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INTEGRATING BIOPHILIA IN ARCHITECTURAL DESIGN EDUCATION: AN EXAMINATION OF ITS IMPACT ON STUDENTS' CREATIVITY

Research article

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Abstract

The architecture, in constant creative evolution, adapts to the changing needs of society by integrating biophilia into architectural education, thus providing an innovative framework conducive to the creativity of future architects. The article explores how second and third-year architecture students explore the concept of biophilia integrated into the second-semester curriculum of their architectural design studies. Conducted at the department, University of Sétif 1, Algeria during the academic year 2022-2023, the study combines quantitative and qualitative approaches, comparing data before and after the integration of biophilia through surveys of 287 students. Data collection began with a survey assessing students' familiarity with biophilia, followed by six questions about their expectations and perceptions before this integration, measured on a Likert scale. Additionally, the study analyzed and evaluated 53 student projects using Kellert and Calabrese's criteria from "The Practice of Biophilic Design." The study spanned a period of 13 weeks and aimed to understand the influence of biophilia education on students' perception of creativity and the quality of their architectural projects. The results highlight a growing awareness of the positive impact of integrating biophilia in architecture reinforcing students' motivation to explore innovative solutions in the design of their projects.

Keywords: Architectural Design, Biophilia, Creativity and Environment, Education, Biophilia Receptivity

1. Introduction

The study delves into the integration of biophilia in architectural design education and its influence on the creativity of students, merging two major domains: architecture and biophilia. Although in 2016, Algeria established various Millennium Development Goals (MDGs 2016) (Abbaoui & al.2020), little effort has been made to reform architecture programs in favor of sustainability. Biophilia, expressing our innate propensity to seek connections with nature, has gained recent prominence in the fields of architecture and design. It promotes the quality of life in built environments while reinforcing sustainability.

Initiated over fifty years ago, the concept of biophilia reflects humanity's ancient instinct to interact with nature. First mentioned by social psychologist Erich Fromm in 1964, defining it as a psychological inclination to be attracted to all that is living and vital (Fromm, 1964). This

term was popularized in the 1980s by biologist and scholar Edward O. Wilson, defining it as an innate tendency to focus on life and realistic processes (Wilson, 1984). Empirical studies conducted among individuals in various settings have shown that merely having a view of natural elements or increasing the intake of natural light indoors can significantly impact the physical and mental health of individuals while promoting their healing process (Ryan and al., 2014).

Contemporary architecture strives to address sustainability challenges, harmony with nature, and the well-being of inhabitants by integrating biophilia. This essential approach fosters environmentally-friendly designs, enhances occupant well-being, stimulates student creativity, and contributes to creating higher-quality urban environments. The study aims to guide the future of architectural education towards sustainable and nature-harmonious spaces to promote overall well-being.

In the field of architecture, biophilia is gaining relevance, encouraging architects to incorporate natural elements such as natural light, vegetation, water, and organic materials into their designs. Adapting the natural context to the built environment, as developed by Kellert, emerges as a crucial element in architectural design. Therefore, biophilia provides a comprehensive framework to enrich the experience of nature within the built environment (Kellert and al., 2005; 2008; 2011; Browning and al., 2014). In architectural education, biophilia becomes a key element of training future architects. Programs often integrate courses and workshops that sensitize students to biophilia and its practical application in architectural design. These students are encouraged to develop a sensitivity to nature and design buildings and urban spaces that promote health, occupant well-being, and environmental stewardship.

The study we are undertaking aims to understand the impact of integrating biophilia into architectural design education, with a focus on its influence on the creativity of architecture students. It explores how the incorporation of biophilic principles in second and third-year architecture studios inspires the design of buildings and urban spaces while contributing to more sustainable environments connected to nature.

The selected projects for this study offer the opportunity to explore the experiences and characteristic aspects of biophilic design, as developed by Kellert and Calabrese, as illustrated in Table 1 (Kellert and Calabrese, 2015). From this perspective, the projects created by students are examined, and their inclinations regarding biophilic design aspects are assessed.

This research aims to enhance the education of future architects and promote environmentally responsible architectural practices.

