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Education for Sustainable Architecture in Asian Countries

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Abstract: The architectural education is a key factor in the re-thinking of the whole industry towards a system of more sustainable buildings and cities. While in the professional world the development of green assessment tools and new professional fields of specialization are a fact, the schools of architecture at undergraduate level have still to struggle against an established academic tradition balanced towards design and aesthetics. Even though the sustainable city movement requests a global effort, regional idiosyncrasies call for local specific approaches to the problem, and generates regionally applicable solutions pulling from local wisdom, knowledge and experience taking climate, culture, resources and technology into account. Especially, Asia is urbanizing with high-density systems more rapidly than any other area in the world, a fact that demonstrates a substantial difference with the West. It is necessary to educate professionals who have well balanced and integrated knowledge of local issues and global standards. Therefore this paper focuses on the education for sustainable architecture in Asian countries, especially Japan, China,

Malaysia, Hong-Kong, Korea, and Singapore. The study is exploratory, digging into the curricula of selected influential schools, comparing them in regards of their methods and degrees of implementation of sustainability education. The results are very heterogeneous, ranging from the provision of a few isolated courses in the upper years to a systematic approach from the first semester. However we are far from finding a final perfect system, the this paper study finds useful references and suggests ways of integrating the spare solutions researched into a more complete approach, with further study and effort still necessary to update the current systems, to make them more efficient and realistic, while keeping the personality and uniqueness of each urban culture and school.

Keywords: Sustainable education; integration; green urban culture; cultural sustainability; local wisdom; sustainable urban culture in Asian countries.

1. Introduction

The architectural education is a key factor in the re-thinking of the whole industry towards a system of more sustainable buildings and cities. While in the professional world the development of green assessment tools and new professional fields of specialization are a fact, the schools of architecture at undergraduate level have still to struggle against an established academic tradition balanced towards design and aesthetics. Even though the sustainable city movement requests a global effort, regional idiosyncrasies call for local specific approaches to the problem, and generates regionally applicable solutions pulling from local wisdom, knowledge and experience taking climate, culture, resources and technology into account. Especially, Asia is urbanizing with high-density systems more rapidly than any other area in the world, a fact that demonstrates a substantial difference with the West. It is necessary to educate professionals who have well balanced and integrated knowledge of local issues and global standards. Therefore this paper focuses on the education for sustainable architecture in Asian countries, especially Japan, China, Malaysia, Hong-Kong, Korea, and Singapore. The study is exploratory, digging into the curricula of selected influential schools, comparing them in regards of their methods and degrees of implementation of sustainability education, in order to extract a better understanding on the uniqueness of that geographical and cultural context, together with possible educational practices or strategies that can be adapted to improve general sustainable education.

2. Methods

2.1. Scope and selection of schools.

As a first approach we selected a variety of countries of East Asia, but in an area reduced enough to be able to compare results. Language was an important factor on the choice, as apart from the Korean language (native of most of the co-authors here) English helps consulting documents more easily. Hong-Kong and Singapore were almost obvious choices due to their strong cultural and economic influence in the whole region, not only for the language. Malaysia is especially interesting for its unique multi-cultural and multi ethnic environment. Japan and China proved the most challenging, as

most information is provided in their national languages. However we felt them essential for the understanding of the region, so we made a special effort to include them.

Only one leading school of each country was selected, in order to keep this study compact, and also as national idiosyncrasies were expected to have more relevance than differences among schools of the same country. The University of Tokyo in Japan and Tsinghua University in Beijing were chosen due to their long tradition, especially the former one, and leading role in their respective countries. In Malaysia, Malaya University was chosen as the most influential and the one with the longest tradition, as well as their fair information in English. In Korea we chose the University of Seoul UOS, instead of the apparently more obvious Seoul National University, as the former one has a leading role in Korea, been more innovative and pioneering the implementation of sustainable and professional programs. Finally The Chinese University of Hong-Kong CUHK and The National University of Singapore NUS were chosen to complete the subject of this study.

One problem we faced was the different undergraduate systems, which ranged from the 3 year program in Malaya University, to the 4 year in Japan, CUHK and NUS, the dual 4 and 5 year programs in Tsinghua, and the 5 year program in UOS. We decided to study only the undergraduate Bachelor degrees, and within them we stressed the mandatory courses over the optional. This may be a disadvantage towards Malaya University, but for the sake of consistency we left out all the Master programs, as the concern of this paper is the basic and general professional Architectural education.

