

Modular Eco-Class

An Approach towards a Sustainable Innovative Learning Environment in Egypt

Ahmed ELSERAGY¹, Amira ELNOKALY² and Mohammed GABR³

¹Associate Professor, Dean of International Network and Affairs, Arab Academy for Science and Technology, London, W1J 9EJ, UK, ahmed.elseragy@aast.edu

²Senior Lecturer, Lincoln School of Architecture, Lincoln University, Lincoln, LN6 7TS, UK, aelnokaly@lincoln.ac.uk

³Architect, Postgraduate Candidate, Arab Academy for Science and Technology, Alexandria, Egypt, arch1_egt@yahoo.com

ABSTRACT: Today, Egypt suffers from deterioration of education quality as a result of deficient learning spaces, insufficient governmental expenditure and funding, and lack of proper research in education developmental strategies. Additionally, 21st century learning requires innovative spaces that connect school, home, and community. Therefore, new learning spaces should increase flexibility, support hands-on and outside-class learning activities in order to motivate learners. Furthermore, they intend to encourage extra-curricular activities beyond conventional learning times. Undoubtedly, comfortable, safe and creative learning spaces can inspire and motivate users, while ugly/unsafe spaces can depress. Therefore, well-designed learning spaces are able to support creative, productive and efficient learning processes on one hand. On the other hand, ecological design measures became an increasingly major keystone for modern sustainable learning-spaces. Thus, learning-spaces' design process, form, components, materials, features, and energy-saving technologies can yield well-educated, environmentally-literate, energy-conscious, and innovative future-generations.

This paper represents a preliminary phase of an ongoing research project that aims to create a framework for an Innovative Sustainable Learning Environment (ISLE) in developing countries, the Middle East region, and Egypt in particular. This project aims at encouraging constructive relationships between users, buildings, ecosystems and to improve quality of learning through intelligent and ecologically well designed learning-spaces. The paper proposes the concept of modular Eco-Class as a framework of learning spaces and a step-forward in the direction of ISLE. Moreover, this Eco-Class aims to educate and provide balance between building's environmental sensitivity, high performance, initial cost, and lifecycle costs without harming the surrounding ecology. The Eco-Class not only intends to promote a positive environmental impact to improve indoor air quality and energy efficiency, it also provides on its own an environment that educates learners and elevates environmental-awareness between future generations. Finally, the study and the ongoing research project of Eco-Class aim to provide validated design-guidelines for sustainable educational buildings, and to achieve the optimum innovative and sustainable learning environment in Egypt for effective and creative future-generation learners, parents, staff, and communities.

Keywords: education, learning spaces, sustainable educational environment, Eco-Class

1. INTRODUCTION

Learning is an act of receiving and processing knowledge. Such an act does not always occur intentionally. However, consciously or subconsciously, one learns even while proceeding with familiar and daily tasks. In his/her act of knowledge intake, the learner opens their mind and senses to incoming messages. And as the mind translates and processes, the senses absorb the context; environment and condition. Thus, the very nature of the learning material is positively or negatively affected by the learning environment, as the material cannot be separated from its context.

Research being undertaken by neuroscientists around the world is beginning to provide new insights into the influence that the qualities of learning spaces have on learning experiences. Learning spaces designed with an understanding of how the minds of children respond to the attributes of spaces and places can lead to enhanced learning [1].

The importance of education in a global economy is undisputed and education of the poor ensures equitable growth and poverty reduction. Among developing countries, Egypt appears to be in a good position to benefit from equitable education-led growth. It has managed throughout the post-war period to make substantial public investments in education, with healthy emphasis on full and equitable access. However, the increase of pupils in Egyptian learning spaces has been both welcome and problematic. The high growth rate of population, the longer duration of the compulsory education of 9 years, the high density rate in the classrooms, the phenomenon of multiple schooling shifts, the non-existence of schools in many regions, and the deteriorating condition of the existing school buildings, all these factors have created an urgent need for new ways and concepts of learning spaces to keep pace with the modern advancement in

education and to achieve the development plans in this sector.

Learning spaces are complex spaces where acquired skills, knowledge, and culture are taught, shaped, encouraged, transformed, and then positively or negatively experienced. The results of quantitative studies suggest that test scores can improve by up to 14% depending on the condition of the learning environment [2]. The figure below brings together the findings from various research studies on factors identified as significant in influencing learning [3].