Table 1. *The three experiences and characteristics of biophilic design. Source: Table compiled from the works of Kellert and Calabrese (2015)*

Direct Experience of Nature	Indirect Experience of Nature	Experience of Space and Place
- Light - Air - Water - Plants - Animals - Weather - Natural landscapes and - ecosystems - Fire	- Nature images - Natural materials - Natural colors - Simulation of natural light and air - Naturalistic shapes and forms - Evoking nature information Richness - Age, change, and the patina of time - Natural geometries - Biomimicry	- Prospect and refuges - Organized complexity - Integration of parts into wholes - Transitional spaces - Mobility and wayfinding - Cultural and ecological attachment to place

2. State of the Art and Principles of Biophilic Design

Biophilia in architecture finds its origin in our deep connection with nature, explored by biologists such as E.O. Wilson. This concept, popularized in the 1980s, reveals our instinctive attraction to nature. Wilson, particularly in his 1984 work "Biophilia," emphasized the crucial importance of this connection for our well-being, creativity, and relationship with the natural environment. Thus, he greatly contributed to promoting biophilic architecture by highlighting the benefits of integrating natural elements into architectural design (Wilson 1984). In a recent study, Kellert and Calabrese (2015) developed a set of biophilia-related criteria, emphasizing the importance of the relationship between humans and nature in the field of architecture. These criteria serve as guidelines for designing built environments that encourage a positive connection between residents and the natural world. These criteria are presented in the form of a concise list titled "Experiences and Attributes of Biophilic Design," divided into three distinct categories, as illustrated in Table 1. The first category, direct experience of nature, involves immersive architectural design, incorporating natural elements such as light, air, water, plants, animals, weather conditions, landscapes, ecosystems, and fire, thereby creating an environment where users live these natural elements. The second category is the indirect experience of nature, where architectural design emphasizes the integration of elements that evoke nature, including the use of images, materials, colors, shapes, and techniques that mimic light, air, natural forms, and reflect the characteristics of the natural world, while also incorporating the concept of biomimicry and natural geometries. Finally, the third category concerns the experience of space and place, where the elements of this criterion refer to the natural relationships between spaces, a sense of belonging, and associations with nature. This includes perspective and refuge, harmonious structuring, integration of components into a coherent whole, transition zones, mobility and orientation, as well as cultural and ecological attachment to the place, evoking the natural environments with which humans are familiar.

Based on the work of the distinguished author Kellert and al. (2008) in "Building for Life," several authors have delved into the design of spaces that integrate nature and the importance of understanding the connection between humans and nature. The work of Joye and Van den

Berg in 2011 challenged evolutionary assumptions in research on restorative environments and nature, highlighting the importance of social and cultural factors, thus expanding the understanding of psychological restoration and the human-nature relationship. Cheng and Monroe (2012) explored children's affective attitude toward nature, revealing how this experience can influence their emotional connection with the natural environment, which, in turn, affects their attitude toward nature in adulthood. Previous studies have explored the effects of integrating biophilia in architectural design education, including studies on biophilic design, such as that of Peters and Peters (2020), which identified environmental design strategies to enhance the health and recovery of university students. Their research examines aspects such as emotional stress, happiness, stimulation, and offers evidence-based recommendations to optimize learning environments. The study conducted by Ertin Tezgör and Karakaya Aytin, (2022) focuses on a studio experience exploring design inspired by biomorphic forms and natural patterns. This research examines how these inspirations influence creativity and architectural design, highlighting the importance of biophilia in the design process. Cobreros and al. (2023) have looked into how the connection with nature impacts the mental well-being of university communities, highlighting how nature can enhance well-being in urban environments while identifying biophilic design patterns for cities and campuses. Mahrous and al. (2023) explored the impact of biophilic design on student satisfaction in academic buildings, emphasizing the importance of natural lighting, natural ventilation, greenery, large windows, and natural materials to enhance their well-being in learning environments.

Creativity is essential in architecture, as architects must design functional, aesthetic, and sustainable spaces. Two exemplary architectural examples illustrate how biophilia has taken a prominent place in contemporary architectural design. These projects aim to significantly integrate nature into built environments while creating healthier and more pleasant living and working spaces.

The first example is the Vertical Garden of Milan, Bosco Verticale in Italy (Figure 1), designed by architect Stefano Boeri in 2014 (Andreis, 2014). This project houses a true "vertical garden" in the heart of the city, improving air quality, providing shade, encouraging biodiversity, and offering a high-quality urban residential environment.