2.2. Information sources, data collection, research method.

The present study is preliminary and exploratory, and due to its wide extent, the data collection has been based on the published syllabus of the respective schools. Where published material has been insufficient (Malaya University, University of Seoul, CUHK and NUS), personal direct inquiries to their faculty provided the necessary data. In all cases it is the official study plan that has been taken as reference, taking out of consideration possible alterations and variations introduced in individual courses by their respective professors.

To make data collection homogeneous, the research was based on four questions, and a short report on each university was done based on them. The texts do not reply the questions explicitly, but provide the information asked in them. These questions were:

- a. General Introduction of the School;
- b. specific courses on sustainability;
- c. other courses with sustainability considerations;
- d. where possible, in which years are these courses taught;
- e. the scope of the courses, whether they are basic or conceptual understanding (i.e. theory, case studies), instrumental (i.e. calculations, simulations) or design (i.e. integration in design, implementation of sustainability strategies and methods in the design process, etc); and
- f. a brief conclusion on the outstanding and unique features of each school, and the potential downsides if any.

3. Results and Discussion

3.1. The University of Tokyo.

Tokyo University has the longest tradition on the modern teaching of Architecture in Japan, where the British Professor Josiah Conder (1852-1920) was appointed in 1877 to organize a curriculum following the RIBA model within the frame of the College of Engineering founded in 1873 [1]. He is still today respectfully reminded as *Conder-Sensei, father of the Architecture School*, and his sculpture stands in front of the Engineering Building I, where the Department of Architecture sits today [2]. Even though the origin of the curriculum was shaped after the British model, the long history of the School has progressively shaped it in the Japanese way of perfecting and adapting until creating a unique result. Today the department of Architecture still belongs to the College of Engineering, and still keeps the tradition of a holistic architectural teaching, where design and technology are not separated into different fields. The Undergraduate program is four years long. Of these, specialized architectural teaching is concentrated in two years (second year second semester, third year, and fourth year first semester). The first three semesters being general education and the last fourth year semester being dedicated to the graduation thesis and project [3, 4].

The short and intensive educational approach of Tokyo University allows for a very well balanced and wide acquisition of skills and knowledge, at the cost of depth. The more specialized and deep approach is developed in the Graduate School. However in this research we concentrate in the undergraduate program, as it is there where the common and general education is provided, independently of the further individual interest and specializations.

Regarding the specific courses, there is not any specialized one dedicated to sustainability. It is remarkable however that here are many courses on environmental technologies (general theory of environmental technologies and services are studied in the second year; specialized courses —light, sound, thermal, water environmental technologies—, and practical courses follow in the third year; Environmental systems theory, and environmental systems design and planning studio are in the fourth year). There is also one course on architectural integrated studio in the second year.

Recycling/reusing and material related issues are addressed in the architectural materials (introduction to materials in second year, science of materials and practical applications in third year) and construction courses (construction in third year, and assemblies in fourth year)

Apart from the specialized courses, many of the professors teaching design, structures, construction, urbanism and environment technology include sustainability topics in their personal research and graduate programs. Therefore they often make reference to sustainable issues within their own field of study.

One remarkable fact is the way the curriculum includes theory, planning, design, practical studio, and architectural projects and drafting studio (the equivalent to the universal “Architectural Design Studio”, with a clear emphasis on the importance on the graphic production and expression skills). Architectural Projects and Drafting Studio is the backbone, with somewhere between nine and fourteen weekly hours. It is also remarkable that most theory courses have corresponding practical studios, so the students not only get understanding but practical application skills. It would be necessary to see the

real development and students' works of these studios, to appreciate the real level of integration of the learned environmental technologies in their own design work.

One outstanding fact of this university approach is the way theory and practice work is well balanced, achieving well beyond mere awareness or understanding, and making sure students graduate will all basic conceptual understanding and engineering and practical skills.

On the other side urban studies are weaker, as they have only one short course on planning and one on modern urban history. In architectural project and drafting studio they address also design and sustainability issues at urban scale, however urban theories are comparatively reduced in favor of the technological/engineering approach.

The case of Tokyo University is very unique, with its very intensive and concentrated approach. The positive side is the way in which the theoretical and practical courses are balanced and alternated, so theoretical understanding, application exercising and design implementation are carried together. One issue is the emphasis on the technological approach to environmental issues, being the urban and social issues more marginal. Other negative side is that this may be very extenuating to students. However the short time helps having the courses fresh, preventing the usual "forget after the exam", as they are exercising and expanding continually in the following courses. Altogether, integration and connection between fields seems easier and more natural than in longer and more divided programs.

