Green Courses and Heritage Conservation for Sustainable Development

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Abstract: Factually, higher education institutions exist for creation and dissemination of the knowledge. Subsequently, they are responsible for the preparation of the young people to contribute to the development of societies and, therefore, should be aware of the society current requests and forecast the type of skills the graduates will need. This research describes the importance of higher education and the role the institutions play in society's sustainable development through imbedding green courses into their plan of study. Through the study of a green course, its assessment methods and learning outcomes, which are linked to the institution graduates' attributes, the paper highlights the input of higher education institutions in formation of a new generation of citizens with sustainable vision. The results of the research show that integration of sustainable development domain into higher education institutions' plan of study or 'greening the curriculum' creates graduates that are well-equipped with knowledge and skills and have the capacity of leadership and of contribution to the future sustainable societies creation.

Key-Words: Education for sustainable development, 'Green courses', Learning outcomes, Green built heritage conservation

1 Introduction

This research emphasis the role the higher education (HE) plays in sustainable development and how does it contribute to it.

Nagoya Declaration [1] proclaims:

"With this declaration, we call upon world leaders to support the transformative role of higher education towards sustainable development, and commit to work together and further promote transformative learning and research by encouraging multi-stakeholder, multi-sector partnership, communicating examples of sustainable practices, promoting broad and strong leadership and public awareness of the values of sustainable development, and recognizing the essential role and responsibility of higher education institutions towards creating sustainable societies."

Hence, according to Cortese [2] HE institutions are responsible for increasing the awareness, knowledge, skills, and values of the present generation that will create the sustainable future for the generations to come. Shepard [3] also acknowledges the contribution of the HE institutions to the sustainable development and states that one of the means of contribution is via integrating specialized courses into the plan of study, or how he puts it - "greening the curriculum".

As a part of "greening the curriculum" process the Department of Architectural Engineering at the College of Engineering in Dhofar University (Salalah, Sultanate of Oman) has had introduced a course Special Topics in Architecture (STIA) - Green Design to the Interior Architecture plan of study. The course is an independent major elective and covers a specific topic suggested by a faculty member. STIA – Green Design has been taken for study in this research, wherein its learning outcomes and especially the final project, where students suggested a green method of conservation of an old traditional dwelling and its' adjustment to contemporary life style's requests, were analyzed.

The paper presents the results of the research and is composed of six parts starting with the introductory (1) and chapter 2, where the literature review explores the role of HE in sustainable development, educational approaches applied by the institutions approaches e.g. integration of green courses into the plan of study, and explores the relationship between sustainable development and cultural heritage conservation. The following chapter 3 formulates the problem and explains the methodology of the research. Forth chapter

describes the course STIA – Green Design, its objectives, learning outcomes assessment methods, also provides information about the final project and samples of students' works. Chapter five discusses the evaluation of students' works and the assessment of the course final project's learning outcomes. Last chapter (6) concludes the results of the research, presents the findings and recognizes the extent of the course contribution to the sustainable development.

2 Higher Education and Sustainable Development

Quality Assurance Agency for Higher Education, UK [4] explains education for sustainable development as a procedure of students' training while providing them with the knowledge and understanding, skills and attributes in the field of sustainability. This procedure guides students to develop a new style of working and living that suggest environmental, social and economic present and future stability. And, in this training process HE institutions play the main role. They, as knowledge's providers, graduate students that are capable of critical thinking, problem solving, meeting the speedily changing demands of the society. Hence, HE institutions' graduates, as future alumni, employees, citizens, mentors of the generations to come, trained in the field of sustainability can take the responsibility of safeguarding the environment [4].

Education for sustainable development should become a propulsive force that will stimulate graduates to think not only about the emergent current satiations and future too. To achieve this future vision, long-term efforts in transformation of the education system at all levels is required [2]. A persistent system of education, which integrates research and service to the local community (for making it economically secure and environmentally friendly, healthier and socially vibrant) into curriculum guarantee graduates with sustainable development vision [2].

