Perceived Role of School Biophilic Design in Learning Sustainability of a University in Northern Luzon

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Abstract:- The effectiveness of teaching and learning is influenced by many factors which includes the environment. The teaching-learning environment is affected by open spaces, noise, temperature and humidity, lighting, overcrowding and classroom layouts. These factors are known as biophilic elements and are known to promote learning thus schools must take into consideration these factors for a learner friendly environment. The main purpose of the study is to find out the biophilic qualities of the school facilities and surroundings and its impact on the learning sustainability of the University. The method used by the researcher is a descriptive mixed method using both qualitative and quantitative approaches. Qualitative method was used to identify areas the teachers and students preferred to stay and study while quantitative method was used to evaluate the biophilic characteristics of the school. The participants of the study on the qualitative approached were 25 students and 23 faculty through random sampling, while those for the quantitative part are 5 individuals considered to be experts in their fields of disciplines. Thematic analysis was used in the qualitative component and rating of 1 to 10 was used for the quantitative component of the study. Results showed that buildings and facilities with more biophilic elements were more preferred by students and faculty because it allows concentration, stimulation and creativity as well as relaxation. It is thus concluded that biophilic designs supports sustainability of learning. Maintenance of the present biophilic designs and renovation of areas with limited natural environment to include more natural light and ventilation so as to improve learning along those areas in the campus with lesser biophilic qualities.

Keywords:- biophilic characteristics, teaching-learning, learning sustainability, learning environment.

I. INTRODUCTION

Learning is the main reason why schools exists. Schools have important role in teaching people not only on life-long careers but meaningful and symbiotic relationships with natural environment (Scott, 2020). The structural components of the school and its facilities make it easier for its role in education to be more effective and efficient (Gower, 2019). The ability to maintain teaching-learning effective is influenced by many factors such as open spaces, noise, temperature and humidity, lighting, overcrowding and classroom layouts (Gilavand, 2016). According to the proponent of the Biophilic concept, humans have a natural affinity to its ecological and biological environment – thus – gravitate towards nature in its journey to full development (Peters &D'Penna, 2020). Thus schools must not only focus on strategies of teaching but also providing an ambiance that promotes learning through the establishment of learning-friendly environment (Fox, 2020).

Biophilic architectural designs were introduced through the concept of Biophilia by Edward Wilson in 1980. It has become popular for most building designers because of its eco-friendly nature and research showed significant findings of its benefits on the social, economic, environmental and developmental aspects of living (Soderlund & Newman, 2015). It has even found to have health benefits coupled with productivity and emotional balance (spacerefinery.com, 2018).

There are 6 fundamental biophilic design elements which was outlined in three (3) classification of user experience according to William and Jenifer Seal Cramer: nature in space, natural analogue and nature of space (Miles, 2021). These three classifications are mapped in the 6 elements of: environmental features, natural shape and forms, natural patterns and processes, light and space, place-based relationships, and evolved human-nature relationships (Hafs, 2013). These elements vary in magnitude and usage in the design but still recognized to have the 12 characteristics of the natural environment: 1.) color – the color theme of the design/structure must represent the local natural environment to create blending and sense of belongingness and attachment to the place; 2.) water – provide a sense of tranquility and soothing sounds and feel to place; 3.) Air – natural ventilation and easy breathing, give sense of calm and relaxation; 4.) sunlight - very important in providing sense of energy because it affects our eye functions and inherent circadian rhythms, natural light stimulates action and activities by preventing onset of sleep through hormone; 5.) plants – improve air quality thus beneficial health implications; 6.) Animals – with plants and trees comes animals, the chirping of birds and insects sounds provides soothing sounds provoking satisfaction, pleasure and emotional interests; 7.) natural materials – presence of these materials gives meaningful direct links with the natural elements and multi-sensory stimulation and diversified movements; 8.) views and vistas – sceneries of

the outside world provides sense of connectivity and inhibits feeling of isolation; 9.) green facades – provokes interest because of its natural attraction to the eyes and stimulates feelings of organic nature, even provides olfactory sensual emotions; 10.) Geology and landscape – gives the sense of rootedness and belonging to the area as the continuity of space and area, these feature must be created in parallel and in consideration to the dominating areas around the building; 11.) Habitats and ecosystems – this characteristics is in consonance with the geology and landscape, plants and animals – this strengthen the connection to the other components of the natural environment creating a sense of links and relationships with other creations; 12.) Fire – provides color, warmth and movement, this can be simulated through the use of lights sources, varying colors and materials to mimic the qualities of fire.