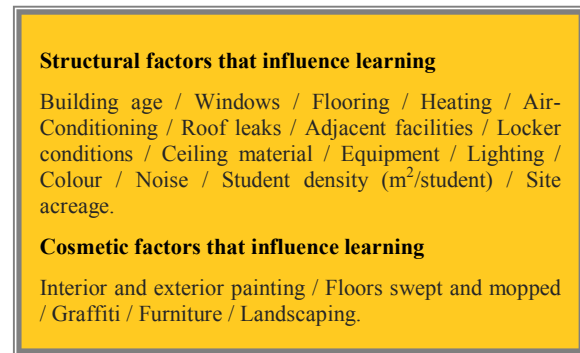


Figure 1: physical factors influencing learning (adapted from Australian Department of Education, Training and Youth Affairs (DETYA), 1999) [3]

The specific scope of this paper; the classroom – the basic unit in learning spaces - is handled as the enclosing environment in which the learning process takes place. All surrounding stimuli directly affect the pupil and define the nature of the learning experience as a whole. Therefore, a new vision for future Eco-Class is intended as an attempt for the most possible encouraging learning classroom applicable for the Egyptian environment.

The objective of this research work, therefore, is to provide design guidelines for ISLE in Egypt's schools (as in Fig.2). This objective entails the manipulation of all design elements within the context of the classroom to serve the function of learning in the most efficient manner. Subsequently,

it was inevitable to address concerns of functional requirements, ecological measures and economical efficiency. These subsidiary objectives are prerequisites to successfully manifest a dynamic, adaptable and pleasurable learning classroom environment. That said, it must be noted that the regional and local environment of the learning space is an active agent in all mentioned prerequisites. But rather than being a prerequisite itself, the surrounding local environment acts more as an established background upon which the prerequisites must fit in accordance with, and use the utmost of it. Basic functional requirements of a productive learning space were addressed along with a design concept that is modularly flexible. Those functions were manipulated and eventually optimized to benefit from appropriate ecological strategies that positively exploit the environment to full potential.

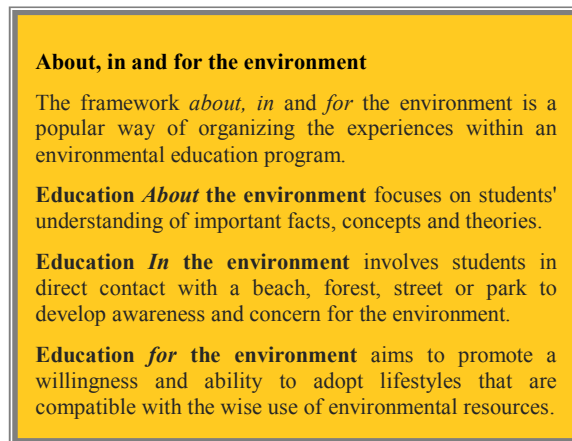


Figure 2: a framework about, in and for the environment [4]

Ecological measures are a major key point of the design process as the form, materials, and energy-saving technologies should be optimised to work in harmony with the surrounding ecology. For instance, efficient natural lighting and ventilation minimizes dependency on energy-consuming artificial devices. Thus, This Eco-design not only promotes a positive environmental impact, but also improves indoor air quality and energy efficiency.

Concomitantly, the design case study implements a number of high standards that would be taken for a high-performance sustainable classroom building and applied to achieve the optimum modular Eco-Class.

2. REGIONAL CONTEMPORARY DEFICIENCIES IN EDUCATION

Research in the field of education in Egypt is full of disappointing findings especially about the discussion of interaction, creative stimulation and such topics which are merely theoretical. Researches observe that such basic requirements as aesthetic acceptability and plausibility, encouraging learning procedures and relations are absent [5]. The application of secondary objectives will fail without the basic primary functions fully realized first. The major problems affecting school classrooms in Egypt are;

2.1 Inadequate Condition of Existing Schools;

Regional deficiencies in schools and economical factors lack research for development on both sides; quantity and quality. The non-existence of schools in many regions and the deteriorating condition of the existing school buildings negatively affect education and produce visually repulsive spaces with unappreciated aesthetic values. The shortcomings as sub-bar ventilation, day-lighting, and poor overall visual contact throughout the classroom causes environmental and functional inadequacy [6]. Many existing schools have narrow, poorly lit corridors with low ceilings. These spaces are unattractive, lead to congestion and, in worst cases, behavioural complications, which can affect subsequent learning time.