Cortese's [2] opinion is that HE institutions' programs of study should be designed to provide students with a clear understanding of the following doctrines: a) Humans are not the dominant species and are not separated from the nature, but an integral part of it; b) The resources of the Earth are free, but not unlimited; c) Planet's ecosystems can't easily recover themselves from the effect of the humans' activities; d) Not all of the humans' and society's problem can be solved via technological development; e) Not all humans' needs can be satisfied through material means; and f) The achievement of an one single person directly depends on the well-being of the community and Earth's life supporting ecosystems.

In education for sustainable development the teacher, who is an architect of the learning environment that motivates widespread social changes, plays a crucial role [3]. The learning environment created by the teacher should be authentic, enable students to link their knowledge/skills to the real-life problems locally and globally, and suitable for exploring and evaluating sustainability practice within the institution and community. As a part of learning experience, e.g. students can work for their community (and within the community), on real-world projects while solving real problems. On the other hand, the learning environment should provide an opportunity for the students to freely express their individual opinion about sustainable development and share it with others [4]. It is also essential that the teachers are high professional academics and researchers, who are well-equipped with knowledge, are dedicated to idea of sustainable development and keen on educational system transformation [5].

Transformation of the HE institutions and their education system and its orientation towards sustainable development is a process that requires long-term efforts, but there are advantages of doing so. The institution will benefit by having: 1) graduates, who are prepared for citizenship and future career; 2) increased external respect; 3) reduced economic, social and environmental costs; 4) augmented cooperation and satisfaction across the institution. In addition to that, the increased respect of the institution will result in attracting more students, professional teachers, funds and the most important – will fulfill the HE's moral and social responsibilities [2].

2.1 Heritage Conservation as Component of Sustainable Development Concept

According to the Council of Europe [6] the concept of sustainable development is rather associated with natural resources protection than with built cultural heritage conservation.

Furthermore, there isn't any clear separation between 'nature' and 'culture' because humans live within the nature and constantly interact with it. Therefore, along with the natural heritage, the cultural heritage, which is a non-renewable recourse, must be handed on to the future

generation. This will retain the continuity between past, present and future [6].

As stated by United Nations Istanbul Declaration on Human Settlements [7]:

"conservation, rehabilitation and culturally sensitive adaptive reuse of urban, rural and architectural heritage are also in accordance with the sustainable use of natural and human-made resources".

Murray [8] also considers that sustainable development and built cultural heritage conservation are tightly interconnected with each other and that the most environmentally friendly building is the one that do not have to be built because already exists [9]. The conservation of the built cultural heritage is a vital part of societies' sustainable development [10], [11]. Hence, the integration of heritage conservation courses into HE institutions' plan of study is a contribution to it. [12], [13].

3 Problem Formulation and Research Methods

3.1 Problem Formulation

Education for sustainable development is already present in various HE institutions' programs and educators who are willing to boost students' learning in this context usually find ways of doing it [4]. 'Greening the curriculum' is one of the ways of doing it. Henceforth, it is important to assess the contribution of those green courses to sustainable development.

3.2 Methods Applied

This research is composed of two phases a) evaluation of the course's STIA – Green Design final project's learning outcomes; and b) valuation of the course contribution to the sustainable development.

For the course, which was offered in Spring semester 2014 – 2015, were registered four students (year three and four). The final year project, which is evaluated in this research, was composed of four stages. At the first stage (S1) of the project the students were working on site - taking measurements, photographs and examining the building. For the second stage (S2) the drawings of the building showing the original layout and exterior view were reproduced. The third stage (S3) required building assessment against: its physical conditions and green design. For the last stage (S4), a green building renovation for its conservation was required. The project took 16 weeks and by the end of the semester the students were asked to submit a set of drawings containing building's floor plans (scale 1:50), two sections (scale 1:50), elevations (scale 1:50), details (scale 1:5), exterior and interior 3Ds, living systems, as well as the project report and posters, which were presented to the jury.

