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To cite this article: Q. O Akande and E. B Aduwo 2019 *J. Phys.: Conf. Ser.* **1378** 042078

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Assessment of Biophilic Design Patterns on Skill Development, In Minna, Niger State

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Abstract

As an interactive sustainable alternative to existing sustainable design practices, biophilic design struggles to promote the possibility of merging the built and natural environment. The study is aimed at assessing the extent to which biophilic design patterns influences skill development in order to suggest interactive sustainable alternatives. The study adopted a mixed method of research. Qualitative data were obtained via the review of relevant literature while quantitative data were obtained via the use of a structured questionnaire administered to 32 respondents in the study population. The respondents were selected from the users of purpose-built skill acquisition and development spaces in Minna, Niger state, to determine the level of satisfaction with the implementation of these patterns and considerations in skill acquisition and development space. The quantitative data was analysed with the use of statistical package for social sciences (SPSS) and the results presented descriptively with the use of tables. The findings suggest that most users were satisfied with patterns from nature in space patterns and natural analogue patterns relating to direct and indirect connection with natural systems.

Key words: Biophilic Design, Skill Development

1. Introduction

As an ever-evolving world, technology and research have improved the classic way of life, evolving it each day to promote growth as well as development. To this end, researchers have turned nature's elements and systems as a means to promote the livelihood of people of today's society. However, due to the continuous advancement of technological developments, severe repercussions plague the environment today such as pollution, deforestation, production of urban heat islands and many more. Through research, strategies were proposed to curb the tendencies that facilitate the infliction of damage on our environment, the most common strategy been relying on history and origin, returning to nature and utilizing and manipulating already existing materials to promote sustainable means of living. This led to the birth of biophilia and by extension biophilic design, as a way to integrate the natural environment into the natural environment to promote the sustainable design of structures and to deal psychological stress and matters springing up in today's society. Biophilic design patterns have been applied to numerous sectors and designs to investigate the responses of the study population to the effects biophilic design patterns on the projects, however, these patterns have not been consciously applied to the African culture of training as well as an apprenticeship.

For a long time, Green or Sustainable Architecture as a concept of design has been thrown around as a way to limit waste and unfriendly impacts on the environment, to this end,



architecture has developed new methods of designing by adapting concepts that are not only environmentally friendly but can be integrated into the architectural and structural framework of designs. The concept that adopts for this design is biophilia, which simply refers to the natural attraction man feels towards nature [1]. The biophilia hypothesis was made popular as the urge to affiliate human beings with other forms of life [2]. The patterns of biophilic design when applied in regulated and monitored measures are proven to motivate as well as stimulate the cognitive function of the learning environment, implementing these patterns appropriately promotes learning in the vocational institute while reducing operational cost and negative impacts on the environment.

Vocational education alludes to the acquisition of necessary skills in certain arts, professions or employment. It requires the necessary training to develop appropriate skill and technical knowledge in the chosen field. The apprentices are able to practice the arts, professions and employment independent of their training ages and levels, training in some cases also contain areas of general education implemented [3]. Vocational training is aimed at providing specialized skills, it can be described as a set of well laid out activities that guide the learning process of apprentices in gaining both theoretical knowledge as well as professional skills needed for the jobs [4]. Vocational education is also known as Career and Technical Education which prepares the student through manual as well as practical activities for the practice of arts and professions [5]. Due to the different structural categories of each country's economy, these skills are made to connect directly to the supply and demand needs of the society.

The findings from this study seek to suggest interactive sustainable alternatives to existing sustainable design practices by examining the extent to which biophilic design patterns through its design considerations influence skill development in vocational centres in Minna, Niger State.