The second example is the Amazon Spheres in Seattle, USA (Figure 2), founded by Jeff Bezos in July 1994 and opened in 2018. This achievement consists of spheres erected on 3 to 4 levels, made of concrete, steel, and glass, requiring 560 tons of steel, 620 steel tubes, and 2,600 glass panels (Kurt, 2018). It was designed to promote a connection to nature within the work environment, stimulate employee creativity and well-being, while creating a unique environment firmly focused on biophilia in the heart of the city.

However, before the emergence of concerns related to biophilia in architecture, many architectural projects had already demonstrated how architecture could be intelligently designed to harmoniously integrate with the surrounding nature. Among these notable examples are:

The Alhambra Palace in Granada, Spain (Figure 3), primarily built in the 13th century by the founder of the Nasrid dynasty, who entered Granada in 1238 and established the site (Dodds, 1992). It is perched atop a lush hill, surrounded by sumptuous gardens. The sophisticated geometric patterns, inner courtyards adorned with fountains, and meticulously maintained gardens blend perfectly with the natural landscape, creating a harmonious integration with nature.

The Kiyomizu Buddhist Temple in Kyoto, Japan (Figure 4), with its origins dating back to 778, towards the end of the Nara period (Louis, 1996). It was erected in the 9th century, nestled amidst a dense forest of cherry and deciduous trees, making it an iconic example of nature integration in Japanese architecture.

Figure 1. Bosco Verticale - Milan's Vertical Garden in Italy. Source: iStockPhoto.com, Source: https://www.istockphoto.com › photos › bosco-vertical

Figure 2. Amazon Spheres Center in Seattle, USA. Source : https://www.usinenouvelle.com › L'Usine Campus

Figure 3. The Alhambra Palace in Granada, Spain Source : https://fr.wikipedia.org/wiki/Alhambra_Grenade)

Figure 4. Kiyomizu Buddhist Temple in Kyoto, Japan Source : https://www.jrailpass.com › blog › temple-kiyomizu-dera

It is interesting to note that these exceptional architectural works, although not initially designed with a concern for biophilia, are now considered excellent examples of successful biophilic design (Moltrop, 2011). Research on the integration of biophilia into architectural design education, while valuable, has been limited by small sample sizes, diverse methodologies, and disparate creativity assessment criteria. Future research should strive to use larger samples, consistent methodologies, consistent creativity measurement criteria, long-term studies in professional contexts, interdisciplinary approaches, and examine the role of instructors in promoting biophilia integration in architecture and enhancing the creativity of future architects.

Our study develops a mixed-methods methodology aimed at assessing the impact of biophilia on the creativity of architecture students by measuring changes in students' creativity

perception before the integration of biophilia and the quality of their projects after incorporating biophilia into the curriculum. Integrating biophilia into architectural education is essential for sustainable environments. However, gaps in previous research have led to our study, promoting the training of creative architects sensitive to nature.

3. Method

The method we adopted combines data collected before and after the integration of biophilia into the architectural design curriculum. Our primary objective is to assess significant changes that may occur in students' perception of creativity and the quality of their architectural projects.

Before commencing our research, we began by educating students about the fundamental concepts of biophilic design. This awareness was created through a series of interventions and presentations led by mentors. During these sessions, examples of buildings and indoor and outdoor spaces that effectively incorporate biophilic elements were highlighted. These examples provided tangible illustrations of how natural features can be cleverly used to enhance space quality and occupant well-being.

The integration of biophilic elements into the educational program is intended to enable students to develop a practical understanding of biophilia in architecture. This integration is primarily based on the key characteristics of biophilic design as defined by Kellert and Calabrese (2015) in their work "The Practice of Biophilic Design." We encouraged in-depth discussions to explore these aspects in detail and study the practical implications of biophilic design (Walliss & Greig, 2009).

3.1. Research Design

Our research approach is based on a methodology that encompasses both quantitative and qualitative approaches. This approach aims to establish a closer connection between students and nature by integrating the fundamental principles of biophilic design into the architectural design process.

The first stage is focused on acquiring essential knowledge regarding biophilia in architecture. This is achieved through courses taught by mentors that introduce the concept of biophilia, as well as through bibliographic research and student presentations on biophilic features. Additionally, a field trip is organized to assess the potential of the site.

The second stage involves site analysis and the integration of biophilic elements within it.

Finally, the third stage centers on the final project and discussions related to the incorporation of biophilic attributes in architectural design.