Biophilic design addresses certain needs of the desire of an individual to learn in many aspects of survival in this modern world. Education provides the most common path for survival. The purpose of this research if to determine how the building structures and immediate environment contributed to this learning. In this regard, this study aims to find out the perceptions of students and employees of University on the roles of the Biophilic characteristics of the structural components of the school in sustaining the learning processes of the institution.

II. METHODS/MATERIALS

A. Research Design.

The study made use of the mixed qualitative-quantitative descriptive design through phenomenological approach to find out the perceptions of the students and employees of the University on the role of the Biophilic characteristics of the school structures in sustaining the learning processes. Criswell (2013) emphasized the study of the phenomenon (influence of biophilic design) on how it influenced the sustainability of learning process to have an insight of the significance of the experiences of the people. This approach could provide ways to understand more phenomenon and its effect on the learning process. It also made use of a cross-sectional method because it focused on the descriptive interpretation of the population under study. The researcher also made use of the quantitative approach in the evaluation of the biophilic qualities of the school facilities and surroundings.

B. Research Setting and Participants.

The study was conducted in a tertiary level education institution in northern Philippines (a University). The school is located in the center of an independent city in northern Luzon. The campus is a sprawling plain with 9 buildings and offices: there are five (5) building used for classrooms and the other three (3) buildings houses laboratories, offices, conference and function rooms and one (1) dormitory/hotel area. There are food stalls along the west side of the campus near the main building housing classrooms and laboratories (Figure 1).

The participants of the study were the students and employees of the institution. There were 48 participants composed of 25 students and 23 faculty from the different colleges. No new participants were recruited when after 10

respondents gave redundancy of answers. The profile of the participants is shown by the table below:

Students (n=25)		
Variables	*Frequency*	*Percentage*
Age		
18	3	12
19	3	12
20	12	48
21 & above	7	28
Gender		
Male	10	40
Female	15	60
Year level		
1st	5	20
2nd	7	28
3rd	10	40
4th	3	12
College		
CBE	3	12
CTEAS	4	16
CMAMP	12	48
CNPHM	6	24
Faculty (n=23)		
Age		
30 & below	2	8.7
31-35	10	43.5
36-40	6	26.1
41-45	2	8.7
46-50	2	8.7
51 & above	1	4.3
Gender		
Male	14	60.9
Female	9	39.1
Faculty Classification		
General Education	10	43.5
Professional Education	13	56.5
Years of Teaching		
5 years & below	4	17.4
6-10 years	10	43.5
11-15 years	5	21.7
16-20 years	3	13.1
20 years & above	1	4.3

Table 1 : Profile of the Participants

C. Data Gathering Tool

The researchers made use of the interview and in-depth conversation with the participants supplemented by observations. The interview guide made use of the biophilic concept to lead the participants to expressing their perceptions on the roles of the school structural and immediate surrounding design on sustaining learning. Notes and recordings were done so as not to miss anything that the respondents has conveyed. Transcription of the interviews were done only after the participants has confirmed and approved of what was has been said to avoid misconceptions and opinions from the researchers. Observations of the biophilic design characteristics was done by the researchers, free-lance architects and clients of the school using evaluation/assessment tool based on the presence or absence of the biophilic features.

D. Data Analysis and Interpretation Method.

The study made use of the narrative analysis because focuses on the experiences and perceptions of the people and answers to the questions. This method is used to analyze the contents of the various sources of data, in this case the perceptions of the students and faculty on the role of the biophilic design characteristics of the school structures and immediate surroundings on sustainability of learning. First step done by the researcher is to evaluate the school structures/buildings and immediate surroundings for the 12 biophilic characteristics and correlate it with the responses of the participants based on the research questions. The inductive approach was use through identification of themes based on the answers to the questions given by the respondents (De Guzman, 2016). For easy coding of data, the table below was used:

Questions	Themes	Significant Statements
Question 1		

The presence of the biophilic design characteristics was evaluated using a 10-point scale to assess the degree of presence and use of biophilic elements on the building structures and immediate surroundings of the campus. The 10-point scale starts with 1= non-existent/absence of the characteristics/element to 10=highly present/very much existent. The 10-point scale is interpreted by its percentage, which means that a total score of 1 means the building has 10% of the biophilic characteristics.