1.1 Patterns of Biophilic Design

The 14 patterns of biophilic design are flexible and adaptive strategies that can be implemented in the design of a wide variety of both interior and exterior spaces. The patterns can be grouped into three [25]. The patterns of biophilic design are;

Nature in space patterns

1. Visual connection with nature [P1]
2. Non-Visual Connection with Nature [P2]
3. Non-Rhythmic Sensory Stimuli [P3]
4. Thermal and Airflow Variability [P4]
5. Presence of Water [P5]
6. Dynamic and Diffuse Light [P6]
7. Connection with Natural Systems [P7]

Natural Analogues Patterns

8. Biomorphic Forms and Patterns [P8]
9. Material Connection with Nature [P9]
10. Complexity and Order [P10]

Nature of the Space Patterns

11. Prospect [P11]
12. Refuge [P12]
13. Mystery [P12]

14. Risk/Peril [P14]

1.1.1 Nature in the Space Patterns

This classification of biophilic design patterns concentrates on the direct, physical and transient presence of nature in a space or place, including and not limited to the following natural elements; plant life, animal life, water, breeze, sounds, scents and many others [6]. Commonly found elements of nature in space patterns are potted plants, green roof, courtyards, as well as fountains. The most profound connections to nature have achieved the creation of deliberate links with nature through diversity, movement and multi-sensory interactions [7]. This category encompasses 7 patterns namely; Visual connection with nature; Non-Visual Connection with Nature; Non-Rhythmic Sensory Stimuli; Thermal and Airflow Variability; Presence of Water; Dynamic and Diffuse Light; Connection with Natural Systems

2.1.1.1 Visual Connection with Nature

It is known as the first biophilic design pattern, and it is denoted as [P1] in architectural designs. The experience evoked by this pattern is meant to immediately grab the attention of users in order to provoke a stimulating or calm outcome, it tends to convey a sense of weather, time and other biotic elements of nature. The foundation on which this pattern was conceived on the evolving idea that experiencing and viewing nature reduces stress while improving recovery and concentration rates [8]. It is often difficult to introduce in already built environments of dense urban settings as there are hardly any flexible spaces to support intentional changes of such magnitude. This pattern, however, stimulates a large section of visual cortex which triggers receptors that prolong interest and help recover from stress faster [9].

Some design consideration that enable strong visual connections with nature are; prioritizing real nature over stimulated nature, prioritizing biodiversity over acreage, enabling a flexible space for exercise opportunities in green areas and spaces, supporting visual connections that can be perceived for at least 5-20 minutes a day, small instances of nature and accenting natural elements through digital mediums [10]

2.1.1.2 Non-Visual Connection with Nature

In experiencing the second pattern connoted as [P2], the feeling of fresh and well-balanced factors is important, since every other sense of stimulus besides sight is to be engaged. Non-visual connection to nature often deals with the perception of sounds, smells and texture that are reminiscent of being outdoors [11]. Studies have shown that when auditory senses are exposed to nature sounds as opposed to urban noise, psychological and physiological restoration increased by 37% which was faster than effects of the stress components on the psychological and physiological state of being [12]. The respondents of the surveys considered sounds of waves more pleasurable when viewing the video to the sounds of video showing traffic, this result contributed to proof of a connection between the visual and auditory sense [15]. Olfactory stimulus process scents and aromas directly to the brain, which can in turn trigger powerful and strong memories. Olfactory exposure has been proven to have a positive effect on the healing process and immune function [13]. Other elements in this pattern are the haptic stimulus which deals with the feel of textures in the sense of touch and gustatory stimulus that focus on the sense of taste to improve cognitive function [14].

Design conditions proposed to establish strong non-visual connection with nature are; prioritize nature sounds over urban sounds, design for non-visual connections that can be easily accessed from one or multiple locations to allow a daily engagement for at least 5-20 minutes at a stretch, integrate non-visual connections in other aspects of the design program, a single interference

that can be felt in numerous ways can boost effects, to experience a maximized potential in response design for visual and non-visual connections with nature [15].

2.1.1.3 Non-Rhythmic Sensory Stimuli

This refers to random connections with nature that last for short periods of time, and though it can be statistically analyzed it cannot be predicted precisely. It encourages the attraction of attention allowing individuals' ability to focus on a task while promoting recovery of fatigue [16]. It is often established by introducing natural elements with characteristics that cannot be precisely predicted into the built space. Some things to consider when designing with this pattern are; design to experience said pattern every 20 minutes for 20 seconds from at least a distance of 6 meters to promote a peripheral outcome, overlapping different interventions of the season for a year-round effect [17].

2.1.1.4 Thermal and Airflow Variability

Thermal comfort and manipulating air flow in space are important factors in design to different climatic conditions, in a tropic zone managing humidity to provide comfortable surrounding atmosphere [18]. Thermal comfort and airflow in a space can be manipulated to provide a constructive environment [19].

