The Role of Regenerative Design in The Sustainability of Educational Buildings

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Abstract. Sustainability is a holistic meaning that has been addressed by many studies in many respects but has agreed to achieve a human-friendly environment, which cannot be sustained without integration with natural ecosystems to reduce the consumption of natural resources needed to sustain life without compromising the ability of subsequent generations. One of the requirements for achieving a livable environment is a healthy lifestyle. The surrounding physical and natural environment affects the health of its users. Attentional fatigue and lack of concentration are the most important negative effects of the health of contemporary society in general and the users of educational buildings in particular, as a result of the continuous daily pressures to which they are exposed, showing the consequences of multiple psychological and physiological diseases. Hence, the research adopted to address the problem of increasing levels of tension and stress among users of educational buildings, assuming that the utilization of regenerative design mechanisms in educational buildings could reduce the levels of tension and fatigue, and increase the stimulation of attention, which is represented by the self-organization of the place. The results of the research proved the effective role of the mechanisms of spatial self-regulation in the manufacturing of regenerative health spaces.

1. Introduction

Green design and construction on giving the least damage on environment and human’s health, besides the efficient use of resources, but they were merely a slowdown of environmental degradation. A deeper design process to construct buildings, houses, and other human’s activities to prevent natural systems degradation. This challenge is not technological only, because it relies on the change of our viewpoint, and to stand in association with nature. As a result of diminished self-organization, self-healing, and the ability to regenerate natural systems by systems designed by man from an integrated viewpoint that we are outside nature, and therefore, there is only a limited understanding of the consequences or effects. Renewable design and development redefine the goal of built environments with the design process and the role of the designer, reversing the state of deterioration and the negative effects instead of slowing it, as it calls for the interdependence between man and nature systems to provide a proper environment to human stability. The research aims to clarify the concept of renewable design and its role in reducing the attention fatigue and the lack of concentration in educational buildings, and the role of special self-organization of educational buildings in that.

2. Regenerative design

Linguistic renewal is: "Grandmother is the antithesis of wear and tear, something new, and renewed thing became new, the antithesis of creation, and grandfather dress finds (broken) is new, and new what you do not have" [1], and renewal means the restoration of the thing In this sense, regeneration in the field of thought or in the field of things alike is to restore the idea or the thing that is worn or presented or accumulated by the features and manifestations of what obliterates its essence, and that Return it to its first state on the first time, renewed the thing to return (new) as well as thought[2].
The regeneration concept, according to the Dictionary of “American Heritage” is identified as:
- To give new energy, energize, to renew existence, to give a new and active life.
- To create, build, or make something unprecedented, that is, to improve the situation, or to restore a better quality.
- To improve the moral situations, and to give a better spiritual character.
- To reform the place or the system, to be more active, or successful.

The Renewable design is a system of multiple technologies, and strategies that are based on the understanding of internal functions of ecosystems, which generate designs to renew the basic systems of life-support, and other resources, rather than bringing them down by the socio-ecological groups [3]. It is a form of sustainable design that incorporates communities and how they relate to the ecological cycles of nature, society and environmental costs. It is also an approach to form a system that seeks to reverse environmental degradation by creating positive impacts and minimizing harm in order to boost the recovery and health of human beings with ecosystems as integrated collaborations. The theory of regenerative design is one of the preceding concepts of sustainable development. In 1987, the World Commission on Sustainable Development set out to meet human needs without prejudice to his own needs. It tried to integrate environmental responsibility and social justice with the potential of economic growth.

The regenerative development is defined as a system of multiple technologies and strategies that is used to generate a full-fledged system, for understanding place, developing the capability of systematic thinking, and the engaging stakeholders or commitment which is in demand for ensuring the process of renewed design that maximizes systemic effect and support. This is called self-regulation and self-development. The emergence of development field, and renewable design is considered an important development in sustainability’s concept, and applications. Regenerative approach supporters consider the need of a deeper integrated approach in design, construction of buildings, human settlements, and almost all other human’s activities. This regenerative approach does not seek for the reverse of Earth's natural systems degradation only, but for the design of human’s system which can cooperate with the natural systems, in order to evolve in a way that gives better benefits, and deeper expressions of life and resilience. The regenerative design field of development is inspired by the self-healing, and self-regulation capability, which is derived from the natural living systems as a source. This field redefines the way sustainability advocates the thought, and design of built environment, it redefines the role of architecture as an area that achieves a regenerative restorative environment as well [4].