Contemporary classrooms are organized in rows that - in most cases - minimize possibilities of interaction with the tutor and among the pupils themselves. The organization of row after row produces advantageous zones and less served weaker zones. The zones in the front receive the

utmost attention and interaction possibilities whereas the ones farther receive gradually less as one delves more into the space. That organization also creates zones with plausible ventilation and natural lighting closer to the windows that are usually on only one side of the class due to the presence of distribution and circulation halls and pathways on the opposite side. Moreover, the minimal space provided for the tutor discourages his interaction with the pupil and his own movement freedom and becomes confined to the front space only, making the rear zones inaccessible. This linear organization also directs the pupils' attention to the board only and eliminates any other possibility of interaction or alternative activities (as in Fig.3). These classrooms also suffer the loss of any accessible connection to private outdoor space. Another primary concern is the minimalist funding on education in most Egyptian regions. The lack of proper funding leaves most of learning facilities devoid of many essential learning tools and slows the maintenance and development. Therefore the Eco-Class must offer economically viable design and should be applicable in poorer Egyptian facilities. It is not logically accepted to discuss the success of any design concept(s) if it is not relevant to reality and the local actual conditions.

2.2 The Higher Growth Rate of Pupils;

The increase in number of pupils and the longer duration of education in Egypt have lead to high classroom density rates and the phenomenon of multiple schooling shifts; increasing numbers of graduates who are literally not well educated. Teachers find it difficult to manage classes. Changes in density accompanied with the same amount of resources (access to the teacher, toys, lab equipment) available to each pupil made spaces in mere terms of area insufficient to accommodate. Unfortunately, little research on the relation between positive social behaviour and density in classroom has been reported in Egypt. However, one study does

report that installing partitions to separate various activities increased cooperation [7].

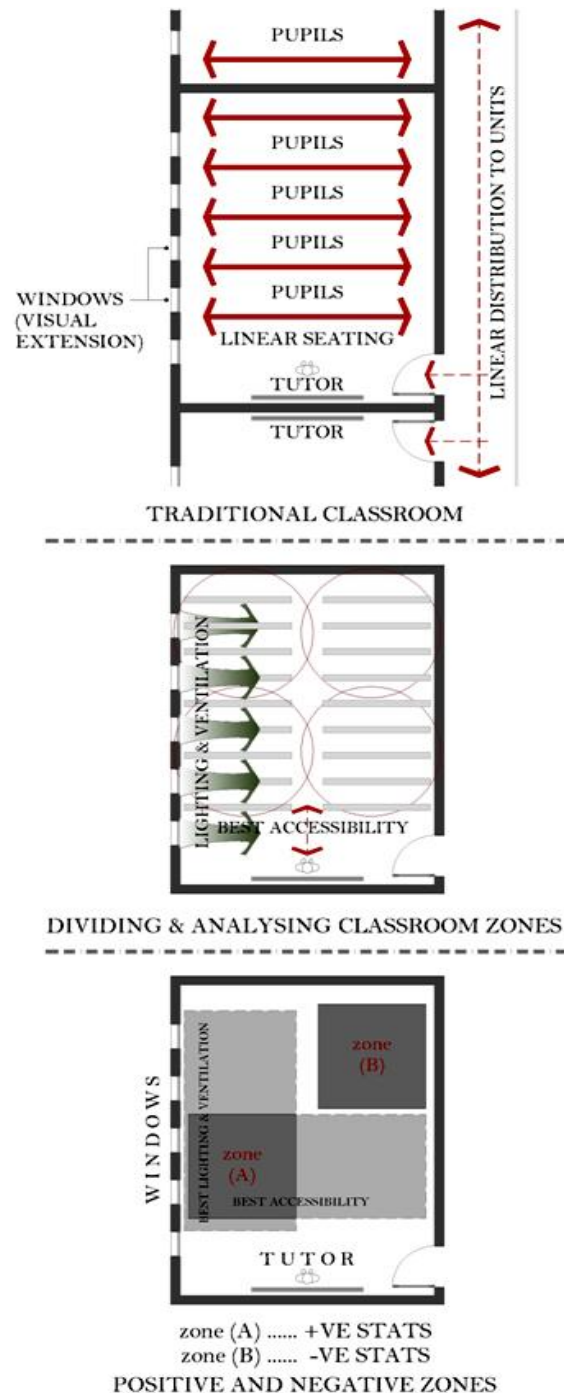


Figure 3: Analysis of traditional classroom

2.3 Undeveloped Teaching methodology and Lack of Extracurricular Activities;

Educational quality in Egypt had seriously declined; most of learners now

imitate things the exact way they see and perceive them and lost the tendency to capture new concepts [8]. Additionally, today's world, talent and competition merits are considered vital. Therefore, the learning space needs to be user-friendly/user-centric, and also, motivate and invent tutors. It should incorporate new teaching methods - rather than only one-way teaching process - and enforces the latest learning and teaching technologies to keep pace with the modern advancement in education.

Many pupils switch to special private classes after school, because public schools include limited activities that may not be up to the mark. The curriculum was generally irrelevant to this fact. Extra-curricular activities include games, painting, religious activities, speech, gathering and workshops. They are recreational activities that help build self-esteem, confidence and satisfaction.

