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Greening the Architectural Curriculum in Egyptian Institutions of Higher Education

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Abstract: Egypt is taking serious steps towards sustainability and energy efficiency. The Ministry of Housing, Utilities and Urban Development (MHUUD) has an interest in promoting green buildings as part of its overall sustainable development policies. The Housing and Building National Research Center (HBNRC) took the initiative to establish the Egyptian Green Building Council (GBC-Egypt). In response to the need for an Egyptian green building assessment system, the HBNRC has produced the Green Pyramid Rating System (GPRS). It is important to raise awareness among the practicing and academic architects to the seriousness of having green buildings as the next future direction for Egyptian buildings. In the Egyptian architectural education, inclusions of sustainability aspects are fragmented relying mainly upon individual efforts of lecturers that are familiar and inclined towards the subject matter. The present paper attempts to integrate the concept of sustainability into the thinking and teaching of architecture in Egypt. This will be achieved by modifying present educational approach and practice. There is a need to review the existing curriculum of schools of architecture to include the important aspects of sustainability in the courses content. Two Egyptian universities are selected: Cairo University (CU) and October University of Modern Sciences and Arts (MSA), and compared with the College of Architecture in Arizona, USA. Introducing sustainability design studios and sustainability related courses to the architectural education are essential. Change in architectural curriculum in Egyptian universities is discussed.

Keywords: *Green architecture, Sustainability, Curriculum, Higher education*

1. Introduction

The need to initiate a change in architectural education that supports the accomplishment and achievement of considerations of sustainability in architecture is primarily activated and generated by the following six factors: natural resource depletion, climate change and ecological damage. The fourth factor is that current building practices have been slow to respond to the need of enhancing sustainable environmental design within a creative architectural discourse. The fifth factor is that the accreditation and qualification criteria established by professional bodies do not yet comprehensively contribute to the efficient promotion of environmental sustainability in building design. The last factor is that the university curricula have proved to be sparsely effective in systematically integrating sustainable environmental design in the education of students in architecture. The role of higher education in creating a more environmentally sustainable future is crucial. The aim would be to train the professionals, students and community to be environmentally literate [1]. An effective way to stop the disastrous degradation of the global environment is to concentrate on architectural and engineering education. Students have to learn how to design and build sustainable buildings that have minimum adverse impacts on the built and natural environment. The rational use of natural resources will contribute to saving scarce resources reducing energy consumption and improving environmental quality [2].

Adopting the concept of Green Building is one of the ways that can enlighten the individual on how earth can survive longer in a suitable way. A sustainable architectural

education enhancement program will work to bridge the gap between the demands of the society and the ability of the existing and up-coming professionals to address these demands. Schools of architecture need to examine their existing architecture education and their future education plans. It is vital that the architects of the future should be learning to define the future through understanding how societies in the past have learned to live within the limited resources available to them [3]. The nature of teaching needs to change in both contents and delivery to achieve a paradigm shift. If educational architectural institutes are to change to a new type of teaching many practical issues are involved. The main problems are in retraining and reorienting staff, besides getting new teaching materials. "The achievement of environmentally sustainable development is dependent on adequate technical education at all levels and on education on how to balance economic, social and environmental goals" [4].

2. The Concept of Green Architecture

Buildings are one of the heavier consumers of natural resources and energy. Current practices in architecture are generally based on standards, leading to a growing dependence on fossil fuels resulting in rapid environmental degradation. Modern buildings are increasingly unable to adapt to a warming climate and inherently energy intensive. A large portion of the energy used in buildings is used for achieving thermal comfort for the inhabitants through cooling, heating and lighting. To be comfortable, homes are provided by mechanical means whose cost is usually high. Large quantities of carbon dioxide and the green house gases produced by building industry causing increased harmful effect on the environment, led to concept of "Green Architecture". This concept took place when the usage of fossil fuels began to do irreparable damage to the environment.

Green architecture aims at reducing the environmental impact of buildings through energy efficient designs and healthy indoor environment. It involves a holistic approach to the design of buildings so that the many conflicting issues and requirements of ecology, economy and human well-being are integrated. There must be a struggle to control pollution and to find responsible sustainable methods of construction [5].