Factors to consider when design with these patterns include; distribution of air through mechanical ventilation and/or natural ventilation (fenestration) to control thermal conditions and variability, features that manipulating temperature of spaces in design (shading devices and materials used in design the building envelope), and managing relative humidity of spaces and its effects to mimic surface temperature of natural systems in ab built space [20].

2.1.1.5 Presence of Water

The only aspect of nature this design pattern is concerned with is water, working with its primary element to capitalize on a multi-sensory plane. Its goal is to highlight the presence of water in order to promote a soothing and contemplating atmosphere [21]. Water bodies perceived as clean or unpolluted are the most appraised forms of water presence, to this end a natural flow of clean water is most effective for this design pattern [22].

Design ideas to cogitate include; prioritizing a multi-sensory experience of water to achieve a positive result, by engaging natural movement that can be established through the introduction of naturally flowing water bodies, as opposed to anticipated vacillation or torpidity of water; high volumes and turbulence of water is to be avoided, however, if this unfeasible proximity can be manipulated to manage the outcome; water fittings that encourage this pattern are often water and energy demand, to manage the repercussions frugal and sparse use is encouraged for areas not easily accessed by water [23].

2.1.1.6 Dynamic and Diffuse Light

This pattern is based on the lighting of interior and occasionally outdoor spaces, the goal of the pattern hinges on the ability to influence and manipulate light and shadows in spaces to provoke feelings of drama and fascination. Lighting is a key factor for controlling ambience in space and is supported by many innovations today [24]. Daylighting, an encouraged design requirement, often aids productivity in space through luminance fluctuation and visual comfort [25].

Contemplated ideas to improve dynamic and diffused light in a space are; transitioning the state of dynamic light between indoor and outdoor spaces; radically and extreme dynamic lighting

options are not suitable for spaces needing attention; quotidian lighting is advised for spaces used for lengthy periods of time to reduce ensuing discomfort, while wayfinding options can be for dark spaces with heavy traffic movement [26].

2.1.1.7 Connection with Natural Systems

This biophilic design pattern works to create a relationship of unity with one's natural environment, it fosters a cognizance of seasonality to yield sentimental, wistful and illuminating results [27]. It works to promote sustainability recycling materials and focusing on environmentally and cost-effective methods of design.

Design consideration for this pattern is as follows: assimilating rainwater capture and treatment into the design of landscape feature react to rain events; on occasion, offering graphic contact with the subsisting natural elements and systems with a plan to for intents and purpose, boost interactive opportunities especially for users of all socio-economic background in the design [28].

1.1.2 Natural Analogues Patterns

This class of patterns tend to focus on the non-living and indirect suggestions in nature. This category often finds its connection to nature in the shapes, colours, sequences, pattern and abstract ideas of nature; examples of elements that provide an indirect connection to nature are finishing and furnishing materials [29]. Deliberate analogue experiences are achieved by providing rich information in an organized and continuously evolving manner [30]. This category encompasses 3 patterns; Biomorphic Forms and Patterns, Material Connection with Nature; Complexity and Order.

2.1.2.1 Biomorphic Forms and Patterns

This represents patterns in nature that are represented through patterns, contours, textures, colours or numerical arrangements preserve in nature. It imparts symbolic design rudiments in the built environment allowing users a versatile, expressive and technologically inclined connection to nature [27]. In tackling this pattern two effective methods of application are; the first highlights the use of ornate modules of a larger design, or as vital functionally and structural components of a design. To highlight ornate modules of a larger design, frames not only acting as aesthetic statements of design but also as functional elements can be introduced to promote the vernacular nature of the design, by imitating cultural elements of the immediate community. Some things to consider when introducing this pattern in designs are: generating a grand variety and incidence of exposure by applying 2 or 3 planes and dimensions; shun the extreme patterns that are visually toxic; introduce conservative intercessions in early stages of design to promote cost-effectiveness, in order words layering simple modules to form a sophisticated pattern that are not considered visually offensive [25].