3. Restorative regenerative environment

The restorative regenerative environment was described as a place of rest and recovery. According to several studies, researchers have assumed that restorative environments are (effective natural environments). To understand how the physical environment can affect a person's well-being, environmental psychology has touched on this phenomenon. Gifford, 2014, explained that environmental psychology studies the relationship between a person and his environment, whether it is a private, public, natural or built space Robert [5]. Environmental psychologist Rachel Kaplan explained that landscapes can produce a regenerative experience and can renew a person's cognitive powers [6]. Health is often misunderstood as the absence of disease, but this is just one dimension, social and psychological dimensions are also important, as the healing process involves physical, social and psychological perfection. Campus spaces (green spaces) can promote all three types of health (physical, social, and psychological), as young adult college students spend most of their time engaging in challenging and competitive activities, and they are in a transition stage from youth to adulthood, and immersed in a new environment with the challenge of completing assignments, studying and exams. All these require a renewable healthy environment that creates reconciliation with the systems that make it up. [6]

Restorative environments are described as spaces with the following characteristics: attractive and quiet, separation from dispersion through visual incentives by roaming in green areas, the use of materials from nature (wood, stone ... etc), permeability outward and landscape viewing [7].

4. Literature review
One of the important references of this research is the work of Banning et al., (2010). In their study, the authors found that American college students were more present in regenerative places of college campuses that were unbuilt environments such as natural areas. Participants also described favourite hiking trails, lakes, water and mountain scenes as restorative and regenerative. A study conducted by Hartig, has distinguished between natural and urban environments, where the research subjects covered in the study included 103 university students asked to assess the restorative value of a walk in the park and walking on a street in the city. People chose to walk in the park and found it more fun, renewable and reconciled with their mental state, especially those who were more stressful and less focused. This study emphasizes the importance of providing a variety of green spaces for university students to be an interactive community within small groups, for teaching and learning, relaxation and meditation. As Hartig et al., (1991) noted, the group performed better in a green living environment than a group that did not experience a natural living environment. Felsten, (2009) research had focused on the recovery of mental fatigue. According to Attention Restoration Theory (ART), targeted attention is voluntary and crucial to maintaining focusing and controlling mental dispersion through inhibitory and demanding mechanisms for effort. Thus, the restorative environment has used several mechanisms to enhance spaces into healing spaces, especially natural environments, where they offer great benefits to individuals suffering from mental fatigue and physical ailments. The campus site could contain park-like areas that can renew mental abilities. The psychological benefit of private spaces for people of all ages and for all stages of health has become a common theme in design, psychology and well-being. The following benefits emerged for restorative spaces:

- Renew the cognitive powers of the individual
- Produce a correctional experience
- Improve recovery after illness
- Promote physical and mental well-being
- It can be concluded from the previous studies that restorative spaces are useful because they renew the individual's cognitive abilities, produce a restorative experience, provide better recovery after illness, and it is necessary for physical and mental health, in addition to the characteristics of restorative spaces include regenerative spaces that are quiet and isolated, small and surrounded by natural elements, which are:
  - Regenerative Plant Areas: Looking at the history of American garden design and landscaping, the designs of Savannah, Georgia, Mount Auburn Cemetery and Central Park are three examples of spaces with restorative as well as regenerative characteristics identified by Kaplan R[10], Deciduous canopy trees, coniferous trees, pale trees, shrubs and ground provide compensatory characteristics for the design of the garden area. Trees and plants provide quiet charm throughout the year, while Deciduous trees offer a range of colours in autumn and reveal the beauty of their trunks in winter. Coniferous trees create special spaces throughout the year. Trees are attributed to privacy and beauty as they change and grow. Shrubs create special spaces and flowers add more attention to gardens of colour and fragrance.
  - Regenerative water spaces: Water has been used in garden design for many years around the world for swimming pools, fountains, ... etc. The use of water in garden design is multicultural and therefore an important feature of the restorative environment space.