Sustainability represents the concept that the human contributes towards meeting the needs of the present generation, while ensuring that the needs of future generation are not compromised. The concept demands participation from every level of the community, aiming at maintaining a balanced ecological, social and economic system. Design approaches in support of sustainable architecture are 'green architecture' [6], 'environmentally responsive design' and 'ecological design' [7]. Vale proposes six green design principles, which are conserving energy, working with climate, minimizing new resources, respect for users, respect for site and holism. Sustainable architecture echoes the concept of 'sustainable development', focusing on the architectural concerns. "Sustainable architecture covers the tri-domain of social-environment-economy parameters. There are differing opinions in the placement of priority between these three aspects [8]. Ray-Jones sums up sustainable architecture as "a thoughtful and well considered use of energy systems to make buildings that are more conductive to human use and comfort, without generating pollutants or borrowing the earth's resources of the future generations." [9]

Rational and sustainable use of natural resources, such as renewable energy, recycling, reduction of pollution and waste, rational use of land and raw material and water are enhanced by green buildings. Recently, the concept of "Green Architecture" has been elaborated and widely spread in many countries. Accepted system of the United States Green Building Council (USGBC) in this respect has been the

"Leadership in Energy and Environmental Design" (LEED). According to the USGBC, LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health, namely: sustainable site development; water savings; material selection and indoor environmental quality. The USGBC also certifies LEED Accredited Professionals since this program was launched in the USA in 2001 [5].

In Egypt, the HBNRC took the initiative to establish the Egyptian Green Building Council (GBC-Egypt) at the beginning of 2009 in harmony with the policies of the MHUUD. Green Pyramid Rating Systems (GPRS) has been developed as a national system for rating the Green credentials of buildings. It involves measuring tools (credits) and efficient Green Pyramid Category Weightings for the following items: sustainable site; accessibility; ecology; energy efficiency; water efficiency; materials and resources; indoor environmental quality; management and innovation and added value. A project can earn a Green Pyramid certification if it satisfies all Mandatory Minimum Requirements [10]. Other countries have applied different methods to assess building compliance to given standards such as: the British Rating Energy Efficiency Assessment Method (BREEAM) for the United Kingdom, the Green-Star for Australia and New Zealand, the Green Mark for Singapore, the Comprehensive Assessment System for Building Energy Efficiency (CASBEE) for Japan, while India has been using LEED for the Assessment and they refer to it as LEED-India [11].

3. Methodology

In order to provide a benchmark for good practice that enables buildings in Egypt to be directed steadily towards green architecture it is inevitable to re-consider the curriculum in institutions of higher education. CU and MSA are selected to show the status of green architecture in the universities in Egypt. For comparison, the College of Architecture in Arizona is chosen to demonstrate the curriculum in one of the top institutions of architectural education in USA.

4. Architectural Curriculum in the Program of Architectural Engineering and Technology (AET), Credit Hours System (CHS) of Cairo University

The AET focuses on providing a comprehensive and holistic approach, which addresses the critical environmental and building design issues. The mission of this program is to pursue architecture as a humanistic and professional discipline, which synthesizes art, engineering sciences and technology through intellectual rigor, aesthetic judgment and technical understanding [12]. The curriculum is based on a total of 180 credit hours; 36 of those are in the freshman year. After this year the student is exposed to fundamental architectural engineering courses related to history and theories of architecture, architectural design courses, design computing and to building construction and technology courses. Table 1 shows the distribution of courses that integrate environmental issues and sustainability principles in AET in Cairo University throughout the five years while table 2 shows the courses and studios that integrate environmental issues to their content.

Table1. Distribution of sustainability courses in the curriculum of AET in Cairo University