2.1.2.2 Material Connection with Nature

Mirroring native biological and geographical elements through slight sorting to generate a definite idea or essence of the place. In order to produce positive cognitive and physiological reactions, surveying geological elements are ideal [25]. Significant features to consider are: the use of materials on the fixtures, fittings or furnishes of each specific space in order to achieve its intended function; natural materials are prioritized in the design of furnishings and utilized in for the specification of finishes, fittings and fixtures over synthetic imitations [25]. This pattern argues that creativity is not be dependent on colours, especially synthetics, but ventures

in the use of natural elements as material to finishes spaces in order to appreciate the materials ability to connect with natural systems through available elements.

2.1.2.3 Complexity and Order

Complexity and order is opulent corporeal information handling that follows a dimensional pyramid-like confronted in nature [10]. The goal of this pattern is balanced, arranged with an articulate dimensional pyramid to create a graphically inducing environment that stimulates an optimistic reaction mental reaction [24].

Provided below are some conditions that improve the quality of this pattern; Organize works of art and material choice, structural articulations scene and an ace, arranging plans that uncover fractal geometries and chains of importance. Fractal structures with cycles of three are more impactful than an outline restricted to two emphases. Analyzing arithmetic and symmetrical capacities can be done with computers for fractal drafts of architectural designing and structural planning.

1.1.3 Nature of the Space Patterns

This category directly affects spatial planning and configuration [2]. The human mind is fascinated with interesting and unknown elements; applying strategies in the spatial array engages the mind. This class of patterns even encourages stimulating phobias in a controlled environment with an element of safety [25]. This category encompasses 4 patterns; Prospect; Refuge; Mystery; Risk/Peril.

2.1.3.1 Prospect

Prospect is an unrestricted view over a space for reconnaissance and designing. Optimal prospect conditions are met when open and liberating spaces give a feeling of security and control, especially in different surroundings. This design pattern was developed from research on visual inclination and spatial natural surroundings reactions.

The goal of the prospect design pattern is to give users a situation suitable to outwardly reviewing and pondering the encompassing condition for both happenstance and peril. In scenes, the prospect is portrayed as the view from an elevated position or over territory. While an elevated position can improve (indoor and outside) prospect, it does not essentially create a high prospect of proficiency [7].

Design considerations that may help create a quality Prospect condition [12] include: maximizing pictorial access to indoor and outdoor spaces through positioning or orienting the building, its openings, hallways and terminals towards views of landscape and points of focal actions. Proposing design around subsisting prairie-like environment, water bodies and areas inhabited by humans aids the information-richness. Spatial properties can be controlled in spaces of satisfactory depth to augment visual experience by removing visual barriers, in cases where barriers are unavoidable, obstacles that do not impede the vision of seated users is to be encouraged. Finding stairwells at building border with glass façade and inside glass stairwell dividers can frame a double prospect condition. At the point when high roofs are available, edge or inside spaces hoisted 300-450 mm upgrade the Prospect condition. Finding optimum view and equilibrium between the prospect and refuge pattern is occasionally more important than size and frequency of encounters. Visual connection with nature can optimize the prospect experience with a quality vista.

2.1.3.2 Refuge

A refuge is a place for withdrawal, from ecological conditions or the principal stream of action, in which the individual is shielded from behind and overhead. A space with a decent refuge condition feels safe and gives the feeling of a haven irrespective of a single person or a small number [28]. A decent refuge space differentiates itself from its surroundings without isolation, providing meditative, cosy and defensive spaces. The Refuge design has advanced from research on visual inclination look into and spatial natural surroundings reactions and its relationship to prospect conditions [9].

Refuge conditions are critical for reclamation encounters and stress decrease, which can be acknowledged by bringing down pulse. Some other advantages of refuge are proposed to incorporate abridged exasperation, exhaustion and apparent susceptibility, and additionally enhanced focus, consideration and impression of wellbeing [9].

The refuge pattern primarily seeks to provide users with a small part of a large space, easily accessible with defensive attributes and characters, its secondary objective is to reduce visual access to into this space. Refuges spaces are created to cover blind spots like the back, sides and over the head.

