Journal of Mediterranean Cities

2024, Volume 4, Number 1, pages 114–129

Exploring the Vital Role of Colors and Shapes in Architectural Design and Education

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A B S T R A C T

This study investigates the crucial influence of color and form on architectural design and architecture education, highlighting how these elements shape the aesthetics of the built environment and impact human experiences. The central problem addressed is the need to understand the interaction between color and form in creating spaces that evoke specific emotions and cultural narratives, contributing to an architecture that goes beyond functionality. The importance of this study lies in demonstrating how the careful integration of these elements can enrich the built environment and improve the quality of architectural education. The methodology adopted includes the analysis of case studies and expert opinions, along with the exploration of innovative methods in the teaching of architecture, which combine practical learning, virtual simulations and interdisciplinary collaboration. The results indicate that an in-depth understanding of the dynamic relationship between colors and shapes allows architects, but also society in general, to enhance their creativity, contributing to a more culturally significant and aesthetically impactful built environment.

JOURNAL OF MEDITERRANEAN CITIES (2024), 4(1), 114-129
https://doi.org/10.38027/mediterranean-cities_vol4no1_7

A R T I C L E I N F O:

Article history:

Received: July 07 2024

Revised: August 16 2024

Accepted: September 20 2024

Available online: Oct. 12 2024

Keywords:

Colors; Street mood; Architectural Design; Teaching Architecture; Urban Design

1. Introduction

The exploration of colors and shapes within the realm of architectural design and education presents a fascinating intersection of art, psychology, and technology. This study aims to highlight how these fundamental elements—colors and shapes—extend beyond basic aesthetic considerations to significantly influence both the visual appeal of structures and the emotional responses they evoke in occupants. By analyzing the interplay between these elements, this research underscores their vital role in shaping the human experience within built environments. This article embarks on an in-depth examination of how these fundamental elements—colors and shapes—play a pivotal role in crafting the aesthetics of our built environment, influencing not just the physical space but also the human experience within it.

The significance of this research lies in its potential to bridge the gap between aesthetic theory and practical application, offering architects and designers insights into how they can effectively use color

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How to cite this article:
Pinto, L. M., & de Matos, R. (2024). Exploring the Vital Role of Colors and Shapes in Architectural Design and Education. Journal of Mediterranean Cities, 4(1), 114-129. doi: https://doi.org/10.38027/mediterranean-cities_vol4no1_7

and form to create spaces that resonate on both a psychological and cultural level. The significance of color and shape in architecture goes beyond mere decoration; it is a powerful tool that architects wield to evoke emotions, narrate cultural stories, and shape spatial experiences. Despite the recognition of these elements in design, there remains a need for more comprehensive studies that explore the depth of their impact on users. This research contributes to filling that void by providing a thorough analysis supported by case studies and expert insights, emphasizing the necessity for architects to integrate thoughtful color schemes with geometric shapes in their work.

Through a meticulous analysis of case studies and expert opinions, this paper aims to underscore the necessity of integrating thoughtful color schemes with geometric shapes to forge compelling architectural narratives. This approach not only enhances the aesthetic quality of architecture but also plays a crucial role in ensuring that the spaces we inhabit are not only functional but also emotionally and culturally enriching.

Numerous successful initiatives demonstrate the utilization of gaming strategies to address specific urban challenges. For instance, the Commission for Architecture and the Built Environment (CABE), which was renamed as the 'Design Council' in 2011, in partnership with the British Council, has developed a variety of games in collaboration with gaming industry experts. These games serve as participatory instruments for exploring and shaping the future of local areas. A notable example is the 'Urban Ideas Bakery game,' a tool crafted to engage local community members in pinpointing unique challenges within their regions, devising creative architectural solutions to these social problems, and ultimately putting these plans into action (Brković Dodig,Marta, N. Groat, Linda 2019). Games act as platforms for conveying insights into the complex interaction between economic, social, political, cultural, and environmental factors that intricately mold spatial design (Salama, 2013: 22).

At the core of architectural aesthetics lies the intricate interplay between form (shape) and color. This relationship is not arbitrary but is deeply rooted in human psychology and cultural contexts. Colors possess the inherent ability to influence mood and perception, a principle widely recognized and utilized in various fields, from marketing to interior design. In architecture, this relationship is particularly important as it dictates how spaces are perceived and experienced, which in turn affects the well-being and satisfaction of individuals who interact with these spaces.

In architecture, the application of color can transform the ambiance of a space, making it feel warm and inviting or cool and serene. Similarly, shapes—be they the sweeping curves of a modernist structure or the rigid lines of a Brutalist edifice—communicate different messages and evoke distinct feelings. The careful selection and combination of these elements can create environments that not only meet the functional needs of their users but also evoke deeper emotional responses, contributing to the overall quality of life.

Together, these elements dictate the narrative of a space, guiding the emotional and psychological journey of its inhabitants. This study proposes that by understanding and strategically utilizing the interplay between color and shape, architects can create more meaningful and engaging spaces that resonate with users on multiple levels, ultimately enhancing the human experience within these environments.

The article delves into how architects leverage the synergy between colors and shapes to elicit specific responses and convey meaningful stories. It is through this lens that we appreciate architecture not just as a functional art but as a medium that reflects and shapes society's cultural narratives. The strategic use of color and form can highlight historical significance, represent cultural identities, or forecast future societal trends. This dynamic interplay is evident in landmark buildings and everyday structures alike, revealing the depth of thought that goes into architectural design.