E. Ethical Considerations

Participation is voluntary and data privacy is strictly observed.

III. RESULTS

The salient findings of the study:

Area/characteristics/elements	B1	B2	B3	B4	B5	B6	B7	B8	B9
Color	8	7.8	8.4	8.0	7.6	8.0	8.0	8.6	6.4
Water	4.4	3.2	5.0	5.0	3.6	4.6	3.6	6.8	5.8
Air	7.4	8.2	8.0	8.6	6.6	8.6	8.0	8.8	2.4
Sunlight	8.2	9.0	7.8	8.2	8.0	8.2	8.0	8.4	4.0
Plants	10.0	7.6	8.4	8.4	5.6	7.8	5.0	9.0	5.8
Animals	7.6	7.6	5.8	4.4	2.4	1.2	2.2	7.6	3.4
Natural materials	1.6	4.0	4.0	3.4	1.6	1.6	1.2	6.4	1.6
Views and vistas	5.8	7.0	7.4	5.6	3.6	7.8	2.0	5.6	2.4
Green façade	9.0	8.0	8.2	6.4	5.4	7.2	3.0	8.0	3.4
Geology & Landscape	7.2	7.0	6.4	6.2	3.6	6.6	3.4	7.4	3.6
Habitats & ecosystem	7.8	6.0	5.6	4.0	2.4	5.2	3.6	7.4	3.2
Fire	7.0	6.8	7.2	6.8	7.4	8.4	5.8	6.2	6.0
Overall Score	**7.0**	**6.9**	**6.9**	**6.3**	**4.8**	**6.3**	**4.5**	**7.5**	**4.0**

Table 2 : Biophilic Characteristics of Building Structures and Immediate Surroundings

Mean over-all score: 7.0 + 6.9 + 6.9 + 6.3 + 4.8 + 6.3 + 4.5 + 7.5 + 4.0 = 54.2/9 = 6.02

The table above shows the scores of the building assessment by the evaluators. The lowest score was given to building 9, followed by building 7 then building 5. The highest score was given to building 8 followed by building 1 and building 2 and 3. Building 4 and 6 have the same score. Looking into the over-all scores, the mean total score is 6.02 which means the school have 60% biophilic characteristics and elements.

Building	Numerical Score	Percent	Building Characteristics
1	7.0	70	Located near the gate of the school; it is surrounded by trees and other buildings; it is near food stalls with tables, seats and gazebos; the corridors of the building is placed on the peripheral aspect of the building providing view of the surroundings of the school and free flow ventilation and natural light; it is surrounded by gardens and landscaped areas. it houses the chapel/campus ministry, audiovisual hall, graduate and main library, the chemistry/pharmacy, physics, speech, material testing and computer/ electronics/ hydraulics laboratories as well as the architecture & engineering drafting rooms. It is where the college of teacher education, arts and sciences and college of engineering and architecture is found.
2	6.9	69	Located perpendicular to building 1. It is surrounded by plants and trees in a lesser degree than building 1. It has almost the same design however because of the proximity of the new gymnasium (attached to the building) and the law

			building, ventilation and natural light source is blocked at the posterior aspect of the building. It houses the canteen, college of information technology, HRMO, student affairs and exhibit room (first floor); the administrative offices of university president, VP for administration and academics, finance, registrar & publications (second floor); third floor houses the research office, EMIS, computer laboratories and the internet/computer servers while the fourth floor is a dormitory. The eastern side is the university condominium attached to the building causing loss of ventilation and light source on lower floors (first, second and third floors). The law building is attached to this building as an annex causing loss of ventilation and light source. Offices in front and the eastern side of the building allows one to see views of the campus.
3	6.9	69	This is a small building on the west side of building 1. It is also surrounded by trees and plants. There is natural ventilation and light sources. It is a two-story building occupied by the college of business education and the alumni office (first floor) and college of accountancy (second floor); Windows are wide with corridors are again on the periphery of the building. This building offers a view of the campus from all sides because of its corridors located on the periphery of the building.
4	6.3	63	This is a small one-story building housing the college of criminology. It is also on the west side of building 1 surrounded by trees and plants. In the