As a result, Egyptian schools are experiencing the need to evaluate and assess their pupils' learning processes. Researchers have classified this evaluation into three main categories; direct observation, interview and stimulation [6]. Measures should be taken to eliminate such mentioned deficiencies and search for new sustainable approaches for enhanced future generations.

3. INTRODUCING THE CONCEPT OF INNOVATIVE SUSTAINABLE LEARNING ENVIRONMENT (ISLE):

Sustainable building design is a significant and growing trend in creating learning space as well as most of the other building types. Therefore, it was of superior priority to develop an innovative design framework of a new classroom that is sustainable and environmentally-friendly, hence, the nomination; Eco-Class. To fully realize ISLE, the paper cultivates symbiotic relationships between learners and ecosystems by improving quality of learning through modular, ecological design of leaning spaces. In addition, the entire

building and its spatial users' experience lead into proper understanding and functioning of sustainability. Merely, building a sustainable building may protect the environment, reduce the environmental global damage, and create user comfort and satisfaction.

4. EVOLUTION OF LEARNING SPACE DESIGN; Modular Eco-Class (MEC)

The process of learning in Egypt suffers from learning spaces which cannot fulfil the ambitious future generations as discussed earlier in this paper. In different learning experiences, learner is the focal part which collectively information, knowledge, and experience should be transferred to learners in order to enhance their intellectual skills and abilities. Thus, quality of learning-education process can be measured. Therefore, learning spaces should include number of sustainability; environment, economic and social features. These are applied into a learning space creating the ISLE-sectors shown in (Fig.4); social and psychological behaviour, function and economic requirements, ecological features.

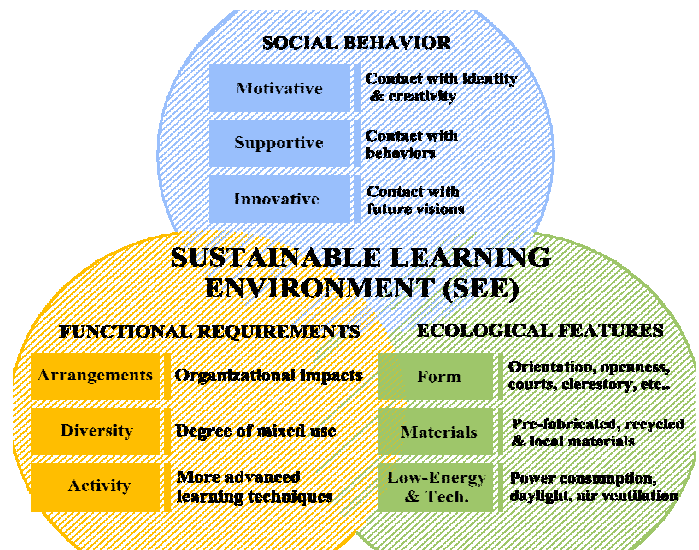


Figure 4: A Framework for Conceptualizing the ISLE

In order to achieve such criteria, this research work investigates the Modular Eco-Class not only as a learning space, but also as an experimental and demonstration

model/tool towards ISLE in Egypt. It also needs to be adaptable framework to suit changing needs and future scenarios.

4.1 Social & Psychological Behaviour:

We shape our buildings and later they shape us. The social and psychological behaviours have to be effectively considered along with the design in order to better meet the needs and expectations of tutor and pupils. Researches provide some design considerations for Welcoming, stimulating learning spaces to be comfortable, imaginative and fun [9] as follows;

Table 1: Shift in learning paradigm [10]

FROM	TOWARDS
Teaching as transmission of knowledge from teacher to pupil	Teaching as encouragement of interaction, construction and communication
Learning as memorizing and repetition	Learning as the understanding of general rules & principles plus the ability to apply them in different contexts
Knowledge can be delivered	Knowledge can be constructed as a complement of existing knowledge structures
The perception and solution – the teacher's – is regarded as the correct one	Multiple perceptions and solutions of the same problem are equally valued
Fixed curriculum focusing on content & objectives	A flexible (i.e. integrated) problem based curriculum focusing on competence development & processes
Teacher directed	Self directed
Teacher centred	Learner centred
Closed learning settings	Open learning settings

4.1.1 Motivation to learn; It is essential in designing schools to motivate learners and promote learning as an interactive activity, support collaborative as well as formal practice, provide a personalized and inclusive environment [11]. Therefore, learning spaces should be designed to be attractive and provide pleasant and rewarding seating of pupils (see fig.6); they should not be just repetitive zones. Better yet, classrooms can provide characteristics that create such excitement and anticipation. The learning space should be also supportive and collaborative; supportive to develop the potential of all pupils, and creative to energies and inspires pupils and tutors.