Furthermore, the discussion extends into the realm of architectural education, highlighting innovative methods that foster a comprehensive understanding of the interplay between colors, shapes, and design. Scholarly works in architecture and urban planning often come from experts who are intensely focused

on specific areas within these fields. For example, some researchers might delve into city planning by applying gaming perspectives (Tan, 2018), while others deeply investigate the nuances of participatory design in architecture (Hofmann, 2014). Traditional architectural education has evolved to incorporate hands-on learning experiences, virtual reality simulations, and cross-disciplinary collaboration. These approaches not only enrich the learning experience but also prepare aspiring architects to think critically and creatively about the use of colors and shapes in their work. By engaging with these elements at a foundational level, students can develop a nuanced appreciation for their impact on design and human experience.

Acknowledging the dynamic relationship between colors, shapes, and architectural design opens up new avenues for creativity and innovation. It challenges architects to think beyond conventional boundaries and consider how their work contributes to the cultural and emotional landscape of the built environment. As this article will demonstrate through case studies and expert insights, the thoughtful integration of colors and shapes is crucial for creating spaces that resonate with people on a profound level. In doing so, architects not only enhance the aesthetic appeal of their creations but also contribute to a more enriched, culturally significant built environment. At the heart of this investigation lies the question: How can interactive game-based learning tools effectively teach architectural styles and the use of colors and shapes in design to different age groups?

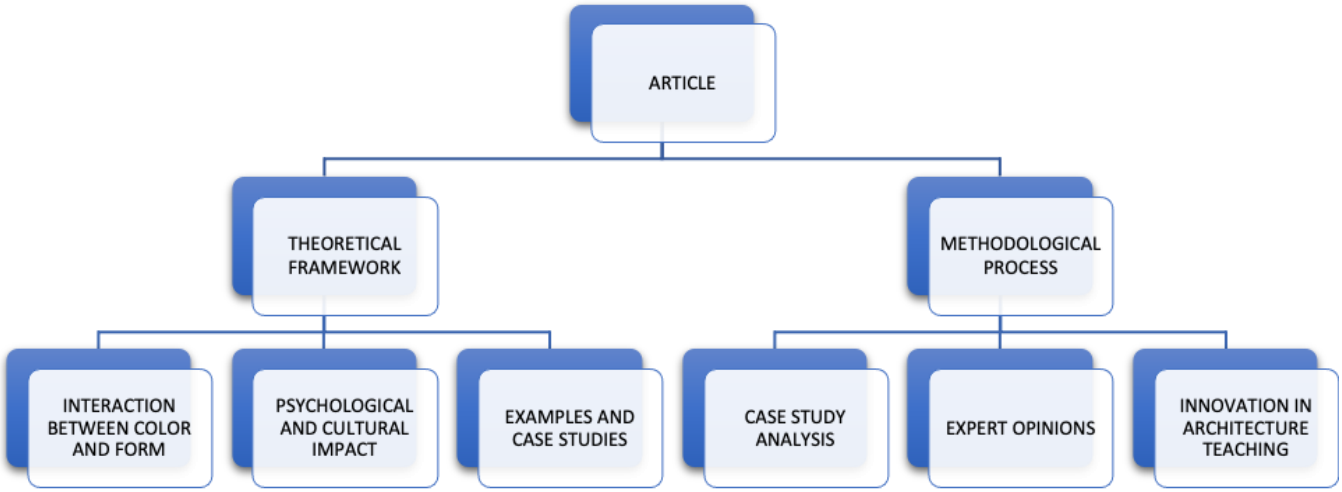


Figure 1. Structure of the Study

2. Materials and Methods

2.1. The Essence of Color and Shape in Architecture

At the heart of architectural aesthetics lie two fundamental elements: color and shape. These components are not mere embellishments but are essential tools that architects use to define space, create atmosphere, and evoke emotional responses. The choice of colors and shapes within a building's design goes beyond subjective preference; it reflects an understanding of how these elements interact with human psychology, influence perceptions of space, and contribute to the overall experience of the environment.

2.1.1. Psychological Impact of Colors

Colors have a profound impact on human emotions and behaviors. The psychology of color is a field of study that investigates how different hues can influence our mood, feelings, and even physiological

responses (Ittens, 1973). In architecture, the application of color theory is crucial, as it can transform the ambiance of a space. Warm colors, such as reds, oranges, and yellows, are often associated with energy, warmth, and comfort, making them ideal for spaces intended to stimulate interaction and activity. Conversely, cool colors like blues, greens, and purples are linked to calmness, serenity, and concentration, making them suitable for areas where peace and focus are desired (Birren, 1976).

2.1.2. Influence of Shapes on Perception

Shapes, the forms that define the structure and layout of space, also play a significant role in architectural design. Geometric shapes—circles, squares, triangles, and their derivatives—carry inherent meanings and associations. Circles, with their endless loop, suggest continuity and protection, often used in architecture to create a sense of inclusion and community. Squares and rectangles, representing stability and reliability, are the foundation of most architectural designs, shaping the basic layout of buildings and rooms. Triangles, with their dynamic angles, can introduce a sense of movement and direction, guiding the flow of space and energy within a structure (Alexander, 1977).

The integration of color and shape in architecture is not merely a matter of aesthetics but a thoughtful consideration of how these elements can enhance or alter the perception of space. Architects use color and shape in tandem to achieve specific effects, whether to make a room appear larger or smaller, to highlight architectural features, or to mask imperfections. The right combination can create depth and texture, add character, and influence the spatial dynamics of an environment.