			back side of this building are the food stalls and their tables and seats. On its east side, there are gazebos of building 1. Natural ventilation and light are good in this building. Offers limited view of the campus.
5	4.8	48	This building houses the center for development and the graduate school. The first floor houses the HRM kitchen and laboratory; there are trees in its front area but plants and trees are far from this building. Although its windows are wide and rooms spacious, ventilation is mostly through the use of air-conditioning and fans. Corridors are in the middle of the building. Gives a limited view of the school grounds since only two buildings are seen – building 6 and 7 from its western windows.
6	6.3	63	This building is located on the west side of building 5 and perpendicular to it. There are few trees on its front side and more trees on the back side. This building serves as hostel for visitors and venue for seminars and trainings. Rooms have wide windows but ventilation and natural light is limited. Plants inside this building offers the green idea. Its foyer is wide and the source of natural light and ventilation.
7	4.5	45	This building houses the college of medicine & allied medical programs, the college of nursing, public health and midwifery, lying-in and birthing center, incubation room of the college of business education and accountancy, the university clinic, crime and self-defense laboratory, office of the prefect of discipline and

			the office of sports. The green areas of this building is from the tree of building 6. This building is composed of several buildings attached to one another by walk-ways. Ventilation is limited and given by air conditioning but natural light to its room is abundant because of the wide windows. Corridors are found in the inner aspect of the building but is the source of ventilation and light coming from the open areas between buildings.
8	7.5	75	This building is found in the westernmost part of the campus and on the east side of building 6. It is s one-story building housing the NSTP office. It is surrounded by trees and plants and have the secluded characteristic because the trees and plants covers the building. There is a wide open space that separates the building from the main area of the campus. The east side of the building is a firing range then building 9.
9	4.0	40	This building houses the biology laboratory and the cadaver holding area. It has poor light and ventilation and sources are all from air-conditioning and artificial. It is fully close space although open on both ends. It is located near the NSTP building in the westernmost part of the university and separated by the firing range. It is surrounded by trees and plants. There is a walkway from building 2 leading to this building.

Table 3. Building Evaluation Scores and Characteristics

The buildings of the University are all made of concrete and the design is the approved plan for school buildings in the time they were built. The first buildings were building 1 and 2 followed by the annex buildings of building 2. Buildings were arranged in such a way that allows good ventilation, people

traffic through walkways and time to enjoy the natural elements. There are enough open spaces for people to enjoy nature inside the campus.

Questions	Themes	Significant Statements
Question 1	Location Presence of plants/trees/ greenery	"gazebo under the trees near building 1" "food stall seats and tables" "along the corridor of building no.1 overlooking the campus (b1- 2/3 floor) ' "graduate school library (b1 – first floor)" "chapel (b1- first floor)"
Question 2	Opportunities of learning Relaxation and focus Creativity and sources of ideas	"gives opportunities for group learning" "helps me relax and focus on the lesson" "keeps me awake and stimulate ideas for my class activities" "allows me to generate ideas from inputs of people around"
Question 3	Inspiration/motivation Focus and concentration	"Yes, because it gives me more inspiration" "I can concentrate and focus more on the lessons"
Question 4	Location of the building Absence of plants/ trees/biophilic materials	" the location of my building is away from people and feels isolated" "my building is too close to people that I find it hard to concentrate" "there are no trees/gazebos near my building"

Table 4. Themes and Significant Statements of the Participants on the Role of the School Structures and Immediate Surroundings on Learning and Performance

The above table shows the dominant themes and statements of respondents. Student respondents gave these most common statements: Q1 - gazebo under the trees near building 1 (58%) and food stalls seats and tables (32%) and

along corridor of building 1 overlooking the campus (10%); Q2 - gives opportunities for group learning (40%) and keeps me awake and gives me ideas for my lessons (32%) and allows me to generate ideas from people around (24%) and helps me relax and focus on the lessons (4%); Q3 - give more inspiration (61%) and I can concentrate and focus more (39%); and Q4 - too far building gives a feeling of isolation (73%) and my building is too close to people and I find it hard to concentrate (27%).

The faculty respondents gave these most common answers: Q1 - graduate school library (68%) and chapel (32%); Q2 – helps me relax and focus on my lessons (39%), keeps me awake and stimulate ideas (38%) and allows me to generate ideas from inputs of people around (23%); Q3 – I can concentrate more (100%) and Q4 – my building is too far from the people and feels isolated (39%), my building is too close to people and I find it hard to concentrate (35%) and there are no trees/gazebos near my building (26%).