The learning outcomes of the final project, which were aligned to the course learning outcomes, and divided into three categories are: 1) Knowledge; 2) Cognitive Skills; and 3) General Competencies, and listed in table 1.

Table 1 STIA - Green Design course learning outcomes and assessment methods

LO**	**Assessment methods***							
	S 1	S 2	S3	S4	PI	IPS	IF	Total
	10	10	10	15	15	20	20	100
Knowledge								
K1				3	2	1	1	7
K2			3			1	1	5
K3	2	2				1	1	6
K4	2	2				1	1	6
K5				2	3	1	1	7
Cognitive skills								
CS1				2	2	2	2	8
CS2			3			2	2	7
CS3	2	2				2	2	8
CS4	2	2				2	2	8
CS5				2	2	2	2	8
General competencies								
GC1				2	2	1	1	6
GC2			2	2	2	1	1	8
GC3	1	1				1	1	4
GC4	1	1				1	1	4
GC5			2	2	2	1	1	8
Total	10	10	10	15	15	20	20	100

*Abbreviations: LO – Learning outcome; S1 – stage 1; S2 stage 2; S3 – stage 3; PI – performance improvement; IPS – interventions on plan scheme; IS – intervention on facade

**Learning Outcomes

KNOWLEDGE

K1 – Collect knowledge in sustainable (green) design
K2 – Recognize green buildings assessment methods
K3 – Examine local traditional architecture
K4 - Distinguish conservation techniques
K5 – Present green building design solutions

COGNITIVE AND PRACTICAL SKILLS

CS1 – Apply green design concepts to solve practical problems
CS2 – Demonstrate the ability of green buildings assessment
CS3 – Contribute to the recognition of local traditional architecture by the community
CS4 – Contribute to the heritage conservation
CS5 – Effectively utilize life-long learning skills to promote sustainable design

GENERAL COMPETENCIES

GC1- Understand the importance of country sustainable development
GC2 - Motivate the community to build green buildings
GC3 - Stimulate traditional architecture employment
GC4 - Inspire conservation of built heritage
GC5 - Encourage community for green design

The assessment methods applied to evaluate the learning outcomes are: Stage 1 (S1); Stage 2 (S2); Stage 3 (S3); Stage 4 (S4); Intervention to the original plan scheme (IPS); Intervention to the original façade (IF) and level of performance improvement (PI).

4 Course STIA – Green Design Description

As mentioned above STIA - Green Design course, which has been first offered in Spring semester 2014 - 2015 and is currently running in Spring 2016 – 2017, is three credit hours.

The course introduces Green building design as an indispensible mechanism for efficient resources consumption. The terms such as sustainability and ecology are studied. Building green rating systems as well as green buildings evaluation methods are introduced. The course also educates students in build cultural heritage conservation with the emphasis on green methods application. The students study local traditional construction techniques, materials and legislation on heritage conservation.

The course combines theoretical and practical modules, wherein the learning outcomes of the theoretical module are assessed through quizzes and a midterm exam. The final project of the course, where the studied theory is practically applied, assesses both modules – theoretical and practical.

4.1 Final Project Description

The aim of the final project given to the students for the course STIA – Green Design was to apply the gathered theoretical knowledge in green design and built heritage conservation methods on a real-world project. The students were requested to suggest a green conservation method for an old traditional residence. The dwelling, which was selected for the project is in Al Haffah district of Salalah city, Dhofar region of Sultanate of Oman. Al Haffah is an old area of the city situated on the coast of the Arabian Sea and consists of old residences and a traditional souk (Figure 1).

The project was divided into four stages: 1) Building's study (S1 - group work); 2) Building's drawings production (S2 - group work); 3) Building's assessment (S3 - group work); and 4) Building green conservation (S4 - individual work). For the first stage (Building study) - literature and site survey was executed: the architecture of the Dhofar region and Al Mahrah style (a region of Yemen), local climate and local traditional construction materials and techniques, conservation methods and legislations were studied, the building was measured, its examination executed (physical conditions, construction materials and techniques and architectural features) and documented.

