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REVIEW

Color and space in the classroom: reflections on their relationship with learning

Color y espacio en el aula: reflexiones sobre su relación con el aprendizaje

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ABSTRACT

The present study explored the educational environment as an active element that influences students' cognition, emotion, and social interaction. It also addressed the influence of color and space in the classroom on learning, highlighting their role as active elements in students' cognition and emotion. The main objective was to analyze how the chromatic and spatial design of classrooms could enhance or limit concentration and creativity, and how this impacted the holistic development of students. Research from various disciplines was reviewed to examine the relationship between color, space, and educational performance. Studies linking the shape, volume, and color of spaces to academic success were also considered. Findings indicated that an inadequate selection of colors could negatively affect students' mood and motivation. Classrooms with neutral colors and rigid arrangements limit creativity and do not meet individual needs, thereby restricting students' appropriation of the space. It was concluded that it was essential to integrate scientific criteria into the design of educational spaces, prioritizing flexibility and warmth. An interdisciplinary approach that included collaboration among educators, architects, and psychologists proved essential for creating inspiring learning environments that foster creativity and personal development. The appropriate selection of colors and classroom design were considered crucial for enhancing the educational experience.

Keywords: Learning Environment; Color and Space; Neuroarchitecture; Color Theory; National Training Program.

RESUMEN

El presente estudio, exploró el entorno educativo como elemento activo que influye en la cognición, emoción e interacción social de los estudiantes. También abordó la influencia del color y el espacio en el aula sobre el aprendizaje, destacando su papel como elementos activos en la cognición y emoción de los estudiantes. El objetivo principal fue analizar cómo el diseño cromático y espacial de las aulas podía potenciar o limitar la concentración y creatividad, y cómo esto impactaba en el desarrollo integral de los estudiantes. Se revisaron investigaciones de diversas disciplinas que abordaron la relación entre el color, el espacio y el rendimiento educativo. Se consideraron estudios que vincularon la forma, el volumen y el color de los espacios con el éxito académico. Los hallazgos indicaron que una selección inadecuada de colores puede afectar negativamente el estado de ánimo y la motivación de los estudiantes. Aulas con colores neutros y disposiciones rígidas limitan la creatividad y no satisfacen las necesidades individuales, lo que restringe la apropiación del espacio. Se concluyó que era fundamental integrar criterios científicos en el diseño de espacios educativos, priorizando la flexibilidad y acogida. Un enfoque interdisciplinario que incluyera la colaboración de educadores, arquitectos y psicólogos, resultó esencial para crear ambientes de aprendizaje inspiradores, fomentando la creatividad y el desarrollo personal. La adecuada selección de colores y el diseño del aula fueron considerados cruciales para mejorar la experiencia educativa.

Palabras clave: Ambiente de Aprendizaje; Color y Espacio; Neuroarquitectura; Teoría del Color; Programa Nacional de Formación.

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INTRODUCTION

The educational environment is not merely a physical container for pedagogical activities but an active element influencing users' cognition, emotion, and social interaction. The relationship between color, space, and the teaching-learning process has been studied in disciplines such as architecture, interior design, education, and environmental psychology, among many others. Recent research highlights that classroom color and spatial configuration can enhance or limit students' and teachers' concentration, creativity, and well-being.[1] In this context, it is imperative to analyze how the design of learning environments, from an interdisciplinary perspective, can become a strategic ally for contemporary education. This text seeks to substantiate the need to integrate scientific criteria into the planning of educational spaces, emphasizing the role of color as a catalyst for meaningful pedagogical experiences.

Similarly, the physical environment in which the educational process takes place is fundamental to students' comprehensive development. In this context, both space and color play a crucial role in creating an environment conducive to learning. The architecture and interior design of classrooms must consider not only functionality but also the psychology of color and its impact on the perception of space.

According to architect Díaz A.[2], Vasili Kandinsky, a prominent artist and theorist considered one of the pioneers of abstract art, had a particular view of color. For him, what was important was not the spectrum but the soul's reaction to colors. This suggests that human beings experience emotional responses to different shades. In his work "Concerning the Spiritual in Art," Kandinsky incorporates Buddhist concepts such as infinity and eternity, which he uses to illustrate the emotions that colors evoke in people.

Similarly, Caba[3] mentions that "there is an almost spiritual handling of light in these buildings. Light enters Richard Meier's works like an overflowing stream, allowing him to experience different sensations throughout the day."