4.1.2 Interactive Classroom:

Interaction in learning spaces is crucial. It encourages a continued exchange between educator, learner, educational systems and functional space. Stimulated interactivity enhances the learning process as individuals learn through interaction much more effectively. ISLE & MEC maximize interactive learning environments.

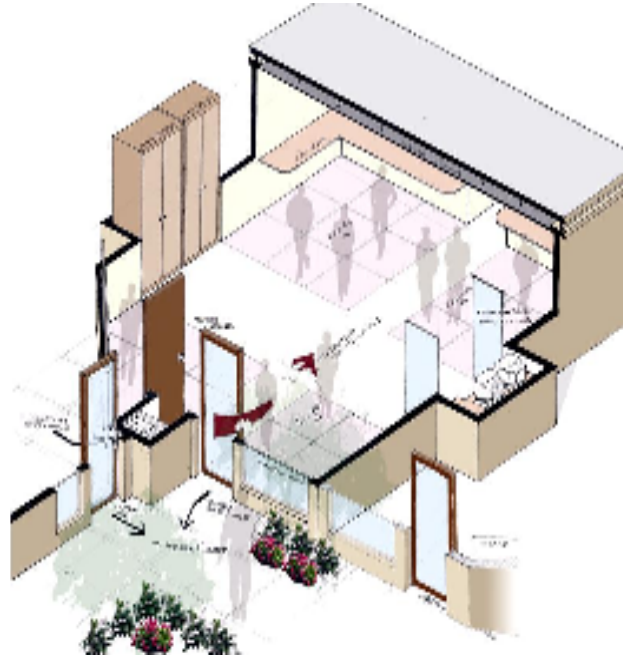


Figure 5: Possible classroom environment

In order to accomplish such activities, the ISLE and MEC are designed in a way that accommodates equal access to all learners and tutors. Centralization of the tutoring space among semi-defined pupil zones is suggested to stimulate interactivity with the tutor, and group activities within the pupil zones. (fig.5)

4.1.3 Creative, Innovative Pupil and Future Proofing Space (New Ways of Learning); an opportunity exists to facilitate the use of advanced learning space in an innovative environment, different and complimentary to current provision and representing a window on the future.

The Eco-Class cannot anticipate future technological or pedagogic developments, but can accommodate change in designs.

Such innovative change will enable space to be aesthetically sensible, re-allocated and reconfigured.

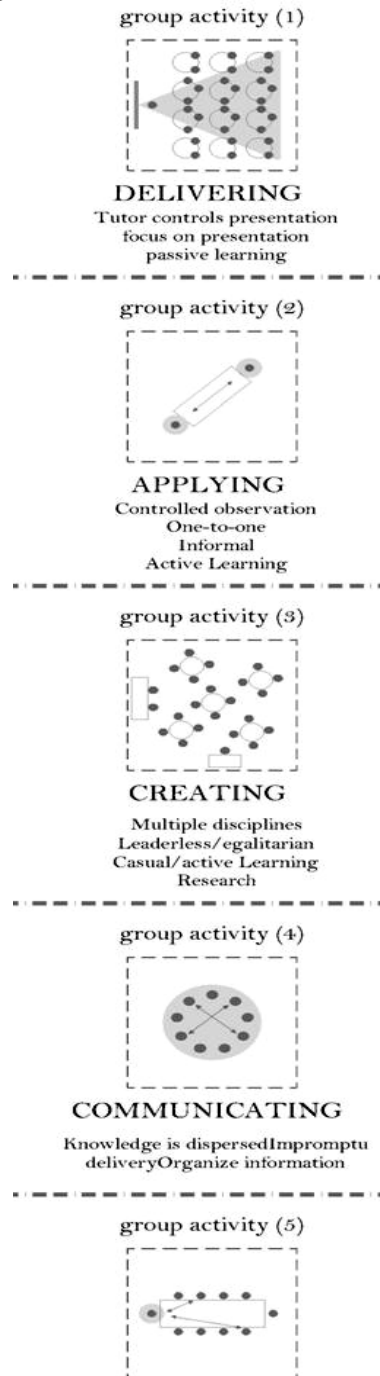


Figure 6: Interior organizational design of proposed classrooms [11]

4.2 Functional & Economical Aspects

Function inherent in the design of a learning space to shape how teaching and learning occurs. New main functional concepts are presented to accommodate well-designed flexible modular systems which function more productively and produce learners who are confident, adaptable, independent and inspired to learn.

4.2.1 Identity of learning zones/spaces

'Because of cultural differences, schools are not alike.' [6] The design of learning space should display a physical representation of its identity, vision and strategy of learning. Each learning zone expresses its individual identity but is connected by social spaces, and it also uses vocabularies from traditional architecture in the design of the building.