2.1.3. Architectural Identity Through Color and Shape

Beyond their psychological and perceptual effects, colors and shapes contribute to the identity of architectural works. Iconic buildings around the world are often recognized by their distinctive color schemes and shapes. These elements serve as a visual language that architects use to express ideas, convey messages, and embed cultural and historical narratives within the fabric of their designs (Lynch, 1960). Through the strategic use of color and shape, buildings can reflect the identity of a place, embody the vision of their creators, and resonate with the experiences of their users.

2.1.4. The Interdisciplinary Nature of Color and Shape in Architecture

Understanding the role of colors and shapes in architecture requires an interdisciplinary approach, integrating knowledge from psychology, art, design, and cultural studies (Zevi, 1989). This holistic perspective allows architects to craft spaces that are not only visually appealing but also emotionally resonant and culturally relevant. It emphasizes the importance of considering the human experience in architectural design, ensuring that spaces are not only functional but also enriching and meaningful (Schulz, 1980).

The exploration of color and shape in architecture is a testament to the complexity and richness of architectural design. These elements are vital in shaping the aesthetics, functionality, and emotional impact of built environments. As we delve deeper into the subjects that follow, we will uncover the nuanced ways in which architects harness the power of colors and shapes to create spaces that are not just structures but experiences that engage, inspire, and move the human spirit. This introduction sets the foundation for a journey through the interplay of color and shape in architecture, highlighting their indispensable role in crafting the built world around us.

2.2. How the dynamic relationship between colors and shapes can inspire creativity?

The game methodology encourages students to experiment with various combinations of colors and shapes, pushing them to think beyond conventional design solutions. This exercise fosters creativity by allowing students to see how unconventional color and shape combinations can still adhere to or even redefine traditional architectural styles. For instance, using non-traditional colors for a Gothic style building in the game might challenge students to maintain the style's essence through form and detailing while innovating with color.

Games used in academic settings that concentrate on architecture and urban planning are recognized as powerful instruments for collaborative education, successfully promoting active participation among students (Salama, 2013).

In the realm of architecture, where the tangible meets the intangible and form intertwines with emotion, the dynamic relationship between colors and shapes not only serves as the foundation for aesthetic and functional design but also as a springboard for creativity and innovation. This chapter delves into how the nuanced interplay of these elements inspires architects to transcend conventional design boundaries, fostering a fertile ground for architectural innovation that marries practicality with profound emotional and cultural resonance.

The architectural process is inherently creative, yet it is the thoughtful manipulation of colors and shapes that propels this creativity into uncharted territories. Colors have the power to transform spaces, influencing mood and altering perceptions of scale and temperature, while shapes dictate the flow and functionality of those spaces, guiding human interaction within them. When architects harness these elements with intention and insight, they do more than create buildings; they craft experiences that engage, inspire, and move the human spirit.

Innovation in architecture often emerges from challenging the status quo, and the exploration of colors and shapes provides a vast playground for such challenges. Architects who experiment with unconventional color palettes or who daringly combine geometric forms often find themselves at the forefront of architectural discourse, pushing the envelope of what buildings can represent and how they can affect those who inhabit them. This exploration is not without its risks, but it is precisely in taking these risks that architects contribute to the evolution of their craft.

The influence of digital technologies has further amplified the potential for creativity through colors and shapes. Advanced software allows architects to simulate and visualize complex interplays of light and shadow, color, and form, enabling a level of experimentation previously unattainable. These technologies have democratized innovation, allowing architects not only to dream up extraordinary designs but also to see them realized.

Moreover, the global and multicultural world of contemporary architecture encourages a cross-pollination of ideas, where influences from one culture or era are reinterpreted through the lens of another, often with surprising and innovative results. This melding of influences, mediated by the universal languages of color and shape, highlights the role of architecture as a bridge between diverse cultures and historical periods, underscoring its power to communicate and connect across boundaries.

Yet, for all the emphasis on innovation and creativity, the use of colors and shapes in architecture is ultimately grounded in the pursuit of creating spaces that resonate on a human level. It is here, in the design of spaces that cater not just to the physical needs but also to the psychological well-being of individuals, that the true genius of architectural innovation lies. Whether through the calming hues of a hospital intended to soothe anxiety or the vibrant colors of a school designed to stimulate learning and curiosity, architects utilize colors and shapes not merely as tools of design but as instruments of human-centric innovation.

In resume, the exploration of colors and shapes in architecture transcends mere aesthetic considerations, embodying a profound vehicle for creativity and innovation. As architects continue to explore these elements with both reverence and daring, they not only redefine the boundaries of their profession but also enhance our collective experience of the built environment. The future of architecture, rich with color and form, promises not just buildings that stand as testaments to human ingenuity but spaces that reflect the full spectrum of human experience, bridging the gap between the functional and the sublime. By manipulating colors and shapes to evoke specific styles and moods, students practice making architectural decisions that align with real-world requirements. This hands-on experience is invaluable, as it translates theoretical knowledge into practical skills. The game's interactive nature allows immediate feedback and reflection, helping students understand the consequences of their design choices in a controlled, risk-free environment.

Overall, the game methodology leverages the synergy between colors and shapes to enhance architectural education by providing a playful yet profound way to explore and understand architectural styles. This not only makes learning more engaging but also equips students with the creative skills necessary to succeed in the ever-evolving field of architecture.

2.3. Cultural Narratives and Spatial Experiences

According to Henri Bergson (1859-1941), memories are intricately tied to specific moments or human actions, intertwined with representations that resonate with us. These representations often revolve around iconic landmarks that serve as the essence of a city, dispersed throughout its territory. Understanding these memories and iconic places is crucial for grasping the architectonic styles within the city. Our game methodology can aid in this comprehension by providing interactive experiences that immerse participants in the city's cultural fabric, fostering a deeper connection and understanding of its architectural heritage.