In retrospect, since the dawn of existence, people have always sought to satisfy their basic needs for personal, social, emotional, and psychological well-being and comfort, in addition to multiple factors such as race, gender, age, physical characteristics, mood, clothing, environmental factors, and visual elements. This is evident from the particular realities and expectations, capabilities and needs, levels of happiness, satisfaction, and reward experienced in areas such as health, family, work, material goods, economy, social relationships, educational opportunities, self-esteem, creativity, and sense of belonging.

How people appropriate space, goods, resources, and social interactions significantly impact their overall development. This appropriation affects various aspects, such as the cognitive, which influences the way information is processed, and problems are solved; the creative, by inspiring new ideas in stimulating environments; the affective, by impacting emotional well-being; the functional, by determining efficiency in daily tasks; and the satisfying, by contributing to a sense of personal achievement. Together, these elements show that the relationship with the environment and available resources is fundamental to the well-being and growth of each individual. The concern of this study arises from the need to reflect on the influence of space and color in the educational process. When analyzing old and new academic buildings, it can be observed that adherence to rigid and standardized guidelines established by competent bodies results in a repetitive model in institutions' construction, aesthetic, and functional characteristics. This uniformity is evident in the finishes and ambiance of classrooms, which contrasts with the view of Villanueva L.[4], who argues that: (…) The image of educational areas should encourage creativity. This can be achieved through different textures and colors, as well as by conveying different stimulating sensations. Therefore, special spaces should be created to apply them and establish which activities will be carried out in each area, thus improving cognitive skills.

This reflective documentary study explores the interrelationship between color and space as determining factors in classrooms and their influence on the teaching-learning process. This led to the identification of a widespread problem in Territorial Polytechnic Universities (UPT) in the way classrooms are perceived, with an undeniable lack of integration of specialized criteria on elements such as color, space, and form within the learning environment. It is hoped that both teachers and students of the National Civil Construction Training Program (PNFCC), by the orientation of their knowledge towards the humanization of spaces, will be constantly and pertinently involved in strengthening the classroom as a socializing environment for experiences, knowledge, and learning, assuming the importance of color and academic space from a physical, functional, psychological, and educational perspective, allowing for intra- and interpersonal development and meaningful learning.

The reality of space and color in the classroom

In most Venezuelan educational institutions, especially in contexts with limited resources, those responsible for classroom maintenance prioritize functionality over sensory experience. This is why we find spaces dominated by neutral colors—white, gray, or beige—chosen based on cost and neutrality criteria but ignoring their psychological impact. As Nair[5] points out, "color standardization in schools reflects a reductionist view of learning, where the environment is subordinated to economics." Similarly, when we look at a classroom with a rigid spatial layout, rows of desks or tables facing a blackboard, it reinforces a unidirectional pedagogical model. These spaces can cause visual monotony, mental exhaustion, decreased creativity, and reduced motivation. Therefore, specialists must generate debate about these models and seek to create designs and guidelines that integrate functionality and cognitive well-being. According to Venezuelan architect Villanueva[6], "architecture should be an instrument of social transformation", which highlights the need to create educational environments that foster creativity and active learning.

During the tour (contrary to what has been expressed by different authors about the importance and function of color and the classroom environment as a learning space), we found that many educational facilities, particularly classrooms, have become spaces with four walls in cold tones, inadequate finishes, and no personality, without considering the effect these colors have on people, who generally spend a large part of their time there.

These spaces unite diverse students with apparent differences, particular needs, tastes, and individual inclinations. However, these aspects are not considered in educational planning due to the inflexibility of these facilities, as they are not conceived as spaces

intended for integration.

In this vein, studies have been conducted that link various spatial elements, such as the shape, volume, temperature, and color of spaces, to educational success. Along these lines, Lei Xia[7] mentions, Like temperature, studying color is a broad subject extensively explored in architecture. Color influences different areas of our brain, affecting our mood. Therefore, it is essential to study the effect of different shades on our brains to use them as efficiently and appropriately as possible. Shades close to natural colors reduce stress, increasing the feeling of comfort and, therefore, influencing the perception of space. Warm colors improve productivity and concentration, making them suitable for study environments.

Similarly, little consideration has been given to the exact location of educational buildings, characterized by the climate, context, or immediate environment of their occupants, who have their own personal, social, and work realities (some with very unfavorable conditions or adversities such as emotional insecurity, low self-esteem, family abuse, gender violence, alcoholism, drug addiction, bullying, and nutritional deficiencies, among others).

These conditions have increased considerably in recent years and undoubtedly influence the low levels of well-being that we experience today in educational institutions. These institutions do not provide the necessary conditions for adequate, harmonious, and dialogic integration. Therefore, they are considered unsuitable environments for interaction, creativity, expression, and motivation, which limits and hinders the proper achievement and development of educational and work processes within these spaces.