The proposed sites are located on the outskirts of the city of Sétif, Algeria, as illustrated in Figure 5, and the envisioned projects will be multifunctional and small-scale (e.g., a youth hostel, a neighborhood library, a school, a daycare, a media library, etc.).

The tutors will encourage students to showcase their creativity by exploring various biophilic features to create satisfying atmospheres and visual effects. Students will present their proposals, highlighting how they have adapted them to the selected sites, with a particular emphasis on how they have leveraged key biophilic elements. During this process, the tutors will closely observe the students and take notes on how they integrate these biophilic elements into their designs.

Subsequently, these proposals will undergo an evaluation based on objective criteria directly inspired by the biophilic design features of "Direct Experience of Nature" as defined by Kellert and Calabrese, as indicated in Table 1 of this article. Tutors will review these projects to determine if the required criteria are present or absent and will create evaluation sheets. This evaluation aims to assess the creativity of students' projects, with a specific focus on aspects such as ingenuity, originality, and relevance.

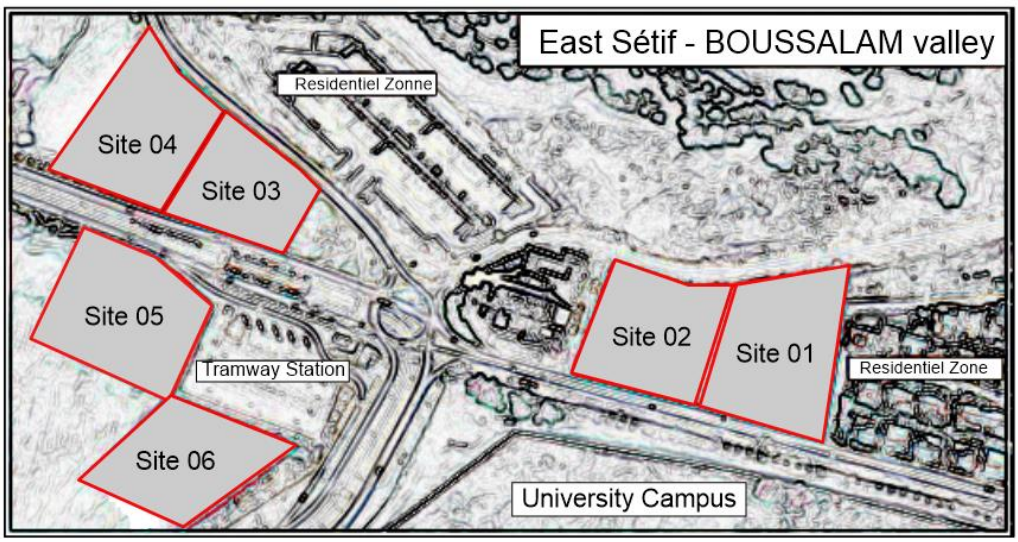


Figure 5. Sites proposed to accommodate student projects
Google image processed by the authors, 2023

3.2. Sampling

The participants in this study are undergraduate students enrolled in the Department of Architecture at the Institute of Architecture and Earth Sciences at the University of Sétif 1 in Algeria. They participated in this research as part of their academic program. It is important to note that the authors of this study are also permanent members of the teaching and research staff of this institution.

In the scope of our study, we initiated a data collection phase by randomly selecting a sample of 287 students from the 2022-2023 academic year. Among these participants, 154 were in their second year, distributed across six studio groups, while 133 were in their third year, distributed across five studio groups at the time of data collection.

Subsequently, we reviewed a sample of 53 design proposals created by students during the second semester of their studio studies. Among these participants, 28 were in their second year, while 25 were in their third year.

3.3. Data Collection and Analysis

An investigation was undertaken to gather crucial information concerning architecture students' experience, their commitment to biophilia, and their conception of creativity in the field of architecture. To achieve this:

First, we examined the participants' prior familiarity with the concept of biophilia. Participants were encouraged to indicate whether they had prior knowledge of the term "biophilia" in relation to architecture before completing this questionnaire, providing responses in a multiple-choice format (Yes/No).

Next, we posed a series of six questions to assess students' expectations and perceptions before the integration of biophilia. Responses to these questions were collected using a five-point Likert scale (Champagne, 2014), where students were asked to express their level of agreement with the following statements. This scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). These questions were distributed as follows:

I) Students' Pre-Integration Biophilia Expectations:

1- I consider the integration of biophilia into architectural design education to be essential.