3.2. Tsinghua University

The School of Architecture of Tsinghua University was established in 1946, just after the World War. It offered originally two undergraduate professional programs of 5 and 6 years respectively. In 1952 Tsinghua University became a Polytechnic institution, centered in Technology and Engineering. In 1992 it received the National Accreditation as a professional school, adapting consequently its program into a 5 year degree of Bachelor in Architecture BArch, with a total of 200 credits. In 2001 they opened a second undergraduate degree of 4 years as Bachelor of Engineering in Architectural Design, BEngArch, with a total of 175 credits. Both programs have the same core, being the 5th year where more specialized courses lead to the upper BArch degree. For this study we concentrate in the 5 year BArch program [5].

The School published curricula provides detailed information on the curses and the main thematic areas in which they are divided, although there is no information on the years in which they are located [6]. There thematic areas are Design Studio, Architectural Theory and History, Urban Planning Theory, Landscape Architecture and Theory, Building Science and technology, Architectural Arts and Visual Arts, and Professional Practice.

The teaching backbone is the design studio, with a total of seven general design courses, plus four additional specialized studios in Landscape, Urban design, Residential Planning and Design and Design. These courses treat different scales, urban settings and typologies, but the implementation of sustainable strategies and techniques for design is marginal, being traditional design quality the main concern.

Within the Architectural Design Theory there are two courses that explicitly address sustainability. The main one is the entitled Principles of Sustainable Architecture, planned in an introductory and conceptual way in three main areas, the first being the historical context of the sustainability theories

and practice, the second being the principles of ecological construction, and the understanding of environmental issues related to water, sound, energy and renewables, and the third being centered on western case studies. Interestingly, the School also owns an ecological rural house in Zhangjiang, where students can experience firsthand what they studied in a practical way. The second course worth mentioning is the entitled Traditional Dwellings and Vernacular Architecture, very much in the point in a country of such a rich and vast architectural culture and tradition. This course stresses mainly the environmental and ecological wisdom of the diverse traditions, with an emphasis on the understanding of the underlying ecological concepts that can be applied in contemporary design.

In the field of Landscape Theory, the course of Introduction to Landscape Architecture stresses also the ecological side of the landscape design, having the theories of Mc Harg as a reference for ecological design and planning.

Finally we find instrumental and conceptual teachings in the technical field. The Introduction to Architectural technology keeps an eye on the environmental and material issues. Three specialized courses on Architectural Acoustics, Thermal Environment and Luminous Environment, provide students with both concepts and tools for numerical calculations and simulations.

In general Tsinghua School of Architecture approach to sustainability seems systematic and quite complete in the theory side, dealing with social, cultural, environmental, energy and design issues conceptual understanding, with the provision of instrumental techniques for environmental calculations and simulations. On the other side there is an apparent division between the theory learned and its application in the architectural design studios, where we find only side references to the environmental conditions, with the risk of conceiving sustainable design as an a posteriori add on, losing the opportunity of a real integration.

3.3. Malaya University

The University of Malaya or UM is Malaysia's oldest university. Situated in the Capital city of Kuala Lumpur, it was established in 1948. UM Architecture is integrated in the Faculty of Built Environment. It offers a 3 year (each year divided in 3 periods, S1, S2 and S3) undergraduate program leading to the Bachelor of Science Architecture BSc Arch, comprising a total of 120 teaching credits. The school offers also MArch and MSc programs, accredited by RIBA (Part II) and LAM (Malaysian Board of Architecture) [7].

The Undergraduate program is structured with Design Studio as its main backbone, with side courses on technology and environment on one side, and culture and practice on the other. There is not any specialized course on sustainability.

In the technology courses, basic environmental issues regarding materials, environment and construction is addressed in the first year (Two courses on Materials and Construction Technology in S1 and S2), together with Environmental technology (Environmental Physics in S1, and Architecture Light and Acoustics in S2). In the second year students learn about specific Building Services (S2). Although not specifically stated as sustainable issue, the curriculum has courses on multicultural and social issues, also a very unique aspect of Malayan culture that makes students more aware of the cultural and social side of architecture. This aspect is seldom seen as a full course in other schools.