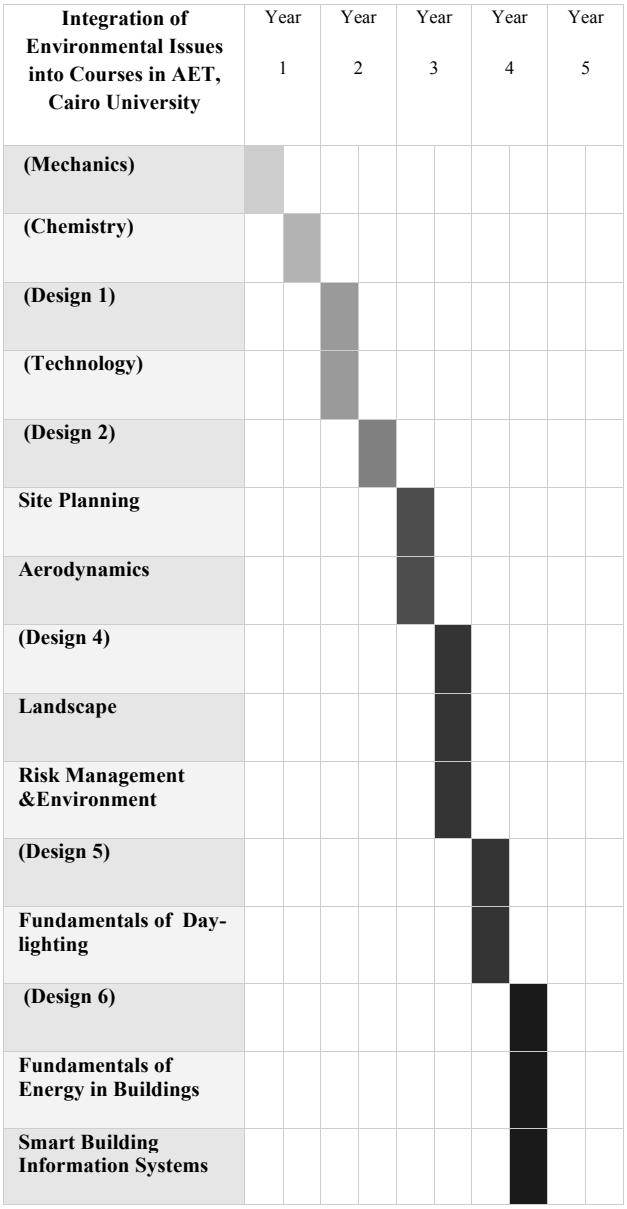


Table2. Courses integrating environmental issues in AET in Cairo University

Year	Course Title	Integration of Main Environmental Issues
1st Fall	Mechanics	Waves, Thermodynamics
1st Spring	Chemistry	Heat, Combustion of Fuel, materials
2nd Fall	-Arch. Design 1 - Building Technology	Environmental determinants Env. Control Systems
2nd Spring	Arch. Design2	Technological and Env. Determinants
3rd Fall	Site Planning & Development Aero-dynamics	Problems of environment (natural systems context) Natural ventilation
3rd Spring	Design 4 Landscape Risk Manag. & Env.	Environmental system Continuities: built & natural world Env. Impact Assessment
4th Fall	Design 5 Acoustics, Daylighing	Environmental System Fundamentals of acoustics, Daylighing
4th Spring	Design 6 Energy in Buildings Smart building information Systems	Smart, green designs Conservation of Energy Empirical Evaluation of built environment

It is clear from Tables 1 and 2 that the emphasis of sustainability courses is in the third and fourth year. Integration of environmental issues is in Design Studio 1, 2, 4, 5 and 6. Through examining the detailed contents of all courses, it is found that 40% of the courses in the curriculum of the Architectural Engineering Technology in Cairo University contain subjects related to sustainability. Around 60% of the design studios accomplish the integration of sustainability principles in the design process.

5. Architectural Curriculum in the program of Architectural Systems Engineering (ASE), Credit Hours System in MSA

Architectural Systems Engineering (ASE) is concerned with the architectural design, and improvement of integrated structural and building systems. It also deals with the principles of architectural modeling: analysis, and design to specify, predict, and evaluate the output as an architectural product of these systems. The architectural Engineering students in MSA are introduced to a broad spectrum of architecture engineering topics. Architectural curriculum emphasizes the need of multifaceted education to close the gaps between art and science, between form and substance, and between aesthetics and technology [13]. The ASE program consists of 54 courses with 168 credit hours. According to the National Academic Reference Standards for engineering programs (NARS), architectural education is concerned with the constraints of the physical world and historical and cultural dimensions. It constantly adapts to a changing social, economic and environmental context nationally, regionally and internationally. The graduate MSA student should be able to exhibit an understanding of the profession of architecture and the role of architect and planner in society, particularly in creating sustainable built environments that directly affects the social, economic and cultural well-being of the society (NARS) [14].