In this context, the Foundation for Educational Buildings and Facilities[8], an entity attached to the Ministry of Popular Power for Education, establishes that: (…) School buildings should be constructed as a set of spaces for educational purposes, whose size and characteristics vary according to the level, type, and enrollment of occupants. Bearing in mind that there are a series of criteria or specifications to consider for the proper design, construction, operation, and use of classrooms.

In this regard, square-shaped spaces are recommended to shorten the distance between the last row of students and the blackboard, which in turn facilitates the adequate projection of the teacher's voice within the learning space. Likewise, the minimum height from floor to ceiling shall be "3 meters, as a minimum standard, the exterior enclosure shall have a parapet with a maximum height of 1,20 meters, above which continuous windows shall be placed to ensure natural lighting; while the enclosure facing the hallway shall have high windows"[8], thus allowing cross ventilation and adjacent to the blackboard, oriented along the axis of the classroom entrance, for better control and visualization of the students. The access door is designed to open outwards, considering that natural lighting must fall on the students from the left side. On the other hand, it is established that the internal colors of the space where the teacher moves around must be lighter to make the most of the reflected natural lighting.

All these specifications are complex to develop in fulfillment of their primary function, which is to "respond to the problems of the physical educational plant, systematically addressing the construction, equipping, rehabilitation, and maintenance of the school complex".[8] This is due to the establishment of various limitations in construction since educational buildings are constructed according to conventional or universal guidelines, without taking into account the slightest environmental or territorial conditions, or even an approximate perspective of the characteristics of the people who will spend their academic lives in these spaces, who will generate, in the medium and long term, relational bonds, cultural attachments, customs, habits, routines, and particular ways of life.

It has also been observed that, in general, standardization in terms of measurements is applied to different academic levels and educational modalities, i.e., the exact height throughout the building, in areas with other functions, the same number of square meters per classroom, and per student, and the precise size of windows throughout the building. These characteristics only vary when the shape of the building makes it necessary. Added to this situation is the cost of materials, and all of this leaves aside the criteria of space and color requirements of educational institutions. This situation, which has been repeated throughout history, has resulted in spaces that hinder proper student progress and make the educational process complex. From this perspective, Ortega, cited by Pírela[9], asserts that optimal spaces must be provided within an environment of affection, harmony, and trust to ensure the educational process adequately.

In this regard,[10] state that: Color has a very important influence on students' lives, as colors create an effect in the human mind on the expression of emotional states, causing different responses that promote calm or excitement, cold or heat, or an association of ideas with joy, sadness, or other positive or negative feelings.

It is evident that if you look around, this statement is far from the reality in Venezuela and even more so in the Andean region that concerns us, given that, according to the National Consultation on Educational Quality, for example, carried out by the Ministry of Popular Power for Education[11] during the 2014-2015 school year, the physical characteristics of educational spaces are consolidated with reduced areas about the number of students they contain, with heights that are inadequate for the academic activities carried out there. The same consultation highlighted the presence of rustic finishes in dull shades of gray and blue, with windows and doors of various sizes, some open and well-lit, others tiny and gloomy, along with mezzanines or ceilings with clearly reduced sound insulation, which distorts any educational activity. In short, the building was in considerable disrepair due to constant use and the low maintenance levels to which it should have been subjected periodically.

Following the aforementioned national consultation, both teachers and specialized sectors pointed out that: The traditional physical structure of the school reflects a model based on the vertical, unidirectional transmission of knowledge, framed by control and discipline. For their part, students say that the school feels like a prison, with poor ventilation and lighting, very small classrooms with little color and no equipment, a lack of sports fields or fields that are in poor condition, and bathrooms that are always dirty and neglected.[11]

These reflections led to a qualitative recreation of the ideal state of educational institutions, from their physical spaces to the layout of their areas, the use and location of material resources, the various learning spaces and environments, and their respective equipment, also taking into account spaces that allow for the development of cultural expressions and sports. Given that these

experiences are not dissimilar to those that may arise in student consultations regarding university buildings, the following is highlighted among the systematized social expectations of the aforementioned National Consultation on Educational Quality[11], section No. 8: Ensure simple, friendly, and safe educational buildings. Students want facilities that are conducive to learning, with clean classrooms and colorful furniture, trash cans, water filters, lockers, touchscreen whiteboards, teaching materials, and musical instruments. The building must therefore be designed from a pedagogical perspective, with workshops for cultural expression and socio-productive work, and a culture of care and maintenance must be created that involves the student organization, teachers, workers, administrative staff, families, and the community.