2- I look forward to deepening my knowledge of biophilia and its application in architecture.

3- I am convinced that the integration of biophilia can enhance my creativity in architectural design.

4- I hope that the integration of biophilia will bring uniqueness and innovation to my architectural projects.

II) Students' Pre-Integration Biophilia perceptions:

5- How would you currently rate your level of creativity in architectural design?

6- How do you judge the overall quality of your architectural projects so far?

The contributions of Champagne (2014) in his work titled "The Survey Playbook: How to Create the Perfect Survey," as well as the use of Sphinx iQ 2, greatly facilitated our data collection process.

Finally, we encouraged students to share their thoughts and suggestions on the optimal way to integrate biophilia into architectural design education, with the aim of improving creativity and project quality.

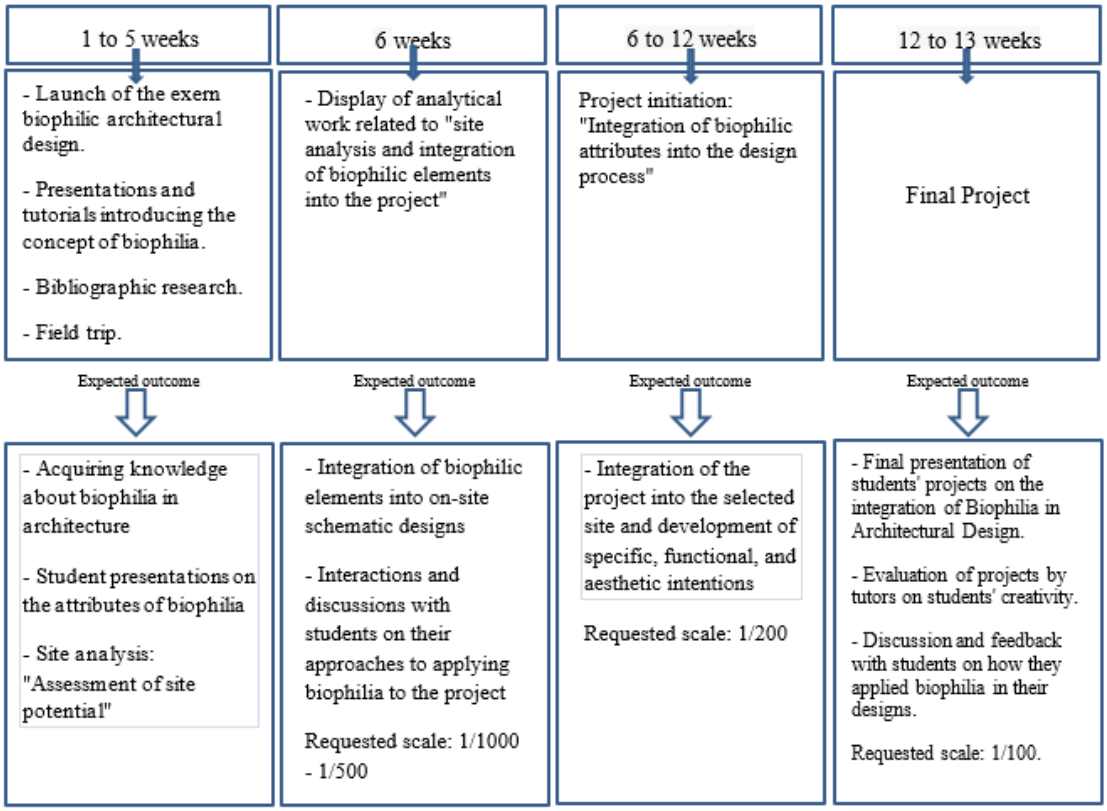
In this second part of the study, students will be tasked with creating architectural projects, taking into account the chosen site locations and actively integrating the biophilic features that these sites offer.

After presenting various studio courses and engaging in in-depth discussions with students as part of the Biophilic Design Experiences program, we found that only four students opted to focus on the categories "Indirect Nature Experience" and "Space and Place Experience." In contrast, the remaining students, totaling 49, chose to delve into the "Direct Nature Experience" category. This category is based on the design of buildings that directly incorporate natural elements such as light, air, water, plants, animals, weather, landscapes, natural ecosystems, and even fire (Table 1).