In the realm of architectural design, colors and shapes are not merely aesthetic choices; they are profound tools for conveying cultural narratives and crafting spatial experiences that resonate with the inhabitants. The architectural canvas becomes a medium through which stories of the past, present, and future are told, shaping not only the physical environment but also the societal context in which a structure exists.

Colors and shapes serve as a language that architects use to communicate and connect with people on a cultural level. For instance, the use of specific colors can evoke cultural or historical significance, such as the vibrant blues and whites found in Mediterranean architecture, symbolizing the sea and the sky. Similarly, shapes can reference cultural symbols or historical events, making the architecture itself a narrative medium. The pyramid shape, for example, immediately evokes images of Egypt and its rich history, while circular designs can suggest unity and community, prevalent in indigenous architectures around the world.

The interplay between color and shape significantly influences how spaces are perceived and experienced. Architects skillfully manipulate these elements to guide the movement within a space, highlight areas of importance, and create atmospheres that provoke specific emotional responses. The strategic use of warm colors can make a vast space feel more intimate and welcoming, while cool colors can lend a serene and contemplative air to a busy urban environment.

Furthermore, the geometry of a building—its lines, curves, and edges—can dramatically affect how people move through and interact with a space. Sharp, angular lines can create a dynamic and energizing environment, whereas smooth, flowing curves can foster a sense of calm and fluidity. The manipulation of shapes and colors can also alter perceptions of scale and distance, making spaces appear larger or smaller and influencing the spatial experience.

Just to ilustrarte what we are talking about and the meaning of Reflecting Cultural Identity we all know that landmark buildings around the world showcase how colors and shapes can embody cultural identities and values. The Guggenheim Museum in Bilbao, with its undulating titanium curves, reflects the fluidity and innovation of contemporary culture, while the red and gold palette of Beijing's Forbidden City encapsulates the power and majesty of Imperial China.

The thoughtful integration of colors and shapes in architectural design serves a dual purpose: it conveys cultural narratives and enhances spatial experiences. By understanding and harnessing the power of these elements, architects can create spaces that not only stand out aesthetically but also offer deep cultural resonance and a profound sense of place. This approach not only enriches the architectural landscape but also fosters a deeper connection between the built environment and the people who inhabit it, ensuring that buildings are not merely structures but meaningful spaces that reflect and celebrate cultural identity and human experience.

2.4. The Interplay Between Form and Color

In the intricate tapestry of architectural design, the symbiosis between form (shape) and color transcends mere aesthetic concerns, embedding itself deeply within the psychological and cultural fabric of human experience. This interplay is not a novel concept; rather, it is foundational, having evolved through centuries of architectural practice and theory. The manner in which architects wield form and color significantly influences not only the physical manifestation of their creations but also the emotional and psychological resonance these structures invoke within their inhabitants.

It is believed that basic geometric shapes can convey different emotions and moods, which can be symbolized by specific colors. This concept forms the foundation of the game methodology used to teach architectural styles to people outside the university setting. By associating shapes with colors that evoke similar moods, participants can better understand and recognize architectural styles through playful exploration (Holmes & Zanker, 2013).

The dialogue between form and color in architecture is intricate, with each element capable of evoking a wide spectrum of responses based on its application. Form, with its inherent capacity to define space and dictate flow, carries with it the power to shape human experiences and behaviors within architectural environments. Whether through the imposing rigidity of rectilinear forms or the fluidity of curvilinear shapes, the form can either invite movement and exploration or command stillness and reverence. Similarly, color, through its psychological impact, can alter perceptions of space and mood. The application of warm hues can transform an environment into a welcoming haven, while cool tones might imbue a space with a sense of calm and focus.

Historically, the convergence of form and color has been pivotal in defining architectural eras and movements. From the ornate gold and intricate forms of Baroque churches to the stark white cubes of Modernist structures, each period in architectural history has utilized this interplay to convey its unique ethos and aesthetic principles. These historical precedents underscore the enduring importance of understanding the relationship between form and color in architectural design, an understanding that remains crucial in contemporary practice. We live surrounded by colors. That is how the world is (Huchendorf, 2007).

In the modern architectural landscape, this interplay has been enriched by technological advancements and a deeper understanding of human psychology. Architects today have at their disposal an unprecedented array of materials and technologies that allow for more complex and nuanced explorations of form and color. Digital design tools enable the simulation and visualization of architectural ideas, allowing for a more thorough investigation of how form and color interact before physical construction begins. This technological evolution has not only expanded the palette of possibilities but

also introduced new challenges and considerations in design, including sustainability and the impact of built environments on human well-being.

The psychological impact of form and color is now a central consideration in architectural design, informed by a growing body of research in environmental psychology. Colors wield significant emotional influence, affecting how we perceive and experience space over time. This visual interpretation of space can evoke sensations ranging from strength to softness, from intensity to tranquility, as highlighted by Birren (2006). Moreover, in architecture, colors play a pivotal role in conveying the essence of different styles. Recognizing the color palettes associated with various architectural movements can aid in identifying and understanding these styles, enriching our appreciation of architectural diversity and historical context. Studies have shown that the architectural form can significantly affect human emotions and cognitive functions, influencing everything from stress levels to productivity. Color psychology further enriches this narrative, offering insights into how colors can affect mood, mental health, and even physiological reactions. These insights have profound implications for architectural design, suggesting that the thoughtful integration of form and color can contribute to healthier, more vibrant living and working environments.