Table 3 shows the courses and studios that integrate environmental issues to their content, while table 4 shows the distribution of sustainability courses in the curriculum of ASE in MSA throughout the five years.

Table 3. Environmental Issues integrated in the architectural courses in Architectural Engineering Systems in MSA

Year	Course Title	Integration of Main Environmental Issues
1st Fall	Physics I	Heat, Thermal Energy
1st Spring	Physics II	Sound waves, light, acoustics
2nd Fall	Arch. History I	Awareness of env. Parameter affecting end product
2nd Spring	Arch. Design IV	Designing sustainable building
3rd Spring	Technical Service Systems I	Renewable energy technologies, evaluation of env. performance
4th Spring	Arch. Design VIII	Design disciplines related to contextual environment
	Technical Service Systems I	Indoor air quality, thermal comfort
	Landscape Design	Respect beauty of nature & deal with it
5th Fall	Env. Control Systems	Principles of environmental systems & techniques
5th Spring	Graduation Project II	Satisfying the environmental aspects

Table 4. Distribution of sustainability courses in Architectural Engineering Systems in MSA

Integration of Environmental Issues into course	Year 1	Year 2	Year 3	Year 4	Year 5
Thermal Energy (Physics I)					
Topography Surveying (Engineering Surveying)					
Awareness of Environmental parameter, History I					
Designing Sustainable buildings(Design IV)					
Renewable Energy Technologies (Technical Service I)					
Integrating Environmental Issues in Design VIII					
Indoor Air quality Thermal comfort Technical Service II					
(Landscape)					
Environmental Control System					
Integrating Environmental Issues in Graduation Project					

Tables 3 and 4 show that the emphasis of sustainability courses is in the fourth year. Integration of environmental issues is in Design Studio 4, 8, and the graduation project. Through examining the detailed contents of all courses, it is found that 23% of the courses are related to sustainability. The environmental subjects are taught as a separate entity and not as an integral part of architectural design. Around 33% of the design studios integrate sustainability issues in the design process. The three main courses that focus on sustainability (Environmental Control System, Technical Service I & II) are taught as a separate entity and not as an integral part of the design process. Integrating the sustainability principles in the design studio relies mainly on the individual efforts of lecturers that are familiar and inclined towards the subject matter. Courses related to sustainability raise the issue of resources leading to the study of buildings that use solar energy for heating and cooling. They do not explore architecture for a society living without fossil fuels and other non-renewable resources. There are no courses that ask students to design buildings that use only renewable resources, and rarely is the whole architect/client relationship examined in such a context.

6. Architectural Curriculum in College of Architecture in Arizona

The professional education in the school of Architecture in Arizona is responsively prepared in the edge conditions of an extreme climate. The school is characterized by its culturally rich past as it is located in the oldest inhabited city in the United States. It has a place-based design approach to the arid environment. There are four main intentions in the policy of education in the school of architecture in Arizona [15]:

- The making of architecture is a practical, functional and aesthetic activity that serves the needs of human shelter.
- The construction of shelter is an imaginative cultural research where the residential buildings are considered as an essential human ambition and means to a graceful life.
- The activity and search must be adjusted and modified according to the place, the geography of Arizona, and the culture of the Southwest.
- The design of place must be influenced by a portable global sensibility, yet respecting local traditions, strengthened by material circumstances, and expressive of spirit of time and place.