College students are looking for restorative spaces for spiritual meditation, relaxation, regeneration, growth, and enrichment. It may include restoring quietly, actively sitting by the pool or sharing a moment with a friend in spaces that provide a connection to nature. Creating diverse spaces on campus to meet the restorative needs of all students contributes to their needs to study or sit to relax and meditate or interact with each other to reduce stress and mental fatigue as a result of the pressure of study[7].

5. Benefits of Nature's Regenerative Environments

As mentioned above, natural environments have the abilities to regain attention, improve the task of individual performance, and recover the stressful university life events. However, there are more generative benefits of nature, including:

- A landscape view outside the window can help in achieving faster recovery, and provides more medication than the view of built environment[10]
Dealing with natural features and sounds allows more interaction to students, even with the use of artificial paintings and recordings. [10]

Watching videos of beautiful scenes can reduce pain and anxiety[12].

Students who can see natural scenes from their windows had less physical illness and more satisfaction in class than other students in the same class. These factors can also affect the satisfaction of life in general [10].

6. Attention fatigue

It is a sense of self and a sense of distress, which leads to depletion of the mental energy of the person and affect his mental activity and thus lose the person's ability to focus and reduce interest in work, study and interact with others. To improve the mental state, many theories have contributed to overcome mental fatigue and improve the ability to focus and guide attention effectively. Kaplan, R, (1993) have described the concept of Attention Restoration Theory is a common topic in environmental psychology, where psychology overlaps with environmental disciplines to explore the dynamic connections between individuals and their surroundings. One of the most important interactions between individuals and their environment is restoring the interest, the attention, and the energy of individuals by the experience, the view, and the inspiration of nature, and its various elements [10]. This theory supposes that exposure to nature is not enjoyable only, but it can help us to improve our focus ability as well. This theory is developed and popularized by Rachel and Stephen Kaplan in the late 1980s and early 1990s, a period that is characterized by a technological progress and increased indoor entertainment. Nature had the ability to bring attention. So Stephen and Rachel Kaplan (1989) proposed four cognitive states, in order to achieve restoration:

- Clarity of mind, to increase concentration.
- Recovery from mental fatigue.
- Attractions.
- Renew ideas.

The first state is characterized by the cleansing of mind. This requires one's attention by allowing thoughts, fears, and information to pass from everywhere through the mind and then fade. This could be achieved by allowing ideas to flow in and out of the mind, rather pushing them away. The second state begins with an actual restoration process, after a specific task or activity which needs care that is focused and targeted. It is common to feel of low energy, while the mental fatigue restoration permits healing and regaining normal level attention. The third state permits gentle disperse, low-stimulating activity reaction, internal noise reduction, and inner space relaxation. In the last state, after spending a long period of time in the four regenerative environments, which meet all the requirements of the individual in relaxing and regaining attention on his life, priorities, actions and goals, this state comes as the deepest and the most restoring, as it represents the place where the most effective restoration occurs. To evaluate the environment which will help in regaining, relaxing, regenerating mind, and attracting attention, according to Attention Restoration Theory (ART), there are four main components of the restorative environment: [13]

1. Being Away: It points out to the sense that separates apart the individual's usual thoughts and interests. As the individual does not have to be physically distant to satisfy this component, but it could be done psychologically, by being away from current fears, demands, and distracting environment which drains attention, and energy [14]

2. Attractive fascination: It means having person’s attention without making any effort, as the regenerative environments must draw attention without the need to focus or directed in a certain way.

There are two types of fascination according to Kaplan [7].

- Hard fascination: When the attention is done by a highly stimulating activity. These activities do not provide a meditation opportunity, due to their high energy absorbing for the stimulus.
- Soft fascination: When the attention is done by a less active or stimulating activity. These activities provide a meditation opportunity for.

Both fascination types can contribute to greater attraction and regeneration. However, meditation is related to soft fascination, as it allows sensation formation, while extreme fascination eliminates and reduces boredom [14]
3. Extent: This component indicates the restorative environments quality that leads human to feel happy, and fully integrated [7]. This means the absence of any unusual, unexpected or unfamiliar features in environment, but it feels comfortable within the surrounding environment, so the environment must be familiar and cohesive in order to be restored.

