrooms. The study comprised an experimental design, pre- and post-test with a control group, applied to a population of 30 male students with ADHD in a primary school in northern Iran. The authors proved that the use of the pedagogical agent can favor the learning of students with ADHD.

Nazer (2017) focused on modeling training and reinforcement of selected and divided attention, academic improvement and self-efficacy of elementary school children with ADHD, in spelling and mathematics, using an academic self-efficacy questionnaire and software selected and divided attention. The research method was a quasi-experimental design with pre- and post-test and follow-up with a control group. The research sample was 40 children chosen by random sampling method from elementary school with ADHD from the city of Rafsanjan, Iran. As a result, the author showed that the training improved the amount of children's attention, but was not significantly effective in time reaction and academic self-efficacy of children with ADHD.

Barnett (2017), in turn, presented environmental, organizational and instructional techniques, in addition to technology applications, to be used by teachers to improve the sustained attention and academic performance of children in the educational environment. This American study aimed to show the need to create an equitable and improved learning environment in the growing era of digitalization, aiming to meet the attention needs of students with ADHD and other students who struggle with attention in the classroom.

### ***Pedagogical and Bibliographic Approach***

Adaskina (2016) carried out a search in the literature for works with strong psychopedagogical aspects, that is, those that examined the factors that contribute to the successful adaptation of children with ADHD to schooling and provide specific guidance on the different aspects of the educational process. This Russian study addressed effective ways of presenting content in the classroom, testing knowledge for children with ADHD, and the importance of more effective classroom environments. It was concluded by the author that behavioral techniques proved to be quite effective in the process of correcting behavioral and educational problems in children with ADHD.

Harrison et al. (2019) presented, through a systematic meta-analysis review, evidence of Design research interventions implemented in classrooms, with students with ADHD, of four types: behavioral, instructional, self-management and environmental. In this American study, the authors observed that classroom interventions for students with ADHD were moderately effective, and Instructional Design interventions that aimed to achieve academic results were more effective when implemented in special education environments.

### ***Technological Approach with a Neuroscience bias***

Garcia-Zapirain et al. (2017) developed and tested, in this Spanish study, a dual system for the rehabilitation of the cognitive functions of children with ADHD on a technological platform developed from "framework.net", using two physiological sensors: the Tobii X1 Light Eye Tracker, eye tracker, and Leap Motion, a hand gesture recognition sensor, with the aim of improving learning and attention for this audience. The system was tested by 19 children. It was concluded that the developed system can help children with attention deficit and learning problems. In addition to helping teachers monitor and progress their students.

The seventh and last work evaluated from this group, Janssen et al. (2017), used the EEG (Electroencephalography) tool with the aim of reducing ADHD symptoms using

neurofeedback. This Dutch study was carried out with 38 children previously diagnosed with ADHD. Users completed an average of 29 Theta/Beta neurofeedback training sessions. The learning effects were analyzed during and between sessions in order to correlate the behavioral effects of these children with the learning curves. As a result, it was identified that there is no correlation between the Theta/Beta wave learning curves and the behavioral changes of children with ADHD during neurofeedback sessions.

Therefore, there are several contributions from this first group to the study, from pedagogical intervention approaches to technological interventions. Therefore, it is clear that Neuroscience can contribute to the behavioral and attention assessment of children with ADHD through technological tools, such as EEG (Electroencephalography) and Eye Tracking, and these devices, together with Design and Ergonomics can constitute an important device for identifying the restorative elements of these children's attention in teaching environments.

However, although these works have addressed Learning, Attention, Neuroscience and Design criteria with children with ADHD, based on the filters previously presented, no articles were found that related Ergonomics and the Theory of Restorative Environments with Design interventions in the educational environment for children with ADHD.

## **Grup B**

In the second group, 7 articles were also analyzed. Although these studies present learning processes of children with ADHD in classrooms through mainly qualitative research, these works were considered to be of less relevance as they do not address intervention criteria from Design, Ergonomics, Neuroscience and the Theory of Restorative Environments. .