The entire semester of the two studios spans 13 weeks and is divided into three stages, as illustrated in the following table (Table 2).

The combination of the results from the survey and the evaluation of students' projects allows us to evaluate the impact of incorporating biophilia into the studio curriculum on the creativity of architecture students.

Table 2. *Organization of the 2nd and 3rd-year architecture studio semester*



4. Results and Discussion

4.1. Survey Response Results

The inaugural element under investigation pertains to prior knowledge of biophilia. We asked 287 students who participated in our survey whether they were familiar with the concept of "biophilia" in relation to architecture before filling out the questionnaire.

The results obtained reveal that 87.46% of respondents provided a negative response, while only 6.97% responded affirmatively. Sixteen students did not provide a response to this question. These results clearly indicate that the majority of respondents, 87.46% (251 students), were not aware of the concept of "biophilia" in connection with architecture before participating in this survey. In contrast, only 6.97% (20 students) were familiar with this concept. It is also noteworthy that sixteen students did not respond to this question.

These findings shed light on the participants' level of familiarity with the concept of biophilia, which can have significant implications for the understanding and acceptance of this concept in the field of architecture.

The following table (Table 3) presents the results obtained from a series of questions aimed at assessing students' expectations and perceptions before the integration of biophilia. These questions inquired about how students expressed their level of agreement with the statements in the table.

Table 3. *Results Regarding Expectations and Impressions Before Biophilia Integration*

	Questions	ICD (Completely Disagree)		D (Disagree)		I (Undecided)		A (Agree)		CA (Completely Agree)	
		Nbre	%	Nbre	%	Nbre	%	Nbre	%	Nbre	%
	Pre-Integration Expectations										
Q 1	I believe that integrating biophilia into architectural design education is essential.	00,00	00,00	02,00	00,70	10,00	3,48	95,00	33,10	180,00	62,72
Q 2	I eagerly look forward to deepening my knowledge of biophilia and its application in architecture.	---	---	---	---	---	---	67,00	23,34	220,00	76,66
Q 3	I am convinced that integrating biophilia can enhance my creativity in the field of architectural design.	08,00	02,79	17,00	05,92	30,00	10,45	80,00	27,87	152,00	52,97
Q 4	I hope that integrating biophilia will bring uniqueness and innovation to my architectural projects.	---	---	---	---	50,00	17,42	105,00	36,58	132,00	46,00
	Pre-Integration Perceptions										
Q 5	How would you currently rate your level of creativity in architectural design ?	143,00	49,82	112,00	39,02	18,00	06,27	09,00	03,13	05,00	01,76
Q 6	How do you assess the overall quality of your architectural projects to date?	78,00	27,18	149,00	51,92	60,00	20,90	---	---	---	---

Regarding expectations before the integration of biophilia in architecture:

The first component examined in this table focuses on students' perspectives regarding the importance of integrating biophilia into architectural design education. The results show that the vast majority of students are supportive of this idea. In fact, 62.72% of them (180 students) expressed complete agreement, indicating that they consider the integration of biophilia as an essential element in architectural design education. Additionally, 33.10% (95 students) were in agreement, suggesting a high level of support for this integration. It is important to note that only two students (0.70%) opposed this statement, representing a very small proportion. No student expressed complete disagreement (0.00%) with this idea. Furthermore, ten students (3.48%) remained undecided on this statement. These results highlight strong student support

for the integration of biophilia into architectural design education, indicating their recognition of its importance in the field of architecture. This positive attitude toward biophilia can have significant implications for how it is taught and incorporated into the academic curriculum.

The second section of this table explores students' expectations regarding their desire to deepen their knowledge of biophilia and its application in architecture. The results clearly indicate that the overwhelming majority of respondents are very enthusiastic about the prospect of deepening their knowledge in this field. Indeed, a large proportion of 76.66% of participants (220 students) expressed complete agreement, indicating a high level of enthusiasm and anticipation for deepening their knowledge of biophilia and its application in architecture. Additionally, 23.34% of respondents (67 students) were in agreement, suggesting a significant level of interest in this direction. These results reveal a positive commitment and a clear desire to delve further into the study of biophilia and its implications in architecture. This may indicate a strong student interest in this specific field and suggest the importance of integrating these concepts into the academic curriculum.