As seen above, educational buildings must be designed and fitted out based on a pedagogy of spaces, recognizing the importance of preventive and corrective maintenance. One way to promote this is by implementing projects that foster ownership, care, and a sense of belonging to the facilities. This ultimately underpins educational development, making it necessary to implement changes within educational facilities, drawing on the creativity and ingenuity of students and teachers. This story is closely linked to Venezuela today, its education system, and its existing infrastructure since one of the most critical challenges we must set ourselves as an almost immediate goal is rehabilitating existing spaces.

In this vein, taking a simple tour or asking students to describe the spaces where they attend classes in any building is enough. We will notice the lack of materials and resources for learning, some of which are inadequately arranged, without considering the characteristics of the students according to their age, area of knowledge, personality, academic level, training program, or modality.

This could result from a lack of knowledge about the use or activities to be carried out in these spaces, leaving behind harmony and balance, which are necessary factors in designing environments for the teaching-learning process and its perception.

Modern psychology has defined perception as the set of processes and activities related to stimulating each individual's senses and internal states. In other words, it is the process by which people immediately become aware of what is happening outside themselves. The singularities described could have a significant impact on the development of teaching and learning in classrooms, as the authors assert.[12]

A well-designed classroom as an educational training space allows for the development of positive participatory interactions and tends to reduce conflicts, as it enables those who are actively involved in it to develop a series of positive attitudes and behaviors.

Among these, the most notable are collaborative relationships, respect, friendship, affection, solidarity, and camaraderie in personal development, as they promote concentration, positive stimulation, attention, and academic performance. Thus, despite being a collective space, the classroom is a private space that allows those who occupy it to take control and self-regulate their interactions or interpersonal relationships. The authors agreed that they contribute to improving attention, analysis, individual participation, and group interaction, as well as significantly influencing mood and disposition for teaching and learning, thereby achieving quality education.

The substantial fact that color in spaces can have a significant influence on human activity, in this specific case educational activity, makes it necessary to recognize the guidelines, orientations, and particularities of each one to use them appropriately in different spaces, to achieve the most suitable comfort for better performance and ensure that their rational use involves minimal stress and maximum well-being for students and teachers. This undoubtedly means that the use of color in educational spaces cannot be done without a prior diagnosis or study since it is necessary to know the degree of stimulation or generation of stimuli in the psychological and overall development of the student.

From the above, it is appropriate to affirm that it is of great importance to carry out projects and research from the PNF of Civil Construction to seek answers and proposals related to the study of color, classroom space, and its link to the teaching-learning process, since according to the observations made and the theoretical approaches, these are not integrated in a balanced way into the educational context; all of this could be crystallized through viable technical guidelines that allow us, as project leaders and researchers, to make a valuable contribution to academic institutions and student communities in general.

From this academic standpoint, in conjunction with the Civil Construction PNF project, student conditions could be improved by integrating color and space into the practical implementation of the educational process while raising awareness among those involved in the situations affected. In this way, from their particular perspective, solutions can be generated that are in line with the specific realities of each space, each teacher, and each group of students according to their age, physical and psychological characteristics, educational level, cognitive process, and area and type of study.

Indeed, developing this type of project and research within the PNFCC is highly relevant, as it contributes theoretical, technical, and procedural inputs from the fields of the discipline to the topic addressed for the construction of knowledge based on the territorial characteristics that surround us. This is innovative, opening up the possibility of generating new lines of research for the National Civil Construction Training Program.

It is essential to generate opportunities to improve educational quality, which can be achieved by integrating existing spaces with lighting studies, appropriate selection of colors and furniture, and, finally, scenic adaptation. Optimizing these elements will guarantee quality and comfort within classrooms and promote well-being, creating an environment conducive to learning that can be replicated in various institutions located in different contexts, thus contributing to the overall improvement of education.

In a study presented by Ortiz[13], entitled "Color, a Didactic Facilitator," related to color and its role in education, it is stated that these elements support students in their learning process more than previously believed. The impact of color on learning, memory, and comprehension was found through different methods and populations. It was also found that the right color positively affects reading and writing as long as color is used as a learning aid, as was the case in the learning experiences with physics formulas. Color is also a key factor in remembering a series of images.

In his study, Ortiz[13] applied different methods with similar results, demonstrating how color in learning does generate a change

in responses, establishing with these results the importance of color in the field of education, as it directly influences the teaching-learning process. This has not been given much consideration in the design, comprehension, and learning of diverse texts, as well as in educational spaces, as these spaces are becoming increasingly outdated, with colors that invite situations that are not conducive to learning and poor lighting. Even today, some spaces are overloaded with inappropriate elements and colors, which lead to distraction, low motivation, depression, boredom, and fatigue in students and teachers, thus limiting the quality of the educational process.