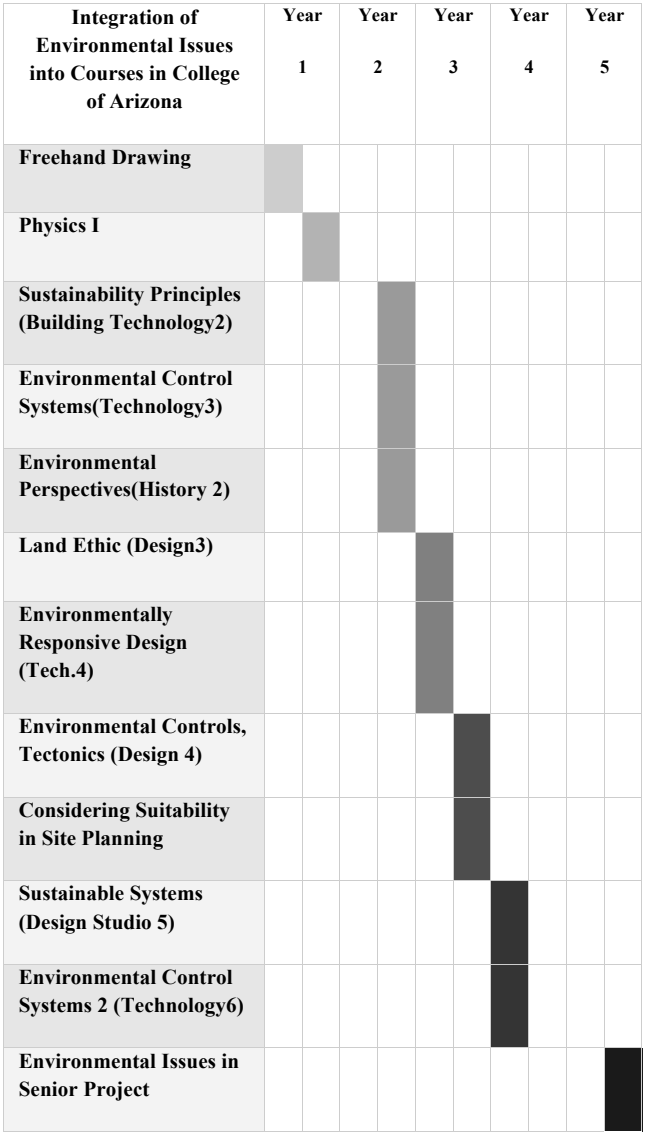
The architectural curriculum of Arizona is concerned of four subjects matter: technology, theory and history, communication methods, and professional practice, all of which must be integrated as appropriate to each level of the architectural studio sequence (Table 5).

The architectural studios are organized in a progressive sequence comprising themes that serve as a scaffolding for the whole curriculum: Foundation; Ergonomics (Study of the Environment); Programming; Land Ethics; Tectonics; Culture; Technical Systems; Urban Form; Research Options; Senior Project. The five-year program comprises a foundation (pre-architecture) year, a three-year professional core and a fifth year focusing on design options and a senior project. The three-year professional core emphasizes five major areas: design/communication, history/theory, technologies, practice/management and electives. Fifth year design options vary but typically include sustainable design, historic preservation, community design, lightweight structures, design/build and behavioral aspects in design. The College of Arizona consists of 50 courses with 171 credit hours. Table 6 shows the distribution of sustainability courses in the curriculum of school of Architecture in Arizona throughout the five years. Table 7 shows the courses and studios that integrate environmental issues to their content.

Table 5. Main concerns of curriculum in College of Architecture in Arizona

Subject	Relevant Issues
Technology	Realities of site, climate and material resources. Familiarity with the local geography, traditional materials & methods of energy conservation are critical factors in the design of a well-tempered architecture
Theory and History	Examining architecture as an intelligent expression of culture. A broad-minded but well-focused analyzing functional & aesthetic continuities in buildings, cities & landscapes Revisions over time &space are necessary for the preservation of and innovation of architecture.
Communicat-ion Methods	Critical tool in the creative process; through drawing, modeling, detailing, oral & written descriptions. Means of effective interaction with clients, material fabricators, members of the construction trades & users of architecture
Practice of Architecture	Ethical act in service of human needs. In compliance with technical protocols and building codes. Interaction with construction trades. Hands-on experience in design/build collaborative projects in an effective introduction to this practice.

Table 6. Distribution of sustainability courses in College of Arizona



It is clear from tables 6 and 7 that the emphasis of sustainability courses is in the second, third and fourth year. Integration of environmental issues is in Design Studio 3, 4, 5, 6 and Senior Project. Through examining the detailed contents of all courses of school of Architecture in Arizona, it is found that 35% of the courses are involved in teaching of building physics or building sciences and environmental issues, while 50 % of the design studios apply the sustainability principles in the design process.