The third box in this table focuses on students' opinions regarding the belief that the integration of biophilia can enhance their creativity in architectural design. The results highlight a variety of opinions among students but with an overall positive trend. A majority of 52.97% of students (152 students) expressed complete agreement, suggesting that they firmly believe that the integration of biophilia can enhance their creativity in architectural design. Additionally, 27.87% of students (80 students) were in agreement, indicating that they are open to this idea and believe it could have a positive impact on their creativity. In contrast, eight students (2.79%) categorically opposed this idea by expressing complete disagreement, while 17 students (5.92%) were in disagreement. This shows that there is a minority of students who are not convinced that the integration of biophilia can enhance their creativity in architectural design. Furthermore, 30 students (10.45%) remained undecided on this matter, suggesting a potential need for more information or reflection for some of them. Overall, these results indicate substantial support for the idea that biophilia can have a positive impact on creativity in architectural design, although differing opinions exist within the sample.

The fourth part of this table examines students' expectations regarding the expected impact of integrating biophilia on the originality and innovation of their architectural projects. According to the results, there is a predominantly positive attitude among students, with a significant proportion expressing support for this idea. A significant percentage of 46.00% of students (132 students) expressed complete agreement, suggesting that they have high expectations for bringing originality and innovation to their architectural projects through the integration of biophilia. Additionally, 36.58% of students (105 students) were in agreement, showing a substantial level of enthusiasm for this perspective. It is important to note that while a significant proportion of students are in favor of this idea, fifty students (17.42%) expressed indecision, indicating that they may need more information or reflection to form a definitive opinion on this matter. Overall, these results indicate that most students have positive expectations regarding the impact of integrating biophilia on the originality and innovation of their architectural projects, though some remain undecided. This suggests that the idea of incorporating biophilic elements in architectural design generates considerable interest and curiosity among students.

As for the perception before integration:

The fifth section of this table explores how students currently assess their level of creativity in architectural design. The results reveal a general trend of disagreement among students regarding their level of creativity in architectural design. In fact, a significant proportion of 49.82% of students (143 students) indicated complete disagreement, suggesting that they do

not consider their level of creativity to be high in the field of architectural design. Additionally, 39.02% of students (112 students) were partially in disagreement, confirming this negative trend. Only a small minority of five students (1.76%) expressed complete agreement, indicating that they evaluate their creativity in architectural design as being at a high level. Nine students (3.13%) were in agreement, also showing a relative minority of participants who believe they have a satisfactory level of creativity. Additionally, eighteen students (6.27%) remained undecided about their assessment of their level of creativity, which may reflect some uncertainty or variability in their perception. In summary, the majority of students are not convinced that they have a high level of creativity in architectural design, suggesting some dissatisfaction or expectations for improvement. This could be an area of interest for the development and encouragement of creativity within the architecture program.

The sixth section of this analysis explores how students perceive the overall quality of their architectural projects up to this point. The results suggest a relatively low overall level of satisfaction among students regarding the quality of their architectural projects. In fact, a significant proportion, 79.10% (combining the 27.18% in complete disagreement and the 51.92% in partial disagreement), expressed dissatisfaction with the quality of these projects. It is important to note that nearly a fifth of students (20.90%) are undecided, which may reflect a lack of clarity or confidence in their assessment. These students may need more information or explanations to express their opinion more accurately. The reasons for this dissatisfaction could be diverse. Students may feel that the architectural projects they have been involved in so far do not meet their expectations in terms of quality, creativity, or relevance. They may also feel a lack of support or resources to carry out their projects successfully. Another possibility is that communication between students and teachers, or among team members, is insufficient, which could lead to misunderstandings and frustrations. In any case, there seems to be a need for reevaluation and improvement of architectural projects to meet students' expectations. It would be wise to conduct further surveys, hold open and constructive discussions with students to understand their specific concerns, and work together to improve the quality of architectural projects in the future.