The early introduction to the theory allows to integrate sustainable requirements right after as basic requirement in the design studios. For example, Advanced Design Studio in 4th year studies sustainable design in High Rise and Low technology, demonstrating a genuine concern for realistic confrontation of the local needs for high density urbanization reducing as possible the dependency on energy hungry high technology solutions, and reducing as possible the impact in the natural environment.

The three year program may seem short on depth, with wider and deeper study of sustainable issues desired. However the interest of Malaya's system is the embedding the students with the environmental concerns from the very first day, trying to achieve a clear conceptual understanding, and apply it right away in the design work. Furthermore, Malay is unique in the strong addressing of the cultural and social issues of the country, providing students with an awareness that for many other schools is marginally treated.

3.4. Chinese University of Hong-Kong

The Chinese University of Hong Kong (CHUK) is the second oldest institution of Hong Kong founded in 1963 during the British Colonial era [8]. Overall it followed the British system 3+2 years (BSSc + MArch in the case of Architecture), but in 2012 due to a general educational reform in Hong Kong, it changed to a longer 4+2 year system [9].

In this background, the professional Program in Architecture of CHUK also changed from an original 3+2 program equivalent to the RIBA Part 1 and part 2, with a total of 75 units, into an also two degree sequence of 4 + 2 years, with a total of 78 units. This addition offers freshmen students a more flexible learning experience in their first year. The School of Architecture of CHUK belongs to the faculty of Social Science. Therefore the two degree are called Bachelor of Social Science in Architectural Studies or BSSc (AS), and Master of Architecture or MArch. The program is professionally accredited by the Hong Kong Institute of Architects (HKIA) and the Architects Registration Board of Hong Kong (ARB) with the University of Hong Kong [10].

The undergraduate curriculum is composed tightly with core-studies in different subject areas [11]. Therefore, at undergraduate level there are no specific courses related to sustainability, although the environmental issues are included in some of them.

The more deep and specialized courses in Sustainability are reserved to the Graduate MSc, offering programs in 'Sustainable and Environmental Design', 'Architectural Conservation and Design' and 'Urban Design' specializing in Sustainability.

In the BSSc (AS) there are two courses dealing with environmental issues and one additional course integrating environmental technology among other subjects.

In the third year, *Building Technology III (Environmental Technology)* introduces the fundamental concepts of passive environmental design. The students learn about the effect on buildings and their occupants of environmental conditions of light, temperature, air movement, and sound. Case studies are used to review both traditional and current approaches of representative building types in more depth. In the same semester, *Design Studio [U4]* under the topic of Structure & Passive Environmental Design, focuses on the impact of natural forces, tools for measuring design performance, sustainability

in architecture, urban design and conservation, design of sustainable and energy efficient human environments. There is also one course on *Building Systems Integration* in the fourth year. This course combines fundamental topics covered in the building technology sequence of materials and construction, building structures, and environmental technology with the objective to provide a holistic overview of the integration of building systems in the design and construction process. It includes several weeks focused on zero energy design strategies.

All three courses are mainly focused on Environment, emphasizing the passive strategy.

There are two more courses that include environmental and sustainable issues, even though they are not specific of that field:

Introduction to Building Technology: The primitive environment technology is introduced as well as construction and structure. It makes emphasis on climate, comfort and passive strategies. *Land and City*: In one of its three modules, 'urban sustainability' introduces theories and practices associated with sustainable urban design and development.

In summary, the Chinese University of Hong Kong (CHUK) has an accredited professional degree equivalent to UK's RIBA. Currently, it is organized as a two-degree sequence, 4+2 years (BSSc + MArch). The undergraduate program provides general core-studies in general subjects, without special emphasis in Sustainability, while it is in the graduate programs where more specialized subjects in Sustainability are offered.

The positive side of this approach is that the theory and design courses focused on passive environmental design are in the same semester of year 3, so theoretical understanding, application, exercising and design implementation are carried at the same time. Also, in year 4, sustainability is studied in integration with various subject areas.

One weak side is the lack of specific sustainability courses at undergraduate level.

A second weakness is that the courses related to sustainability are mainly focused on environmental technology and design, especially passive strategies, with less emphasis other important areas of sustainability.