Of the seven studies, only one presented a group of adolescents with ADHD as a sample (Wiener and Daniels, 2016), the others had children with ADHD as their target audience.

The first work analyzed focused on students with ADHD. It brought together important testimonies and school experiences from these students in relation to learning processes (Wiener and Daniels, 2016); In the following five works, experiences, experiences, knowledge and training of educators regarding students with ADHD were portrayed (Souza, 2016; Mohr-Jensen et al., 2019; Greenway and Edwards, 2020; Dwarika and Braude, 2020; and Moore et al., 2017); The last work raised an important discussion regarding exclusive teaching applied to ADHD, in contrast to the criteria of inclusive education (Malmqvist and Nilholm, 2016). The studies were better explained, sequentially, below.

### ***Focus on Students with ADHD***

Wiener and Daniels (2016) present a portrait of the school experiences of adolescents with ADHD, in the context of quantitative research, on teachers' attitudes and practices, adolescents' self-assessment and their social and family relationships. This American study was carried out with twelve adolescents with ADHD. Semi-structured interviews were carried out covering the main aspects of the students' school life and there were three main themes raised by them: (a) performance deficit, (b) academic and social engagement and (c) transition from dependence to independence. As a result, the authors suggest that educators should apply evidence-based interventions to provide greater academic support to these students.

### ***Focus on Educators***

Souza (2016), through a single case study with a student diagnosed with ADHD, carried out in a public school in the city of Sinop - Brazil, aimed to understand the difficulties encountered in this student's learning process, based on the teaching methodology of the teacher. Data were obtained through observational methods and questionnaires with teachers. Thus, the author concluded that there is a constant search for education professionals to provide

better teaching-learning conditions for students with ADHD, amid the challenges caused by this condition.

Mohr-Jensen et al. (2019) aimed to identify what Danish primary and secondary school teachers know about ADHD in children and also identify which factors predict this knowledge. To this end, a 29-item questionnaire on ADHD was administered and distributed to a random, national and representative sample of 528 elementary and secondary school teachers. As a result, most teachers recognized the symptoms of ADHD and were able to propose effective classroom intervention strategies. However, the authors highlighted that they still need to acquire knowledge about the etiology, prognosis and treatment of ADHD so that they can improve the management of children in the educational environment.

Greenway and Edwards (2020) used knowledge (SASK) and attitude (SASA) scales, from Mulholland, Cumming and Jung (2015), ADHD training and perceived support in the classroom, to compare public school teachers and teaching assistants. The British survey was carried out with a sample of 165 teachers and 157 teaching assistants. As a conclusion of the research, the authors indicated that both teachers and assistants exhibited adequate levels of knowledge. However, teaching assistants had better knowledge about ADHD than teachers. Regarding training, it was found that both professionals need further improvement in the area.

Dwarika and Braude (2020) aimed to provide a description of teachers' understanding of ADHD and their experiences in the classroom. The South African research is qualitative and data was collected through individual interviews with seven teachers, each representing a series from 1 to 7. The authors reported that teachers' understanding of this condition was limited, making it necessary to improve these professionals in order to develop better support and teaching strategies for students with ADHD.

Moore et al. (2017) focused on the experiences and practices of educators on how to work with inattentive, impulsive and hyperactive children. To this end, 42 early childhood education professionals participated in this British study, through focus groups or individual interviews that explored: (1) the experiences of managing students with ADHD in the classroom and (2) factors that helped and hindered them in this effort. The authors identified the need to develop more research on the implementation of evidence-based school interventions for ADHD, and the importance of considering the experiences of these students to develop the best teaching strategies to be implemented in the classroom.

### ***Exclusive/Inclusive Education and ADHD***

In the seventh and final work of this group, Malmqvist and Nilholm (2016) addressed the growing increase in exclusive educational classes to specifically serve children with ADHD in Sweden, and how this fact is contrary to the notion of social inclusion and is in conflict with the law Swedish school. To this end, a questionnaire was sent to all 290 Swedish municipalities about the schooling of students with ADHD, and obtaining a response rate of 76%, it was identified that in 40 municipalities there are classes specifically planned for students with this disorder. Therefore, the authors found that classes planned exclusively for students with ADHD are not properly evaluated, presenting differences in municipalities. They still discuss the permanence of these classes in the light of inclusive education.