Fig. 1 Al Haffah traditional residences

The second stage of the project resulted with building's drawings - original plans, elevations, sections (scale 1:50), 3Ds, façade attributes (scale 1:10) and construction details (scale 1:5).

During the third stage the dwelling was assessed according to the following criteria: a) site; b) energy efficiency – passive techniques (thermal mass, solar orientation, surface to volume ration, insulation, and ventilation); c) water efficiency; d) indoor air quality; e) materials (quality and effective use).

At the forth (final) stage of the project each student suggested a method of green conservation – dwelling re-use via restoration and its systems design for comfort improvement and water, energy and materials efficiency.

By the end of the project students were asked to present their design and green conservation solution along the list of interventions to the plan scheme and façade and new systems for building performance improvement.

4.2.1 Students works

Stage 1 – Building study

Local traditional houses Description. The old residential buildings of Haffa area are nearly one century old and follow Al Mahrah architectural style. They are one or two-storied (rarely three), and usually built around the inner courtyard. Each floor of the residence is named differently according to its function e.g. the ground level is called Bakhkhar, the first – Ghafat, the second – Gasr, and the last, which is a roof terrace, - Rawshan [14].

The selected dwelling is composed of two levels – Bakhkhar and Rawshan. The Bakhkhar, which is the ground level and higher than the upper ones,

houses public spaces such majlees (male reception room), workshops and private spaces such as multipurpose rooms (utilized as family bedrooms), sallah (living room), kitchen and storage rooms. The first level (roof terrace), which is named Rawshan, is an expansion of house living area and houses three multipurpose rooms (bed rooms), an unroofed toilet and an open terrace used by inhabitants for lounging in the afternoons and evenings (Figure 2).

Fig.2 Dwelling exterior view – street façade

Fig. 3 Dwelling interior spaces

Selected Dwelling attributes (See figures 2 & 3 exterior and interior views):
Geographical location - 17° 1' 3" North, 54° 4' 58" East.
Architectural style - Al Mahrah
Year – 1st half of 20th century
Number of floors – 2
Courtyard – inner
Occupancy – abandoned
Construction materials – lime stone walls, compacted earth floor, multilayered ceiling and roof (wooden beams, palm fronts, coconut fiber, sand and plaster), exterior and interior plaster (local traditional plaster – nurah), wooden beams at openings, wooden locally carved windows and doors.
Physical condition – bad (partially ruined).

Stage 2 – Building's drawings

The building original layout, which was produced by students as a group work (after the site measurements) is shown by figure 4.

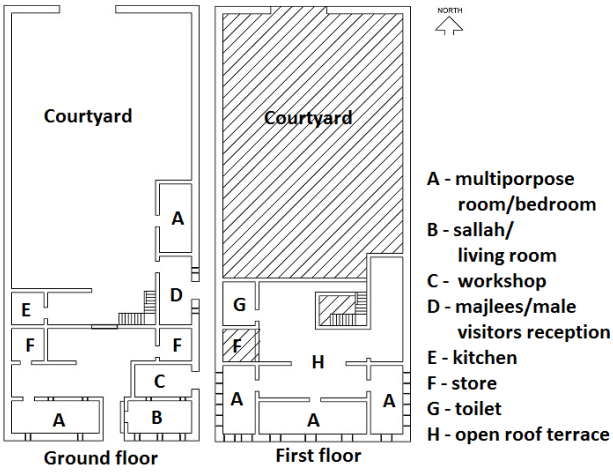

Fig.4 Ground and first floor - original plans

Stage 3 – Building's assessment

Table 2 demonstrates the summary of the building's performance assessment.

Table 2 Building green assessment.