3.5. National University of Singapore

The National University of Singapore (NUS) is the oldest higher learning institute in Singapore, founded in 1905. NUS adopts features of the British system, such as small group teaching (tutorials) together with features of the American system (course credits). The original architectural program was first established in 1958, consolidated into a full program in the University of Singapore in 1969 [12]. In its current organization after 2006 renovation of the programs, NUS Architecture offers a 4-Year Bachelor of Arts in Architecture (Honors) program with 160 course units as the first Architectural degree, BA (Arch) Hons. It comprises a general program accompanied by four tracks for specialization: Architectural Design (AD), Design Technology & Sustainability (DTS), Landscape Architecture (LA) and Urban Planning (UP). The curriculum for the first three years (Levels 1, 2 and 3) is common, with the specialization modules offered at the fourth year level. The B.A.(Arch) program is accredited by the Royal Institute of Architects (RIBA) to Part One standard.

The M.Arch program course completes the professional education with an additional year, and is RIBA Part Two accredited. In order to eventually register as an architect with the Board of Architects, Singapore BA(Arch) Hons. graduates must complete the M.Arch degree [13, 14].

Sustainability mandatory courses are included across freshmen to junior curriculum in common education. After that, in Level 4 only students in DTS track will receive more specialized sustainability courses. The general courses are organized in four segments, i.e. Design & Design Lectures, History Theory & Criticism, Urban Studies, and Technology & Environment. The common sustainability courses are a part of the Technology & Environment segment. In Level 4, DTS students receive their sustainability courses under the segment of Design. Throughout the core courses, students learn the principle of sustainability, both passive and active methods with technology, and simulations which can be practiced in real life. Comprehensive sustainability is also discussed in classes. Students experience how the theory is realized in real design by practice.

The core sustainability learning starts with the principles of passive design in Level 1. In the Level 2 the teaching focuses on strategies for environmental design in order to achieve sustainability objectives via integrated design process. Finally in Level 3 students concentrate on sustainability-in-practice to promote critical understanding of problems of sustainability in the built environment in their full complexity.

In the Level 4, under the DTS specialized track, the design application is treated in the studio and theory curriculum. For instance, the 1st semester design studio class covers the opportunity to learn design detailing, technological development and resolution of architectural schemes. The 2nd semester design studio class allows students to employ digital design processes to simulate building performance impact on building form and configuration as an interactive design process in the development and study of optimal solutions.

Regarding specific courses, in the first year, *Climate Responsive Architecture* introduces the principles of environmental responsive architecture, focusing on passive mode and other low energy design strategies for architecture in the various climates. Topics included address the impact of sun, daylight, wind, and rain on architectural design. The module enables students to formulate holistic approaches in generating design solutions.

In the second year, *Strategies for Sustainable Architecture* deals with topics in sustainable architecture. It takes an interdisciplinary and socio-technical approach —focusing not only on technological and environmental issues but also the social, cultural and historical dimensions— to sustainability and the built environment. It also takes on international perspectives by examining and comparing the diverse practices of sustainable architectures in various Western and non-Western, developed and developing countries.

In the third year, *Environmental System & Construction* introduces fundamental building physics (thermal, lighting, acoustics), building materials, and systems to achieve environmental performance-targets and sustainability. Technology integration is emphasized via understanding how materials and systems are related, detailed, and assembled. It deals with quantitative means to evaluate environmental requirements, and develop familiarity with system strategies and construction details to integrate the various building systems (such as structure, mechanical and electric services, architecture exteriors and interiors). The goal is to integrate those technologies in a symbiotic manner to achieve human well-being.

In the fourth year, *Integrated Design & Sustainability* provides an in-depth understanding on the principles, systems and strategic framework that are essential in an integrated design approach to achieve a sustainable architecture. It is aimed at enabling students to have a holistic insight and forming strategies for managing design information and resources to facilitate an integrated design development. The module addresses issues and strategic implications of integrated design, benchmarkings, building performance assessment, design documentation and systems cum material specifications have on the outcome of the sustainable design intent. The design principles of sustainability and practice of technologies are learnt in the design studio classes as well. In the fourth year 1st semester, *Architectural & Technology Design 1* studio aims to provide the students with an opportunity to learn design detailing, technological development. In the fourth year 2nd semester, *Architectural & Technology Design 2* studio allows the students to employ digital design processes to simulate building performance impact on building form and configuration as an interactive design process in the development and study of optimal solutions [14].