Culturally, the application of form and color in architecture serves as a narrative device, telling stories of place, identity, and community. Through the strategic use of these elements, architects can create buildings that not only respond to their physical context but also reflect and celebrate the cultural and historical narratives of their surroundings. This aspect of architectural design underscores the responsibility of architects to consider the broader cultural implications of their work, ensuring that their projects contribute positively to the social and cultural fabric of their communities.

As the field of architecture continues to evolve, the exploration of form and color remains a vibrant area of inquiry and innovation. The ongoing dialogue between these two elements promises to yield new insights and possibilities, challenging architects to think creatively and critically about how they shape the built environment. By embracing the dynamic interplay between form and color, architects can continue to create spaces that are not only visually compelling but also deeply resonant with the human experience, spaces that reflect the complexity and richness of life itself.

3. Analysis and Results

3.1. Workshop Case Study

Throughout 2022 and 2023, we conducted workshops (Fig.1) outside of the university setting for adults and children with the aim of introducing some of the architectural styles found in the city of Covilhã, Portugal, as well as discussing the significance of colors and shapes in architecture and urban spaces, and how they relate to the sensations they convey.

To further elaborate on the methodology, the workshops were carefully designed as a series of interactive sessions aimed at engaging participants in both a practical and educational manner. The study was structured into three main phases: preparation, implementation, and data analysis.

In the preparation phase, we developed specific activities and materials that would allow participants to explore architectural concepts hands-on. This included selecting appropriate tools such as "Tangram" and "Jenga," which served as analogs for urban form and structure, to ensure that participants could tangibly interact with the ideas being presented. Additionally, we prepared pre- and post-workshop surveys to quantitatively measure the participants' knowledge before and after the sessions. Structured interviews were also prepared to gather qualitative insights into the participants' experiences and learning outcomes.

In this scenario, an in-person game emerges as a collaborative and imaginative tool, effectively engaging both children and adults outside the academic realm. This approach aims to impart knowledge about architectural styles. It serves not only as a means of education but also as a method to involve

communities in preserving and enhancing cultural landscapes. Through such interactive experiences, the game facilitates the transmission of the values intertwined with these architectural styles (Garcia-Fernandez & Medeiros, 2019).

During the implementation phase, the workshops were held at the C3D Space - Makerspace Covilhã within the Covilhã Municipal Library, drawing around 200 participants divided into groups of 25 spanning all age groups. Each group engaged in three workshop sessions, with activities designed to encourage creative expression and a deeper understanding of the architectural styles being taught. Data collection during these sessions was comprehensive, involving not only the collection of participants' drawings and models but also detailed observational notes, recordings of group discussions, and direct feedback from participants. These data points allowed us to gather a broad spectrum of information, from the participants' cognitive engagement to their emotional reactions to the architectural concepts presented.

Cities are often perceived merely as chaotic collections of concrete buildings and tangled streets. However, they are indeed vibrant ecosystems rich with stories, forms, and heritage that are typically overlooked. A series of three innovative workshops offered a distinctive chance to reshape how various groups, from children to the elderly, perceive and engage with urban spaces, thereby deepening their connection to these environments.

In the analysis phase, both qualitative and quantitative data were analyzed to assess the impact of the workshops. The qualitative data, including participant drawings, observational notes, and interview responses, were analyzed thematically to identify common patterns and insights related to the participants' learning experiences. The quantitative data, derived from pre- and post-workshop surveys, were statistically analyzed to measure the improvement in participants' ability to classify architectural styles and understand the emotional impacts of colors and shapes. This mixed-methods approach provided a robust framework for evaluating the effectiveness of the workshops, allowing for a comprehensive understanding of how participants engaged with the material and how their perceptions evolved throughout the process.

The initial workshop employed the games "Tangram" and "Jenga" to explore urban form and structure. Just as Tangram pieces fit together to form complex shapes, buildings in a city work in conjunction to shape their environment. This interactive and cooperative activity led participants to recognize the city as a dynamic mosaic, constantly in flux.

Overall, this study was conducted with a focus on creating an engaging, educational environment that was both interactive and reflective. The data collection methods were designed to capture a wide range of participant experiences, providing valuable insights into the effectiveness of the workshops and the potential for game-based learning methodologies to enhance architectural education.

In the second workshop, which utilized a "Pedagogical Suitcase," attendees delved into the city's historical and cultural aspects. Through crafting and interacting with puzzles or memory games that highlighted key landmarks, historical events, and notable personalities, the activities went beyond simple fun. They served as a portal to the past, breathing life into the heritage of the city and making its rich history palpable and engaging.

The third workshop positioned participants as urban artists, tasked with portraying the characteristics of the city's landmark buildings through various artistic methods. They examined intricate architectural details, the stories told by different colors, and the unique textures of each building, leading to a newfound appreciation and understanding of their architectural significance.

These workshops were held at the C3D Space - Makerspace Covilhã within the Covilhã Municipal Library, drawing around 200 participants divided into groups of 25, spanning all age groups. Although originally part of doctoral research, these gatherings surpassed their scholarly purpose, enriching participants' collective perception of their city.

Bruno Zevi argued that architectural representation has always been constrained by the limitations of available tools (Zevi, 1989). Today, while digital drawings and sketches can appear almost unbelievable to the modern eye, the fundamental process of image creation remains consistent.