	№	Evaluation		Suggestions
Criteria	a	Sun path	P	
		Wind direction	P	Front courtyard or tall trees
		Spaces location – day/night activities	P	
	b(1)	Thermal mass	P	
		Absorber	P	
		Control	A	Overhangs
		Aperture	P	
		Distribution	A	Improve air circulation
		Surface to volume ratio	P	
	b(2)	Active techniques	N	Mechanical ventilation Alternative source of energy
	c	Water well	N	Hot and cold water supply Grey water reuse Rain water harvesting Water saving appliances and fixtures Solar water heater
	d	Indoor air quality	N	Improve ventilation Dust control
	e	Materials	P	

*Abbreviations: P – positive; A – average; N - negative

The performance of the building was assessed according to the criteria: a) site; b) energy efficiency (b1-passive techniques and b2-active techniques); c) water efficiency; d) indoor air quality and e) materials. Each of the criteria and its attributes was evaluated as positive (P), average (A) or negative (N). For the criteria or attributes with average or negative score, suggestions for its improvement were given, which were further considered during the design stage.

Stage 4 – Dwelling green conservation – design solutions by students

Article 5 of the International Council of Monument and Sites (ICOMOS) Venice charter [15] states that the conservation of built heritage is facilitated by making use of it for social purpose. Such use is, therefore, acceptable if doesn't add changes to the original layout or façade's attributes and decoration. No new construction, demolition or modification, which would alter the relations of mass and color, must be allowed states ICOMOS Article 6 [15]. The ICOMOS Charter on the Built Vernacular Heritage [16] requires that in case of vernacular structure adaptation (reuse) its integrity, character and form is kept. On the other hand, the structure should be brought to the condition to be compatible with acceptable contemporary standards of living.

Figures 5, 6, 7 and 8 show building green conservation design solutions, which were produced by the students.

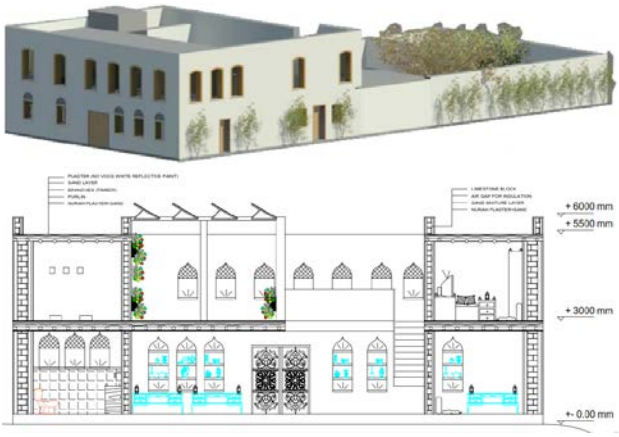

Fig.5 Green conservation solution №1 - 3D and section, design by Nusrath Mozumber (project 1)

As required by ICOMOS Article 5 [15], students suggested as conservation method for the old traditional residence – adaptation (compatible use), wherein the function remains the same.

Fig.6 Green conservation solution №2 - 3D and section, design by Sharifa Al Shanfari (project 2)

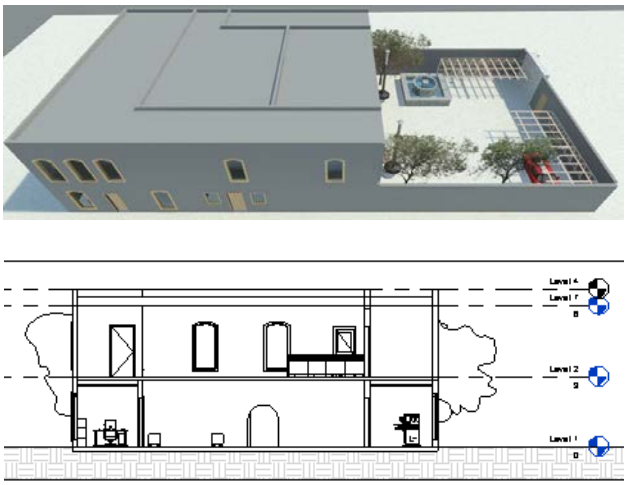

Fig.7 Green conservation solution №3 - 3D and section, design by Alia Fadhil (project 3)