In several other courses, Sustainable issues are introduced such as the following: *Theory of urban design & Planning*: In this course, social aspect of sustainability is dealt in terms of Urban Life, Street life, socio - cultural aspects. Also, this course covers Conservation & Revitalization issues in urban design and Urban Ecology & sustainable city. *Architecture, Structure and Construction*: In this course, the principles of construction in Architecture are explained and the possibilities for sustainable solutions in Design are explored [15].

As a summary, this university general approach is the way theory and practice work is well balanced, achieving well beyond mere awareness or understanding and critical thinking on sustainability. Also the school emphasize in technological integration and its application to design to achieve sustainability. Sustainability is dealt with in detail levels. Various technologies and their application in architecture, e.g. details, systems, are covered in the classes, both quantitatively and qualitatively alike. The design studios of senior students provides both creative and holistic approach to sustainability, e.g. (This proves that there is a great difference from general architecture education, where mechanical or renewable energy solutions are the only topics for low-energy buildings). Sustainability courses are included across freshman to senior curriculum. Only senior students of Design Technology and Sustainability Specialization can complete three more specialized sustainability courses.

It is a great advantage that students learn the principle of sustainability, both passive and active methods with technology, and simulations which can be practiced in real life. Comprehensive sustainability is also discussed in classes. Students experiences how the theory is realized in real design by practice. Also the techniques studied are well suited to the peculiarity of Singapore climate, where a good understanding of the nature and passive strategies can greatly reduce the dependence on energy and technology. While the sustainable issues are covered in a systematical manner, senior students, only who are specialized in Design Technology & Sustainability, can learn the topics. However, students in the Design & General Programs do not have the sustainable courses in their senior studio classes, which we find a disadvantage as it is not clear the advantage of radically separating the sustainability expert as a separate professional. Nevertheless, the sustainability education of NUS is well designed to tap into the sustainability issues in the south Asian regions,

understanding economies, tropical climates, and histories. This shows that NUS does not simply adopt western education programs, but localize the programs, unique for their geographical characteristics and cultures [16].

3.6. University of Seoul

The School of Architecture of the University of Seoul (UOS) was founded in 1975, as a Department of Architectural Engineering, which was the usual in Korea during the fast developing years. It belongs to the College of Urban Sciences. It is one of the two public Architectural Schools in Seoul, belonging to the Metropolitan Government of the same city (The other being Seoul National University). In 2000 the department pioneered its splitting in two departments, Architectural Design, which became a 5 year undergraduate program in 2002, and Architectural Engineering which kept the original 4 year undergraduate program. Most Schools in Korea today follow the same format. UOS Architecture was also pioneer in professional accreditation, being the first Korean School accredited in 2007 by the KAAB (Korean Architectural Accreditation Board). UOS Architecture keeps its leading role in innovating and actively improving students excellency in design and technical matters, together with environmental consciousness and tools, and social and economic training. Also they remark their fluid connection with the other Urban Sciences departments, as Engineering, Urban Science and Landscape [17].

The sustainability training has its core between the 3rd and 4th year. Theory is extensively taught in a dedicated course (Sustainable Architecture) in the 3rd year, comprising a complete overview of theories, tools and strategies to apply to a wide range of issues, from climate and materials, to health, environment, energy and design assessment tools.

The 4th year completes the technological training with a semester of Environmental Technologies, completing the conceptual part with specific tools for application in design, including simulations and planning. In the same year, Architectural Design Studio (Studio 5) stresses the implementation of the learned concepts and techniques into the students' design, especially in site and natural flows consideration, material use and energy, passive strategies and environment control, so they receive complete and balanced formation in this field [18]. Apart from these specialized courses, sustainability is also addressed within more general courses, as for example MEP systems (also in the 4th year).

In general we see the approach of UOS Architecture well integrated and balanced between conceptual and operative training, with the bulk of the sustainability education concentrated in the third and fourth year, with other general courses addressing sustainability issues related to their subject. As a pioneer school, its pattern has been followed by many other Korean schools, with the advantage of introducing complex matter when the students have already enough skills and understanding. This strategy also may turn into a disadvantage, as the students wait long time to receive this education and may create a "design only" mentality, where the sustainability they learn in the latter years becomes just another technical course, instead of an integrant part of their education and practice. Another issue we find is that the Social Sustainability is apparently not as stressed as the other aspects of sustainability.

Table 1. Summary of Schools and Sustainability Related Courses.