4.2.2 Interior Architecture and Design

In order to invent new envision for classroom interior design in a sufficiently vivid way and increase pupils cooperation it needs to be elaborated on by the use of divided zones and a shift from a linear format to small-groups work (see section 2.2). Various groups' zones may carry out such activities as hands-on experience, computers applications, and the inquiry practices of disciplines that explore the natural, social, and cultural realms.

(A) Building Approach; design that offer welcoming, clear and accessible information about the whole cluster(s) and identity of the place. Approaching the learning space should also create a sense of excitement about learning [1][12].

(B) Service spaces - such as toilets, hygiene rooms, changing areas and storage - are core facilities that support the main school spaces and are often neglected. Storage for example; users need to store their teaching materials and equipment as well as personal belongings. The location of storage areas is essential in order to ensure learning spaces are kept clear and are more flexible in use.

(C) Walls; Walls are often used without much deeper thought. Researchers believe that carefully designed classroom walls have

a strong impact on learning [11]. They argue that walls should accommodate the three following jobs, each with its certain location;

- **An acquisition wall** which should include the board and be in front of the classroom.
- **The maintenance walls** are along the sides of the room where they may be seen but are less focus. It should include review material that helps pupils fully understand what they already know. Note that the sides also include windows for enhanced day-lighting, ventilation and views (as in Fig. 7).
- **Dynamic wall** should be at the back, and it should be changed often; it contains pupils work, school notices, holiday decorations, and other organizational or social materials.

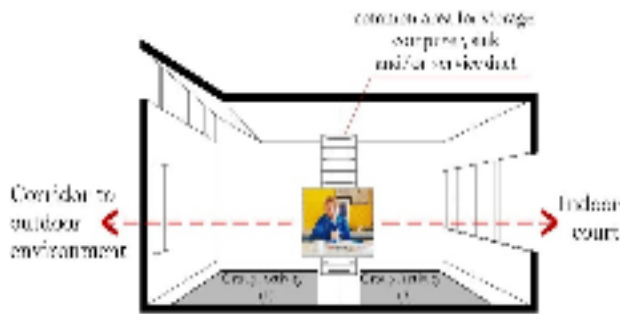


Figure 7: Window Positions (views to outside spaces are important)

(C) Spatial relationships and circulation in learning spaces should be designed to cater for a range of users, some of whom will be coming for the first time. There are a number of circulation issues to be considered, including planning, lighting, acoustics and finishes. A view from the corridor into a learning space or outside gives a sense of openness and increases the sense of width [13] (fig.7). The learning zones are located both horizontally and vertically by open central atrium space and the corridors. Each zone has a close link to these primary spaces but is also located to maximize connections with the external context. All learning zones have a common central “social space” and a series of break out spaces (Fig.8).

(E) Accessibility; Moving learners away from a format that focuses all seats on a single teacher, to one; which allows learners to sit closer to the teacher and/or to view and learn from each other and not as in more conventional classroom settings as discussed in Section 2.1. (Fig.9)

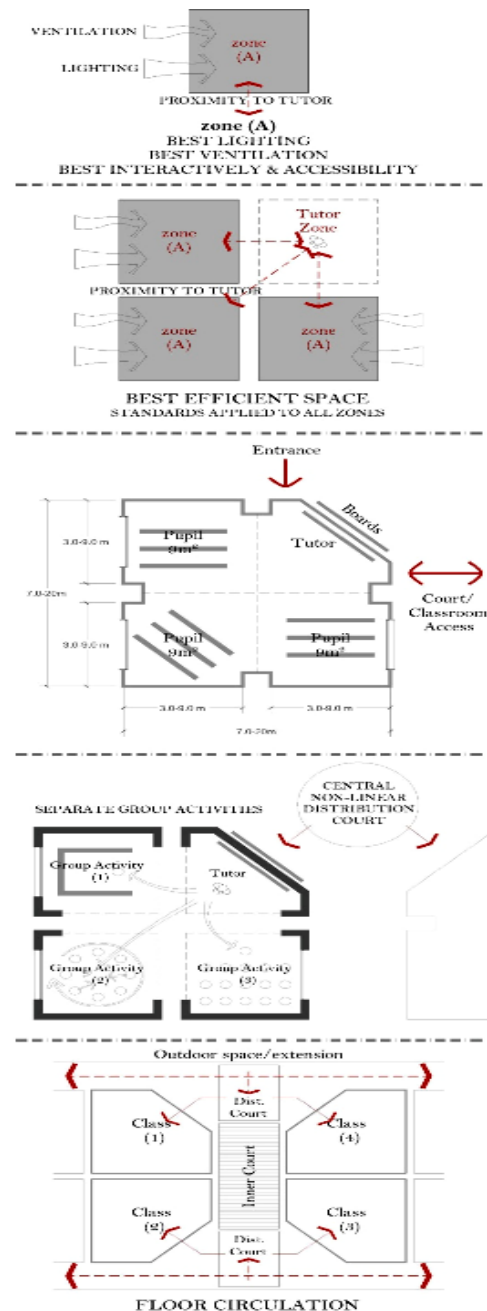


Figure 8: Schematic diagram for arrangement, circulation and orientation of classrooms