Common functions of Refuge conditions:

1. Protection from atmospheric elements of nature
2. Speech or visual privacy
3. Contemplation and introspection
4. Studying
5. Multifarious and difficult cognitive cases
6. Defense from abusive situations

By providing visual and auditory contact, the spaces are not completely enclosed evoking a sense of reconnaissance, the more the protective barriers the more a sense of refuge is felt [23]. The full refuge is created when all sides are covered, however, it is not the most ideal answer the pattern can offer as it completely isolates the space and terminates the connection to the larger space. Common examples of the basic refuge are lean-to, bench by bay windows, fireplace inglenook. There is variety in the shapes refuge can take, understanding the concept thoroughly impact the planning and designing decisions. Implementing these many elements to produce refuge is aimed to protect users from man-made or natural environmental components.

The following design considerations act as a blueprint for the design pattern; these spaces are characterized by low ceilings, especially in large daring spaces. In spaces with many activities, it is important to remember introducing refuge spaces that meet different needs by manipulating lighting, dimensions and rate of camouflage [14]. The degree of light in refuge spaces vary from adjacent spaces, placing lighting controls for such spaces expands the functionality of the space [25].

2.1.3.3 Mystery

Mystery as its name suggests promises intrigue through its spaces by manipulating information by hiding views and other sensory devices to tempt users to venture deeper into space [16]. The pattern is founded on the need of people to investigate, exciting man's natural curiosity [12]. By implementing this pattern, a strong sense of pleasure relating to anticipation is aroused [3]. Quality mystery conditions can be met with these conditions; as a pattern that is most

effective in curved spaces. It also manipulates light and shade in light to enhance the mystery experience. These elements project a sense of speed when moving through areas and are enhanced by manipulating the size of spaces.

2.1.3.4 Risk/Peril

Risk/Peril is a recognizable danger attached to a trustworthy measure of safety and control [26]. It induces an exciting feeling through indirect danger, the threat is dormant or passive due precautions taken. This pattern aims to stimulate attention and interest while rejuvenating memory and problem-solving skills. Some examples are cantilevered walkways and zoos. Some options to consider in this design are;

Due to the use of deliberate elements of design, there is no one cure-all method for different kinds of spaces, in other words risk/peril is determined by the function of the space and its spatial conditions. However, it is important to remember that the risk/peril pattern must always be accompanied by safety [25].

2. Methodology

The sample size for the first group of respondents are a census of users in the vocational or incubation centres visited during the case study due to the nature of insufficient awareness of purpose-built spaces for vocational training. The sample size for the users of skill acquisition and development spaces is 32 users, therefore 32 questionnaires were being administered. The second sample size poses a finite population size hence the Yamane equation is considered most appropriate to define the sample size.

2.1 Material Processing

The data required is quantitative in nature. The biophilic design patterns to be investigated include; nature in space patterns, natural analogue patterns and nature of spatial patterns. The data type is ordinal as respondents were asked to rank the extent to which the vocational centres exhibited the stated patterns using a 5-point Likert scale. The data were sourced through a questionnaire administered to the indigenes and residents, as well as architects in Minna, Niger state. Data were analyzed using the relative importance index. Data were presented using tables.

3. Results and Discussion

3.1 Users' Socio-Demographic Characteristics of Respondents

In this section of the survey analysis, the following socio-demographic characteristics of the respondents were analyzed namely; gender, age, highest educational qualification, marital status, ethnic group, the category of users and vocational types. According to Table 1 below, the female respondents made up approximately 63% of 32 respondents. This suggests that the users of vocational centres are predominantly female participants. Also, about 87% of the respondents fell between the ages of selected their average age to be between 16 and 20 years of age. This suggests that most users of vocational centres are young men and women. The next characteristic ascertains the highest qualification of the respondents, with 88% of respondents as bachelors and master's degrees' holders. This suggests that most respondents are literate and have a sufficiently fair understanding of the design considerations that are employed to achieve biophilic design patterns in their spaces.

Accordingly, 94% of respondents selected single in the survey, suggesting that the majority of users have not been married. From this data, it can also be assumed that single people are more inclined to learn a new vocation, than married people. The next category to be analyzed was the ethnic group of the respondents. Hausa respondents made up 34% of the users, while the Yoruba, Igbo and other ethnic groups made up 66% of the remaining population, suggesting that policies concerning vocational interstate training are favorable to other ethnic groups. Also, about 56% of respondents in the centres were students or apprentices, 28% as commercial workers and 16% as mentors or teachers in the centres. Finally, when categorizing vocational types, 47% of the respondents categorized their vocations between the following, descending from the first most popular vocation to the third most popular vocation namely; agricultural, woodworks and fashion design.