University	University of Tokyo	Tsinghua University	Malaya University	CUHK	NUS	UOS
FACULTY/COLLEGE	Fac. of Engineering	School of Architecture	Fac. of Built Environment	Faculty of Social Science	School of Design and Environment	College of Urban Sciences
Program Duration	4 Years	4 or 5 Years	3 Years	4 Years	4 Years	5 Years
YEAR SEMESTER		(Year not specified)				
1_1			Architectural Materials and Construction I; Environmental Physics I;		Climate Responsive Architecture;	
1_2		ARCHITECTURE AND DESIGN THEORY: Principles of Sustainable Design; Traditional Dwellings and Vernacular Architecture;	Architectural Materials and Construction II; Environmental Light; Environmental Acoustics			
2_1			Building Services	Introduction to Building Technology;	Strategies for Sustainable Architecture;	
2_2	Environmental Theory; Building Services; Integrated Studio	SCIENCE AND TECHNOLOGY: Introduction to Architectural technology,; Architectural Acoustics; Building Thermal Environment; Building Luminous Environment;				
3_1	Luminous Environment; Acoustic Environment; Thermal Environment; Water; All courses with theory and application			Building Technology III; Design Studio U4 (Passive and Environmental Studio)	Environmental Systems & Construction	Sustainable Architecture
3_2	Environmental Systems Theory; Environmental Systems Design; Environmental Systems Planning; Environmental Systems Studio.					
4_1		DESIGN STUDIO: Landscape Architecture Studio (5th year)		Land and City; Building Systems Integration	Architecture and Technology Design I; * Integrated Design and Sustainability (*DTS Track only)	Environmental Technology; MEP Systems; Design Studio 5 (Sustainable Design Studio)
4_2					Architecture and Technology Design II	
5_1						
5_2						

4. Conclusions

Table 1 above summarizes all the previous information. After analyzing and discussing all data, it becomes clear that the sustainable education strategies in Asia are very heterogeneous. On one side we find the British oriented schools, Malaya, NUS and CUHK, which follow RIBA accreditation. All have a comprehensive and wide approach to sustainability. In the case of Malaya it is more general and conceptual and implemented in the early half of the program, which we consider desirable as it is positive the students realize from the beginning the necessity to consider sustainability from the start of any design process. NUS follows a similar scheme but with additional more specialized and instrumental courses in the fourth year, unfortunately reserved to those students choosing the sustainability track. CUHK has a different approach, and divides the teaching of sustainability in the latter half of the program, introducing complex subjects when students are more mature, but risking the students' misconception of sustainability being a specialized a posteriori add-on. All three schools integrate the teaching in design studio, with a shared emphasis on low energy and passive strategies adequate to their warm and humid climate. Malaya also takes special care on the social and cultural issues derived from their unique demographics.

Tsinghua and Tokyo share their Engineering technological approach, and maybe the ones that take more pain to embed in all its wideness the instrumental methods of calculations and simulations for sustainable climate control and energy usage. While Tokyo has its professional teaching very concentrated in a period of just four semesters that allows for the students to understand the basics, learn the tools and apply them in a very active and intense process. Their having theory, practice and even systems design studio courses compensates the lack of deep with the understanding and skills only direct practice can provide. Tsinghua has a remarkable care for cultural issues, especially in the modern possibilities of application of the traditional wisdom of their vast and rich cultural and historical tradition. Furthermore, the existence of a real experimental building where students can see reality beyond paper and computer is outstanding.

Finally UOS sits in a middle ground, with a program complete (except for a less explicit emphasis in social sustainability) and concentrated in the late half of the program, sharing the advantages and risks we discussed above. The school treats all main issues the professional architect needs to know, from basic conceptual and theoretical understanding to the application in design studio.

In general we see a first difficult decision in the way the sustainability programs are implemented, basic understanding in the early half, or more specialized courses in the latter one. We think both approaches are compatible, and students would benefit from a continuous exposure to sustainability teaching during the whole program, instead of concentrating it in a short period of time. The second difficult decision is to which extent skills should be provided, when there are Engineering majors specialized in this field. We find also the different approaches we see compatible, providing students with enough conceptual understanding, basic instrumental skills and practice of implementation in design studio. Finally we see also compatible to extend the studies to cultural and social issues, as not only China and Malaysia, but all Asian countries have unique individualities that can coexist with new ways of design.

The findings are inspiring, and encourage further research country by country, adding more cases to the research, and deepening more in detail in the schools already studied.

Conflict of Interest

The authors declare no conflict of interest.

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