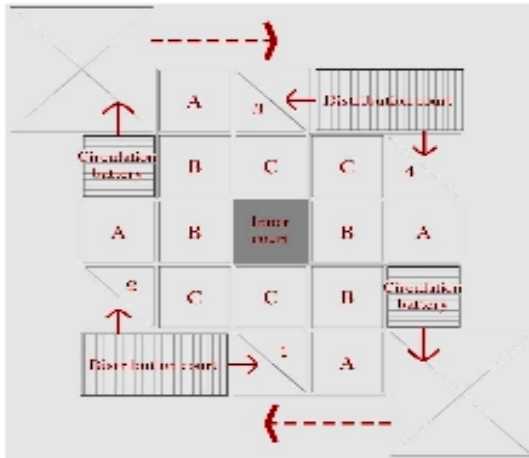


Figure 9: Clustering & Courts Concept (Modular Cluster unit)

4.2.2 Flexibility & Adaptability;

A flexible design allows a variety of activities to be accommodated without cost or inconvenience. This definition of flexibility differs from adaptability, which is the ability to adapt a building over time to suit changing needs [14]. Both flexibility and adaptability are keys to making efficient use of the available area. The furniture may be moved around daily to suit different activities. To achieve this flexibility, architects are designing classrooms, with movable furniture and walls that can easily be reconfigured for different class sizes and subjects [15]. The modular zones will be defined by prefabricated partitions that will further allow for on-site changes to form and space as the need arises. The flexible design also allows each space to be capable of supporting different purposes, (fig.10)

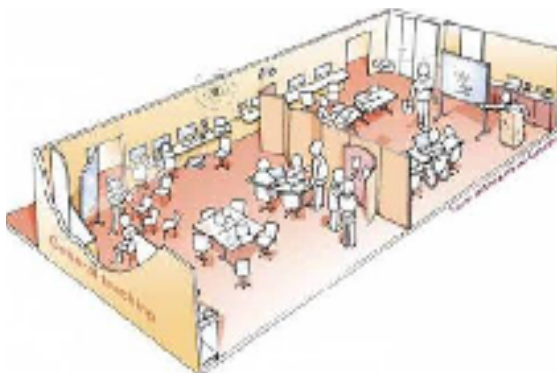


Figure 10: 21st century classroom design [15]

4.3 Ecological Strategies

"It's time that we all have greater appreciation for the benefits of building "green," not only for the future protection of our environment and resources, but for the well-being and comfort of the students and teachers who occupy the buildings", Laurie Robert, Vice President of NRB, a leading manufacturer of modular buildings since 1979. The ecological features are major concerns in applying the sustainable design process. Three main criteria are followed to propose an Eco-design for specifically addressing the local environment's considerations, whether they are possibilities or limitations; building form and envelope, construction materials and energy-saving technologies (see fig.4). The Eco-Class is also used as hands-on teaching tool for pupils to study "green" principles and learn the significance of their role in the protection of environment and resources.



Figure 11: Conceptual elevation with courts on different levels (modular formation)

4.2.1 Form and Envelope; Classrooms were formed into modular zones that will all receive equal ecological privileges. Zones should be orientated to maximize natural lighting and ventilation (Fig. 11). Also several local insulating and venting techniques appropriate to context should be applied, (Fig.12).

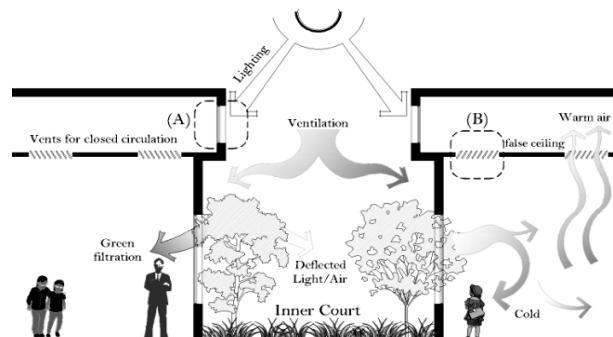


Figure 12: Green Filtration of Air intake

4.2.2 Construction Materials & Renewable Resources; Blending and balancing all the elements of sustainability, versatility and aesthetics, the construction materials are local, eco-friendly and recycled. The Eco-Class will be constructed of recycled pre-fabricated steel or wood panels/partitions which allow each unit to "personalize" their private space/zone by painting their own mural low-VOC paints, giving the tutor and pupils "ownership" of their learning space. The wood is of MDF made from recovered wood fibre, bamboo, and recycled-content carpet tiles with water-based icynene floor insulation. Furthermore, to minimize the amount of construction waste - most of which should be recyclable - the building module will be based on standard local building material dimensions. Low Embodied Energy and/or Recyclability with a whole life cycle consideration and end of life reusability.