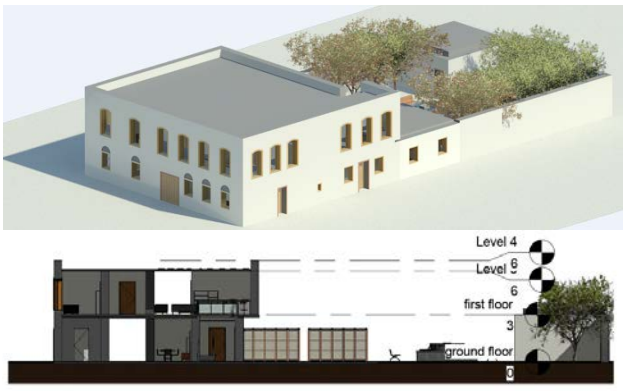

Fig.8 Green conservation solution №4 - 3D and section, design by Abir Bakhit (project 4)

Students' design solutions also respect ICOMOS Article 6 [15] and suggest for reconstruction application of identical materials and construction methods. The building was brought to the conditions that are compatible with contemporary standards of living as requested by ICOMOS Charter on the Built Vernacular Heritage [16]. For comfort improvement, new building systems were suggested.

The result of Table 2 were used to identify the areas of building's performance and comfort improvement. For criteria evaluated as 'negative' or 'average' new design solutions were suggested. Some of the suggested by students' green solutions are: a) site – water well as fountain and surround pool, trees, shading devises, outdoor sitting area, parking; b) energy efficiency – triple glassed windows with reflective coating, wait paint of the roof, solar water heater, PV panels, LED lights, energy efficient home appliances; c) water efficiency – water supply and distribution system (which was not available), rain water harvesting system, grey water domestic treatment, water saving plumbing features; d) indoor air quality – exhaust fans for better air circulation and ventilation; e) materials – to be kept as original.

Consequently, four solutions for dwelling green conservation were presented for the jury by the end of the semester.

5 Discussions

According to the Quality Assurance Agency for Higher Education, UK [4] the methods of assessment of the course learning outcomes should be aligned to the HE institution's graduates' attributes and be appropriate to reflect the outcomes students are expected to achieve.

The learning outcomes of the final project of the course STIA – Green Design, as mentioned in sub-chapter 3.2, were aligned to the course's learning outcomes, which are aligned to the university graduates' attributes. The assessment methods of the course's final project learning outcomes are shown in table 1, wherein each of the assessment methods – 1) Building's study (S1); 2) Building's drawings production (S2); 3) Building's green assessment (S3); 4) Building's green conservation (S4); 5) Performance improvement (PI); 6) Intervention on plan scheme (IPS); and 7) Intervention on façade (IS) – were evaluated against the three criteria: a) knowledge; b) cognitive and practical skills; and c) general competencies.

Table 1 shows that in the category of knowledge students have attained acquaintance in green/sustainable design (K1), green building assessment methods (K2), and green building design (K5). In the category of cognitive and practical skills students practiced in: green design concepts application for practical problems solving (CS1), green building assessment (CS2); effective utilization of life-long learning skills for sustainable design promotion (CS5). As general competencies, the students were trained to: understand the importance of county sustainable development (GC1), motivate the community for shifting to green buildings (GC2).

Table 3 Students' projects assessment according to the level of interventions

	Interventions	Level of interventions (Students projects)			
		1	2	3	4
Interventions to the original plan	Original plan conservation	VL	VL	M	VL
	Original structure conservation	VL	VL	VL	VL
	Original construction materials conservation	NI	NI	VL	NI
	Modern addition to the structure	NI	VL	VL	NI
	Application of modern materials	NI	VL	VL	NI
Interventions to the original facade	Original façade features conservation	VL	VL	M	VL
	Original floors and façade heights conservation	VL	VL	VL	VL
	Original façade materials conservation	NI	VL	VL	VL
	Modern addition to the structure resulting in original façade view change	VL	VL	VL	VL
	Application of the modern materials	VL	VL	VL	VL