4. Compatibility: It means the feeling of pleasure and compatibility in the surrounding environment. As the environment should be chosen by the individual to be restorative, besides an intrinsic motivation. This compatibility is higher when the activity is familiar, new, or it is learned within a regenerative environment, that leads to feel comfortable and restored. There are six other aspects of harmonization in a regenerative restorative environment [14]:

- Distraction (where the environment is not dispersed but it requires a little effort to stimulate interaction within).
- Lack of information (restorative environment does not require understanding information for the individual to seek. Each individual must already have all the necessary information to understand and enjoy the environment).
- Safety (the environment cannot be dangerous and produce fear and anxiety).
- Duty (the environment should not attract the individual because of duty sense or responsibility, but because of the enjoy and restore desires).
- Clarity (the individual must not endure from feeling conflict between the task and the real).
- Easy to move.

From the foregoing, there are many researchers who have been involved in experiments and applications on the impact of the natural environment on restoring focus and stimulating attention, such as the research by Carolyn et al, (1995) to supposed that having a better nature view can improve individual's attention and enhance the environment of education, and compare university students' performance in direct attention tests based on the degree of landscape from their own window. The test results for the students who have a better landscaping view were better than the test result for those who did not have sufficient landscape view.

It can be noted that the restorative regenerative environment adopts the strategy of green eco-design, which depends on plant and water features to achieve stimulation and excitement for the treatment of attention fatigue in educational buildings. This requires the presence of these Biophilic elements within the surrounding environment. However, the restorative regenerative environment in local environments with extreme climatic influences in summer and winter, in addition to the determinants of social influences, requires other strategies of self-regulation of space to achieve reconciliation and renewal [13].

7. Self-Organization

7.1 Flexibility

Flexibility in the language is defined as “the ease of change in something to suit new circumstances” (Oxford English Dictionary Online), while in architecture, flexibility is “an architectural area that is concerned with the continuity of the work of the building despite the change of functional requirements through restructuring. It can continue to meet the new requirements” (Encyclopedia of Britannica, 1996). Friedman (1993) defined the flexibility as “allowing the user to participate in the design decision-making process and providing him with design and management tools so that he can match his changing needs and requirements [15].

Several researchers have suggested that flexibility is a key factor in determining sustainability in socio-environmental systems, where the concept of flexible thinking is based on the idea of multiple systems that are capable of change, separation and interaction with change, describing flexibility as the ability of systems to change and move to gain recovery and healing without loss of physical functional identity. A flexible tactic focuses on responding, adapting and evolving to learn about surprise, while avoiding changes that could threaten the life-sustaining capability by bringing local and global socio-environmental systems closer to the threshold. [16] Gunderson and Holling (2002) showed two ways of explaining flexibility concept. The First, is called “engineering flexibility,” that focuses on stability and its maintaining. This is related to adequacy, control, duration and predictability, which are features that “lie at the heart of desires of design that are fail-safe with an optimal performance” (Holling and Gunderson, 2002, P. 27–28). Although this could be adequate for uncertain systems, these features intent
in dynamic systems may be counterproductive with high doubt. The other definition of flexibility, called “ecosystem flexibility,” which focuses on system conditions that remain far from equilibrium, with emphasis on “stability, adaptation, variability and unpredictability” [17]. This last interpretation of flexibility is what they see as “the essence of understanding and designing for sustainability” [17].

The main advantage of employing the concept of flexibility within the framework of regenerative design lies in its absolute understanding of the possibilities and opportunities that can be used to design new and developed pathways and areas and to take full advantage of the opportunities in rearranging places according to a more effective approach to regenerative design.

Regenerative design is the reconnection with the cultural, ecological and economic patterns of the place itself. The construction process represents the scientific understanding, psychological inclusion of the place spirit, and system’s functional identity, besides the physical scope [4].

It refers to the diversity using spaces (public, private) and events (formal, informal). Diversity in use is a key to flexibility such as the diversity of space forms (study area, recreation area), and the diversity of activities to attract students at various times and for various reasons, and consequently, provides a rich mix of perception and diversity contributes to the creation of effective and renewable environments [18].