The educational space and environment

The educational space encompasses not only the physical layout of classrooms but also the atmosphere created within them. A well-designed classroom can facilitate social interaction, group mastery, focus and concentration, and collaborative work, while a disorganized environment can cause distraction and anxiety.

Researchers Laorden C. and Pérez C.[14] point out that, Understood from this perspective, space becomes a teaching factor since it helps us define the teaching-learning situation and allows us to create a stimulating environment for the development of all our students' abilities, as well as promoting the autonomy and motivation of the teaching team.

Returning to the ideas of Iglesias M.[15], we can see that his analysis is in line with what we are developing, recognizing that these intentions have been in the making for years,

Two terms are often used interchangeably when referring to classroom space: "space" and "environment." However, we believe that a distinction can be made between them, although it should be noted that they are closely related. The term "space" refers to the physical space, that is, the premises for the activity, characterized by objects, teaching materials, furniture, and decoration. On the other hand, the term "environment" refers to the physical space as a whole and the relationships established within it (affections, interindividual relationships between children, between children and adults, between children and society as a whole).

About the development of educational activities, it is common to see that when entering a space as teachers or students, the focus is on the performance of each of their roles, without considering the possibility that the classroom offers a valuable environment for promoting cognitive-creative and social-emotional development and, with it, the construction of knowledge since the school is not just a colorful and decorated space. This indicates the social and civic culture that thrives within the institution, as is how desks and chairs are arranged inside and outside the classroom, showing whether the intention is cooperative or individualistic learning. Hence, the classroom is a space for coexistence with knowledge: (…) It is a place where the educational community reflects, with the sole aim of achieving intellectual, personal, and human growth among all students and of identifying the relevant and significant knowledge they need to successfully integrate into today's society.[16]

And, as the educational environment is essential in all activities or experiences evidenced within the teaching-learning process throughout everyday life, it is essential to consider color, space and its dimensions, and the distribution of furniture, among other things; conditionally, these elements contribute to consolidating or limiting the relationships that occur inside and outside the classroom, where there is an atmosphere of freedom that stimulates creative potential and expressiveness. If students and teachers feel free to try new ways of working, they will be more innovative than those taught a single way of solving everything. Therefore, it is necessary to delve deeper into the terms physical space and physical environment, which, despite their interrelationship, do not mean the same thing. In this context, it is pertinent to quote Iglesias[15], mentioned in the study by Hernández[17], who argues that the: (…) Physical space refers to the premises where activities are carried out, which are characterized by materials, furniture, decoration, and objects. At the same time, the environment is the physical space and the interpersonal relationships established in the classroom or place where educational work is carried out. (...) the environment as a whole, inseparable from objects, smells, shapes, colors, sounds, and people who inhabit and interact within a specific physical framework that contains everything and, at the same time, is contained by all these elements.

Related to the above, it is essential to mention the contribution of María Montessori (1957), who argues that the educational environment must allow students opportunities for action and choice to strengthen knowledge, freedom, autonomy, and independence through the succession of shapes, colors, interaction with the external environment, and promoting socio-ecological and environmental contact. This is complemented by the statements of García and Polanco in Escalante et al.[18], who refer to: (…) Learning occurs through the construction of knowledge generated through interactions between peers, with the teacher, and with resources. In this way, students explore, experiment, and construct. Thus, teachers must not only consider the placement of objects within the classroom, but also determine the use of color according to the space and its influence on individuals and on the teaching-learning process.

Hence, all these environmental and spatial factors influence and converge in improving the educational process within the academic space. They leave behind the teacher-centered teaching model and conceive an active model where the teacher encourages group interaction, using space and color as teaching tools in the practical implementation of the process of teaching, learning, and building knowledge within the learning environment.

The learning environment within the educational space

The infrastructure in educational spaces is understood as a training area where teaching and learning activities take place, creating distinctive environments that can enhance or diminish students' development and well-being.[19]

An effective learning environment transcends the mere transmission of content; it must stimulate curiosity and creativity and facilitate collaboration. In this sense, color acts as a nonverbal language that modulates emotional states. For example, warm tones such as yellow or orange are associated with creativity and energy. They are ideal for group workspaces, while cool tones like blue

favor concentration on individual tasks.[20] Likewise, spatial flexibility—through modular furniture and transition zones—allows the classroom to be adapted to different methodologies, from lectures to practical workshops. As JISC[21] states, "the versatility of educational space is key to responding to the pedagogical demands of the 21st century." Integrating strategic color palettes and dynamic layouts can turn the classroom into an innovation ecosystem.