Table 1: Socio-Demographic Characteristics of Respondents (Users)

S/N	Socio Demographic Characteristics	Count	Percentage %
1. Gender of respondents	Male	12	37.5%
	Female	20	62.5%
	Total	32	100.0%
2. Age of respondents	Below 16	0	0.0%
	16-20	7	21.9%
	21-25	21	65.6%
	26-30	0	0.0%
	Above 30	4	12.5%
	Total	32	100.0%
3. Educational Qualification of respondents	WAEC/SSCE	0	0.0%
	ND/NCE	2	6.3%
	BSc/HND	12	37.5%
	MSc/MBA	16	50.0%
	Ph.D	2	6.3%
	Total	32	100.0%
4. Marital Status of respondents	Single	30	93.8%
	Married	2	6.3%
	Widowed	0	0.0%
	Divorced	0	0.0%
	Total	32	100.0%
5. Ethnic group of respondents	Yoruba	11	34.4%
	Igbo	4	12.5%
	Hausa	11	34.4%
	Others	6	18.8%
	Total	32	100.0%
6. Category of Vocational Users	Student/Apprentice	14	56.0%
	Mentor/Teacher	4	16.0%
	Commercial worker	7	28.0%
	Program coordinator	0	0.0%
	Total	32	100.0%
7. Categories of vocation	Cosmetics and Beauty	2	6.3%
	Fashion design	4	12.5%
	Wood work	5	15.6%
	Metal work	3	9.4%
	Agricultural	6	18.8%

Leather works	2	6.3%
Art and Design	3	9.4%
Culinary	3	9.4%
Programing and computer sciences	1	3.1%
Others	3	9.4%
Total	32	100.0%

3.2 Level of Satisfaction with Nature in Space Patterns (Users)

In this section, the data was analyzed based on their level of satisfaction with biophilic design patterns in their learning environment. For the first category of biophilic design patterns to be analyzed were the nature in space patterns, a total of 6 patterns were listed and the respondents were required to select according to respective understanding, their level of satisfaction with the design consideration and characteristics those patterns exhibited in their learning environment. The responses ranged from the lowest being 'Very dissatisfied' to 'Dissatisfied' to 'Indifferent' to 'Satisfied' to 'Very satisfied' which was the highest selection. A total of 29 questionnaires were completely filled in this section.

By conferring with Table 1 below, the respondents' level of satisfaction with the selected patterns of nature in space biophilic design patterns were ranked from the highest level to the lowest level. This data, therefore, suggests that a majority of the users were satisfied with the design considerations related to the visual connection to nature biophilic design pattern. Therefore, it can be assumed that skill acquisition and development activities are positively impacted by their satisfaction with these patterns. It is important to note that 29 respondents count for this pattern. For the following patterns, 32 respondents rated their levels of satisfaction evenly accordingly the subsequent pattern. Consecutively, the numerous levels of satisfaction of the following patterns varied alternating from dynamic and diffuse light, a pattern, architects were statically proven to be satisfied within Table 1 above, to connect with natural systems to non-visual connection with nature to thermal and airflow variability to the presence of water in descending order. By recognizing the presence of the design consideration implemented to express these patterns intentionally or otherwise, the respondents were able to rate how these were able to satisfy their needs to affiliate with natural elements and systems.

Table 2: Level of Satisfaction with Nature in Space Patterns (Users)

S/N	Nature in Space Patterns	Frequency	Mean	Std. Deviation	Ranking
1.	Visual connection with nature	29	3.5862	0.73277	1
2.	Dynamic and diffuse light	32	3.4375	0.80071	2
3.	Connection with natural systems	32	3.3750	1.00803	3
4.	Non visual connection with nature	32	3.2500	0.67202	4
5.	Thermal and airflow variability	32	3.0938	1.25362	5
6.	Presence of water	32	2.6250	.97551	6

3.3 Level of Satisfaction with Natural Analogue Patterns (Users)

In this section of the analysis, the data collected was analyzed based on their level of satisfaction with these patterns dealing with indirect connection with nature in their learning environment. For the second category of biophilic design patterns to be analyzed was the natural analogue patterns, a total of 2 patterns were listed and the respondents were required to indicate, according to respective understanding, their level of satisfaction with the design

consideration of those patterns in their learning environment. The responses ranged from the lowest being ‘Very dissatisfied’ to ‘Dissatisfied’ to ‘Indifferent’ to ‘Satisfied’ to ‘Very satisfied’ which was the highest selection. A total of 32 respondents count for this section of the completed survey.