In conclusion, the combination of qualitative and quantitative data collected through these workshops provided a rich and detailed picture of how different age groups engage with architectural education. The mixed-methods approach ensured that both the emotional and cognitive aspects of learning were captured, offering valuable insights into the role of game-based learning in architectural education.

In our game methodology workshops, drawings play a crucial role in representing, storing, and transmitting important architectural information. By visually engaging participants with sketches and models of different architectural styles, we can more effectively teach and illustrate the distinctive features and emotional impact of various designs. The act of drawing itself encourages participants to explore architectural styles deeply, while the interactive nature of the game methodology makes learning accessible and enjoyable.

Figure 2. Workshops with children and andults, held at Covilhã (2022-2023) (Photo Rúben de Matos)

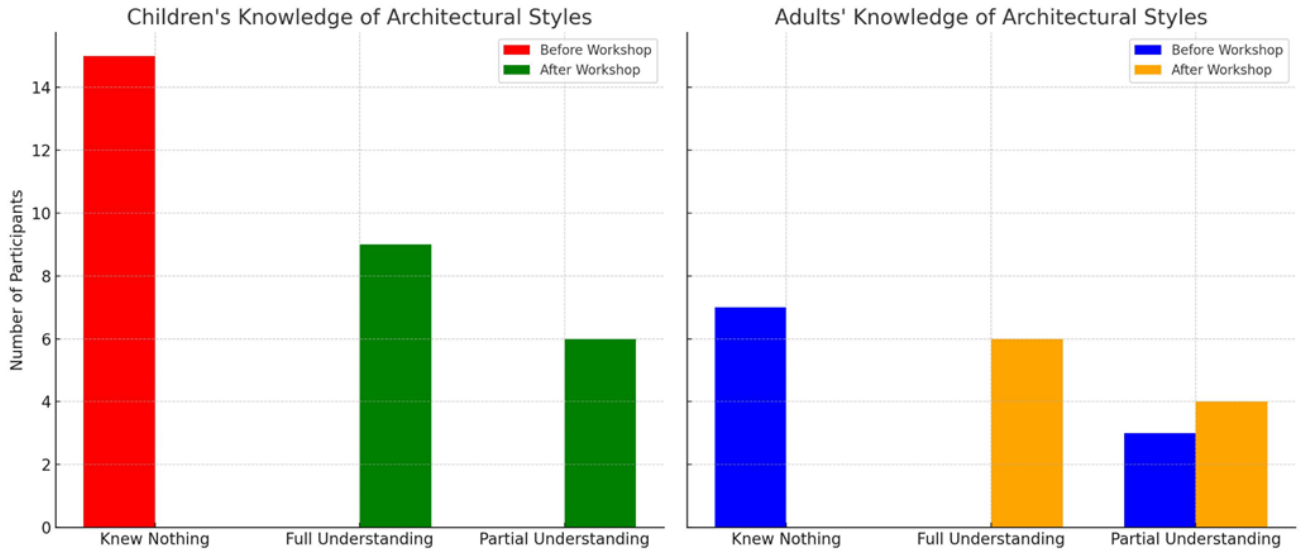
Children's Knowledge of Architectural Styles (Graph.1)

- Before the workshop:
  - 15 children knew nothing about architectural styles.
  - Before the workshop, no children could correctly classify architectural styles.
- After the workshop:
  - 9 children could easily classify all styles.
  - 5 children correctly classified 6 out of 8 styles.
  - 1 child correctly classified 3 out of 8 styles.
  - After the workshop, a significant improvement was observed:
  - 60% could easily classify all styles.
  - Additional improvements brought the total average effectiveness to about 77%.

Adults' Knowledge of Architectural Styles (Graph.1)

- Before the workshop:
  - 7 adults knew little to nothing (3 knew about 4 styles, 4 knew less or none).
  - Initially, adults had some basic understanding, but none could fully classify all styles correctly.
- After the workshop:
  - 6 adults correctly answered all styles.
  - 2 adults correctly answered 6 out of 8 styles.

- 2 adults remained with lower understanding
- After the workshop, there was a notable improvement.
- 60% of the adults were able to correctly answer all styles.
- Additional improvements brought the total average effectiveness to about 80%.



Graphic 1. Workshops with children and andults, held at Covilhã (2022-2023) (Photo Rúben de Matos)

Collectively, the workshops not only offered insights into the structural and aesthetic components of the city but also strengthened participants' connections to its historical heritage and introduced them to new artistic interpretations of familiar surroundings. These experiences did more than educate; they enhanced the communal bond with the urban setting. This approach sparked interaction, creativity, memory-sharing, and revealed the potential for collaborative endeavors to foster a comprehensive and enriched understanding of urban life.

3.2. Innovative Methods in Architectural Education

The focal points of gaming and education often revolve around player motivation and engagement, extensively investigated by scholars (Boyle et al., 2012; Viola, 2018; Wouters et al., 2013). These areas encompass two vital components: the impact of games on enhancing students' drive to learn and the inherent motivations and anticipations that drive individuals to engage in gaming pursuits. For an aesthetic experience to come to life, there must be a meaningful relationship between the subject and the object, guided by time and perception (Eco, 1987). In our game methodology for teaching architectural styles, it's crucial to establish this connection by immersing participants in hands-on exploration of iconic forms and structures. By creating a playful yet informative interaction between participants and architectural designs, the game methodology helps them develop a deeper understanding and appreciation of various architectonic styles. This interactive approach enables learners to connect emotionally with the subject matter, facilitating a comprehensive learning experience.