Ian Bently, in his book “Responsive Environment (1985),” noted that flexibility relates on a small scale to the ability of interior spaces to contain a wide variety of uses. It is a measure of the suitability of the vast majority of ordinary users and contains direct effects on their choices to achieve their own goals to create an active environment. Flexibility is characterized by providing attention to two types of spaces including (dynamic/active) and (passive/inactive). The negative areas are characterized by the presence of common spaces and facilities (stairs, elevators and vertical service are always called difficult and characterized by high level of movement and noise and are fewer jobs change during the life of the building. These difficult areas are put away from the restriction of the remaining spaces, while for the positive areas, are intended to closed areas and adjacent to the open areas and adjacent to the outside) [18].

7.1.1 Sports and Exercises

Many students experience stress and consequently inactivity, as a result of constant sitting for hours of study, while searching in the computer screen for hours leads to stiffness in the neck, back pain and various physical problems. Competition within the scope of the study is the other main reason for psychological pressure where students are forced to stay long hours without movement causing tension and psychological stress. Robert Pozen pointed to exercise as being a regular routine that can make individuals happier, smarter and more active. As Pozen, the author of “Maximum Productivity”, stated: "As we age, our bodies generate less and less brain cells, and researches have found that exercise can contribute to preventing this slowdown” [19]. Studies refers to a range of points that sport exercise promotes:

• Physical activity helps to increase blood flow to the brain, making the individual more mentally alert. This helps to stay awake and can increase the employee's ability to stay focused on tasks. As Figure (1)
• Physical activity is a natural way to increase both serotonin and endorphins levels. Increasing these hormones contributes to improving mood, and reducing exposure to depression. Increasing the level of endorphins due to exercise makes the individual less likely to be distracted.

7.1.2 Meditation:

Stress and tension come with hard work and therefore affect productivity and concentration at work. Meditation contributes to relieve stress and anxiety. A recent study by the University of Washington examined meditation and its significant impact on better focus at work and staying more active in space. As Figure (1). This simply requires a small, quiet space and free of windows and means of communication to minimize distraction and external distraction as a refuge of privacy (www.inc.com).

7.1.3 Informal Spaces:

These spaces are usually comfortably furnished and located in open areas adjacent to private spaces. The purpose is to encourage and support spontaneous meetings in a more relaxed atmosphere than the formal classrooms [20]. As Figure (1)
7.2 Optical Stimulus

The concept of stimulus is important to humans and is at the core of its ability to succeed. Stimulation is defined as “those efforts made by the administration to urge employees to increase their productivity, by satisfying their current needs and creating new needs for them and seeking to satisfy those needs provided that this is characterized by continuity and renewal [21]. Motivation is based on the use of incentives to stimulate the motivation of individuals to do their work better, as the effectiveness of the stimulation depends on the reception of external stimuli and the realization of the implications of positive push for better behaviour and higher performance, taking into account the disparity in the momentum among stimuli with desired behavioural trends. The process of motivation consists of a set of elements interact positively and sometimes negatively in the light of the attitudes and considerations governing these elements during the process of interaction [22]. The sensory stimuli, as well as visual stimuli, are varied according to forces to move students to perform better within the study environment. This could be as follows:

7.2.1 Colors

Colours are silent language, which is the language of the soul to the soul. Since this silent language speaks directly to the soul, designers had to design offices and use the language of colours to create a different atmosphere comfortable for the interior spaces of the offices [23]. The beginning of color openness was the use of green in all its tones, relying on that the green colour is comfortable for the eye, as well as the agreement of engineers specializing in lighting and specialists in the psychological impact of colors that the green colour serves two purposes: being a good reflector of light, and is comfortable to look [24]. Warm colours that stimulate the work are the colours of sunlight and therefore include (yellow, orange, red and pink). Cold colours in the colours of water, snow and sky, and therefore include (green-blue, green and light purple). As Figure (2)

7.2.2 Looking at nature

In the study of Rachel Kaplan, “The Role of Nature in the Context of the Workplace”, he addressed the question of studying the potential benefits of vegetation in the context of work. He points out that the micro-restorative opportunities offered by the plant play an important role in reducing attention fatigue, which is usually experienced by the employee in the context of work. As Figure (2). Some landscapes