Responses	Students (n=25)		Faculty (n=23)	
	Frequency	Percent	Frequency	Percent
Q1				
Gazebo under the trees in building 1	15	58	-	-
Food stall seats and tables	8	32	-	-
Along the corridor of building no.1 overlooking the campus grounds	2	10	-	-
Graduate school library		-	16	68
Chapel		-	7	32
Q2				
Gives opportunities for group learning	10	40	-	-
Helps me relax and focus on the lesson	1	4	9	39
Keeps me awake and stimulate ideas for my class activities	8	32	8	38
Allows me to generate ideas from inputs of people around	6	24	5	23
Q3				
Yes, because it gives me more inspiration	15	61	-	-
I can concentrate and focus more on the lessons	10	39	23	100
Q4				
the location of my building is away from people and feels isolated"	18	73	9	39
my building is too close to people that I find it hard to concentrate	7	27	8	35
there are no trees/gazebos near my building		-	6	26

Table 5 : Comparison of Responses of Students and Faculty

Comparing the responses of the participants, students prefer more areas being visited by fellow students and along people traffic while faculty prefer more areas which are quiet and relaxing. The reasons for choosing the area in the campus are it helps them generate ideas and focus on their lessons. Student and faculty said that being in the place of choice inside the campus keeps them awake and stimulate/generate ideas from inputs from other people and said that it has helped them perform well. The respondents prefer a building or area in the campus which is not too far from the center of the campus yet not too close to people to allow focus and concentrate yet stimulating enough to aid in learning and concentration to lessons.

IV. DISCUSSION

The University campus has exhibited 60% biophilic characteristics based on the overall evaluation score. The biophilic characteristics differ from one area of the campus and from one building to another. The most abundant of the biophilic elements are color, air, sunlight, plants, views and vistas, green façade and habitat and ecosystem. The University campus boast of open spaces thus allowing air and sunlight. The presence of plants and trees allows insects, birds and other living creatures to thrive along areas of the campus that are limited to people traffic.

The most limited present element are water, animals and natural materials and fire. The landscape and gardens of the University grounds possess only one artificial fish pond that contains only gold fishes but are not allowed for student use. There is one fountain in front of building 6 but is not functioning. The buildings are made of cement and concrete. There is limited integration of water in university design. No natural materials like cogon, wood and bricks. Although the façade of some buildings are full of plants, the use of natural materials are not practical because of these materials do not last long.

The designs of the buildings which are intended for teaching purposes (classrooms) are those that are

recommended by government agencies responsible for regulating education. Building 1, 2, 5, 7 and 9 are intended for classrooms, the other buildings are those that houses offices. Building 5 is intended for seminars and trainings as well as group functions. Most buildings boasts of large picture windows to accommodate air and sunlight. Because of the climate change and increasing temperature, classrooms and offices have their air conditioning for more comfortable ambiance for learning and for work. The quality of air inside the classroom influences comfort and academic performance (Shi et.al, 2017). Light is very much important for schools and teaching facilities because it gives feelings of space and stimulation of creativity and ideas. Daylight or natural light are preferred because its connectivity to the outside and nature (Benya, 2001). Sources of light makes it possible to respond to different teaching & learning activities (Hui & Cheng, 2008).

The presence of color through the abundant greens and foliage of different hues allows greater stimulation of senses. Colors red and yellow are stimulating while blue and green have calming effects based on experiments done by psychologist. It was found out in studies that appropriate coloring of the teaching learning environment has significant positive effects on the cognitive performance of students (Gilavand, 2016). Animals and plants experienced by students and faculty through the chirping of insects and singing of birds. Sounds of these natural entities lend to the acoustic quality of the surroundings like songs not only sooth the respondents but also help them maintain good sense of well-being

Participants who were interviewed of their preferences to stay in order to facilitate learning showed that they prefer to stay in areas of the campus which have more biophilic characteristics. Their preference is influence by the surrounding landscape that inspire and motivate learning activities as well as provision of stimulation and ideas that support their learning (Roetzel et.al, 2019). Learning spaces with biophilic elements support college students in creating a stress reducing environment, improve their formulation of ideas and enhance cognitive functions (Peters &D'Penna, 2020). As shown by the responses of the students and faculty alike, areas of more biophilic elements contributes to the overall learning sustainability through the promotion of psychological well-being via stimulation and enhancement of cognitive functions (De Alencar et.al, 2017) and environmental comfort such as light and ventilation conducive for learning (Kim et.al, 2018; Shi, et.al, 2017). Educational sustainability is greatly influenced by the learning environment provided by the school through its buildings, gardens and areas of 'belongingness' (Selvanathan, (2013).