Kennedy (1973: 331) points out that architecture and education, both at institutional and functional levels, not only present challenges but also create substantial obstacles to effective collaboration between architects and educational specialists. This game methodology will help to make an easy link between Learning and teaching, between professionals and people in general.

In the pursuit of innovative educational methodologies within architectural education, integrating game-based learning presents an exciting avenue for teaching architectural styles, as well as understanding the influence of colors and shapes on architectural feelings and moods. This game, adaptable for digital platforms or traditional hands-on materials, is designed to engage students in a dynamic exploration of architectural elements, fostering both knowledge acquisition and creative thinking.

Game Overview: "Architectonic Moods & Styles Explorer"

Objective: Players navigate through various architectural styles and create buildings that evoke specific feelings and moods, utilizing a strategic selection of colors and shapes.

Game Setup:

Digital Version: A software application where players can design buildings using a library of shapes (geometric, organic, etc.) and colors. The game includes a gallery of architectural styles (Gothic, Baroque, Modernism, etc.) and a mood board for inspiration (serenity, excitement, melancholy, etc.).

Traditional Version: Using cardboard cutouts of different shapes and colored papers or markers, players manually create models. Printed cards represent different architectural styles and moods, serving as prompts for the players.

Gameplay Mechanics

Learning Phase: Players begin with a brief interactive tutorial (digital) or a guided session (traditional) on architectural styles and how colors and shapes influence mood and perception in architecture.

Challenge Rounds: Each round, players draw a card or receive a digital prompt detailing a specific architectural style and desired mood (e.g., "Create a Modernist library that evokes serenity"). Players then have a set time to design a building that aligns with these criteria using the available digital tools or physical materials.

Design and Justification: Upon completion, players present their designs to the group, explaining their choice of shapes and colors and how these elements combine to reflect the given style and mood.

Feedback and Reflection: In the digital version, an AI-powered tool provides instant feedback on how closely the design matches the style and mood, along with suggestions for improvement. In the traditional version, peers and instructors offer feedback, fostering a collaborative learning environment.

Scoring: Designs are scored based on creativity, adherence to the architectural style, and the effective conveyance of the specified mood. Points accumulate over several rounds, and the player with the highest score wins.

Reflection and Learning: Each session concludes with a reflective discussion, allowing players to articulate what they have learned and how they might apply these insights to future architectural projects.

Educational Outcomes:

Through engaging with "Architectonic Moods & Styles Explorer," students gain a deeper understanding of the historical and cultural contexts of various architectural styles. They learn how to strategically use colors and shapes to elicit specific emotional responses, enhancing their design skills. The game encourages critical thinking and creative problem-solving, as students must navigate the constraints of each challenge to produce coherent and innovative designs. Additionally, the collaborative and competitive aspects of the game foster a dynamic learning atmosphere, encouraging students to learn from one another and to see architectural design from multiple perspectives.

Adaptability and Expansion:

The game is designed to be flexible, allowing for updates with new styles, moods, and challenges. In the digital version, expansions can include interactive elements such as virtual reality (VR) walkthroughs of

player-created buildings. In the traditional version, new materials and tools can be introduced to diversify the design possibilities. This adaptability ensures that the game remains a relevant and engaging educational tool in the ever-evolving field of architecture.

The "Architectonic Moods & Styles Explorer" game embodies a pioneering approach to architectural education, blending the realms of interactive learning and creative design. As we've seen through various implementations, this game not only demystifies complex architectural concepts but also enriches students' understanding of the emotional and psychological impacts of architectural elements. The dual versions of the game—digital and traditional—ensure that it is accessible and adaptable to diverse learning environments and technological availabilities.

This innovative game-based methodology has proven its efficacy in fostering an engaging and immersive learning experience. Participants leave with a robust toolkit of knowledge and skills, from recognizing architectural styles and their historical significances to applying color theory and design principles in creating emotionally resonant environments. Moreover, the game's scoring system and competitive element add an enjoyable challenge that encourages deeper engagement and collaboration among students.

As architectural education continues to evolve, the "Architectonic Moods & Styles Explorer" serves as a scalable model that can be continuously updated and expanded to include new technologies and pedagogical strategies. Future iterations could incorporate augmented reality (AR) or virtual reality (VR), offering even more immersive experiences that could simulate real-world architectural design processes. The use of games as a methodology offers a novel approach for involving the community in discovering the architectural elements of their city (Duke and Greenblat, 1979).

Ultimately, the success of this educational tool highlights the potential of game-based learning in transforming educational landscapes—not just in architecture, but in various fields where complex, abstract concepts can be made tangible and engaging through innovative teaching methodologies. This approach not only prepares students to excel in their academic pursuits but also equips them with the critical thinking and creative problem-solving skills necessary to succeed in their future careers. As educators and innovators, our challenge is to continue refining and expanding these tools to meet the ever-changing needs of learners in a dynamic world.

4. Discussion

4.1. Critical Review of Results and Theoretical Framework Implications

The workshops conducted as part of this study provided a unique opportunity to explore the impact of colors and shapes on architectural perception across different age groups. The results, as demonstrated by the significant improvement in participants' ability to classify architectural styles and understand the emotional impacts of colors and shapes, support the hypothesis that interactive, game-based learning methodologies can enhance architectural education. This finding aligns with the theoretical framework that posits the integration of psychological and cultural dimensions into architectural design as crucial for creating spaces that resonate with users on multiple levels. The observed improvement in participants' knowledge, particularly among children and adults who initially demonstrated limited understanding of architectural styles, suggests that the interactive and hands-on nature of the workshops effectively bridged the gap between abstract architectural concepts and practical application. This outcome supports the initial hypothesis that engaging participants through interactive methodologies would lead to a deeper understanding and retention of architectural knowledge. The successful application of these methodologies also highlights their potential for broader use in architectural education, particularly in community settings where traditional academic approaches may be less effective. However, a critical review of the results also reveals areas for further investigation. For instance, while the majority of participants showed significant improvement, there was still a subset of participants who did not achieve the same level of understanding. This suggests that while the methodology was effective for most, it may

need to be adapted or supplemented with additional support for those who may require different learning approaches. This aspect underscores the importance of developing flexible educational strategies that can accommodate diverse learning needs within architectural education.