Thus, although considered to be of less relevance, the articles in this group have important contributions to the evaluation of learning processes in classrooms, since the works covered are the result of real experiences, both of children and adolescents with ADHD, as well as their educators. That said, even though they do not establish direct correlations with Design, Neuroergonomy and the Theory of Restorative Environments, these articles will be taken into consideration for the theoretical basis of the thesis under development.

## FINAL CONSIDERATIONS

From the Systematic Review, a huge geographic diversity of studies involving children and/or adolescents with ADHD in the educational environment was found: Iran, Spain, Russia, United States, Netherlands, Brazil, Denmark, United Kingdom, South Africa, and Sweden . The systematization and distribution of articles into two groups enabled a better understanding of the works found.

It can be seen that even the articles in group A, considered to be of greater relevance, did not address all the elements of the topic sought. The work of this group correlated attention, suggesting interventions of pedagogical and/or technological procedures to assist in the teaching and learning process for children with ADHD.

Regarding the research methods used in this group, two studies presented an experimental design with pre- and post-test and monitoring with a control group (Mohammadhasani et al., 2018; and Nazer, 2017), one study presented techniques and technological applications to be used and tested by teachers (Barnett, 2017), two studies developed systematic literature reviews (Adaskina, 2016; and Harrison et al., 2019), and finally, two studies used neuroscience tools (Garcia-Zapirain et al., 2017; Janssen et al., 2017).

Many digital tools were used, such as a computer-assisted instruction (CAI) system: Koosha (Mohammadhasani et al., 2018); Physiological sensors: the Tobii X1 Light Eye Tracker and the Leap Motion (Garcia-Zapirain et al., 2017); And an EEG (Electroencephalography) tool for performing Neurofeedback (Janssen et al., 2017).

The interventions in this group were generally considered to be positive and effective in helping the behavior and educational process of children with ADHD; and thus, the tools mentioned will be studied and taken into consideration, later on, for the methodological development of the thesis.

It was also noted that although several works from this group suggest that the classroom environment should be equitable among students, only two studies directly cited the need to have effective classroom environments as one of the factors that contribute for the successful adaptation of children with ADHD to schooling (Adaskina, 2016; and Harrinson et al., 2019).

The works of group B, even considered less relevant articles, were taken into consideration due to their important theoretical contributions to the research.

In the work of this group, the importance of understanding the experiences of education professionals and students with ADHD in classrooms was verified, so that Design and Neuroergonomics interventions can be proposed that meet the real needs of this public, help restore attention, and consequently, the learning of children and adolescents with this condition.

The methodological procedures and tools used in this group's research were: observational methods (Souza, 2016); Assessment using knowledge and attitude scales (Greenway and Edwards, 2020); Semi-structured interviews (Wiener and Daniels, 2016; Dwarika and Braude, 2020; and Moore et al., 2017); And questionnaires (Souza, 2016; Mohr-Jensen et al., 2019; and Malmqvist and Nilholm, 2016).

It was also found, in almost all group B research, that professional educators need more training and qualification to better serve children and adolescents with ADHD in the classroom (Wiener and Daniels, 2016; Moore et al., 2017; Dwarika and Braude, 2020; Mohr-Jensen et al., 2019; Souza, 2016).

In short, through the Systematic Literature Review, the gap between Design, Neuroergonomy and the Theory of Restorative Environments was perceived to promote a built teaching environment, which collaborates in the learning process of children with this neurobehavioral condition. And given this, it can be proven that there is a lot of space to be explored in this field, highlighting the relevance of this type of research for society.

For the next steps of this study, we intend to expand the bibliographic search by expanding the filter from “only articles published in the last 5 years (2016 – 2021) with a focus on children and adolescents with ADHD”, to “articles published in the last 10 years (2011 - 2021) that cover the public of children, adolescents and adults”, since no articles were found that correlated the Theory of Restorative Environments with ADHD in children and/or adolescents in the period searched.

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