4.2.3 Energy Saving Techniques; Buildings have a major impact on the environment, not just in terms of materials used in construction, but also due to energy usage during their lifetime[16]. To minimize electrical usage, the Eco-Class should integrates several day-lighting strategies to maximize natural light such as increased glazing utilizing exterior sun shades, interior light shelves, light-tubes, and automatic self-dimming lighting controls.

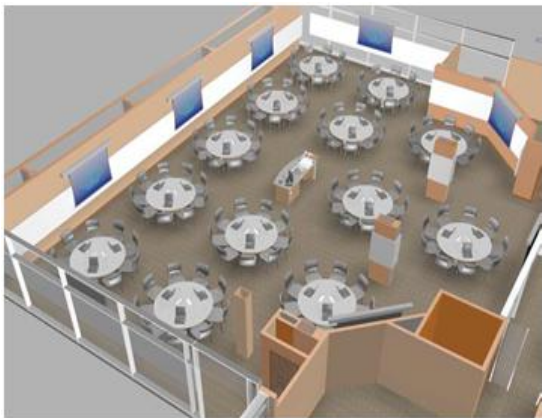


Figure 13: Technology enabled active learning (TEAL) classroom for engineering, MIT [17]

Technologies also improve efficiency by using innovative technology solutions and thus reduce costs while improving the quality of the educational process, (Fig.13).

5. CONCLUSION

It is indeed daunting to conceive of the ideal setting in which to raise future generations. Yet, that is the challenge to raise learners increasingly in organized classes outside their homes. The framework of an Eco-class presented in this paper is conceptualized as new vision for effective learning space in search of ISLE in Egypt that not only provide learners' local basic needs but also honour them by nurturing their spirits particularly during the most formative and vulnerable period of their lives. The paper shows how effectively sustainable features - such as conservation of resources, energy efficiency, passive design, renewable energies, local non-toxic construction materials, and air-quality - affect student performance and relevant for Eco-Classes that are convincing and pioneering rather than imitative.

Considering the advantages of the Eco-class vision for the total well-being of learners, parents, and staff, will encourage more focused studies and innovative designs and enhance learning environments that reflect the highest goals for pupils in Egypt.

The rapid rise in pupil numbers and the decay of learning facilities in Egypt has necessitated serious action. Therefore, the concepts and philosophies behind ISLE are changing, searching for ways to make all learning spaces more fun, more relevant and more capable of responding to social need. Classrooms are always changing to facilitate new ways of learning and organization. It is not possible therefore to create a plan that will work forever. However, there should be a clear framework within which design alternatives can take place. As discussed in this paper, the following are a set of recommendations influencing the so-called ISLE that need to be available in the MEC;

- **Well-designed;** inspiring creative, productive and efficient learning, and putting structure, order, and context to free-ranging ideas.
- **Signature;** express the learning space's identity to all who approach. Moreover, connecting the history and culture of the place and its aspirations and accordingly building a sufficient Egyptian signature.
- **Living Eco-Class;** to explore strategies that make building systems visible & sustainable to provoke inquiry and understanding among learners.
- **Multi-Use Eco-Class;** to design classrooms into more flexible zones which accommodate more varieties of teaching and learning approaches.
- **Clusters of Learning;** to shape variable numbers of Eco-classes into clusters that support autonomous larger groups.
- **Indoor & Outdoor Connections;** to consider both indoor & outdoor spaces as sites of active learning by the use of courts.
- **Learning Supports:** Furniture & Storage to provide; first a comfortable, sturdy, and movable furniture. Second, an accessible storage that adapts to a wide variety of user needs. Third, optional furniture that support applied learning and hands-on activities.
- **Technologies;** increasing investment learning technologies, combined with the need for more cost-effective space utilization, is making it increasingly important to keep abreast of new thoughts/ideas about the design technology-rich Eco-Class.

Finally, Education in Egypt will continue to face shortages of teachers, schools, and equipment unless the state makes a far greater financial commitment. Now, it is time for decision-makers in school districts across the region to commit to providing their future generations with the improved learning space provided by sustainable environment.

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