Table 7. Environmental issues integrated in the architectural courses in Arizona College

Year	Course Title	Integration of Main Environmental Issues
1st Fall	Foundation Studio I	Freehand drawing to reveal world around us
1st Spring	Physics I	Thermodynamics, Sound, heat
2nd Spring	- Building Technolog2	Sustainability Principles
	- Building Technolog3	Env. control systems
	- History 2	Env. Consideration
3th Fall	-Design Studio3: Land Ethic	Analyze phenomena regarding earth (geology), water (hydrology) & light and air (meteorology)
	-Building Technolog4	Environmentally responsive design
3rd Spring	-Design Studio 4: Tectonics	Definition of specific needs for spatial adjacencies, circulation, lighting, ventilation & env. controls, resolved through appropriate use of materials, geometry of structure & external envelope &internal configuration & partitioning of space
	-Site Planning	Awareness of uniqueness of Sonoran Desert context, encourage sustainability
4th Fall	DesignStudio 5: Technical Systems	Active/passive cooling, heating, Env. controls, sustainable systems
	Building Technology	Intelligent use of natural resources, Env. Context
	Design Studio 8: Senior Project	Integrating all aspects of design/research proposal in a developed project

7. Discussion

A comparison between the curricula of the three universities (Cairo University, MSA and Arizona) is given in table 8.

Table 8.Percentages of Sustainability courses & their integration in the Design studios of three different universities

	AET	MSA	Arizona
Percentage of Sustainability courses in the curriculum	40	23	35
Percentage of Design studios Integrating sustainability Principles in Design Process	60	33	50

Table 8 shows that the curriculum of Architectural Engineering and Technology (AET) in Cairo University provides the highest percentage of sustainability courses and integrates sustainability principles in the design process. The course of 'Introduction to Building Construction and Technology' (Table 2) explores innovative environmental solutions. 'Fundamental of Energy in Buildings' deals with conservation of energy and creative design projects. "Smart Building Information Systems' focuses on illustrating the building components and systems, and interactions between building, occupants and environmental conditions. The Architectural Design 1 and 2 focus on conceptual design process emphasizing technological and environmental determinants. Architectural Design 4, 5 and 6 integrate environmental and climatic issues in the design process. There is an emphasis on energy efficiency, environmental systems integration and building envelope design.

On the other hand, the courses' content of curriculum in Arizona (Table 7), deals with the Building Technology more thoroughly. In Arizona curriculum, there are four courses of Building Technology that explain the environmental control systems, climate responsive building design, sustainable systems and the role of material, detail and assembly strategies in building enclosures for making sustainable environments. Such in-depth study and application of this knowledge result in more advanced and enhanced Design Studios (3, 4, 5 and 8).

MSA has the lowest percentage of both sustainability courses and their integration in the Design Studios. There are three main courses that deal with sustainability (Table 3). 'Technical Service Systems I' explores the renewable energy technologies and evaluation of environmental performance of design proposals. 'Technical Service Systems II' focuses on the indoor air quality, thermal comfort and room comfort zones. The 'Environmental Control Systems' focuses on the environmental systems and techniques, alternative solution for human comfort, renewable energy technologies and their applications to design proposals. Only Design 4, 8 and graduation project integrate sustainability issues into the design process.

8. A Need for Change in Architectural Curriculum and Education in Egyptian Universities

According to Glyphis, there are important strategies for integrating sustainable design concepts in all four major areas in the architectural curriculum: History/Theory; technology; studio; and professional practice [16].

- Integrating sustainability into history/theory is the most difficult and rewarding arena. The environmental movement must open up to broader theoretical investigations. In addition, architectural history courses could incorporate more perspectives on ecological design and more courses to address diverse culture, climates and regions.