From a global perspective, the environment can involve multiple factors or areas in diverse contexts. When talking about the environment from a pedagogical point of view, it is seen as a space that responds to an educational strategy and constitutes an instrument that supports the teaching-learning process. According to some writers,[22] the starting point is a concept of a living, changing. Dynamic environments, conceived in terms of the age, gender, interests, and particular needs of each person or group and the surroundings, are essential in promoting the physical, social, and cognitive development of human beings. Therefore, the learning environment must be a place where its five main components coexist in a balanced way, such as the teacher and the student (the leading actors who, with a minimum of tension and maximum efficiency, carry out their role of teaching and learning); the physical sensory elements (such as light, color, sound, space, furniture, among others); educational content (the educational curriculum); and the resources and means for learning (information and communication technologies and media), following the ideas of [23].

In other words, learning environments must provide the appropriate conditions for students to acquire new knowledge and come into contact with new experiences of the subject or discipline they are studying, using new elements and strategies that generate processes of construction, analysis, reflection, and assimilation of curricular content with the use and incorporation of new technologies. This is achieved through greater participation and interactivity between students and content in the participatory relationship between students and between students and teachers, characterized by collaboration and cooperation, where the role of the teacher as mediator emerges.[24]

It should be noted that, on this subject, Escalante et al.[18], following the contributions of the authors referenced, establish some principles of the learning environment that must be present in the classroom. Firstly, the climate must facilitate knowledge within the group through a participatory dialogue between individuals, allowing them to align themselves and bond with common objectives, goals, and interests. The educational environment must also provide the means for the appropriate use of resources and learning tools, with diverse activities that include a wide range of learning strategies, emphasizing the cognitive, creative, affective, and social aspects.

Secondly, the environment must be diverse, allowing students to transcend the four walls of the classroom by offering different contexts and scenarios, considering the activities and tasks undertaken according to the objectives pursued. The learning environment must be within the classroom, offering different scenarios based on the particular expectations and interests aligned with the curricular goals that integrate external contexts for greater application and transfer of knowledge. Thirdly, the learning environment must, in most, if not all, cases, reflect its own identity and sense of belonging.

Indeed, the learning environment within the educational space is related to the environment provided by the teacher and the training curriculum to influence the lives and behavior of students throughout their lives. This is achieved through designing and organizing the physical space, adapting the furniture to height and function, with walls in optimal finishes, and arranging durable finishes with representations of the context, region, or content themes. Similarly, the design and organization of the environment should consider the promotion of cultural activities and professions, including motivational signs, among others related to the student profile. In this case, Molina, cited by [22], emphasizes that the learning environment should reflect the type of activities carried out, the educational project, the relationships established, and the interests of the group so that all student activities are motivated by the educator through dynamic, planned, evaluated, and success-oriented instruction.

Space and its influence on the teaching-learning process

Classroom layout is another factor that can influence teaching and learning dynamics. A flexible classroom with different furniture configurations can encourage more active and participatory learning. Research from the University of Salford indicates that "well-designed learning environments can increase student academic performance by 25 %." This highlights the importance of understanding how the layout of a space can affect attention, collaboration, and information retention.

Based on the concept provided by [25], who understood space as an environment structured in four clearly defined and interrelated dimensions consisting of the physical dimension (what is in the space and how it is organized), the temporal dimension (when and how the space is used); the functional dimension (what the space is used for); and the relational dimension (who uses the space and in what circumstances). It is possible to determine how an educational space (classroom) is vital in developing student-teacher-student interaction.

Given these circumstances, in the training of PNFCC students, it is essential that, during the project phase, the need to design, adapt, rehabilitate, structure, and organize educational spaces appropriately be addressed to optimally and effectively influence the classroom climate, strengthening communication processes, discipline, and intellectual, emotional, personal, and human growth. For this reason, it is essential to be clear about these dimensions to respond to the use of specific colors, tastes, interests, needs, and particular forms of interaction and socialization among students to commit to their successful integration into society.

Due to its connection to the topic, this "Pilot Plan," which can begin in the PNFCC, can later be extended to all PNFs. This will guarantee the effectiveness of the resulting proposal and generate the design to create teaching-learning spaces.

Psychology of color, shape, and their relationship to school building design

Color psychology offers compelling evidence about how shades influence human perception. In a study titled "Empirical evidence of color on motivation toward learning," conducted in 2017,[26] color was used to provide physical stimulation to reinforce concepts

taught in the classroom. The results showed that color acted as a positive stimulus, facilitating more effective learning in children. In addition, colorful decorations related to the curriculum left a lasting impression on the participants' memory, contributing to their understanding. In fact, 57 % of those surveyed indicated they could understand their lessons better.