V. CONCLUSION AND RECOMMENDATIONS

From the given findings, the following conclusions were drawn:

1. Biophilic characteristics of an area inside the University campus were the most preferred sites by most students and faculty;
2. These preferences were influenced by their experiences on their teaching (for faculty) and learning (for students).
3. The more presence of biophilic elements especially light, air and green foliage, the more the respondents' experienced better teaching and learning to occur.

In view of the drawn conclusions, the researchers gave the following recommendations:

1. Maintenance of the present biophilic characteristics of the school, even with the present COVID-19 pandemic, because it is not only the students that benefit from the natural environment of the institution;
2. Inclusions of more natural elements and colors to the existing buildings and facilities;
3. Renovation of areas and building that are deficient in biophilic elements like that of building 7 and 9, this includes planting of trees and gardens with gazebos around building 7 for students to stay. Building 9 needs more light and ventilation so putting more picture windows for more natural look and connection with the surrounding areas.

REFERENCES

[1] Benya, J.R. (2001). Lighting for Schools. National Clearinghouse for Educaitonal facilities: Washington, DC, USA. https://files.eric.ed.gov/fulltext/ED459598.pdf
[2] De Alencar, E.M.L.S., De Souza Fleith, D., Pereira, N. (2017). Creativity in Higher Education: Challenges and Facilitating Factors. TemasPsicologia, 25, 553-561 [CrossRef]
[3] De Guzman, A. B. (2016). Qualitative Research: Interactive-Lecture Information Map. University of La Salette, Aurora, Isabela
[4] Fox, J. (2020). Jodi Kreider (ed.). Biophilic design for learning, rlpsinterior.com/blog/2020/09 downloaded 5-8-2021
[5] Gilavand, A. (2016). Investigating the impact of environmental factors on learning and academic achievement of elementary: Students: Review. International Journal of Medical research and Health Sciences 5, 7S:360-369
[6] Gower, S. (2019). How biophilic learning environment boost student achievements. Demcointeriors.com/blog downloaded 7-4- 2021
[7] Hafs, M. (2013). Six Biophilic Design Elements, hafs.epstein.com/blog/2013/5/20/ downloaded 7-15-2021
[8] Hui, S.C., & Cheng, M.K. (2008). Analysis of Effective Lighting Systems for Unviersity Classrooms. In

Proceedings of the Henan-HongKong Joint Symposium, Zhengzhou, China

[9] Kim, T.W., Cha, S., & Kim, Y. (2018). Space Choice, Rejection and Satisfaction in Unviersity Campus. Indoor Building Environment, 27, 233-243 [CrossRef]

[10] Peters, T. &D'Penna, K (2020). Biophilic design for restorative university learning environments: A critical review of literature and design recommendations. Sustainability. MDPI

[11] Roetzel, A., DEKay, M., Kidd, A.N., Sadick, A.M., Whittem, V. &Zinkiewicz, L. (2019). Architectural, Indoor Environemtnal, Personal and Cultural Influences on Students' Selection of a Preferred Place to Study. Architectural Science Review 63, 275-291

[12] Scott, S. (2020). Learning spaces:Biophilic design in schools. Long Reads, teachermagazine.com/au_en/ downloaded 6-27-2021

[13] Selvanathan, R.G. (2013). Measuring educational Sustainability. International Journal of Higher Education. vol 2, no. 1, https://dx.doi.org/10.5430/ijhe.v2n1p35

[14] Shi, S.,Ma, Y., Wang, Z., Wang, L. &Zjang, X. (2017). On Site Measurement and Analysis on Indoor Air Environment of Classroom in University Campus. Procedia Engineering, 205, 2200-2207 [CrossRef]

[15] Sodelund, J. & Newman, P. (2015). Biophili architecture: A review of the rationale and outcomes. AIMS Environmental Science, 2 (4):950-969 DOI: 10.3934/environsci.2015.4.9