4.2. Implications of the Results

The implications of these results are significant for both architectural education and practice. The study's findings suggest that incorporating colors and shapes into the design process, informed by a deep understanding of their psychological and cultural impacts, can lead to the creation of more meaningful and resonant architectural spaces. This has direct implications for architects who seek to create designs that not only fulfill functional requirements but also engage users on an emotional and cultural level. The success of the workshops in enhancing participants' understanding of these elements demonstrates the potential for broader application of such methodologies in professional practice, particularly in community-driven architectural projects where public engagement is crucial. Furthermore, the results reinforce the importance of integrating interactive and experiential learning methods into architectural education. The positive response from participants across different age groups indicates that such methods can effectively engage diverse audiences, making architectural education more accessible and relevant to a wider population. This has potential implications for educational institutions, which may consider incorporating similar approaches into their curricula to better prepare students for the challenges of modern architectural practice.

4.3. Evaluation of Methodology and Tactics

The methodology employed in this study, particularly the use of game-based learning tools, proved highly functional in achieving the study's objectives. The interactive nature of the workshops allowed participants to engage with architectural concepts in a tangible way, leading to a more profound understanding and retention of the material. The use of games like "Tangram" and "Jenga" not only made the learning process enjoyable but also facilitated the exploration of complex ideas in a manner that was accessible to participants of all ages. However, the functionality of the methodology also raises important considerations for its broader application. While the hands-on, interactive approach was effective for most participants, the variation in outcomes suggests that the methodology may need to be adapted for different learning styles and abilities. This points to the need for a more nuanced approach to educational design, one that considers the diverse needs of learners and provides multiple pathways for engagement and understanding.

4.4. Response to the Hypothesis

The aim of the article was to explore how interactive, game-based methodologies could enhance understanding of architectural styles, colors, and shapes among a diverse group of participants. The results of the study strongly support the initial hypothesis that these methodologies would lead to significant improvements in participants' architectural knowledge and their ability to apply this knowledge in practical contexts.The study successfully demonstrated that engaging participants through interactive workshops not only improved their knowledge but also deepened their appreciation for the emotional and cultural dimensions of architecture. This outcome is consistent with the theoretical framework that emphasizes the importance of integrating psychological and cultural insights into architectural design. Moreover, the positive feedback from participants indicates that the methodologies used were both effective and enjoyable, suggesting that similar approaches could be widely adopted in both educational and professional settings.

5. Conclusion

In navigating the complex interplay of colors and shapes within the architectural realm, this article has illuminated the profound impact these fundamental elements exert on both the aesthetic and emotional dimensions of space. As we have explored, the careful selection and integration of colors and shapes are instrumental in conveying cultural narratives, evoking desired moods, and defining the character of architectural works. From the psychological influence of colors on human perception and emotion to the cultural significance embedded in architectural forms, it becomes evident that these elements are far more than mere components of design; they are essential tools through which architects communicate, innovate, and express the intangible. The exploration of architectural styles, alongside the innovative methodologies in architectural education, underscores the dynamic evolution of how we understand and implement colors and shapes in design. By embracing new technologies and interdisciplinary approaches, architects and educators are fostering a rich environment of experimentation and discovery, enabling the next generation of architects to push the boundaries of what is possible. Furthermore, the drive towards innovation, as highlighted in the discussions on creativity and the utilization of digital tools, reflects a broader trend in architecture towards more personalized, responsive, and emotionally resonant spaces. In this light, the role of colors and shapes transcends mere aesthetics, acting as a bridge between the human experience and the built environment, between our past cultural heritage and future aspirations.

In conclusion, the thoughtful integration of colors and shapes in architectural design emerges not only as a critical factor in achieving harmony and beauty but also as a catalyst for emotional engagement and cultural expression. As we look towards the future of architecture, it is clear that the continued exploration of these elements will play a pivotal role in shaping innovative, meaningful, and responsive spaces. Architects, armed with an understanding of the psychological and cultural dimensions of colors and shapes, are well-positioned to create environments that not only meet the functional needs of society but also enrich the human spirit, weaving the fabric of our shared spaces with threads of color and form that resonate deeply with our collective psyche. In doing so, architecture transcends its physical boundaries, becoming a testament to the enduring power of human creativity and ingenuity. The use of colors and shapes was particularly pivotal in our workshops, serving as a visual and intuitive guide to understanding different architectural elements and styles. These visual tools helped demystify the subject matter, making it more accessible and enjoyable. Moreover, discussing the meanings behind various architectural forms deepened the learners' appreciation of how architecture interacts with cultural and historical contexts, enhancing their overall learning experience. This approach not only educates but also inspires creativity and a deeper appreciation of our built environment. After our workshop experience and results, also after our research, we can say that integrating game methodologies into the teaching of architectural styles has proven to be a remarkably effective educational strategy for both children and adults.

Conflict of Interests

The author declares no conflict of interest.

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