- Technology: courses should introduce the basic sciences of ecology, air and water movement, energy use and material composition in the fundamental way that physics and static are taught. The faculty needs opportunities and support to be constantly updated on new examples, tools and case studies.
- Studio: introductory studios that begin by introducing community and regional scale issues would initiate an awareness of the larger environmental context of design. Shorter studio modules would provide flexibility for a wide variety of interdisciplinary approaches. Specific studio programs on sustainable design issues could be developed and widely shared. Finding workable methods for breaking down the usual differentiation of the studio and the lecture is a very important step. Studios working on real life problems at different scales either on the campus itself or in the community at large are always effective, especially when the studio begins with urban and regional-scale problems. There is a need for developing adaptable ecological learning tools. There is also a need for a methodology and a visual icon to represent the ecological footprint as a standard indicator on projects, analogous to the use of the compass north arrow. Moreover, developing layered drawings to include Geographic Information System (GIS) information is essential. Addressing the issues of beauty, performance and ecological economics simultaneously helps in combining the major disciplinary divisions in design training.
- Professional Practice: course materials are needed on issues of environmental ethics, responsible design, law and liability as pertains to environmental quality.

We need buildings that are efficient, comfortable, adaptable, and durable but this can also mean beautiful, exciting buildings, contributing to places that make sustainable living easy, affordable, and attractive [17]. To achieve this goal, it is important to transform the conventional course content to be more environmentally friendly. Moreover, the mindset of lecturers has to change. They should attend relevant seminars, do research, and from research findings present papers, write books, and submit articles, all pertaining for sustainability. Existing lecture materials need to be upgraded to meet climate change demands and examinations to be geared towards green buildings. For many of the staff in the universities this means retooling, retuning or even reeducation oneself to suit new goals in not only the subjects they teach, but to incorporate them in the studio teaching. It is a task for educators to shift the students' attention to emulate the work of sustainable architects who may not receive as much publicity or attention [11].

Integrating sustainable design concepts into curriculum is essential for education progress. Transforming architectural education means focusing on how to teach rather than what is being taught. Teachers need to expose students to the best ideas, set good example by showing commitment in their own work and expand the boundaries of the discipline and the profession. The understanding of design that goes beyond buildings is an essential step to move architecture education beyond architecture. Architects can be considered as generalists, but also there is a necessity of specialization. Architects are also practical visionaries with an ability to project possibilities and to connect knowledge with action. They have the ability to use visual demonstrations of different alternative possibilities and to resolve the tension between problem solving and creation. They have a capacity to identify shared values to build shared vision. Architects understand the importance and the need for teamwork inside and outside the profession besides having the ability to make impacts visible within local

communities and make connections to community health [16].

As practicing professionals, architects provide analyses and identification as problem definitions by asking questions, specifying the boundaries of the system, and understanding of natural systems, site and community. Architects can expand the knowledge base inside and outside the profession. They can develop ideas and apply modes of thinking analogous to that used in education. Architects can connect acquired learning to arts and sciences where certain types of teaching elements are created and used, such as learning by doing and using the campus and the community as a laboratory. Architects are basically familiar with rules, codes, specifications, and practice.

It is equally important for teachers to produce ideal professional work as well as to take definitive stands on social and ethical issues. They should also be role models as individuals, engaged with the larger world, and visibly leading interdisciplinary design teams. "Teaching meant bringing new synthesis to students and illuminating how things happen in the larger and rapidly changing world, including how the marketplace works" [16]. The role of designer must be re-framed politically, symbolically and structurally within the context of human resources.

One should consider how sustainability could change the complex structure of the academia compared with a more straightforward research unit. Hands-on project-based learning process should become the driving mechanism for a meta-disciplinary education. Inspiring and affecting students could be enhanced by sharing resources (e.g. slide shows via internet) developing internship, and creating and managing competitions for students. They should be involved in existing sites and real projects. It is important to assist them to be interconnected and empowered, and also to build confidence to use their acquired knowledge more effectively. Inspiring a mode of inquiry in students to find the significance of different patterns and prototypes and to be intellectually and theoretically convincing in their search will enhance the learning process.

Students should realize that there is an essential role of architects. The first component of the role is to design buildings that imitate natural systems and have the capacity to reconnect people to the spirit of nature. Accordingly, it is necessary for architects to work with others outside architecture and to explicitly support the contribution of users. Finding multiple ways to connect community to urban issues is essential. A second and crucial component of the role of the architect is to be a social change agent and an advocate for natural systems and ecological thinking. This comprises concepts such as community, refinement, integrity, completeness and "sense of place". A new language of architecture would have support a principle of moving away from the luxury of excess.