By conferring with Table 2 below, the respondents’ level of satisfaction with the selected patterns of natural analogue biophilic design patterns were ranked from the highest level to the lowest level in descending order. This data, therefore, suggests that a majority of the users were satisfied with the material connection with nature biophilic design pattern. Therefore, it can be assumed that skill acquisition and development activities are positively impacted by their satisfaction with these patterns. Consecutively, the levels of satisfaction of the following patterns varied with most respondents more satisfied with material connection with nature to biomorphic forms and patterns. Due to the respondents’ ability to recognize the characteristics of the design consideration used by these patterns, the respondents were able to effectively scale how satisfying the patterns were in affiliating the built environment and natural environment.

Table 3: Level of Satisfaction with Natural Analogue Patterns (Users)

S/N	Natural Analogue Patterns	Frequency	Mean	Std. Deviation	Ranking
1.	Material connection with nature	32	3.4063	.66524	1
2.	Biomorphic forms and patterns	32	3.0625	.66901	2

3.4 Level of Satisfaction with Nature of Space Patterns (Users)

For this section of the survey analysis, the data collected was analyzed based on their level of satisfaction with patterns that evoke a specific human emotive response of safety, adventure and imagination in their learning environment. This category is the third and final category of biophilic design patterns to be analyzed, known as the nature of space patterns presents a total of 4 patterns listed and the respondents were required to indicate according to respective understanding their level of satisfaction with the design characteristics and consideration of those patterns in their learning environment. The responses ranged from the lowest being ‘Very dissatisfied’ to ‘Dissatisfied’ to ‘Indifferent’ to ‘Satisfied’ to ‘Very satisfied’ which was the highest selection. A total of 32 respondents count for the completion of this section of the survey.

By conferring with Table 3 below, the respondents’ level of satisfaction with the selected patterns of nature of space biophilic design patterns were ranked from the highest level to the lowest level in descending order. This data, therefore, suggests that a majority of the users were had an evenly balanced satisfaction rate with the design considerations of biophilic design patterns pertaining to mystery and prospect. Therefore, it can be assumed that skill acquisition and development activities are positively impacted by their satisfaction with these patterns. In this section of the questionnaire, all questions were answered by 32 respondents. Consecutively, the levels of satisfaction of the following patterns varied with most respondents more satisfied with the refuge to risk or peril. Furthermore, the respondents’ ability to make out the characteristics of the design consideration, an effective scale to measure the satisfaction of patterns that provoke a human emotive response.

Table 4: Level of Satisfaction with Nature of Space Patterns (Users)

S/N	Nature of Space Patterns	Count	Mean	Std. Deviation	Ranking
1.	Mystery	32	3.5625	0.66901	1
2.	Prospect	32	3.5625	0.71561	2
3.	Refuge	32	3.4063	0.66524	3
4.	Risk/Peril	29	3.3448	0.85673	4

4. Conclusion

The findings of this study reveal that the respondents perceive the nature in space biophilic design pattern, visual connection with nature, which deals with direct connection to natural systems as the most satisfying while the presence of water pattern is the least satisfying. It showed that natural analogue biophilic design pattern, material connection with nature, was perceived as more satisfying than biomorphic forms and patterns. The final group of biophilic design patterns, nature of space patterns, indicates that mystery is the most satisfying while risk/peril is the least satisfying. Although the level of satisfaction for the biophilic design patterns range, the average perception of the users is above being higher than the median value on the 5 Likert scale used in the questionnaire. This suggests that biophilic design patterns can be an interactive sustainable alternative to existing sustainable design practices skill development in vocational centres in Minna, Niger State.

5. Recommendation

Biophilic design patterns and design considerations that relate to these pattern can be used as an interactive alternative to the conventional means of sustainable design in order to promote skill development in vocational schools.

Acknowledgements

The authors wish to acknowledge the financial support offered by Covenant University in actualization of this research work for publication

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