However, it is essential to avoid color overload, as this can cause overstimulation. A balanced design considers the users' age, the space's purpose, and natural light, incorporating principles of neuroarchitecture to improve academic performance.

In this sense [27], "neuroarchitecture constitutes a two-way dialogue between neuroscience and the design and construction of architectural spaces, focusing its studies on highlighting how this duality between mind and physical space is related." In this way, neuroarchitecture emerges as a discipline that highlights the relevance of how spaces impact thought and cognitive processes in human beings. Vitruvius, an architect from the 1st century BC, argued that architecture should be a practice that draws on various sciences.

In order to respond appropriately to the design and adaptation of educational spaces, those involved in this field must consider color theory. This was initially studied and conceived by the research physicist Isaac Newton (1643-1727), who determined that color is light, which was explained in his wave theory, in which Moreno:[28] (…) What is referred to as white light is the impression created by the combination of radiation visible to the human eye; when white light is broken down, it produces the phenomenon of the rainbow, which is what we call colors. "...The senses allow human beings to perceive phenomena, where the eyes can memorize color differences. Still, we rarely perceive a color as it is visually, as it is physically. By this, the word color is used to encompass two different concepts, the physical phenomenon and the biological-psychological perception of the eye, whose principle is a perception in the observer's visual organ, which is epistemically necessary for learning since it is based on the observation of objects within the visual context".

In turn, Aznar[29], in his analysis of the work of the famous painter Matizze, states that: "...color expresses light, not its physical phenomenon, but the only light that exists, that of the artist's brain."

Color, as a visual phenomenon, is based on Edmund Husserl's (1859-1938) theories through his phenomenological approach, which highlights the importance of subjective experience in perception. According to Husserl, consciousness is always directed toward something, which means that our perception of color is not a passive process but an active interpretation based on previous experiences and contexts.

Furthermore, phenomenology emphasizes that color perception varies from person to person and is influenced by memories and cultural associations. Husserl also explores how temporality and spatiality affect our experience of color, as light and the environment can alter how we perceive it. In this sense, color becomes a sensory quality essential to understanding our environment and interactions.

The Role of Color in Creating Learning Environments

Color has a significant psychological impact that can influence students' mood and concentration. Studies conducted by psychologist Angela Wright suggest that specific colors can stimulate creativity and calm, while others can cause anxiety or aggression. For example, blue and green tones are associated with tranquility and concentration, while warm colors such as red can be stimulating but also distracting. Therefore, the choice of color for classroom paint should be a strategic decision that considers the desired effect on learning.

If you want these proposals to be technical, they are relevant to studying color. In the case of Venezuela, the FEDE[8], in its publication Manual de Mantenimiento de Edificios Educativos (Manual for the Maintenance of Educational Buildings), details that paint fulfills a protective function and that contains color and that its choice can affect the user's mood, either by producing tension and unease or a feeling of pleasure and comfort. The function of color in buildings is to identify facilities using color codes that differentiate them from each other according to their use.

As a result of this point and to preserve the useful life of the educational building, as well as its internal and external environments, it is inevitable that paint will be applied to walls, ironwork, and enclosures. Therefore, FEDE[8] summarizes in its manual that paint is linked to the concept of maintenance. It thus highlights that visual language is a mechanism that encourages participation and identifies values, people, groups, and institutions. Similarly, when used well and with the right finishes, the rainbow colors can represent a sense of collaboration and integration, giving the physical and educational environment levels of height, proportion, brightness, spaciousness, and closeness to generate attitudes of attention, comfort, and optimism.

An experience that clearly illustrates this theory can be seen in the study conducted by Vidal, Rodrigo, and Avendaño[30], who designed and applied a method that allowed them to collect academic performance data to infer the causal relationship between classroom color and the learning process. They compared students' mathematics and language arts results before and after the classroom transformation, revealing that the appropriate and relevant combination of colors in the classroom stimulates and improves learning. In contrast, a classroom in unfavorable conditions, whose structure was not modified, showed that a comprehensive improvement in learning requires the intervention of a set of stimulating and motivating elements in the educational environment.