4.2. Results of Student Studio Assessments by Tutors

The data summary (Table 6) generated from evaluations conducted by two teams of three tutors for each studio, based on the assessment of student projects (2nd year - Table 4 and 3rd year - Table 5), as well as their observation of the design development process over a period of 14 weeks, presents the following results:

Table 4. *Summary Table of Student Projects Evaluation Sheets (2nd year) Developed by Tutors*

« Indirect experience of nature » in biophilic design		
biophilic criterion	Students enrolled in **2nd year** of architecture (28)	
	biophilic criterion **present** in the project	biophilic criterion **absent** in the project
Light	21	7
Air	22	6
Water	20	8
Animals	11	17
Weather	9	19
Natural Landscapes & ecosystem	17	11
Fire	00	28

Table 5. *Summary Table of Student Projects Evaluation Sheets (3rd year) Developed by Tutors*

« Indirect experience of nature » in biophilic design		
biophilic criterion	Students enrolled in **3nd year** of architecture (25)	
	biophilic criterion **present** in the project	biophilic criterion **absent** in the project
Light	20	5
Air	20	5
Water	18	7
Animals	13	12
Weather	10	15
Natural Landscapes & ecosystem	14	11
Fire	00	25

Table 6. *Summary Table Derived from Evaluation Sheet Results Developed by Tutors*

Students enrolled in 2nd & 3nd year of architecture (53)	« Indirect experience of nature » in biophilic design.	biophilic criterion **present** in the project		biophilic criterion **absent** in the project	
		Nbre	%age	Nbre	%age
	Light	41	77,36	12	22,64
	Air	42	79,24	11	20,76
	Water	38	71,70	15	28,30
	Animals	24	45,28	29	54,72
	Weather	19	35,85	34	64,15
	Natural landscapes & ecosystem	31	58,49	22	41,51
	Fire	00	00	53	100

The results reveal that biophilia has influenced the architectural design of students, with 77.36% of them incorporating light into their projects. Their innovative approach has harnessed natural light in various ways, such as optimizing daylight, creating soothing atmospheres through interplay of shadows and light, and integrating natural elements that respond to light, such as indoor gardens. This integration demonstrates their sensitivity to the relationship between humans and nature, stimulating creativity and fostering biophilic environments in architecture.

Furthermore, 79.24% of the students chose to integrate the air criterion, emphasizing the importance of air quality in built spaces. Their creativity was expressed through strategies for natural ventilation, air purification systems, and arrangements for improved fresh air circulation, thereby creating healthier and more pleasant environments.

Regarding water, 71.70% of the students recognized its significance by designing spaces with aquatic elements like fountains, pools, and artificial streams. This integration strengthened the connection between occupants and nature while stimulating creativity through opportunities for artistic expression and relaxation within the built environment.

However, only 45.28% of students explored the animal criterion, reflecting practical and ethical challenges related to cohabitating with wildlife in built spaces. For those who did

integrate it, the creation of artificial habitats for wildlife and animal-friendly spaces demonstrates their sensitivity to biodiversity.

Regarding weather, 35.85% of students addressed this criterion by creating spaces that respond to climate variations, such as covered outdoor areas or seasonally adaptable features. This innovative approach encouraged contemplation of interactions between humans and nature.

As for natural landscape and ecosystem, 58.49% of students integrated this element, demonstrating their growing interest in environmental preservation. Their designs harmoniously fit within the surrounding ecosystem, promoting biodiversity and sustainability.

Finally, the fire criterion was not explored by any of the students, possibly due to safety considerations. It seems that students prioritized focusing on safer and more readily applicable biophilic elements to foster creativity while ensuring the safety of occupants.

6. Conclusions

In summary, the conclusions of the study on "Integrating Biophilia into Architectural Design Education: An Examination of its Impact on Student Creativity" provide a comprehensive overview of the impact of biophilia in the field of architecture.

On one hand, they underscore the importance of raising awareness among students about biophilia while highlighting their enthusiasm for its integration into architectural design education. However, they also reveal concerns about the level of student creativity and the quality of current projects, prompting a reevaluation of teaching and assessment methods.

On the other hand, the conclusions demonstrate that integrating biophilia has a significant impact on the creativity of architecture students. They highlight the importance of natural light, air quality, water, and natural landscapes in their designs, while pointing out challenges associated with criteria like animals, weather, and fire.

By juxtaposing the survey responses with the studio assessments conducted by tutors, it is clear that integrating biophilia holds considerable potential to enrich the creativity of architecture students and promote more sustainable environments. However, it is imperative to continue addressing students' concerns about their creativity and the quality of current projects while balancing creative expression with biophilic design.

Moving forward, it is recommended to incorporate biophilia awareness modules into educational programs, develop pedagogical methods aimed at stimulating student creativity, and further explore biophilic criteria. These measures will contribute to shaping a new generation of environmentally-conscious, creative architects capable of designing built environments that are sustainable and in harmony with nature.

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