Figure 1 shows the area of exercise and physical activity with the informal area of rest and mental relaxation [20]
draw the attention of the individual effortlessly, such as snow scenery on trees, and change the colours of the leaves, providing a short chance to recover the psychology of the individual's attention and enhance efficiency and sense of cooperation [10]

Green areas and landscapes generally contribute to the improvement of the psyche of individuals, where a number of studies and research, including the study of (Mortensen), that the exposure to green areas or the presence of plants within the internal space contributes to increasing human activity, as it affects an area associated with anger and tension in the brain, also the visual factor contributes by viewing green plants through addressing and regulating social pressures, whether they are containerized plants, real scenes or landscape paintings that include images of green spaces or images of forests, which contribute to fighting stress, increasing one's ability to focus and maintain attention as well as lowering diastolic blood pressure and anxiety [25]

As Figure (2)

![Figure (2)](image)

**Figure (2)** represents the area, which is a motivational area for the student by employing the stimulating colors or looking at nature through openness to the outside[25]

| **The main element** | **The main indicator** | **The secondary indicators** |
|----------------------|------------------------|-----------------------------|
| Flexibility          | Variety                | Transitional spaces         |
|                      |                        | Participatory spaces        |
| Exercise             |                        | Comfortable dynamic axes    |
|                      |                        | Playgrounds                 |
| Meditation           |                        | Comfortable seating areas   |
| Social interaction   |                        | Indoor seating areas        |
|                      |                        | Outdoor seating areas       |
8. Study Sample

The theoretical framework gained from the indicators of self-regulation was adopted in Table (1), and the extent of their presence in the two research samples represented by educational buildings of the Faculty of Arts and the Faculty of Management and Economics at Mustansiriyah University.

8.1 First Sample (Faculty of Arts)

Represented by a three-storey building. The classrooms occupy the ground floor by 7 classrooms. The upper floors occupied by laboratories, professors' halls and the college deanship. The building is designed by the Iraqi architect Qahtan Awni in 1963. The building was characterized by its distinctive local character of building materials, finishing and space organization (adopting principles of containment, positioning, roofed corridors, space flowing from the inside out and a visual diversity of shadow and light, reflecting the space privacy of the public, private and semi-private space by isolating between them visually. In a study conducted by a team from the Faculty of Engineering in 2018, the college obtained the gold standard due to the application of (LEED) indicators. After the application of the self-regulation indicators, the building achieved the presence of 85% of them in the design of educational spaces, as figure(3)

Figure (3) shows the building of the Faculty of Arts, Mustansiriya University
8.2 Second sample (Educational departments of the Faculty of Administration and Economics)

Consists of six similar buildings, each three-storey building. The classrooms occupy the ground floor, while the first and last floor for the head of department, where each building represents one of the departments of the college. The buildings gather around open spaces where students gather at limited times during the year (an average of only two months). As open spaces directly exposed to the extreme climatic environment, they became dead areas during the remaining months of the year. The buildings are connected to each other by external dynamic axes (external corridors), 80% of which are roofed. The buildings lack any details or materials that the user feels local, despite the presence of green vegetation and water elements. The buildings achieved a weak criterion in the study conducted by the team of the Faculty of Engineering 2018 adopting LEED indicators, while self-regulation indicators for the buildings achieved 36% of them. as figure(4)
9. Conclusions

- Strategies for restorative regenerative design vary according to the social and climatic environment of the educational environment, where indicators of self-regulation of the local environment are preferred.
- The restorative and regenerative educational environment is an important indicator for the design of educational buildings for their positive products.
- Self-regulation achieves great flexibility linked to the ability of internal spaces to contain a wide range of uses, and is a measure of the suitability of the vast majority of ordinary users and contain the direct effects on their options to achieve their goals to create an effective environment.
- Reduce closeness towards increasing openness through transparency and private/public relation.

Recommendations

- The research recommends relying on achieving self-healing of the individual by employing the mechanisms of renewable restorative environment and promotion in sustainable design using green construction effectively to achieve comfort and stay longer within educational buildings.
- The research recommends the preparation of more studies and research oriented towards the concept of creating and developing renewable restorative environments within the reality of the building, and emphasize the harmonious integration with all design disciplines to form an integrated design.

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