To contextualize and support color theory in educational buildings, we analyzed the color wheel, which is composed of primary colors (yellow, blue, and red) that, when combined, produce secondary colors (orange, green, and violet). We also found tertiary colors that arise when mixing secondary colors (generating blue-green, violet-blue, orange-red, greenish-yellow, among others). These fundamental colors include black and white, which give rise to an infinite range of shades, grouped into two families: warm colors with a marked presence of red and greenish yellow, whose effects express activity and excitement and can make people feel uneasy, generating behaviors that may be contrary to those expected in an educational setting. On the other hand, cool colors, with a predominance of blue, violet, red, and green, tend to have a neutral visual effect, reflecting tranquility, togetherness, and intimacy.

All these considerations, added to the type of surface where color is used, undoubtedly generate diverse psychological impacts on people, as shown in the table below.

Table 1. Overview of the relationship between color tone, surface, and psychological effect

Relationship: Color Tone – Surface – Psychological Effect			
Colors	**Roofs**	**Walls**	**Floors**
Warm-clear	Exciting	Cozy/intimate	Lightweight
Warm-dark	Dignity	Limitation	Insurance
Cool-light	Illuminated	Companions	Sliding
Cold-dark	Threatening	Sad-cold	Heavy

Source: Foundation for Educational Buildings and Facilities, FEDE

The choice of color in school buildings should be a thoughtful process involving educators, architects, and psychologists. According to school design expert Dr. Lutz[31], "the color palette used in an educational environment can influence students' perception of safety and well-being." Furthermore, the colors chosen must be consistent with the institutional identity and promote a sense of belonging. Implementing strategic colors beautifies the space, improves academic performance, and increases student satisfaction.

Therefore, no single color is best suited to promoting a willingness to learn, and no ideal classroom environment exists. The challenge lies in creating harmonious environments where change and emotions flow positively for the entire educational community.

CONCLUSION

In this tour, we have seen that the aesthetics of educational spaces directly influence learning. Traditionally, furniture is arranged to promote individual work and hinder collaboration and teamwork.

The climate does not significantly influence the design of the building. Many educational centers around the country repeat the same model, regardless of the climate variability of the context, which detracts from territoriality. The same is true of acoustics, which is not determined by any clear criteria but responds to factors other than those indicated.

With regard to colors, it is important to note that those chosen may not be the most appropriate. It has been shown that color directly influences emotions, and it is possible that the shades used are not stimulating creativity or creating a motivating environment in the classrooms. Therefore, what needs to be improved is the appropriate selection of colors to create more productive classrooms.

Barret, Davies, & Zhang[1] demonstrated evidence of verifiable and demonstrable impacts of school building design on student learning levels. Given that spatial factors in educational buildings, such as size, corridors, and specialized or sports facilities, do not seem as important as the sound design of other classrooms or halls, in addition to the quality and impact of using color as a functional component in learning.

In addition to these premises, we can also mention that the state of deterioration of educational facilities, caused by the lack of adequate maintenance, also leaves its mark on the way participants engage in the educational process, with dirty walls, scratched furniture, and non-functioning electrical infrastructure, among other things.

Current teaching conditions make it urgent to understand that classrooms must respond to the characteristics and qualities of the people who occupy them, using color as a teaching tool, an educational resource of great importance for learning. For this reason, they must be the subject of study, reflection, and planning in the PNFCC projects, as they are a key element for, as suggested by Escalante et al.[18], "enhance self-esteem, personal development and growth, discipline, discovery, and the experience of meaningful experiences within educational settings, spaces whose characteristics should promote the teaching project", without establishing the practical implementation of the teaching-learning process. It is a learning environment that promotes the development of all intellectual abilities.

Ensuring meaningful, high-quality learning requires the integration of aspects such as color, space, and the learning environment. Ideally, these aspects meet the conditions for fulfilling the curriculum. In this regard, it is worth referring to Moreno & Palau[32], who formulate guidelines for classroom design and use, presenting techniques so that officials involved in the creation, construction, and configuration of these spaces are aware of the number of elements they can work with to make these spaces inspiring, changeable, flexible, safe, pleasant, and sustainable. Hence, lines of research and socio-technological projects should be promoted by the PNFCC in the real context to help understand that the design of learning spaces is an opportunity to obtain more innovative classroom solutions in which all current educational methodologies can be included.

Rethinking classroom design from an interdisciplinary perspective is not just a whim but a necessity in education. Research shows that well-designed spaces—with thoughtful colors, flexible layouts, and natural elements—help students retain information better and engage more in class. However, some obstacles must be overcome to achieve this, such as the lack of teacher training in environmental design and resistance to policy change in institutions. As co-authors of this essay, we suggest that polytechnic universities take the lead in practical research, training professionals who can apply theories about color and space in classroom construction. According to UNESCO[33], "The education of the future requires classrooms that inspire, not confine." Only then will we make educational architecture a pillar, not an obstacle, to learning.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTION

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