Abbreviation
NI – no interventions
VL – almost no interventions
L – low level of intervention
M – medium level of interventions
H – high level of interventions
VH – very high level of interventions

The course and its final project also provided students with an opportunity to gain a) knowledge in heritage and local traditional architecture (K1), heritage green conservation (K4, K5); b) cognitive and practical skills in contribution to the recognition by the community of local traditional architecture (CS3), heritage conservation (CS4) and utilization of life-long learning skills to promote sustainable design (CS5); and general competencies in community stimulation to employ traditional

architecture (GC3), and community inspiration for green built heritage conservation (GC4, GC5).

The respect to the heritage conservation legislation (the level of interventions) assessment is shown Table 3. Students green conservation projects' assessment according to level of intervention shows that the interventions to the original building's plan scheme, façade, structure, materials, features are moderate, very low or there are no any interventions. As table 3 demonstrates there are no any (or very low level of interventions) modern materials applied. Also, the building's layout (plan), façade height, visual appearance and façade features were kept as original once.

Students green conservation projects' assessment according to building's performance improvement shows the areas of enhancement are: energy efficiency through passive design and application of active techniques; water efficiency; indoor air quality; and general comfort conditions (Table 4).

Table 4 Students' projects assessment according to the building performance improvement

Improvements	**Level of improvements**			
	Students projects			
	1	2	3	4
Energy efficiency – passive techniques	M	H	M	L
Energy efficiency – active techniques	H	H	H	H
Water efficiency	H	H	M	M
Indoor air quality	H	H	H	H
Comfort	H	H	H	H

Abbreviation
NI – no any improvement
L – low level of improvement
M – medium level of improvement
H – high level of improvement

6 Conclusion

This study showed that through the course of STIA – Green Design the students were trained in the field of sustainability and green methods of heritage conservation and learned to respect their country's cultural heritage. Furthermore, they understood that cultural heritage conservation is an integral part of country's sustainable development

The assessment of the course's learning outcomes demonstrated that the course has contributed to the students' knowledge, cognitive skills and general competencies improvement in the domains of 1) global citizenship - students were trained to think globally, and to consider individuals/communities' decisions and actions' consequences on communities'/world's societies, economy and environment; 2) environmental stewardship – students can understand and manage the physical environment and consider the social and environmental impact of their managing and planning actions; 3) social justice, ethics and wellbeing – students are competent to consider the individual as a part of the whole local and global communities; and 4) future-thinking - students developed future vison and consider individuals/communities' consequences of social, economic and environmental decisions and actions on the present and also future societies.

Additionally, by the end of the semester students have developed the following skills: a) capability to formulate problems and develop critical thinking for problems solving; b) ability to apply knowledge and skills in the domain of sustainable development and green heritage conservation to real-world problems;
c) understanding of the relationship between their major and sustainable development;
d) aptitude of life-learning that encourage future achievements in the areas of values, attributes and behaviors for sustainable development.

The results showed that integration of sustainable development domain into the plan of study or 'greening the curriculum' enable HE Institutions to graduates young people that are equipped with knowledge and practical skills in corresponding field and trained for life learning are capable of continuous self-improvement. Consequently, graduates with such potentials can recognize their responsibilities as leaders and creators of the future sustainable societies. This new generation with future oriented vision will change the demographics and boost the process of sustainable development.

The integrations of green courses into the plan of study is gradually changing the orientation of the HE institutions' education system towards sustainability, nevertheless is a long-term process [17]. Though, the integration of sustainability doctrines into each course of the curriculum will speed up this process. The changes in HE institutions' orientation towards sustainable development will generate changes in communities and transform them into socially, economically and environmentally sustainable.

Acknowledgement

The author thanks her students Abir Bakhit, Nusrath Mozumber, Sharifa Al Shanfari and Alia Fadhil, who had registered and successfully completed the course Special Topics in Architecture – Green Design that was studied in this article, for all the time and effort they put to comprehend green built heritage conservation and contribute to the country sustainable development.

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