9. Conclusion

The concept of "Green Architecture" is the remedy for the increasing ecological impacts of buildings. Architects could help to protect the future generations against the serious threat of pollution and depletion of natural resources. This goal is achieved by enhancing the curricula in institutions of higher education and integrating sustainability issues within the courses and applying it in the design process. Architects would think creatively about how sustainable solutions can be designed in the Egyptian built environment.

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Year	Course	Integration of Main

	Title	Environmental Issues
1st Fall	Mechanics	Waves, Thermodynamics
1st Spring	Chemistry	Heat, Combustion of Fuel, materials
2nd Fall	-Arch. Design 1 - Building Technology	Environmental determinants Env. Control Systems
2nd Spring	Arch. Design2	Technological and Env. Determinants
3rd Fall	Site Planning & Development Aero-dynamics	Problems of environment (natural systems context) Natural ventilation
3rd Spring	Design 4 Landscape Risk Manag. & Env.	Environmental system Continuities: built & natural world Env. Impact Assessment
4th Fall	Design 5 Acoustics, Daylighing	Environmental System Fundamentals of acoustics, Daylighing
4th Spring	Design 6 Energy in Buildings Smart building information Systems	Smart, green designs Conservation of Energy Empirical Evaluation of built environment

		Issues
1st Fall	**Mechanics**	**Waves, Thermodynamics**
1st Spring	**Chemistry**	**Heat, Combustion of Fuel, materials**
2nd Fall	**-Arch. Design 1** **- Building Technology**	**Environmental determinants** **Env. Control Systems**
2nd Spring	**Arch. Design2**	**Technological and Env. Determinants**
3rd Fall	**Site Planning & Development** **Aero-dynamics**	**Problems of environment** **Natural ventilation**
3rd Spring	**Design 4** **Landscape** **Risk Manag. & Env.**	**Environmental system** **Continuities: built & natural world** **Env. Impact Assessment**
4th Fall	**Design 5** **Acoustics, Daylighting**	**Environmental System** **Fundamentals of acoustics, Daylighing**
4th Spring	**Design 6** **Energy in Buildings** **Smart building information Systems**	**Smart, green designs** **Conservation of Energy** **Empirical Evaluation of built environment**

Year	**Course Title**	**Integration of Main Environmental**

Table 3. Environmental Issues integrated in the architectural courses in Architectural Engineering Systems in MSA

Year	Course Title	Integration of Main Environmental Issues
1st Fall	**Physics I**	**Heat, Thermal Energy**
1st Spring	**Physics II**	**Sound waves, light, acoustics**
2nd Fall	**Arch. History I**	**Awareness of env. Parameter affecting end product**
2nd Spring	**Arch. Design IV**	**Designing sustainable building**
3rd Spring	**Technical Service Systems I**	**Renewable energy technologies, evaluation of env. performance**
4th Spring	**Arch. Design VIII**	**Design disciplines related to contextual environment**
	Technical Service Systems I	**Indoor air quality, thermal comfort**
	Landscape Design	**Respect beauty of nature & deal with it**
5th Fall	**Env. Control Systems**	**Principles of environmental systems & techniques**
5th Spring	**Graduation Project II**	**Satisfying the environmental aspects**

Year	Course Title	Integration of Main Environmental Issues
1st Fall	Foundation Studio I	Freehand drawing to reveal world around us
1st Spring	Physics I	Thermodynamics, heat
2nd Spring	- Building Technolog2	Sustainability Principles
	- Building Technolog3	Env. control systems
	- History 2	Env. Consideration
3th Fall	-Design Studio3: Land Ethic	Analyze phenomena regarding earth (geology), water (hydrology) & light and air (meteorology)
	-Building Technolog4	Environmentally responsive design
3rd Spring	-Design Studio 4: Tectonics	Definition of specific needs for spatial adjacencies, circulation, lighting, ventilation & env. controls, resolved through appropriate use of materials, geometry of structure & external envelope, partitioning of space
	-Site Planning	Awareness of uniqueness of Sonoran Desert context, encourage sustainability
4th Fall	DesignStudio 5: Technical Systems	Active/passive cooling, heating, Env. controls, sustainable systems
	Building Technology	Intelligent use of natural resources, Env. Context
	Design Studio 8: Senior Project	Integrating all aspects of design/research proposal in a developed project